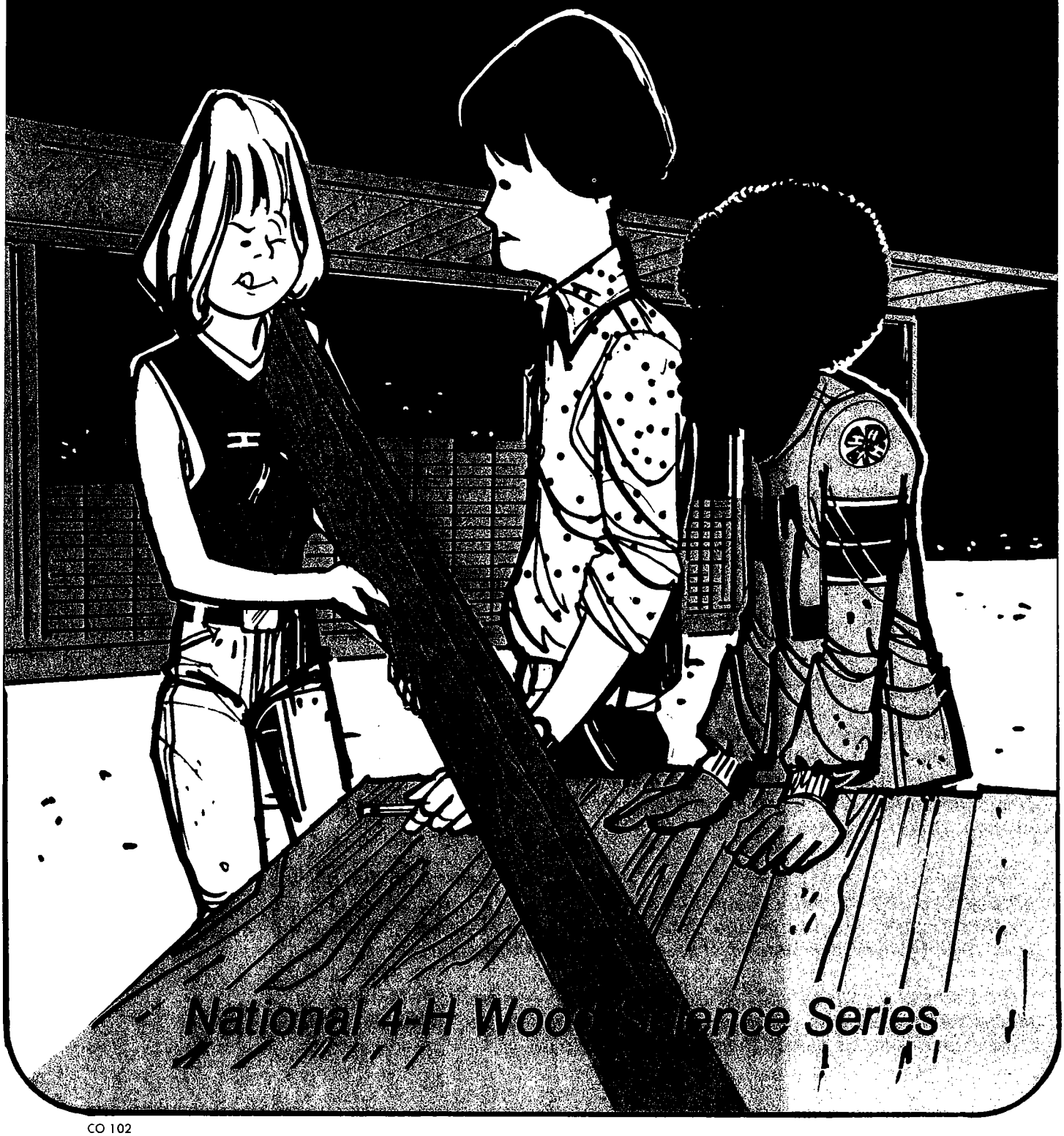
Unit III Member Manual

BUILDING BIGGER THINGS



National 4-H Wood[illegible]ence Series

CO 102

Contents

Acknowledgement

This educational material has been prepared for 4-H use by the National 4-H Wood Science Committee composed of representatives of Extension Service, U. S. Department of Agriculture and the Cooperative Extension Services of the State Land-Grant Universities. Special thanks are extended to the Weyerhaeuser Company Foundation for financial and technical assistance. This material is published by the National 4-H Council, 7100 Connecticut Avenue, Chevy Chase, MD 20815.

National 4-H Council is a not-for-profit educational organization that utilizes private resources to help expand and strengthen the 4-H program. 4-H is the youth education program of the Cooperative Extension Service of the State Land-Grant Universities and the U.S. Department of Agriculture.

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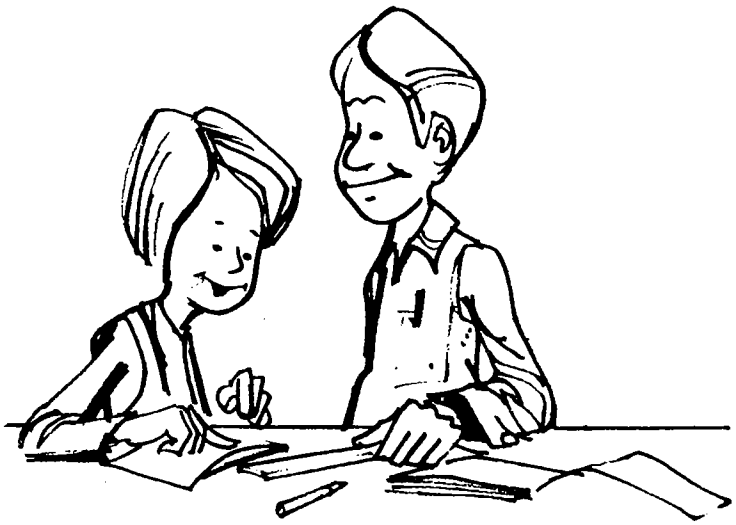
Note to Parents and Home Helpers

Your 4-H'er is now moving into the third unit of the 4-H Wood Science project series, "Building Bigger Things." Through your support, this member has been able to participate in woodworking projects and activities that helped him/her learn about wood as a product and to construct items from wood.

At this point, your 4-H member is probably continuing in Wood Science because of personal interest, positive experiences or because of the enthusiasm that you, club leaders or other members have generated. You can help your 4-H'er keep up his/her initiative by continuing to be personally involved and interested in the project.

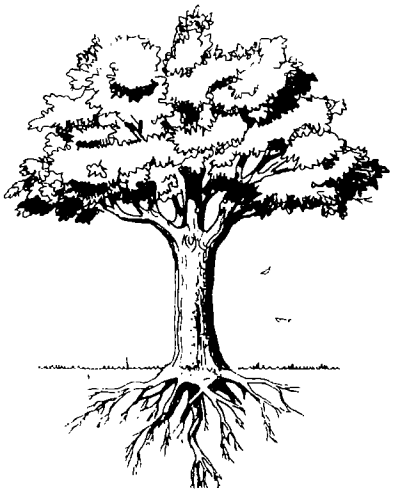


In this unit new concepts of wood science are introduced. Activities and experiments are provided that will help youth better understand these concepts. In addition, youth will be learning how to use new tools and machinery for constructing items from wood. The provided learning experiences, woodworking tools and plans for constructing items from wood are now becoming more sophisticated, so your 4-H'er is going to depend on you for help. You can see that he/she has positive experiences in this unit by:

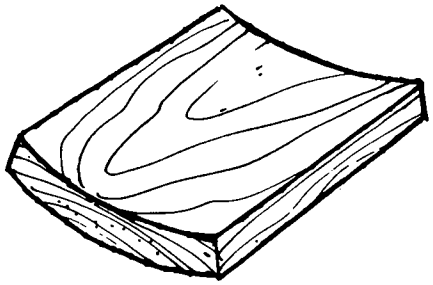
- Helping the 4-H'er understand new concepts being taught.
- Assisting, when needed, in completing the activities and experiments provided within.
- Helping to locate wood samples.
- Helping select items for their personal woodworking projects that they can realistically complete.
- Working with club leaders to plan, supervise and chaperone group activities, as needed, and to help provide transportation.
- Being available to lend a hand, if needed, while your 4-H'er is working on his/her project.

Remember, 4-H'ers learn by doing, so DON'T DO THE WORK FOR THEM, but give all the support you can to your 4-H'ers and leaders!

In Unit III you will learn more about . . .

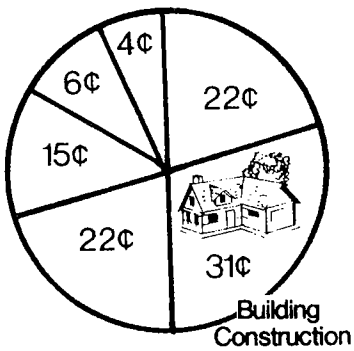


WOOD SPECIES



WARP

STRUCTURE and PROPERTIES



ECONOMICS

Introduction

This is Unit III of the 4-H Wood Science project series, "Building Bigger Things."

In the previous two units you learned a variety of things: how to measure, mark, cut, sand and smooth wood; how to use wood finishes; how to buy and use lumber and plywood; and how to use a variety of woodworking tools in constructing items from wood. You also learned how wood is harvested and processed into usable wood products. But there are still many things that you need to learn about wood in order to use it properly when building your projects.

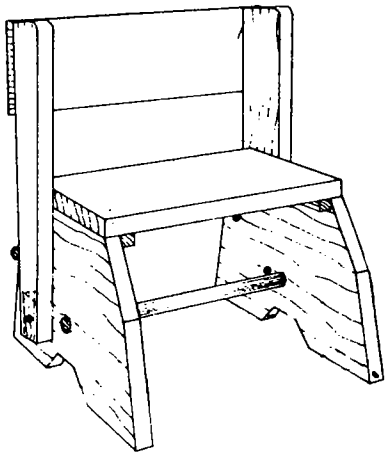
Science is learning about things — why things are the way they are and how we can change them to make them better or easier to use. Wood Science is learning about wood.

In this unit you will learn more about wood itself. You will learn how woods are named and classified, more about the physical characteristics and properties of wood and why one wood works better than another for a specific woodworking project. You will learn about economics of the wood products industry and how various products are made. You will be introduced to more woodworking tools and machinery, allowing you to gain new skills in constructing items from wood. All these things will be learned through your participation in individual and group activities, by completing the activities and experiments in this manual and through the items you choose to make as your own personal woodworking projects.

Set goals for what you want to accomplish this year in the Wood Science project. When setting these goals, keep in mind your abilities and skills. Several woodworking plans are included in the back of this manual. Select items to make from these plans, but you are also encouraged to use plans from other sources.

CAREERS

TOOLS



WOODWORKING/PLANS

Learning More about the Forest Products Industry

The forest products industry is made up of many different types of companies. Some are very large with factories all over the world that produce a wide range of wood products. Others are very small and may only produce one type of product in one location. Some companies do everything, from growing the trees to selling the product to you at a local lumber yard or building houses with the products. Others may only be involved in one part of the process of getting wood from the tree to its final use.

As part of your project work, activities are suggested that will help you learn more about how we get wood products — some of the processes, costs and people involved. Local libraries, wood products companies, forest products trade associations and other forest products companies are good sources of information too.

Activities: Exploring the Forest Products Industry

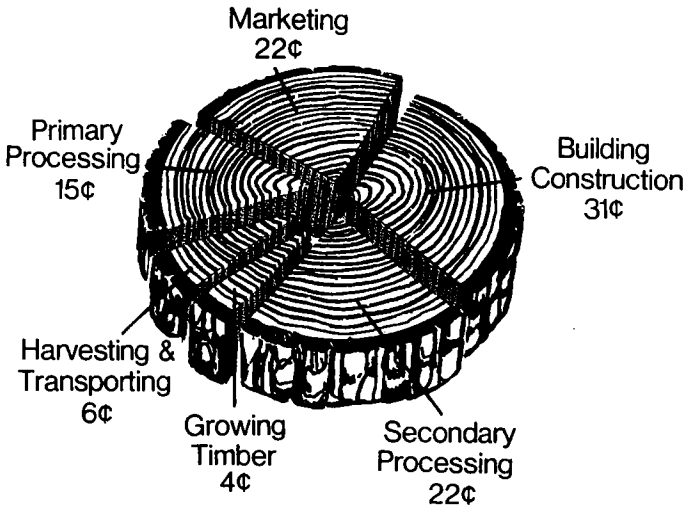
A. Learn all you can about the manufacturing and marketing of one or more wood products. This could be a piece of lumber, plywood, paper or a piece of furniture. Visit your local lumber yard. Find out what kinds of wood products are sold and where they come from. Visit a furniture store. Find out what woods are used to make furniture. If you have a sawmill, pulpmill, furniture plant or other wood processing plant nearby, find out how specific products are made. Report what you have learned to your club or plan a special presentation for another club.

B. Sketch a diagram of the wood processing plant you visit so that you can teach other club members how the manufacturing plant works. This can be a group activity.

C. Learn more about career opportunities in the forest products industry and also in woodworking. Write to the National Forest Products Association, 1619 Massachusetts Avenue, N. W., Washington, D. C. 20036.

D. Help your club plan tours of industries and places in your local area that process and market wood products, such as lumber yards, sawmills, furniture manufacturers, processing plants, cabinet makers, etc.

E. Ask your leader or parent to help you organize a "Wood Bowl" contest for your club. The competition can be between individuals within your club, or your club can compete as a team against other clubs. Use what you have already learned to help you develop questions for the Wood Bowl.



Dollar Value of Wood Products

Economics of the Forest Products Industry

America is a timber-using country. The average volume of timber used per person each year in the United States is about 65 cubic feet. This is the amount of wood that is in a tree 22 inches in diameter with a 40 foot trunk. It takes a forest nearly the size of a football field to grow that much wood. Since we use so much lumber, let's take a look at the cost of each process involved in getting the timber from the forest to the consumer.

Growing timber is only a small part of the total cost of wood products. Out of each dollar spent on producing and distributing wood products, the cost of growing and caring for the trees is about four cents.

Many different people are involved in growing trees. Professional foresters manage timber lands for private companies, for the U.S. Government and for states. They also help farmers and landowners manage their timber. It takes college training to become a professional forester. Many foresters have forestry technicians working with them. You can learn to be a technician in a two-year program after high school.

Almost 60 percent of our timber is grown by farmers or other private individuals, so anyone can be a part of the timber-growing phase of forest products.

Harvesting and transporting timber is the second step. The cry of "timberr" rings out in the forest and a tree crashes to the ground. This begins the long trip of a tree toward becoming the wood in the project you build, the paper on which this page is written, or the pencil you use at school.

Harvesting and transporting the logs require many types of employees, many very skilled in their particular jobs. Truck drivers, equipment operators and maintenance men are needed in addition to skilled fellers and buckers. Harvesting and hauling the timber from the woods costs about six cents out of each dollar spent on the final wood product.

Processing is the third step. It begins with "primary processing." Primary processing activities include sawmilling, pulp and paper production, and plywood and particleboard manufacturing. Primary processing costs about 15 cents out of each dollar spent on the final wood product.

Users don't always want to buy lumber or other primary processed products. They may want products that have been further manufactured, such as furniture, cabinets and flooring from lumber; book cases; corrugated boxes from paper and other items from wood. This is

called "secondary processing" and it accounts for 22 cents of every dollar spent on the final wood product.

Marketing wood products is the fourth step. Many people are needed to make and sell the products consumers want. Much of the lumber is sold by building supply stores and lumber yards where consumers choose what they need. Other forest products are sold at specialized stores, such as office supply stores, furniture stores and hardware stores. (Think of the stores in your town that sell wood products.) Getting the wood from the factory to the consumer costs about 22 cents out of every dollar spent on the final product. This not only includes shipping costs, but it also includes the cost of wholesalers, distributors and retailers.

Building construction is another large part of the forest products industry. Most homes and small buildings are made from wood. The average home being built in the U.S. today contains the equivalent of about 1500 board feet of wood. It takes about 24 good-sized trees (22 inches in diameter with a 40 foot trunk) or many more small trees to make this much wood. The building industry is active in all areas of the country and offers many job opportunities for people who enjoy working with wood. The building construction industry accounts for the remaining 31 cents.

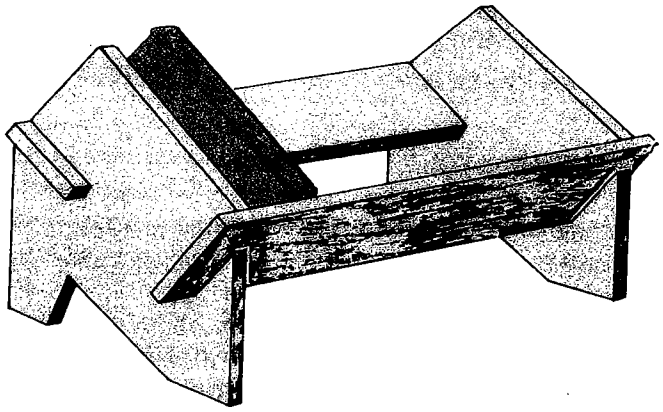
As you can see, a lot has to happen to a tree before it serves a useful purpose as a wood product. The tree in the forest makes up only a very small part of the value of the final product. Each additional step makes the wood more valuable. The values shown in the illustration on page 6 are averages for the whole wood products industry. Each individual product would be divided differently. For example, the wood in a fine carving would naturally cost more than a similar amount of wood in a fence post.

Careers in the Wood Products Industry

There are many job opportunities in the wood products industry. This industry employs about one out of every 20 working Americans. Some of the job opportunities have previously been mentioned. It takes a lot of mill managers, lumber graders, kiln operators, wood chemists, salesmen, equipment operators and servicemen, and many others to bring wood products to customers.

Activity: Trace The Flow of Wood Products You Use

Give a report on how one wood product (lumber, plywood, hardboard, etc.) you use to build a woodworking project was produced. Design a flow chart to help you illustrate the steps. You may also want to learn how other wood products are made. For instance, if you want to build the book rack below, you will need two types of wood products — lumber and plywood. When the book rack is completed it holds another wood product — books; and books are printed on paper. So your flow chart could show how the wood product gets from the tree to lumber or plywood; from the tree to book rack; or from the tree to book.



Book Rack

For more information on careers in wood science and technology, write to the Society of Wood Science and Technology, P. O. Box 5062, Madison, Wisconsin 53705. For more information on careers in forestry, see the 4-H manual "Forestry Careers."

Learning More About Wood Itself

Now that you know a little about how the wood was manufactured for your woodworking projects, you may want to learn more about the wood itself — the structures and properties of wood, how to identify different kinds of wood, and which type of wood works best for a particular woodworking project. If you learn this, you will know more about wood than many people who have spent a lifetime working with it but never bothered to learn anything about it.

Wood is divided into two groups, "hardwoods" and "softwoods." When magnified, hardwoods look different than softwoods. Each group also has different properties which make one group of wood, perhaps, better for a particular wood product than another. For example, hardwoods are usually heavier and usually harder than softwoods, and perhaps, would be better for flooring than a softwood. There are many other properties, as you will learn later, that make a particular wood more appropriate for a particular product than another.

Within the hardwood and softwood groupings, different kinds of trees are further identified by name. Let's see how each group of trees gets its name.

Names of Woods

There are more than 100 different kinds of woods (trees) in the United States. Approximately 60 are widely used for wood products. Your lumber yard may only sell a few of the different kinds. Each different kind of wood is called a "species." Each species has at least two names — a common name and a scientific name. The common name, such as white oak or eastern white pine, may vary in different parts of the country because a number of different woods have the same common name. Some woods may even have several common names.

One scientific name is given to each species, and this name is always the same. The scientific name has two parts. For example, the scientific name of white oak is "Quercus alba." The first part, which always begins with a capital letter, is kind of like your last name — the family name. It is the same for closely related woods. All oaks are given the first name Quercus. The second part of the scientific name is like your first name. It tells which oak it is. Quercus alba is white oak and Quercus rubra is northern red oak. Likewise, the scientific name for eastern white pine is Pinus strobus.

The scientific name is handy to know when discussing wood products with technical people, but don't expect the clerks at the lumber yard to know the scientific name of the lumber they sell you.

Activity: Wood Sample Collection

Start a collection of wood samples. It will help you learn more about the different types of woods that are available and what they look and feel like. It will also make a very good 4-H demonstration, or you can use it to show some younger club members how they can tell the differences between woods. The collection can also be used in displays and exhibits.

A 1"x 3" x 5" piece of wood is a good sample size for your collection. Each sample should be labeled. Some of the things you might include on the label are: the common name, scientific name, whether it is a hardwood or softwood, where the wood grows and some of its common uses.

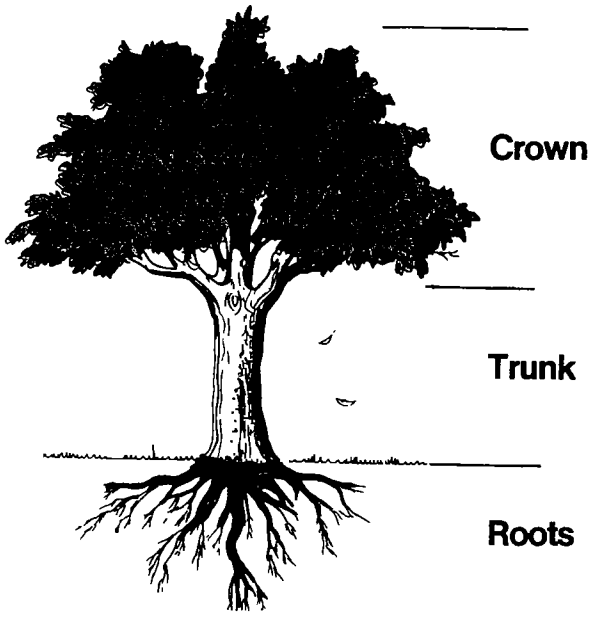
Each time you work with a new kind of wood you should add a sample of it to your collection. Your leader may have some woods that you do not have, so you can exchange samples.

Other sources for wood samples are lumber yards, cabinet shops, sawmills and woodworking shops. Products that can be included in your collection are plywood, particleboard, fiberboard, edge grain and flat grain lumber, and treated wood. Treated wood is wood that contains a chemical that makes the wood resistant to decay and insect damage. The other terms were discussed in Unit II. Do you remember what they mean?

Structure of Wood

Knowing more about the structure of wood will help you know how to use it. In the first two units you learned a little about the structure of wood. You learned that a tree has annual rings; one for each year that the tree has grown. Let's look at a tree to learn more about its structure.

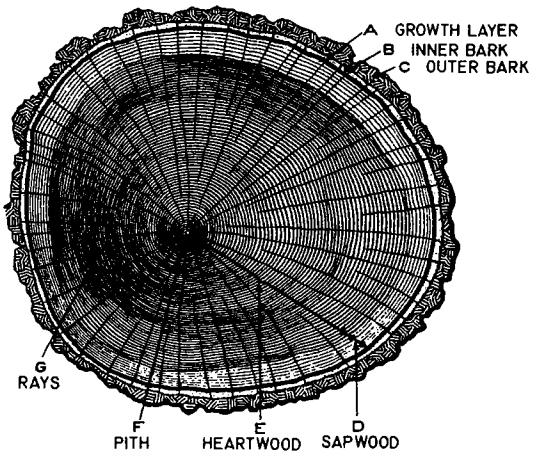
A tree can be divided into three parts — the crown, trunk and roots. The crown contains the branches, twigs and leaves, and it is the food factory in the tree. The roots anchor the tree to the ground and absorb water and nutrients from the soil. The trunk of the tree holds the crown up to the sun. It also conducts water and nutrients up to the leaves and distributes the manufactured food to points of growth.



Parts of a Tree

The trunk of the tree is the major source of the wood we use. The wood in the branches and the wood in the roots is rather similar, but not often used because branches and roots are usually not long enough nor straight enough to make lumber.

The trunk is divided into many parts. There is the *bark, sapwood, heartwood, pith* and *rays.* Take a look at each part. Get a piece of tree trunk to look at when identifying these parts and refer to the illustration shown. Even a small tree will have all of these parts, except that some small trees may be too young to have developed heartwood.



Parts of a Tree Trunk

On some trees, the bark is thick and chunky, and on others, it is thin and smooth. Tree bark is made up of inner bark and outer bark. The inner *bark* "B" on a living tree is soft and moist. It is a living part of the tree and carries food from the leaves down the trunk. The outer *bark* "C" is dry and crumbly. It protects the growing areas from outside injury.

The *sapwood* "D" is the living part of the wood. The sapwood layer may be very narrow or it may be wide. It carries water from the roots to the leaves and also serves to store food.

The *heartwood* "E" is generally darker or more brightly colored than sapwood. Early in the life of the tree the heartwood was sapwood, but as the tree grew older the inner sapwood died and turned to heartwood. The major function of heartwood is to help support the tree, but heartwood is important for another reason — it sometimes makes the wood decay resistant.

The very center of the tree is called the *pith* "F" and was formed when the tree was very young. Wood close to the pith may have properties very different from the wood that is formed later on in the life of a tree.

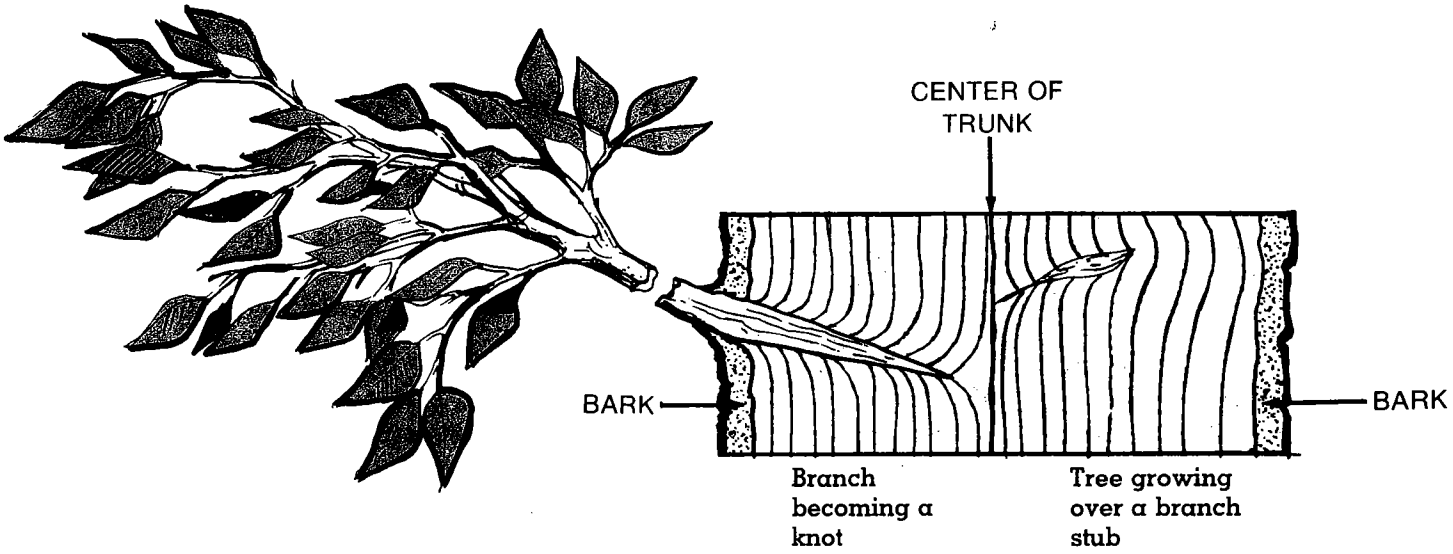
Between the bark and the wood in the tree trunk is a layer called the *cambium layer* "A." The cambium is the growth layer and it allows the tree to grow larger in diameter, adding new wood just inside the cambium layer and new bark just outside the cambium layer. In other words, the tree grows two ways at once — an inner layer of tree trunk and an outer layer of bark. The additional inner layer of wood makes the tree bigger, so the cambium layer has to stretch. At the same time, each year the bark gets thicker by the additional layer of bark grown. In fact, the reason that the bark of older trees is rough with ridges is that the bark you see is old bark, which was grown when the tree was small, and it cannot stretch enough to smoothly cover the now larger tree. There are a few exceptions to the rule. For example, older beech trees, aspen and red alder have smooth bark. It's a characteristic of these trees.

Wood is a very complex material. It is made up of millions of small fibers or "cells." These long hollow tubes are connected together with a glue-like substance. If you look at the end of a piece of wood that has been cut with a very sharp knife, you may be able to see the open ends of some of the cells.

Most of the cells in the trunk of the tree are aligned up and down the trunk. This is what gives the wood its grain direction along the trunk. A tree also has cells that are aligned from the bark to the pith. These are called *rays* "G."

As a tree grows, it produces branches as well as a vertical stem. As the tree trunk grows in diameter, it grows over the branches. An overgrown branch is called a "knot." If a branch remains on the tree throughout its life, the knot will extend from the center of the trunk out through the bark where it becomes a visible branch (left side of illustration). However, many times the lower branches on the tree die and fall off, or they are cut ("pruned") from the tree. When this happens, the tree will grow over the stub and the knot will end in the wood at the point where the branch stub becomes overgrown with clear wood (right side of illustration). This is how it becomes possible to have a board which has a knot on one surface and no knot on the opposite surface — if the board happened to be cut so that the knot ended within the board. The grain direction in the knot will be perpendicular to the trunk and the grain in the wood that surrounds the knot will have to curve around the knot. These changes in grain direction, and the knots themselves, can give wood a very attractive appearance, but sometimes detract from the appearance; and knots usually reduce the strength of wood because the grain direction is different than in clear, knot-free lumber.

As long as the branch is alive, the wood and knot will grow together. Lumber cut from these trees will have tight knots which will stay in the wood. If the branch dies but remains on the tree, the trunk will still grow around the knot but the wood of the knot and the wood of the tree



will not actually grow together. Such a knot will be loose, and when cut into lumber, the knot may fall out leaving a "knot hole." Loose knots and knot holes weaken wood, therefore, knots are referred to as defects in wood.

Activity: Compare Tight and Loose Tree Knots

Find a piece of wood that has a loose knot and a piece of wood of the same species that has a tight knot. Examine the area around the tight knot to see if you can tell how solidly the wood in the branch and trunk are grown together. Compare this with the loose knot. Do you see any differences? Could you knock the loose knot out, leaving a knot hole? Add these two pieces to your wood sample collection.

Identifying Hardwoods and Softwoods by Structure and Appearance

Wood identification is not easy. It is both an art and a science. The art cannot be taught in a book. It comes from handling different woods. The science can be taught, and the first step is learning the characteristic differences between hardwoods and softwoods. Start learning the differences by trying the following activity.

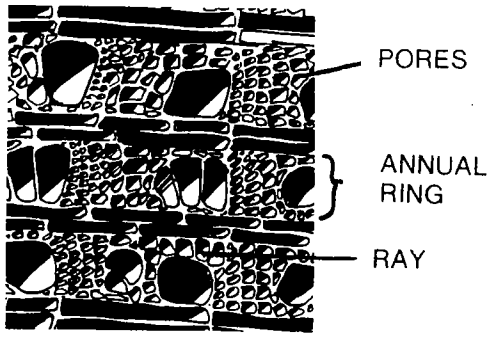
Activity:

To help you in identifying woods, you will need a hand lens or magnifying glass and a sharp knife. You will also need a piece of hardwood and a piece of softwood. Oak (a hardwood) and white pine (a softwood) will work best.

Make a small clean cut on the ends of the wood samples. Look at the cut surface with the hand lens or magnifying glass. (It may help if you wet the cut surface.) What do you see? Do you see any differences in the two pieces? If you have samples of other woods, examine them also. Do you see any similarities? Differences? Are there similarities in the softwoods? Are there similarities in the hardwoods?

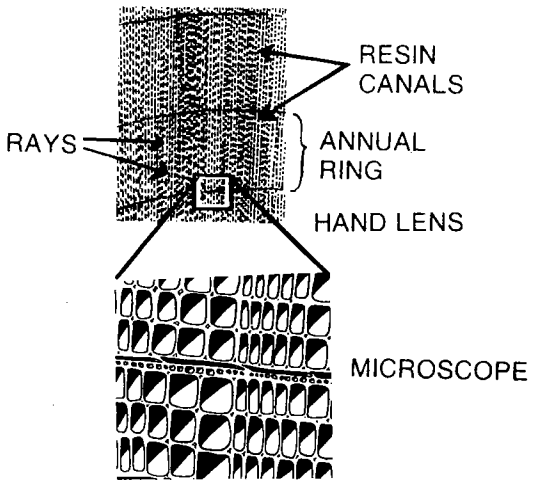
The first major difference that you should notice is that the oak has large open cells at the start of each annual ring. These are called

Your oak sample will look similar to this:



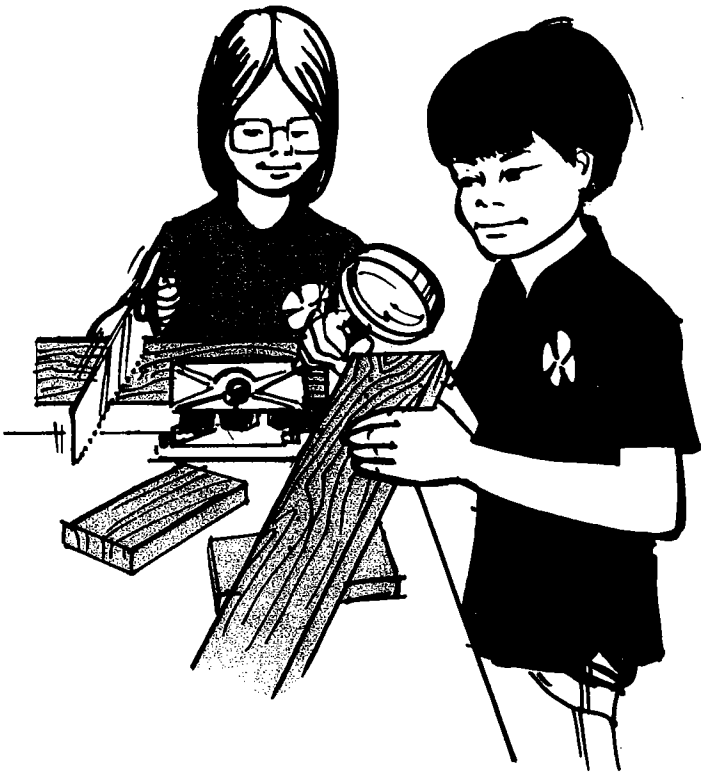
HAND LENS

Your pine sample will look similar to this:



"pores." All hardwood species have pores, but the pattern and number of pores will vary. This is one way of telling different hardwood species apart.

Pine does not have pores. It does have a few scattered openings that are called "resin canals," but they are not all located along each annual ring as pores are. Look at the pine sample again. If you have a good, clean cut and



look real close, you can see the tiny cell openings. They are shown in the magnified pine illustration on page 11. These cells are lined up in a very uniform pattern from the center of the tree to the bark. The cells in oak are not lined up in straight rows like the pine.

Therefore, the most accurate method of separating hardwoods and softwoods is the presence of pores and lack of cell alignment in hardwoods, as compared to the lack of pores and obvious cell alignment in softwoods.

In the end view of the oak you will also see large bands of lighter colored wood material that cross the annual rings. These are the rays. Both the oak and pine have rays, but they are larger in the oak and much finer in the pine. All wood species have rays, and their size and spacing can be used to help identify different species.

Activity: Compare Wood Structures

Look at some wood samples other than oak or pine. Look for patterns of cells, pores or rays that are different from the oak and pine. List some of the things that are different, such as the presence of resin canals, size and spacing of rays, patterns of pores, coloration, odor, etc. Some of these may be used to identify woods. Others may be used to separate woods into smaller groups. Later you will learn how pores and rays affect the use of wood.Your leader may have a book which shows magnified sections or cross sections of different woods which will help you identify your samples. If not, go to your local library for help.

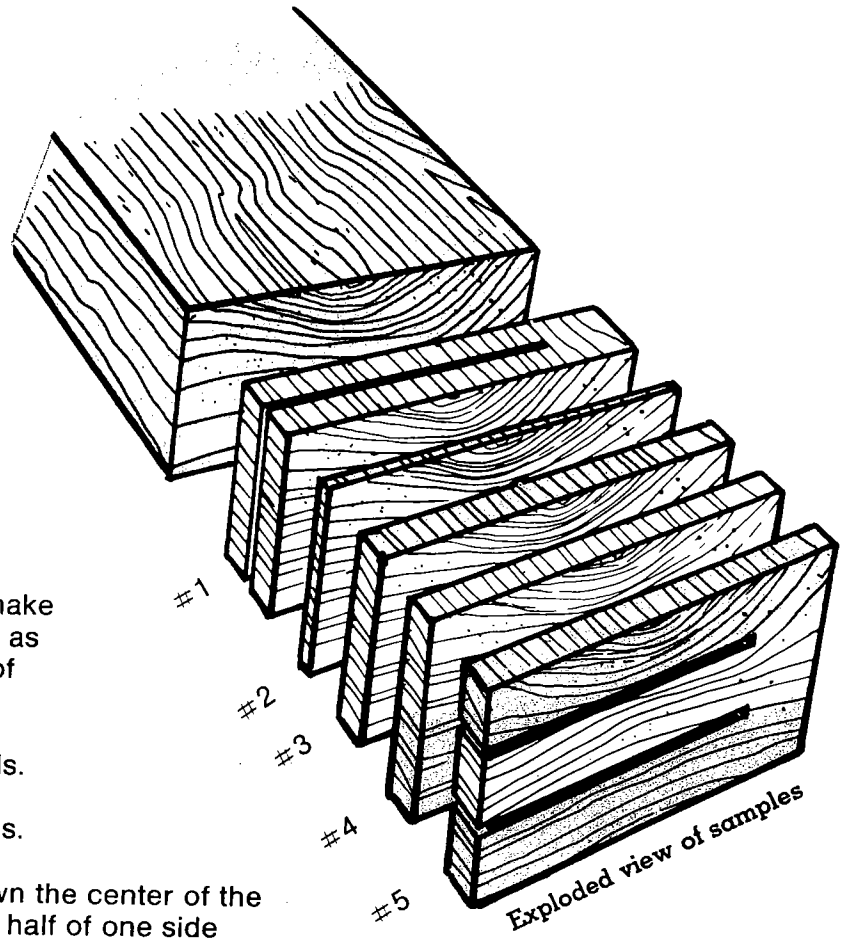
How Moisture Affects Wood

Wood in its natural state always contains some moisture (water). Wood is nearly saturated with water when it is growing, and, although it may feel dry, some of this water is still present in the normal use of wood. Only wood that has been dried at temperatures above the boiling point has no water in it. Even if water is removed by drying, the wood will begin to regain moisture when exposed to the atmosphere, because even the driest climates have some relative humidity (moisture) in the air.

When wood picks up a lot of moisture or becomes saturated with water, it changes in some ways. It gets heavier. It changes shape. And, it can even become deformed. These properties affect how we can use wood, and in some situations, what we must do to finish and protect the wood from moisture and water.

This suggested experiment for observing what happens when wood gets wet will require some assistance from your leader or parent, so be sure to ask an adult to help. To conduct the experiment, you need five small blocks of wood from the end of a 2 x 4 or 2 x 6. It will be best to get your leader or parent to help you cut these with a power saw. You might find some scraps of wood to use in the scrap bin at your local lumber yard.

Experiment: Wood and Water



Exploded view of samples

Instructions:

1. Cut 5 blocks of wood from a 2 x 4 or 2 x 6 in the following thicknesses:

   Block #1 — ⅞" thick
   Block #2 — ⅛" thick
   Block #3 — ⅜" thick
   Block #4 — ⅜" thick
   Block #5 — ⅜" thick

   Block #1 — Paint it completely and allow it to dry. (It will take a day or two.) Then make a saw cut across the grain as illustrated, but stop short of cutting the block in two.

   Block #2 — Paint one side and the ends.

   Block #3 — Paint one side and the ends.

   Block #4 — Draw a line lengthwise down the center of the block; on both sides. Paint half of one side as illustrated. Turn over and paint same half on reverse side. Also paint ends on that half.

   Block #5 — Make two saw cuts (but stop short of cutting the finger off) then paint the center finger as illustrated.

2. Place all blocks aside to dry. Let them dry thoroughly.

3. Fill a flat, shallow pan (about 2" deep) half full with water.

4. Place the five blocks in the water and leave for 30 minutes or more.

5. Observe what happens to the different blocks. Some will react more rapidly than others.
   What happens to each block? List.
   Which one curved the most? Why?
   What caused the blocks to curve?
   Which block increased in length?
   Are there similiarities or differences between block #2 and #3?

6. After you have completed all the steps above and answered the questions, place the blocks in an oven at 225 degrees for at least 30 minutes. Observe what happens.

In this unit you have been provided activities and experiments to help you better understand wood. There are many other activities that you can do and many other things to learn. Handle wood samples. Ask questions. Experiment. You and your leader, together, can think of other creative things to do. Now it's time to move on to "Building Bigger Things." Following are some new tools that you will learn to use.