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СОДЕРЖАНИЕ

1 UNITED KINGDOM

UNITED KINGDOM is a country in northwestern Europe. It consists of four political divisions-England, Scotland, and Wales, which make up the island of Great Britain, and Northern Ireland, which occupies the northeastern part of the island of Ireland. The nation's official name is the United Kingdom of Great Britain and Northern Ireland. When people refer to the country, most shorten its name to (1) the United Kingdom, (2) the U.K., (3) Great Britain, or (4) Britain. London is the capital and largest city.

More than 70 countries are larger in size than the United Kingdom, and the country has only about 1 percent of the world's people. But the United Kingdom has a rich history. The British started the Industrial Revolution, a period of rapid industrialization that began in the 1700's. They founded the largest empire in history. They have produced some of the world's greatest scientists, explorers, artists, and political leaders.

Cut off from the rest of Europe by the sea and secure from invasion, the British developed their own character and way of life. They came to respect privacy and to value old traditions. They developed a dry wit, a love for personal freedom, and a high degree of self-criticism. The British have shown themselves at their best-brave and united-in times of crisis. Their courage against German bombs and overwhelming odds during World War II (1939-1945) won the admiration of the world.

The history of Britain is the story of how a small country became the world's most powerful nation--and then declined. In the 1700's, the Industrial Revolution made Britain the world's richest manufacturing country. The British ruled the seas and were the world's greatest traders. By 1900, they had an empire that covered about a fourth of the world's land and included about a fourth of its people. The British spread their way of life throughout their empire.

2 UNITED KINGDOM / PEOPLE

Population. The United Kingdom is more thickly populated than most countries. It has an average of 612 people per square mile (236 per square kilometer).

The United Kingdom has a population of about 58 million. About nine-tenths of the people live in cities and towns. About 35 percent of the urban residents live in England's seven metropolitan areas. Greater London, the largest metropolitan area, has about 6 1/2 million people, which is about 10 percent of Britain's total population. The six other metropolitan areas are as follows, with the largest city of each area shown in parentheses: Greater Manchester (Manchester), Merseyside (Liverpool), South Yorkshire (Sheffield), Tyne and Wear (Newcastle upon Tyne), West Midlands (Birmingham), and West Yorkshire (Leeds).

Ancestry. Celtic-speaking people lived in what is now Britain by the mid-600's B.C. Over the next 1,700 years, the land was invaded by the Romans, Angles, Saxons, Jutes, Danes, and Normans. Most of the British are descendants of these early peoples.

Since the 1950's, many immigrants have come to Britain from countries that belong to the Commonwealth. The Commonwealth is an association of countries and other political units that were once part of the British Empire. Many immigrants have come from Commonwealth countries in Asia and the West Indies. Most of the newcomers have settled in cities and towns already facing housing shortages. In the early 1960's, the British government began restricting immigration.

Language. English is the official language of the United Kingdom and is spoken throughout most of the country. English developed chiefly from the language of the Anglo-Saxon and Norman invaders.

Less than a fifth of the people of Wales speak both English and Welsh, a language that developed from one of the languages of the Celts. A few people of Wales speak only Welsh. Thousands of people in Scotland speak the Scottish form of Gaelic, which is another Celtic language. The Irish form of Gaelic is spoken by a small number of people in Northern Ireland.

3 UNITED KINGDOM / WAY OF LIFE

City Life. About 90 percent of the population of the United Kingdom lives in urban areas. A number of important cities grew rapidly in the 1700's and early 1800's, during the Industrial Revolution. But today, many of those cities-including London, Birmingham, Liverpool, Manchester, and Leeds--are in decline. They are faced with such problems as falling employment, rising crime, and poor housing. They are losing population as people move from the inner cities into the suburbs and beyond. Greater London's population, for example, peaked at about 8 1/2 million in 1939 and has been falling ever since. In 1991, it totaled about 6 1/2 million.

Rural Life. About 10 percent of the population of the United Kingdom lives in rural areas. At one time, the rural areas were devoted mainly to farming. But the availability of convenient transportation enables people to work in a city and live in the countryside. In many rural communities, full-time farmers are outnumbered by retired people, commuters, and workers who serve the needs of tourists.

The attractiveness and variety of rural Britain is one of the tourist industry's prime assets. These qualities also attract many retired people. In some rural areas, more than a fifth of the population is over retirement age. These areas include the counties of Cornwall, Devon, Dorset, East and West Sussex, and the Isle of Wight; the Scottish Borders; and parts of rural Wales.

Recreation. The British love the outdoors. They flock to Blackpool, Brighton, and other seaside resorts on vacation. Several million vacationers visit Spain, France, and other countries. Other vacationers prefer mountain climbing or walking in Wales or in the beautiful Lake District of northwestern England. Still others enjoy

automobile or bicycle trips through the country. The British also spend much time in their gardens. About half of Britain's families have a garden.

4 MUSEUMS AND LIBRARIES

Museums and Libraries. The United Kingdom has about 2,500 museums and art galleries. The largest collections are owned by about 20 national museums and art galleries, most of which are in London. The world-famous British Museum, in London, is noted for its outstanding collections in archaeology and many other fields. The National Gallery and the Tate Gallery, also in London, have some of the world's greatest paintings.

Britain's public library system serves people throughout the country. The nation's largest library, the British Library, has about 18 million volumes. The national libraries of Scotland and Wales have about 5 million volumes each. Other important libraries include Oxford's Bodleian Library and the Cambridge University Library.

The Arts. The government encourages and supports the arts in the United Kingdom chiefly through agencies called arts councils. There is an arts council for England, Scotland, and Wales and another one for Northern Ireland. Each council receives a government grant and, in turn, makes grants to help pay for musical, theatrical, and other artistic activities. Many local areas have their own arts councils to coordinate and finance local artistic activities.

The United Kingdom is one of the world's major centers for theater. Visitors come from all parts of the world to see British theater productions. About 50 theaters operate in the central London district known as the West End. The Royal National Theatre performs at its three stages on London's South Bank. The Royal Shakespeare Company is based at Stratford-upon-Avon and also performs at the Barbican Centre in London. The English Stage Company at the Royal Court Theatre in London performs the works of talented new playwrights. Notable regional theaters include the Bristol Old Vic, the Festival Theatre in Chichester, the Lyric Theatre in Belfast, and the Royal Lyceum in Edinburgh.

The United Kingdom has 11 principal professional symphony orchestras and several smaller orchestras. Five of the principal orchestras have their headquarters in London. The best-known orchestras outside London include the Halle Orchestra of Manchester and the City of Birmingham Symphony Orchestra.

The most famous British arts festival is the Edinburgh International Festival, which was founded in 1947. It is held every August. Its program includes operas, concerts, ballets, and plays. The Cheltenham Festival, held in July, specializes in music by contemporary British composers. A summer drama festival takes place in Chichester. Glyndebourne, near Brighton, has an annual summer opera festival of international fame.

5 ECONOMY

1. The United Kingdom is an important manufacturing and trading nation. In fact, Britain can survive only by manufacturing and trading. The country's farms produce only about two-thirds of the food needed by the people. Except for coal, natural gas, and oil, Britain has few natural resources. The country must import about a third of its food and many of the raw materials it needs for manufacturing.

Service Industries account for about two-thirds of the United Kingdom's gross domestic product (GDP). The GDP is the total value of goods and services produced within the country annually. More than 70 percent of British workers are employed in service industries. The country's service industries are concentrated in and near its largest cities, especially London.

Finance, insurance, and real estate is the most important service industry in Britain. This industry accounts for a larger portion of the United Kingdom's GDP than any other industry. Most of the country's financial companies operate in London, one of the world's leading financial cities. Major financial institutions in London include the Bank of England, the United Kingdom's national bank; the London Stock Exchange; and Lloyd's of London insurance society.

Community, social, and personal services rank second among the service industries in the United Kingdom. This industry employs more British workers than any other service industry. It includes such activities as education and health care, and advertising and data processing.

Wholesale and retail trade is the third most important service industry in Britain. The most valuable wholesale trading activities include the distribution of petroleum and textiles. Aberdeen and London are important centers of petroleum refining and distribution. Leeds is the chief center of the British clothing industry. Retail trade is centered in London, which has thousands of small shops and attracts millions of tourists yearly.

Tourism is another of Britain's important service industries. It is a growing source of income and employment. Other large service industries in the United Kingdom include government, transportation and communication, and utilities.

2. Manufacturing. The United Kingdom is a leading industrial nation. Most British industries are in central England, the London area, the Scottish Central Lowlands, the Newcastle upon Tyne area, and southern Wales. Early factories were located near the coal fields because coal powered the steam engines that moved the machinery. Today, the use of electricity, oil, and gas has enabled many new industries to develop far from the coal fields, especially in southern England.

Britain ranks as an important steel producer. It exports nearly half of its finished steel. The rest is used in Britain to make hundreds of products. Much steel is used in automobiles, buses, trucks, and motorcycles.

Britain also produces heavy machinery for industry, farming, and mining. The country is one of the world's largest producers of tractors. Other products include cranes, earth movers, road graders, harvesters, and drilling machines. British factories

also make railway equipment, household appliances, and machine tools. The city of Sheffield is famous for its high-quality knives and hand tools.

British Aerospace makes a wide range of jet aircraft. It is the largest aerospace company in Europe. Rolls-Royce is world famous for airplane engines as well as luxury automobiles. Space satellites and weapons defense systems are also produced in Britain. Aerospace equipment and heavy machinery are major British exports.

An increasing percentage of Britain's manufactured goods consists of sophisticated electronic equipment. Much of this equipment is exported. Factories produce such items as cable television equipment, data processing equipment, fiber-optic communications systems, radar devices, and undersea telephone cables.

The chemical industry in Britain produces a variety of products from industrial chemicals to plastics and soap. Britain is the fourth largest exporter of pharmaceuticals. The country's pottery industry is centered in Stoke-on-Trent. Outstanding names in British pottery include Worcester, Spode, and Wedgwood.

The United Kingdom is one of the world's chief centers of printing and publishing. British companies print paper money and postage stamps for many countries. Books published in Britain are exported to countries throughout the world.

The Industrial Revolution began in Britain's textile industry. Today, Britain remains an important producer of cotton and woolen textiles. British manufacturers also make synthetic fibers and fabrics. England's east Midlands region is a center for the production of lace and knitwear. Cotton and wool are produced in northern England. Scotland produces knitwear and is famous for its fine woolen products. Northern Ireland has a worldwide reputation for its linen goods.

Britain has one of Europe's largest clothing industries. The biggest centers are Leicester, Leeds, London, and Manchester. British clothing has long been famous for its quality. But today, Britain imports more clothing than it exports because many countries with lower labor costs can produce clothing more cheaply than the British can.

Processing of foods and beverages ranks as one of Britain's major industries. Most processed foods and beverages are consumed in Britain. But some are exported. Scotch whisky has a large world market. Other British industries manufacture bricks and cement, furniture, leather goods, glassware, and paper.

3. Agriculture. Britain imports about a third of its food supply. The imports include avocados, bananas, oranges, peppers, pineapples, and other items that cannot be easily grown in Britain's climate.

The United Kingdom has about 240,000 farms. They average about 175 acres (71 hectares) in size. About two-thirds of Britain's farmers own the farms on which they live. The rest rent their farms. About half the people who operate or work on farms do so on a part-time basis.

Many British farmers practice mixed farming that is, they raise a variety of crops and animals. Methods of mixed farming vary from farm to farm. In the rough highlands of Scotland, Wales, and western England, grass grows much better than farm crops. There, farmers use most of their land for grazing. The land in southern

and eastern England is drier and flatter, and it is more easily worked. Farmers in eastern England use most of their land for raising crops.

Britain's most important crops are barley, potatoes, rapeseed, sugar beets, and wheat. Farmers in southern and eastern England grow almost all the country's rapeseed, sugar beets, and wheat and most of its barley. Potatoes are grown throughout the United Kingdom. Farmers in southern England grow most of Britain's fruits and garden vegetables. One of the most productive regions is the county of Kent in southeastern England. It is called the Garden of England and is famous for the beautiful blossoms of its apple and cherry orchards in springtime. Farmers in Kent also grow hops, which are used in making beer.

Sheep are Britain's chief livestock. Farmers in almost every part of the country raise sheep for meat and wool. British farmers also raise beef cattle, dairy cattle, and hogs. Chickens are raised mainly in special mass-production plants.

4. Mining. The United Kingdom is a major world producer of petroleum, coal, and natural gas. These three fuels account for about 85 percent of the value of total mineral production in the country.

Petroleum is Britain's most valuable mineral. British oil wells produce about 650 million barrels of petroleum a year. In the past, the country had to import petroleum to meet its needs. But during the 1970's, Britain began producing petroleum from wells in the North Sea. Today, Britain's oil wells provide nearly all the petroleum that the country uses and also supply petroleum for export.

Britain's largest coal-mining region lies near the River Trent in central England. Coal from this area is an important source of fuel for the country's electric power plants.

Britain obtains natural gas from deposits below the North Sea. These deposits provide enough gas to meet most of the country's needs.

Britain's next most important minerals, in order of value, are sand and gravel, limestone, and clays. The Southwest Peninsula has fine china clay, used in making pottery. Southeastern England has large deposits of chalk, used for cement. Other British minerals include sandstone and gypsum.

5. Fishing. The United Kingdom is an important fishing nation. The British fishing industry supplies about 685,000 short tons (621,000 metric tons) of fish yearly. About half this catch comes from the waters surrounding Britain, especially the North Sea. British fishing crews also fish as far away as the Grand Banks of Newfoundland. The principal catches include cod, haddock, herring, mackerel, plaice, pollock, sand lance, sole, and whiting. Large catches of shellfish are also brought in. The United Kingdom's main fishing ports are on the east coast and in the southwestern part of the island of Great Britain.

6. International Trade. The United Kingdom ranks as a leading trading nation. Britain once imported chiefly raw materials and exported mostly manufactured products. However, manufactured goods now account for about three-fourths of British imports and also about three-fourths of its exports. Britain exports aerospace

equipment, chemicals and pharmaceuticals, machinery, motor vehicles, petroleum, and scientific and medical equipment. Its imports include chemicals, clothing, foods (especially fish, fruit, vegetables, meat, coffee, and tea), machinery, metals, motor vehicles, paper and newsprint, petroleum products, and textiles.

Most of the United Kingdom's trade is with other developed countries. France, Germany, and the United States are Britain's leading customers and suppliers. A growing proportion of the country's trade is with members of the European Community, which the United Kingdom joined in 1973. Other trade partners include Canada, Ireland, Japan, Norway, Saudi Arabia, Sweden, and Switzerland.

The value of Britain's imports of goods usually exceeds the value of its exports. British banks and insurance companies make up part of the difference by selling their services to people and firms in other lands. Another important source of income is the spending by the more than 15 million tourists who visit the United Kingdom each year. The British merchant fleet also brings in money by carrying cargoes for other countries. The income from all these invisible exports exceeds $200 billion a year.

7. Transportation. Roads and railways carry most passenger and freight traffic within the United Kingdom. An excellent system of high-speed motorways links major cities and towns. Bus systems provide local and intercity transportation. Lorries (trucks) carry about 80 percent of the inland freight.

An extensive rail network crisscrosses the United Kingdom. The railroads are owned by the government and provide excellent high-speed passenger service, as well as freight hauling.

Britain has a large merchant fleet. The ships in the fleet carry British-made goods to ports throughout the world and bring back needed imports. British ships also carry freight for other countries. There are about 80 ports of commercial significance throughout the United Kingdom.

The country's inland waterways are used to carry freight, as well as for recreational boating. The Thames, which flows through London, is Britain's busiest river and one of the busiest in the world.

Ferry services connect coastal and island communities. Hovercraft (vehicles that ride over water on a cushion of air) carry passengers mainly across the English Channel between England and France. In 1987, work began on a railway tunnel to link Britain and France beneath the channel. The tunnel was scheduled for completion in 1994.

British Airways, the United Kingdom's largest airline, operates flights to all parts of the world. Smaller airlines provide service within Britain and to other countries. Britain's largest airports are Heathrow and Gatwick, both near London, and those at Birmingham, Glasgow, and Manchester.

8. Communication. Britain has about 100 daily newspapers. About 15 have nationwide circulation. Their main offices are in London. The Sun and the Daily

Mirror have the largest circulations. Other leading papers include The Times, The Guardian, The Daily Telegraph, and The Independent.

The British Broadcasting Corporation (BBC), a public corporation, provides commercial-free radio and television service. The BBC is financed chiefly by yearly licenses that people must buy to own a television set. Television stations controlled by the Independent Television Commission and radio stations controlled by the Radio Authority broadcast commercials, but advertisers do not sponsor programs.

The British Post Office provides many services in addition to handling mail. For example, local post offices sell TV licenses, dog licenses, and national insurance stamps. People can draw pensions and family allowances and also bank their savings at the post offices.

6 EDUCATION. HISTORY

1. When and where universities first began is a matter of considerable debate. In ancient Greece, such famous teachers as Socrates and Aristotle gave instruction in philosophy and science, but their teaching was not within a university setting. In those days, students did not have to pass entrance examinations or attend regularly scheduled classes, nor did they receive academic degrees. Likewise, in early India, Hindu scholars taught religious lore, but their tutorial approach could not be considered university instruction in the present-day sense.

Although early forms of advanced education exerted some minor influence over the nature of present-day education, the direct ancestors of modern universities were institutions that arose in Europe in the Middle Ages. The earliest universities were not founded as complete institutions. They grew gradually as collections of individual schools, and the conditions and dates of their beginnings remain unclear. The most prominent of the early centres were the University of Bologna in Italy, which came into existence about 1100, and the University of Paris, which developed in the late 11OO's. Each evolved as a merging of separate colleges.

The original subjects taught were the seven liberal arts Latin grammar, rhetoric (speaking and writing well in Latin), dialectic (reasoning skills), arithmetic (using Roman numbers), geometry, astronomy, and music. Such programmes were expanded when the work of Muslims in the Middle East, North Africa, and Spain brought long-lost Greek and Roman scholarship to the attention of European academicians. The efficient Arabic number system was substituted for Roman numerals, a clumsy system that had made computation slow and difficult. Among the Islamic institutions that contributed to this intellectual renaissance was AI-Azhar University in Cairo, Egypt, founded more than 1,000 years ago and still operating today.

The University of Paris was the model on which Oxford and Cambridge universities, in England, were fashioned. At both Oxford and Cambridge, students at first lived wherever they pleased. But, gradually, they collected in lodging houses that

developed into the colleges that still serve as students' living quarters and study centres.

The six earliest colleges founded at Oxford were University (founded 1249), Balliol (1263), Merton (1264), Exeter (1314), Oriel (1326), and Queen's (1340). For centuries, Oxford accepted only male students. However, after 1878 five women's societies were founded; most of them attained the status of colleges in 1926. Now colleges are generally coeducational, with both men and women students.

The evolution of colleges at Cambridge was similar to the Oxford pattern. The six earliest Cambridge colleges were Peterhouse (1284), Clare (1326), Pembroke (1347), Gonville and Caius (1348), Trinity (1350), and Corpus Christi (1352).

Throughout the following decades, a variety of Europe's most distinguished universities were established, including Vienna (1365) in Austria; Heidelberg (1386), Cologne (1388), and Leipzig (1409) in Germany; St. Andrews (1410) in Scotland; and Copenhagen (1479) in Denmark.

When the United States was still a British colony, institutions of higher learning were founded, each modeled on Oxford and Cambridge. The first was Harvard, which was founded in 1636 in the Massachusetts colony, where more than 100 graduates of Oxford and Cambridge had already settled. The second was William and Mary. It was founded in 1693 in the Virginia colony by authority of a charter from Britain's King William III and Queen Mary II. The third was Yale. Inaugurated as a collegiate school in 1701 in the Connecticut colony, Yale was then reorganized as a university a century later when schools of medicine, divinity, law, and fine arts were added.

Other colonial universities patterned after their European predecessors include McGill (1821), Toronto (1827), and Ottawa (1848) in Canada; Sydney (1850) in Australia; Calcutta, Bombay, and Madras (all 1857) in India; Otago (1869) in New Zealand; and Cape of Good Hope (1873) in South Africa. In the Philippines, two universities have a long history: Santo Tomas (1611) and San Carlos (founded 1595, university status 1948). The Technological University of Malaysia was founded in 1925 (university status 1972). The National University of Singapore, established in 1980, has its origins in the King Edward VII College of Medicine (1905).

Today, there are hundreds of universities throughout the world. Most have been created by expanding existing academies and colleges to serve the rapidly growing numbers of students seeking higher education. In formerly colonized areas of Asia and Africa, nations that attained independence after World War II ended in 1945 have established many universities to serve populations that previously lacked opportunities for advanced education.

2. Degree, College. A university or college awards a degree to a person who has completed a required course of study. The institution presents the degree in the form of a diploma, a document certifying the award. The four basic kinds of degrees are called associate, bachelor, master, and doctor. An honorary degree may be awarded for an outstanding contribution in a field.

The associate degree is awarded by many U.S. colleges and universities and most community, or junior, colleges (see Community college). An associate degree usually indicates completion of two years of college work. The most commonly awarded associate degrees are the Associate in Arts and the Associate in Science.

The bachelor's degree. In the United States, a college student normally receives a bachelor's degree after four years of study in a university or college. Most students specialize in a field of study called a major subject. Many institutions require other types of study outside a major to ensure a liberal education. There are many kinds of bachelor's degrees, but the two most common are the Bachelor of Arts (B.A.) and the Bachelor of Science (B.S.). The B.A. usually includes majors in such subjects as history, literature, and fine arts, and, in certain cases, science and mathematics. The B.S. usually includes majors in the physical and natural sciences. Most engineering students receive B.S. degrees. Many colleges offer specialized degrees, such as the Bachelor of Education or Bachelor of Architecture. Law students obtain the Doctor of Jurisprudence (J.D.) after more training. Outstanding achievement in a bachelor's degree may be designated by the Latin phrases cum laude (with praise), magna cum laude (with great praise), or summa cum laude (with the highest praise).

British colleges and universities offer two types of bachelors degrees, an ordinary, or pass, degree and an honors degree which requires more extensive and more advanced work. Canadian colleges and universities usually follow British or French tradition in their systems of degrees. See Canada (Education).

The master's degree. In the United States, students who desire a master's degree must complete one or two years of advanced study beyond the bachelor's degree. Many institutions require a thesis, a written report of a special investigation in the student's major field. The two most common master's degrees are the Master of Arts and the Master of Science.

In Great Britain, the master's degree is usually considered the highest requirement for an academic career, but a number of British universities also offer the doctorate. In Scotland, a student proceeds directly to the master's degree without taking a bachelors degree.

The doctor's degree is the highest earned degree in the United States, France, Germany, and many other countries. There are two distinct types of doctor's degrees. One is a professional degree required to practice in certain professions, such as medicine. The other is a research degree that indicates the candidate has acquired mastery of a broad field of knowledge and the technique of scholarly research.

In the United States, the research doctorate requires at least two or three additional years of study beyond the master's degree. Most doctoral students are expected to have a reading knowledge in two foreign languages. The candidate must also complete examinations and present a written thesis or dissertation. The doctoral thesis represents an original contribution to knowledge, and is a more detailed study of a research problem than that required for the master's degree.

The Doctor of Philosophy degree is the most important research doctorate and may include specialization in almost any academic subject. The Doctor of Education,

Doctor of Medicine, and Doctor of Dental Surgery degrees represent advanced professional training. Students in such professions as medicine and dentistry can obtain a doctor's degree without first receiving a bachelors or master's degree. But most acquire a bachelor of science degree before entering medical training.

Honorary degrees. Many award honorary degrees to people for achievement in their chosen fields. Chief among these are the Doctor of Letters and the Doctor of Laws. These are given to prominent authors, scholars, and leaders in the professions, business, government, and industry.

History. College degrees date from the 1 ZOO'S when schools in Europe won the right to examine and license their graduates. The system of degrees, which took form by the 1 SOD'S, was modeled on the guild system. A student spent a sort of apprenticeship as a candidate for a bachelor's degree. Receiving the bachelor's degree resembled becoming a journeyman in a craft. The master's degree represented the status of a master craftsman, and served as a license to teach. The student's thesis was his "masterpiece," just as a journeyman submitted an example of his work to become a master craftsman. If the student continued to study and teach in law, medicine, or theology, he might earn the title of doctor. The medieval system remained largely unchanged until the impact of science on education in the 1700(5 and 1800's. During the last hundred years, college degrees in the United States have been extended to include many new fields of knowledge.

7 POST-SCHOOL EDUCATION

All 16- and 17-year-olds are guaranteed a place in full-time education or training and all suitably qualified people are encouraged to go into higher education. Almost 65 per cent of young people (67.7 per cent in Northern Ireland) receive some form of post-school education, compared with 20 per cent in 1965. Around 30 per cent of all young people in Britain go into full-time higher education.

Higher Education

Higher education covers all post-school courses above GCE A level standard. These courses are available at:

universities;

colleges;

institutions of higher education (some wholly concerned with teacher training); and institutions of further education.

In 1992-93 there were a record 1.4 million students in higher education, 66 per cent more than in 1982-83. The Government wants to see greater participation in the field of technology and engineering. One of its chief aims is to see an increase in the proportion of students on sub-degree courses, including two-year full-time vocational diplomas.

8 HIGHER EDUCATION INSTITUTIONS

These institutions comprise universities, teacher training colleges and other colleges of technology, art and medicine. Britain has 89 universities, including the Open University, and 70 other HE institutions.

Universities and most other higher education institutions enjoy complete academic freedom, appointing their own staff and deciding which students to admit, what and how to teach, and, where they are empowered, which degrees to award. Oxford and Cambridge Universities date from the 12th and 13th centuries, and the Scottish universities of St Andrews, Glasgow, Aberdeen and Edinburgh from the 15th and 16th centuries. All the other universities were founded in the 19th and 20th centuries; the 1960s saw the opening of several new universities.

Of the 1.4 million full-time and part-time students in higher education in the UK in 1992-93, 213,000 were postgraduates. In 1991-92 there were about 32,000 full-time lecturers in the traditional universities and 86,000 in other further and higher education establishments.

Most courses last between two and four years. Sandwich courses, which include a period of work experience outside the institution, can extend the length of the course by up to a year, and medical and veterinary courses require five years. Although most students take degree courses, in 1992-93 nearly 361,000 students throughout Britain, 60 per cent of whom were part-time, were on sub-degree courses such as Higher National Diploma (HND) or Diploma in Higher Education (Dip HE), many of which allow a student to progress from one level to another.

In addition, many students attend continuing education courses which have close links with business. Professional qualifications validated by the relevant professional bodies can be gained from many institutions.

While the majority of people entering higher education institutions are school leavers, an increasing number are mature students who often qualify on the basis of approved 'access' courses. Access courses provide a foundation of study and an appropriate test for prospective students holding non-standard entry qualifications. The growth of access courses has been very rapid in recent years and there are now around 770 recognized access courses throughout Britain.

The Open University is Britain's main distance-learning institution for adults. Its courses are also available in other European countries. No formal academic qualifications are required to enroll on undergraduate courses, but the standards of its degrees and other qualifications are as high as other universities. In 1993 about 96,000 people registered on the university's degree courses and by the year 2000 it expects to have around 200,000 students on its rolls. Nearly 8,000 students were registered on postgraduate courses in 1993. The University also has a programme for professionals in education and the health and social services, and for updating managers, scientists and technologists, and a comprehensive series of study packs. A new centre for Modern Languages has been established, with the first courses available from 1995.

9 HIGHER EDUCATION IN THE USA

Higher Education continues a person's education beyond high school. More than 60 per cent of all high school graduates in the United States receive some type of advanced schooling. The United States has about 3,000 institutions of higher learning. More than half of them are privately owned and operated, and most of these are small liberal arts colleges. Many of the publicly owned institutions of higher learning are large state universities that enroll thousands of students. About four-fifths of all the college and university students in the United States attend public institutions.

Institutions of higher learning include a wide variety of community and junior colleges, technical institutes, colleges, universities, and separate professional schools. Community and junior colleges offer two-year programs in both general and career education. Most technical institutes offer two-year programs in such fields as automotive engineering, business, and electronics. After completing a two-year course at a community college, junior college, or technical institute, a student receives an associate's degree-or a certificate in the case of certain types of specialized training.

Colleges and universities provide a wide selection of liberal arts and career programs. Most offer a four- or five-year liberal arts program leading to a Bachelor of Arts or Bachelor of Science degree. Many colleges and most universities offer advanced courses leading to a master's or doctor's degree. Most universities also have professional schools, which provide training and award degrees in such fields as business, dentistry, education, engineering, law, and medicine. Students ordinarily must complete a certain amount of college work before gaining admission. Some professional schools are not connected with a university. They offer advanced courses in business, law, and other fields. Many award the same kinds of degrees as do professional schools of universities.

10 TEXTILE. HISTORY

Prehistoric and Ancient Times. No one knows when people first made textiles. The earliest evidence of woolen textiles dates from about 6000 B.C. This evidence comes from what is now southern Turkey. Bits of linen from Egypt indicate that people there wove flax about 5000 B.C. Archaeologists have found Egyptian mummies from the 2500's B.C. wrapped in linen as well made as that produced today.

By 3000 B.C., cotton was grown in the Indus River Valley in what are now Pakistan and western India. Cotton may also have been used for textiles in the Americas by this time. The Chinese began to cultivate silkworms about 2700 B.C. They developed special looms for silk filaments.

The ancient Greeks used chiefly woolen textiles. They also used some linen. In the 300's B.C., Alexander the Great's army brought cotton goods from what is now

Pakistan to Europe. The ancient Romans developed an enormous trade in textiles. They imported woolens from Britain, Gaul, and Spain; linen from Egypt; cottons from India; and silks from China and Persia.

During the Middle Ages, from the A.D. 400's to the early 1500's, the textile industry gradually developed in Europe. The production of woolens centered in England; northern Italy; and Flanders, a region that now covers parts of present-day Belgium, France, and the Netherlands.

As the textile industry expanded, production techniques improved, stimulating further growth. The spinning wheel came into use by the 1200's. Meanwhile, Italy had become the silk center of Europe. The invention of a machine to unwind silk from cocoons led to further expansion of Italy's silk industry.

In the large towns of Europe, associations of weavers and other craftworkers regulated textile production. These associations, called guilds, established prices and standards of quality for all products made by their members. But the cottage industry, also called the domestic system, produced most textiles during the Middle Ages. Under this system, merchants delivered raw materials to workers in their homes in rural areas. Later, the merchants collected the work and paid the workers for it by the piece.

The Industrial Revolution. Important developments in textile production continued after the Middle Ages. For example, an English clergyman named William Lee invented a machine for knitting hosiery in 1589. During the 1600's, textile workers in the Netherlands developed improved methods of dyeing and finishing cloth. But the greatest advances in the textile industry occurred during the Industrial Revolution, which began in England in the 1700's. In fact, the Industrial Revolution was largely a "textile revolution" created by a flood of English inventions that enormously increased the production of yarns and fabrics.

In 1733, John Kay, an engineer, invented the flying shuttle. This device enabled weavers to pass the filling through the warp yarns mechanically instead of by hand. About 1764, a weaver named James Hargreaves invented the spinning jenny, the first machine that could spin more than one yarn at a time. In 1769, Richard Arkwright, a former barber, patented the water frame, a spinning machine that ran on water power.

A weaver named Samuel Crompton introduced the spinning mule in 1779. This machine combined the features of the spinning jenny and the water frame and gradually replaced them both. Edmund Cartwright, an Anglican clergyman, patented the first power loom in 1785.

In the United States, the New England region became the center of the textile industry. In 1790, an English textile worker named Samuel Slater built the first successful water-powered machines for spinning cotton in the United States. The machines were installed in a mill in Pawtucket, R.I.

The production of cotton textiles in New England grew rapidly after the American inventor Eli Whitney developed his cotton gin in 1793. Before Whitney's invention, workers had to remove cotton fibers from the seed by hand. This slow

process could not meet the textile mills' demand for cotton. Whitney's gin separated the fibers far faster than workers could by hand. As a result, textile mills received ever-increasing supplies of cotton. During the 1920's and 1930's, most of these mills moved to the Southern States, nearer to the supply of cotton.

The Age of Modern Textiles began in 1884, when Hilaire Chardonnet, a French chemist, developed the first practical manufactured fiber. This fiber, now known as rayon, was first produced in the United States in 1910 under the name artificial silk. Wallace H. Carothers, an American chemist, developed the synthetic fiber nylon in the mid-1930's. During the 1940's and 1950's, polyester, acrylic, and other manufactured fibers were introduced.

In the 1960's, textile companies began making double-knit fabrics of textured polyester yarns. These fabrics were lighter in weight and more comfortable than double knits made of other materials. As a result, the popularity of knits greatly increased

Today, new manufacturing processes and devices have made the textile industry one of the most modern of all industries. For example, knitting machines controlled by computers now produce fabrics with highly complex patterns at tremendous speeds. Many textile firms also use high-speed looms that have many tiny shuttles called darts instead of a single shuttle. Other looms weave with no shuttles at all. A jet of water or air carries the filling through the warp up to 1,000 times a minute, about four times faster than a shuttle works on a standard loom.

11 TEXTILE

1. TEXTILE has traditionally meant a woven fabric. The term comes from the Latin word texere, meaning to weave. Many fabrics are still made by weaving yarn on a loom. But today, all other types of fabrics are also considered textiles. They include knitted goods, felts, laces, nets, and braids. The textile industry also refers to the fibers and yarns used to make fabrics as textiles.

Textile mills produce an incredible variety of fabrics. They turn out huge rolls of soft cotton, warm wool, strong nylon, and other fabrics. The mills produce these textiles in every color imaginable and in countless patterns. The largest share of all textile production goes to garment manufacturers to be made into ready-to-wear clothing. The second-largest share is used to make such household products as draperies, blankets, sheets, and towels. In the United States, the textile industry manufactures about 25 billion square yards (21 billion square meters) of fabric a year. About 70 per cent of this output is used in making clothing and household goods.

Textiles are also used in thousands of other products. These products include basketball nets, boat sails, bookbindings, conveyor belts, fire hoses, flags, insulation materials, mailbags, parachutes, typewriter ribbons, and umbrellas. Automobile manufacturers use fabrics in the carpeting, upholstery, tires, and brake linings of cars. Hospitals use such textile products as adhesive tape, bandages, and surgical thread.

Surgeons replace diseased heart arteries with arteries knitted or woven from textile fibers.

Most textiles are produced by twisting fibers into yarns and then knitting or weaving the yarns into a fabric. This method of making cloth has been used for thousands of years. But throughout most of that time, workers did the twisting, knitting, or weaving largely by hand. With today's modern machinery, textile mills can manufacture as much fabric in a few seconds as it once took workers weeks to produce by hand.

Fibers are the raw materials for all fabrics. Some fibers occur in nature as fine strands that can be twisted into yarns. These natural fibers come from plants, animals, and minerals. Most natural fibers used for textile production measure 1/2 to 8 inches (1.3 to 20 centimeters) or longer. Such short fibers are called staple fibers.

For most of history, people had only natural fibers to use in making cloth. But modern science has learned how to produce fibers by chemical and technical means. Today, these manufactured fibers account for more than two-thirds of the fibers processed by U.S. textile mills. Unlike most natural fibers, manufactured fibers are produced in long, continuous lengths called filaments. Many manufactured fibers also have certain qualities superior to those of natural fibers. For example, they may be stronger or more elastic.

Natural Fibers. Plants provide more textile fibers than do animals or minerals. In fact, one plant, cotton, accounts for about 95 per cent of the natural fibers used in the United States. Cotton fibers produce soft, absorbent fabrics that are widely used for clothing, sheets, and towels. Fibers of the flax plant are made into linen. The strength and beauty of linen have made it a popular fabric for fine tablecloths, napkins, and handkerchiefs. Fibers of the jute plant can be woven into burlap. Burlap is a coarse, heavy cloth used for sacks and as backing for rugs and carpets.

The main animal fiber used for textiles is wool. Another animal fiber, silk, produces one of the most luxurious fabrics. Sheep supply most of the wool, but members of the camel family and some goats also furnish wool. Wool provides warm, comfortable fabrics for dresses, suits, and sweaters. Silk comes from cocoons spun by silkworms. Workers unwind the cocoons to obtain long, natural filaments. Fabrics made from silk fibers have great luster and softness and can be dyed brilliant colors. Silk is especially popular for scarfs and neckties.

The only natural mineral fiber used for textiles is asbestos, which comes from rocks. It will not burn, but it melts at very high temperatures. Manufacturers use it in making brake linings and other products.

Manufactured Fibers. Most manufactured fibers are made from wood pulp, cotton linters, or petrochemicals. Wood pulp comes from trees and the waste products of the lumber industry. Linters are the short fibers remaining on the cottonseeds after the longer fibers have been removed by the cotton gin. Petrochemicals are chemicals made from crude oil and natural gas.

The fibers made from wood pulp and linters are rayon and acetate. These fibers are called cellulosics because they are made from the cellulose in wood pulp

and cotton. Rayon and acetate are widely used for clothing, draperies, and upholstery. The properties of rayon resemble those of cotton. Rayon produces absorbent fabrics that dye easily. Fabrics of acetate are silkier than rayon. Acetate resists shrinking and stretching.

The chief fibers manufactured from petrochemicals include nylon, polyester, acrylic, and olefin. Nylon has exceptional strength, wears well, and is easy to launder. It is popular for hosiery and other clothing and for carpeting and upholstery. Such products as conveyor belts and fire hoses are also made of nylon. Polyester resists wrinkling and is widely used in permanent press clothing. Acrylic fibers produce soft, bulky, lightweight fabrics for blankets, carpeting, and children's snowsuits. Olefin cleans easily, dries quickly, and resists mildew. It is widely used for indoor-outdoor carpeting.

Other manufactured fibers include those made from glass and metals. Fabrics of glass fibers are used for insulation and to make boat hulls, molded products, and flame-resistant fabrics. Metallic fibers are made chiefly by bonding aluminum, gold, and silver foils to plastics. These fibers provide decorative yarns for bedspreads, evening gowns, and tablecloths.

11.1 KINDS OF FABRICS

About 90 per cent of all fabrics produced in the United States are made by weaving or knitting. The rest are made by other processes. In producing fabrics by the various processes, textile mills may use yarns finer than sewing thread or as heavy as rug yarn.

Woven Fabrics are made of two sets of yarns a lengthwise set called the warp and a crosswise set called the filling or weft. The warp yarns are threaded into a loom through a series of frames called harnesses. During the cloth-making process, the harnesses raise some warp yarns and lower others. This action creates a space, or shed, between the yarns. A device called a shuttle carries the filling through the shed and so forms the crosswise yarns of the fabric. The pattern in which the harnesses are raised and lowered for each pass of the shuttle determines the kind of weave. There are three basic patterns: (1) the plain weave, (2) the twill weave, and (3) the satin weave.

The Plain Weave is the simplest and most common pattern. In this weave, the crosswise filling passes over one warp yarn and under the next alternately across the width of the fabric. The weave produces long-lasting, flat-textured cloth used in making such products as bedsheets, dresses, and upholstery. Plain-woven fabrics include gingham, percale, and taffeta.

The Twill Weave has a pattern of raised diagonal lines. The filling crosses over and then under two, three, or four warp yarns at a time, with each row following the same pattern. However, each row's pattern begins slightly to the right or left of the pattern in the previous row. This technique creates the diagonal lines. The twill

weave produces strong, tightly woven cloth used in coats, sportswear, and work clothes. Popular twill fabrics include denim and gabardine.

The Satin Weave is the least common pattern. The filling may span as many as 12 warp yarns. The weave produces soft, luxurious cloth, but it may snag easily. Satin-weave fabrics are made into such products as draperies and formal clothes. Common satin weaves include damask and satin.

Knitted Fabrics are made from a single yarn or a set of yarns. In making cloth, a knitting machine forms loops in the yarn and links them to one another by means of needles. The finished fabric consists of crosswise rows of loops, called courses, and lengthwise rows of loops, called wales. This looped structure makes knitted fabrics more elastic than woven cloth. Garment manufacturers use knitted fabrics in producing comfortable, lightweight clothing that resists wrinkling. Textile mills manufacture knit goods by two basic methods: (1) weft knitting and (2) warp knitting.

Weft Knitting is done with single lengths of yarn, which a knitting machine forms into the crosswise courses one row at a time. The loops of each course are pulled through the loops of the previous course. This process forms the wales at the same time as the courses. Weft knits can be made in the shape of a tube or as flat pieces of cloth.

Most weft-knitted fabrics are used in making hosiery, sweaters, and underwear. These fabrics are knitted in three basic constructions, known as jersey fabric, rib fabric, and purl fabric. All of them are based on a simple loop.

In jersey fabric, which is sometimes called plain knit or single knit, the long part of the loop forms a V shape over the face of the fabric. The curved, or bottom, part of the loop forms the reverse side. In rib fabrics, the V part of the loop makes up long, vertical raised wales that alternate with wales consisting only of the curved part of the loop. A kind of rib fabric commonly called double knit is made with smaller, tighter stitches. Double knits are used for sportswear. Lightweight cotton double knits are usually sold as interlock knits. A purl fabric consists of rows in which the V shape alternates with the curved part of the loop.

Warp Knitting requires hundreds of yarns fed as a sheet to a knitting machine. A separate needle for each yarn forms the wales of the fabric. At the same time, the needles interloop the wales crosswise and so form the yarns into a fabric. Almost all warp knits are produced in flat pieces.

Warp-knitted fabrics may be tightly constructed and thus may not stretch as much as weft knits. In warp knits, the loops stand out on the face of the cloth, and the connecting yarns stand out on the back. Common warp-knitted fabrics include tricot and raschel. Tricot knits are lightweight fabrics that are widely used in making bedsheets, blouses, dresses, and women's underwear. Raschel knits are heavier fabrics and are used for a variety of products, including blankets, carpeting, men's suits, and swimwear.

Other Fabrics include tufted fabrics, nets and laces, braids, and felt. None of these fabrics is woven or knitted. However, the textile industry produces another class of fabrics specifically called nonwoven fabrics.

Tufted Fabrics are used in about 95 per cent of the carpeting produced in the United States. Such fabrics consist of cut or uncut loops of yarn that have been punched through a backing material.

Nets and Laces, which are called open-mesh fabrics, have wide spaces between the yarns. These fabrics can be produced on certain kinds of knitting machines. Netting is used for curtains, fishing nets, hammocks, and tennis nets. Laces have delicate designs and are popular as trim for clothing.

Braids consist of three or more interlaced yarns. Braided fabrics are used for such narrow items as ribbons and shoelaces.

Felt is chiefly produced from fibers of wool, fur, or animal hair. The fibers are matted together by moist heat and pressure. Felt is used in making billiard table covers, hats, and padding.

Nonwoven Fabrics include needle-punched fabrics and fabrics produced by a process called bonding. Needle-punched fabrics, or needle felts, consist of fibers that have been tangled together by means of hooked needles. Such fabrics look like felt and are used in making blankets, indoor-outdoor carpeting, and insulation. Fabrics produced by bonding are made by joining fibers with adhesives. Many of these fabrics are made into items that are used only once, such as disposable diapers and surgical gowns.

11.2 HOW FABRICS ARE PRODUCED

Designing a Fabric. Most fabric designers work for companies that manufacture fibers, fabrics, or clothing. Designers create new patterns and color combinations and decide what fibers and methods of construction to use in various fabrics. They must know enough about textile production to realize whether their ideas can be converted into actual products. Fabrics must also be designed so that they can be produced economically on standard textile machinery, such as looms, knitting machines, and tufting machines. In addition, a design has to appeal to a great many consumers for the fabric to be profitable.

Making the Yarn. Yarn can be manufactured in various ways. Fiber companies may take filaments that is, long, continuous fibers and draw 15 to 100 of them together to make multifilament yarn. Or they may use a single filament to make monofilament yarn. Some filament yarns, including those made from nylon and polyester, can be heat-set to form stretch yarns. In one method of heat-setting, manufacturers tightly twist the yarn and heat it. After the yarn is untwisted, it tends to snap back like a spring. Such yarn is used in double-knit and stretch-woven fabrics. Other treatments can be applied to filament yarns to give them a bulky texture.

Filaments may also be cut into staple, or short, lengths that measure 1 to 3 inches (2.5 to 7.6 centimeters) long. Staple fibers cut from filaments produce yarn that is softer than filament yarn and not as lustrous. Yarn producers can also mix together natural fibers and manufactured fibers of staple length to form blended yarns. These yarns have the characteristics of each of the fibers used in their construction. For example, yarn produced from cotton and polyester is absorbent because it contains cotton and wrinkle resistant because it contains polyester.

Yarn made from natural fibers or manufactured fibers of staple length is called staple yarn or spun yarn. All staple yarns are manufactured in much the same way, whether they are blended or consist of only one kind of fiber. The fibers arrive at the mill in bales, which workers feed into a series of opening machines. These machines break up the large masses of fibers, remove some of the trash, and mix the fibers together. A carding machine then removes smaller impurities and some of the exceptionally short fibers and arranges the remaining fibers into a loose rope called a sliver. Next, as many as eight slivers at a time are drawn together into another sliver. This sliver is then formed into a thin strand called a roving. The roving is twisted on a spinning frame to form yarn. Some spinning frames produce yarn directly from slivers. Different kinds of fibers may be blended when the bales are opened, when the slivers are drawn together, or when the roving is spun.

After the yarn has been manufactured, it is wound onto large spools. Sometimes, two or more strands of yarn are twisted together for added strength. Each strand of such heavier yarn is referred to as a ply. Three-ply yarn, for example, consists of three strands of yarn. After the yarn has been spooled, it is ready to be woven or knitted.

Making the Fabric begins when workers place the spools of yarn on a rack called a creel. The creel feeds the yarns onto a beam (roller) that is placed on a loom or a knitting machine. For a discussion of how looms and knitting machines make cloth, see the previous section, Kinds of fabrics.

Manufacturers produce woven and knitted fabrics in various lengths, depending on the orders of their customers. Woven fabrics made for clothing manufacturers are usually produced in widths of 36 to 60 inches (91 to 152 centimeters). Most woven narrow goods, which are used for such products as gauze bandages and labels, measure 1/2 to 3 inches (1.3 to 7.6 centimeters) wide.

In general, a knitting mill specializes in one of four kinds of products-fabric; hosiery; underwear; or such outerwear as dresses, shirts, slacks, and sweaters. Most fabric in widths of 80 to 168 inches (200 to 427 centimeters) is sold to clothing manufacturers. Fabrics made in the shape of tubes are used for the bodies of sport shirts and of T-shirts. Such cloth can also be cut and sewed together like flat-knitted fabrics to make garments.

Finishing the Fabric. Fabrics that come directly from a loom or knitting machine are called gray goods. This term does not refer to the color of the cloth. It merely means that the fabric has not received any finishing treatments and so is unsuitable for most purposes. Gray goods are also called greige (pronounced gray).

Almost all gray goods are washed to remove dirt, grease, and other unwanted substances. Many fabrics are also bleached to whiten them or to prepare them for dyeing or printing. Cotton fabrics may be treated with caustic soda before dyeing. This process, called mercerizing, swells the cotton fibers and thus increases the strength and luster of the cloth.

Some gray goods are made from dyed yarn. Such cloth may have brilliant colors and highly detailed designs. But most textiles are dyed a single color after the yarn has been made into cloth. Dyeing machines pull the fabric through a dyebath or force the dye into the cloth by means of pressure.

Designs are printed on fabrics by three chief methods. Roller printing uses rollers that have designs deeply engraved on their surface. Dye is applied to the rollers and then wiped off the surface. The dye that remains in the engraved design is then transferred onto the cloth by the rollers. Screen printing is similar to using a stencil to form a design. Dye is pressed onto the cloth through a pattern on a screen. Rotary screen printing uses porous rollers that fit inside cylindrical screens. The rollers hold the dye and force it into the cloth through patterns on the screens. In another process, called heat transfer printing the design is printed on paper with special ink and then ironed onto the fabric. When the paper is peeled off, it leaves the design on the cloth. Some fabrics are dyed and then printed.

After the cloth has been dyed or printed, it may be dried and stretched on a machine called a tenter frame. Fabrics made from heat-set fibers may also be treated by this device to help the cloth resist shrinking and wrinkling. A patented process called Sanforizing preshrinks cloth to prevent it from shrinking or stretching more than 1 per cent in home laundering. Other finishing treatments help fabrics resist bacteria, fading, flames, mildew, moths, stains, static, and water.

The final step in manufacturing cloth is ironing it between heavy rollers, a process called calendering. The fabrics are then rolled onto bolts for shipment to clothing makers and other customers.

11.3 THE TEXTILE INDUSTRY

In the United States, the textile industry consists of about 4,800 companies that operate more than 6,000 plants. Many of these companies perform every step in the manufacturing process, from making the yarn to finishing the fabric. But some manufacturers specialize in only one operation. For example, a textile mill may produce cloth with yarn it buys from one company and then sell the fabric to another firm for finishing.

The textile industry employs about 700,000 people. Specialized workers include cloth inspectors, designers, dyeing supervisors, and loom technicians. Two labor unions the Amalgamated Clothing and Textile Workers Union (ACTWU) and the International Ladies' Garment Workers' Union (ILGWU) represent nearly a fourth of the workers in the textile industry and in such related industries as fiber production and clothing manufacturing.

The U.S. government requires the textile industry to observe certain federal laws designed to protect consumers and give them information about the textiles they buy. The Wool Products Labeling Act of 1939 provides that all garments made of wool have a label telling the amount and kind of wool used. The Textile Fiber Products Identification Act of 1958 covers all other fibers. It requires that all clothing and most home furnishings have a label showing the fiber content by percentage. The Flammable Fabrics Act of 1953 prohibits the sale of fabrics that burn rapidly.

In Canada, about 1,000 textile mills produce goods each year worth about $5 billion in U.S. dollars. Canada's textile industry employs about 60,000 workers. Another 110,000 people work for clothing manufacturers. About a fourth of all the workers belong to local unions of the ACTWU and the ILGWU.

Canada's Textile Labeling Act requires a label on all clothing to show the fiber content by percentage. The Department of Consumer and Corporate Affairs enforces the law. Labeling garments with instructions for their care is voluntary in Canada.

In Other Countries. Almost every country has a textile industry. In Japan and the countries of Western Europe, textile production is highly industrialized and centered on manufactured fibers. For example, England, Italy, and Switzerland are leading exporters of textile machinery and manufactured fibers. Textile production is also highly mechanized in most Eastern European countries. But natural fibers have greater importance in these countries than in most Western nations.

In some developing nations, such as India and Pakistan, millions of workers still weave fabrics of cotton, silk, and other natural fibers in their homes. As the economies of developing countries advance, however, textile manufacturing often becomes one of the first industries to be mechanized. Textile production provides many jobs that can be filled by unskilled and semiskilled workers. It also supplies a nation's people with clothing, one of the basic human needs.

12 ENGINEERING

ENGINEERING is the profession that puts scientific knowledge to practical use. The word engineering comes from the Latin word ingeniare, which means to design or to create. Engineers use principles of science to design structures, machines, and products of all kinds. They look for better ways to use existing resources and often develop new materials. Engineers have had a direct role in the creation of most of modern technology the tools, materials, techniques, and power sources that make our lives easier.

The field of engineering includes a wide variety of activities. For example, engineering projects range from the construction of huge dams to the design of tiny electronic circuits. Engineers may help produce guided missiles, industrial robots, or artificial limbs for the physically handicapped. They develop complex scientific equipment to explore the reaches of outer space and the depths of the oceans. Engineers also plan our electric power and water supply systems, and do research to

improve automobiles, television sets, and other consumer products. They may work to reduce environmental pollution, increase the world's food supply, and make transportation faster and safer.

In ancient times, there was no formal engineering education. The earliest engineers built structures and developed tools by trial and error. Today, special college training prepares engineers to work in a certain branch or field of engineering and standards of quality and performance guide them on the job.

13 BRANCHES OF ENGINEERING

1. Most of the specialized fields of engineering developed since about 1750. Before that time, engineering dealt mostly with the construction of buildings, roads, bridges, canals, or weapons. As people gained more knowledge of science and technology during the 1700's and 1800's, engineers began to specialize in certain kinds of work.

Today, new fields of engineering are continually emerging as a result of scientific and technological breakthroughs. At the same time, the boundaries between the various fields are becoming less and less clear-cut. Numerous areas of engineering overlap, and engineers from different specialties often work closely together on projects. The following section discusses the major branches of engineering, as well as some of the smaller specialized fields.

2. Civil Engineering, the oldest of the main branches of engineering, involves the planning and supervision of such large construction projects as bridges, canals, dams, tunnels, and water supply systems. Civil engineers also cooperate with architects to design and erect all types of buildings. Other civil-engineering projects include airports, highways, levees, irrigation and sewerage systems, pipelines, and railroads.

Civil engineers work to build strong, safe structures that meet building codes and other regulations and are well suited to their surroundings. They are responsible for surveying and preparing building sites and for selecting appropriate materials. Civil engineers must also understand the use of bulldozers, cranes, power shovels, and other construction equipment.

3. Environmental Engineering concerns efforts to prevent and control air, water, soil, and noise pollution. Environmental engineers develop equipment to measure pollution levels and conduct experiments to determine the effects of various kinds of pollutants. They design air pollution control devices and operate water purification systems and water treatment plants. They also develop techniques to protect the land from erosion and from pollution by chemical fertilizers and pesticides.

Environmental engineers are specialists in the disposal of hazardous wastes from factories, mining operations, nuclear power plants, and other sources. They

work to clean up unsafe dump sites created in the past and do research on new storage and recycling techniques. Environmental engineers are also involved in the development of cleaner and more reliable forms of energy and in developing ways to make the best present and future use of natural resources. Environmental engineers work with agricultural and mining engineers to develop production techniques that do the least possible damage to the land. They assist civil engineers in the design of water supply, waste disposal, and ventilation systems and chemical and nuclear engineers in waste disposal.

4. Industrial Engineering applies engineering analysis and techniques to the production of goods and services. Industrial engineers determine the most economical and effective ways for an organization to use people, machines, and materials. An industrial engineer may select the location for a plant or office, determine employee requirements, select equipment and machinery, lay out work areas, and plan steps in operations. Industrial engineers also develop training and job evaluation programs and work-performance standards, and help determine wages and employee benefits. They work to solve such problems as high costs, low productivity, and poor product quality.

Materials Engineering deals with the structure, properties, production, and uses of various materials. Materials engineers work with both metallic and nonmetallic substances. They try to improve existing materials and develop new uses for them, as well as to develop new materials to meet specific needs. Mining and metallurgical engineering are major subdivisions of materials engineering. Mining engineers work closely with geologists to locate and appraise deposits of minerals. They decide how to remove the ore from the ground as cheaply and efficiently as possible. Mining engineers have to know about civil, mechanical, and electrical engineering in order to plan shafts and tunnels, ventilate mines, and select mining machinery.

Metallurgical engineering deals with separating metals from their ores and preparing them for use. In extractive metallurgy, engineers remove metals from their ores and refine them to a pure state. Engineers in physical metallurgy develop methods for converting refined metals into useful finished products. Other materials engineers specialize in the production and uses of such synthetic materials as ceramics and plastics. Materials engineers help develop new materials for the aerospace, biomedical, construction, electronic, and nuclear fields. They cooperate with chemical, industrial, and mechanical engineers in working out the complex processes that convert raw materials into finished products.

5. Mechanical Engineering involves the production, transmission, and use of mechanical power. Mechanical engineers design, operate, and test all kinds of machines. They develop and build engines that produce power from steam, gasoline, nuclear fuels, and other sources of energy. They also develop and build a wide variety of machines that use power, including air-conditioning, heating, and ventilation equipment; automobiles; machine tools; and industrial-processing equipment. Mechanical engineers are involved in every phase in the development of

a machine, from the construction of an experimental model to the installation of the finished machine and the training of the workers who will use it.

Mechanical engineers work in many industries, such as power generation, public utilities, transportation, and all types of manufacturing. Many mechanical engineers concentrate on research and development because new types of machinery are continually in demand. Mechanical engineers are involved in almost every other branch of engineering, whenever a new or improved machine, device, or piece of equipment is required.

6. Other Specialized Fields focus on even more specific areas of engineering than do the major branches. This section describes a few important specialties.

Textile Engineering is concerned with the machinery and processes used to produce both natural and synthetic fibers and fabrics. Engineers in this field also work to develop new and improved textiles.

14 HISTORY OF ENGINEERING

1. The history of engineering is the record of human ingenuity through the ages. Even in prehistoric times, people adapted basic engineering techniques from things that were available in nature. For example, sturdy sticks became levers to lift large rocks, and logs were used as rollers to move heavy loads. The development of agriculture and the growth of civilization brought about a new wave of engineering efforts. People invented farming tools, designed elaborate irrigation networks, and built the first cities. The construction of the gigantic Egyptian pyramids at Giza during the 2500's B.C. was one of the greatest engineering feats of ancient times. In ancient Rome, engineers built large aqueducts and bridges and vast systems of roads. During the 200's B.C., the Chinese erected major sections of the monumental Great Wall of China.

2. Early engineers used such simple machines as the inclined plane, wedge, and wheel and axle. During the Middle Ages, a period in European history that lasted from the A.D. 400's to the 1500's, inventors developed machines to harness water, wind, and animal power. The growing interest in new types of machines and new sources of power to drive them helped bring about the Industrial Revolution of the 1700's and 1800's. The role of engineers expanded rapidly during the Industrial Revolution. The practical steam engine developed by the Scottish engineer James Watt in the 1760's revolutionized transportation and industry by providing a cheap, efficient source of power. New iron making techniques provided engineers with the material to improve machines and tools and to build bridges and ships. Many roads, railroads, and canals were constructed to link the growing industrial cities.

3. Distinct branches of engineering began to develop during the Industrial Revolution. The term civil engineer was first used about 1750 by John Smeaton, a

British engineer. Mechanical engineers emerged as specialists in industrial machinery, and mining and metallurgical engineers were needed to supply metals and fuels. By the late 1800's, the development of electric power and advances in chemical processing had created the fields of electrical and chemical engineering. Professional schools began to be founded as the demand for engineers steadily increased.

Since 1900, the number of engineers and of engineering specialties has expanded dramatically. Artificial hearts, airplanes, computers, lasers, nuclear energy, plastics, space travel, and television are only a few of the scientific and technological breakthroughs that engineers have helped bring about in this century. Because science and technology are progressing and changing so rapidly, today's engineers must study throughout their careers to make sure that their knowledge and expertise do not become obsolete. They face the challenging task of keeping pace with the latest advances while working to shape the technology of the future.

15 ENGINEERING CAREERS

1. The field of engineering offers a broad range of job opportunities. Engineers may work in factories, offices, and government laboratories or at construction sites. Some engineers are involved in the research and development of new products. Others are responsible for turning plans and specifications for new structures, machines, or systems into reality. Still others use their background and training to sell and service technical equipment. Many engineers work on projects in teams that include scientists, technicians, and other engineers. But some engineers act as independent consultants who sell their services to people who need engineering assistance. Engineers may also hold teaching positions or move up into management positions in business.

Certain abilities and traits help qualify a person for an engineering career. Engineers must have technical aptitude and skill in mathematics and the sciences. They should be curious about the "how" and "why" of natural and mechanical things and creative in finding new ways of doing things. Engineers need to be able to analyze problems systematically and logically and to communicate well-both orally and in writing. They should be willing to work within strict budgets and meet tight deadlines. Skill in directing and supervising other workers is also an important part of many engineering jobs.

2. Education and Training. For students considering a career in engineering, the most important subjects to take in high school are mathematics, science, and English. Typically, the mathematics courses should cover algebra, geometry, trigonometry, and introductory calculus. Chemistry and physics are important sciences for students to take. Helpful electives include foreign languages; economics, history, and other social studies courses; and composition and public speaking.

To enter the engineering profession, most students complete a four-year bachelor's degree program at a college or university. In addition to a course of study

in their chosen engineering fields, engineering students must take several advanced mathematics and science courses. Most undergraduate degree programs also include courses in such subjects as economics, history, languages, management, and writing to equip students with the skills that will be needed in their later work as engineers. Many programs require the completion of an independent study or design project, including a formal report, before graduation.

3. Undergraduate engineering students often take part in internships or cooperative education programs in which they alternate between going to school and working for nearby companies as special engineering trainees. These programs give students the benefit of practical experience while studying for their degrees.

Graduate study gives the engineering student additional preparation for a professional career. Some engineering students study for another year after receiving a bachelor's degree. They undertake a program of advanced course work in a specialized field and earn a master's degree. The completion of an original research project called a thesis is part of most master's programs. Engineering students who want to teach at a college or university or do advanced research may then study three to five more years to earn a doctor's degree.

4. Some universities, junior and community colleges, and technical institutes offer two-year and four-year degree programs in certain specialized areas of engineering technology, such as computer maintenance and electronics. Engineering technology programs prepare students for basic design and production work in engineering rather than for jobs that require extensive knowledge of science or mathematical theory. Engineering technicians, graduates of the two-year programs, and engineering technologists, graduates of the four-year programs, form an important part of professional engineering teams.

5. Engineers continue their education after they complete their formal studies and obtain a job. Engineers, as well as engineering technicians and technologists, must continually update their knowledge by taking courses, attending workshops offered by professional societies, and reading technical journals.

Registration and Licensing. In the United States, laws affecting the registration and licensing of engineers vary from state to state. In general, engineers must be registered if they offer their services to the public or if they are involved in construction. The usual requirements for registration are that the engineer must (1) be a graduate of an approved engineering school, (2) have four years of applicable engineering experience, and (3) pass a state examination. Each state has a board of engineering examiners that administers the licensing laws.

In Canada, engineers must be registered before they can practice. Each province has an association that administers the licensing requirements.

6. Professional Organizations and Standards. Many of the specialized fields of engineering have their own professional societies. The societies publish technical articles and help members keep up to date. They also grant awards to outstanding engineers, work to promote public understanding of engineering, and encourage young people to become engineers. Many engineering societies prepare standards for procedures and sponsor research of general interest.

Many professional engineers in the United States observe a code of ethics called Canons of Ethics of Engineers, which is recognized by the ABET. The code tells how engineers should conduct themselves in dealing with the public, with clients and employers, and with other engineers. Professional societies specializing in one area of engineering often have additional rules governing the professional behavior of engineers in that specialty.

In Canada, the Canadian Council of Professional Engineers, headquartered in Ottawa, Ont., assists the provincial licensing associations in coordinating their activities. The council's accreditation board evaluates engineering courses of study, faculties, and facilities at Canadian colleges and universities. The council also judges the academic qualifications of foreign engineers who are seeking immigration to Canada. The council works closely with the ABET in the United States.

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