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Industry

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Industry

The term industry covers all the businesses and factories that convert raw materials into goods or that provide useful services. Industry produces all the goods and services required by society and distributes them to consumers. The term is also used to describe a group of businesses that produce a similar product or service. All the factories, mills, and other enterprises that produce steel, for example, are known as the steel industry. The tourist industry is comprised of hotels, travel agents, rental car companies, airlines, railroads, and all the other companies in the business of providing services to tourists.

A nation's wealth is based largely on its industry. The more productive the industry, the greater the national wealth. The standard of living in a country can be measured by the number, cost, and quality of goods produced by its industry. The United States is the world's most industrialized and wealthy nation. The high living standards are the result of American industry's productivity. Both the luxuries and necessities of life are mass produced and made available to the American consumer in great numbers. Goods like automobiles and washing machines are considered to be necessities in the United States; yet in many unindustrialized countries they are rare luxury goods that must be imported.

Before the Industrial Revolution the ordinary possessions that make up daily life for most people were in short supply. Clothes were handmade, and they were expected to last for many years. In colonial America iron nails were so scarce that old houses were burned in order to collect and reuse the nails. Goods that required much labor to produce, such **products** as paper and glass for example, were expensive, and only the wealthy could afford them.

The Industrial Revolution replaced many human workers with machines. Inexpensive mass-produced goods replaced expensive handmade goods. As a result, goods became less expensive and were available in greater quantities. As industry became more productive, more and more goods were produced to be sold at lower prices. (See also [Industrial Revolution](#).)

Productivity

Technology is responsible for the continual increase in the productivity of industry. Productivity is a measure of how efficiently things are made. It can be counted in the number of hours it takes a worker to produce a particular item—the fewer man-hours, the more productive. Since 1860 the average productivity of a worker in the United States has increased about ten times. This industrial efficiency is translated into the number of goods and services that are available to the American consumer. The United States has about 5 percent of the world's population and 7 percent of the world's land; American factories, however, turn out about a fifth of the world's manufactured goods.

The great productivity of the American worker has supported high living standards in the 20th century. As things are made more efficiently, in less time, the industrial worker gains more leisure time to enjoy the fruits of labor. Since 1920 the average leisure time of industrial workers has doubled. In

the 19th century a 60- or 70-hour workweek was common. In the 20th century most workers have a 40-hour workweek and also usually get generous vacations, holidays, and other benefits.

Changing Nature of Work

Industrial production has changed the nature of work. One hundred and fifty years ago the majority of Americans lived and worked on farms. Goods were produced in small workshops or in people's homes. The factory system of production brought workers together to operate machines.

The skilled labor of the craftsman was replaced by the monotonous, repetitive work of tending a machine. As the United States industrialized, more people left farms to live in cities and work in factories. The character of industrial production continues to change as workers move from manufacturing to service industries. Many of the great factories of the 19th- and 20th-century United States were abandoned. New methods of production, such as those resulting from automation, changed factory work, which is now less strenuous and more clean. The introduction of new **products**, and new methods of making them, continues to alter the nature of work.

Measuring Performance

The economic health of a nation's industry can be measured by counting the total value of goods and services produced each year. This figure provides an approximation of national income and is called the Gross National Product (GNP). It puts a monetary value on the output of industry and the goods and services from farms, factories, and offices.

There has been a great increase in the United States GNP during the 20th century. In 1900 the GNP was 35 billion dollars. In 1987 it was 4.5 trillion dollars. Comparing these two figures presents a problem because a dollar in 1900 bought a great deal more than a dollar does today. This is because prices have risen since 1900-the result of inflation. Except for the depression years of the 1930s, the GNP showed a slow and steady increase each year. The GNP for each year can be divided by the number of consumers who share the goods and services produced. This measure is called the GNP per capita, or per person. It gives a rough indication of the standard of living.

INDUSTRIAL CLASSIFICATION

Industry in the United States is made up of about 16 million businesses. They range from giant corporations like General Motors, which employs hundreds of thousands of workers, to the small businesses that fill up the Yellow Pages in the telephone directory. Although each business is independent, all members of industry are joined together in a web of business transactions. Small businesses depend on larger corporations to buy their **products** or use their services. General Motors supports many smaller manufacturing and service companies that provide the parts needed to make automobiles. Each sector of the industrial economy provides its part of the total output.

Several methods of classification have been devised to explain industry and its role in producing a national income. The United States government has produced a Standard Industrial Classification that is widely used. It groups industries into broad divisions, each division using similar production techniques and materials or producing the same product.

Agriculture

Farming, forestry, and fishing are among the oldest occupations of humankind. Agriculture is often called the most basic of all industries and the most important. Farming, forestry, and fishing also provide raw materials for other industries.

About half the world's work force is employed in agriculture. Methods of farming and the kinds of crops raised differ from country to country. In some parts of Africa and Australia farming has not

changed much since ancient times. Agriculture in underdeveloped countries is very simple compared to the farming technology of industrial nations. Much of the agriculture of underdeveloped countries is at the level of subsistence—that is, the farmers produce just enough to feed themselves and their families. Farming in advanced economies is more mechanized and much more productive. Farmers raise crops to sell on the market. This is called commercial farming.

The Industrial Revolution was made possible by a dramatic increase in agricultural productivity. The application of new technology and the use of farm machinery enabled farmers to produce more crops with less labor. This freed farm workers to work in factories. Scientific methods of farming have continued to increase agricultural productivity. Farmers use chemical fertilizers, irrigation systems, and machines that do everything from sowing seed to milking cows. The average American farmer in 1850, for example, produced enough food to feed four people. By 1980 productivity had increased so much that the average farmer produced enough food for 78 people. Operating a modern farm demands a high degree of **technological** understanding. It also requires considerable management skill because modern farms require large investments of capital.

Farmers choose the crops they raise by considering the climate, the kind of soil, and the condition of the market for agricultural commodities. Some crops are intended for human consumption. Others provide feed for animals. Farmers produce raw materials for use in manufacturing such as cotton for clothing. Animals are raised for meat, eggs, milk, fur, and leather.

Many crops are raised for export. In the developing countries of Africa, Asia, and South America, much agricultural effort is expended on crops like coffee, tea, and cocoa. The prices these crops bring in the world market are an important part of national income for developing countries. The United States also exports many agricultural commodities, especially grains like wheat and corn (maize). American farmers exported about 20 percent of their crops in the early 1980s. (See also [Agriculture; Farming](#).)

Mining

Many raw materials needed by industry must be brought out of the ground. Mining is another basic industry that has occupied humankind since the earliest times. Mines provide ores to make metals and chemicals, gold and silver for jewelry, and salt for food. Most of the world's sources of energy must be mined: coal, petroleum, natural gas, and radioactive ores for nuclear power.

Unlike the **products** of agriculture, resources from mining are nonrenewable. The farmer can reuse land by planting a new crop from seeds, but the miner must find another mine. Thus, nonrenewable resources must be conserved. The mining industry helps conservation by finding more efficient ways to mine natural resources and less wasteful ways of turning them into raw materials. Much of what is brought out of the ground is disposed of during smelting and refining. The industry also searches for new mines, employing advanced technology to locate minerals underground. Geologists and exploration engineers search for new sources of minerals.

The mining industry is a heavy user of automated machinery. Mining is dangerous work, and machines have replaced many workers underground. The first steam engines and locomotives were used in mines. Modern mines use mechanical cutters to break away minerals, and large conveyors take the ore to the surface. The use of machines has increased the productivity of miners. In the United States coal mining industry, the average worker produced about 950 tons of coal a year in the 1920s. This figure reached 3,700 tons in the 1980s. The American mining industry employs only about 1 percent of the labor force but produced an output of \$94 billion in 1980. Its major **products** were coal and petroleum, followed by iron and copper. (See also [Mine and Mining](#).)

Construction

The construction industry builds offices, factories, and houses. It also constructs roads, bridges, harbors, and other parts of the transportation system. This is called the infrastructure of industry, and it is necessary for industrial development. The infrastructure includes power stations, electricity distribution systems, and communications networks. All the vital arteries of industry are grouped in the infrastructure.

A major priority of developing nations is the building of an infrastructure. The money earned by selling commodities in the world market is often used to build bridges, ports, and factories. The oil-rich Organization of Petroleum Exporting Countries (OPEC) used increased prices for petroleum to finance their construction plans. Their goal was to make it easier to get their **products** to overseas markets and to build up their own industries.

Developing nations also need construction industries to build houses for their rapidly growing populations. Industrialization involves the formation of an urban work force, all of which must be housed. Overcrowded cities are a serious problem for developing countries. Eastern European nations face a major overcrowding problem, for instance, because most of the effort of their construction industry goes into building the infrastructure rather than housing.

The construction industry is sensitive to changes in economic activity. In times of prosperity and expansion, the construction industry booms. When economic development slows, so does construction. The United States government has often attempted to stimulate the economy by spending federal money on construction. The building of roads provides employment and increases demand for raw materials. The government also supports housing projects and the construction of dams and bridges.

The costs of construction have increased dramatically since 1945, and this has increased the construction industry's share of GNP. In 1980 this share was \$119 billion. The industry is a major employer of labor because construction is difficult to mechanize. In 1980 the American construction industry employed about 6 percent of the labor force.

Manufacturing

The major industries in developed nations are engaged in manufacturing—turning raw materials into finished **products**. Manufacturing adds value to materials because it increases their usefulness. The output of manufacturing is often calculated in terms of value added—the difference between what industry pays for the raw materials that go into production and what it charges for the finished goods. Factories can produce either consumer or producer goods. A consumer product is made to be sold to the public, like a radio or an automobile. A producer good is used in the production of another product. The component parts of a radio or an automobile are producer goods, also called intermediate goods because they come at an intermediate stage in production.

The manufacturing section of American industry is made up of about 350,000 establishments that employ a quarter of the work force and pay about \$211 billion in wages and dividends. The leading manufacturing industries, by value added, are nonelectrical machinery, transportation equipment (including automobiles), food **products**, chemicals, and electrical and electronic equipment. This industrial structure reflects the maturity of the American economy. Manufacturing industries are high-technology industries that make complex **products** involving advanced technology. When the United States was a developing country in 1860, the structure of industry was much different. The leading industries were cotton goods, lumber, boots and shoes, flour milling, men's clothing, and then iron and machinery. These are basic industries supplying the needs of food, clothing, and shelter. This pattern of development of manufacturing industries is repeated in many other countries. Industries progress from making basic goods to manufacturing advanced consumer and producer goods.

Industries have a life cycle: They start as fast-growing 'new' industries, reach maturity as the leading industries in the economy, and then decline as 'old' industries. This life cycle is determined by the changing structure of the economy. The clothing, food, tobacco, lumber, automobile, and steel industries have all had their day as the leading manufacturers in the United States. They are now in

decline. America's new industries are computers, semiconductors, aerospace, and communications. These industries are growing rapidly, employing more people, and using more raw materials and intermediate goods. They are strong competitors in the world market. The semiconductor industry promises to be the great industry of the future. It provides the chips that make up computers and other electronic equipment. A semiconductor stores and moves information and is used in a wide range of **products**, including automobiles, typewriters, calculators, cameras, television sets, and home appliances. The world market for semiconductors has expanded from around \$1 billion in 1970 to about \$15 billion in 1980.

Transportation, Communications, and Utilities

Another part of the infrastructure that provides services to manufacturing and agriculture is made up of the transportation, communications, and utilities industries. Goods and raw materials must be moved from factories and farms to markets and to other manufacturing centers. Industry and commerce are dependent on information. The flow of information between businesses and from industry to consumer is the work of the communications industry.

Transportation

was difficult and expensive before the Industrial Revolution. The cost of bringing goods to market was high, and transportation charges were a large part of the final cost of a product. Pepper, for example, was an extremely valuable commodity in the 18th century. The cost of bringing it to Europe from the East Indies accounted for its high price. The Industrial Revolution was accompanied by developments in transportation that drastically reduced the time and costs of transportation. The decline in transportation costs lowered the prices of many commodities, like pepper, and made them available to many more consumers. Canals and railroads were the new methods of transportation during the Industrial Revolution. The automobile and airplane are the new forms in the 20th century, and they are used for pleasure as well as for business.

The transportation industry uses goods and services provided by other industries. About half of the petroleum used in the United States is for transportation. The automobile, aviation, rubber, construction, and petroleum industries are all linked to transportation. Eight of the top ten American companies, for instance, including General Motors, Exxon, and Ford, are connected with transportation.

The transportation industry is involved in international trade. The lower costs of transportation have allowed more countries to enter world markets. Goods made in the Far East can be transported to markets in Europe and North America and still be priced competitively. Containerization, a shipping method in which a large amount of material is packaged together in a single container and can therefore be moved intact from one carrier to another, is a major **technological** innovation that has decreased the cost of transportation.

Communications.

American industry is part of the world economy and must buy and sell in world markets. Businesses need efficient communications to keep in touch with their suppliers and customers. Parts of an American industrial enterprise may be spread over the globe. One of the leading computer manufacturers in the world, for example, is International Business Machines (IBM). It is based in the United States and has about 80 foreign subsidiaries. To remain competitive, IBM's managers need to gather information from all parts of the world. Even the smallest local business depends on accurate and up-to-date information to be delivered to them by mail, telephone, fax, computer, television, newspapers, and magazines.

The communications industry uses the most advanced technology. Messages are sent via satellite, along tiny glass cables, or on laser beams. The increasing use of semiconductors has led to a revolution in modern communications equipment. Computers store and deliver messages and

converse with other computers. Word processors and minicomputers are linked in networks that can move messages and ideas rapidly around an office, making office communications far less dependent on books, papers, telephones, and the postal service.

Utilities.

The utilities industry provides electricity for factories, offices, and homes. It provides power for industry. Every advance of industrial production uses more power. The first factories were built to exploit waterpower. The Industrial Revolution was based on steam power. Electric power dominates modern industry. American industry, for instance, increased its annual consumption of power from 65 million horsepower in 1900 to 30 billion in 1980. Most power comes from the utilities' electrical distribution systems. Electricity is generated by oil-, coal-, or nuclear-power stations and distributed to the consumer. The price of electric power has fallen gradually since 1900 because utilities have become more efficient in producing it.

Services

Many industries provide services instead of physical goods. Transportation and communication industries provide services. Accountants, bankers, barbers, computer operators, physicians, dancers, social workers, teachers, and rock stars all work in service industries. The major parts of this sector of the economy are business services, health care, education, leisure services, and wholesale and retail trade.

Service industries are the last part of an economy to develop, in contrast to agriculture and mining, which are always first. These are the basic industries present in all economies-even in the underdeveloped nations of Africa and Asia. The process of industrialization produces manufacturing, which in turn needs services such as finance and communications. As the manufacturing sector grows, more jobs are created in the service, or tertiary (third), sector. In an advanced nation such as the United States, the service sector is the fastest growing part of the economy. It now provides employment for about 70 percent of the labor force, and employment opportunities in service industries are still growing. All the service industries combined account for nearly half the total value of the GNP-double the share of manufacturing.

Retail trade is an important service industry and one of the first to develop in an expanding economy. Without mass consumption there is no purpose in mass production. Customers must be found for all the goods produced by industry. The retailer and wholesaler move goods from the factory to the consumer and find buyers for industry's output. This process employs the services of the transportation industry, marketing and advertising, and finance for credit. In the United States there are about 17 million retail operations and about 350,000 wholesalers. Wholesalers are the middlemen between producer and retailer.

The American consumer has a wide choice of goods from which to choose. Manufacturers must devise programs to make their goods attractive to buyers or face losing customers. Marketing and advertising are means to obtain and keep customers. Marketing a product begins at the design stage, where consumer tastes and needs are incorporated (see [Industrial Design](#)). The function and price of a product are influenced by marketing considerations. Market research is carried out to discover consumer attitudes toward a product. Once placed on the market, a product is promoted. Advertising expenditures have increased rapidly in American industry. In 1867 about \$50 million was spent on advertising; by 1980 the figure had reached \$50 billion. Advertising is an essential of modern industrial enterprise (see [Advertising](#)).

Industry requires specialized business services produced by accountants, consultants, and bankers. Industry has a constant need for credit, and this is provided by the finance industry (see [Bank and Banking](#)). Most healthy businesses operate in debt; their outgoing payments exceed their income. Money is needed to pay for raw materials, labor, and other costs before income is received from selling the product. Businesses obtain credit to meet these short-term expenses. Much

of the short-term debt of industry is serviced by banks, which lend businesses the deposits of their customers. Industry also needs long-term credit to pay for replacing machinery and to expand production. The costs of research and development are often part of the long-term debt. Industries obtain long-term credit by selling stocks and shares to investors. Special banks called investment banks buy these shares in industry and resell them to investors. Investment banks advise industry on obtaining credit and act as intermediaries between buyers and sellers of stocks and shares.

The market for shares in industry is called a securities exchange (see [Stock Market](#)). The New York Stock Exchange is the main securities exchange in the United States. The concentration of investment banking and securities exchanges is known as the money market. Here industry comes to finance its long-term debt. The world's major money markets are in New York City and London. Not only individual investors are interested in buying shares in industry. Insurance companies and pension funds buy stock and shares. Investment companies buy groups of industrial shares and then sell their own stock to investors.

The purchase of a company's shares gives the buyer a share in the ownership of that concern. If the company makes a profit, a portion of it called a dividend is paid to investors. Long-term finance for industry is provided in the hope that continued investment in capital stock will bring profits and dividends in the future. The finance industry advises investors on investment opportunities. Financial analysts try to pick out the most promising companies and direct investment into them. They also counsel industry on the management of their debt.

Financial services are provided internationally. International trade is financed by special banks that deal in foreign currencies. The finance industry also directs American investment overseas. Many American banks have arranged loans for developing countries that need money to industrialize.

Government

The United States government provides jobs for about 5 percent of the work force and spends about 20 percent of GNP. This gives it great power in the economy. Other national governments own large sectors of industry and control finance. The amount of government participation in the economy differs from country to country. In most countries government has been increasing its involvement in industry.

Government provides goods and services collectively, things that private industry cannot, or does not, produce. These include health care, education, highways, airports, defense, and postal services. Government raises money through taxes and spends it on behalf of its citizens. Many goods and services are provided for no additional charge. Government consists of state, local, and federal bodies. The federal government spends a large portion of its income on defense. State and local government spending is concentrated on health, education, and transportation.

Federal government spending in defense industries increased from the 1930s to the end of the 1980s. The electronics, aerospace, transportation, communications, and machinery industries benefitted from government contracts for defense as did research and development. The connection between government and defense industries was called the military-industrial complex. About one in every eight workers was involved, and it accounted for about 10 percent of GNP. Some other countries, such as the Soviet Union, spent roughly the same proportion of national income on defense, while still others, like Japan, spent considerably less. As a result of the ending of the Cold War in the late 1980s federal spending for defense was decreased, though it remained a significant part of the budget.

STAGES OF GROWTH

The process of industrialization occurs in stages through which every nation passes. The experience is always different because countries have different resources and labor skills. Yet there are broad stages of industrial growth that are alike.

Rostow's Definition

The most common definition of stages of growth was produced by the American economist Walt Rostow. His definition is made up of five stages. The first stage is the traditional economy with only the basic industries of agriculture and mining. Its economy is unproductive and its labor force unskilled. This stage describes underdeveloped economies.

In the second stage an infrastructure is constructed, and finance is directed toward industry. Agriculture becomes more productive with new technology.

The third stage is called the 'take-off' stage. It involves a rapid growth of industries using new techniques of production. Leading sectors of industry, like railroads and steel, lead the industrialization process and stimulate growth of other industries.

When an economy has moved beyond the basic industries of the take-off period and developed new, more advanced industries, it has entered the fourth stage. Industrial technology is applied to all sections of industry, and a service sector is developed.

The fifth, and final, stage marks the emergence of a mass-consumption society. Industry moves from making producer goods to providing consumer goods. The service sector achieves rapid growth. The United States is now in the fifth stage.

Division of Labor

Although industrial enterprises are diverse, they all share features that account for increased productivity. A factory can produce goods more quickly and cheaply than a group of craftsmen working individually. The reasons can be found in some economic principles first outlined in the 18th century. In 1776 a British economist named Adam Smith wrote about production. His book, 'The Wealth of Nations', is the basis of modern economic thought.

Smith imagined a factory in which each worker did one part of a job instead of making a whole product individually. Smith thought that the manufacture of any product could be broken down into steps. Each worker could complete one step-like filing a piece of metal or tightening a screw-and then pass it to the next worker. This concept of the division of labor is responsible for the great productivity of the modern factory.

As workers specialize in one part of production, they become better at it over a period of time. The process of specialization has been applied both to jobs in the factory and to management and services. As industry grows and new technology is applied to production, the number of specializations also increases. This adds to the list of jobs available to workers. In mature industrial economies, the list of jobs is long. In underdeveloped countries it is much shorter: farmer, forester, fisherman, and craftsman.

Economies of Scale

In 1776 Smith thought that a factory of ten workers was possible. In the 20th century a factory employing thousands of workers is not unusual. The increased scale of production is the result of applying new technology. The first factories were built in the 18th century to exploit new textile machines. In the 19th century factories were built to make use of groups of machines, each of which specialized in one part of production. Factory owners found that the more they made of a product the less it cost them to make each unit. This reduction is the result of economies of scale. A large factory can break down production into more stages and make more use of the division of labor. Buying raw materials in bulk lessens their cost. The more a machine is used, the more its cost is spread over the number of goods it produces-decreasing the cost of each product.

An example is the electronic calculator, which was introduced in 1971. It cost about \$240. It was made possible by advances in the technology of semiconductors-electronic chips that act like switches. The selling price of the first calculators reflected the costs of research and development and of buying the machine tools to make their component parts. As more calculators were made, the cost went down. Each stage of production was carried out more efficiently. By 1973 the cost of each calculator was about \$110. Methods of mass production were applied. Calculator component parts were standardized and made in larger quantities. Chips were made smaller and were cheaper to make. So many calculators were made that it was possible to sell one at a price near the cost of making it. Its modern equivalent is much smaller and is priced at about \$10.

MASS PRODUCTION

Mass production is a system of manufacturing used by all kinds of industry. It involves the assembly of standardized parts (all the same) into **products**. The parts are made by machine tools that cut and shape pieces of metal or plastic. These parts are standardized and made to be interchangeable. The product is broken down into parts, and each part is designed to be made and assembled as cheaply as possible. The fewer parts in a product, the lower the cost to make it. A television set is made of many parts: switches, circuit boards, picture tubes, and wiring. The low cost of Japanese television sets is partly the result of careful standardization. A single circuit board replaced several boards and was used in the manufacture of several types of televisions. This part was then mass produced, resulting in lower cost.

The manufacture of standardized parts demands precise measurement, for each part must fit exactly into the final product. Machine tools were operated by skilled workers, but now they are often controlled by computers to make sure that each part is identical.

The speed and low cost of mass production depends on the orderly layout of a factory. Machine tools are arranged to ensure the rapid flow of parts. During the Industrial Revolution power sources were applied to machines to increase their speed and output. As more power was made available by the introduction of electricity, power was applied to moving parts from machine to machine.

This was the basis of the assembly-line form of production pioneered by Henry Ford. The manufacture of his Model T automobile was carried out in an exact sequence of production and assembly. Conveyor belts brought parts from machine tools to the point of assembly and then moved semi-assembled parts along the production line.

Each major section of the Model T Ford-engine, chassis, and body-was put together on its own assembly line and then brought together. The assembly-line form of production resembles a network of rivers and streams all coming together at one point. (See also [Automobile Industry](#); [Ford, Henry](#).)

Makeup of Production

Design

is the first step in the production process. Engineers and draftspeople draw plans for a product and work out the stages of its production. The product is broken down into standardized parts, and its assembly is carefully considered. Labor productivity is based on the production process. Time-and-motion studies are carried out to make sure that workers do not waste time on unnecessary steps.

During the Industrial Revolution the design of **products** followed traditional patterns. The plan of the product and its assembly was drawn on paper. Today the computer creates three-dimensional plans that designers can alter and arrange on the computer screen. This is the CAD part of CAD and

CAM-computer-assisted design and manufacture. CAD is responsible for design, CAM directs machine tools or robots to make the part (see [Industrial Design](#)).

Purchasing.

Once a design has been determined, purchasers buy the needed raw materials. Their job is to locate materials and obtain them at the lowest cost. Cost accountants determine how much it will cost to make the product, and their estimates are used by management to decide how many finished **products** to make and what to charge for each.

The assembly line.

Process engineers set up the machines and tools to be used in manufacture. They make sure that the machine tools are suited to their task and coordinated in the flow of production. The production engineer schedules the stages of production. The movement of parts on the factory floor and the exact time they are needed is calculated. The assembly-line process is based on precise timing, and a constant flow of information about the location of parts is needed to avoid traffic jams. This is now handled by computers, which monitor information and adjust the flow of parts accordingly. This is part of the CAM portion of CAD and CAM.

Inventory control.

The management of inventory is another essential to lower costs. Inventory is the store of raw materials, parts, and finished **products** on hand. Inventory control is concerned with keeping these stores as small as possible so that they do not remain unused, and therefore unprofitable, for long periods of time. Managing inventories requires a flow of up-to-date information about what is in storage and what is needed on the assembly line. This job formerly occupied many workers, but computers now work out the exact number of parts needed and arrange for delivery at just the right time. The highly successful Japanese Kanban, or 'just in time,' system is computer based and has reduced the costs of manufacture considerably.

Quality control

is an essential part of production and is needed at every stage of manufacture. Parts must be correctly made or they will not fit properly. The finished product should be free from defect. Poor quality control leads to slow and expensive production. It also loses customers and sometimes results in expensive recalls.

In British and American factories quality control is the work of skilled inspectors who examine parts and finished **products**. German and Japanese factories involve the workers themselves in quality control. Groups check their own output and make suggestions to improve quality. The Japanese 'quality circles' involve workers and managers. The high standards achieved in this manner bring lower costs and more satisfied customers. Many American companies are now instituting such circles.

Location

Industrial managers constantly search for ways to lower costs of production and to ensure maximum efficiency. The location of the factory plays an important part. The first industrial managers of the 18th century had little choice; they had to establish factories next to rivers in order to use water power. The introduction of steam and electric power allowed managers more flexibility. Factories that use large quantities of raw materials locate near the source, and many locate in cities to take advantage of services that are concentrated in urban areas.

Division of labor can also be applied to factories. Large companies like General Motors divide the work between factories-one might make only doors, another only engines. Many American companies

have overseas operations. These companies are called multinationals. They often locate parts of manufacturing in foreign countries to take advantage of lower labor costs. A manufacturer of consumer electronics **products** might make some parts in the United States and other components in Taiwan or South Korea. Such less developed countries pay workers less because they have a lower standard of living. In the case of consumer electronics, the wage rates might be as little as one fifth of American wages.

Industry is no longer confined to industrial regions like the Black Country in the North of England, the German Ruhr, or the northeastern United States. Multinational companies operate internationally. Most color television sets sold in the United States are designed in Japan; manufactured in South Korea, Taiwan, or Hong Kong; and marketed by American retailers. The 'designer' jeans sold in America may be designed in the United States, made in Asia, and shipped back to be sold in American stores.

BASIC ELEMENTS

Industry in an economic sense utilizes raw materials, labor, and capital to make goods. The factory is the place where these inputs are brought together to produce output. Two other inputs influence the production of output: technology and management. These are not direct inputs but act on other inputs to make them more productive. Inputs are also called factors of production.

Raw Materials

The price and availability of raw materials determine much of the cost of production. Price is determined by the world market. Manufacturers try to ensure a low-cost source of raw materials by buying mines, farms, or forests. Producers of raw materials naturally want the highest possible price for their resources. Underdeveloped countries are the main sellers of raw materials. They sometimes group together to raise the price of their **products**. The Organization of Petroleum Exporting Countries (OPEC), for example, successfully increased the price of petroleum in the 1970s.

Labor

The work men and women do to produce goods and services is the labor input. The supply of labor, and its level of skills, plays a major part in a nation's industrial performance. Workers must be trained. Their skills improve over time; this is called 'learning by doing.' Much of the increase in productivity in the 20th century is the result of workers improving their skills. Underdeveloped nations face the difficult task of educating their unskilled work force. Even simple tasks, like getting to work on time, may require instruction.

A distinction is made between jobs that require much labor input, called labor intensive, and those that use more machinery, or capital, than labor. The manufacture of clothing and watches is labor intensive. The production of steel and computers is capital intensive. The development of industrial technology has tended to be capital intensive. Machines have replaced labor. The work of skilled labor has been replaced by machines designed to be used by unskilled labor. The industrial technology of the future promises to be highly capital intensive and to displace both skilled and unskilled workers. The increasing use of computers, robotics, and automation will cause drastic reductions in the labor needed. Although these new technologies will generate new jobs and create new industries, it is unlikely that all the jobs lost through automation will be replaced.

Automation was first used in industry to do difficult and dangerous jobs like paint spraying and welding. The advance of technology has greatly improved the workplace and the nature of industrial work. Although work is less demanding than the 12-hour day of early factories, it can also be boring and monotonous. Mass production methods are efficient but cannot impart the job satisfaction of older craft skills. Some European manufacturers have experimented with changes. Workers complete groups of tasks and have the satisfaction of seeing a finished product.

The relations between workers and management are crucial to industrial production. Bad labor relations result in many work stoppages, poor quality control, and low productivity. In the United Kingdom there is often antagonism between labor and management. Strikes are common, and overall productivity is low. Workers resist management decisions that they believe will hurt their interests.

Management in other countries has tried to involve workers in decision making. Japan and Germany, for example, have programs to ensure worker participation in policy making. Germany has a co-determination law that gives workers that right. The goal is for the labor force to identify its interests with those of the company. This encourages productivity. Workers and managers both benefit from a profitable company. (See also [Labor Movements](#).)

Capital

Capital goods, such as machines and tools, are used in the production of other goods. Companies acquire capital to begin or expand production or to become more productive. The term capital stock denotes all that is needed to produce goods. Labor skills are referred to as human capital.

The first factories of the Industrial Revolution cost only a few hundred dollars to build and equip. **Technological** advance has increased the size and cost of industrial production. Companies must now invest many millions of dollars to build or modernize a factory. Entering an industry like automobiles or steel is so costly that only a very large company can afford to do so. The machine tools of the 19th century were designed to last a lifetime. Technology now progresses so rapidly that machine tools can become obsolete quickly. To stay competitive a company must continually replace its capital stock. Industrialization involves great expenditure of capital, as much as 10 percent of GNP. The leading industrial nations must spend more than this in order to compete for shares in world markets. From 1961 to 1976 Japan's investment in capital stock was about 33 percent of GNP. West Germany invested 24 percent, the United Kingdom 18 percent, and the United States 17 percent.

Technology

Much of the money spent on capital goes for new technology, which is embodied in the machines and tools bought by industry. The term covers all knowledge that can be applied to production. Technology does not have to be incorporated into a machine. It can be in the form of an idea—a new way of making things. Technology is a powerful force in increasing productivity. It can also help to bypass raw material shortages in the discovery of new materials or new processes. The increased price of petroleum led to new methods of making synthetic oil and the development of new sources of power such as solar energy.

Companies have research and development (R and D) programs to generate new technology that can be useful to them. R and D replaces the great inventors of the 19th century like Thomas Edison who invented new **products**. Technology is often too complex to be developed by one person alone. In the 20th century teams of engineers and scientists work in industrial laboratories to improve old **products** and to find new ones. The highly complex technology of computers and aerospace involves cooperation between industry, government, and the educational establishment. Much of the R and D expenditure in the United States is paid for by the government in its military contracts. Some of this research has led to spin-offs used by civilian industry. Many technologies developed for the space program have been transferred to such everyday **products** as the coating on frying pans.

R and D makes up the first step in producing industrial technology. Inventions also have to be commercially successful. New ideas and new **products** must be applied to industry. This is the work of the applications engineer, who tailors new technology to the needs of manufacturers. A new product needs to be marketed before it is accepted by consumers. The technology of the portable personal tape recorder was available well before its introduction. Marketing the technology in the form of the tiny machine and suggesting uses for it led to its commercial success.

Although the lone inventor has been replaced by large R and D organizations in modern industry, there are still opportunities for individuals to invent and introduce new **products**. Many small, high-technology companies have been formed to market new ideas. The video game industry, for example, was begun in this way. In 1971 an engineer formed a company with \$500 to make video games. By 1973 it had become Atari and had sales of more than \$3 million. It was purchased for \$28 million by Warner Brothers and in 1982 contributed about two thirds of Warner's total profits-from television, movies, records, and books. In 1983, however, Atari profits turned to losses.

Much of the new technology of industrial production, like automation and robots, is introduced by small companies built around one invention. Only a small number survive. Competition is intense-the number of video-game manufacturers, for instance, has increased rapidly. Many high-technology companies fail because the engineers who run them do not have adequate management skills.

Management

Management is concerned with combining all the other inputs of production. Managers decide what to make and how to make it. They choose from the available inputs and work out the right mix. Management must organize production to meet the goals of the company, which normally include keeping manufacturing costs low and producing a profit.

The first industrial managers were men like Richard Arkwright and Thomas Edison, both inventors and businessmen. They owned their companies and made all the management decisions. As the scale of production increased in the 19th century, ownership of companies was divided among shareholders. Management gradually became separated from ownership, and a class of professional managers emerged.

The division of labor has been successfully applied to management. In the modern factory, managers specialize in one function: production, finance, marketing, personnel, or public affairs. Management is a skilled occupation, and the amount of education needed to become a professional manager is increasing. Managers are schooled in all aspects of production and business before specializing in one field. Many of today's managers are college graduates who also have advanced degrees in business.

The emphasis on well-trained managers reflects the belief that good management is essential to industrial success. Companies can go bankrupt very quickly if they are poorly managed. Each nation and company develops a style, and the management techniques of leading industrial nations and of individual companies are admired and copied. Japanese forms are currently imitated in many industrial nations. Yet as economic fortunes rise and fall, the popularity of management styles changes.

VARIOUS ECONOMIC SYSTEMS

Industry operates within various economic systems, and each country's is different. Managers decide on the goals of companies, but national economic goals are set by politicians. Economic systems influence the organization and output of industry, and governments play an influential part in the planning and decision making.

Free Enterprise

The United States, Japan, Germany, and Canada have a free-enterprise, or capitalist, economic system combined with high levels of government regulation. Capitalism is also known as the market system because many economic decisions are made in the marketplace. The system is based on an individual's right to own a business or to work where he or she wishes. The interaction of buyers and sellers fixes the price of raw materials, labor, and finished goods. Competition between businesses determines profits and losses. The true free-enterprise system, however, does not exist because governments in every country play a part in the economy. Governments use tax money to buy goods and services for defense and education. The United States government, for example, is the largest

single purchaser in the American economy. Governments also regulate hiring policies, product quality, international trade, and other matters.

In Japan the Ministry of International Trade and Industry (MITI) determines which industries have the potential for growth. It channels capital investment in chosen industries and directs research and development. The government works with management and labor to plan strategies of growth. They have chosen high-technology industries and promoted them.

Mixed Economies

Some countries try to combine the free-enterprise system with a modified socialism. Many European governments, for example, own major industries. These countries have what are called mixed economies or socialist economies, depending on the amount of government ownership. The United Kingdom, Germany, France, and Italy have mixed economies. The British government, until the 1980s, owned the railroads; steel, communications, and utilities industries; and large shares of the automobile and aviation industries. (Many of these were privatized after 1980.) Government-controlled industries do not make a profit: their operating revenues come partly from taxes, and they are not run on a cost-benefit basis. Even where a large private sector exists, as in Germany, it is heavily regulated and taxed.

The French government controls the communications, transportation, and utilities industries. It tries to guide industries to take part in an overall plan but does not force them. In the early 1980s the socialist government of Francois Mitterrand increased government ownership of industry and took over the banking system. Much of this control was relinquished when this system proved a failure.

Planned Economies

Communist governments came to power in the 20th century, beginning with the Russian Revolution of 1917. Following World War II the Eastern European countries, China, Cuba, North Korea, and other places also adopted Marxist socialism-the completely planned economy. In such a system, all economic activity was directed by the government, and all means of production were owned by the state. The state decided what would be produced, hired workers, set wages and prices, and determined all production quotas and allocation of resources. Because prices did not reflect supply and demand, it was quite difficult to set priorities according to the actual costs of resources, land, machinery, and workers.

The major economic goal of the Communist countries was to develop heavy industry. This was especially true in the Soviet Union. The government directed industrial effort into producer goods and military hardware at the expense of consumer goods, which remained in perpetual short supply. Fortunately, illegal or 'black markets' quickly appeared to augment shortages caused by faulty state planning; these markets were unofficially encouraged by the state. In a planned economy a black market is the only genuine market, because its prices accurately reflect supply and demand.

Agriculture proved the most intractable problem for Marxist economies, especially in the Soviet Union. Private farming was officially abolished, and farmers were put to work on collectives or state farms. Shortages were chronic. The farm program of the Soviet Union was saved from collapse by allowing farmers to grow **products** on their small private plots for their own profit. In China, when agriculture was freed from state control, the country quickly became self-sufficient in food production. Industry also began to flourish in south China, when controls were lifted.

State ownership and collective responsibility tended to destroy individual initiative, all the while making the state responsible for everything from housing to medical care. Since rewards for productivity were not forthcoming in better wages, housing, food, or other goods, the workers did not see the system as benefiting them. The sudden collapse of Communist governments in 1989-91 was a vivid demonstration of the inherent weakness of planned economies. (See also [Communism](#); [Socialism](#).)

