Chapter Highlights

- Technology depends on seven resources: people, information, tools and machines, materials, energy, money, and time.
- Each resource of technology is necessary for the production of goods and services.
- People create, produce, and maintain the products and services of technology.
- The products people produce and consume have an impact on our nation's economy.
- People create laws to control the use of technology and its impacts on society and the environment.

Test Your Knowledge

1. List the seven resources of technology.
2. Imagine that you are the owner of a company that manufactures sunglasses. Give one example of each of the seven resources of technology you need to produce your product.
3. How does the consumption of products and services affect our nation's economic health?
4. As a consumer of products, how can you have an impact on what is sold in local stores?
5. Explain what "human factors engineering" involves.
6. What is an entrepreneur? Name at least one modern entrepreneur.
7. How are product innovations different from inventions?
8. Which federal office is responsible for creating environmental regulations?
9. Name one agency that tests products to make sure they are safe.
10. Schools, like factories, have regulations designed to protect your safety. List three safety rules that apply in your school.

Correlations

SCIENCE

1. Choose one of the following industrial materials and write a report about the health risks faced by the people who work with the material: asbestos, polyvinyl chloride, uranium, coal dust, naptha, benzene.

MATH

1. Matt has developed a protective case for Nintendo® cartridges. The production costs are $0.78 each. He sells them for $1.45 each. How much profit does he make on one item? On a dozen?

LANGUAGE ARTS

1. How would you like to become an entrepreneur? Develop an idea for a business that would appeal to other students. You may invent or innovate, but consider all seven resources. Describe your new company in a news release.

SOCIAL STUDIES

1. Your book defines the economic term GDP. What is America's current gross domestic product? What industries in the United States have decreased the most in production? See if you can find out at least one reason why the GDP has changed in the last ten years.

CHAPTER 4

Tool and Machine Resources

Introduction

It was not by accident that the first attempt at technology resulted in a tool. Tools make work easier. Our ancient ancestors were trying to make everyday life less difficult.

Modern technology uses many different kinds of tools and machines to accomplish this same goal. In this chapter, we will look at many tools and machines and how they help change materials, energy, and information into products and services.

After reading this chapter, you should be able to

Discuss the different families of tools and what they do.

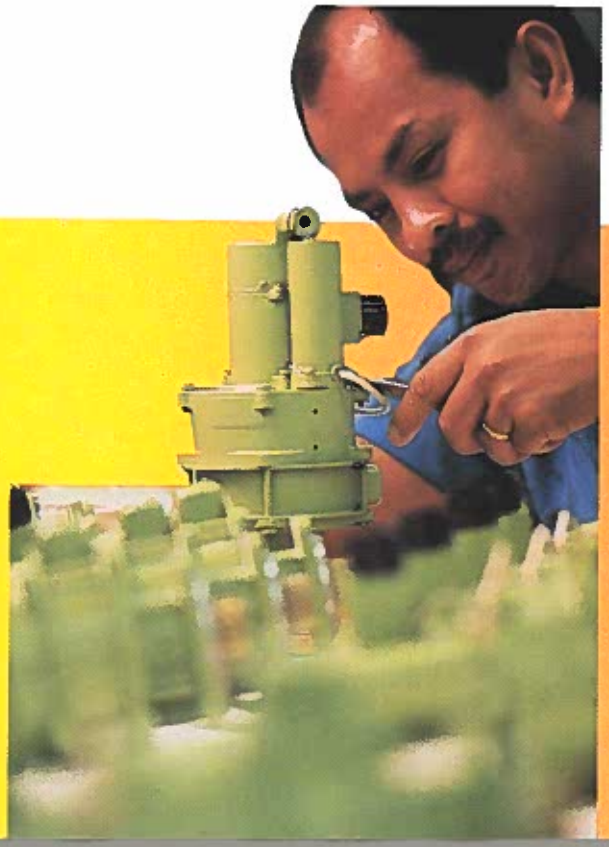
Identify specific tools and machines.

Understand the importance of safe tool and machine operation.

Understand the importance of safe conditions in a laboratory.

Words you will need

force
mechanical advantage
measuring
layout
separating
forming
combining
optical



What Are Tools and Machines?

How many tools and machines can you name? Your list would probably be quite long. Somewhere on your list, we would find hammers, saws, and wrenches. These are common tools that most people know about.

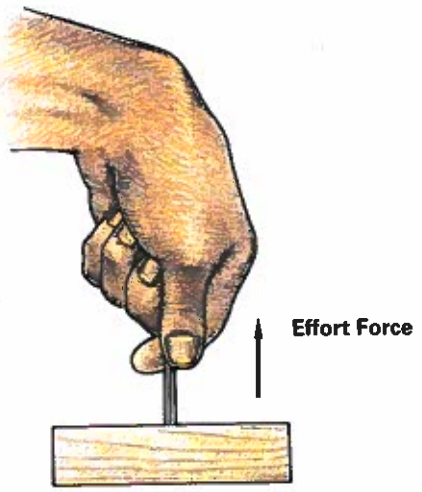
Technology is dependent on these as well as tools and machines that many people do not usually consider. For example, is a computer a tool? What about a microscope?

A good definition for tools and machines might help answer these questions. Tools and machines are devices that help make work easier.

Some tools and machines make work easier by changing the amount of force and the direction of the force you place on an object. **Force** is the push or pull that gives energy to an object. For example, a crowbar increases the force applied by your arm to pull a nail. Fig. 4–1.

Tools and machines that increase our applied force create a mechanical advantage. **Mechanical advantage** is the number of times a machine increases the force we apply. Fig. 4–2.

Not all tools and machines increase our force. Some make work easier by extending our human powers. Microscopes and telescopes allow us to see objects that are too small or too far away to be seen by the human eye alone. Computers help our brains organize large amounts of information and make instant calculations. Are computers and microscopes tools? According to our definition, the answer is yes.



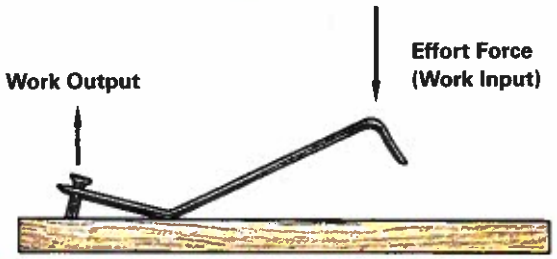
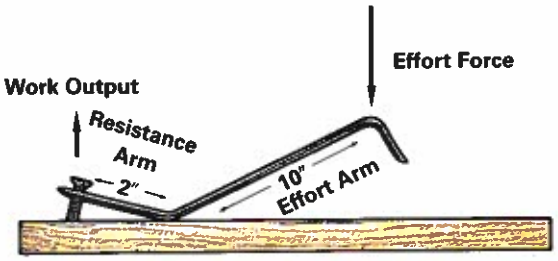


Fig. 4-1. To pull this nail, you would push down on the crowbar with less force than you would need to pull it by hand, but you would have to push through a greater distance.



$$\frac{\text{Effort Arm Length}}{\text{Resistance Arm Length}} = \text{Mechanical Advantage} = \frac{10}{2} = 5$$

Fig. 4-2. To calculate the mechanical advantage of this crowbar, divide the length of the effort arm by the length of the resistance arm.

▶▶▶ FOR DISCUSSION ◀◀◀

1. You have two hammers, one with a 10″ handle and the other with a 14″ handle. Which hammer gives you the greatest mechanical advantage for pulling a nail from a board? Why?

2. Make a list of the tools and machines commonly found in a dentist's office.

Uses of Tools and Machines

Tools and machines can be organized into groups. The tools in each group are designed to perform a variety of processes. The groups are:

- hand tools
- power tools and machines
- computer-controlled machines
- electronic equipment
- optical tools and machines

Different tools are designed to be used for different processes. **Measuring** tools, for example, are used to determine the size of objects. **Layout** tools are used to draw lines, angles, and circles on different materials. These lines tell us where to cut or bend the material.

Separating tools and machines cut or remove part of a material. **Forming** tools and machines change the shape of materials such as clay and metal without removing any materials. **Combining** tools and machines allow us to fasten materials together using nails, screws, or other fasteners.

Other tools and machines are designed to collect and help us examine information. A battery tester is a good example of this type of tool. It not only measures the output of the battery but uses this information to determine whether the battery needs to be replaced.

Hand Tools

Hand tools are tools for which people supply the power—muscle power. Some of the more common hand tools used in technology are found in figures 4–3 through 4–7 (pages 54–58).

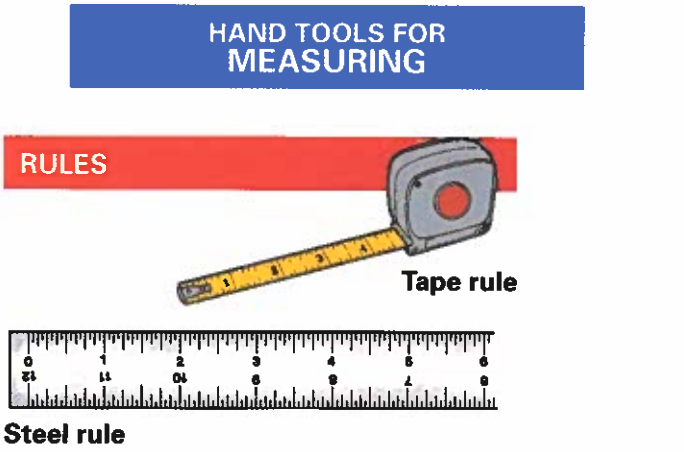
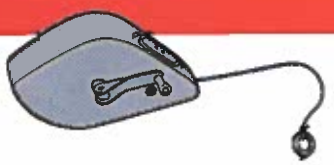


Fig. 4-3. Rules measure distances such as length, width, and thickness. For finer measurements, precision tools are needed.

HAND TOOLS FOR LAYOUT

CHALK LINE

for long lines (horizontal and vertical)



LEVEL

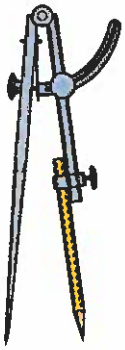
for level surfaces (horizontal and vertical)

CENTER PUNCH

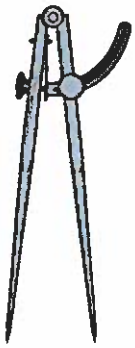
for points (locations to be drilled or punched)

DIVIDERS AND COMPASSES

for arcs and circles



Compass

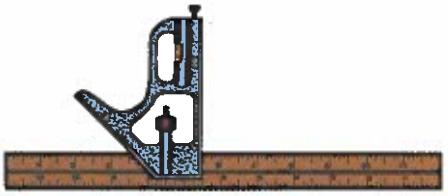


Dividers

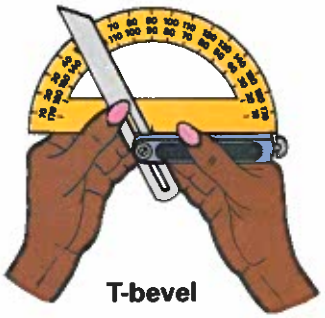
SQUARES AND BEVELS

for angles

Try square



Combination square



T-bevel

MARKING GAUGE

for parallel lines

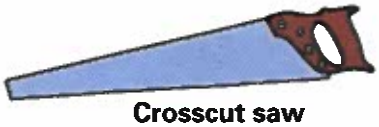
Fig. 4-4. A wide range of layout tools allows us to lay out designs accurately.

HAND TOOLS FOR SEPARATING

SAWS

for wood

Ripsaw



Crosscut saw

for metal

Hacksaw

FILES

for wood, plastic, metal, and other materials

Half-round file

Flat file

DRILLS

for holes in a variety of materials—

Bit brace for auger and expansive bits

Expansive bit

Auger bit

Hand drill for twist drill bits

Twist drill bit

BLOCK PLANE

for wood—smooths and trims by shaving off fine pieces

SURFORM TOOLS

for metal—smooths and trims by shaving off fine pieces

CHISELS

rough or smooth cuts

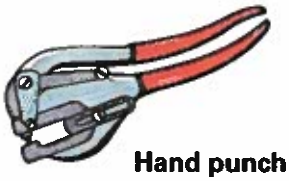
Wood chisel

Cold chisel (for unhardened metal)

SNIPS AND PUNCHES

for sheet metal

Tin snips



Hand punch

Fig. 4-5. Hand tools used for separating.

HAND TOOLS FOR COMBINING

WRENCHES

tighten nuts and bolts

Adjustable open-end wrench

Open-end wrench

Ratchet wrench with sockets

Box-end wrench

PLIERS

hold fasteners in place during installation

Slip-joint pliers

Long-nose (needle-nose) pliers

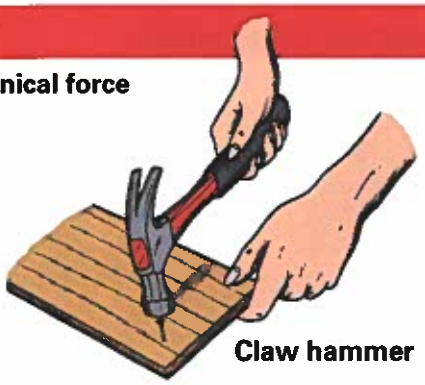
Locking pliers

HOT GLUE GUNS

melt solid glue or adhesive, which is used to combine materials

HAMMERS

apply mechanical force to fasteners



Claw hammer

SCREWDRIVERS

turn screws, which fastens materials together

Standard screwdriver

Phillips screwdriver

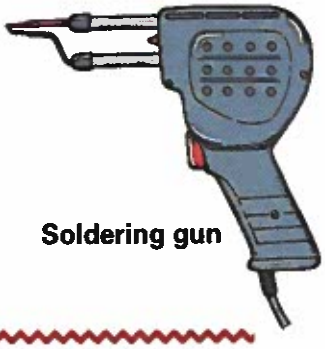
Square-head screwdriver

POP RIVETERS (BLIND RIVETERS)

install rivets

SOLDERING TOOLS

melt solder, which is used to combine materials



Soldering gun

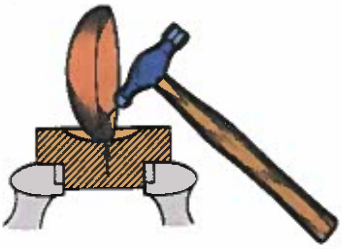
Soldering iron

Fig. 4-6. Hand tools used for combining.

HAND TOOLS FOR FORMING

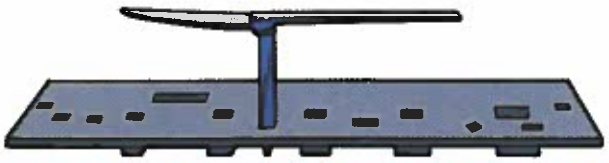
BALL PEEN HAMMER

for cold and heated metals



STAKE AND BENCH PLATE

for sheet metal



HAND SEAMER

for sheet metal

Fig. 4-7. Hand tools used to form metals.

MACHINES

HYDRAULIC

Robotic gripper

Floor jack

PNEUMATIC

Jack hammer

Nail gun

Backhoe

Dentist drill

Fig. 4-8. Have you ever felt the force inside a bottle of soda when you shake it up? This force is caused by the gases inside pressing against the bottle walls. The same force is used to power pneumatic and hydraulic machines.

POWER TOOLS AND MACHINES

SMOOTHING

Orbital sander

Belt sander

Surface planer

Surface grinder

DRILLING

Electric hand drill

Cordless hand drill

Drill press

CUTTING

Circular saw

Jigsaw

Router

Saber saw

Reciprocating saw

Table saw

Fig. 4-9. Power tools and machines make many tasks easier by substituting electrical energy for human effort.

Power Tools and Machines

Power tools and machines use energy from other sources to accomplish work. Electrical energy and energy from compressed air (pneumatics) and compressed fluids (hydraulics) are common sources of energy for power tools. Fig. 4–8 (page 58).

Most power tools are handheld or portable. Machines are usually large pieces of equipment that are not moved around. Figure 4–9 (page 58) shows some of the more common power tools and machines.

TECHNOLOGY TRIVIA

The first power tools were developed in the early 1800s when the steam engine was applied to various tools. More than 1700 years earlier, however, the first known steam engine was described (about A.D. 60) by Hero, a scientist who lived in Alexandria, Egypt. Unlike later steam engines, Hero's steam engine performed no useful work.

Computer-Controlled Machines

Computers can be found almost anywhere work is being accomplished. In technology, computers are used to gather, organize, store, and share information. They are also used to control machines. Fig. 4–10.

To help you understand computer control of machines, let's "computerize" your kitchen toaster. You could program your computerized toaster to produce toast as light or as dark as you wanted. You could even have a piece of toast that was light on one side and dark on the other. A sensor might sense the color of the toast and feed this information to the computer. The computer would turn off the heating elements when the right color was reached and pop the toast up.

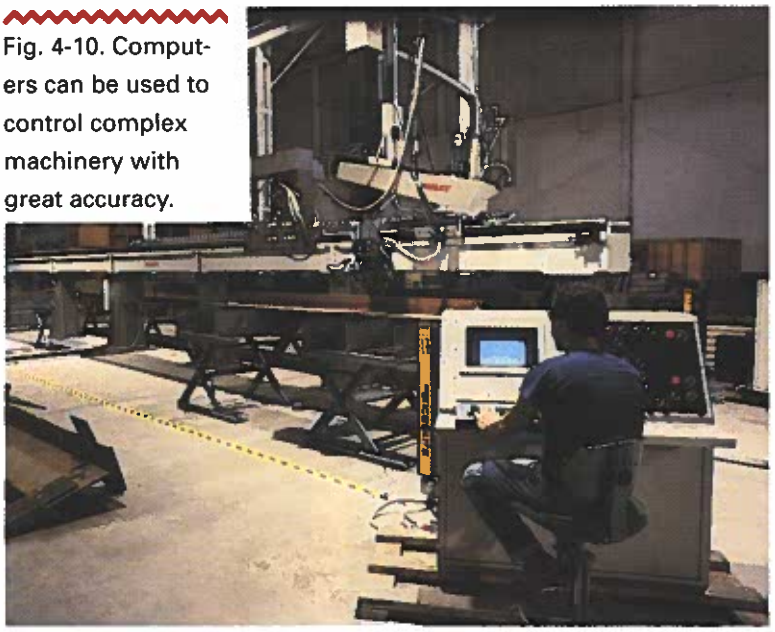


Fig. 4-10. Computers can be used to control complex machinery with great accuracy.

Using computers, operators can program machines to do a variety of tasks. For example, a computer-controlled lathe can be programmed to make a baseball bat without help from a human operator.

TECHNOLOGY TRIVIA

Computers can make milling operations 53 times faster. A part that takes an experienced machinist four hours to make on an ordinary milling machine can be made in 4½ minutes with computer control.

IMPACT

As machines become "smarter," fewer people are needed to work in factories. In the future, there may be large factories with only a few humans supervising the machines. Where will the rest of the people find work? Many of them will be in service industries, such as health care, food service—and computer repair!

Electronic Equipment

Electronic equipment is used to gather, test, and evaluate information about machines. Using sensors, electronic equipment supplies information we need to determine how well a machine is performing. Some electronic equipment can even evaluate this information and tell us where there is a problem.

Optical Tools and Machines

Optical tools and machines allow us to view things that we could not ordinarily see. Microscopes and telescopes are optical machines. Using lenses, these machines help us investigate things as small as a human cell or objects as far away as a star. Fig. 4–11.

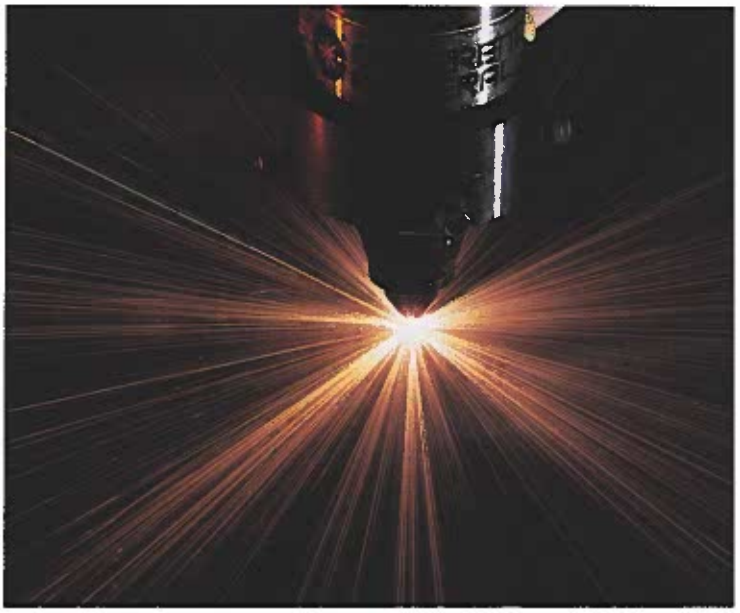
Fig. 4-11. Telescopes and microscopes are two common examples of optical tools.

Lasers are another type of optical tool. Lasers are devices that produce a concentrated beam of light that is very powerful. Fig. 4–12. Modern lasers can also be controlled by computers.

▶▶▶ FOR DISCUSSION ◀◀◀

1. How has the development of computer control and optical equipment changed supermarket checkout counters?
2. List each piece of equipment in your kitchen as a hand tool, power tool, or computer–controlled/electronic machine. Tell which ones measure, separate, or combine materials.

Fig. 4-12. Laser tools use a concentrated light beam to do tasks that range from cutting materials to performing human eye surgery.



■ **If you were to build a model of a structure, what tools in your laboratory might you use?**

Tool and Machine Safety

The safe use of tools and machines is very important. Each year, thousands of people are injured while working with tools and machines. Whether we are working for a company, at home, or in the school laboratory, there are common safety rules we must follow.

Tool and Equipment Safety Rules

1. Get proper instruction and permission before using a tool or machine.
2. Keep the work area clean and organized.
3. Keep all cutting tools sharp.
4. Always use the correct tool or machine for a particular job.
5. Always use guards and safety equipment on tools and machines.
6. Report all damaged tools and machines to the instructor.
7. Be sure machines and portable power tools are unplugged when you change their settings.
8. Handle tools and equipment with care. Abuse of tools can cause accidents.
9. Allow only one person in a machine safety zone at a time.

Personal Safety Rules

1. Keep your hair away from moving parts. Wear a hat or tie back your long hair.
2. Do not wear loose-fitting clothes while you are using tools and machines.
3. Roll up your sleeves before you operate tools and machines.

COLORS FOR SAFETY	
Color	**Meaning**
Red	Danger or emergency
Orange	Be on guard
Yellow	Watch out
White	Storage
Green	First aid
Blue	Information or caution

4. Always wear safety glasses, goggles, or a face shield while operating tools and machines.
5. Know where all the emergency shut-off switches are.
6. Remove all jewelry before using tools and machines.

Laboratory Safety Rules

1. Clean up spills immediately.
2. No horseplay or fooling around is permitted in the laboratory.
3. Place tools back in their proper places when you finish using them.
4. Place oily rags in a safety container.
5. Learn and follow the fire safety rules for your laboratory.

Make a drawing depicting (showing without words) one of the personal or lab safety rules.

Chapter Highlights

- Tools and machines increase our mechanical advantage and our ability to get work done.
- Tools and machines are used to change materials, information, and energy into products and services.
- The many different types of tools and machines perform a variety of operations.
- Tool and machine safety is important to your health and safety.

Test Your Knowledge

1. Why are tools the earliest forms of technology?
2. Why are a stone ax and a laser both considered tools? Explain.
3. "Tools increase our mechanical advantage." What does this statement mean?
4. What type of operation does a ruler perform?
5. What type of operation does a pencil sharpener perform?
6. What type of operation does a calculator perform?
7. What do we call the group of tools that are usually powered by humans?
8. In which group of machines does a factory robot belong?
9. List three personal safety rules that you must follow when you use machines.
10. Do safety rules apply when you are using power gardening equipment? Explain your answer.

Correlations

SCIENCE

1. Power = Force × Distance, divided by Time. Calculate the horsepower you use to go up a flight of stairs. First, multiply your weight (in pounds) by the vertical height of the stairs (in feet). Then divide by the time (in seconds) that it took to climb the stairs. Note: 1 horsepower = 550 foot pounds per second.

MATH

1. The two most widely used measuring systems are the customary and the metric systems. One customary inch equals about 2.5 metric centimeters. About how many centimeters equal one foot?

LANGUAGE ARTS

1. Write directions for using a tool you have at home. Be sure your directions include safety rules for use.

SOCIAL STUDIES

1. When Samuel Slater came to the U.S. in the late 1700s, he began the factory system as we know it today. Compare the power tools used in the factories of the early 1800s with the power tools used in today's factories.

CHAPTER 5

Material Resources

Introduction

All technologies depend on materials. Materials are the "stuff" that things are made of. Early products were limited by the material resources available. Today, products are created from thousands of combinations of materials.

During the Stone Age, people chipped the first tools from rocks. The first metal tools were made during the Bronze Age (3000 B.C.). Bronze tools were stronger than tools of stone and wood, and they could be made in more shapes and sizes.

During the Iron Age, a period beginning about 1200 B.C., people learned to remove iron from iron ore and create tools that were even stronger than bronze tools.

After reading this chapter, you should be able to

Describe and give examples of the different categories of materials.

Discuss the basic principles of material science.

Describe some properties of materials.

Words you will need

natural resources
raw materials
renewable resources
synthetic materials
hardwoods
softwoods
alloy
ferrous
ceramics
polymers
thermoplastics
thermoset plastics
composite
molecule
plasticity