

The Wonderful World of Wood

Unit II Member Manual

National 4-H Wood Science Series

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Acknowledgment

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Note to Parents and Home Helpers

You as parents and home helpers are the key to your children completing Wood Science Unit II, *The Wonderful World of Wood*. Even though 4-H leaders help guide and direct your children's work, as parents you should be involved in the planning stages, and also work with your children throughout this project.

Get involved! Make woodworking a family activity. Wood science provides one of the best "learn by doing" opportunities in 4-H. Members have almost an unlimited scope of interesting, educational challenges including designing, constructing, and finishing wood. However, in order for them to complete the activities in the wood science units, they need your help.

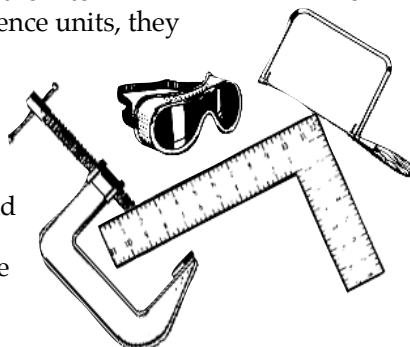
In Unit II, your children will be introduced to power tools. For safety purposes, it is recommended that power tools not be used by children younger than 10 years old, and then only with the supervision of a leader or parent. Leaders can supervise

your children only while at meetings, so it is up to you to help at home. Make this a safe and enjoyable experience for your children. Help them get the most out of this project by:

- Making this a family project.
- Helping to plan and select woodworking projects that suit your children's ages and abilities.
- Working with them to decide what tools, equipment, and supplies will be needed.
- Helping them set goals they can realistically meet so that they don't get frustrated with the project.
- Planning time that you can work with your children on wood-working projects and activities.

For safety purposes, remember to supervise whenever they are using power tools. Be there to lend a hand, if needed, and to show them that you are interested in the work they are doing, but **DON'T DO THE WORK FOR THEM.**

It's a challenging world, **THE WONDERFUL WORLD OF WOOD!**





Introduction

Welcome to Unit II of Wood Science, THE WONDERFUL WORLD OF WOOD!

This is the second in the series of 4-H Wood Science manuals. If you have completed Wood Science I, you probably are asking, “Now what?” Wood Science can be so interesting and challenging that you never really finish. Making beautiful and useful things of wood is limited only by your interest and imagination.

Unit II and subsequent units will help you continue to grow in your ability to create and assemble items of wood. You will learn more about wood itself—how to identify wood, how to measure wood, and how to buy wood.

In the back of this manual are plans for some woodworking items you may wish to make; however, you also are encouraged to make items from other plans. Before you start, make sure you can get the necessary materials and make certain that you have, and can use, the right tools. Ask your parent or leader to help you select a woodworking project that is suited to your ability.

You may do your project work at home, or you may be invited to your leader’s home or shop. You will enjoy the project more if you have your own work area in the shop, basement, or garage. Be sure to have a place to store your woodworking tools. The tools described in Wood Science Unit I make a good start on a tool set, and you may also want to add some of the tools that are discussed in this unit.

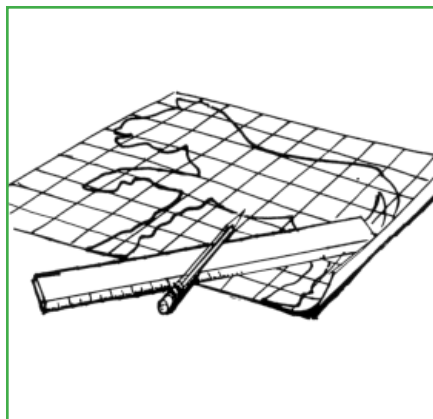
You will be using some power tools now: an electric drill, sander, saber saw, maybe a jigsaw, and others. These tools are powered by electricity to provide more force so you can do your woodworking jobs more easily and more accurately.

Considering your age and beginning skills, use power tools only when being supervised by a leader or parent. Be sure to read and obey the safety warnings provided by Woody Wise.

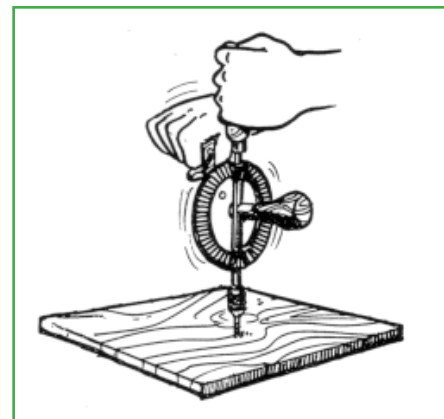
In Unit II, learn how to construct fun woodworking projects using different tools.



Measure and Mark



Use a Grid



Drill Holes



Opportunities for Learning and Doing

In Wood Science, there are many different things you can do and things you can make. There also are many opportunities to learn while doing.

A list follows. These are merely suggestions. There may be other things you wish to add. Also, there may be things on the list you may not want to include.

1. Make a wooden toy or gift as a holiday gift or birthday present.
2. Learn to enlarge irregular-shaped drawings using the grid system.

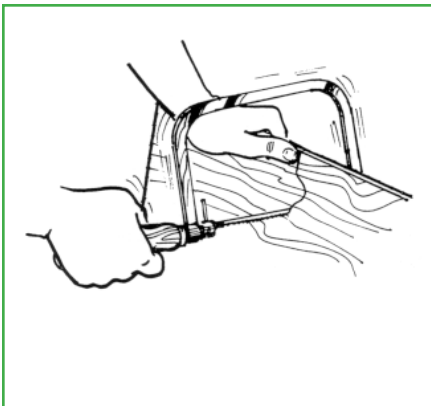
Power Tool Users

Since moisture conducts electricity, never use an electric tool in wet or moist conditions.

Power tools put out quite a lot of force, but they can't think! They depend on you to think. So, stay alert all the time you are using them.

Wear safety goggles when driving nails and when using power tools. They protect the eyes from sawdust and chips.

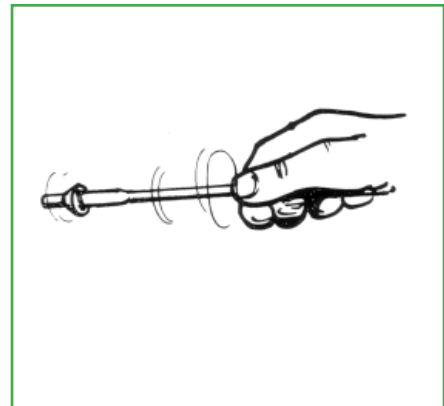
3. Add to your tool set.
4. Build a tool box or storage area for your tools.
5. Start a collection of various-size wood screws.
6. Give a demonstration on the correct use of a hand drill, electric drill, or any other woodworking tool. Consider other possible demonstrations that are related to woodworking.
7. Learn the differences between hard and soft woods.
8. Make a list of different jobs that are related to the wood industry.
9. Talk to some of the people who work in those jobs. Find out what they do.
10. Make a list of products obtained from wood. Write a speech or give a club demonstration on products obtained from wood.



Sand Wood



Build Things



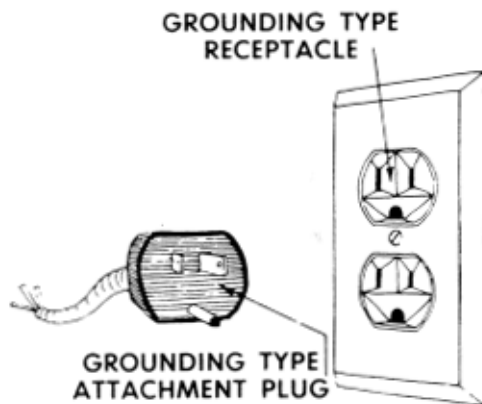
Use glue and finishes



Work Safely

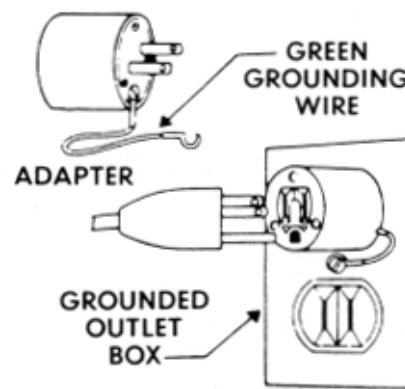
1. When working in the shop area, wear comfortable clothes. Avoid loose-fitting or dangling clothing, which might get caught in a machine.
2. Avoid carrying sharp or pointed tools in your pocket. They may cut or scratch you or somebody else, or tear a chair or auto cushion.
3. Be sure every electric tool you use, such as a jig saw, electric drill, or sander, is double insulated or properly grounded to protect you from electrical shock.

Many manufacturers are now making portable electric tools with a specially insulated motor and switch housing. Since the housing provides a second layer of insulation to protect the operator, it is referred to as “double insulated” and does not require a third wire or prong to ground the tool. These units have a two-wire cord and should be identified as “DOUBLE INSULATED” and bear the (UL) label on the unit rather than just on the cord.



4. All tools that are not marked as double insulated should be properly grounded for protection against electrical shock. This can be done by connecting the tool to the power source with a cable or extension cord that has three conductors. The wire that attaches to the third blade of the plug safely grounds the tool. **This wire usually is green.**

Caution: A three-prong plug must always be plugged into a three-hole receptacle.



A grounding adapter used with a grounded outlet box.

Adapters are available for use with two-prong electrical outlets, but they should be used with caution. **Use an adapter only if the outlet box is grounded and the green grounding wire is properly attached.** (See illustration above.) If the above precautions are followed, you can then plug the three prongs of your tool into the adapter and use the tool safely.

Be sure to read your instruction manual before using your power tools. If your manual has been lost, ask your leader or parent for help *before* using the tool.

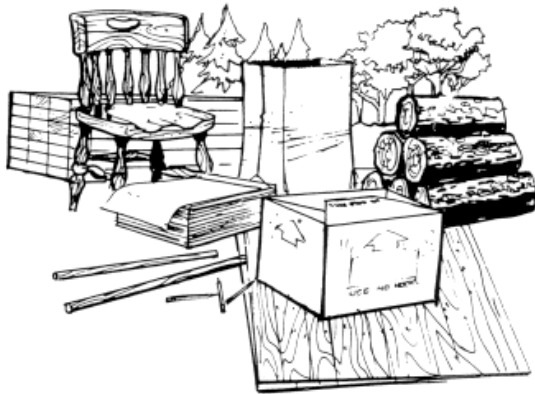


Trees, Forests, and Forest Products

Take a look around you. No matter where you are—in your home, at school, at church, on a farm, or in your yard—you will see wood being used. Wood is an important natural resource, and it's renewable.

Since the United States was first colonized, billions of board feet of timber have been used to build homes, farm and industry buildings, and other wood products, too many to mention. Yet it is estimated that there is still two-thirds as much land in forests as there was when America was discovered.

Trees and forests not only provide wood products for us, they also provide other benefits such as recreational areas for picnicking, hiking, camping, hunting, and fishing. They provide homes and shelter for wildlife. Trees help keep the soil from washing away and protect our valuable water supply. They also help to purify our air and give us fresh, clean air to breathe.



Our forests are called a “multiple-use” resource because they provide so many benefits. Trees, and the wood from trees, are important resources. They provide more than 5,000 beneficial products useful to humans. How many ways can you think of in which wood is used? Remember that paper products also come from wood.

Trees must be harvested to obtain wood products. Through proper forest management and harvesting methods, we can have the wood products we need as well as the many other benefits of the forest.

From Trees to Wood Products

The forest products industry is a large and complex industry. Forest resources are converted into usable wood products. This industry is an important part of our nation's economy.

Some regions of our country are almost totally dependent on it for income and employment. About 1 out of every 20 people who work is employed in some part of the forest products industry. Let's take a look at this industry to see how we get our wood products.

Growing the Timber

The first step in the forest products industry is growing the timber. This is called **forestry**. Professional foresters manage the forests to increase growth and to protect them from fires, insects, and diseases. Keeping forests healthy ensures their usefulness to humans.

To learn more about our forests and growing timber, you may want to enroll in the 4-H forestry project.

Harvesting and Transporting the Timber to the Mills

Harvesting and transporting the timber to the sawmill is the next step in the forest products industry. Harvesting actually involves several steps. Before reaching the mill, trees are cut down, limbs are removed, then the trees are cut into logs. This is called **harvesting**. These steps are sometimes done by one person using a chain saw and a truck. However, large operations employ many persons and use large machines to cut the trees and haul the logs to the mill.

Processing

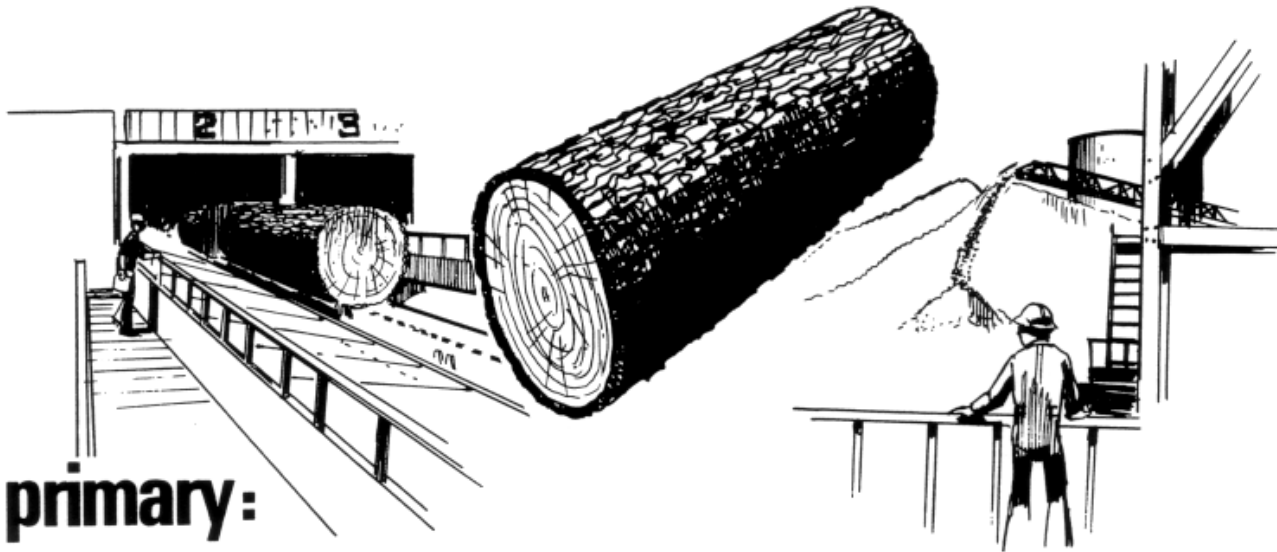
Processing is the third phase. It is divided into two segments: (1) primary processing, and (2) secondary processing. **Primary processing** is the sawing, chipping, or slicing of the log to convert it into lumber or other raw wood products. Examples of primary processing would be sawmilling to produce pulp and paper, veneer, plywood, or particleboard.

Some products need additional manufacturing before use, such as making furniture from lumber, particleboard, and plywood. Other examples include producing cardboard boxes or bags from paper, or making flooring from lumber. This is called **secondary processing**.

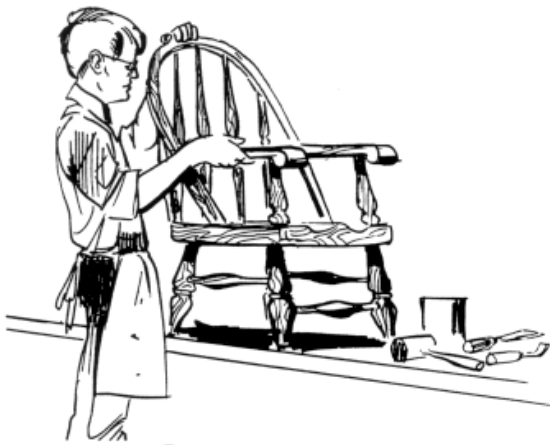
Marketing Wood Products

Marketing forest products also is important to the industry. Many individuals handle the products from manufacturer to user. Much of the lumber is delivered to the lumber yards or building supply stores where customers choose what they need. This is where you may find materials for your woodworking project. Other forest and wood products are sold at commercial and retail outlets, such as office supply stores, furniture stores, hardware stores, etc.

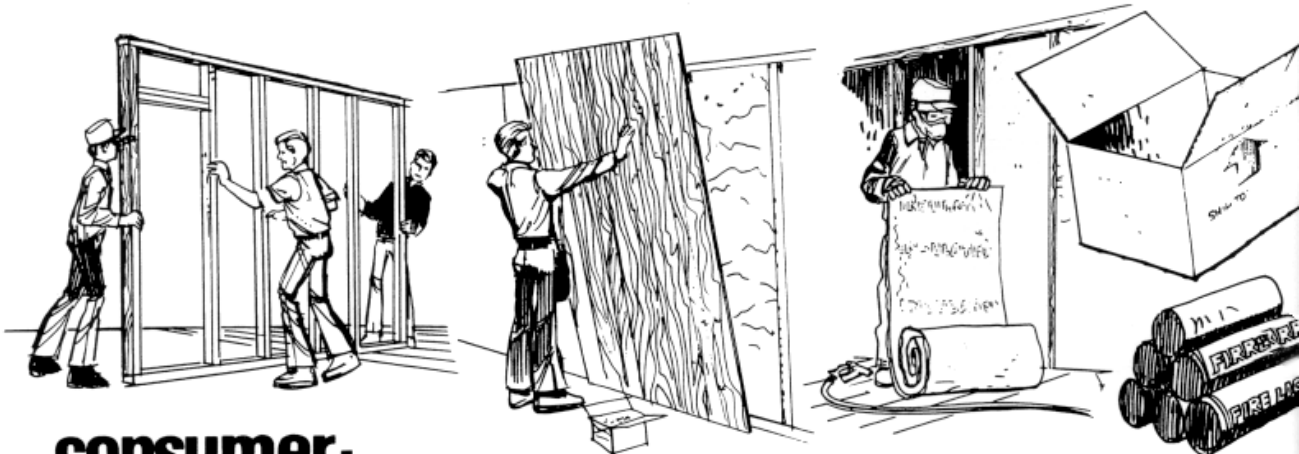
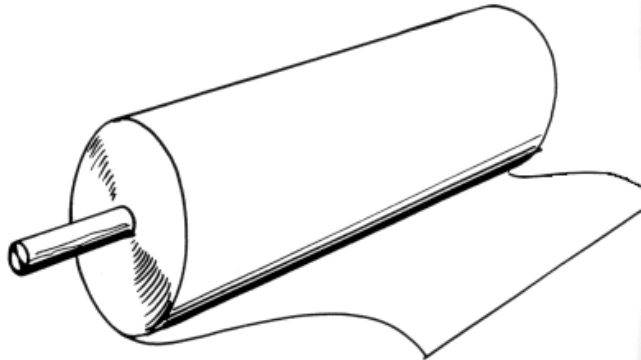
Wood construction and building trades also are part of the forest products industry. Much wood is used in homes and other buildings. Some homes are partially or totally built from lumber in factories, while others are built by carpenters on the site.



primary:



secondary:



consumer:



Learning to Use Wood

How do trees become the wood we use for making things? For some products, the logs can be used almost as they come from the tree. Telephone poles, fence posts, and firewood need little manufacturing. For most of the wood we use, the logs are cut into lumber or made into plywood, particleboard, or fiberboard. The type of tree the wood comes from, how it is cut, and how it is treated after cutting affect how it can be used—and even whether it can be used—for a particular project.

You learned in Unit I that trees can be divided into two basic groups. We call these **hardwood** and **softwood** trees. Hardwoods have broad, flat leaves; examples are oak, maple, and cottonwood. They usually turn color and lose their leaves in the fall. Softwoods have needle-like or scale-like leaves; examples are pine, cedar, and fir. They usually keep their leaves through the entire winter.

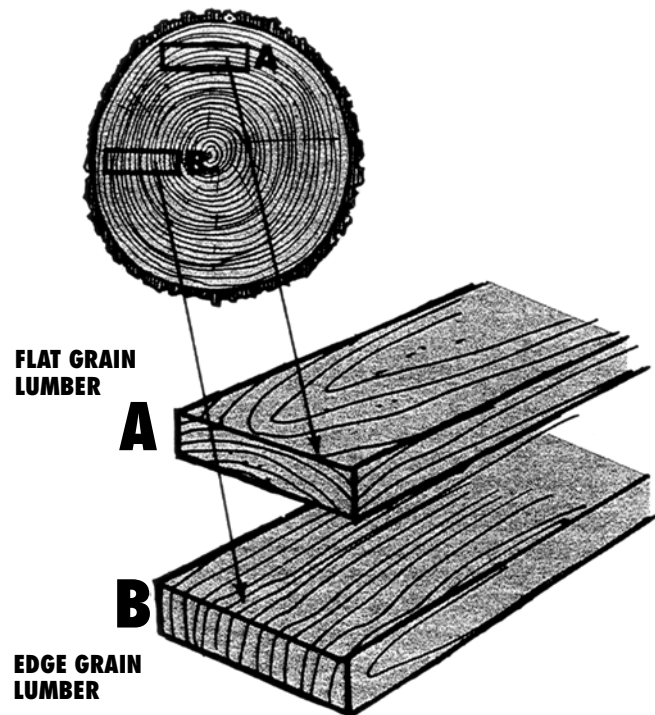
These names may fool some people into thinking that the wood from a hardwood tree is always hard, and the wood from a softwood tree is always soft. In fact, this is not always true, but the names remain because it is true in many cases.

The wood from hardwoods and softwoods is used for different things. Hardwoods are often used to make furniture, flooring, and paneling because of the attractive grain and colors. Softwoods are more often used as lumber or plywood for general building construction. For your project, you probably will use softwoods because they are usually available at local lumberyards. Hardwoods may be harder to find. Discuss with your leader or helper the various woods that are available and have them help you select the best wood to use in your project.

Let's look at wood to see how other things might affect its use. If we look at the cut end of a branch, log, or stump, we will see rings surrounding the center. They look like a target or bullseye. Each year a tree grows, it adds a new ring. This is why they are called **annual rings**. You also can see the annual rings on the cut ends of lumber.

The annual rings not only show on the ends of lumber, but they continue up the length of the board and appear on the faces and sides. They will appear as bands, lines, or other patterns. It is these annual rings that give wood its attractive patterns when cut and finished. On the faces and sides of wood, we call the annual rings and their patterns the "grain" of the wood. Look at a piece of lumber and see how the annual rings form patterns on the surface.

When a sawmill cuts a log into lumber, it may be cut in several ways. If you cut the log off center, closer to the edge like "A," you get **flat grain** lumber. The



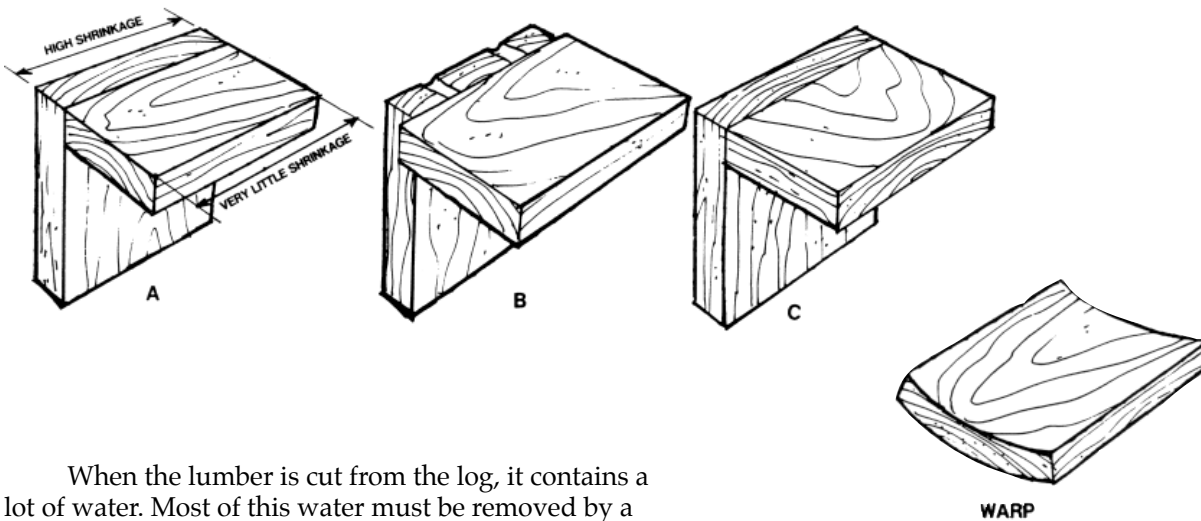
grain on the wide face of the board will be large, flat bands; long, wavy arches; or long patches, depending on how the saw cuts through the annual rings of the log. The grain on the edges will be narrow stripes or lines.

If the log is cut through the center like "B" in the drawing, you get **edge grain** lumber. In edge grain lumber, the grain goes nearly straight across the board from top to bottom and gives a pattern of stripes or lines on the wide face of the board. Lumber cut near the center of the log has edge grain.

Something for You to Do

Find a tree stump or a round piece of firewood, or ask your parent or leader to help you cut a piece from the end of a log or tree branch. Count the annual rings to see how old that piece of wood was when it was cut.

Remember that the rings go all the way around the trunk, so count only from the center to the bark. If the stump or log is old enough, you may even be able to find rings corresponding to some of the important dates in your life, the life of your family, or the history of your community. You may also want to use annual rings and the history they tell as a demonstration in your 4-H club meeting.



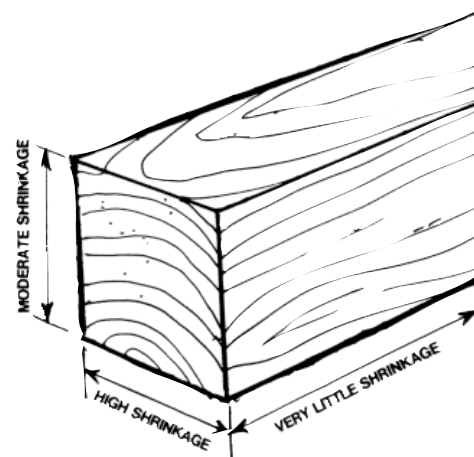
When the lumber is cut from the log, it contains a lot of water. Most of this water must be removed by a wood-drying process before the wood can be used, or the water eventually will evaporate, causing the wood to shrink. Some sawmills stack the lumber outdoors to let the water evaporate. This is called **air drying**. When complete, the lumber is called **air-dried** lumber. Others put the lumber in special buildings called dry kilns and heat the lumber to speed dry. Lumber dried like this is called **kiln-dried** lumber.

Some of the water in lumber evaporates without changing the size or shape of the wood. The amount of water that remains in the wood depends on the temperature and the **relative humidity** of the air around the lumber. Relative humidity is a measure of the moisture that is in the air. If the relative humidity of the air increases, the wood slowly gains moisture from the air, which causes it to swell. If the relative humidity of the air decreases, the wood loses moisture to the air and shrinks. These changes are always taking place, but if the wood has been dried properly and is protected and used correctly, the changes will be small and should not affect your project.

When wood shrinks and swells, the change in size is not the same in all directions. Wood shrinks and swells most in the direction along the annual rings. Along the grain or lengthwise to the piece of lumber, shrinkage is very small. Wide and thick boards shrink more than thin and narrow boards.

When we build projects, we must be careful to use wood correctly so that shrinkage and swelling do not hurt our finished product. Pieces put together like "A" (above) end up split and of different sizes (like "B") because the wood did not shrink the same amount. The proper way of joining these two pieces is shown in "C." Here the two pieces of wood will shrink and swell about the same.

When wood loses moisture or picks up moisture, it sometimes changes shape. This is called **warp**. Edge-grain lumber does not warp as much as flat-grain lumber.



Lumber that has been dried is better to work with than lumber that is **green** or wet, because it does not shrink or warp as much as green or wet lumber. Green lumber is lumber that has not been dried.

For projects that will be kept inside a house or building, drier lumber is needed than if the project is to remain outside. Check with your leader or parent for help.

The size of lumber is called its **dimensions** or measurements. The dimensions tell you the rough size of lumber when it was originally sawn at the sawmill. A 1 x 4 (one by four) is 1" thick and 4" wide when cut. As you know, lumber shrinks when it dries. Some material is also removed when the wood is planed smooth. As a result, most lumber cut 1" thick will end up being about $\frac{3}{4}$ ". A board cut 4" wide will be only $3\frac{1}{2}$ " wide after drying and planing. The original sawn size is still used to describe the piece, so it is called a 1 x 4.

The same thing happens to a 2 x 8 (two by eight). It is 2" thick and 8" wide when sawn. After drying and planing, it will be $1\frac{1}{2}$ " x $7\frac{1}{4}$ ", but it still is called a 2 x 8.



Plywood

You were introduced to plywood in Unit I. Plywood is made by gluing together three or more thin layers of wood called veneer and laying the grain of each piece at right angles to adjacent pieces. This gives the plywood extra strength and reduces shrinking and swelling.

Plywood is normally sold in sheets 4 feet by 8 feet (4 x 8). It comes in many thicknesses. It is measured in inches and sold by thickness. (For example, plywood called $\frac{3}{4}$ " plywood is $\frac{3}{4}$ -inch thick.) Unlike lumber, 1" plywood is 1 full inch thick.

Plywood is made in two types: (1) exterior type, and (2) interior type. The type refers to the glue used between the plies. If your item is going to be used outdoors, be sure to get exterior-type plywood, or the plies will come apart when the plywood gets wet. For indoor use, buy interior type plywood because it is less expensive for the same grade surface.

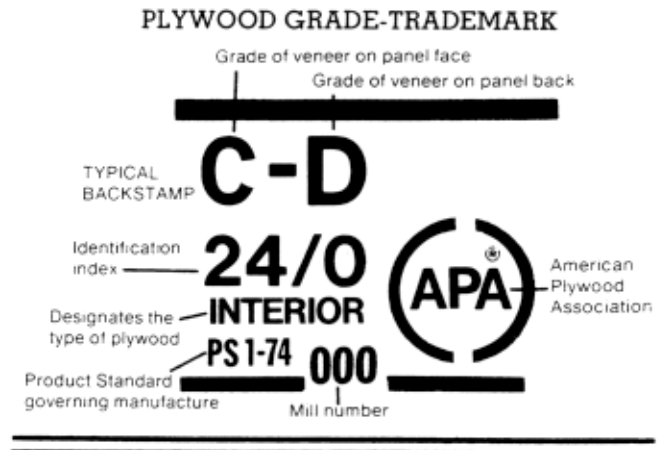
Many different species of trees are used to make plywood. Most of the softwood plywood comes from either Douglas-fir or southern pine.

The grades of softwood plywood are based on the quality of the veneer. The standard grades of veneer are A, B, C, and D, with A being the highest grade and D being the lowest. In the lower grade, more knots and defects will be present; however, these defects have little effect on strength.

Both sides of the plywood sheets are graded and do not have to be graded the same. If a sheet of plywood is graded A-D, the face will be A grade and the back will be D grade. In this manner, we can get greater use out of the high-grade logs than we could if all plies were required to be grade A throughout.

Interior-type plies usually have D veneer on the inside plies. Exterior-type plies must have C or better veneer throughout.

If you are building a project where both sides will show, you want to use an A-A plywood. If only one side will show, you can use A-C or A-D panel. You sometimes can cut pieces with clear faces from lower grade plywood by cutting between the defects.



Mill-Certified or Shop Grade Plywood

Some plywood is sold as mill-certified plywood. It also may be called shop plywood or shop cutting panels. This is plywood that has some defects that keep it from being sold as a standard grade. Mill-certified or shop plywood is found most often in areas where plywood is made. This is in the southern and western coast states. It may not be available in areas that are a long way from plywood plants. Mill-certified and shop plywood costs less than standard-grade panels. Many good, small pieces of plywood can be cut from mill-certified panels. These can be used for your woodworking projects.

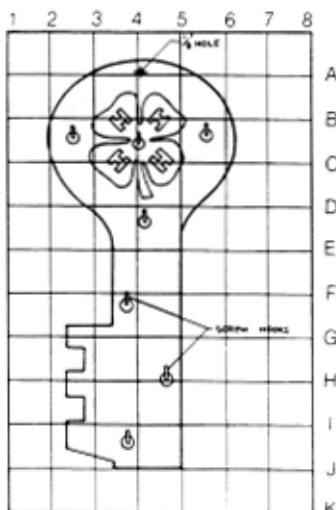


How to Use the Grid System

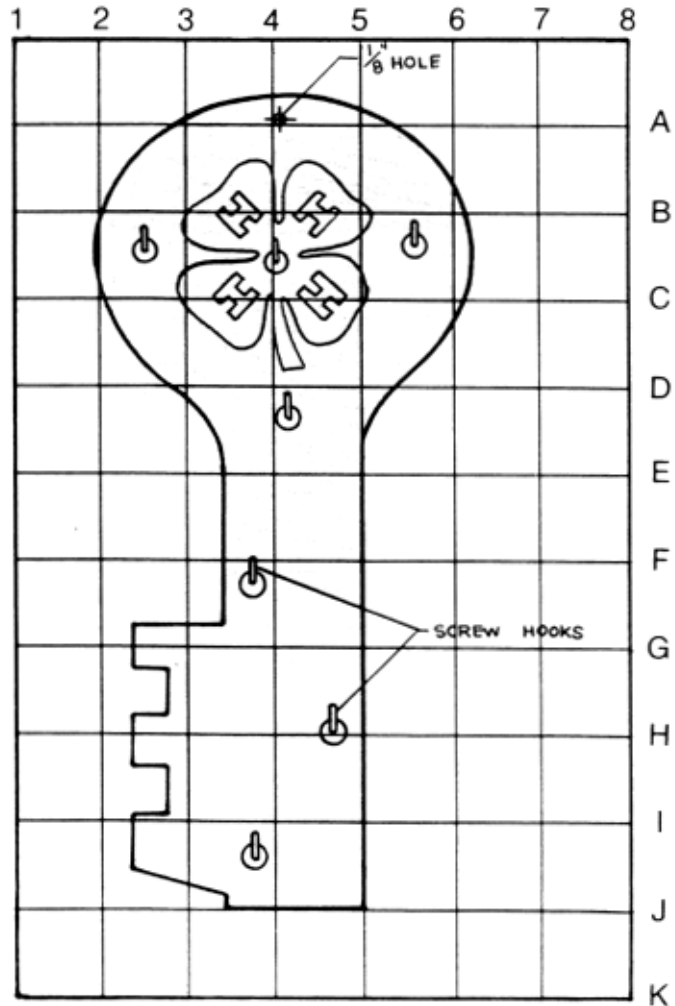
You may want to learn how to use the grid system to make drawings of irregular-shaped articles. The grid system is used to enlarge irregular-shaped drawings that are too small for a trace pattern.

For instance, if you had a 2" x 2" drawing of this key hook holder and you wanted to make it larger, you would follow these steps:

1. Decide on the size you want your pattern to be.
2. Draw a grid on your original article, and draw a grid the size you want your pattern to be on a clean piece of paper or wood. Both grids must have an equal number of squares, but the larger the drawing the larger the squares. The new drawing will then be your pattern.
3. Along one side number the lines. Place letters of the alphabet along the other. Remember, the squares on both grids must be identified the same.
4. Now you are ready to draw. On your original drawing, place dots where the outline of the picture crosses the grid lines. Transfer these dots to your new grid pattern, plotting the points one by one and connecting them in order as if you were trying to draw the picture free-hand. Use straight lines and curved lines where appropriate. As you connect the dots, your new pattern should be the same shape as your original, only larger.
 - To make a 12" x 12" drawing, use 12 rows of 1" squares.
 - To make a 16" x 16" drawing, use 16 rows of 1" squares or 8 rows of 2" squares.
 - To make a 24" x 24" drawing, use 24 rows of 1" squares or 16 rows of 1½" squares.



Original Pattern.



New Enlarged Pattern.

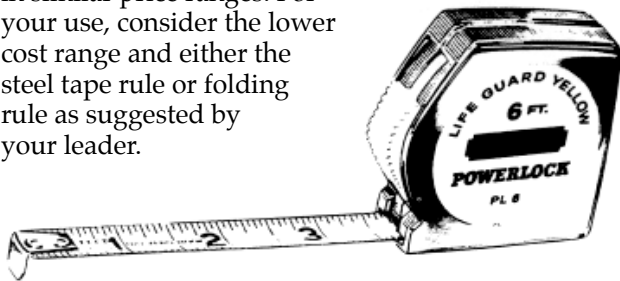


Woodworking Tools

Wood Science Unit I contains information about a group of tools and some equipment you should have for your use. This unit contains information about more tools. You may want to add some of them to your tool set.

Steel Tape and Folding Rule

In this unit, you will be making bigger things than before. Therefore, you may desire a steel tape rule or a folding rule. Both are available in similar price ranges. For your use, consider the lower cost range and either the steel tape rule or folding rule as suggested by your leader.



The steel tape rule is available in many lengths: 6, 8, 10, and 12-foot lengths. The 6-foot length probably is adequate for your use.



Folding rules are available with either standard inside reading or outside reading. The numbers on the inside-reading rule begin on the inside face. Thus the markings are close to the work when the rule lies on the work with the unfolded portion up.



Scratch Awl

Now that you are doing more exact and accurate work than before, you may need a scratch awl for marking. It gives a very clean, sharp, distinct line for accurate cutting. It can be used to make a center point in wood for drilling.



Attention Awl Users

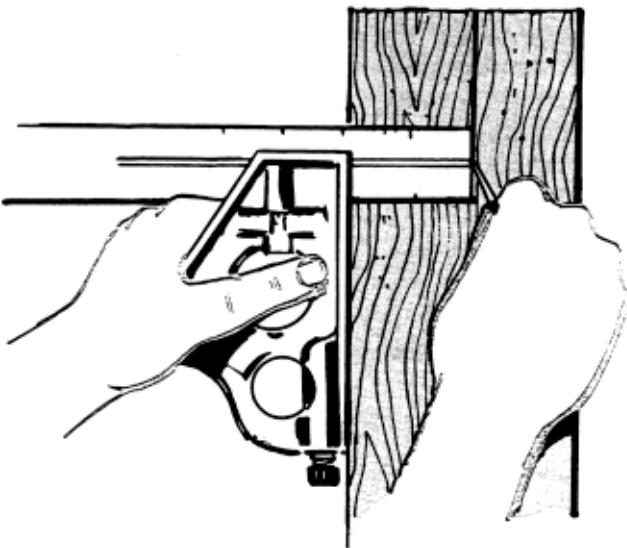
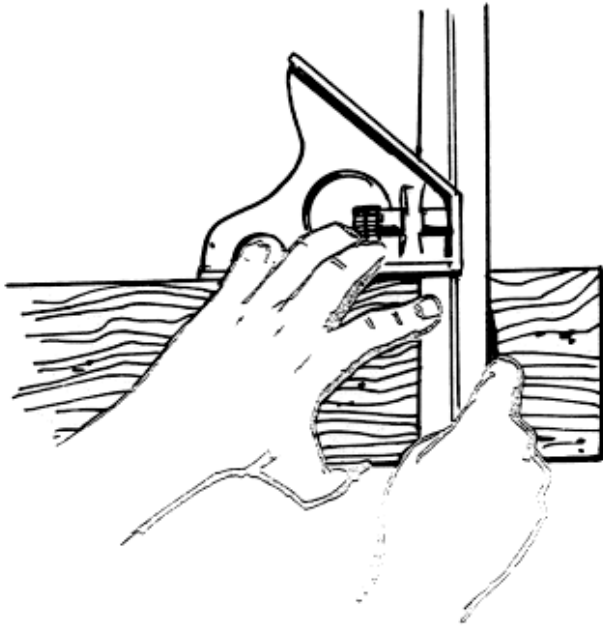
An awl is sharp-pointed like an ice pick. It is used for marking lines or piercing small holes in wood. Because of its sharpness, it must be handled carefully at all times so it won't pierce your skin.



Combination Square

A steel combination square and a scratch awl marker or pencil can be used to make a line of uniform distance from one edge of the wood piece.

Set the blade of the square in the desired position and securely tighten the adjusting nut. Hold the square firmly against the edge of the wood. Slide the handle along the edge of the wood piece with one hand while marking at the end of the blade with the other hand. Slant or slope the marker in the same direction as you are moving the square.



Pencil Compass

A moderately priced pencil compass works well for drawing circles or parts of circles. The pencil should be adjusted so that when the compass is closed, both the pencil point and the needle-like point of the leg are the same length. To use the compass, push the needle-like point into the center spot of your circle and move the compass in a circular motion. Slightly lean the compass in the direction you are moving.

When drawing a circle on a piece of paper, place a piece of cardboard or wood under the paper. Otherwise, the needle point may go through the paper and harm a nice tabletop.

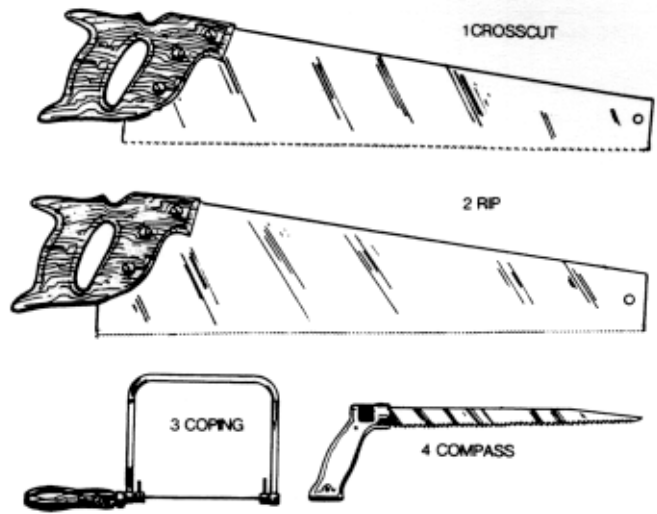
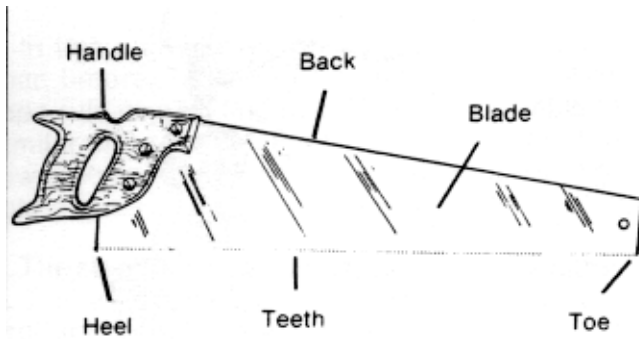




Hand Saws

Saw size is determined by the length of the blade in inches. Some popular sizes are 20", 22", 24", and 26". The coarseness or fineness of a saw is determined by the number of teeth points per inch.

There are different types of hand saws, each suited for a particular job.



Crosscut Saw

This saw is used frequently by woodworkers. Crosscut saws cut across the grain of wood, and they cut on both the forward and backward strokes. They are available with coarse teeth or fine teeth. The teeth have knife-like points.

A coarse, crosscut, 8-point saw works well for fast work and for green wood. A fine saw, 10 to 14 teeth points per inch, is better for smooth, accurate cutting and for cutting dry wood.

Rip Saw

Rip saw teeth are shaped like chisels. They cut like a gang of chisels in a row. The rip saw cuts mostly on the forward stroke and is used for cutting with the grain of the wood.

Coping Saw

This saw is used commonly for cutting curves in wood. It is small with a narrow blade and cuts better on wood that is not too thick, such as 1/4" to 1" thick. As the saw cuts, it tears and breaks the wood fibers, cutting in the direction that the teeth are pointing. For example, if the blade is placed in your saw with the teeth pointing toward the handle, the saw will be cutting on the pull stroke.

Compass Saw

This saw is small with a short, narrow blade. It is used to saw curves in wood too thick for a coping saw. To start an inside cut with the saw, you must bore one or more holes large enough to admit the point of the saw. Insert the saw point in the hole and cut with smooth, even strokes.

Crosscut Saw Teeth



Rip Saw Teeth





Attention Power Saw Users

Wear safety goggles whenever using electric saws.

Keep a firm grip on the saw so it does not jump out of your hands.

Turn the saw off and unplug it when cutting is finished.

Do not let the blade touch any part of your body. It can inflict serious damage.

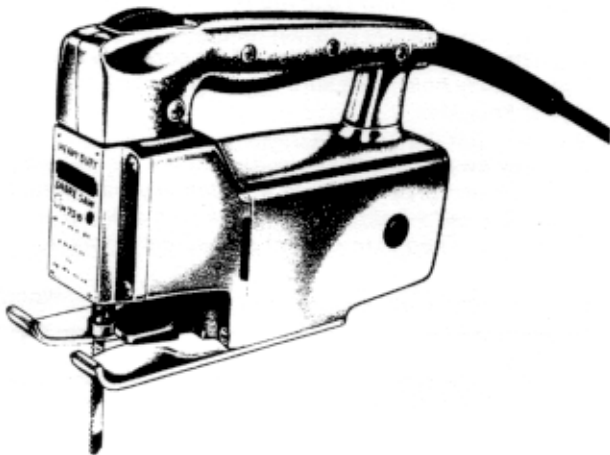
Use with supervision.

Power Saws

Saber Saw and Jig Saw

These power saws cut straight lines, curves, circles, and irregular shapes. Blades are available for these saws that can be used to cut metal, plastics, composition board, rubber, etc.

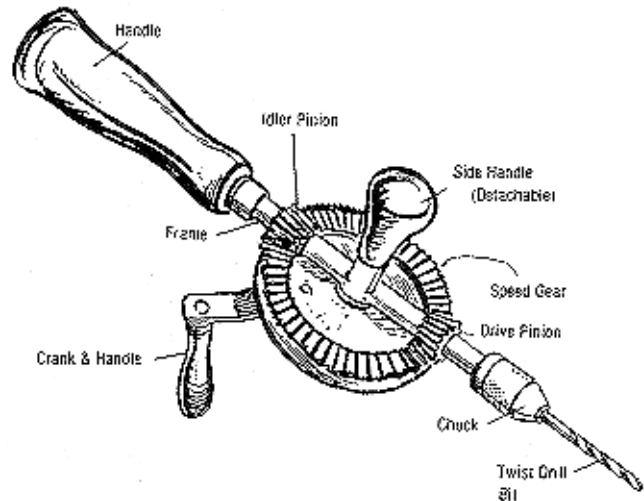
It would take many pages to explain in detail the operations of these saws. If you have one of them, study the instruction book you received. Operate power saws only with the supervision of a leader or parent.



Tools for Boring Holes in Wood

Hand Drill

The hand drill is used with removable drill bits of different sizes. It is used to make small pilot holes up to 1/4" for nails and screws. This prevents splitting the wood. Use it also to drill a starting hole for the coping saw blade.



Before you start drilling, make a small starting hole in the wood with a scratch awl or a nail and hammer. The hole prevents the drill point from slipping or sliding. Always make sure you have the right size drill bit properly placed in the chuck before you start to work.

To put the drill bit in the chuck, hold the crank handle and frame with one hand and turn the chuck to the left with the other. Open the jaws only a little more than the size of the drill bit. This helps to center the bit. Turn the chuck back to the right to tighten and hold the bit in place. The drill is used by holding it straight up and down. Hold the handle in your left hand and turn the crank with the right hand.

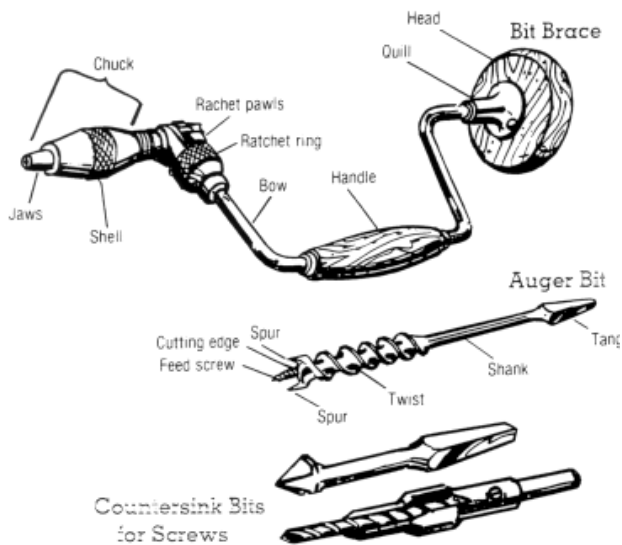
Proper Use of Hand Drills

Be careful. The drill may be jerked out of the wood and injure you. The gears also can pinch.



Bit Brace and Auger Bits

To bore large holes ¼-inch and larger, use your bit brace and auger bit or electric drill and appropriate bit. The bit brace is used for turning such tools as wood auger bits, screwdriver bits, twist drill bits, and countersink bits. Braces are made either with or without the ratchet device. The ratchet makes it possible to bore holes where the handle cannot be turned all the way around, as in corners. The size of a bit brace is designated by its sweep. The sweep is the diameter of the circle through which the handle swings. A brace with an 8- to 10-inch sweep is suitable for average work.



Can you see the similarity between the hand drill and this tool? They are both used to bore holes. However, on the hand drill the part that makes the hole is called the **twist drill bit**. On this tool it is called an **auger bit**. You can use either for making small holes, but it is easier to make large holes with an auger bit.

The bit and brace is used by pressing down on the head and turning the handle. As the feed screw starts to break through your item, turn the item over and finish boring the hole from the other side. This prevents splitting and splintering.

Most hardware stores sell auger bits individually or in sets. The number usually stamped on the tang (shank) indicates the size of the bit by 16ths of an inch. For example, 4 indicates ¼" or 1/4".

Brace and Bit Safety

This is a fairly safe tool, but accidents can happen. Hands have been pinched where the handle or head bearing became worn. Don't use the brace if it is badly worn.

Make sure the tang of the bit fits correctly and the chuck jaws firmly hold it. Be sure the ratchet won't slip and scrape your knuckles.

Stay away from the back side of the piece being bored. The bit can break through accidentally with great force. If possible, put a board on the back side of the piece you are drilling to keep your project piece from breaking.

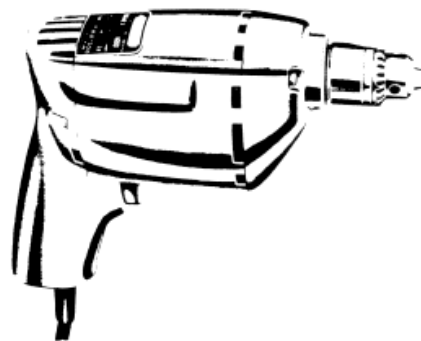
Electric Drill

The electric drill can be used for all sizes of holes, depending on its size and your ability to safely use it. A small electric drill is a very handy tool for drilling holes up to ¼ inch, and larger electric drills using special bits can drill holes up to 1 inch in diameter.

When using the electric drill, make a pilot hole in the wood the same as you would when using a hand drill. Always make sure you have the right size drill bit properly placed in the chuck before you start to work.

Drills are available in the light-duty, inexpensive range, medium-duty, heavy-duty, or industrial class. Electric drills also are available with varying speeds.

Electric drills run at a very high speed. When using the electric drill, grasp the handle firmly. The drill develops a twisting force called **torque** when in motion. If the bit suddenly became stuck, the torque of the drill could jerk your arm enough to strain a muscle.





Electric Drill Users

Always make sure the key is removed from the chuck before pressing the switch.

There may be a sudden twisting force on the drill handle should the bit become stuck. You must have a firm grip on the drill handle at all times.

Never use the electric drill where there is the possibility of touching water or in damp conditions.

Any slight break in the electric-cord insulation could give you a severe shock.

The wood being drilled should be clamped or held securely.

Keep the tool in good condition at all times.

Carbon steel drill bits work well in wood, but high-speed drill bits are necessary for drilling in metal. Metal is considerably harder than wood; therefore, carbon steel bits become dull very quickly when used in metal. The higher quality steel used in high-speed bits makes them more durable than carbon steel bits.

Wood Screws

There are various kinds and sizes of screws. The flat-head screw is used most commonly in woodworking, although the oval-head and the round-head screws are sometimes used, mainly for ornamental effect. The pan-head screw also is used.

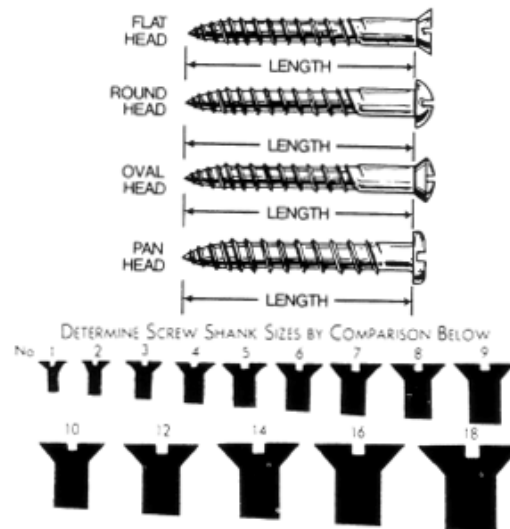
The size of wood screws is designated by:

- (1) Size of the shank
- (2) Length

You may use screws to assemble some of the things in your woodworking project. Remember to drill pilot holes to prevent splitting and to make the screws turn more easily.

To make pilot holes, find the proper drill size from the table. Drill the first hole as deep as the length of the screw from the head to the beginning of the threads. Then drill the second hole inside the first hole and drill as deep as the screw length. Instead of using two different-size drills to make pilot holes, you can buy combination pilot hole drill bits in a variety of sizes to fit the different-size screws.

Wood Screws



Sizes of Bits or Drills to Bore Holes for Wood Screws

Number of Screw	1	2	3	4	5	6	7	8	9	10	12	14	16	18	
Body Diameter of Screw	073	086	099	112	125	138	151	164	177	190	216	242	268	294	
	$\frac{5}{64}$	$\frac{3}{32}$	$\frac{3}{32}$	$\frac{7}{64}$	$\frac{1}{8}$	$\frac{9}{64}$	$\frac{5}{32}$	$\frac{11}{64}$	$\frac{11}{64}$	$\frac{3}{16}$	$\frac{7}{32}$	$\frac{15}{64}$	$\frac{17}{64}$	$\frac{19}{64}$	
First Hole	Twist Drill Size	$\frac{5}{64}$	$\frac{3}{32}$	$\frac{7}{64}$	$\frac{7}{64}$	$\frac{1}{8}$	$\frac{9}{64}$	$\frac{5}{32}$	$\frac{11}{64}$	$\frac{3}{16}$	$\frac{3}{16}$	$\frac{7}{32}$	$\frac{1}{4}$	$\frac{17}{64}$	$\frac{19}{64}$
	Auger Bit Number						3	3	3	3	4	4	5	5	
Second Hole	Twist Drill Size		$\frac{1}{16}$	$\frac{1}{16}$	$\frac{5}{64}$	$\frac{5}{64}$	$\frac{3}{32}$	$\frac{7}{64}$	$\frac{7}{64}$	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{9}{64}$	$\frac{5}{32}$	$\frac{3}{16}$	$\frac{13}{64}$
	Auger Bit Number											3	3	4	



Using the Screwdriver

Turn the screw in until the two pieces of wood fit tightly together. If you turn the screw too much, the wood around the screw threads will break out. Then the strength of the screw is lost.

The screwdriver should be the same width as the slot on the screwhead. It should be thick enough so it fits snugly into that slot.

Screwdriver Users

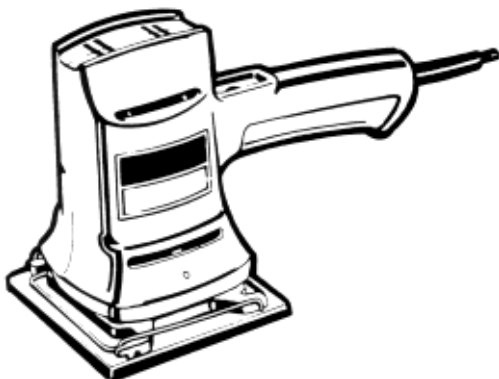
Imagine! Some people have been seriously hurt while using screwdrivers when the screwdriver slipped and struck them in the palm of the hand.

Objects you are working on should always be placed on the work surface. Never hold the object in the palm of your hand.

Screwdrivers must fit the slots of the screws properly.

Oscillating Sander

Oscillating electric sanders can be used in the shop and home. They can be used for paint removal, refinishing furniture, finishing wood and smoothing wood, wallboard, or plaster wall joints. The sanding action is provided by a rectangular piece of sanding paper attached to a sanding pad. The pad oscillates either back and forth or in a circular motion. A sander that oscillates in a circular motion may not be satisfactory for fine work, because it may leave circular scratches on the wood surface. If you are not sure whether to use this sander, ask your leader or parent for help.



Using the Sander

Be sure the sander is properly grounded through a three-wire grounding cord. Check to see that the switch is in the OFF position before connecting the electric plug to the outlet. Lift the sander off the work before starting or stopping it. Hold it firmly with little or no downward pressure. The weight of the sander is enough in most cases.

To smooth a rough surface, start with a coarse sandpaper because it cuts faster. Change to medium and then to fine sandpaper as the surface becomes smooth. Remember to sand along the grain (along the length of your wood piece), never across the grain.

Lubricate the sander according to recommendations of the manufacturer.

Using the Electric Sander

Because moisture conducts electricity, never use the electric sander in wet conditions. You can get shocked!

Unplug the sander when changing the sandpaper.

Never let the moving sandpaper touch the power cord. It can quickly ruin the insulation, which can then shock you.



Woodworking Plans

4-H Key Holder

Materials needed

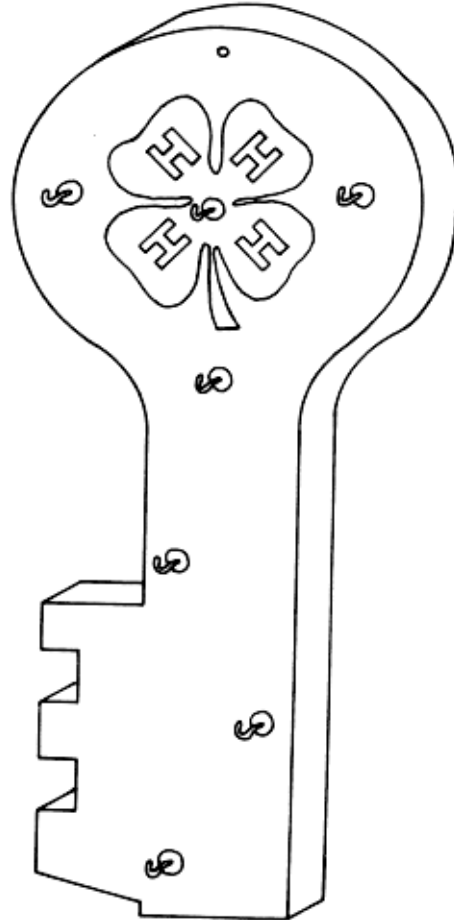
- 1 piece of 1 x 6 lumber (actual size $\frac{3}{4}$ " x $5\frac{1}{2}$ " x 11" long)
- 7 — $\frac{1}{2}$ " cup hooks
- Carbon paper
- Sandpaper (medium and fine grit)
- Paint (green and white)
- Stain
- Varnish

Tools needed

- Coping saw or saber saw
- Boring tool with $\frac{1}{8}$ " bit
- Woodburning tools (optional)

Instructions:

1. Trace pattern onto wood using carbon paper. (See instructions for grid enlargements on page 11.)
2. Cut out the key using the saw.
3. Drill $\frac{1}{8}$ " hole at top for hanging.
4. Sand the wood piece thoroughly.
5. Stain the piece.
6. Take the pattern and re-mark your wood for the 4-H Clover design and cup hooks.
7. Paint the clover green and the H's white. (Instead of using paint, you can burn the clover design into the wood with a woodburning tool.)
8. Varnish the entire item.
9. Install the hooks.





Cutting Board

Materials needed

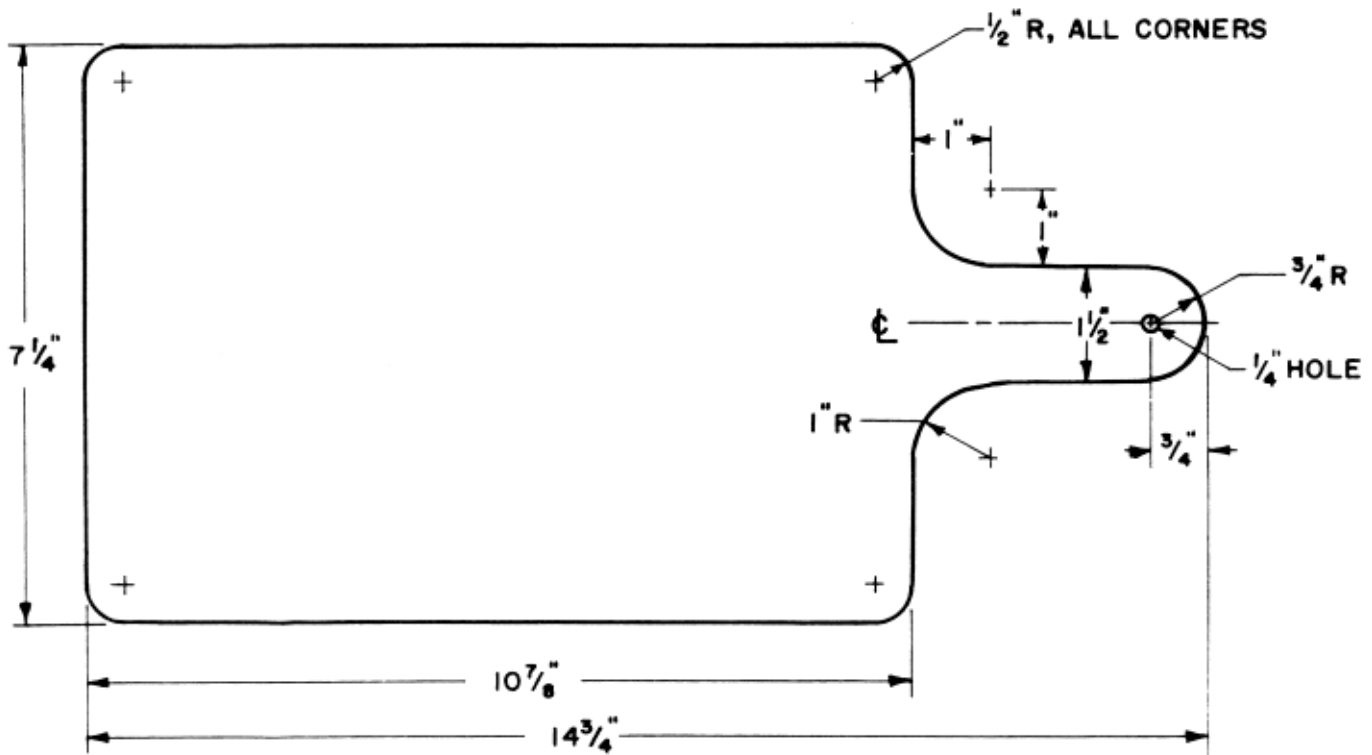
- 1 piece of 1 x 8 hardwood (actual size $\frac{3}{4}$ " x $7\frac{1}{4}$ ") x 15" long
- Sandpaper (medium and fine grit)
- Varnish

Tools needed

- Pencil compass
- Square
- Saw (coping, jig, or saber saw)
- Boring tool with $\frac{1}{4}$ " bit

Instructions

1. Using the pencil compass, lay out curves and the hole in the handle on your wood piece. Use the square to make straight lines on the sides and end.
2. Cut out the curves and drill hole.
3. Sand both sides.
4. Finish with two or three coats of varnish, on one side only. (This process is optional.)





The Shifting Pyramid Game

Materials needed

- 1 piece of $\frac{3}{4}$ " x 8" x 8" A-D or better plywood, or use a piece of lumber 1 x 10 (actual size $\frac{3}{4}$ " x 9 $\frac{1}{4}$ ") x 8" long (base)
- 1 piece of $\frac{1}{4}$ " x 6" x 6" A-D or better plywood, or use a piece of lumber 1 x 8 (actual size $\frac{3}{4}$ " x 7 $\frac{1}{4}$ ") x 6" long (game pieces)
- 1 piece of $\frac{1}{4}$ " dowel stock, 12" long (pegs)
- Glue
- Sandpaper (medium and fine grit)
- Finishing material (optional)

Tools needed

- Saw (coping, saber or jig saw)
- Boring tool with $\frac{1}{4}$ " and $\frac{3}{8}$ " bits

Instructions

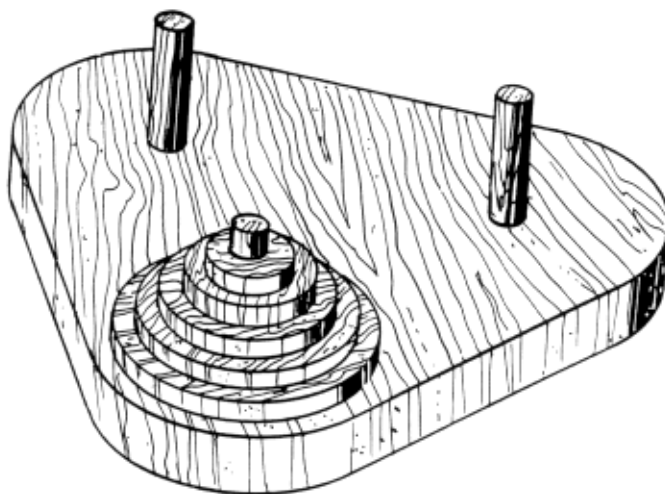
1. Trace the pattern for the base using carbon paper between your piece of wood and the pattern. Use the pattern on page 22.

NOTE: If your saw cuts on the pull stroke, trace your pattern on the back side of your wood piece so that the front face of the piece does not get damaged during cutting.

2. Cut out the base using a saw.
3. Mark and drill $\frac{1}{4}$ " peg holes, $\frac{1}{2}$ " deep in the base at the locations marked with an X.

4. Sand the surfaces and edges of the base.
5. Cut three pieces of the $\frac{1}{4}$ " dowel stock, 3" in length.
6. Sand the dowel pegs, rounding the top ends.
7. Apply glue to the sides of the holes with a small stick, then place the pegs in the holes.
8. Mark and cut the five movable pieces from the $\frac{1}{4}$ " plywood. Dimensions of the pieces are (3 x 3"), (2 $\frac{1}{2}$ " x 2 $\frac{1}{2}$ "), (2" x 2"), (1 $\frac{1}{2}$ " x 1 $\frac{1}{2}$ "), and (1" x 1"). These pieces can be cut round or square.
9. Mark the centers of each individual piece, and drill a $\frac{3}{8}$ " hole completely through the piece.
10. Sand each piece and finish with a material of your choice. Painting the pieces different colors adds eye appeal.

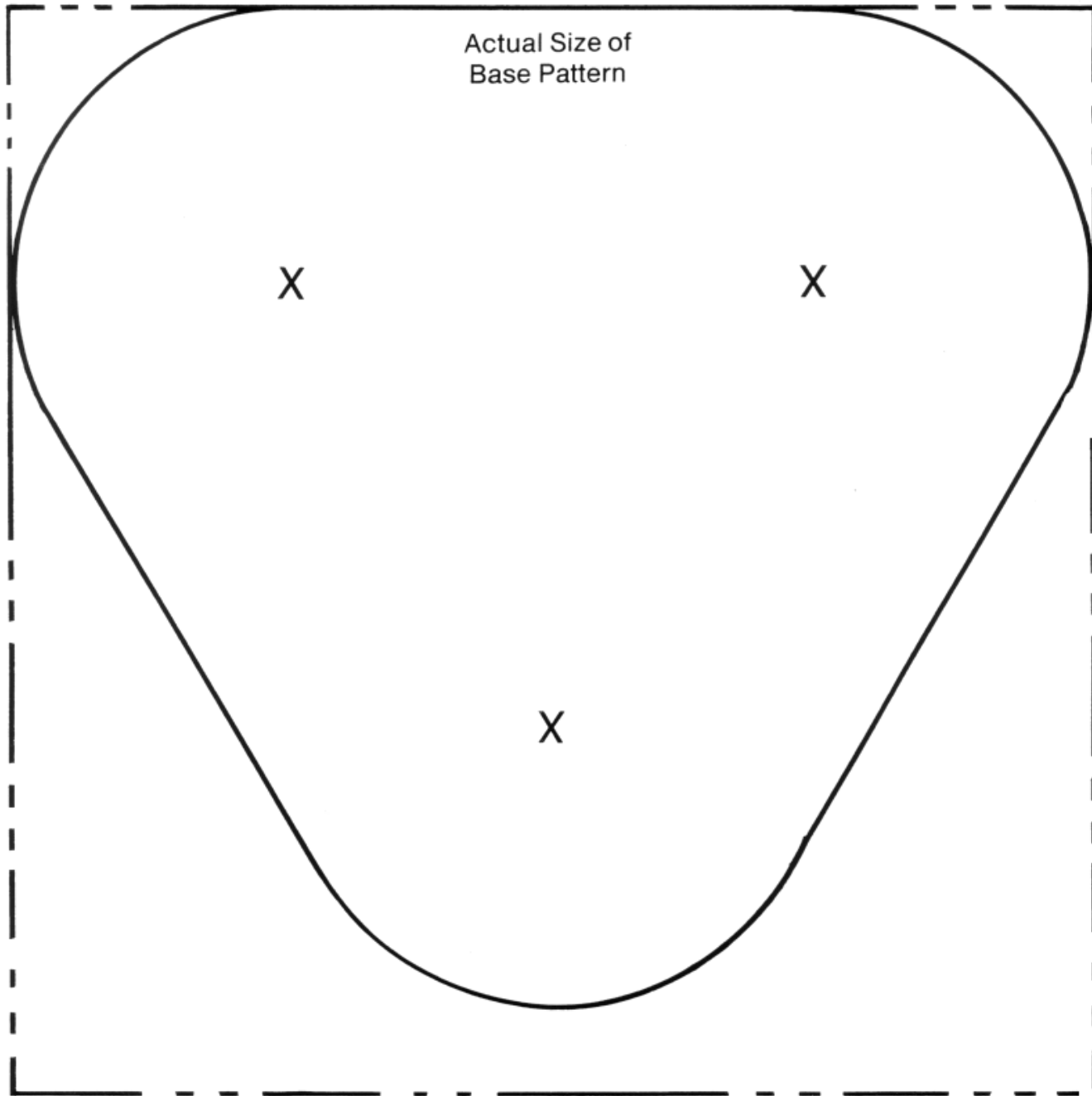
How to Play:





Place five pieces on one peg in pyramid formation. The object is to shift the entire pyramid (5 pieces) to another peg, moving one piece at a time and at no time having a larger piece above a smaller one. Can you do it in 31 moves (that's perfect)?

To make the puzzle more challenging, use seven blocks instead of five.





Bird House

Materials needed

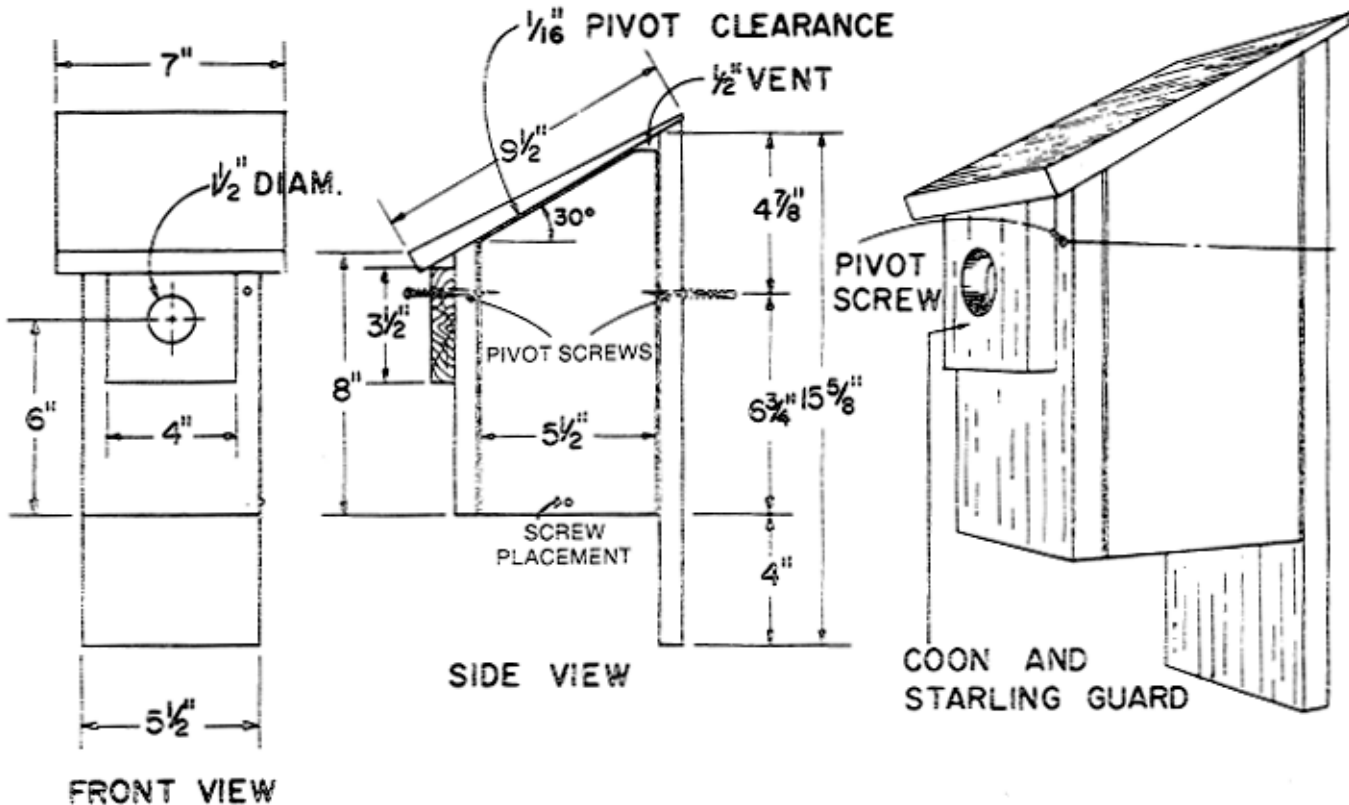
- 1 piece of lumber 1 x 6 (actual size $\frac{3}{4}$ " x $5\frac{1}{2}$ ") x 54" long
- 1 piece of bevel siding or other material for roof $\frac{3}{4}$ " x 10" x 8"
- 1 piece of lumber 1 x 4 (actual size $\frac{3}{4}$ " x $3\frac{1}{2}$ ") x 4" long for coon and starling guard
- 3 — No. 10, $1\frac{1}{2}$ " round-head wood screws
- $1\frac{1}{4}$ " galvanized or aluminum nails for roof and guard
- $1\frac{3}{4}$ " to $2\frac{1}{4}$ " galvanized or aluminum nails
- Sandpaper (medium and fine grit)
- No finish is necessary for the bird house

Tools needed

- Square
- Hand saw
- Hammer
- Boring tool with $\frac{3}{8}$ " and $1\frac{1}{2}$ " bits (bird hole can be cut with a compass saw or saber saw instead of using a drill)
- Pilot hole bits to fit the screws
- File

Instructions

1. Mark and cut pieces as shown in the diagram below.
NOTE: One side of the house is hinged to pivot on screws for easy access for annual cleaning. Removal of the screw at the bottom of the side allows the top of the side to be pushed inward. The hinged side should be $\frac{1}{16}$ " shorter than the other side.
2. Sand pieces smooth.
3. Drill a $\frac{3}{8}$ " drain hole in each corner of the bottom.
4. Drill holes in the front and back pieces to accommodate the screws.
NOTE: Follow the instructions on page 17 for making pilot holes.
5. Assemble all pieces using nails, except for the hinged side.
6. Install hinged side using screws.





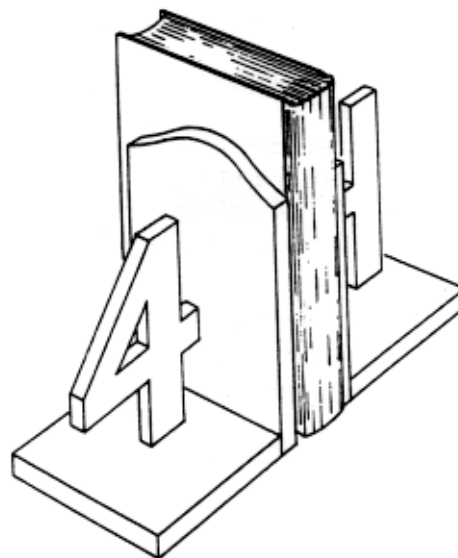
4-H Book Ends

Materials needed

- 1 piece of 1 x 6 lumber (actual size $\frac{3}{4}$ " x $5\frac{1}{2}$ ") x 36" long, or you can use interior-type plywood ($\frac{3}{4}$ " A-C grade or better)
 - 10 — 1 $\frac{1}{2}$ " finishing nails
 - Sandpaper (medium and fine grit)
 - Glue
- Paint and varnish, optional

Tools needed

- Saw (coping, jig, or saber)
- Hammer



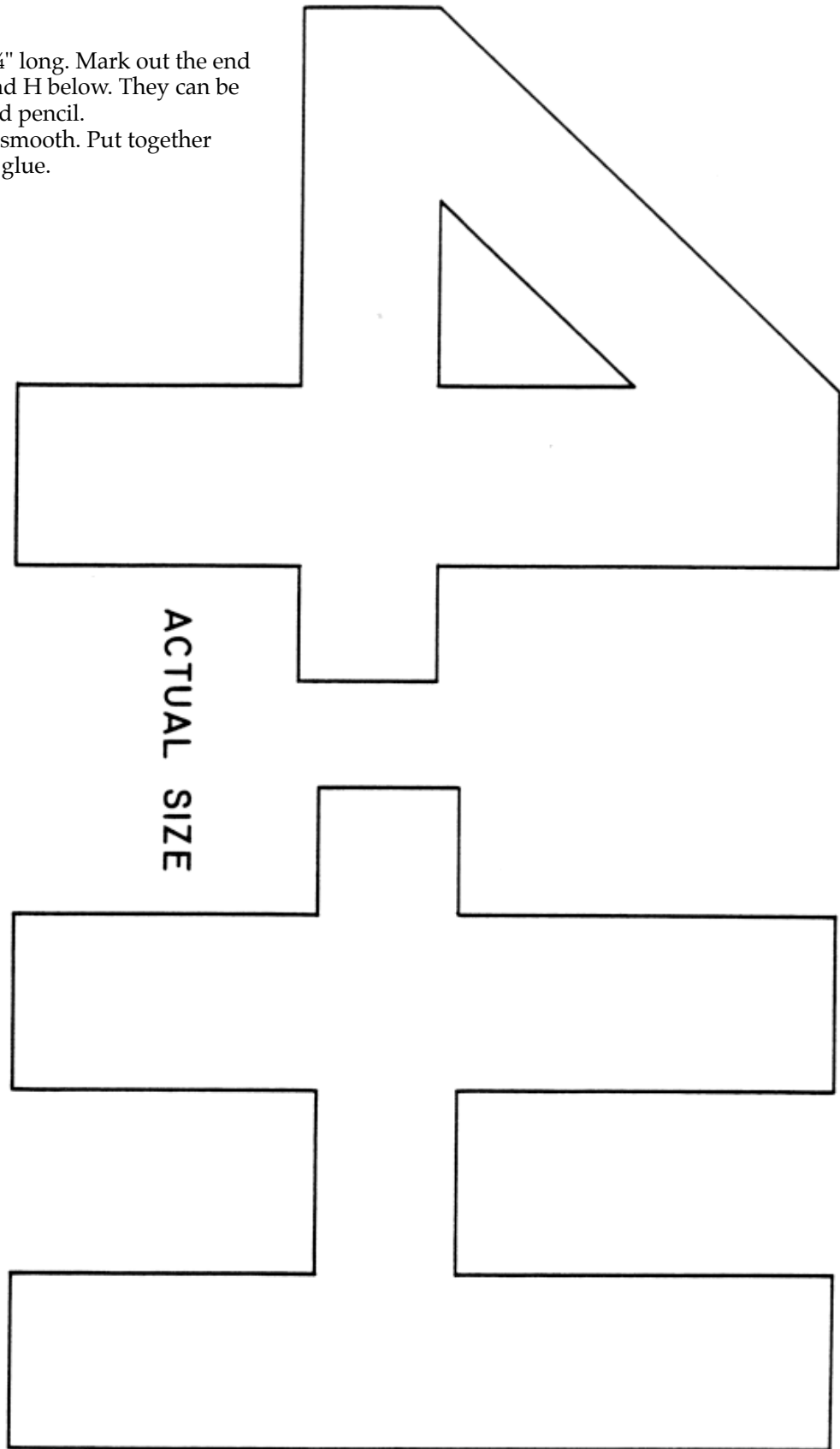
ACTUAL SIZE



4-H Book Ends (continued)

Instructions

1. Mark out two base pieces $5\frac{1}{4}$ " long. Mark out the end pieces (page 24) and the 4 and H below. They can be traced with carbon paper and pencil.
2. Cut out the pieces and sand smooth. Put together with $1\frac{1}{2}$ " finishing nails and glue.
3. Apply finish.





Foot Stool

Materials needed

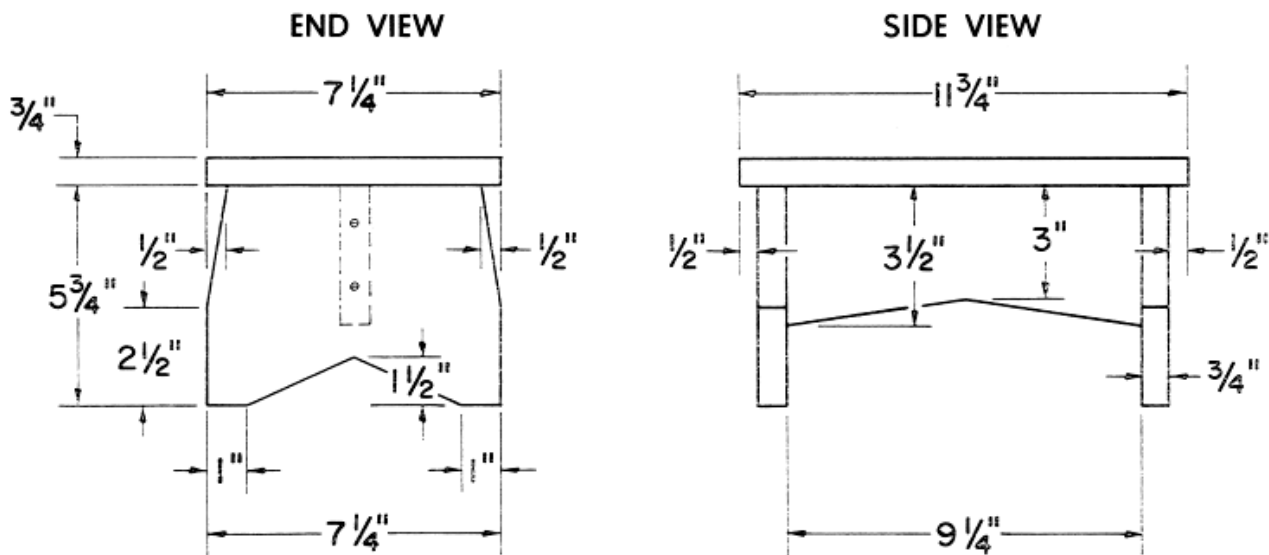
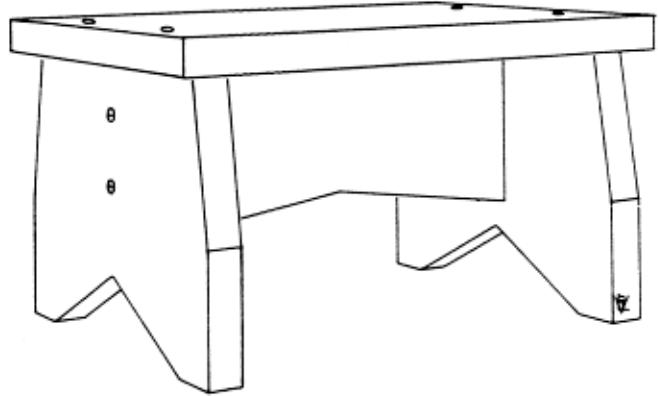
- 1 piece of 1 x 8 lumber (actual size $\frac{3}{4}$ " x $7\frac{1}{4}$ ") x 24" long—for top and legs
- 1 piece of 1 x 4 lumber (actual size $\frac{3}{4}$ " x $3\frac{1}{2}$ ") x 12" long—for stretcher
- 8 — No. 8, $1\frac{1}{2}$ " flathead wood screws
- Sandpaper (medium and fine grit)
- Glue

Tools needed

- Hand saw
- Screwdriver
- Boring tools
- Pilot hole bits to fit the screws and countersink

Instructions

1. Measure and mark the pieces for the footstool.
2. Cut out the pieces.
3. Drill holes for the screws and countersink them so that the screwheads are just below the wood surface.
4. Sand the pieces.
5. Assemble with glue and the screws.
6. Finish as desired.





Book Rack

Materials needed

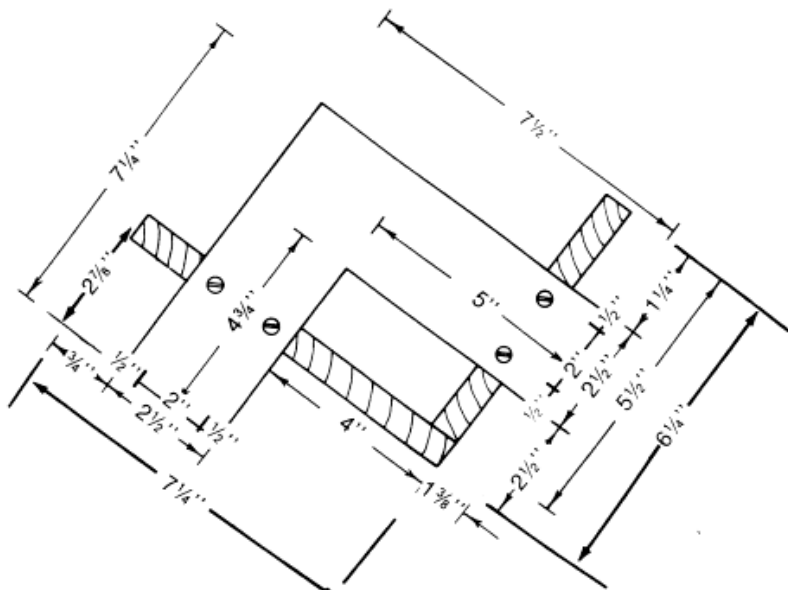
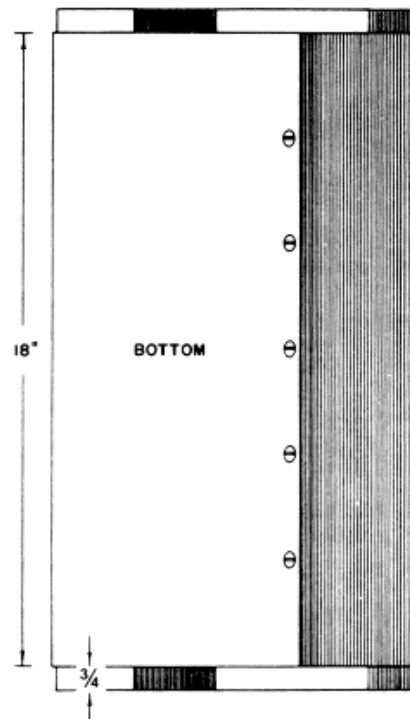
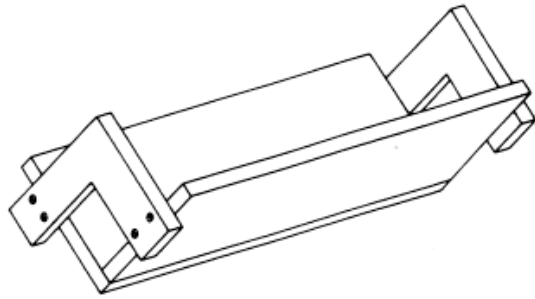
- 1 piece of 1 x 8 lumber (actual size $\frac{3}{4}$ " x $7\frac{1}{4}$ ") x 18" long (bottom)
- 1 piece of lumber 1 x 6 (actual size $\frac{3}{4}$ " x $5\frac{1}{2}$ ") x 18" long (back)
- 1 piece of 1 x 8 lumber (actual size $\frac{3}{4}$ " x $7\frac{1}{4}$ ") x 16" long (L-shape ends)
- 13 — No. 6, $1\frac{1}{4}$ " flat-head wood screws
- Stain and varnish (optional)

Tools needed

- Hand saw
- Screwdriver
- Boring tool with a $\frac{1}{8}$ " bit and countersink

Instructions

1. Cut pieces to size, including the two L-shaped ends.
2. Sand pieces smooth.
3. Drill and countersink five holes, 3 inches apart, $\frac{3}{8}$ " from the edge on a long edge of the 1 x 8 x 18" piece.
4. Screw the 1 x 6 x 18" piece to the 1 x 8 x 18" piece using five of the wood screws.
5. Mark, drill, and countersink the four holes in each L-shape end.
6. Screw the L-shape ends to the ends of the shelf assembly using two screws on each end.
7. Stain and varnish or finish as desired.





Tool Box

Materials needed

- 2 pieces of 1 x 4 lumber (actual size $\frac{3}{4}$ " x $3\frac{1}{2}$ ") x 18" long—sides
- 2 pieces of 1 x 4 lumber (actual size $\frac{3}{4}$ " x $3\frac{1}{2}$ ") x 10" long—ends
- 1 piece of 1 x 8 lumber (actual size $\frac{3}{4}$ " x $7\frac{1}{4}$ ") x 18" long—bottom
- 1 piece of 1 x 6 lumber (actual size $\frac{3}{4}$ " x $5\frac{1}{2}$ ") x 18" long—handle
- 4 — No. 8, $1\frac{1}{2}$ " flat-head wood screws
- 25 — No. 8, 2" flat-head wood screws
- Sandpaper (fine grit)

Tools needed

- Saws (hand saw and coping, jig, or saber saw)
- Screwdriver
- Round wood rasp or file
- Boring tool with a 1" bit
- Pilot hole bits to fit the screws and countersink

Instructions

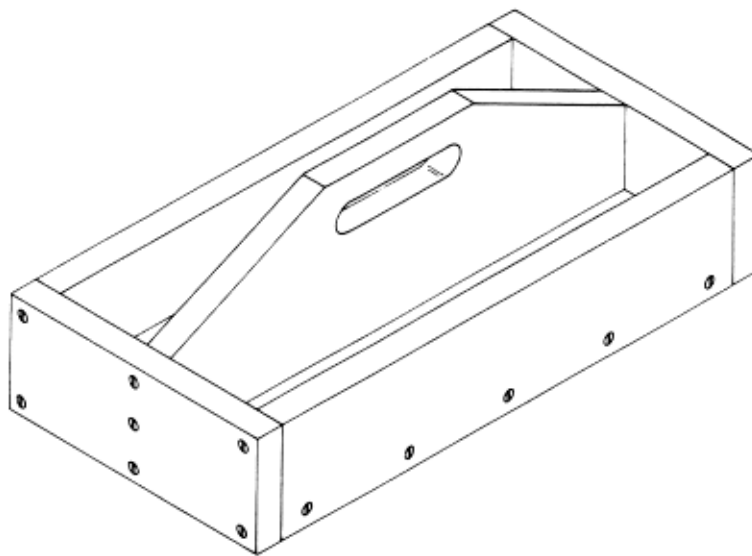
1. Cut pieces to size. (See diagram on page 29.)
2. Mark the angled cuts on the handle as shown in the diagram. Cut the angles with the saw, leaving $\frac{1}{16}$ " or so for sanding.
3. Mark the handle hole. Bore a 1" hole at each end of the mark and remove the rest with a coping saw. Use a round wood rasp or file to even the handle edges. Sand the handle smooth.

4. Draw the center line lengthwise on the 1 x 8 x 18" bottom piece. Drill and countersink holes every 3 inches on that line and screw the handle to the bottom using 2" wood screws.

NOTE: Follow the instructions for drilling pilot holes on page 17. Countersink the holes on the outside of the tool box so the heads of the screws are slightly below the surface of the wood. A careful craftsman lines the slots of the screws so that they are all in the same direction.

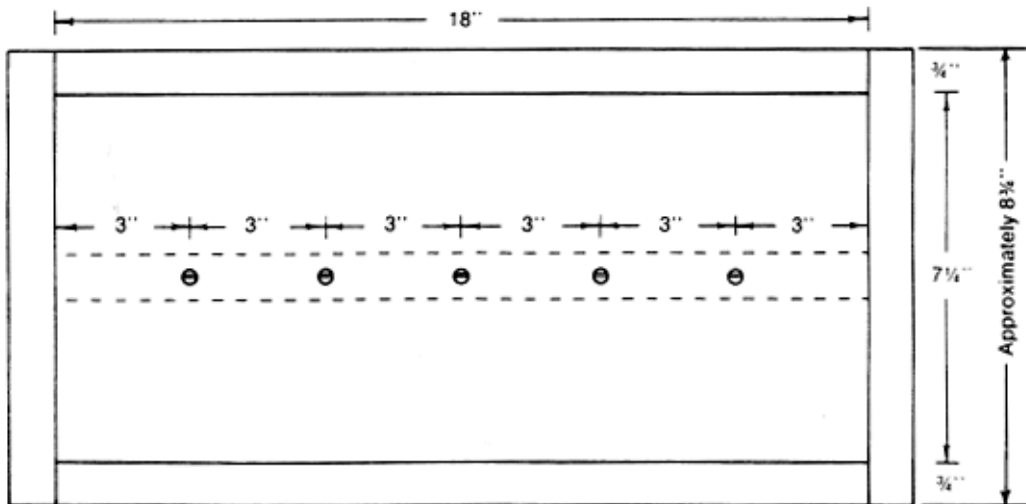
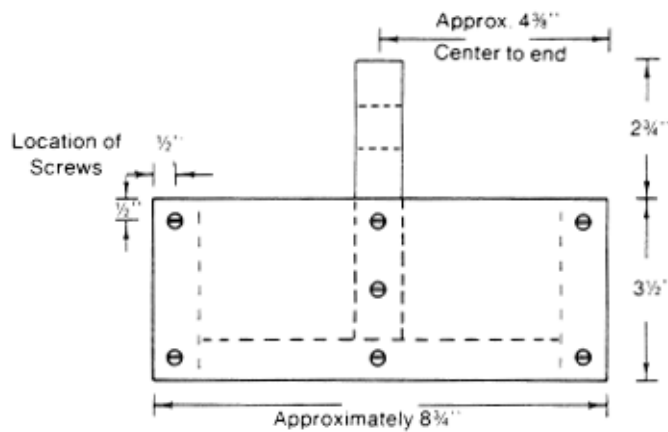
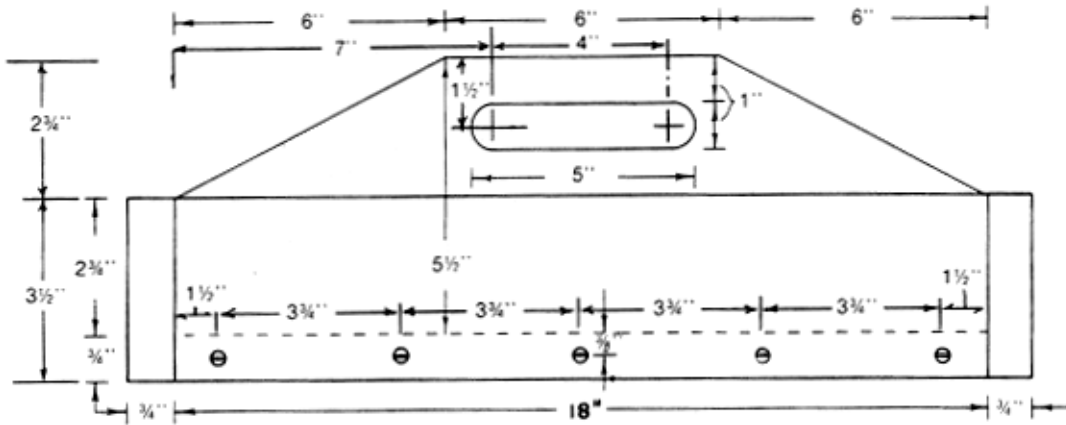
5. Drill and countersink holes in the two 1 x 4 x 18" side pieces, $\frac{3}{8}$ " from the bottom edge. Space the holes as shown in the diagram. Now screw both sides to the edges of the bottom piece using 2" screws.
6. Add the ends in the same manner, except use $1\frac{1}{2}$ " screws in the bottom corners of each piece.
7. For added strength, drill and countersink three holes in each end piece to hold the handle. Space them as shown in the diagram, and insert a 2" screw in each hole.

NOTE: This tool box is approximately $8\frac{3}{4}$ " wide. This measurement may need to be adjusted to the width and thickness of your bottom and side pieces.





Tool Box (continued)





Wonderful World of Wood Glossary

Annual rings

Rings or circles seen on the cut end of a branch, log, or stump. They resemble a bullseye and actually are showing the layer of wood produced by a single year's growth of the tree.

Bevel siding

A wedge-shape board or piece of wood, thicker along one edge than the other. One board edge has been cut and trimmed to an angle.

Board foot

A measurement of wood that is 1 foot long by 1 foot wide by 1 inch thick. It also can be other sizes that have the same total amount of wood. For example, a piece of wood 2 feet long, 6 inches wide, and 1 inch thick or a piece of wood 1 foot long, 6 inches wide, and 2 inches thick also is 1 board foot of wood. To get the number of board feet in a piece of lumber, measure your lumber and multiply Length (feet) x Width (inches) x Thickness (inches) and divide by 12. The formula is written

$$\frac{L' \times W'' \times T''}{12}$$

Countersink

A tool used to make a tapered hole for the head of screws to fit into.

Grain

The lines, bands, or patterns that appear on the ends, faces, and sides of lumber. The grain is formed from the annual rings.

Grid

A graph-like square consisting of horizontal and vertical lines placed equal distances apart. It is used for plotting points to change the size of irregular-shape drawings. Drawings can be increased or decreased in size.

Kerf

A slit or notch made by saw teeth.

Kiln

An oven used to dry wood. The temperature and relative humidity are controlled to minimize shrinkage and warping.

Particleboard (chipboard)

A panel of wood, usually 4 x 8 feet and of several thicknesses, made of wood chips bonded together under pressure. It has a very high resistance to warping, shrinking, and expanding.

Pilot hole

The starting hole placed in wood to prevent a drill or auger bit from slipping, or to accommodate a screw. Pilot holes help prevent the wood from splitting when boring holes into wood. Pilot holes can be made with an awl or a hammer and nail when used to start a drill or auger bit, but should be drilled to proper size to match a screw.

Plane

A tool for smoothing and leveling wood.

Plywood

A building material consisting of wood glued or cemented together with the grains of the wood laying adjacent to each other at right angles.

Primary processing

The sawing, chipping, or slicing of the log into lumber or other raw wood products. Examples of primary processing are sawmilling to produce pulp and paper, veneer, plywood, or particleboard.

Secondary processing

Additional manufacturing of wood beyond the primary processing stage before the wood can be used, such as making furniture from lumber, particleboard, and plywood. Other examples include producing cardboard boxes and paper bags from paper or making flooring from lumber.

Torque

A turning or twisting force felt when using power tools. The motion is caused by the electrical force.

Veneer

A thin slice of wood cut from a log with a knife or saw.

Vise

A device for holding wood stationary while you work on it at the workbench.

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