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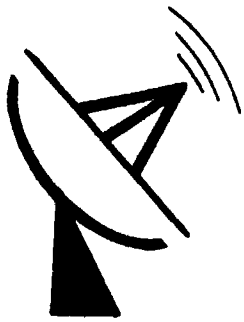
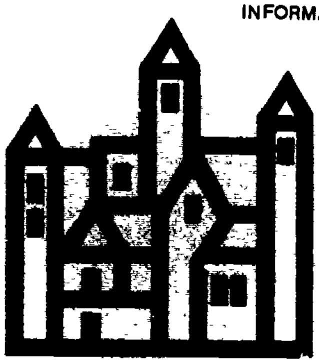
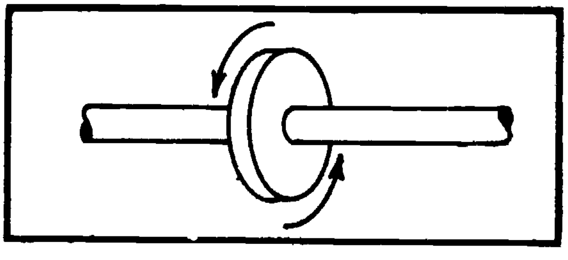
ABSTRACT

This document--intended for secondary school and college students--contains technology education instructional units on engines and power, energy conversion, energy futures, energy sources, communication and society, energy and power in communication, communication systems, microelectronics in communication, transportation in society, energy and power in transportation, transportation systems, electric and hybrid vehicles, production and society, energy and power in production, production systems, and robotics and production. Each unit typically includes a list of what students should be able to do after reading it, narrative information, line illustrations, a self-quiz with answers, a list of suggested activities, and a resource list for further study. (CML)

Resources in Technology







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Resources in Technology

Engines and Power

An engine is a machine that converts energy into mechanical force and motion to do work. In a sense, the human body is an engine because it converts food energy into muscle power. But, because our strength is limited, we have developed engines to do work for us. Let's look at some engines and how they produce power.

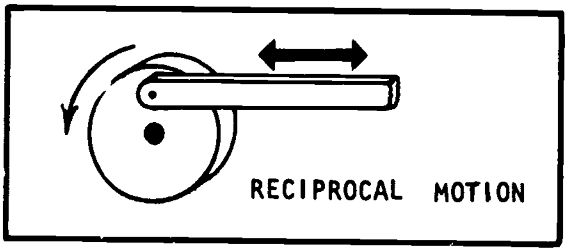
After reading this unit, you will be able to:

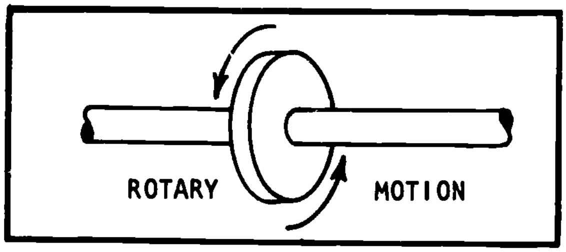
- Describe the three main components of all engines.
- Explain how engines use potential and kinetic energy.
- Explain how engines control input and convert it to produce useful work.
- Describe how engine power is measured.

First, let's look at . . . ENGINES.

What do a windmill, an automobile engine, and a person riding a bicycle have in common? Aside from the fact that each word has the letter *i* in it, each is a type of engine. Remember, an engine is a machine for converting energy into mechanical force and motion to do work. A windmill changes the force of wind into **rotary** (turning) or **reciprocal** (back-and-forth) motion to pump water from a well. An automobile engine converts heat energy from petroleum fuels into rotary motion to drive the wheels. A bicycle rider converts food energy into muscle power to crank the pedals.

Can you think of other rotary examples? How about the pencil sharpener?





CONFUSED?

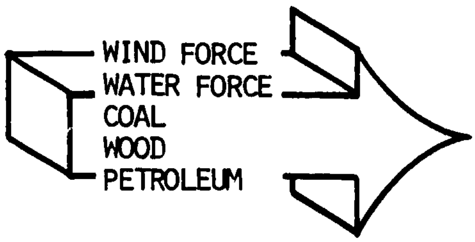
If there are so many different types of engines, how can you study them all? The secret is that all engines have three major components: input, process, and output. Essentially, the idea is this:

INPUT (fuel energy) → PROCESS (conversion) → OUTPUT (power)

Engines begin with . . . INPUT.

All engines require inputs of kinetic energy, or energy in motion. Some engines, such as windmills and water turbines, use kinetic energy directly available from nature. The natura, force of moving water or wind is made to turn a wheel or turbine blade, which provides power. Because these direct conversion engines use renewable energy sources, they are inexpensive to run. Recently, there has been a renewed interest in developing more efficient direct conversion engines. New designs for wind machines and low pressure water or hydro generators may help reduce our dependence upon fossil fuels.

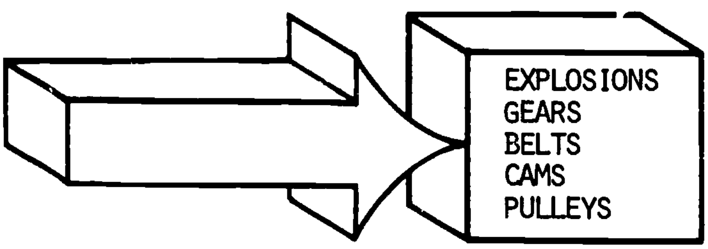
Other types of engines, such as those in automobiles or motorbikes, convert potential (in-storage) energy of fuels into kinetic energy. They do so by burning fuel to provide heat. Although most heat engines use costly petroleum fuels, almost anything that burns will work. The first automobiles were powered by wood-fired steam engines. Unlike direct engines, heat engines are portable—they carry their own fuel source in tanks or storage areas.



INPUT

Once we have input, we still need a . . . PROCESS.

In order to provide po\`'er in a usable form, engi⁻es must include a means to co:.vert and *control* the input and output energ\ This isn't as mysterious as it sounds. Both speed and direction must be regulated. Engines convert input into output in a variety of w:'ys. Windmill gears change the rotary (circular) motion of the turbine blades into reciprocating (up-and-down) motion to pump well water. Internal combustion engines convert liquid fuel by injecting it into a closed cylinder with air, compressing the space with a piston and exploding the mixture. This creates a force against the piston and exhaust gases. The force against the piston causes a shaft to turn, thereby converting liquid fuel into mechanical motion. Gears, pulleys, chains, and belts are also used to increase or reduce (control) the speed of output motion. Direction of motion can be controlled with crankshafts and cams, often used in combination with gears and pulleys. This process is exemplified in a bicycle as the reciprocating motion of the rider's legs are changed into circular motion to turn the rear wheel.

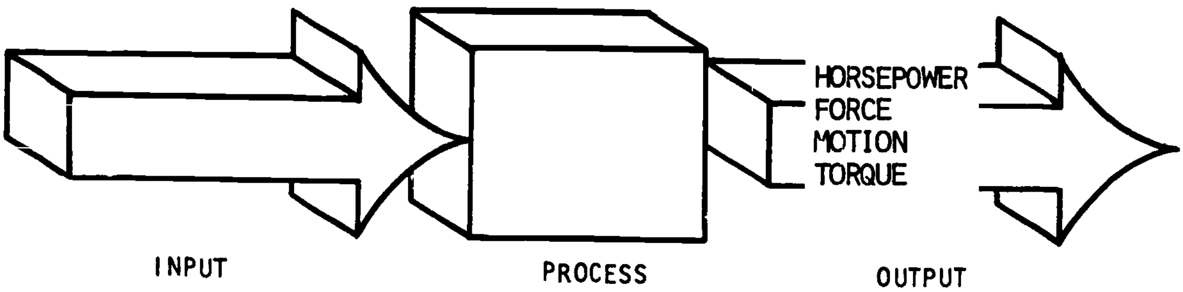


INPUT PROCESS

The result of all this is . . . OUTPUT.

The output of an engine is energy to do work. Work is usually measured in foot-pounds. One foot-pound of work is equal to lifting a one pound weight a distance of one foot. Work accomplished per unit of time is called **power**. The term *horsepower* is commonly used in measuring engine power. One horsepower (HP) is the rate at which a strong horse can work (550 foot-pounds of work done in 1 second). The term *force* is also used to measure power. Force equals work over distance, and is a useful measure of jet engine output. *Torque* is a measure of the power of the turning effort (force) of an engine shaft.

Depending on the type of engine, there are also outputs, such as noise, waste gases, and pollution. Some of these outputs are harmful to humans and the environment, and must be considered in the design of engines and the use of power.



So you see . . .

If we put all the parts together (input, process, output), we have an engine. The input is kinetic or potential energy. The process controls the input energy and converts it into the type of output needed. The output is mechanical force and motion to do the work. Wasn't that easy?

SELF-QUIZ

Now that you have worked through this, try a self-quiz. On your own sheet of paper, write the answers to these questions.

1. What are the three major components of all engines?
2. Give an example of an engine that uses kinetic energy directly.
3. Give an example of an engine that converts potential energy into kinetic before producing mechanical motion.
4. What is the horsepower rating of an engine that can do 550 foot-pounds of work in one second?

Turn this page upside down, you will find the answers at the bottom of the page. Go back and read again about the ones you missed.

Answers
1 Input, process, output
2 Windmill or waterwheel
3 Steam engine or automobile engine
4 one horsepower

THINGS TO DO

Try to design and build a perpetual motion machine, one that will not need any further fuel after it has been started.

Compare the efficiency of a 4-cylinder, 6-cylinder, and 8-cylinder gasoline engine. Include the cost of fuel, available power output, and pollution considerations as factors when determining the total efficiency Now, try it with diesel

Build a bicycle test stand to measure the input (force on the pedals) and the output (RPM) of the turning wheel. Use a 3- or 10-speed bicycle to compare gear ratios. Also try applying resistance to the wheel to see how the input and output are affected.

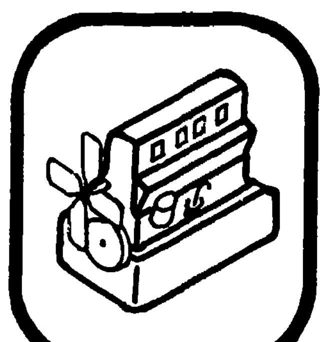
FOR FURTHER STUDY

Duffy, J. W. *Power: Prime mover of technology.* Bloomington, Ill.: McKnight, 1972.
Norbye, J. Direct ignition diesel. *Popular Science*, November 1980, 217(5), 84–86.

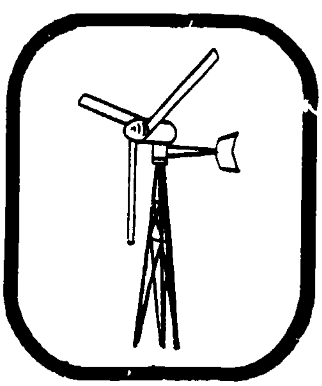
Energy Conversion and Storage

ENERGY CONVERSION

ENGINES



An engine is a machine that converts a burning or exploding fuel (energy) into mechanical force and motion. Internal combustion engines burn gasoline or diesel fuel and are used to turn wheels that power cars and trucks. Airplanes and spacecraft get their power from jet and rocket engines that burn fuel to create thrust.

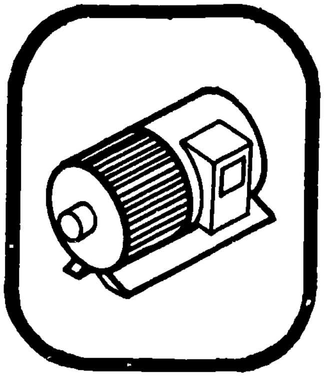


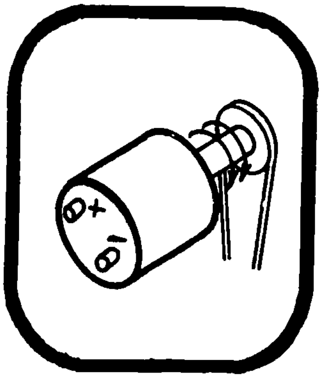
TURBINES

The kinetic energy of water, steam, or air is captured by the blades, or fins, of a turbine and is converted into mechanical and then electrical energy. Large turbines are used to generate electricity at such places as the Hoover Dam and Niagara Falls. A windmill is a turbine engine that harnesses wind energy to drive a pump or generator.

MOTORS

A motor is a device that converts electrical energy into mechanical energy, or motion. Some motors run on AC (alternating current) and DC (direct current). The electricity causes a magnetic field (electromagnet) to be produced. Fluctuations in this field cause the armature, which is connected to the shaft, to spin.





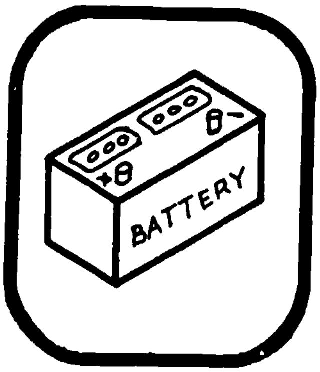
GENERATORS

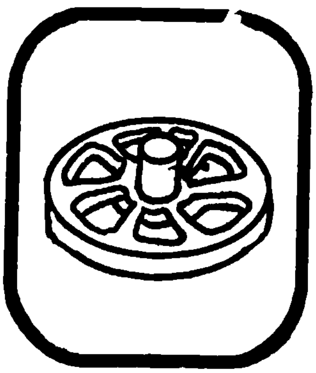
Generators are devices that are used to convert mechanical motion into electricity. They are just the opposite of motors. As a wire is passed through a magnetic field, an electric current is produced. With more wire and a larger magnet, a greater amount of electricity may be produced. Steam from burning fossil fuels or nuclear reactors is used to drive very large generators that generate much of the electricity in the U.S.

ENERGY STORAGE

BATTERIES AND FUEL CELLS

A battery is a device that stores chemicals and metals that produce electricity when activated. Direct current (DC) is the product of the reaction between the chemicals and the electrodes. A fuel cell is similar to a battery except that it does not have to be recharged and the electrodes do not decompose.



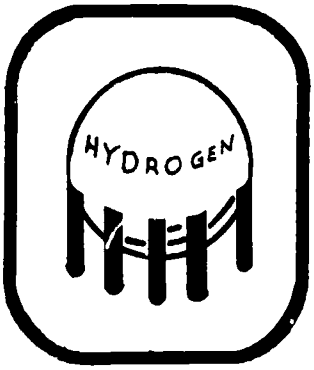


FLYWHEEL

A flywheel is a spinning wheel that is set into motion by other means. It takes advantage of the law of inertia. Energy is stored as the speed of the wheel is increased. Energy is released as the speed decreases or when a load is placed on it. Some experimental vehicles are using flywheels to save petrochemical fuels.

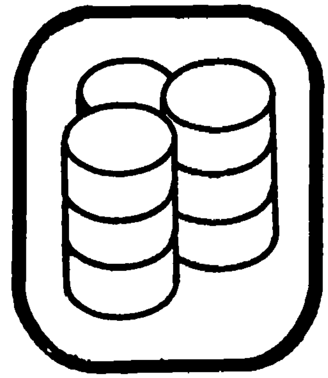
EUTECTIC SALTS

Solar energy can be stored in eutectic salts, or change-of-state storage, as it is also known. These salts are special compounds that change from crystals to liquids when heated to 32°C (90°F) or above. This change-of-state from a liquid to a solid or from a solid to a liquid requires a great deal of heat. For this reason, a lot of energy can be stored in a small volume of eutectic salts. Tanks full of eutectic salts are used to store heat in passive solar homes.



HYDROGEN

Hydrogen can be used to store energy. Electrical energy that is generated and not needed can be used to separate water into hydrogen and oxygen. This is called electrolysis. The hydrogen can then be stored and converted back into electricity, using a fuel cell, whenever it is needed.



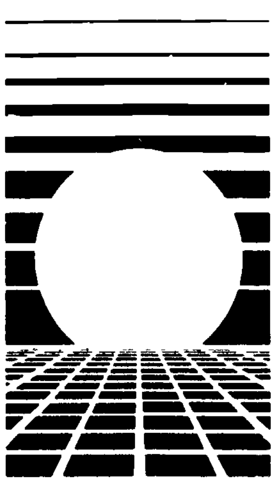
AIR AND WATER STORAGE

Solar energy can also be stored in water or air. Water can pass through a solar collector and absorb the heat that has built up inside. This water can then be put into storage tanks for later use. Hot air from a solar collector is usually forced through a large container of pebbles or rocks. This heats the rock and can be used later to heat cold air in a home or office.

FOR FURTHER STUDY

Crawley, G. M. *Energy* New York· Macmillian, 1975
Popular Science, August 1981 *219*(2), 48, 62–63
Schwaller, A E. *Energy technology Sources of power* Worcester, Mass Davis, 1980

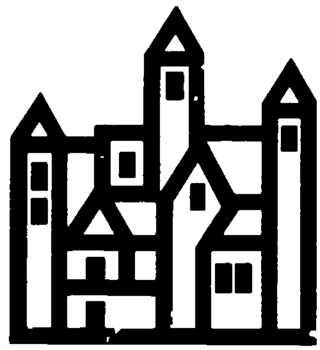
Social/Cultural Impacts of Energy



As our nation has developed over the past 200 years, society has been changed by energy resources and the way we live. Energy plays an important role in our lives, even if we don't always realize it. Our food, shelter, work, travel, and even the air we breathe, depend in part on energy resources and their use.

LIFE-STYLE

Our style of living (life-style) is affected by changes in energy costs and availability. When gasoline costs increase, we tend to cut down on our vacation plans, and we make fewer trips to visit friends and relatives. Higher utility rates have forced many people to adjust thermostats in homes and business places to use less energy. Increased shipping costs have made some fresh fruit and vegetables more expensive. Energy-related cost increases such as these can affect the health and comfort of individuals and families.

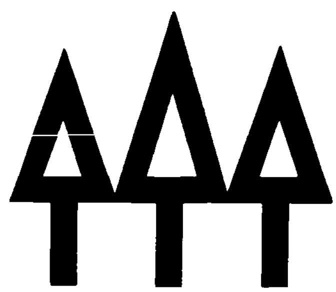


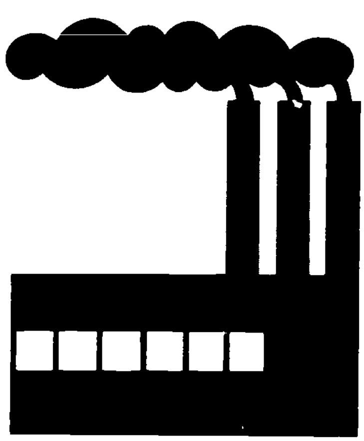
JOBS

The types of jobs available in the U.S. have also been affected by the energy situation. In colonial times, a large percentage of workers were employed in basic agriculture and related occupations. Today, as a result of technology and industrialization, most Americans are employed in the production of non-farm goods and services. Many jobs today are highly dependent on fuel and energy sources. When energy supplies dwindle or costs go up, plants may be shut down and workers laid off.

ENVIRONMENT

Many people believe it is important to keep our natural environment clean and fresh. The problem begins when we are forced to make choices between having cleaner air or cheaper fuel. Technologists call these choices trade-offs. In our quest for more and cheaper energy, we are sometimes faced with acid rain and mine drainage, spills, smog, and deforestation. In many cases, it is a close race between the harmful effects of increased energy production and use and the discovery of technical solutions to the problems.



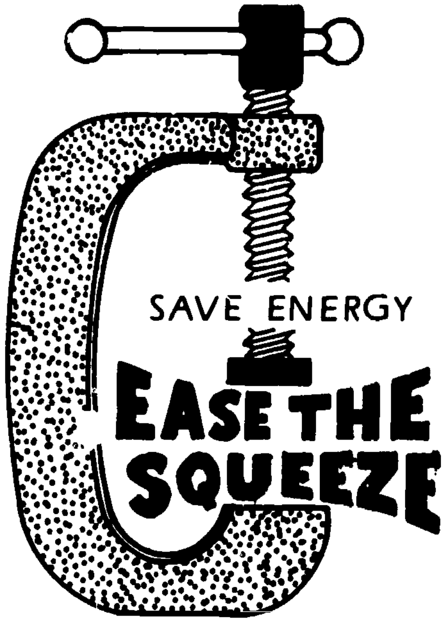


INDUSTRIAL GROWTH

Energy also affects our society indirectly through industrial growth. Industry constantly strives to expand in order to provide more consumer goods and services. Most people interpret this as progress. But, as industry grows, so does its appetite for energy. As energy costs to industry increase, the extra costs are added to the price of consumer products and services. When that happens, many people are unable or unwilling to pay the higher prices. As a result, energy supply and demand is partly responsible for economic inflation (decreasing value of the dollar).

WORLD COMMUNITY

The location and availability of energy resources has a major impact on society. Because no single nation is totally energy independent, resources such as coal, natural gas, and petroleum must be purchased by one country from another. In 1980, the U.S. spent 80 billion dollars (nearly $200,000 per day) for imported oil. Japan imports 90% of all its energy. As world competition for energy reserves becomes tighter, international politics become volatile. Many of the less industrialized nations, such as India, have a large percentage of the world's population but few energy resources. Future shortages of affordable energy may cause developing nations to fall even further behind in their ability to provide an adequate quality of life for their citizens. This increasing gap between the "have" and "have-not" nations could have significant implications for our future as a world community.



SELF-RELIANCE

The sensitive nature of world politics, coupled with increasing fuel bills, has caused many Americans to consider becoming **self-reliant**. When an individual furnishes his or her own food, clothing, shelter, and energy, he or she is self-reliant. A nation would be self-reliant if it could provide all of its own energy without resorting to imports. Is it possible for individuals or nations to become totally self-reliant? Most experts believe not, but with our energy future in doubt, many people are beginning to rethink their old beliefs about energy conservation and use.

For Further Study

Brown, L. R. *The twenty ninth day*. New York: W. W. Norton, 1978.
Kransberg, M. *Energy and the way we live*. San Francisco: Boyd & Fraser, 1980.
Ruby, D. From the far north: Lessons on how to slash fuel bills. *Popular Mechanics*, October 1981, *219*(4), 106–108; 144
Textbooks relating to technology in industrial arts can be obtained from Davis Publications, Printers Building, Worcester, MA 01608.

Energy Futures

ENERGY AND THE FUTURE

The energy policies we choose for the future will affect people's daily lives. It is easy to review our energy history by looking into the past The difficult part is to look forward and anticipate our needs. Futurists have a method of forecasting called **scenario-building**. A scenario is an imaginary look into the future The two energy scenarios that follow describe views about what your life could be like 20 years from now.

Scenario #1

You wake up in the morning to a cool room. The day is a Friday in September. Sleepily, you make your way to the bathroom to wash your face with water heated by a flat-plate solar collector on the roof. While you open the insulated window curtain in the passive solar greenhouse, you hear the used water from the bathroom sink run down the grey-water recycling unit. The water will provide a welcome drink for the house plants. Breakfast is an omelet, fixed with tomatoes and onion from your greenhouse.

Before you leave for work, you load the wood stove with fuel. Your electricity is efficiently generated by a local hydroelectric plant, so your utility bill is low. As you bicycle to work, you pass neighborhood windmills and other solar homes. Enjoying the late autumn, you remember that tomorrow is Saturday, and you will need to take the electric car to do some shopping and to run errands.

This scenario is a possible "best case" view of a life-style that could exist by the year 2001. For the scenario to become a reality, energy policies must focus on conservation, alternatives, and the decentralization of energy sources. In other words, it will require a redefinition of our quality of life.

Scenario #2

It is cold Monday morning in January. You have just arrived at the Foolish Manufacturing Company where you work. Ms. Smith, company president, is at her desk when the phone rings.

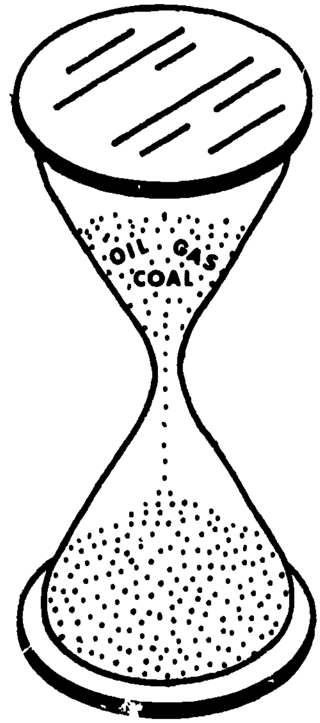
"Ms. Smith, this is Kil A. Watt of the Public Utilities Company," says the voice on the phone. "We have a very serious problem that must be taken care of immediately, and I need your cooperation. We are dangerously low on fuel, and I want you to close your plant for two weeks in an effort to conserve fuel."

Ms. Smith decides that the problem is real and starts making preparations to send employees home.

You catch a ride home with a friend. On the way you pass two closed gas stations and a third that has 20 cars waiting in line. A stop at the grocery store finds your favorite foods out of stock. The store manager says the delivery trucks can't get enough gasoline to make their rounds this week.

At home, an announcement on the radio indicates that the electricity will be off for 1 hour during the afternoon to help conserve. Unfortunately, the outage happens to be at the same time you planned to watch television. The energy "crisis" seems to be affecting everyone in your neighborhood. Stores are closed, steel mills are shut down, and the mines and factories are working shortened weeks. You find yourself with a cold house, little food, and a slim paycheck.

This scenario is perhaps a "worst case" view that could happen as a result of decreasing energy supplies and increased demand. This view considers a dependency on fossil fuels that are distributed from a centralized large-scale source. Inefficient energy use and a "bigger-is-better" growth concept could be responsible for such a scenario. Although these two views are imaginary, the second scenario is based on an actual situation during the oil embargo of 1973–74. How this happened and the possibility of it happening again will be discussed in the following sections.



The Setting

Throughout history, energy availability in societies has contributed to the way people live. People use energy to heat their homes, to produce and prepare their food, to manufacture products, and to transport them from one place to another. As people build larger homes and travel over greater distances, an increasing amount of energy is required. In general, the greater the population of a given society, the more energy it needs to meet the demands of its people.

The U.S. has historically been rich in energy resources. The availability of wood and coal fuel was supplemented by the discovery of oil by Colonel Drake in Titusville, Pennsylvania on August 27, 1859. With cheap fuel to supply the growing industry in this country, people's lives began to change rapidly. The U.S. grew into an industrial giant that produced services and products for 76 million people in 1900 and 226 million people in 1980. This increased population, along with a basically stable economy, abundant natural resources, and a strong technical base, has created an advanced technological society.

The energy needs of our technological society have been met by imported oil, domestic coal-fired electrical generating plants, and nuclear-powered electric generating plants. But, at the current rate of energy consumption, the U.S. could consume more energy in the next 30 years than in its entire 200-year history. Nearly all energy and political experts tell us that future demand could cause an oil crunch on a global scale. Regardless of the actual energy consumption, the future will likely be different from today.

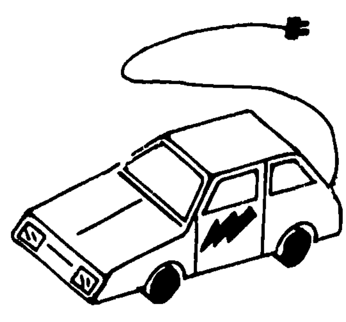
The Future

There are many things to consider when we look at our energy future. Many of our fossil-fuel energy sources, such as natural gas and oil, may be depleted within the next 40 years. But it seems as though everyone has a different prediction of future energy supplies. Energy-producing industries, scientists, environmentalists, governments, and economists all have their own views about energy forecasts for the future.

According to the Exxon Corporation, the U.S. will continue to depend on imported oil until 1990. Exxon believes that proposals to limit oil imports could have severe consequences, such as (a) higher unemployment, (b) slower economic growth, and (c) a stagnating national economy.

Many people believe that energy needs for the future can be met by increasing oil production and exploration, mining coal, producing synthetic fuels, and increasing the use of nuclear power. These solutions, however, require big corporations, and advanced technology.

Other people support a more decentralized path that would depend on wind, solar, and hydro technologies. These could be individual or community based and would be less complex and less expensive than other technologies.



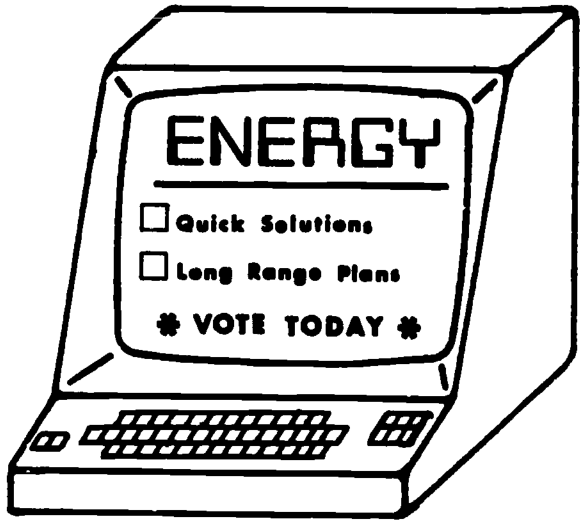
Forecast Of Energy Use

In 1980, the U.S. consumed approximately 80 quads of energy (one quad equals 10^{15} Btu). According to current trends, the U.S. may use 90 quads of energy in 1985 and as much as 125 quads in the year 2000. Whether this forecast comes true will depend on (a) the supply of fossil fuels; (b) expansion of nuclear-reactor construction; (c) development of solar, wind, and other alternatives; (d) energy savings through conservation; and (e) social/environmental impacts.

Fossil Fuels. The supply of domestic (U.S.) oil and natural gas between now and the year 2000 is expected to remain constant. It may even decline somewhat. Increased use of coal will depend largely on coal gasification methods and pollution-control methods. Imported oil and natural gas are dependent on an extremely volatile international political situation.

What You Can Do

If you want to have a say in your future, you must prepare yourself now. By adopting a "conservation mentality," you can save energy in your home by weatherizing it against the cold. You can plan your travel to accomplish more with fewer trips. You can become active in school and community efforts to deal with the energy problem. Local decisions are often made by a handful of people as members of zoning boards and town councils. You can make your views known to them. If you believe some products are energy wasteful, don't buy them. As a consumer, you can have an impact on the marketplace.



To become a more intelligent consumer and citizen in the future, you should, (a) learn as much about energy as possible; (b) study science and technology areas that relate to energy recovery, conversion, and use; (c) become active in the political process to decide energy policies; and (d) develop a life-style that makes the most efficient use of available energy sources.

Future Forecasts

1985
- Up to 40% of our energy could be saved by a national conservation plan. (Stobaugh & Yergin, 1979)
- Fast breeder reactor in operation. (Marien, 1980)
- Large-scale shale oil recovery developed. (Marien, 1980)

1990
- 1.3 billion tons of coal produced per year. (Exxon, 1979)
- Unit price reduction of flat-plate solar collectors as a result of mass production. (Dorf, 1978)

1995
- Microwave power transmission. (Marien, 1980)
- Fail-safe system for drilling and producing hydrocarbon at any depth. (Marien, 1980)

2000
- 2.2 billion tons coal produced per year. (Exxon, 1979)
- U.S. electric utility demand: coal, 49%; nuclear, 34%; hydro, 12%; oil, 2%; gas, 2%; geothermal, 1%. (Exxon, 1979)
- Efficient storage of electrical energy in large quantities. (Marien, 1980)
- Commercially available fusion reactors. (Dorf, 1978)
- Laser power transmission. (Marien, 1980)
- Shale oil makes up 10% of total U.S. oil production (Dorf, 1978)
- 20% of energy for U.S. will come from solar; equal to one billion barrels of oil per day. (Stobaugh & Yergin, 1979)

2010
- High temperature gas reactor with thermal cycle other than helium. (Marien, 1980)

2020
- Oil and natural gas resources depleted. (Dorf, 1978)
- Widespread use of geothermal power. (Marien, 1980)
- Solar energy accounts for 25% of total energy supply. (Dorf, 1978)

2030
- Earth-based solar energy devices for bulk-power generator. (Marien, 1980)

2040
- Cryogenic superfluid transportation of mechanical energy over long distances. (Marien, 1980)

2050
- Use of gravitational energy—antigravity. (Marien, 1980)

2500
- Exhaustion of recoverable coal fuel resources at 600 million tons per year. (Dorf, 1978)

FOR FURTHER STUDY

Branley, F.M. *Energy for the 21st century*. New York: Thomas Y. Crowell, 1975.
Dorf, R.C. *Energy, resources, and policy*. Reading, Mass. Addison-Wesley, 1978.
Exxon Company, U.S.A. *Energy outlook 1980-2000*. Author, December 1979.
Marien, M. The good news and the bad news: Optimism vs. pessimism in recent writing about the future. *The Futurist*, 1980, *14*(3), 3–9.
National Geographic Society. *National Geographic special report: Energy*. Washington, D.C.: Author, 1981.
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World Future Society. *The Futurist*, 1974, *8*(1).

Energy Sources

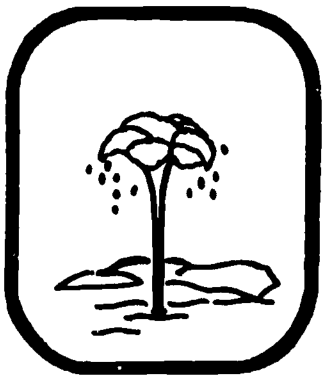
NONRENEWABLE RESOURCES

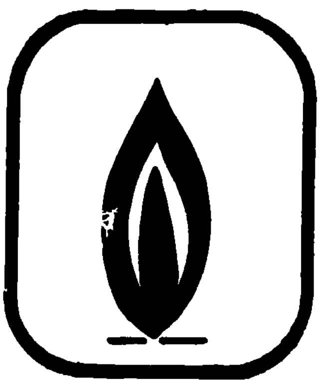
COAL

Although coal is found in many places throughout the world, nearly half of it is located in the United States. Of the 700 million tons of coal mined each year in the United States, two-thirds is burned to fuel electric generating plants. The reminder is used to provide heat for buildings and to make steel and other industrial products.

GEOTHERMAL POWER

Geothermal energy comes from the tremendous heat trapped deep within the earth. Natural steam geysers are used to generate electricity. Hot water can also be pumped out of the ground to heat buildings. Geothermal sources account for less than 1% of the total energy produced in the United States. Most of the sources are in the western third of the nation.

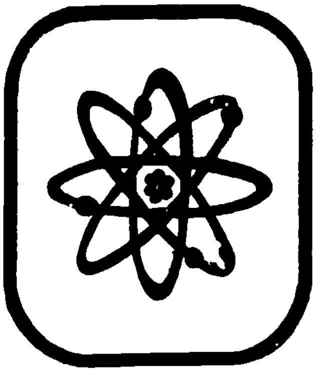




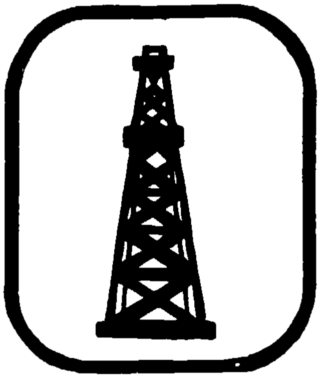
NATURAL GAS

It is estimated that there is only enough natural gas in the world to last for 20 more years. Most of the recoverable supplies are found in the U.S.S.R., the Middle East, and the United States. Natural gas provides about 32% of the total energy used in the United States. Some natural gas is used for home heating and cooking, but most is used in industry.

NUCLEAR POWER



Nuclear power requires uranium as the fuel source. When uranium atoms are split (fission), heat is released. Water is circulated through the reactor to keep it cool. As the water turns to steam, it is forced through a turbine to generate electricity. There are 52 nuclear generating plants which provide about 1% of our total energy in the United States.



OIL

Oil is a fossil fuel that is recovered by drilling wells either on land or from offshore rigs. The world produces about 20 million barrels of oil each year, one-third of which is used by the United States. Only about 35% of the oil in a well can be recovered. Some oil is used to heat buildings and to generate electricity. The remainder is distilled (cooked) to produce gasoline and other by-products.

RENEWABLE RESOURCES

BIOFUELS

Biofuels are organic (once-living) matter such as trees, sugarcane, corn, manure, and seaweed. Some of these organic materials can be burned directly to produce heat. Others are converted into flammable liquids or gases. Corn can be distilled to produce methanol, which is then mixed with gasoline to produce gasohol. Biofuels provide about 2% of our energy in the United States.

WATER POWER

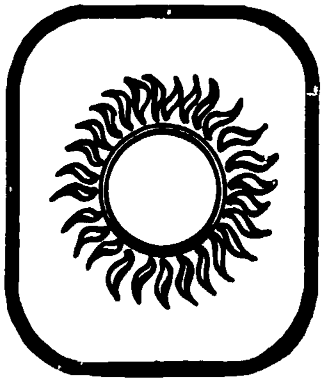
Moving water holds a tremendous amount of potential energy. Dams are built to direct falling water through turbine blades to generate electricity. About 3% of our total energy in the United States comes from water power. Small generators are being developed to generate electricity from small streams and rivers.

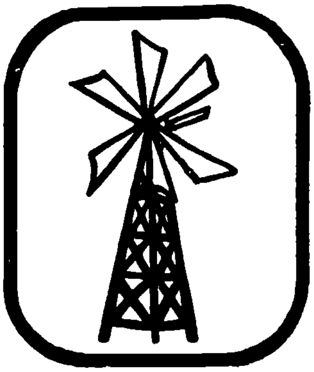
OCEAN POWER

Experiments are currently under way to capture power from the tides. Other efforts are being directed toward using temperature changes and wave action to produce electricity. There may be enough energy in the oceans to power all the industrial machines in the world. But we still need to discover some practical ways to harness this power.

SOLAR POWER

The sun's energy can be used to directly heat buildings or to provide hot water. It can also be converted to electricity. Photovoltaic devices (often called "solar cells") are expensive and can as yet produce only small amounts of electricity. Although solar power presently provides less than 1% of our energy, future developments may make it a convenient and inexpensive source of energy.





WIND POWER

Windmills have been used for many years to pump water or to grind flour. Modern wind devices are being developed to generate electricity Small wind turbines can light a home or run small appliances. Less than 1% of our energy is now being produced by wind power, but larger, more efficient generators are being tested.

FOR FURTHER STUDY

Energy primer. Portola Institute, 1974.
Hinkelkbein, A. *Energy primer.* Collins Publishers, 1971.
Woodburn, J.H. *The whole earth energy crisis.* New York: Putnam's Sons, 1973.

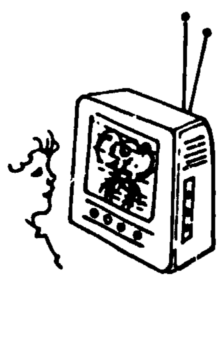
Communication & Society

Communication plays a vital role in any culture. By freely sharing their thoughts and feelings, individuals in a society work together to understand the past and build for the future. People in high-technology societies often use sophisticated technical systems and devices to help them communicate. Let's look at some of those systems and their effects upon society.

After reading this unit you will be able to:

- Name four ways in which communication systems can have an effect on individuals.
- Identify three social issues raised by modern communication technology.
- Identify the federal government agency responsible for regulating communication media.
- Explain how some modern communication devices can lead to social problems.

In early times, communication among humans was primarily a personal exchange of languages or gestures, usually on a one-to-one basis or in small groups. The development of the printing press, radio, and television changed all of that. After the radio was developed, for example, broadcasts could be made to thousands of people at one time. Today, a single television program relayed from a satellite can be seen and heard by millions of people around the globe. Communication of this magnitude influences how people think and act—it is a social phenomenon. As members of society, each of us is affected by communication systems personally, *and* as a member of groups. Let's look first at the personal effects of communication.



THE PERSONAL SIDE OF COMMUNICATION

Does communication affect you as an individual? Of course it does! Each day you are bombarded with words or pictures from radio, television, telephone, newspapers, magazines, and even the intercom in your school. These means of communication are sometimes called **media**. Although you may not always be aware of it, communication media often transfer information that affects your emotions, values, attitudes, and perceptions.

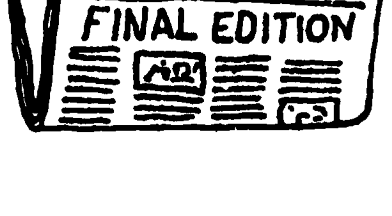
Think about what happens to your **emotions** when you hear an ominous voice on the school intercom calling you to the principal's office! Does your attitude change when the television news tells you that your favorite rock star is in trouble with the law? Your **values** about what is right and wrong, good or bad, depend in part upon what you see and hear in the media. In other words, your **perception** of the real world is influenced by communication technology. In turn, your behavior depends upon what you think and feel.

Modern communication systems are usually quite helpful. For example, a pocket-sized "beeper" can summon a physician to save lives. Likewise, a teletype-phone can improve personal communication for people with hearing impairments. Listening to a miniature, walkaround tape player can help calm your nerves after a hectic day.

Communication systems can have negative effects, also. Some people refuse to watch television news or read newspapers because the bad news depresses them. Some people are so afraid that the ringing telephone may bring bad news that they refuse to answer it. One famous newscaster, in order to counteract such fears, opens his radio broadcast each day by exclaiming, "There's good news tonight!"

Communication and Groups

As you participate in society, it is usually through the association with groups. The action of groups is very important to the society. Although communication certainly affects individuals, the actions of individuals in groups can also affect the methods of communication. Have you noticed the number of newspapers that have gone out of business in the last five years? How about record stores? Why is this happening? It may be the result, partially, of the fact the people are turning to other types of communication. Radio and television are a very real threat to newspapers because people can get information much faster. Records and newspapers are not going to disappear completely, but the days of their peak use are declining.



There are other kinds of issues that society has raised with regard to modern communication and the ways in which it is used. For example, with the growing popularity of cable television, there are more movies available in the home that have questionable subject matter. Some groups argue that this use of television cable is undermining the moral and ethical standards that are established by the family unit. Others find such devices as answering machines to be very dehumanizing. So there has to be a balance between the technical means and people using them, or we will find ourselves in the middle of a social problem.

TV TODAY

RATING	PROGRAM
G	Kiddy Time
PG	Afternoon Special
R	Documentary
X	11:00 Movie

Control

The flow of all types of information in the U.S. is relatively unrestricted. However, because we have hundreds of television and radio stations, and thousands of newspapers, and millions of computers and telephones, just to mention a few technologies, someone must keep track of it all. In some cases, it is the industry that imposes a self-governing watchdog authority; in other situations, it is the government. There are either laws passed or groups are established with authority to make decisions and enforce certain specific rules. The **copyright law** is an example of a regulation that protects authors. Have you ever copied a sheet of music or something from a book to avoid buying it? How about making duplicate tapes or recording shows and movies on your video tape player? All of these are violations of the copyright law.

COPYRIGHT

©©©©©©©

COPYRIGHT

FCC

The **Federal Communications Commission** (FCC) is one federal agency that helps regulate communication systems. Its job is to regulate and control the communication industry so that it operates in the "public interest." Who decides what is in the public interest? Obviously, the job of trying to stay up with all of the latest developments in all of these areas is very complex. With the recent approval of AM stereo, what might happen to your local radio stations? What could happen to the cost of stereo radios? Direct broadcast satellites have been approved for testing. How will this affect what you see on television, and what will it cost? There are no certain answers to these questions yet. But, it is the job of the FCC to keep communications media in line so you can benefit from them.

So, you see . . .

We depend a great deal on communication (individually and as a society). However, it is a two-way street. Communication can change the way we live and feel about things, and at the same time society determines which means of communication will be used.

SELF-QUIZ

Now that you have worked through this, try a self-quiz. On your own sheet of paper, write the answers to these questions.

1. What is the name of a federal agency that controls and regulates technical communication systems?
2. Name four personal characteristics that can be affected by communication.
3. What law prohibits unauthorized duplication of books, sheet music, tapes, and movies?
4. If society and technology are not kept in balance, a ______ begins to develop.

Turn this page upside down; you will find the answers at the bottom of the page. Go back and read again about the ones you missed.

THINGS TO DO

© Make an audio- or videotape of opposing viewpoints on an issue in your school or community. How difficult is it to report a balanced perspective?

During a two-hour time span, listen to the radio and keep track of the exact amount of time devoted to music, news, commercials, etc., and then compute the percentage of time devoted to each. You will need a stopwatch.

© Take or obtain photographs of your community that are not easily recognized. Show these to five people and record their reaction. Did the pictures give a fair representation of your town?

Find two different newspapers which include reports of the same news incident. Did they both report the facts the same way? Which was more accurate?

FOR FURTHER STUDY

DuVall, J. B., Berger, E.; Maughan, G. *Getting the message: Communication technology.* Worcester, Mass.: Davis, 1980.

Hawkins, W. J. Dashboard CRT: on the road info at a glance. *Popular Science*, July 1981, p. 10.

Michels, D. L. Bringing the future into your office: A guide to computer shopping. *The Futurist*, June 1982, pp. 49–53.

Answers:
1. Federal Communications Commission.
2. Values, attitudes, perceptions, emotions.
3. Copyright Law.
4. Social problem.

Energy & Power in Communication

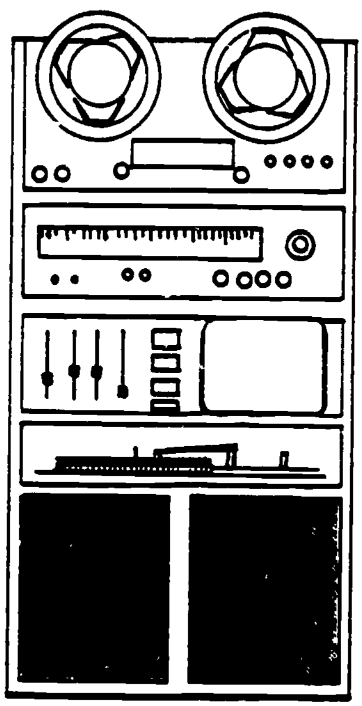
Stereo phonographs, tape decks, radios, televisions, telephones, cameras, and computers all have something in common. They are devices that help people communicate. As you probably know, the activity of communication is a basic function of human beings. Over the centuries, people have invented devices and machines to improve this process. Technical systems must have an energy or power source to make them work. Whether a device uses batteries, solar cells, wall plugs; or processes sound waves, light waves, or radio waves; some form of energy is present. To find out more about the use of energy in communication, let's continue.

After studying this unit you will be able to:

- Describe how information is carried by a variety of energy forms through communication devices and machines.
- Name common devices in communication systems that transduce energy.
- Identify two sources of electrical energy used for communication systems.
- Explain the relationship between communication systems and energy use.

O.K. Let's tune in here . . .

ENERGY AND INFORMATION



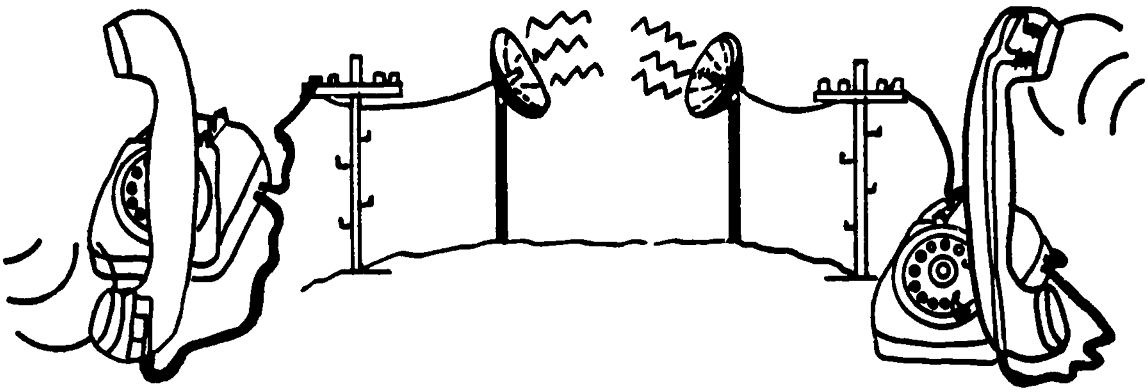
When people use devices or machines to communicate to one another, they are transferring ideas (information). **Information** usually is in the form of music, words, or video signals. Information also can be in the form of Morse code, numbers, or a variety of other forms. Consider the telephone conversation you had the other day. If you think of the spoken words as information, then the conversation represents the transfer of information. Just by speaking the word "hello," you sent information from your telephone to a telephone somewhere else. The music and words you hear over the radio are information. The television video and audio are information. And so on, and so on. . . .

Information often changes forms in a technical system from those that we commonly recognize (sound and picture) to forms that are not so common, for example, electrical pulse and radio waves.

What is a technical system?? Well, keep going, you'll find out...

A technical system is an arrangement of hardware devices or components that perform a particular function, such as transferring information. When you speak, information in the form of words is carried by sound waves. This is a form of energy caused by vibrating vocal cords. If you speak into a microphone or telephone, sound waves (acoustic energy) cause vibrations that are changed into electrical pulses (electrical energy) and transmitted along cables. A television camera changes light energy into radio waves (electromagnetic energy), which are sent out through the antenna.

Energy Conversion



Acoustical Energy ⟶ Electrical Energy ⟶ Electromagnetic Energy ⟶ Electrical Energy ⟶ Acoustical Energy

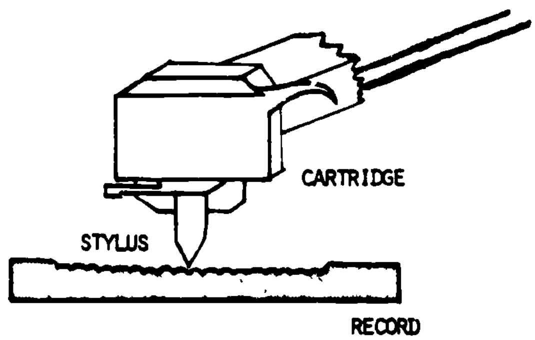
So you see, whatever the information, it is carried by some type of energy. Energy changes its form (acoustical to electrical, electrical to visual, etc.) in a technical system. Whenever the form of energy used to carry information is changed, the process is called **transduction**. A microphone and a television camera are examples of **transducers**.

What is the transducer on a sound system that changes electrical energy to acoustical energy? Read on and you will see...

As you may know, information can be stored. Books, magazines, and newspapers store information in a printed form. Photos represent the storage of visual information. Phonograph records, magnetic tapes, and video disks store both video and acoustical information.

So, you can see that devices and machines used to transmit, store, retrieve, and receive information really are processing information carried by some form of energy—light (visual) energy, acoustical energy, electrical energy, or magnetic energy.

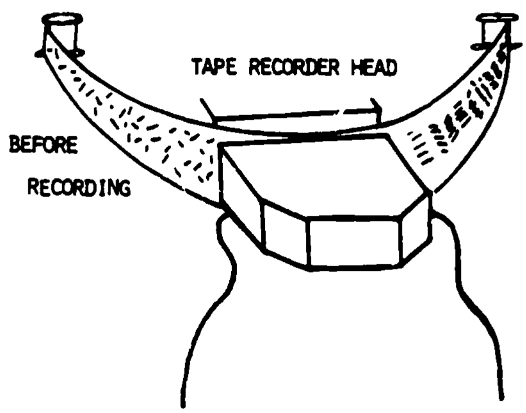
TYPES OF ENERGY USED



Communication devices and machines did not operate always as they do today. For example, until about the 1920s, music was stored and retrieved by music boxes and handcrank gramophones. The devices had windup springs, much like clock mainsprings, which turned the record disk. The sound was not amplified, but was focused by a wooden or metal megaphone.

Contemporary communication devices need power sources for two purposes:

1. To perform functions, such as to move magnetic tape past the record, playback heads of a tape machine, and power to turn the record turntable.
2. To process and amplify the information signals through the system.



Do you know that . . .

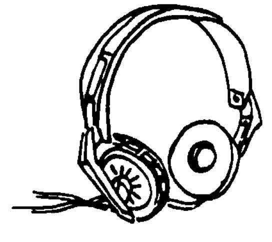
The energy used to amplify signals and to provide power for the speakers of a sound system is measured in watts. Many home sound systems require up to 100 to 150 watts to drive speakers. Concert sound systems require greater amounts of power to drive their speakers at high sound levels.

These power needs commonly are met with electricity. Electricity supplies power to electric motors, which physically move things, and to components, which switch or amplify information signals.

Electrical power for communication is supplied either by storage batteries or by the 110-volt current found in wall sockets in U.S. homes and businesses.

Size D batteries (1.5 volts) generally are used to supply power for moving parts. Batteries commonly used for solid state electrical circuits are the 9-volt "transistor type." A variety of other battery sizes also are used. Devices that are plugged into the wall or operate from batteries have converters and transformers to supply the type and amount of power needed.

Listen to this . . .



IMPACTS OF COMMUNICATION SYSTEMS ON ENERGY

The amount of energy and time that can be conserved is considerable when communication systems are compared to traveling. If you live more than 20 miles from school, it would take 60 times more energy to ride back and forth to school than to communicate by using a telephone/computer system.

Now, can you communicate this information that you've been storing? With your own energy and paper, write the answers to this quiz.

SELF-QUIZ

1. Explain what happens to the type of energy used when you speak into a telephone.
2. What is the name of the device that changes the form of energy in communication systems?
3. Name and describe 3 types of energy forms commonly used to process information.
4. For what two purposes do *modern* communication devices need a power source?
5. What form of energy is used most frequently to provide power for communication devices?

Turn this page upside down; you will find the answers at the bottom of the page. Go back and read again about the ones you missed.

THINGS TO DO

Connect a microphone to a power supply and a multimeter. Create a carrier voltage through the microphone and record it on the meter scale. Talk into the microphone, and watch the voltage fluctuate. (Also, try a microphone and oscilloscope.)

Light bulbs are rated in lumens/watts. Find out how 9-volt transistor batteries are rated, and compute the amount of energy it takes to play a 60-minute cassette tape.

How much energy does it take to make a 3-minute local telephone call, including switching, bells, and transmission? Consult your local telephone company.

FOR FURTHER STUDY

DuVall, J.B.; Berger, E.; & Maughan, G. *Getting the message: Communication technology.* Worcester, Mass.: Davis Publications, 1980.

Martin, J. *The wired society.* Englewood Cliffs, N.J.: Prentice-Hall, 1978.

Papallo, G. *What makes it work.* New York: Arco Publishing, 1976.

Answers:

1. acoustical/electrical.
2. transducer.
3. visual (light acoustical elec.)
4. to move equipment (i.e., magnetic tape or record turntable to process and amplify information).
5. electricity.

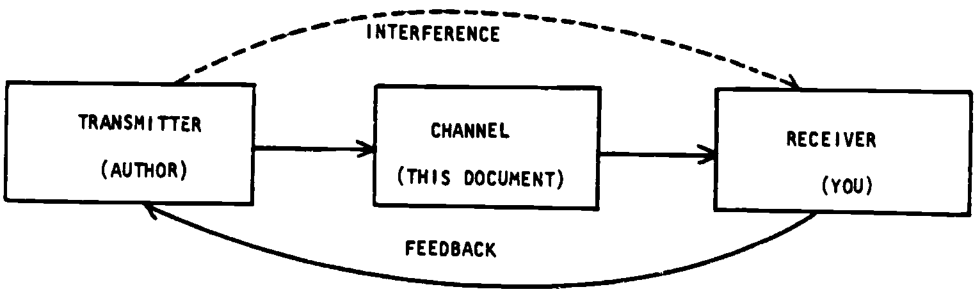
COMMUNICATION SYSTEMS

When we think of communication, we usually think of people talking or listening to each other. This may happen face to face, or it may occur through the assistance of a telephone, radio, or television. We also know that there are other types of communication. Bees have a way of passing along information about the location of nectar. An automated machine can be left to control its own speed of production and make certain corrections when its sensors detect a problem. All of these examples represent a communication system in action.

To fully understand communication, we need to look at its parts. Basically, communication is the transfer of information. In a sense, information is the glue that holds society together. Life in our modern, complex world depends more and more on the transfer of information. The increasing dependency on the transfer of information has stimulated the growth of more and more communication systems. This surge in communication and **communication systems** has been referred to as a technological revolution. We now live in the **Information Age**.

Communication Process

The transfer of information happens in a very orderly sequence. A communication theory model makes it easy to see how the process works.



This model and similar ones have been used for many years and are still very useful when trying to understand the transfer of information in a communication system. It doesn't matter whether the act of communication takes place across the dinner table or a continent; the communication system will consist of at least the three parts shown. The channel can be as simple as the air that carries the sound of your voice, or as complex as the satellite network required to carry a television program around the world. The model is useful in understanding new systems and devices.

The most common problem encountered by the communication process is **interference**. Interference is any force that disrupts or distorts the information or message while it is being "channeled." It could be noise, as in the case of normal conversation, or atmospheric weather changes, as in the case of radio or television. The biggest cause of interference, however, is a simple misinterpretation of the intended message. Cultural, economic, and political diversities allow people to receive the same message but interpret it differently.

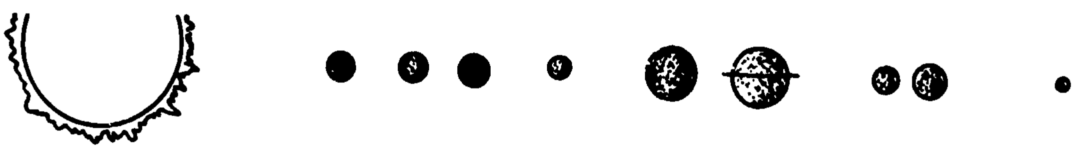
HUMAN AND TECHNICAL BASE

Information may be transmitted through human or technical means. Human-based communication is the transfer of meaning directly from one mind to another. Talking to someone, using sign language, and making facial expressions are examples of human-based communication. Human communication is dependent on the sensory organization of sight, hearing, taste, touch, and smell. The personal response (feedback) indicates that the information is received and is being processed.

Technical-based communication depends on the use of devices (sometimes called "hardware") to serve as extensions for the human senses. A telephone allows conversation to take place between two people hundreds of miles apart. We could not yell loud enough for such an exchange ("process") to take place. Similarly, printing and photography store visual images and allow information to be shared many times after they were produced. Automation in industry has removed some of the human element from dangerous or boring situations by using "sensing" devices that detect heat, light, or motion. The variety of technical communication devices can become very confusing. One way to understand different devices is to classify them into communication systems.

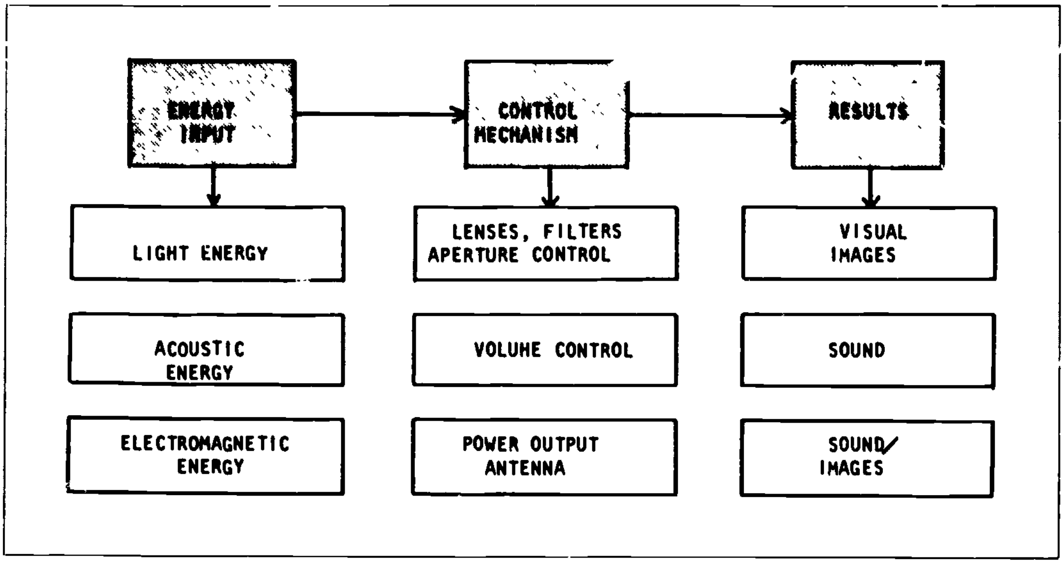
COMMUNICATION SYSTEMS

Before you read on about particular types of communication systems, it would be helpful to examine what is meant by a system. A system is a group of interrelated parts. By using this definition we find that there are systems all around us. In nature, we find our solar system and systems of rivers and lakes. Biology shows us systems that exist within an organism—digestion, circulatory, and nervous. We can also find examples of systems that have been created by people. An automobile, a washing machine, and an electric drill are examples. Larger types of systems have also been created, such as transportation, political, and communication. The key idea is that all these systems and others consist of related parts working together to meet human needs.



A communication system is a combination of processes and hardware used to accomplish the transfer of information (communication). This definition of a system allows us to consider it as a whole or complete unit. One of the easiest ways to do this is to look at a graphic representation of a system.

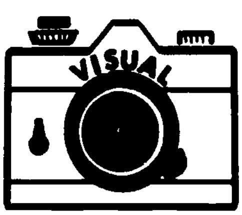
An energy input is necessary to get the system started. The control mechanism regulates the process. That is, it manipulates the message input into whatever form is necessary. The result of the process is the presentation of the message in a form that will allow communication to take place.



Innovation in the field of communication technology has helped to eliminate much of the traditional interference in communication systems. One of the most striking developments in the field of communication, if not in all of science and industry, has been the joining of communication and computers into the so-called **information systems**. Out of this "marriage" have come the space program, complex banking, and economic information. At the center of it all lies the idea of communication—information exchange between humans, between humans and machines, and between machines.

It is helpful to look at this idea of communication systems in smaller pieces that are easier to understand. We can do this by dividing it into four smaller subsystems that follow the definition of a system but accomplish the task of communication in a specific way. These four subsystems are (a) visual systems, (b) acoustical systems, (c) telecommunication systems, and (d) data-processing systems.

VISUAL COMMUNICATION SYSTEMS



A visual communication system is a combination of processes and devices to accomplish a desired result, such as the transmission of information from one point to another. Printing and photography are examples of visual systems. In each example, many people can communicate at the same time. A newspaper gets the same information to many people at the same time by making a number of copies that may be distributed to many individuals. Holography, copying machines, and video systems are also considered visual systems.

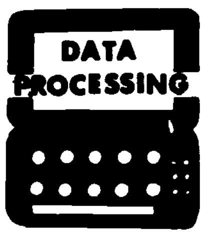
ACOUSTICAL COMMUNICATION SYSTEMS

An acoustical communication system is a combination of processes and devices to accomplish a desired result, such as the transmission of information from one point to another. The telephone, telegraph, and record player are examples of acoustical systems. Acoustical systems can transmit or store acoustical energy in the form of electrical pulses or magnetic energy by media such as cables, optical fibers, or disks. It is possible to make a long distance call or send a telegraph or cassette tape farther than we could shout. Information is thus transmitted by devices, usually in coded form, to the destination.

TELECOMMUNICATION SYSTEMS

A telecommunication system is a combination of processes, circuits, and devices to accomplish a desired result, such as the transmission of information from one point to another. Radio, television, and microwave transmission of information are examples of telecommunication systems. The key to this kind of system is that the message is sent by means of electromagnetic energy through the air. There is no need for a physical carrier, such as a wire or phonograph record, as there is in acoustical systems.

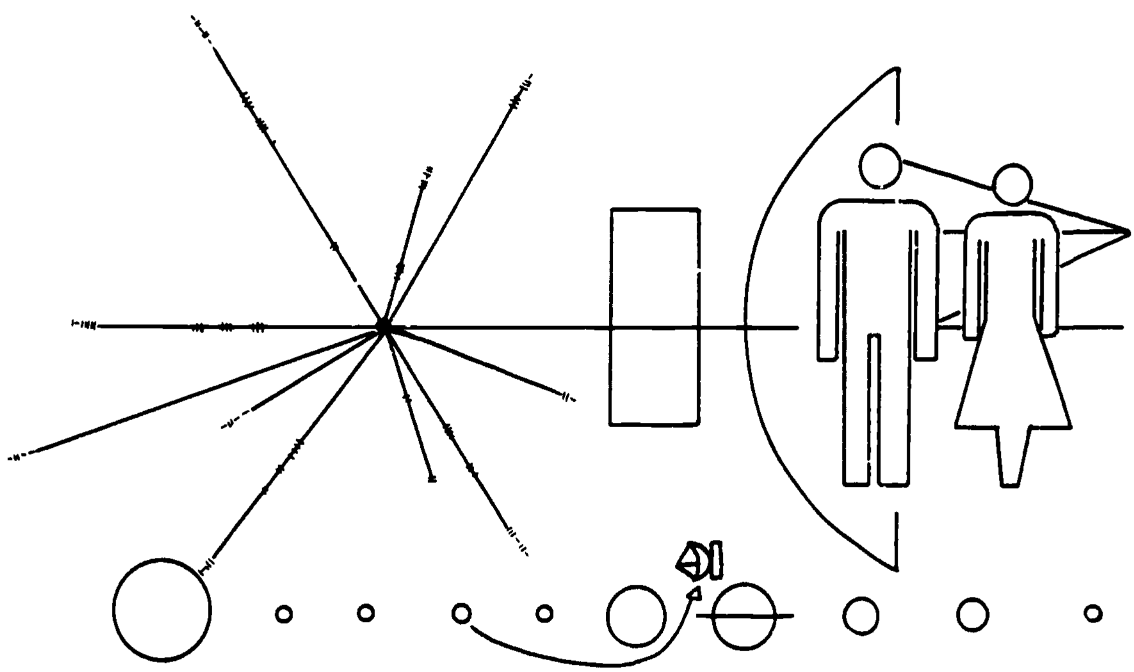
DATA-PROCESSING SYSTEMS



A data-processing system is a combination of processes, circuits, and devices to accomplish a desired result, such as the transfer or processing of information. The computer is the best example of a data-processing system. This type of system transfers or processes information faster and more accurately than is possible by human means. The computer is also used in conjunction with the other systems to improve all areas of communication technology. This blending of various communication systems can be seen in the following example.

PIONEER 10

On March 9, 1972, a rocket called Pioneer 10 was launched on a half billion mile trip to the planet Jupiter and beyond. There are no people on this craft, yet it travels at a controlled 7 miles per second. It will take Pioneer more than 80 thousand years to reach the nearest star. Microprocessors (data processing) onboard gather and transmit information to scientists on earth (telecommunications). Attached to the antenna is a plaque carrying a message for any extraterrestrial creatures that might encounter it (visual). Scientists had to decide what to say in the message and how to say it. What language would they speak? The following simple line drawing is a representation of the message. Pictographs were chosen because they can be more easily translated by other cultures.



The drawing represents a man and a woman next to a scaled drawing of the spaceship (to show our size). Perhaps the most important part is the inclusion of a hydrogen atom (the most common element in the universe), using the wave length of radiation given off to communicate where the rocket came from and how far our sun is from the center of the galaxy. This simple drawing is our first attempt to communicate with the rest of the universe using a variety of communication systems.

In short, communication keeps our society moving forward. The transfer of information by technical systems is a critical part of communication. The communication systems described here will continue to influence the way information is transferred in the future. Some of the individual components of the system may change, but the functions of the system will remain basically the same. The "Information Age" is here to stay.

COMMUNICATION TERMS

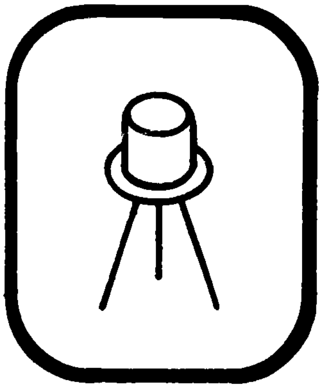
- **ACOUSTICAL:** Communication system that uses sound energy as a channel to transfer information.
- **CHANNEL:** That which conveys the information from transmitter to receiver (air, light, electromagnetic spectrum).
- **COMMUNICATION SYSTEM:** A combination of processes and hardware used to accomplish the transfer or processing of information.
- **DATA PROCESSING:** The storage, manipulation and retrieval of large amounts of information.
- **HUMAN-BASED COMMUNICATION:** Communication occurring directly between people without the use of technical devices.
- **INFORMATION AGE:** Used to describe the current explosion in information in terms of quantity, storage, and distribution.
- **INFORMATION SYSTEMS:** The combination of technical communication systems including telecommunication devices, computers, and visual devices used to create a network to process, store, and transfer information.
- **INTERFERENCE:** Anything that interrupts, distorts, or destroys the message before it reaches the receiver.
- **SYSTEM:** A number of things, devices, or forces acting together to form a whole in order to meet established goals.
- **TECHNICAL-BASED COMMUNICATION:** Communication through the use of technical means used to extend the human capability of sensory communication.
- **TELECOMMUNICATION:** Communication system that uses the electromagnetic spectrum to transfer information.
- **VISUAL:** Communication system that uses light energy as a channel to transfer information.

FOR FURTHER STUDY

Communicating the future. *Futurist*, April 1981.
Communications: Dramatic changes ahead. *Futurist*, April 1978.
Haykin, S. S. *Telecommunication*. New York: John Wiley & Sons, 1978.
Hellmen, H. *Communications in the world of the future*. New York: M. Evans, 1975.

Microelectronics in Communication

Electrical circuits that are very small in size are called **microelectronic circuits**. These circuits contain many components that are capable of performing complex electronic functions, such as switching electron flow off-and-on and amplifying electron power. The microelectronic circuits have been connected with power supplies and control boards to perform many functions in a variety of communication devices. Video games, door bells, hand calculators, and computers are just some of the devices that use microelectronic circuitry.

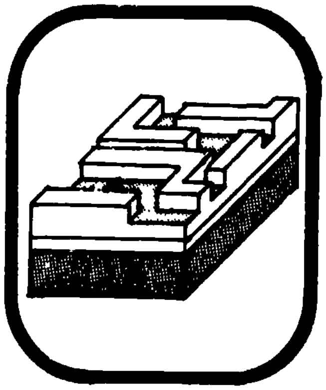


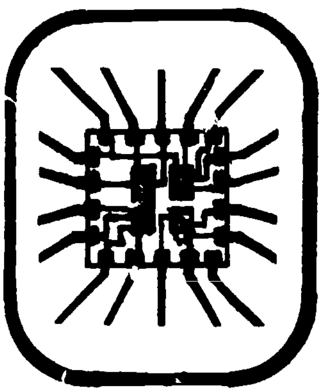
TRANSISTOR

A transistor is an electronic component that was developed in 1949 to amplify and switch electricity. Made of a material that was a semiconductor of electricity, the transistor is so named because it **transfers** voltage across a **resistor**. When first used in electronic circuits the transistor was a cylinder approximately, ½ inch (1.27 cm) wide and ½ inch (1.27 cm) high. Currently thousands of transistors are manufactured within the original transistor space requirements. The transistors of a digital circuit operate as switches.

INTEGRATED CIRCUITS

Integrated circuits include various elements, such as resistors and capacitors, that are interconnected as a complete circuit. The circuit is manufactured as a printed circuit that has printed connector leads to eliminate wires. Original circuit boards of the 1950s used standard-sized components. Today's circuit patterns are so small that they must be generated by computer-controlled electron beams.



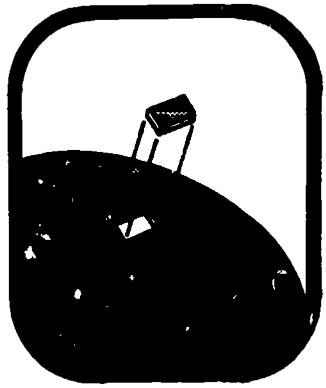


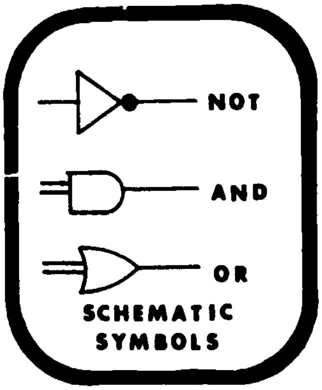
ELECTRONIC "CHIP"

An electronic "chip" is a very large-scale integrated (VLSI) circuit that contains microscopic components on a single silicon crystal. Currently, it is possible to fabricate and interconnect more than 150,000 components on a single chip of silicon approximately ¼ of an inch (.635 cm) on a side.

SILICON "WAFERS"

Very large-scale integrated circuits (chips) are fabricated on pure single-crystal silicon wafers. Hundreds of VLSI chips are fabricated on a single wafer currently 3 or 4 inches (7.62 or 10.16 cm) in diameter. The microscopic pattern of the VLSI circuit is transferred to the wafer by photolithography, then cut into individual "dice," each bearing a complete circuit. Because a single dust particle can cause a break in an electrical connection, sophisticated testing of each chip on the wafer is computer-controlled.



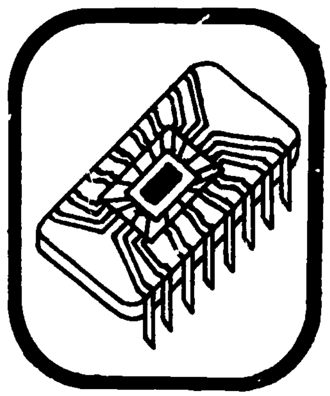


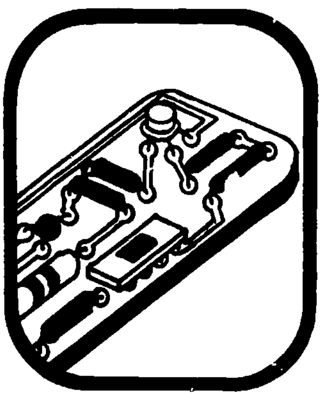
LOGIC GATES

An electronic logic gate is a miniature switch (constructed from metal-oxide transistors) on a chip that can detect high voltage that represents a binary 1 and low voltage that represents a binary 0. These gates control the processing of digital signals by a computer program.

MICROPROCESSOR

A microprocessor is a computer central processing unit (CPU) on a single chip. The microprocessor controls the strings of electronic signals flowing through the circuitry and performs arithmetic and logic operations. Housed into a black plastic package with electrodes connecting the wire leads to the chip, the microprocessor is inserted into a larger circuit board to be used in devices such as pocket calculators, toys, and computers.





PRINTED-CIRCUIT BOARDS

A single printed-circuit board or "card" can contain as many as 100 chips. The boards use printed connector paths to interconnect each chip. The circuit design minimizes connector paths resulting in boards approximately 5 by 7 inches (12.7 cm × 17.78 cm). Each board plugs into power supplies, and control circuitry in devices.

MICROCOMPUTER

When a microprocessor is mounted onto a printed circuit board and interconnected with devices that allow information to be entered, stored in memory, and displayed or printed, the result is called a **microcomputer**. Microcomputers about the size of an electric typewriter can process complex operations in nanoseconds.

FOR FURTHER STUDY

Cromie, W. J., & Rodgers, H. A. The big squeeze. *Technology Illustrated*, February/March 1982, 55–60.

Edelson, E. Mammoth magnets to microchips from superconductors. *Popular Science*, 1981, *218*(5), 72–75; 152.

Evans, C. *The micro millennium*. New York: Viking Press, 1980. *Scientific American*. September 1977 issue.

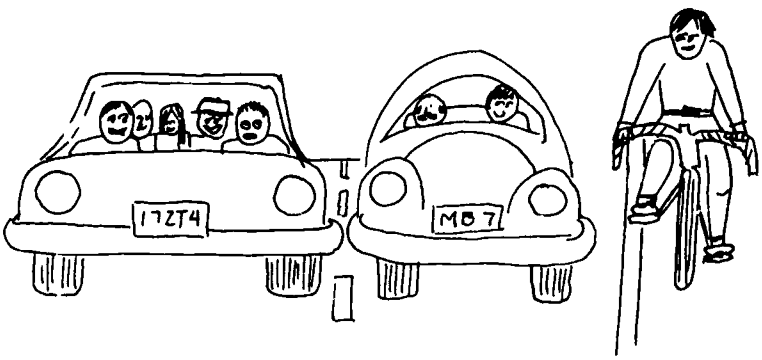
TRANSPORTATION & SOCIETY

Transportation is such a natural part of our daily activities that, like eating and sleeping, it goes almost unnoticed. Transportation is central to everything we do. In high-technology societies, transportation systems use devices such as conveyor belts, pipelines, automobiles, and jet aircraft to move people and goods. Let's explore some of the social impacts of transportation.

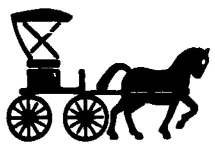
After reading this unit, you will be able to:

- Identify three ways our lives have been changed by developments in transportation.
- Describe the importance of transportation in today's society.
- Discuss how transportation has changed social relationships.
- Describe three government agencies that regulate transportation.

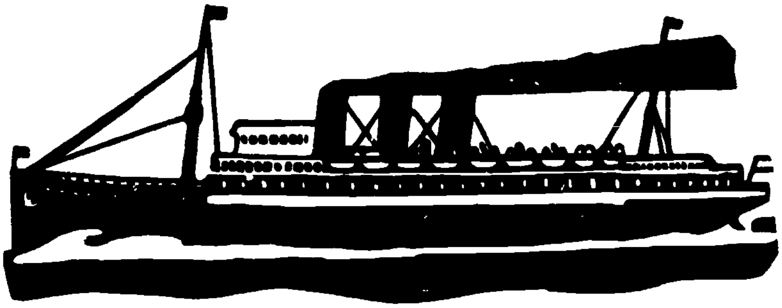
Yes, the new Firebirds and Camaros are hot cars, but are they really useful? What good are they in rough terrain? How much coal can they carry? Sometimes we need more than a fast car. For each aspect of transportation—such as speed, load limits, distance, and cost—there are social effects. The social effects caused by transportation have changed the way we think of ourselves. There are very few items we use or things we do that are not affected by transportation.



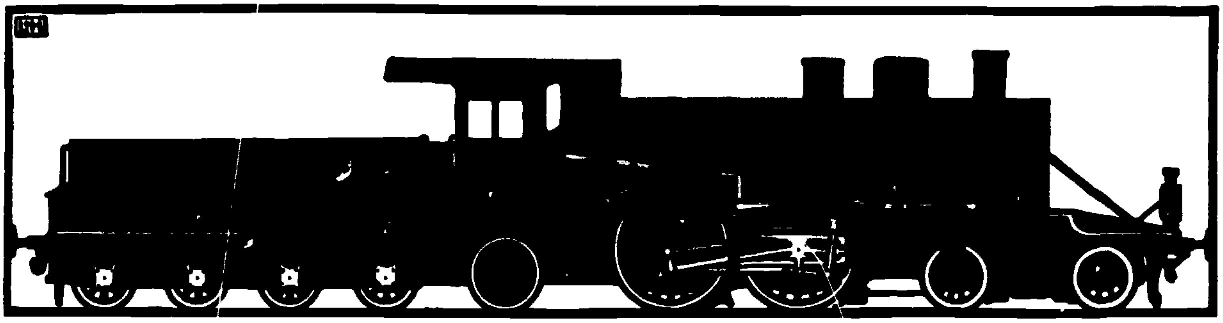
LOOKING BACKWARD



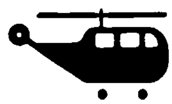
If you had to walk everywhere, you wouldn't get far. Your experience with other people and places would be limited. A major change came many years ago when humans domesticated animals and used them to carry people and their possessions. This change greatly expanded opportunities for travel and altered the way people lived and governed themselves.



Boats were developed that could carry heavy loads over great distances. Many of the great cities of the world were built on rivers and harbors where large boats could be accommodated. The adoption of the steam engine to propel marine vessels was a major development in transportation during the 1800s. The steam engine increased the reliability of marine transport. Later, the steam engine was adopted to rail transport, and the railroad opened the interior of the United States to agricultural development, business, and commerce. New towns and cities and new ways of earning a living came into being.

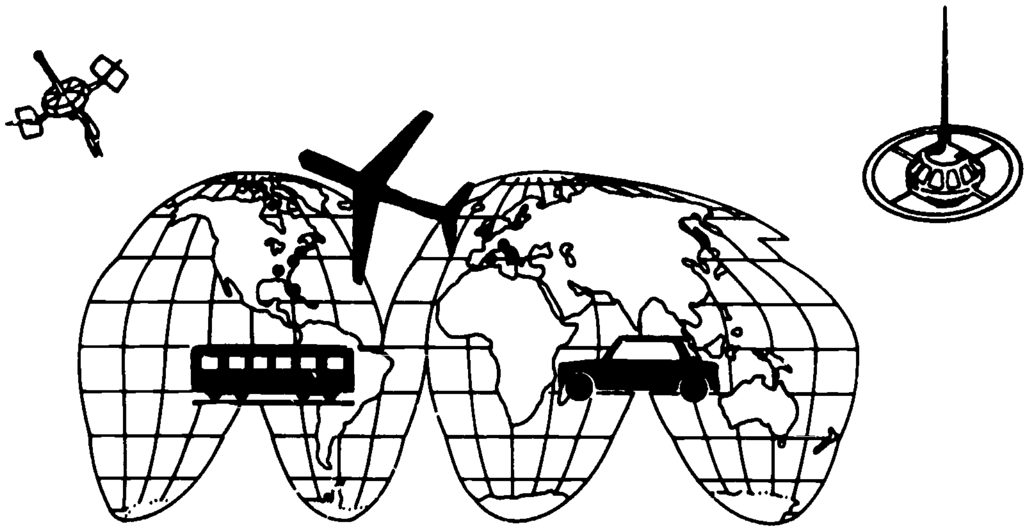


Where would we be without automobiles and trucks? They enable people to live almost any place. And, where the terrain is rugged, the airplane and helicopter expand the potential for transporting people and their goods and services to any place on earth. Interplanetary travel began with the landing of humans on the moon in July 1969. Again, we have expanded the potentials of human beings and altered the way we view ourselves and our future.



OUR INTERDEPENDENT WORLD

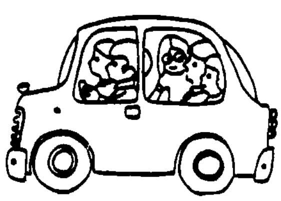
Because of modern transportation systems, it is possible to have breakfast at home, lunch in England, view a bicycle race in France, and go to dinner and a concert in Italy (if you can afford it). We live in an interconnected and interdependent world. Today's trucks, ships, planes, and trains link the resources and products people produce in a worldwide network. Some people in the United States drive cars manufactured in Japan and transported to the U.S. in specially designed ships. The United States ships food worldwide from its agricultural heartland. In turn, we use raw materials shipped in from around the world—industrial diamonds from the Republic of South Africa; manganese from Brazil, Australia, and South Africa; chromium from South Africa, the USSR, Turkey, and Zimbabwe; and oil from the Middle East.



Today we have a modern, worldwide transportation network made possible by high-performance diesel and turbine engines, electronic navigation, specialty containers and unit trains, and communication and information systems using satellites and computers. Shopping centers and food stores are stocked daily with products from a world market. Shirts from Hong Kong, cameras from Japan, strawberries and fresh vegetables from California, and paper from Canada are available most anywhere in the U.S.

SOCIAL IMPACTS

The automobile, tour bus, train, and airplane have increased the range of people we contact each day. The auto provides personal freedom for all ages, thereby expanding their social relationships. Dating patterns, family activities, choices of recreation, and personal perceptions of self have all changed. Such resources as food, water, and energy are distributed by a variety of transportation networks. For example, water is piped great distances in the western United States. Where once there was dry, unproductive land, successful farms now prosper. All this has changed where people live, but it also has increased our dependency on technical transportation systems.



SOCIAL CONTROLS

In the United States, we are free to move goods and people wherever and whenever we wish. Millions of people travel in cars, trains, buses, and airplanes each day. Tons of goods are shipped across the state and national boundaries each day. But with all this freedom of transportation, there are basic social issues, such as safety, price, and unfair business practices.

In some cases, laws have been passed or groups have been established by industry to regulate and control transportation in the U.S. For example, the Interstate Commerce Commission (ICC) regulates trucking and the transfer of goods across state lines. The Federal Aviation Administration (FAA) has certain rules to ensure the safety of airline passengers. Vehicle and roadway safety is regulated by the Department of Transportation (DOT). It appears that without some transportation regulations, our individual rights and freedoms might be abused.

SELF-QUIZ

Now that you have worked through this, try a SELF-QUIZ. On your own sheet of paper, write the answers to these questions.

1. What was the first major breakthrough for humans in improving their means of transportation?
2. How has an increasingly interdependent world affected the products we use in our daily lives?
3. What changes have automobiles made in our social relationships?
4. What three federal agencies act to regulate transportation in the U.S.?

Turn this page upside-down; you will find the answers at the bottom of the page. Go back and read about the ones you missed.

THINGS TO DO

Design a model of an urban mass transit system of the future. Construct both the model city and the transit system from "found" materials (old erector sets, scrap woods, model trains, etc.).

Design a "fantasy" trip anywhere in the world. Use as many modes of travel as possible. Include time tables, route, and cost. Be as detailed as possible. Make use of maps and travel agencies.

FOR FURTHER STUDY

Hellman, H. *Transportation in the world of the future* New York: M. Evans, 1968.
Nelson, R. Eight days on straight alcohol. *Popular Science*, April 1982, pp. 89–91; 188–191

Answers:
1. *the domestication of animals.*
2. *more imported goods.*
3. *dating and courtship patterns, recreation, and self-perception.*
4. *FAA, ICC, DOT*

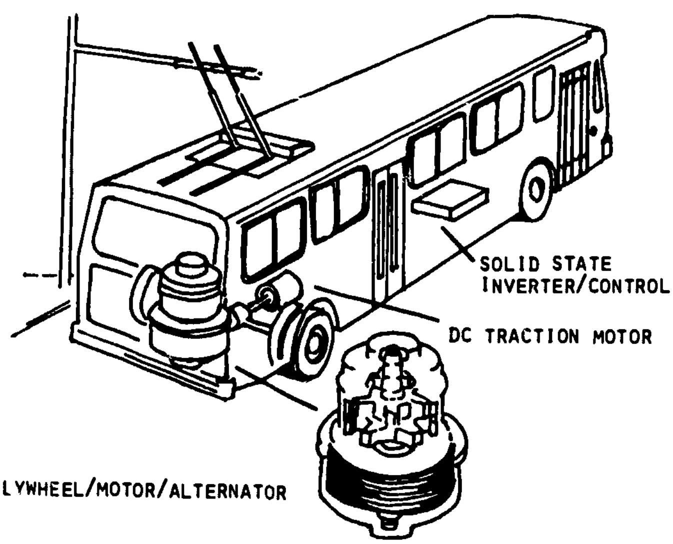
Energy & Power In Transportation

When you buy fresh bananas at the local grocery, do you ever wonder how far they traveled to get there? Do you know that the milk you drink probably came from cows hundreds of miles away? How much fuel does your family use each week traveling to work and to school? Moving people and goods from place to place takes lots of power and energy. More than one quarter of the total energy used in the U.S. goes for transportation. Let's look more closely at the situation.

After reading this unit you will be able to:

- List at least eight different transportation devices.
- Name the types of energy used in transportation vehicles.
- Understand the use of power plants.
- Tell what the efficiency of a power plant means.
- Describe the three components of a transportation system.

Many kinds of devices are used for transporting things or people. Some transportation devices are called **vehicles**; trains, cars, trucks, planes, and ships are examples. But pipelines, conveyor belts, and elevators are also transportation devices. Can you think of others?



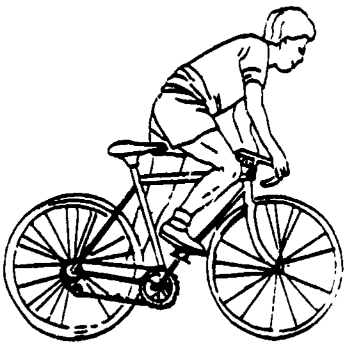
THIS TRANSIT BUS WITH A FLYWHEEL-ELECTRIC PROPULSION SYSTEM IS NOW UNDER DEVELOPMENT.

Most vehicles run on fuels made from petroleum (oil), and that energy source is in short supply. Some experts say that more than half of all petroleum energy is used for cars, trucks, and buses. What would happen if much of our world oil supplies were cut off? What would we use to power our transportation system? How would you get fresh milk, bread, and eggs?

Let's move ahead to find out . . .

WHERE THE POWER COMES FROM

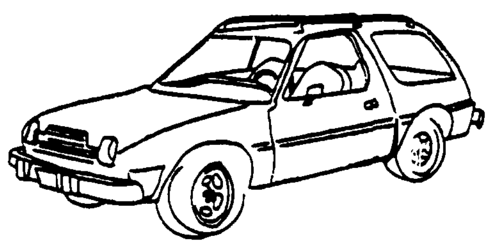
Transportation devices require power. Most vehicles carry power plants with them to convert fuels into useful energy. When you ride a bicycle, you are the power plant. The power plant in a vehicle is called an **engine**. The most common automobile engines burn gasoline, but some are diesel-powered. Electricity is also used to power vehicles, such as subway trains. For years, batteries have been used to power golf carts, lawn tractors, and other small vehicles. Battery-powered cars, and even small trucks, are now available. The U.S. Postal Service is testing some battery-powered trucks to deliver mail in urban areas.



For years, engineers have been experimenting with different designs for power plants for vehicles. One of the problems engineers try to overcome is low **efficiency**. The efficiency of an engine is described as energy output divided by energy input. In other words, if an engine provides one energy unit of output while using two energy units of input, it is only one-half (50%) efficient. It may surprise you to learn that most gasoline automobile engines are only 20% efficient. The battery-powered motors of electric cars are 60% to 90% efficient. How about that?

APPROXIMATE EFFICIENCY OF POWER PLANTS

60%–90%	Fuel Cell
33%	Electric Generating Plant (Coal)
33%	Stirling Engine
33%	Gas Turbine
30%	Diesel Engine
20%	Gasoline Engine

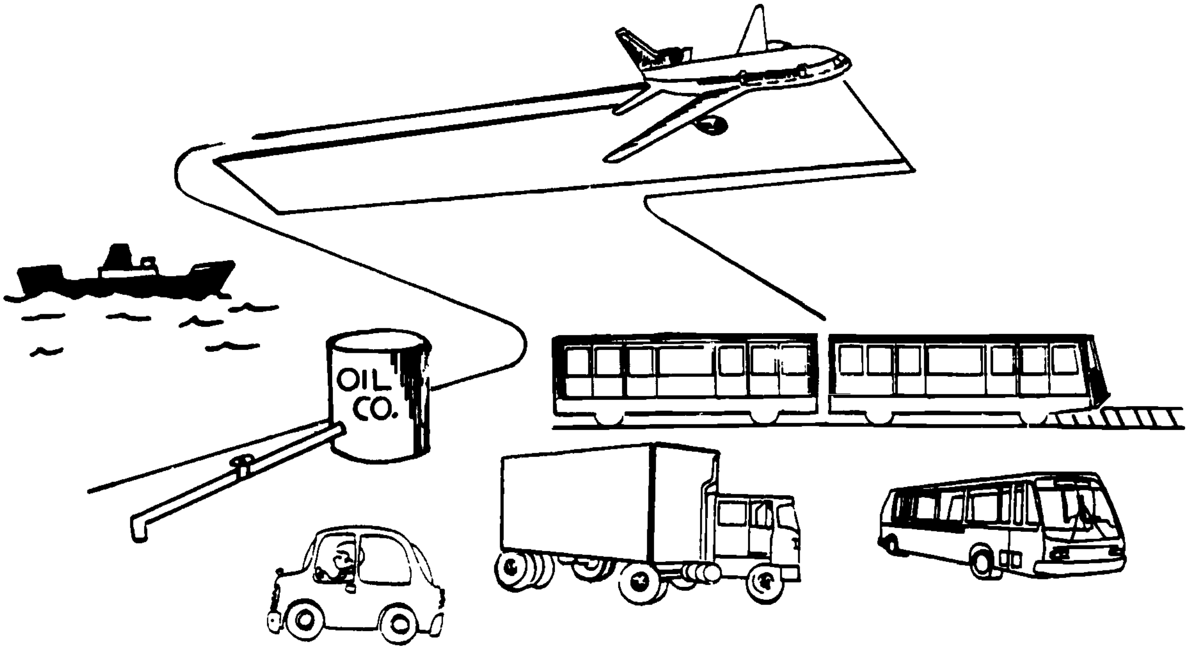


TRANSPORTATION SYSTEMS

In order to understand more about energy and power in transportation, you need to know about **systems**. A transportation system has three parts: collection, transport, and distribution. Often, several types of vehicles are used in the system. Engineers call this **multimodal** transport (*Multi* = many, *mode* = type).

An example of multimodal transportation is the movement of containers that can be carried by both trains and trailer trucks. The containers carrying goods are transferred from the trains to trailer trucks, which deliver the goods to their destinations.

In order to work best, each part of a transportation system should connect with the others. This means that **interfacing** of transportation systems is necessary. An example of interfacing is an airport where taxis, buses, trains, and delivery trucks collect and distribute people and goods. Interfacing of transportation systems requires careful planning for access to major centers by road, rail, waterways, and air.



Now, to link it all together . . .

Because of the limited supply of petroleum fuels, such as gasoline, diesel fuel, and oil for engines, scientists are working to find other sources of energy. More efficient power plants are being developed by technologists. Engineers are designing lighter-weight, smaller vehicles. Better design and use of public transportation systems will aid in energy conservation and will result in less air pollution from the exhaust of cars and trucks. Evaluation of your own transportation needs will help you to choose the "least-energy" approach. Can you carpool, use public transit, bike, or walk more often to save fuel?

How well have you collected this information? Using your own paper, write the answers to the following quiz.

SELF-QUIZ

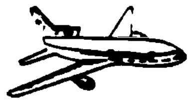
1. What percentage of the total energy consumption of the U.S. is used for transportation?
2. What types of fuels are used by transportation devices?
3. At the present time, what is the most efficient power plant that has been developed?
4. Describe the three parts of a transportation system.
5. Discuss ways in which energy can be conserved in transportation.

Turn this page upside-down; you will find the answers at the bottom of the page. Go back and read again about the ones you missed.

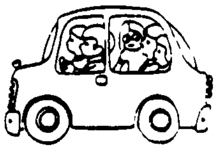
Answers:

1. More than 25% (one-quarter)
2. Petroleum fuel (i.e., gasoline, diesel fuel, oil)
3. The fuel cell
4. Collection, transport, and distribution
5. Efficient engines, public transport, carpooling, etc.

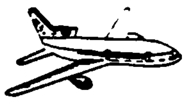
THINGS TO DO



Design a transportation system of the future for your community. Make sure to connect the various services needed by the people, such as shopping, schools, industry, hospital, homes, etc.



Find out the miles per gallon for a school bus, family car, bus, and train. Multiply the miles per gallon by the number of people transported to obtain person-miles per gallon. Which do you find to be the most efficient?



Construct a model rocket and test three different engines. Calculate the velocity and altitude of the vehicle with each engine.

FOR FURTHER STUDY

Assenza, T. Living with an electric car. *Popular Mechanics*, June 1980.

Carpenter, R. et al. *Power vehicles*. New York: Crown Publishers, 1974.

Gell, J. J. *Energy and transportation Power* Englewood Cliffs, N.J.. Prentice-Hall, 1976.

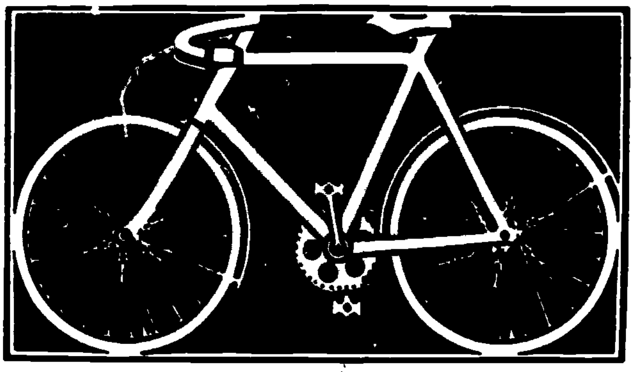
Transportation Systems

Most people think of transportation as cars, buses, trains, airplanes, elevators, bicycles, and sometimes even roller skates. All of these are common modes of transportation today. If we are involved in the study of transportation, systems, methods, and the design of new or alternative forms of transportation, then we find that other ways of viewing the movement of people and goods help us solve our problems.

Transportation systems are made up of natural and created elements. The natural elements consist of the environment in which the transportation device operates: water, air, land, or space. Sometimes technical words are used to described these mediums: *terrestrial* for *land*, *marine* for *water*, and *atmospheric* for *air*. The created elements—like roads, harbors, automobiles, airplanes, and spaceships—help provide the technical means to move people and goods in a specific environment.

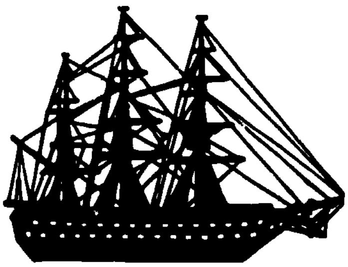
The Terrestrial Environment

The major portion, nearly 95%, of the movement of people and goods occurs on land. Many ways have been created to move people and goods. Some of these are the automobile, bicycle, pipeline, truck, conveyor, and elevator.



There are two types of systems for moving goods on land—**vehicular** and **stationary**. Cars and trucks are classified in the vehicular system. All vehicular devices move goods over the land on a fixed or random route. Pipelines and conveyors are stationary systems. The primary unit remains stationary while the item being moved is transported within or on the system.

Transport modes designed to move people are either **fixed route**, such as subways, elevators, or escalators, or **random route**, such as bicycles and automobiles. Fixed routes are efficient in land use and energy consumption but lack in the degree of responsiveness to human needs for transport.

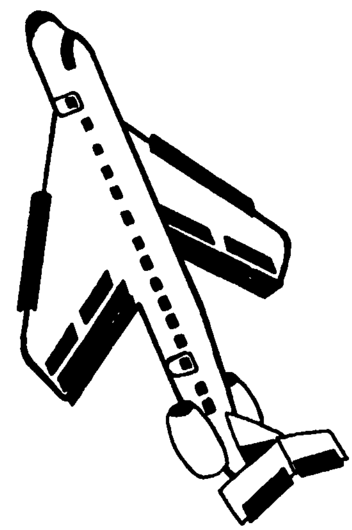


The Marine Environment

Water covers about 70% of the earth's surface. From the earliest of times, people have used rivers, lakes, and the oceans to move themselves and their goods from one place to another. Various forms of boats propelled by currents, oars, wind, and propellers, driven by steam, diesel engines, or turbines have been created and used.

There are two types of marine transport: **inland waterways** and **maritime**. Inland waterways include canals, domestic lakes, and coastal waters. Maritime includes transport in large inland lakes and oceans. Both inland and maritime waterways continue to grow in tonnage transported, primarily because of their economy in moving bulk commodities such as coal, grain, ore, and petroleum.

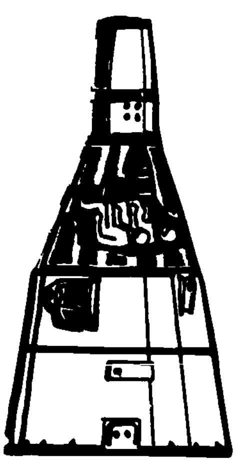
The Atmospheric Environment



This category includes any transport of people or goods above the surface of the earth but not beyond the atmosphere. Atmospheric transportation includes not only the vehicles but also the transport systems, such as airports and navigation devices. The development of atmospheric modes of transport has occurred primarily in the twentieth century. Kites, gliders, and balloons were the predecessors of today's powered, controlled, sustained flight.

The vehicles used in atmospheric transportation are classified as either **heavier-than-air** or **lighter-than-air**. Lighter-than-air vehicles include hydrogen, helium, or hot air balloons and nonrigid, semirigid, or rigid-type airships. Heavier-than-air vehicles include passenger or cargo conventional fixed-wing aircraft and rotary-wing aircraft.

The Space Environment



Transportation in space is a recent development. When we speak of space transportation we mean transportation in the reaches beyond the earth's atmosphere. Vehicles have been designed with the capability of orbiting the earth, transporting humans or cargo from the earth to the moon and back, and carrying instruments to the outer reaches of space. Vehicles used for transportation in space vary widely in design. Some are designed for earth's orbiting work; the space shuttle is an example. Others, such as the *Mariner* and *Viking* spacecraft, are designed for lunar, planetary, or deep space transportation.

Space transportation consists of **manned** and **unmanned** systems. The unmanned systems include various forms of missiles, sounding rockets, communication satellites, and deep space probes. Manned systems consist of spacecraft that are capable of orbiting the earth or traveling to another planet and returning to earth. Spacecraft for this form of transportation have their own built-in-propulsion, guidance, control, communication, and life-support systems for the humans on board.

TECHNICAL SYSTEMS IN TRANSPORTATION

All useful forms of transportation devices must have a means of propelling, suspending, guiding, and controlling the vehicle. In addition, each vehicle has a structural system that is designed to function in a land, marine, air, or space environment. These five technical systems, together with appropriate support systems, are common to all modes of transportation, varying in design and application by the nature of the transportation needs.

Propulsion Systems

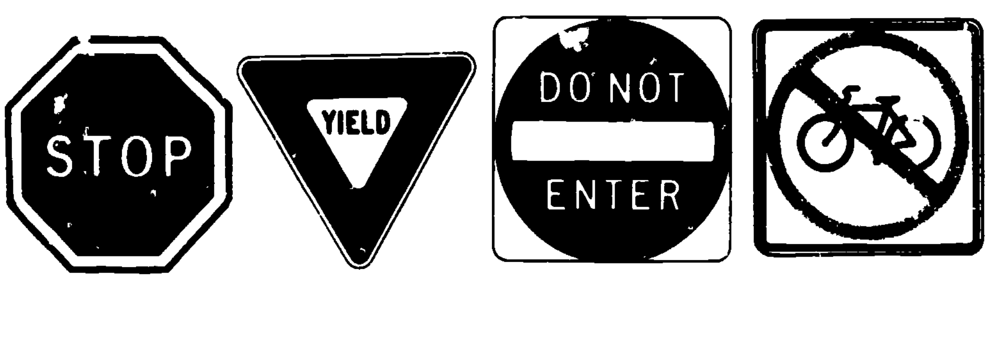
Propulsion systems consist of an energy source, a means of converting energy to do work, and a system for transmitting power to move people and materials. Most automobiles use a heat engine for propulsion, with a liquid gasoline or diesel fuel stored in a tank onboard the vehicle. The fuel is transmitted to the engine, where it is burned to provide power. The power generated by the conversion process is transferred to the drive wheels by a transmission system.

Every form of transportation expends energy to move a vehicle in a given environment. Improvements in propulsion systems have been responsible for major advances in transportation. The steam engine, compression ignition engine, and turbine have contributed in recent years to improvements in efficiency and reliability. Now, engineers are experimenting with electric and hybrid vehicles. New means of propulsion may greatly alter transportation in the future.

Guidance Systems

Guidance systems are designed to provide information to the vehicle or its operator to direct the vehicle along a prescribed path. Guidance systems are designed for specific purposes. Two factors determine the complexity of the guidance system: the environment the vehicle is to operate in and the nature of the vehicle and its purpose. A roller coaster in an amusement park requires a tightly controlled guidance system for obvious safety reasons. On the other hand, a bumper car ride provides less guidance and more driver freedom.

Human beings use visual and tactical information to guide them in walking. Traffic lights, signs, and center and edge markings on the highway are used by drivers to obtain guidance information to control the automobile. Aircraft, operating in a three-dimensional environment, use more complex information systems.



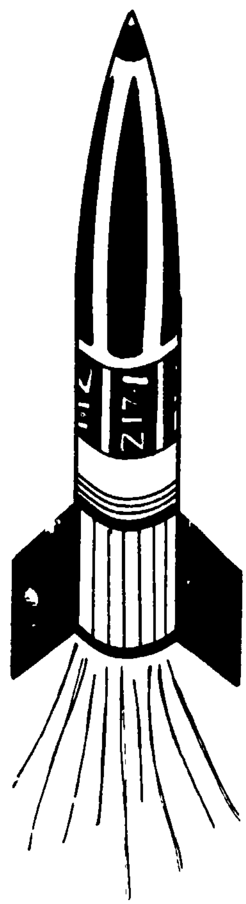
Control Systems

Control systems are closely related to guidance systems. They are either fully automated or activated by humans and receive information from the guidance systems. Control devices—such as brakes, wing flaps, diving planes, and throttles—are used to change, alter, and regulate the velocity, direction, or altitude of a vehicle within its environment.

Control systems often consist of **sensing devices**. The human operator or an instrument that measures velocity, altitude, or direction provides the sensing. There are also **activators**. These can be human or mechanical. Mechanical activators are pneumatic, hydraulic, or electrical devices which move a throttle to change velocity, alter a surface to change altitude, or apply brakes to arrest motion. Fully automated systems combine the guidance and control systems into a fully integrated system using a computer in place of a human operator.

Suspension Systems

Each type of transportation vehicle is suspended in some way in the environment in which it operates. Automobiles have wheels and springs, airplanes have wings, and ships have hulls. The wheel and axle is a mechanical suspension system, and the airfoil and the ship's hull are fluid systems. Some experimental vehicles even use magnetic fields for suspension. One such system, a high-speed train, has reached speeds of 200 miles per hour partly because of reduced friction.



Structural Systems

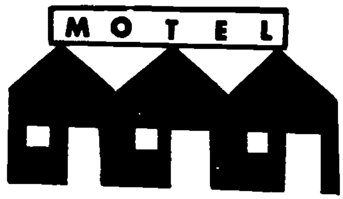
The shape of transportation vehicles and the way they are constructed are heavily influenced by the environment and the task they must perform. Automobiles are designed to carry people safely at moderate speeds over distances ranging from several miles to several hundred. The body or structure must also provide the occupants with comfort and safety.

Submarines and airplanes have different requirements. The submarine is exposed to a corrosive salt environment and high external pressures at great depths. On the other hand, an airplane must operate at high altitudes where the external pressure is reduced. The pressurization of the cabin exerts internal pressures. Both vehicles operate in a fluid medium, so streamlining is essential to reduce drag for high speeds and to achieve fuel economy.

The rockets that launch spaceships must be designed to withstand the tremendous forces at lift-off and to operate in the atmosphere. Spacecraft, however, do not require streamlining because they operate in a vacuum.

Support Systems

In addition to vehicles and their various technical systems, there are fueling stations, hotels, motels, airports, space stations, maintenance facilities, training facilities, maps, and emergency medical services. These are the support systems for transportation. Without these, transportation as we know it today would be impossible.



Transportation in the Future

Some people believe that the amount of travel will greatly decrease in the future because of fuel shortages and high costs. Others suggest that "technology" will provide innovative alternatives in transportation modes and systems. Already, complex mass transit systems or "people movers" are in use. In Japan, a train capable of speeds of up to 200 miles per hour moves people on a fixed-route transportation system from city to city. Electric and hybrid random-route vehicles can provide an alternative to the gas-powered internal combustion cars common today. Finally, smaller, more efficient gas-powered cars are becoming more and more popular. These are just a few of the possibilities for more efficient passenger transportation. However, there are still technical problems to be solved. People must also be made aware of the need for alternative means of transportation.

It should be obvious that transportation systems play an important role in our lives. With nonrenewable fuels in short supply and with the environmental problems associated with these fuels, many questions must be addressed. How might transportation be different in the future? What new kinds of vehicles might be developed? What can *you* do to help?

TRANSPORTATION TERMS

Activators: Devices that effect *change* in velocity, altitude, or direction.

Atmospheric: The transportation environment in the gaseous envelope surrounding the earth.

Control system: A means to change, alter, and regulate the velocity, direction, or altitude of a vehicle within a given environment.

Fixed route: Follows a predetermined path guided by some sort of track or wire system.

Guidance system: A means for providing information for the purpose of directing a vehicle along a prescribed path.

Inland waterways: Includes all waterways surrounded by land (rivers, lakes, bays) excluding the larger inland lakes.

Marine: The transportation environment on and in lakes, seas, and oceans.

Maritime: Includes oceans and large inland lakes.

Multimodal: Any form of transportation which could be used in more than one environment, for example, amphibian, land-water based vehicles.

Propulsion system: A means of converting and transmitting energy to move a vehicle in a given environment.

Random route: Can be determined by necessity and change to meet new needs of individuals at will.

Sensing devices: Devices that *measure* velocity, altitude, or direction.

Space: The transportation environment beyond the gaseous envelope surrounding the earth.

Stationary: Devices that move people or goods the distance of the device itself without the device actually moving.

Structural system: A systematic arrangement of the components of a vehicle body to provide for maximum performance in a given environment and protection of the people, goods, and/or instruments being transported.

Support system: Those components of a transportation system that provide logistic, maintenance regulatory, training, supervision, facilities, and other necessary services required by passengers, good movement, the vehicles, or other systems.

Suspension systems: The means by which a vehicle is related, connected, and/or associated with the environment in which it operates.

Terrestrial: The transportation environment on the surface of the Earth.

Transportation modes: Any specific form of transportation used in one specific environment.

Vehicular: Devices that move people or goods over the land on fixed or random routes.

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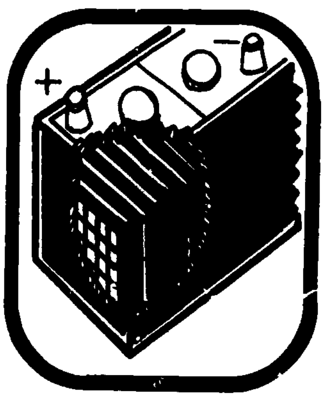
Electric & Hybrid Vehicles

INTRODUCTION TO ELECTRIC VEHICLES

Internal-combustion engines are the most common type of engine in cars today and are responsible for the majority of transportation in this country. Unfortunately, these engines also produce a major share of urban air pollution and gasoline consumption. Because preventing environmental pollution and conserving resources are important national goals, economical, pollution-free engines are the object of much research and development. Electric vehicles (EV's) are a promising solution to these problems.

ELECTRIC DRIVE

An EV is a transportation device that uses an electric motor to drive its wheels. The motor uses electrical energy stored in batteries. A motor converts the electrical energy to mechanical energy. An electronic control unit allows the driver to adjust the speed of the car by controlling the flow of energy from the battery to the electric motor. Electric drives can deliver maximum torque (twisting force) when the vehicle is starting from a dead stop. In this way, a heavy load can be started with a relatively small motor.



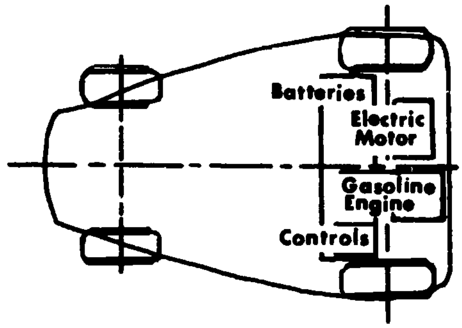
BATTERIES

The most common battery currently used in EV's is the lead-acid battery. This is the same type of battery used to start gasoline powered cars. They have the potential of producing about 10 watt-hours of energy per pound. Therefore, batteries have 100 times less energy. A 15-gallon tank of gas weighs about 100 pounds; the amount of batteries needed to produce the same energy would weigh more than 10,000 pounds. Excess weight is a major problem for electric vehicles. In the future, more efficient batteries may include lead-lead oxide, nickel-iron, nickel-zinc, zinc-air, sodium-sulfur, zinc-chloride, and lithium-air among others. An alternative to the lead-acid battery must be found before EV's can become a practical form of transportation.

OPERATING AN ELECTRIC VEHICLE

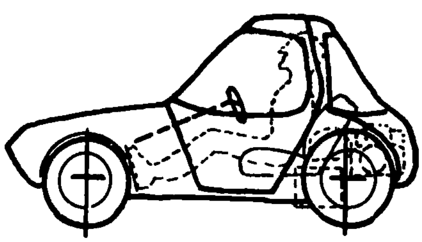
Lead-acid battery-powered EV's usually carry between 16 and 20 batteries. Most can go about 60 to 80 miles before they need recharging. A "charger" converts and regulates electricity from a common outlet to recharge the batteries. The vehicle must be plugged-in for 6 to 10 hours if the batteries are down to one-third capacity or less. Most lead-acid batteries will last 2 or 3 years with daily use. This becomes a major cost factor. EV's have a top speed of about 60 miles per hour, with cruising speeds for maximum mileage ranging from 35 to 45 miles per hour. The most practical use of electric vehicles presently are for commuting and short-haul delivery. They are easy to drive and the controls are similar to those in a conventional gas-powered car.

INTRODUCTION TO HYBRID VEHICLES



Hybrid vehicles combine an electric motor with a generator operated by an internal combustion engine. The generator charges the batteries when they are "drained," at the same time providing energy to run the vehicle. This back-up system helps to reduce pollution in several ways. As with EV's, hybrid vehicles can be operated at a constant speed all the time. Pollution is decreased because it is during acceleration and deceleration that most pollutants are emitted. Hybrid vehicles can operate exclusively on batteries in urban areas where air and noise pollution are critical.

HYBRID DRIVES



The combining of an electric motor with a generator allows for recharging the batteries while the vehicle is being operated. The engine generator unit provides the drive power during recharging. The hybrid vehicle also delivers maximum torque when the vehicle is starting from a dead stop. The advantage of moving heavy loads with little engine input is retained. The weight problem found with EV's is even greater with hybrids because they carry both the electric motor with batteries *and* the internal combustion engine.

OPERATING A HYBRID VEHICLE

The efficiency of hybrid vehicles falls somewhere between common gasoline-powered cars and battery-powered vehicles because the motor in the engine/generator unit can be smaller and more economical. Hybrids give the vehicle longer range than that of pure EV's because of gasoline assisted propulsion. The source of energy (electric or gasoline) would be determined by the length of the trip. The electric motor could operate on short trips and urban driving while the gas-powered engine would serve better on longer trips.

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Production & Society

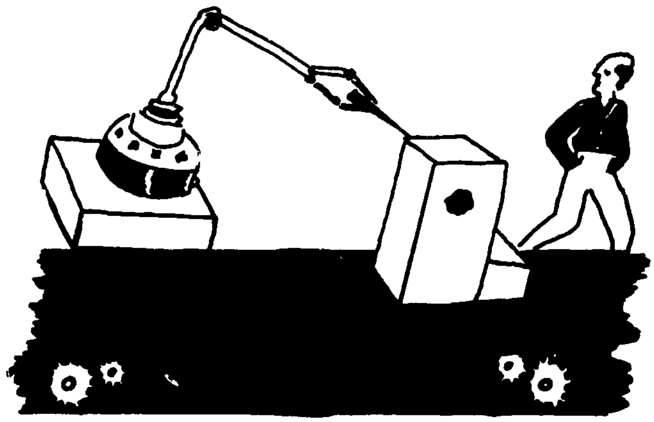
The production of goods and services is an important part of our society. Production technologies are a major cause of social change. For example, new types of work skills are needed as old ones are eliminated. Also, new production processes often require new raw materials. Such materials must be located and processed for use. These changes in materials and processes affect workers and their families. Workers must adapt to these changes, which is not always an easy task.

After reading this unit, you will be able to:

- Describe the impact of automation on unemployment.
- Discuss both the positive and negative effects of automation on work environments.
- Discuss the effect of a shorter work week on the recreation industry.
- Discuss environmental effects of production industries and recent efforts at making a more healthful environment.

Most everyone agrees that high unemployment is a major problem today. The number of people left jobless as large industries lay off workers increases daily. Why are workers out of jobs? One of the main reasons is automation. Automation normally allows goods to be produced faster, cheaper, and safer. Machines can do many of the routine jobs requiring little skill. They often eliminate the most dangerous and tedious tasks. After all, machines don't get bored, make mistakes, or get hurt in accidents.

Automation can leave many workers jobless, and the problems of unemployment may reach much further than just the individual worker. When a worker has been put out of a job by a machine or by a new production procedure, he or she is considered to be "**displaced.**" When workers are displaced, families and whole communities can be greatly affected.



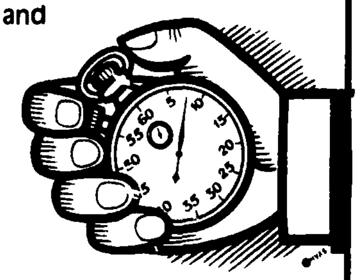
DISPLACED WORKERS

If a worker is displaced, the company will often try to retrain the worker for a new position, but frequently only the larger companies can afford to do this. Sometimes, the displaced worker can find a similar position with another employer who has not yet converted to automation. But, it may be only a matter of time before the new employer is also forced to change production techniques to keep up with the competition. The new employer might be located far from the worker's home, requiring more time spent traveling back and forth to work. Sometimes the new job is so far away that the family must move to a new home. This may mean that new friends must be made, new schools and churches located, and family life be disrupted.

THE NATURE OF WORK

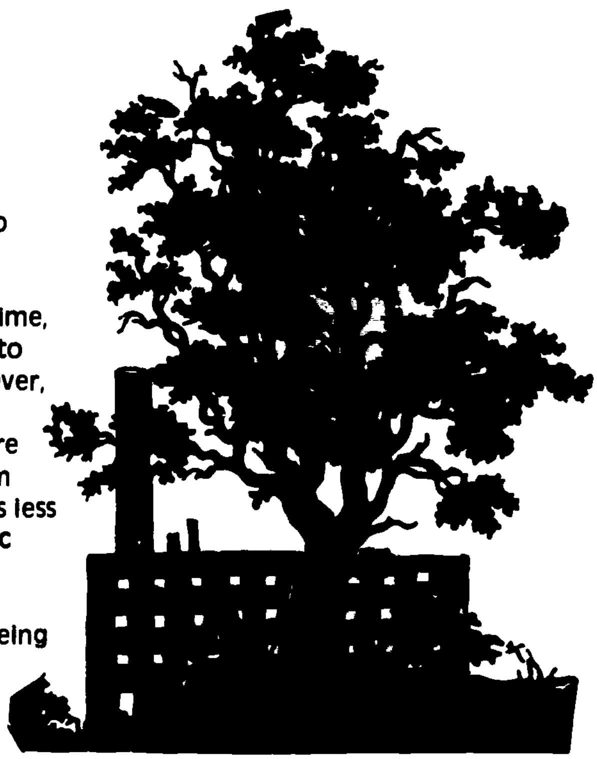
As new production techniques eliminate the more dangerous jobs, the workers may enjoy a safer and healthier life. Another positive result of automation is the reduced number of work hours that are required. In the early 1900s, production workers commonly worked more than 55 hours per week. Today, most production employees work fewer than 40 hours per week.

One of the reasons for this change in work hours has been the increased productivity of the worker. Modern production techniques have increasingly allowed each worker to produce more goods per hour. This increase in volume of production allows the employer to have the required amount of goods in a shorter period of time. In some cases, it also allows the employer to reduce the employee work time and increase the worker's salary.



INCREASED LEISURE TIME

The worker who is required to work only 40 hours a week rather than 55 or 60, obviously is less tired at the end of the week. This allows more time for relaxation and for recreation. The recreation industries have been among the fastest growing industries in the past 30 years. Tennis, racketball, boating, golf, bowling, softball, camping, gardening, and cycling are commonly enjoyed by more people than previously. Have you noticed how many television commercials and magazine advertisements are for recreation equipment? Effective use of leisure time is becoming more and more important as our society moves toward more sophisticated automation and robotics in the production of its goods and services.



ENVIRONMENTAL CHANGES

Changes in production technology have also helped to create a more healthful environment for our society. The production of goods for our consumption often results in large amounts of waste materials as by-products. At one time, these dangerous materials were allowed to be dumped into our waterways and our public lands. In recent years, however, responding to considerable societal pressure, "waste dumping" has been reduced. More than ever, industries are finding ways to recycle their waste products to make them harmless to society. As a result of these methods, our air is less polluted and waterways are cleaner. In some cases, specific land areas have been set aside and special containment apparatus developed to keep toxic waste materials from contaminating large land masses. In many areas, fish are being seen in lakes and streams for the first time in many years.

As new technologies, such as microcomputers and robotics, affect production systems, life-styles also will change. As an active member of our technological society, you can help make the changes be positive ones.

SELF-QUIZ

Now that you have worked through this, try a Self-Quiz. On your own sheet of paper, write your answers to these questions.

1. Does automation generally increase or decrease the number of workers required for production?
2. When production systems are automated, which types of jobs are the first to disappear?
3. What can workers do when they are "displaced" by automation?
4. What is the average work week today in production industries?

Turn this page upside down to find the answers. Go back and read again if you have missed any questions.

THINGS TO DO

- Visit a local production industry. Observe one of the workers and dream up a machine that could do the same job faster and safer.
- Develop scenarios in which the average work week in your community would be 30 hours. What might people do with their additional free time?
- Working with your classmates, design a child's toy. Set up an assembly line and produce 20 to 30 of the toys in as little time as possible. How many of the jobs on your production line could be done by automatic machines? Could production time also be shortened?
- Interview a worker who has recently been put out of a job by a change in production methods. How does the person feel? What does he or she plan to do next?

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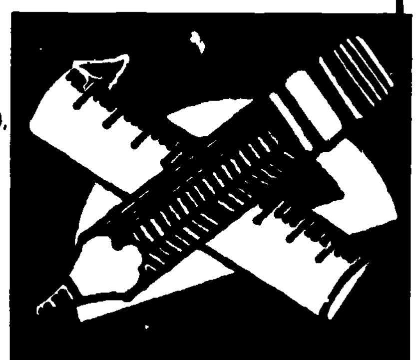


Answers:
1. Decrease
2. Hazardous, tedious, less skilled
3. Retrain, move to another location
4. 40 hours or less

Energy & Power In Production

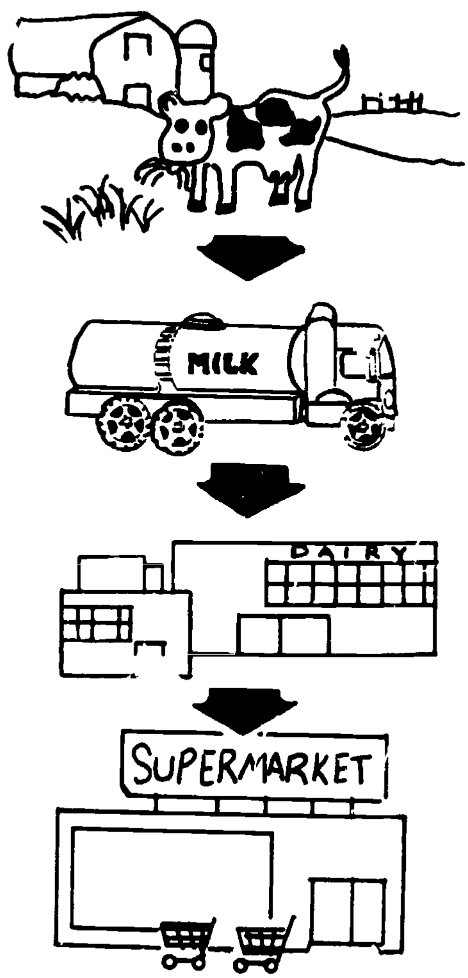
Have you ever thought about how much energy it took to construct your house . . . grow your food . . . manufacture your refrigerator? Almost one-half of the energy used in the United States is used for production of goods and services. Let's look at some of the ways energy is used in production.

After studying this unit you will be able to:

- Name three types of production systems.
- Explain where energy is used in production systems.
- List types of fuels used in production systems.

There are many kinds of industries involved in production. Some industries make tires or build houses; others mine coal or can food. All production industries can be divided into three types: processing, construction, or manufacturing. These are called the **production systems**. Energy is used throughout all of the production systems.

Let's proceed with . . .



PROCESSING

Processing industries extract (remove) raw material from nature and alter it for direct use by consumers or for use in the construction and manufacturing industries. For example, petroleum is pumped from the earth and is processed into gasoline and other products. Fishing, farming, and forestry are other examples of processing industries.

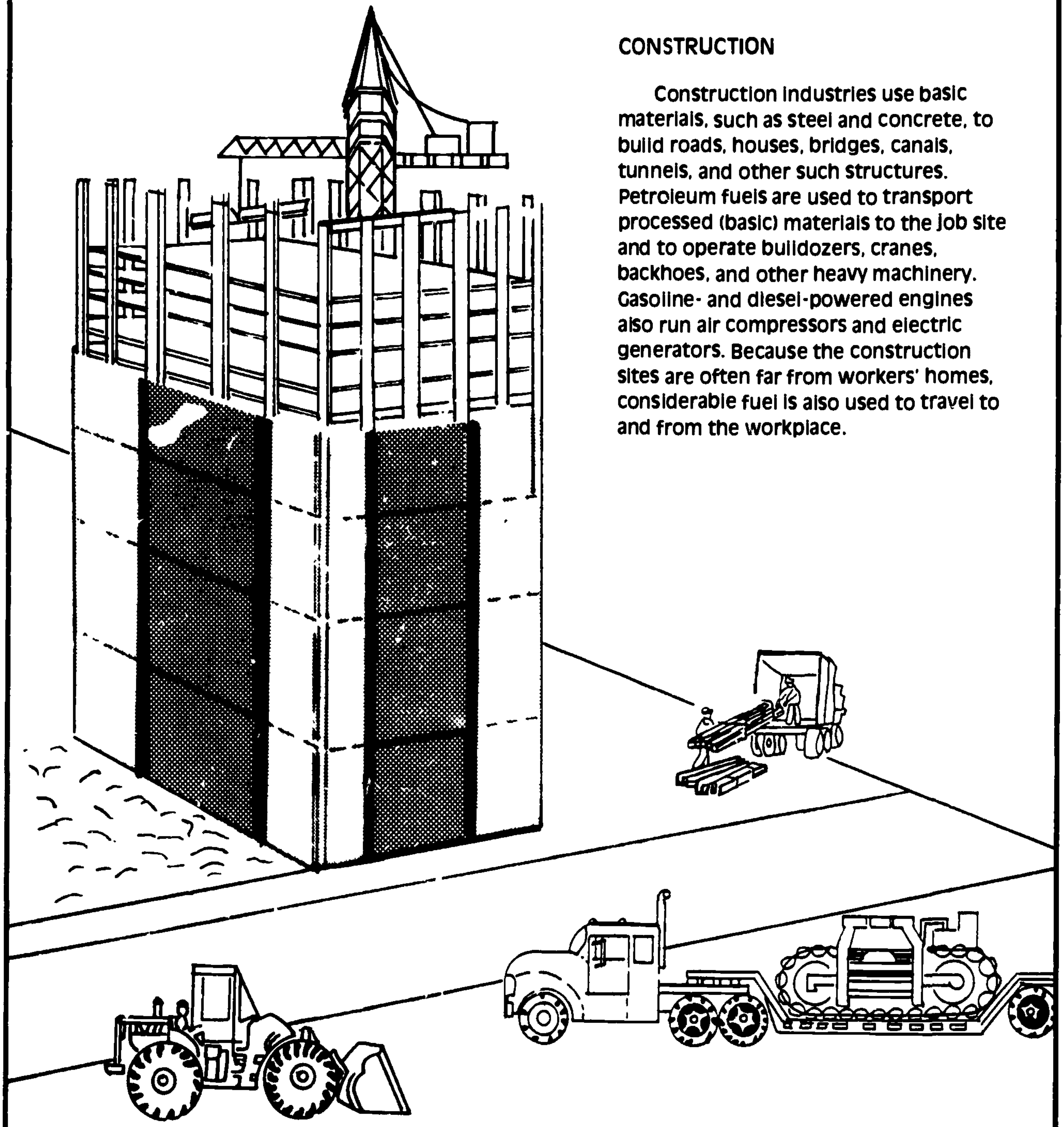
The processing of raw materials requires the use of petroleum fuels to operate the equipment. For example, diesel-powered fishing trawlers are used to haul fish from the sea. Modern farming methods also require large tractors and other harvesting equipment that use large amounts of petrochemicals.

Once raw material is extracted from the earth, it is transported (using more fuel) to a place where the material will be processed for further use. For example, coal is washed and sorted. Trees are sawed into boards and dried in large ovens called kilns. Iron ore is smelted (melted down) to make steel. Many of these processing steps require large amounts of fossil fuels and electricity, especially for heating or cooling the raw material. When a natural resource (raw material) has been processed to a more usable form, it is called a **basic material**.

Let's build on this and go on to . . .

CONSTRUCTION

Construction industries use basic materials, such as steel and concrete, to build roads, houses, bridges, canals, tunnels, and other such structures. Petroleum fuels are used to transport processed (basic) materials to the job site and to operate bulldozers, cranes, backhoes, and other heavy machinery. Gasoline- and diesel-powered engines also run air compressors and electric generators. Because the construction sites are often far from workers' homes, considerable fuel is also used to travel to and from the workplace.



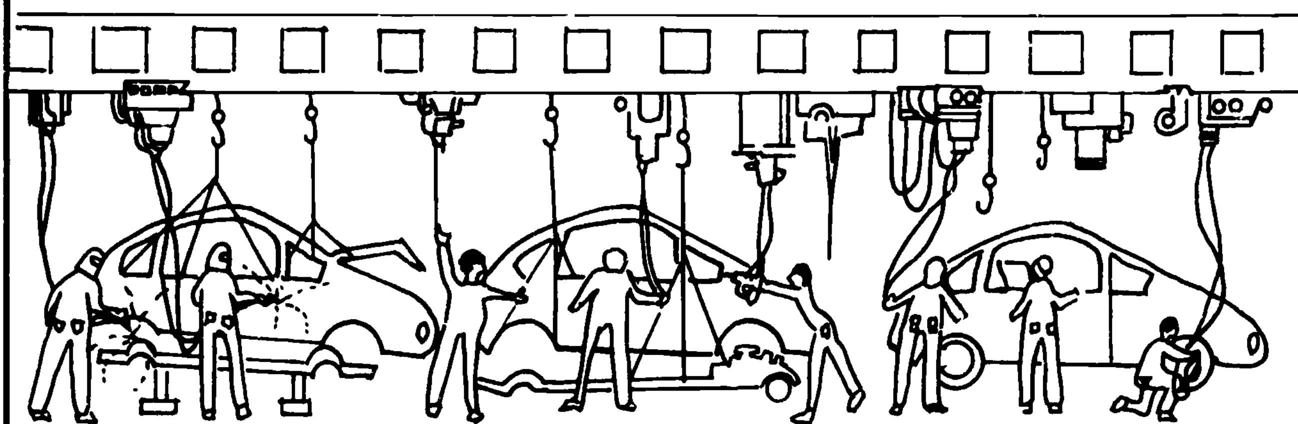
Take a look at . . .

MANUFACTURING

Manufacturing industries transform basic materials produced by the processing industries into finished products. Sheet steel, for example, is formed into home appliances, such as refrigerators and washing machines. Casting industries turn "pig" iron into engine blocks and pipe fittings.

As with construction industries, large amounts of petroleum fuels are required to ship materials to the place of assembly. Most manufacturing plants use materials from hundreds of individual suppliers, each located in a different part of the country.

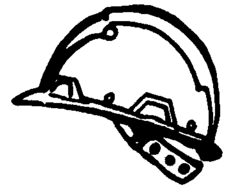
Fuel and energy are also used during the manufacture of products. Natural gas or electricity is used as a heat source in several processes. Electricity is used to operate tools and machinery. Even heating and lighting the workplace require considerable energy. Once the products are completed, additional fuel is used to ship them to distributors and retailers.



Now, to put it all together . . .

A great deal of energy is used by production systems. Almost half the energy used in industry is used to extract raw materials, process them, and manufacture and construct usable products. Unfortunately, much of the energy used in production is wasted because the equipment is not energy efficient. Because increasingly scarce fossil fuels are often used as energy sources, production industries are beginning to explore new methods to conserve energy while maintaining both quality and quantity of production.

Now, how well have you processed this information? Using your own paper, write the answers to the following quiz.



SELF-QUIZ

1. What fraction of all energy used in the U.S. is used for production?
2. What are the three types of production systems?
3. Which types of production industries require energy for heating and lighting the workplace?
4. In which type of industry are raw materials changed into basic materials?
5. Which production industry requires energy to move materials?
6. What fuels are often used to power bulldozers and heavy construction equipment?

Turn this page upside down, you will find the answers at the bottom of the page. Go back and read again about the ones you missed.

THINGS TO DO

- List the types of energy used to produce your school lunches. Analyze the amount and cost of energy used.
- Set up a small production line to manufacture a product. Record all energy-consuming activities, such as drilling and cutting. Be sure to include the energy needed to move parts from one station to another on the assembly line.
- Select a local construction project. Identify where the construction materials come from and how they are transported. Calculate the amount and cost of fuels used.

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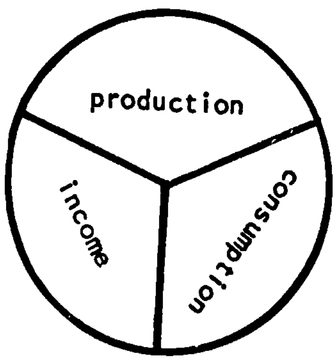
Pannell, J. P. M., *Man the builder*. New York: Crescent, 1977.

Answers:
1. One half
2. Processing, construction, manufacturing
3. Processing, manufacturing
4. Processing
5. All production industries
6. Petroleum fuels (gasoline & diesel)

Production Systems

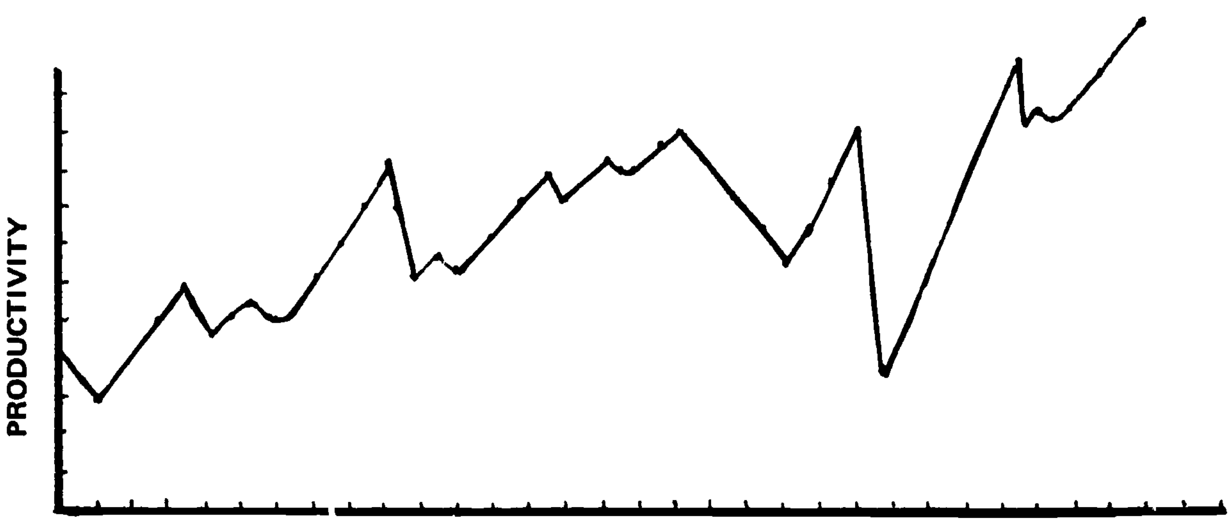
The production of goods and services is a major part of the economic system in the United States, as well as in most other countries in the world. To purchase goods and services, it is necessary to use or manipulate natural resources in the form of raw materials and human resources in the form of labor. We can define production, then, as the creation of goods and services of economic value for human wants and needs through the use of natural and human resources.



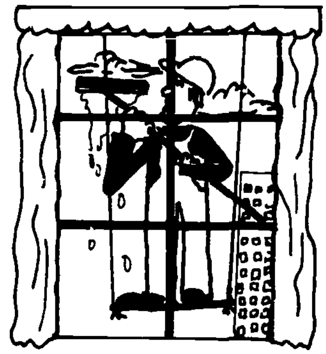
Production is one of the three major parts of a larger economic system. The **production** system provides the goods and services we use in the **consumption** cycle. It also provides **the income** through payment for labor, which allows us to consume the goods purchased. The profits made by the companies from these sales are reinvested to produce more goods and services, and the cycle is repeated.

MEASURING PRODUCTION

A common way to measure how well our economy is doing is to measure our productivity. We often hear on the news that "productivity increased this month by 1.2%" or that "the productivity of our nation's industries declined two-tenths of a percent last month." Such figures are an indication of how efficient our production system is during a particular period.



There are many ways to measure productivity or efficiency. One of the most common ways is to divide the output (the amount of goods and services produced) by the number of worker hours (labor) it took to produce this output. So if you cleaned 4 windows in 1 hour, your productivity would be rated 4/1 or 4. If you sped up the next week and cleaned 6 windows in 1 hour, your production rate would increase. An increase in productivity, then, would mean that the amount of goods and services produced had increased while the amount of labor it took to produce them remained the same, or perhaps even declined.



Production systems can be divided into three major subsystems: service, manufacturing, and construction. Since the end of World War II, the number of employees required in each of these subsystems has changed drastically. The worker needs in the subsystems that produce goods (manufacturing and construction) have remained practically unchanged. But the service industries subsystem has more than doubled its need for workers. Only the agriculture sector of the economy has shown a constant decline of workers needed in the service industry subsystem.

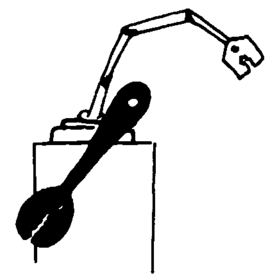
PRODUCTION SYSTEMS

Manufacturing | Construction | Service

Household | Intermittent | Handicraft | Continuous | Automated

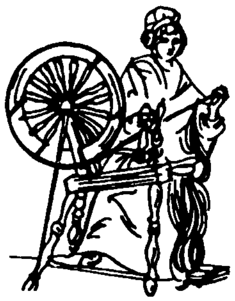
Why has this change in worker demand occurred? Part of the reason lies in the continuous automation of our manufacturing and construction industries. Another is that as the production systems become more complicated because of automation, there is an increased need for support systems that help keep the system working. For example, where it once took 10 people to weld a section of automobile body frame, it is now done automatically by an industrial robot. But a worker is still needed to program the robot so that it does what it is suppose to do. That person, called a computer programmer, performs a service for the automobile manufacturing company. The programmer does not actually produce a product but performs a service that allows the manufacturer to produce many products more efficiently, thus increasing the company's productivity.

MANUFACTURING



The production industries that are a part of the manufacturing subsystem are those that produce goods for consumption by the society. These goods are produced in a variety of ways, ranging from the use of simple tools and a maximum of labor to the use of complex tools and a minimum of labor. Most of our manufacturing concerns are moving toward the use of more complex tools and less labor.

The manufacturing industries can be further subdivided into five general categories. They are listed below.

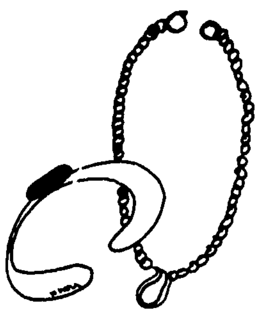


HOUSEHOLD

In this category, items are produced or manufactured in the home, primarily for personal or family use. Knitting an item of clothing and canning garden vegetables are examples of household manufacturing.

INTERMITTENT

This category identifies those manufacturing industries that are generally small in size. Their production of a particular item is not constant; emphasis is on producing small volumes of a number of different items. Machines are almost always used to produce these items, but these machines are usually controlled directly by the worker. Sometimes small "job-shops" produce seasonal items, such as picnic tables or Christmas toys, using this method.

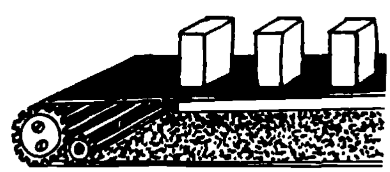


HANDICRAFT

Handicrafts are items that are usually, but not always, produced in the home using simple hand tools. Usually the items manufactured are sold for income rather than for use by the manufacturer's family.

CONTINUOUS

A continuous manufacturing industry produces large volumes of one or just a few items. Emphasis is placed on making large numbers of items in the shortest period of time. The production lines in this method are often permanent, with only minor changes made as the design of the product changes. The major manufacturing industries in the United States apply the continuous manufacturing method. The machinery used in this production method is very sophisticated. Often, the worker controls a machine by manipulating a few levers or pushing a few buttons to perform a series of complicated operations.



AUTOMATION

The automated method for producing goods is a complex system in which the materials move through the required operations with little or no human assistance. An oil refinery is an example of this type of manufacturing.

In some operations, human perception, senses, and muscle have been almost entirely replaced by electromechanical subsystems. A feedback closed-loop control system, often controlled by a computer program, is used to maintain a continuous flow of production. When the combination of automation and computers is used, this combination is called **cybernation**.

CONSTRUCTION

Whereas products made by manufacturing processes are usually produced in a factory or shop, constructed products are often assembled at the site where they will be used. This is partly because of the size of the job, the location, and the small number of items being produced. Large, one-of-a-kind products—such as bridges, roads, and dams—are produced by construction methods. Constructed products normally require that workers, tools, and materials travel to the assembly site. There are generally three types of products made of construction methods: shelters, supporting structures, and containing structures.

SHELTERS

Houses, barns, stores, and tents are constructed for the purpose of shelter. The design and materials need only to hold up the weight of the structure itself and to survive the weather. Recently, new designs and materials have been used for shelters. The roof of the Pontiac, Michigan, football stadium is made of nylon fabric and is held up by air pressure.

SUPPORT

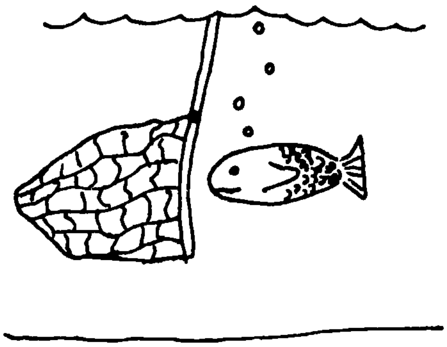
Some structures are designed primarily to hold things up. Bridges, antenna towers, roads, and furniture are examples. Support structures often must be designed to withstand heavy loads, including severe weather and natural erosion of the construction materials.

CONTAINMENT

Cages, bins, closets, dams, and pipelines are constructed to hold materials in place or to direct them along a pathway. As with many other types, containment structures must be able to survive the natural elements over a long period of time. The Alaskan oil pipeline is perhaps one of the most famous of recent containment structures.

SERVICES

The service industries subsystem is the fastest growing area of the production systems. No original goods are produced in this subsystem, but natural resources are manipulated and human resources are used to perform special services. The subsystem is further divided into two major categories: the harvest industries, where the natural resources are primarily used, and the services-performed industries, where the human resources are primarily used.



HARVEST INDUSTRIES

This category identifies the industries in which natural resources are harvested. Included are agriculture, forestry, fishing, and mining. The harvested products of these industries are often changed into goods in one of the manufacturing industries. For example, harvested food is processed by canning, freezing, and so forth; harvested trees are turned into lumber to build homes; and harvested minerals (commonly called mining) are processed into a variety of metals, which in turn are turned into individual products in the manufacturing area.

SERVICES-PERFORMED INDUSTRIES

As noted earlier, this system is the fastest growing area in terms of numbers of persons employed. One of the major reasons for this expansion is because technology is constantly making new things as well as making old things more and more complicated. Therefore, the average person must look to an "expert" to help maintain, repair, and, in some cases, even manipulate the new technology.

PRODUCTION AND THE FUTURE

It should be obvious to any student of industry and technology that changes are coming at a faster and faster rate. The National Academy of Sciences recently stated that "the modern era of electronics has ushered in a second industrial revolution . . . its impact on society could be even greater than that of the original industrial revolution." If this is true, then we need to prepare ourselves for the future.

Of the three major production systems (manufacturing, construction, service), the fastest growth in employment opportunities will continue to occur in the service industries. Manufacturing industries, as more and more robotic devices replace hand labor, may require fewer workers in the years ahead. Employment levels in the construction industries will remain steady because hand labor is an important part of most on-site building procedures.

PRODUCTION TERMS

AUTOMATION: A self-controlled production system. Once the system is turned on, it operates continuously until shut off. A human operator is needed only to make adjustments.

CONSTRUCTION: Building stationary structures such as roads, custom-built homes, dams, and factories. Constructed products are built on the same site where they will be used.

CONSUMPTION: The "using up" of goods and services. When items are consumed, new ones are produced for purchase with income.

CYBERNATION: Computer-controlled automation. Often very complex, cybernetic production systems make their own adjustments with human intervention.

ECONOMIC SYSTEM: The larger context in which production systems operate, along with systems of consumption and income. Goods and services produced are purchased with income, and then consumed.

GOODS: Materials resulting from production systems.

HARVESTING: Gathering natural resources for further use. Includes activities such as mining coal, picking apples, and baling cotton.

MANUFACTURING: Producing portable products that will be used at another location, such as clothing, tools, appliances, and machine parts.

NATURAL RESOURCES: The "stuff" of production. Naturally occurring materials, such as the raw materials used in the production of goods and services.

PRODUCTIVITY: A measure of output (amount of goods and services produced) divided by the amount of input (worker hours).

PROCESSES: Operations performed as part of the systems. Examples: drilling, cutting, baking, freezing, and dyeing.

SERVICES: Activities that do not produce real objects but that serve the economy in some way; for example, repair and maintenance.

FOR FURTHER STUDY

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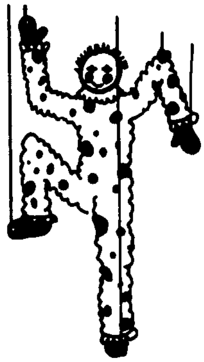
Robotics & Production

Although the idea of robotics has existed since ancient times, the term is only about 60 years old. The term robot, coined in 1921, means employing a mechanical device that can perform some type of manipulation or locomotion under automatic control.



A BRIEF HISTORY

Today's concept of the robot is the result of an evolutionary process. The robot's original function was to entertain humans. The ancient Greeks, Ethiopians, and Chinese built many statues powered by water and steam and were entertained by puppets made of weighted cords. As time continued, the form of the "robot" became more humanoid (humanlike).

Although these mechanisms were implemented for entertainment, their appearance and actions were very humanlike. During the eighteenth and nineteenth centuries, as technological advancements progressed to skilled watchmaking, the performance of robots also advanced. Machines were built to aid draftsmen. In one sense, these drafting machines were robots; they relieved people from labor. Machines were developed to make straight lines, intricate patterns, and exact copies. Most notable of this period's robotic devices is the automaton. Automatons could write, draw pictures, and play musical instruments.

REPLACEMENTS IN WORK

During the 1920s, robotic devices relieved humans from toil. Machines washed clothes and directed traffic, entering home and business solely for the purpose of relieving people of their tedious work. We now have mechanisms to control our heating and cooling systems, wake us in the morning, turn our lights on and off, open our doors, and type our papers for us.

COMPUTERS AND ROBOTICS

The impact of introducing robotics into industry has been enormous. The impact of combining robotics with computers (artificial intelligence) will greatly affect industry and work people do. Today, robots perform tasks that are risky or boring to humans. Most of the industrial robots are servo-mechanism robots that do a specific task or movement An electronic memory enables the machine to store programs. Linked with the computer, the robot can be adapted to different situations. A robot programmed to spot weld a 1983 Chevette can be reprogrammed for next year's model.

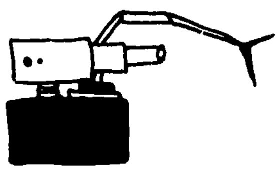
SOME UNUSUAL ROBOTS

Many industries have developed unusual robots to aid in work. "Silent Sam" now replaces the flagperson in controlling traffic. This humanlike figure raises and lowers a flag to warn of oncoming traffic. It never tires, needs no supervision or health insurance, and is not bothered by careless drivers. The Mobot Mark II is even more sophisticated. To provide maximum maneuverability, Mobot's arms, wrists, elbows, and shoulders are doubled jointed. General Electric has developed a robot as large as an elephant that can lift great weights. The "Exoskeleton" mimics and amplifies the movements of the user's arms and legs, giving superstrength to the operator.

SENSORY SYSTEMS

Because robots mimic certain human functions, they contain complex sensory systems. These sensory systems, include vision, tactile (touch), and auditory (hearing) systems. Currently, photoelectric cells and television cameras are used to perform tasks that require sight. The process is still very crude in comparison to human sight.

THE FUTURE



Use of industrial robots has just begun and is likely to double about every three years for the rest of the century. Currently, the United States uses about 3,000 new robots every year. In some countries, such as Japan, many times that number are in use. In the future, robots will be rented; we will have robots to build houses, mine the ocean floors, and even farm the seas to produce food.

ROBOTS AND SOCIETY

The relationship between humans and robots has gone through many stages, from enjoyable entertainment to an industrial villain. Robotics are often regarded as thieves of jobs. Welding robots never tire, require no insurance, and do not complain or become ill. Most robots do jobs that are distasteful or environmentally dangerous. Sometimes jobs are created for humans to make more robots. The reaction to robots is changing from fearful to friendly. After all, they are machines that must be programmed by humans. As we adjust to this "invasion," robots may become accepted in a positive way.

FOR FURTHER STUDY

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