unit 1

Introduction to woodworking

During this space age when men orbit the earth and walk on the moon and probe even further, we might wonder whether a traditional material such as wood can still be important (Fig. 1–1). But new techniques of processing and use, imaginative design, and inherently desirable characteristics combine to make it one of the best raw materials. The consumption of wood is greater today than ever before.

About half the land area of the earth was once covered by forests (Figs. 1–2 and 1–3). Today only about one-third of the land surface is forested, but there is a possibility that planning and forest conservation will make a never-ending supply of wood available.

Use of wood is traditional, but the variety of uses of lumber in modern times would amaze our Colonial forefathers. As an illustration, the scientific development, processing, and improvement of plywood (Figs. 1–4 and 1–5) indicates the intensive research conducted today. Another valuable process is the lamination of timbers (Figs. 1–6 through 1–8), which resulted from recently developed glues and adhesives.

Since lumber is the oldest manufacturing industry, the use of wood has developed into a strong material technology. The photographs in this unit give evidence of the vision of scientists (Fig. 1–9), engineers, architects,

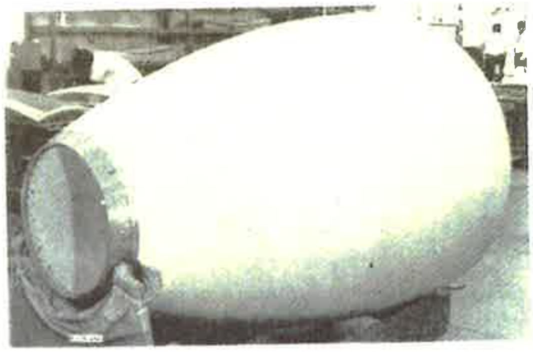


Fig. 1–1. Because of its low-weight strength and stiffness, Sitka spruce plywood was selected for the nose fairing of a Polaris missile. *(U. S. Forest Products Laboratory.)*

Fig. 1–2. Forests such as these now cover approximately one-third of the land surface of the earth. This spectacular view shows Mt. Hood and the forest surrounding it in Oregon, the leading lumber-producing state in the United States. *(U. S. Forest Service.)*

Fig. 1–3. These Douglas firs were old trees when Europeans first settled the forest areas of the Northwest. Today they are ready for market to make way for new forests that will spring up when these trees are removed. *(American Forest Products Industries.)*

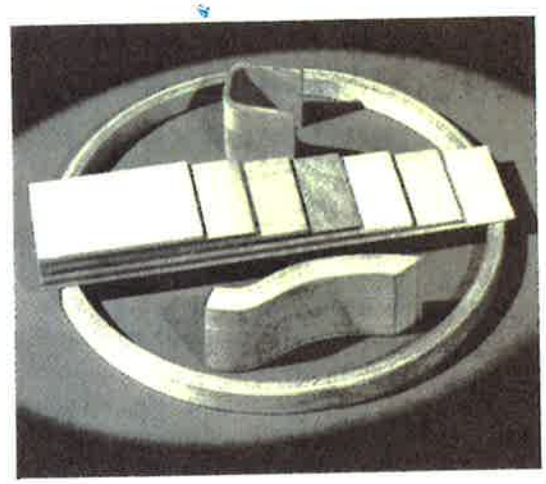


Fig. 1–4. Plywood can be formed into many shapes. *(American Forest Products Industries.)*

Fig. 1–5. Brazilian rosewood, one of the most sumptuous woods in the world, is used lavishly in the plywood panels which line the walls and conceal the built-in closet areas in this executive office. *(United States Plywood Corporation.)*

and contractors. Through the application of new techniques of frabrication and of artistry in design, wood is used in all its forms (Fig. 1–10).

The increasing demand for wood products will probably quicken the current trend of better and more intensive utilization of what was formerly considered unavoidable waste in the forests and at processing plants. Your experiences with this warm, interesting, and versatile material will give you an insight into the vast scientific potential of industrial and consumer uses.

Industrial arts woodworking prepares you in four ways for your future. *First*, it provides an opportunity for study of the vast field of lumber and wood products as related to manufacturing industries. *Second*, in the event you plan to attend college or university, industrial arts gives you an excellent introduction into the study of industry and how technology affects our economy. *Third*, if you decide to prepare yourself for a vocation or a trade, industrial arts enables you to acquire many practical skills dealing with many materials. You also have the opportunity to study vocational occupations. In doing so, you may make a wise choice of trade or vocational studies in the remainder of your high school career, or in a technical school immediately after high school graduation. *Fourth*, the information and the training you acquire will provide you some saleable skills.

Industrial woodworking laboratory activity must have organized and clear-cut objectives. The following suggestions should help you develop a clear concept of wood technology.

1. Acquaint yourself with the occupational and professional opportunities in careers relating to lumber, research, and wood-products manufacturing.

Fig. 1–6. Engineering and technology open new vistas as wood takes previously undreamed-of shapes and forms. Arches, beams, and trusses can support heavy roof loads in complete safety without a single supporting post. *(Weyerhaeuser Company.)*

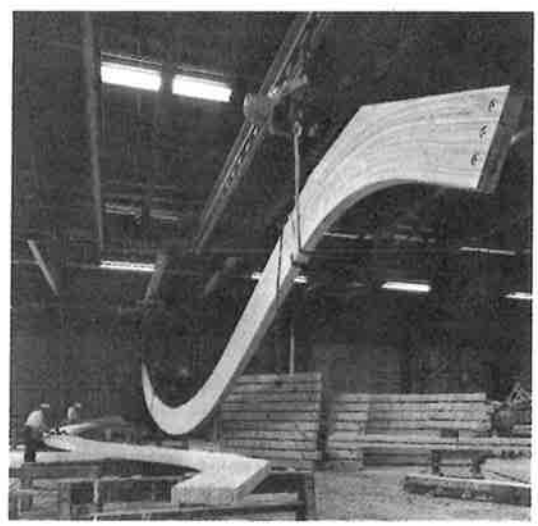


Fig. 1–7. This imaginative, dynamic, cliff-hanging house has won many awards for the wood products industries because of the ingenuity in the use of laminated supporting structures, and the interesting use of wood throughout the house. *(American Plywood Association.)*

Fig. 1–8. The interior of this home is made most interesting because of the laminated ceiling and roof supports, and the beautiful wood ceiling and wall treatment. *(Weyerhaeuser Company.)*

Fig. 1–9. Scientific investigation of the chemical composition of wood is responsible for many new industrial products. *(Western Wood Products Association.)*

2. Develop an avocational interest in woodworking.
3. Learn to appreciate the high standards of workmanship in superior products made of wood or wood-oriented materials.
4. Practice the correct and efficient way to handle tools and machines in woodworking.
5. Cultivate a sense of pride in your ability to do useful things well. The skills developed can lead to increased interest in additional woodworking activities.
6. Develop a creative and scientific attitude through involvement in technical experimentation with wood and wood products.
7. Develop an analytical ability through planning and observance of orderly procedure for any activity, project, or experiment undertaken.

8. Study and understand working drawings so that you can make both useful and well designed projects.

9. Understand and appreciate lumber and wood products as one of the major manufacturing technologies.

10. Always use safe working practices with tools, machines, and materials, after learning what these practices are.

11. Take an active interest in individual technology and the problems relating to the production of wood products.

12. Appreciate the importance of lumber and wood products in national as well as world economy.

13. Understand the importance of conservation of our vast timber resources.

Fig. 1–10. The appealing design of this commercial building uses laminated structures to solve a technical engineering problem. *(Southern Pine Association.)*

unit 2

Understanding a working drawing

Craftsmen, engineers, architects, and designers must know how to read and understand a working drawing (Fig. 2–1). This kind of drawing uses a language of its own. It gives the dimensions, or sizes, of the parts of a project, and shows how the project is to be put together. When you study a working drawing or a sketch, you will follow exactly the same steps that a craftsman and an engineer do. They study a working drawing, as you will, before attempting to build any part of a project.

In industry, special classes are often held for workers to teach them how to read blueprints and/or make working drawings (Fig. 2–2). Blueprints are duplicates, or copies, of tracings or original drawings. They are made by chemical action which gives them their color and their name. Industrial workers therefore often read white lines on a blue background. You will read black lines on a white background in most of your work. You will learn to read many types of lines on working drawings. You will also need to know how to explain the views shown.

Fig. 2-1. Details and dimensions of the original piece are carefully measured and checked for industrial production. *(Baker Furniture Company.)*

LINE SYMBOLS

The line symbols in Fig. 2-3 and the description of each will help you to read drawings. Apply what you learn from Fig. 2-3 in your study of a drawing (Fig. 2-4). The photograph in Fig. 2-5 shows the finished project. It will help you understand the views shown in Fig. 2-4.

Border lines are the heaviest of all. They are used only for making a neat border around a drawing.

Object lines are fairly heavy and very distinct. They show the visible portion of an object. They are very important to the craftsman.

Hidden, or *invisible, lines* are short dashes which make up a broken line. They show that part of an object which needs to be shown but which is not visible in the particular view drawn.

Extension lines are thin lines. They extend from the edges of a view so that dimension lines may be placed between them. These lines should never connect with solid or object lines.

Center lines are light long and short dashes. They indicate, or mark, the center of any symmetrical figure or object. Every major arc (part of a circle) or circle should have intersecting, or crossing, center lines.

Dimension lines are light lines which include measurements. All dimensions are indicated by this type of line. When you read a working drawing, you should assume that the dimension is the distance between the point of the arrow on one end of the line to the point of the arrow on the other end.

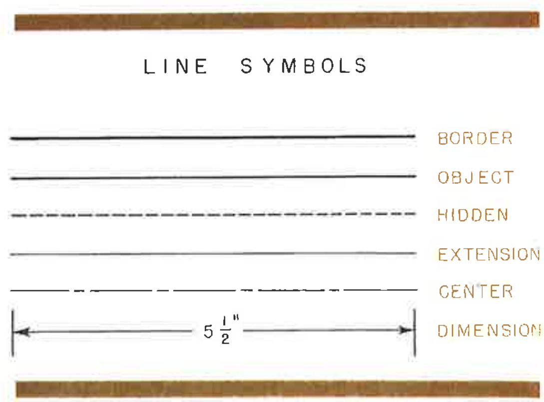
A working drawing usually shows the object in a size smaller than it will really be made. The drawing has to be smaller in order to get it on one sheet of drawing paper. To make the drawing smaller, a draftsman draws the object *to scale*. He makes a scale, or reduced, drawing of the object. This means that he draws the lines only a fraction of their actual length. For example, the lines may be $1/2$, $1/4$, or $1/8$ as long; but the draftsman puts the dimensions of the actual object on them. A working drawing reduced to $1/4$ scale means that $1/4$ inch on the drawings equals 1 inch of actual size. A line 2 inches long on this drawing equals 8 inches of real size ($4 \times 2 = 8$). It is labeled with an "8." All dimensions given on a scale drawing are those of the actual size of the completed object.

VIEWS ON A WORKING DRAWING

The working drawing in Fig. 2–4 has two views, front and top. Two views are shown in order to include all the measurements and details of construction. Often only two views (front and top, or front and one end) are needed to give complete measurements and construction details.

Fig. 2–2. Architects and structural engineers combine talents and resources to develop drawings and specifications for the use of wood in construction. *(American Institute of Timber Construction.)*

Fig. 2–3. Line symbols for drafting.



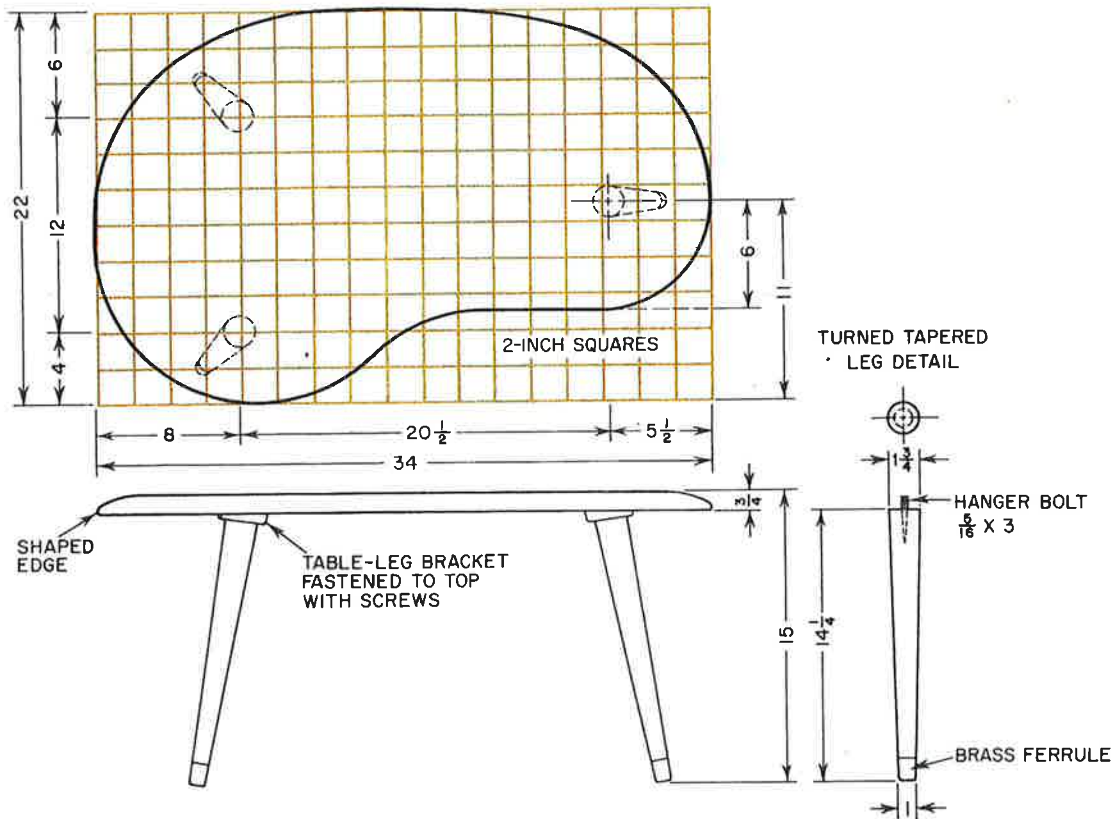


Fig. 2-4. Working drawing for novelty coffee table.

Fig. 2-5. Coffee table.

It is seldom necessary to show more than three views, such as front, top, and one end. Detailed drawings of construction sometimes require as many as six views: front, top, rear, underside, right end, and left end. Working drawings like the one shown in Fig. 2-4 are called multiview, or orthographic, drawings.

A working drawing is frequently shown as a pictorial sketch with the dimensions added. This kind of drawing is very easy to read and understand because it looks like the actual object.

The method of figuring the amount of lumber used to make a project is discussed and illustrated in Unit 4.

Discussion Topics

1. What are the overall length, height, and width of the coffee table?
2. What is the thickness of the top?
3. How long is the top?
4. What does the widest part of the top measure?
5. How large is each square in the graph for the top?
6. How many legs are there?
7. How long are the legs?
8. How can you tell whether the legs are round or square?
9. How are the legs fastened to the top?
10. How is the table-leg bracket fastened to the top?
11. Give the size and name of the bolt which fastens the leg to the bracket.
12. What is the diameter of the leg at the top? At the foot?
13. What is fastened to the foot of each leg?

unit 3 Designing in wood

Before the Industrial Revolution, the average person had to make most of the things he needed. Inventive minds and skilled hands joined to create furniture, clothes, homes, and other products necessary to daily living. Ideas, tools, materials, and craftsmanship were the basic ingredients in the design and construction of each of the products and objects. Although intervening years have taken design and manufacturing processes out of the home, design procedure and elements have remained essentially the same.

WHAT IS DESIGN?

Design is creative planning used to solve a problem. The key words of this definition are *creative*, *planning*, and *problem*. These three words are discussed in the following paragraphs to help develop a better understanding of the word "design."

Creative: A person who is creative uses his intelligence, skills, and past experiences to help solve a problem. A good designer will not try to create or solve a design problem by trying to use skills and concepts he has not yet mastered. If he has had no experience with woodworking machines, it would not be practical for him to try to design a complex piece of furniture or cabinetwork involving intricate machine operations. Figures 3–1 and 3–2 are examples of beginning design problems that involve simple woodworking activities.

Planning requires evaluation of the problem to organize thoughts and procedures. To

Fig. 3–1. Freeform shapes usually require simple hand tools for construction.

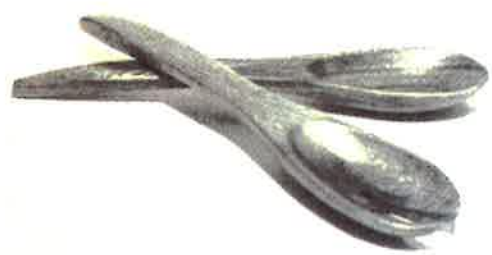


Fig. 3–2. Salad fork and spoon. The jig saw and some hand tools are required for their construction.

solve a design problem in the best possible way, you must first study (analyze) each part, searching for a proper approach to the solution.

The most efficient approach to a design problem is to study it carefully with an inquiring mind. You must use imagination in search of new uses for materials and tools. Since no two people are alike or think alike, no two people will design in the same manner. Figure 3–3 shows two solutions to the same design problem. Although it was the same assignment in each case, there is a great deal of difference between the two end products in function and appearance.

The pair of bookends and the book rack are shown holding the same number of books (Fig. 3–4). However, the bookends are more pleasing in appearance and do a better job of holding books in an upright position.

Figure 3–5 shows another example of two solutions to the same design problem. Here the results are very similar in appearance.

Problems in design begin with a need. The need for man to shelter himself from the weather led to design of homes. His need to clothe himself ultimately led to the design

Fig. 3–3. Two solutions to the same design problem.

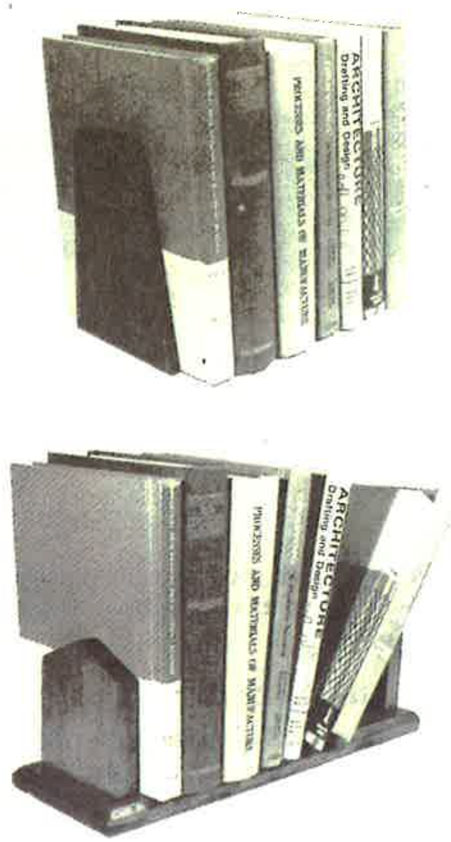


Fig. 3–4. The bookends are more functional and more aesthetically pleasing than the book rack.

Fig. 3–5. Both serving trays in this design problem are functional and aesthetically pleasing.

of today's styles. To travel great distances, he designed the airplane. The problems with which the designer works invariably stem from human needs of one kind or another.

MAJOR DESIGN ELEMENTS

Three major elements that guide the design process are the function, the material/technical aspect, and the appearance.

The *function* of the finished product or object must be considered carefully. The product must work properly; it must efficiently fulfill the need for which it was designed. It must solve the original problem. If it does not function properly, it is of no value, and hence is poorly designed.

The *material/technical* aspect includes selection of materials as an essential part of good design. Understanding the properties of various kinds of wood and other materials is important. It would be impractical to select white pine to make a baseball bat, or walnut for the frame of a chair that is to be completely upholstered. Cost, as well as the strength of the material, must be considered in each design experience.

It is necessary sometimes to use a variety of materials to solve a problem in design. Figures 3–6 and 3–7 are examples. Stainless steel and ceramic materials were used to make these projects more functional.

Material/technical considerations require development of safe and skillful use of tools before designing a product to be made with them. If you have had experience only in the understanding and use of hand tools, it is difficult to design properly a product requiring the use of complicated woodworking machinery.

If you are to use hand tools to construct the product designed, you should not plan a complex piece of furniture involving a large amount of lumber. Design a product around skills and understandings already acquired. Plan ahead for those closely related skills

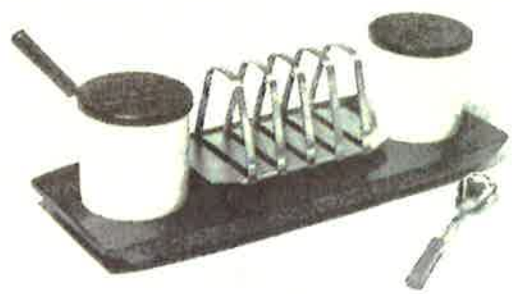


Fig 3–6. Wood, metal, and ceramic are combined in the toast and jam server.

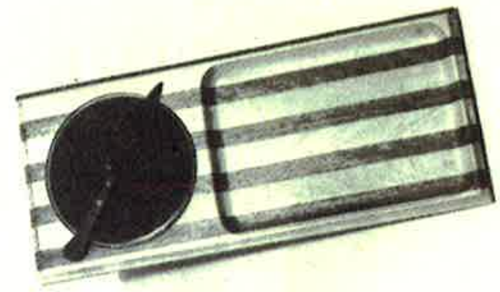


Fig. 3–7. Two kinds of wood are used in combination with the ceramic plate to make the cutting board.

you hope to learn. This means that new processes and concepts may be introduced, provided you have a basic understanding of what is involved in those operations.

The most creative and practical design idea will add little to a product that is crudely constructed. If joints are loose, surfaces not sanded properly, and the drawers not fitted properly, you have not constructed a high-quality product. Sharp tools, skilled hands, and a creative mind go far in complementing a good idea.

Appearance is the third element of a well designed product. The term generally used to describe the appearance, or beauty, of an object or product, is "aesthetics." If the aesthetic qualities of a particular product are valid, it is pleasing to the eye and has an attractive appearance.

A well designed product requires more than a good finish and fancy surface decorations. The form (shape), relationship of lines, color, balance, and other factors all are important considerations in the design process.

Thus, one realizes that the three elements of design, the *function*, the *material/technical* aspect, and the *appearance*, are equally important. If one element is weak, the design of the completed product will be weak. Figure 3–8 shows examples of well designed pieces of work.

RECOGNIZING GOOD DESIGN

Recognizing the factors that constitute good design helps create a well designed product. When you go to a store to buy furniture, you look for certain characteristics. One of the first is *pleasing appearance*. Does the piece of furniture have a graceful or pleasing shape? Is the color suitable? Will it fit well with other furniture in the room? These are some of the questions that will help in determining whether or not the customer thinks the product has a pleasing appearance.

You consider *function* when you decide whether the product or object fulfills the role for which it was originally planned and designed. If the design problem calls for a bookcase to hold fifty books, and there is room for only thirty, the product will not do the job for which it was intended, and is therefore not useful.

High-quality craftsmanship is essential to good design. No one wants to buy a piece of poorly constructed furniture. Tight joints, smooth finish, and precise cutting and fitting

Fig. 3–8. Examples of well designed products.

of parts are a few of the important considerations in selecting a well designed and well constructed product.

Practical use of materials is another consideration. If a piece of furniture is to be painted, it should not be made from expensive cabinet-quality lumber such as walnut or mahogany. If a piece of furniture is to have a natural finish, it should not be made from yellow pine, poplar, or other kinds of unattractive wood.

EXAMPLES OF GOOD AND POOR DESIGN

Study Fig. 3–9 before going on to the design process steps. The illustrations in this figure show some examples of good and poor design. Study each one carefully, and try to determine what makes the design either a good or a poor one.

THE DESIGN PROCESS

The complete design process involves eight steps:

1. Select and define the problem.
2. Limit the problem in size and complexity.
3. List or sketch several possible solutions.
4. Select the best solution to your design problem.
5. Make refinements in the design. Construct a model, if necessary.
6. Prepare working drawings, materials list (bill of materials), procedure sheet, and a finishing schedule.
7. Select materials and construct the product.
8. Evaluate the final solution, based on the original problem.

Each of these steps should be completed for every design problem. The following paragraphs describe how each step is accomplished. The example given after the description of each step provides an insight into the designing process.

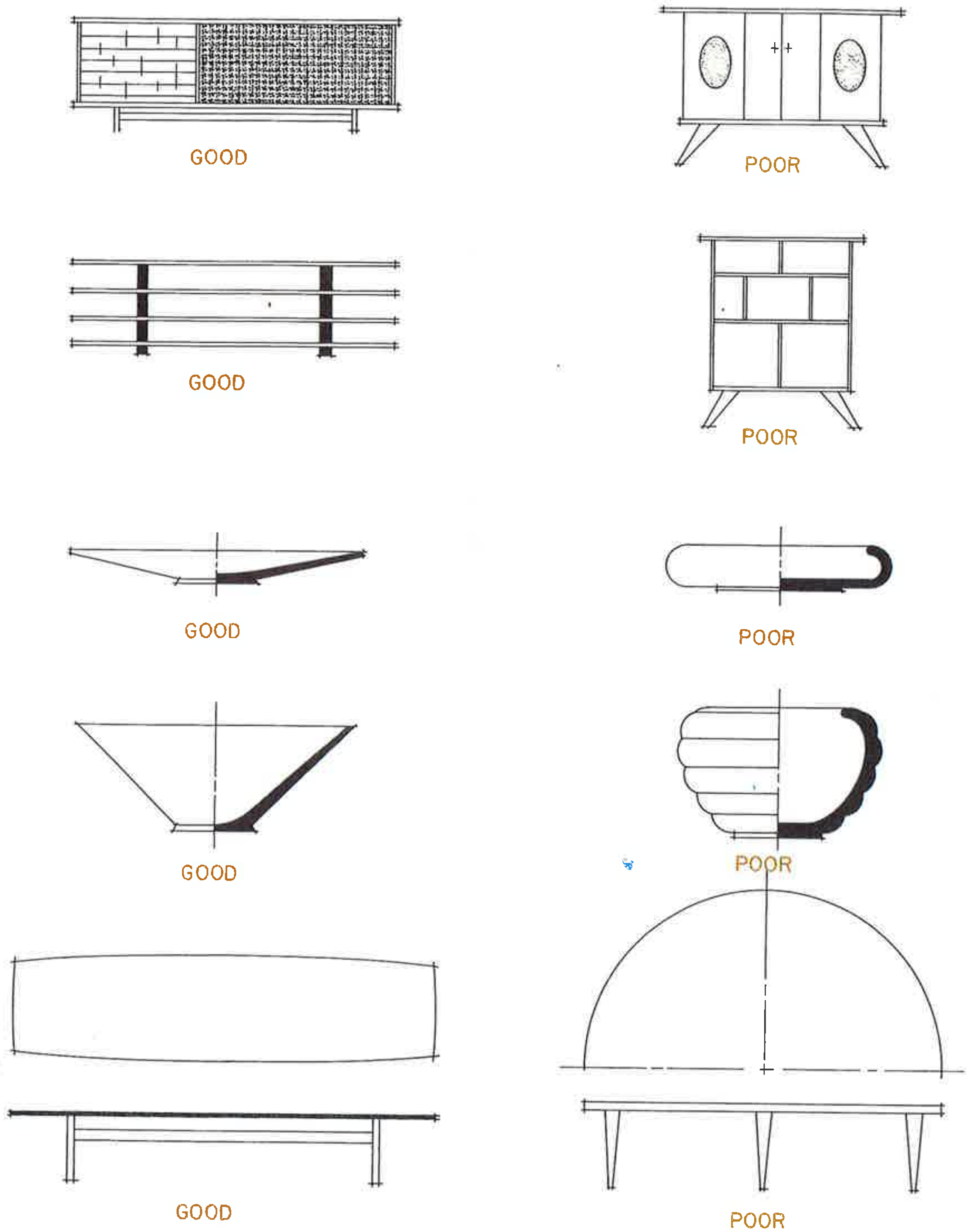


Fig. 3–9. Examples of good and poor design.

Select and define the problem. Select a design problem based on a specific need; or you may want to accept one assigned to you. In either case, a clear definition, or description, of the problem should be understood before going to step 2.

Example: Design a desk caddy to fit the following specifications:

1. It must hold 5″ × 8″ note paper.
2. There must be an integral letter holder.
3. There should be a pen holder attached.
4. It should be designed to hold several pencils.
5. It should not scratch the desk top.

Limit the problem in size and complexity. These considerations are based on the amount of time available to construct the object, the amount of material required, and the industrial-laboratory experiences you have had in working with tools and materials. Large objects are difficult to complete in the small amount of time you may have. Therefore, adapt ideas to the guidelines formulated in this unit.

Example:

1. The desk caddy must not involve more than two board feet of lumber.
2. It should not be larger than 4″ × 10″ × 12″ in overall dimensions.
3. Butt, lap, or rabbet joints should be used.
4. Construction should involve hand tools, or simple woodworking machines.

List or sketch several possible solutions. This phase of the design process is sometimes called "brainstorming." At this point you may want to solicit ideas and list several possible solutions in very general terms before you begin to sketch. Freehand sketching is a very valuable part of this phase of the design process. Several pictorial sketches will help visualize your ideas. Figure 3–10 shows some sketches of possible solutions that developed from a brainstorming session for the desk caddy.

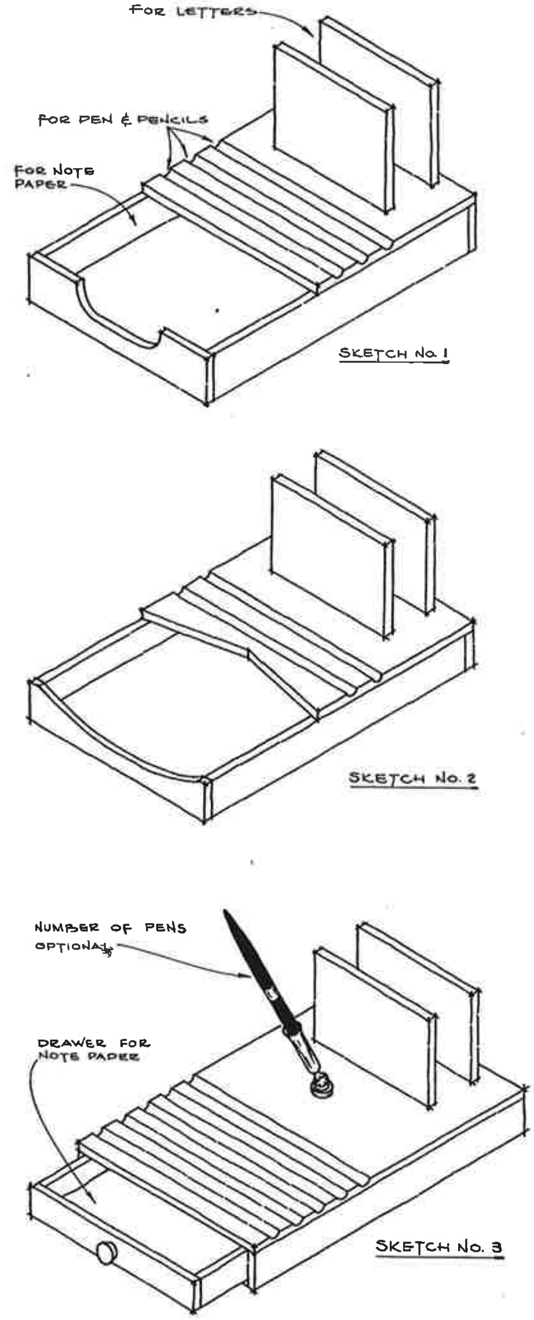


Fig. 3–10. Preliminary sketches of the desk caddy.

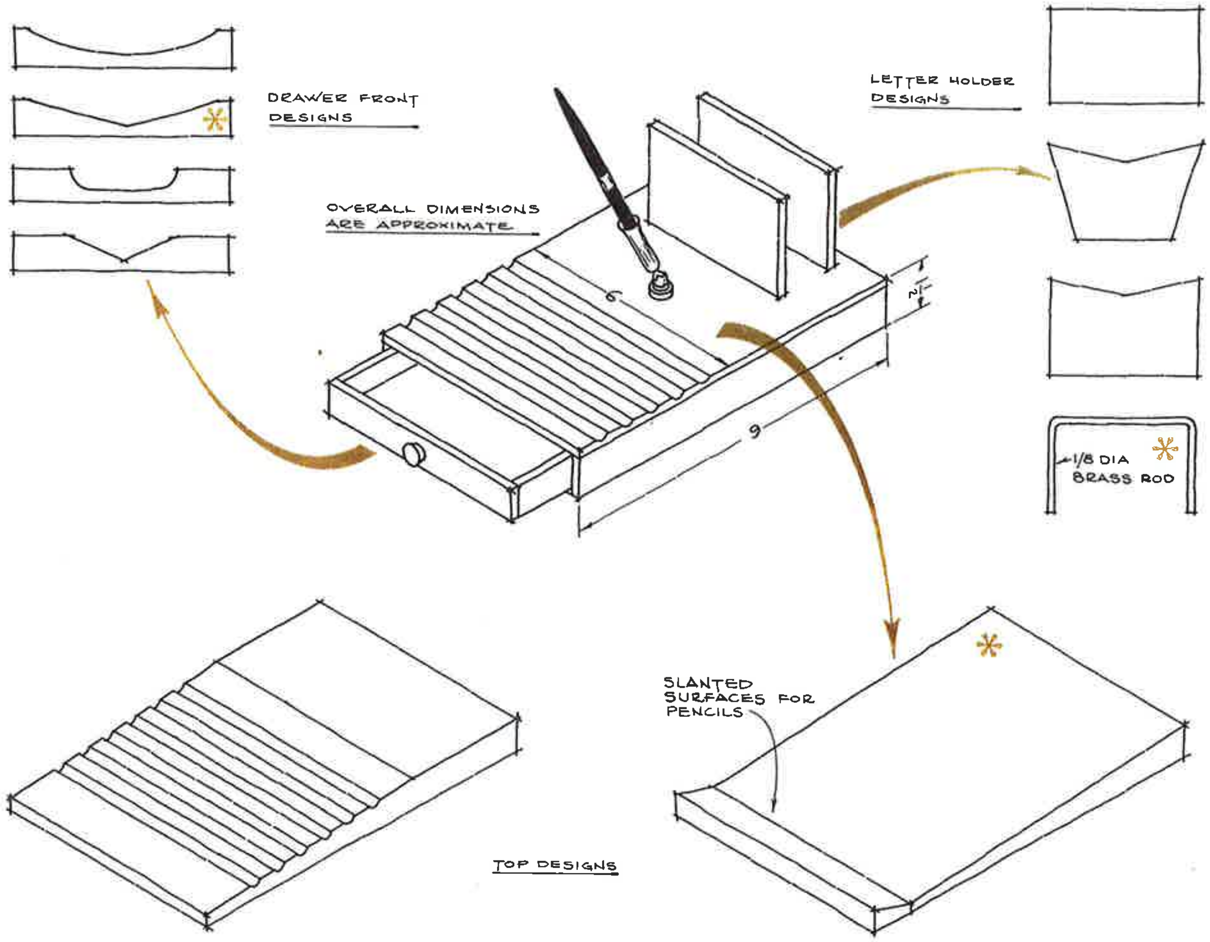


Fig. 3–11. Make refinements while still in the sketching stage of design.

Select the best solution to your design problem. The final solution to your problem should be determined by considering the function (use), and the aesthetics (beauty) of the design. Check back to make sure you have remained within the limitations of size and complexity. Also decide if your design solves the original problem.

Notice that each of the possible solutions shown in Fig. 3–10 will function well, and that about the same amount of material is required for each. However, one of the three might appear more attractive to you than the others.

Make refinements in the design. Construct a model, if necessary. Some refinements can be made while you are still in the preliminary sketching stage, as shown in Fig. 3–11. The stars indicate the selection of parts to be used in the final design. The shape of various parts, as well as the kind and size of materials, may be altered. An accurate pictorial drawing (Fig. 3–12) would ensure pleasing aesthetic qualities.

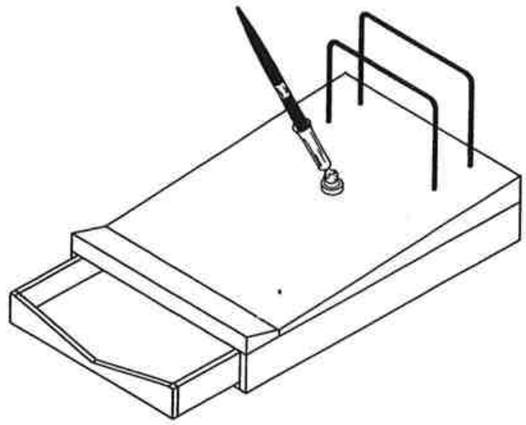


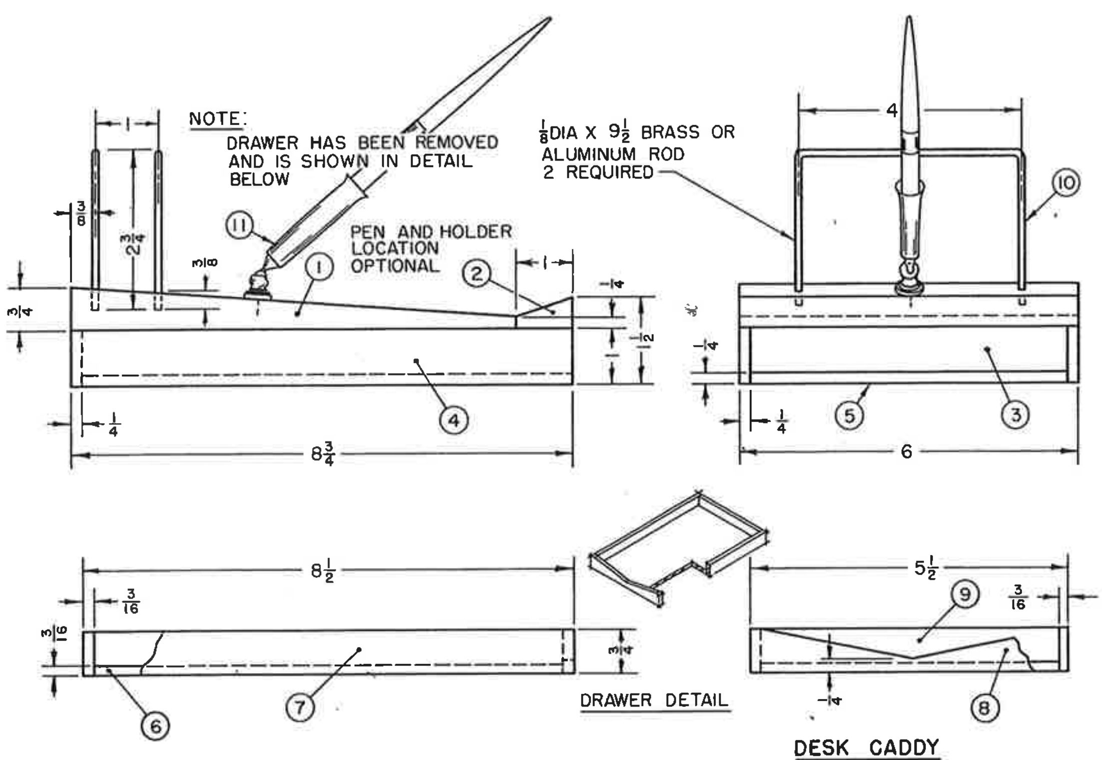
Fig. 3–12. An accurate pictorial drawing will help to ensure good aesthetic qualities.

Sometimes it is desirable to construct a scale model of the proposed product. This technique is generally used when large products of a rather complex nature are being designed.

Prepare working drawings, materials list (bill of materials), procedure sheet, and finishing schedule. The working drawing in Fig. 3–13 is an accurate description of the shape and size of the desk caddy. Do not begin to construct a product unless there is an accurate drawing from which to work. Complete and accurate dimensions are extremely important if all parts are to fit together properly.

The student's plan sheet shown in Fig. 3–14 is also very important. This will include an accurate bill of materials, a list of

Fig. 3–13. Working drawings give accurate size and shape description.



INDUSTRIAL ARTS WOODWORKING

STUDENT'S PLAN SHEET

Student's Name TIM JONES Class 9-B

Name of Project DESK CADDY Date Started MARCH 10 Date Completed APRIL 14

Estimated Time 8 HOURS Actual Time 10 HOURS

Personal Efficiency: Actual Time - Estimated Time = 80 % Source of Drawing ORIGINAL

BILL OF MATERIALS

PART NO.	PART NAME	NO. OF PIECES	SIZES			MATERIAL	UNITS	UNIT COST	EXTENDED COST
			T	W	L				
1	TOP	1	3/4	6	7 3/4	WALNUT	.33 BD. FT.	$.90/BD. FT.	
2	FRONT RAIL	1	1/2	1	6	"	.02 BD. FT	"	
3	BACK	1	1/4	1	5 1/2	"	.01 BD. F.T.	"	
4	SIDES	2	1/4	1	8 3/4	"	.03 BD. F.T.	"	
5	BOTTOM	1	1/4	5 1/2	8 1/2	"	.06 BD. F.T.	"	
6	DRAWER BOT.	1	3/16	5 1/8	8 1/8	"	.05 BD. F.T.	"	
7	" SIDES	2	3/16	11/16	8 5/16	"	.02 BD. F.T.	"	
8	" FRONT	1	3/16	11/16	5 1/2	"	.01 BD. F.T.	"	
9	" BACK	1	3/16	11/16	5 1/8	"	.01 BD. F.T.	"	
		SUB TOTAL FOR WOOD					.54 BD. FT.	$.90/BD. FT.	$.49
ADD 20 % OF COST OF WOOD FOR WASTE AND FINISHING									.10
10	LETTER RACK	2	1/8 DIA		9 5/8	BRASS	19 1/4 IN.	$.01/IN.	.20
11	PEN HOLDER	1	STOCK					$.50 EACH	.50
							TOTAL COST		$1.29

Tools and Machines Required:

1. HAND SAW
2. JACK PLANE
3. HAND DRILL
4. TRY SQUARE
5. BENCH RULE
6. JIG SAW
7.
8.
9.
10.
11.
12.

Procedure:

1. OBTAIN THE FOLLOWING ROUGH STOCK:
   - 1 PC 1 X 7 1/2 X 8 (FOR PARTS 1 & 2)
   - 1 PC 3/8 X 8 1/4 X 9 (FOR PARTS 3, 4, & 5)
   - 1 PC 1/4 X 3 X 9 (FOR PARTS 7, 8, & 9)
   - 1 PC 1/4 X 5 1/2 X 8 1/2 (FOR PART 6)
2. PLANE ROUGH STOCK TO FINISHED THICKNESS.
3. RIP STOCK TO OBTAIN INDIVIDUAL PARTS.
4. PLANE PARTS TO CORRECT WIDTH.
5. SQUARE ONE END OF PARTS AND CUT TO CORRECT LENGTH.
6. LAYOUT TAPERS ON PARTS 1 & 2 AND PLANE TO FINISHED SHAPE.
7. CUT "V" SHAPE ON DRAWER FRONT. (JIG SAW)
8. PRE-SAND ALL PARTS BEFORE ASSEMBLY.
9. ASSEMBLE MAIN BODY OF CADDY.
10. ASSEMBLE DRAWER.
11. BEND BRASS RODS AND DRILL HOLES FOR ASSEMBLING LETTER HOLDER.
12. LOCATE POSITION OF PEN HOLDER AND DRILL HOLE FOR ASSEMBLY.
13. ASSEMBLE LETTER HOLDER AND PEN HOLDER AFTER FINISH HAS BEEN APPLIED.
14. SMOOTH WITH 6/0 GARNET PAPER.

Finishing Schedule:

1. SMOOTH WITH 6/0 GARNET PAPER.
2. SELECT A WIPE-ON OIL FINISH AND APPLY ACCORDING TO INSTRUCTIONS ON CONTAINER.

Approved J.R.H.

Fig. 3–14. A completed student's plan sheet for the desk caddy.

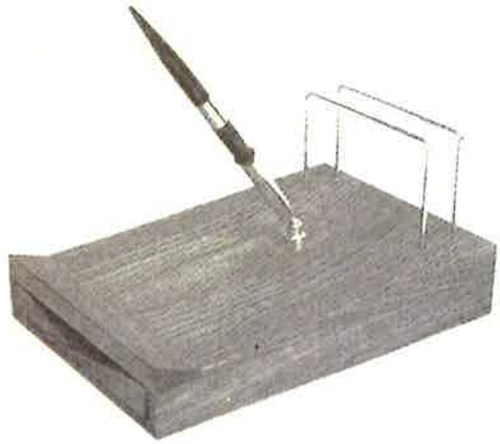
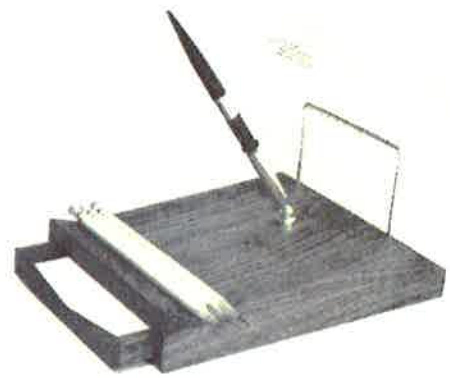


Fig. 3–15. The finished product.

tools and machines required, construction procedure, finishing schedule, and other important information. Study Unit 5 before completing this student's plan sheet.

Select materials and construct the product. The intelligent selection of materials, mentioned earlier, and safe and skillful use of tools are essential factors in good design. The most creative and practical design idea will add little to a product that is crudely constructed from poor materials. Figure 3–15 shows pictures of the finished desk caddy. Notice the effective use of a variety of materials.

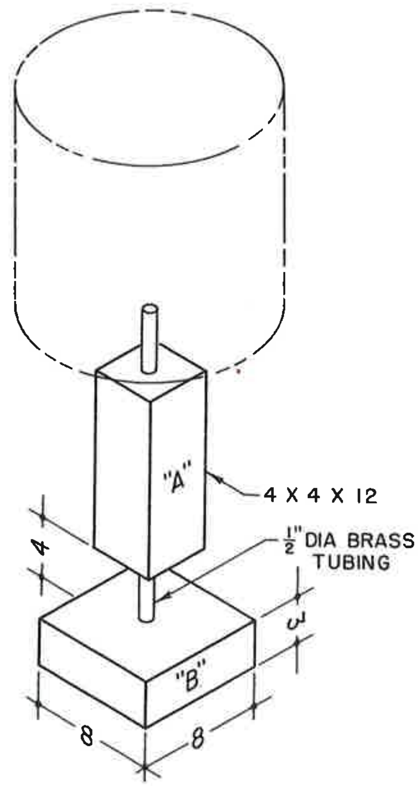


Evaluate the final solution, based on the original problem. The following questions help evaluate your work:

1. Is the product functional?
2. Were you able to remain within the design specifications?
3. Is the product pleasing in appearance?
4. Did you select the best possible materials for your specific need?
5. Is the workmanship of high quality?

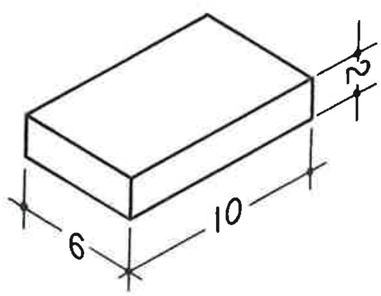
If you can answer *yes* to all of these questions, you have completed successfully your design problem.

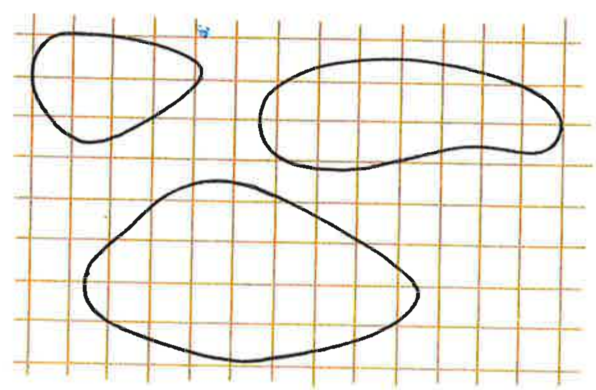
DESIGN PROBLEMS

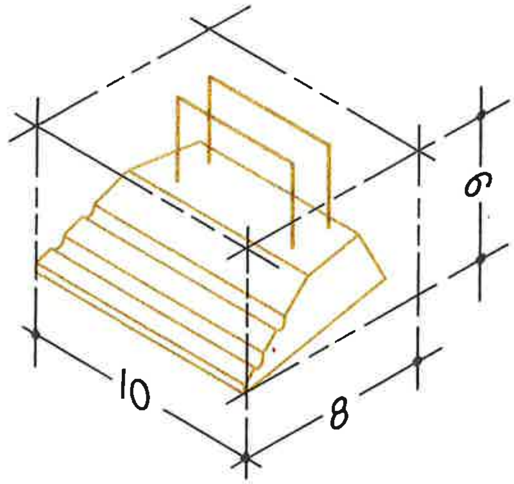


No. 1 Use the approximate sizes and proportions of the lamp shown here. Develop new shapes for blocks *A* and *B* to improve the design of the lamp by making it more pleasing in appearance. Prepare a working drawing and a complete student's plan sheet. Construct the lamp.

No. 2 Design and construct a free-form candy dish from a blank of this size. The drawing to the right will give you some suggested free-form ideas. Design the dish to be made using only a band saw, a jig saw, and some basic hand tools.

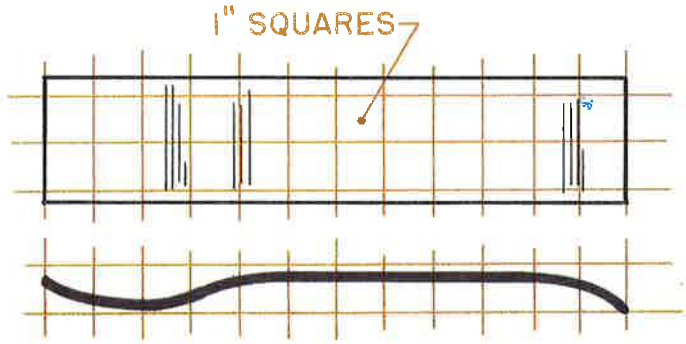




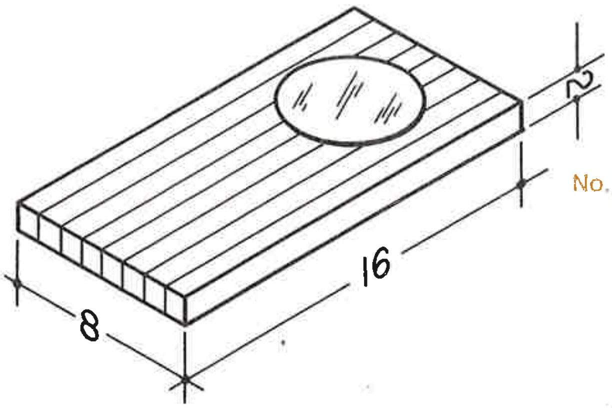


No. 3 Design a combination letter and pencil holder. It should not be larger than the overall dimensions shown here. This drawing shows one solution to this design problem. You may want to include more than one type of material in the finished product.

No. 4 Design a serving tray using wood as the basic material. The surface is to be covered with an interesting mosaic design. The handles may be made from brass rods or may be purchased. You may want the tray to be as small as 8 × 16 inches or as large as 12 × 24 inches. Make refinements in your design during the preliminary sketching stage. Make an accurate pictorial drawing and a complete working drawing. Prepare your student's plan sheet before beginning construction.

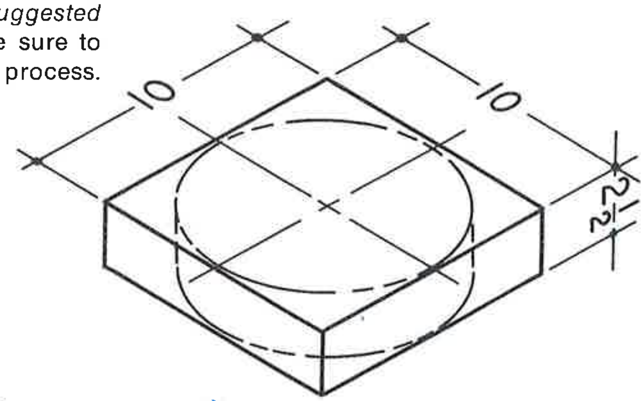


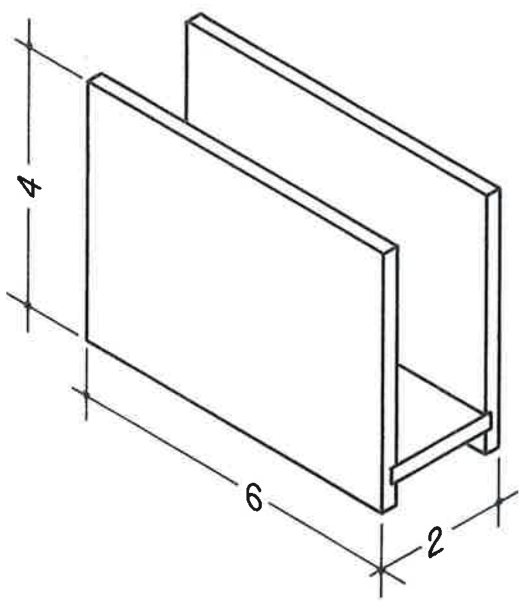
No. 5 Complete the top view for the design of a salad fork and spoon using a blank of the size shown here. The blanks are made from five layers of thin veneer. Refer to Unit 22 for information on how to construct the forms for producing the blanks.



No. 6 Design a cheese cutting and serving tray. Purchase a 6 inch round or square ceramic plate at a hobby shop for the cutting surface. The tray should be made from strips of hardwood glued together. Be sure to make provisions for carrying the tray. Grooves may be cut in the ends or purchased handles may be attached. The drawing will give you an idea from which to begin.

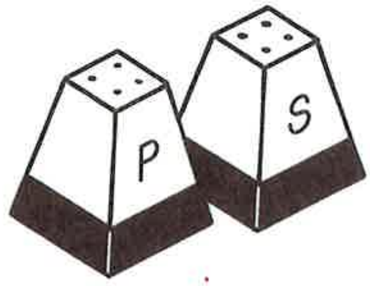
No. 7 Design a turned bowl from a blank similar to the one shown here. Study this unit and Section 9, *Suggested Projects*, for design ideas. Be sure to complete all steps in the design process.



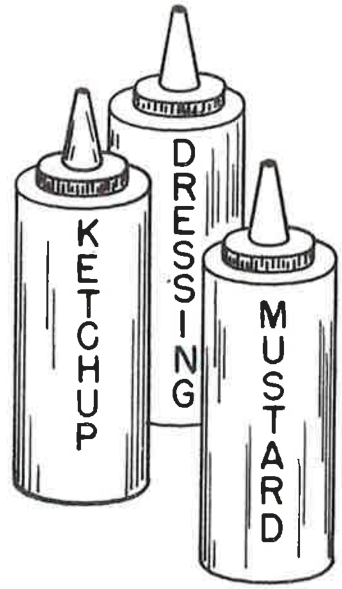


No. 8 Redesign the napkin holder shown here to make it more interesting and more pleasing in appearance. You may want to change the sizes to suit your design ideas. Initials or other designs may be inlaid or overlaid on the sides as desired.

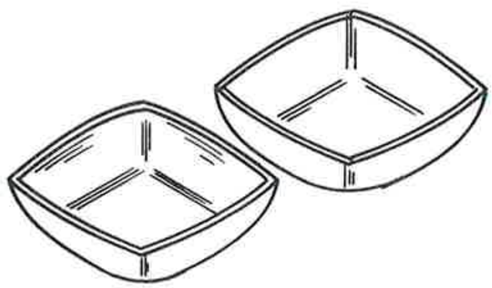
No. 9 Design a barbecue serving tray to hold the following items:



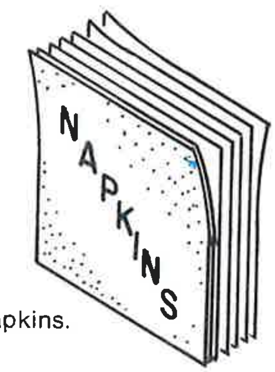
Salt and pepper shakers.



Catsup, mustard, and mayonnaise dispensers.

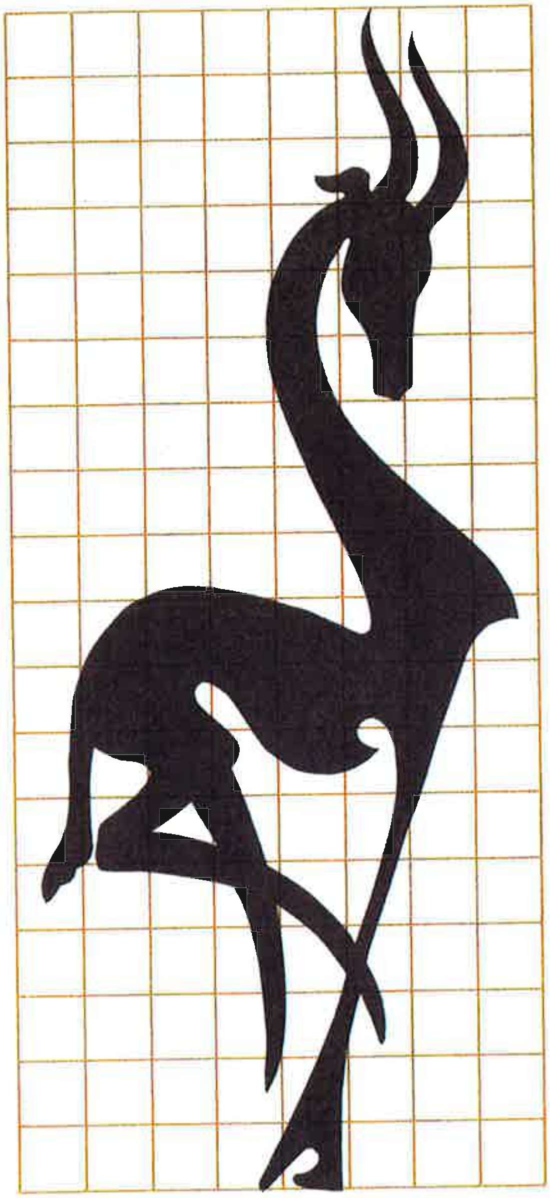


Relish dishes.



Napkins.

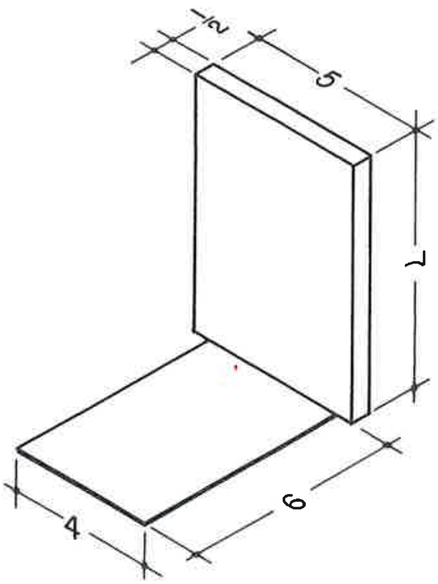
The tray should be designed so that the containers will be held in an upright position and will not be tipped over easily.



No. 10 This drawing shows a silhouette of a gazelle. You will notice that the shape has been streamlined to make it more pleasing in appearance. Some parts are exaggerated to stylize the design. This is sometimes called a characterization.

Use your favorite animal for the subject of this design problem. Find a picture of the animal having clear definition of detail in the outline. A side view of the animal is usually best for this purpose. Sketch the outline of the animal just as it appears in the picture. From this sketch begin to stylize the silhouette by streamlining some parts and exaggerating others. As many as five or six sketches may be necessary to develop a pleasing appearance.

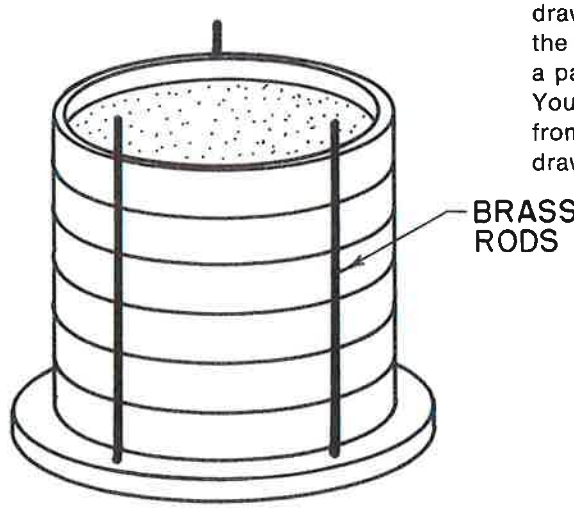
When you have completed your design trace it on ¼ or ⅜ inch thick wood or hardboard and cut it out. If you use an attractive cabinet wood, such as walnut or mahogany, a hand-rubbed oil finish should be used. Harboard should be finished in flat black enamel or lacquer.

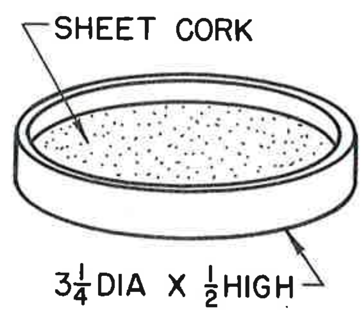


No. 11 Design a pair of bookends using sheet metal as the base, wood as the upright, and mosaics, glass chips, or plastic chips as a surface decoration. The drawing gives some basic sizes from which to start.

No. 12 Obtain a mechanism for a small electric clock. Design a wooden case to house the mechanism. You may want to design and make a new face to complement the design of the case.

No. 13 Design a set of drinking glass coasters and a rack to set them in. The left hand drawing shows one simple solution to the problem. Sheet cork may be used as a pad on which to set the drinking glass. You may wish to begin the design process from the coaster shown in the right-hand drawing.





unit

4

Purchasing and measuring lumber

You should use a student's plan sheet for planning your project. Figure 5–1 is a good one, unless your teacher has another to suggest for your use. Before you make out the plan sheet, you should know the types of materials needed, how to figure the amount used, and the costs. You will save time and materials if you make an accurate listing of the materials needed before you begin your project.

The words and expressions which you must understand to figure a materials bill successfully are explained in this unit.

PURCHASING INFORMATION

The *board foot* (Fig. 4–1) is the measurement by which most lumber is sold. It represents 144 cubic inches of lumber in its rough state. A piece of wood 1 inch think, 12 inches wide, and 12 inches long contains this amount of lumber. The size is reduced when the wood is prepared for use. It then measures approximately $\frac{3}{4}$ to $\frac{13}{16}$ inch thick, $11\frac{1}{2}$ to $11\frac{5}{8}$ inches wide, and 12 inches long. Wood 2 inches thick by 6 inches wide by 12 inches long also makes a board foot. The reason is that this size also contains 144 cubic inches of unfinished lumber. A board figured as 2 inches thick is actually only $1\frac{5}{8}$ inches thick when delivered. The difference between what we figure and what we get is lost in sawing and planing. A board less than 1 inch thick is usually figured as though it were 1 inch thick. Plywood, however, is an exception; it is sold by the square foot. See page 28 for additional information about measuring and figuring board feet.

In a materials bill, the thickness and width of boards are always figured in inches ("). Lengths for long boards are figured in feet ('). Lengths for short pieces are often figured in inches. In estimating amounts of lumber, lengths in feet and in inches require different formulas. You will use both in figuring the problems on page 29.

The lumber industry generally quotes lumber prices by the thousand board feet, as 540/M. This means that one thousand (M) board feet cost $540. One board foot, therefore, would cost 54 cents. The price per board foot is the quotation often given by the teacher. Refer to Table 4–1 for a guide to lumber sizes.

TYPES OF LUMBER

Hardwoods are used for architectural woodwork, furniture, and cabinetmaking. They do not contain resin. *Softwoods* are used in

Fig. 4–1. Three boards which represent a board foot.

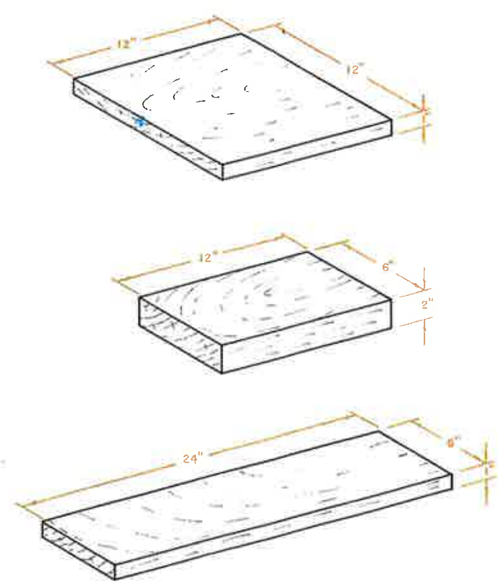


Table 4–1. Guide to Lumber Sizes

NOMINAL SIZE INCHES	ACTUAL SIZE INCHES	BOARD FEET PER FOOT OF LENGTH
1 × 2	25/32 × 1 5/8	1/6
1 × 4	25/32 × 3 5/8	1/3
1 × 6	25/32 × 5 5/8	1/2
1 × 10	25/32 × 9 1/2	5/6
1 × 12	25/32 × 11 1/2	1
2 × 4	1 5/8 × 3 5/8	2/3
2 × 6	1 5/8 × 5 5/8	1
2 × 10	1 5/8 × 9 1/2	1 2/3
2 × 12	1 5/8 × 11 1/2	2
3 × 6	2 5/8 × 5 5/8	1 1/2
4 × 4	3 5/8 × 3 5/8	1 1/3
4 × 6	3 5/8 × 5 5/8	2

building and for construction. For names of some of the common hardwood and softwood trees, see Unit 64, *Common Woods*.

Hardwood lumber is cut in standard thickness and width. Since it is a scarce wood, however, it is cut in any length that can be obtained from the log.

Softwood lumber is generally sawed in even widths, such as 2, 4, 6, or 8 inches, and in even lengths, such as 8, 10, 12, 14, etc., up to 20 feet.

Grading. Hardwood lumber in the United States generally follows the grading, or rating, rules of the National Hardwood Association. The grade of lumber is based upon the amount of usable lumber in the piece. Such timber must have one side *clear* and the reverse side *sound*. This means that it must be free from rot or any other defect which affects the strength of the board.

The term *Firsts* is used for the highest grade of hardwood lumber. *Seconds* is used for the next grade. Firsts and Seconds (FAS) are nearly always combined in one grade. *Selects* form the third grade. Other grades are No. 1 Common, No. 2 Common, Sound Wormy, No. 3A Common, and No. 3B Common. These are only general grades, for there are always exceptions and special rules for certain species, or kinds, of trees.

Softwoods have many more grades than hardwoods do. This is because they are graded by several associations and organizations. Some of these are the California Redwood Association, Southern Cypress Manufacturers Association, Southern Pine Association, West Coast Lumberman's Association, and the Western Pine Association. This makes the grading of softwoods very confused and difficult.

The grading of ponderosa pine will be mentioned briefly here because it is a softwood well known to most woodworkers. Sugar pine is graded in a similar way to ponderosa pine. The Western Pine Association classifies ponderosa pine as *Select*, *Shop*, and *Common*. *Select* grades include B and Better Select (sometimes called No. 1 and No. 2 Clear), C Select, and D Select. *Shop* grades are classified as 3rd Clear (3rd Clear and Factory Select), No. 1 Shop, No. 2 Shop, and No. 3 Shop. *Common* grades are divided into No. 1 Common, No. 2 Common, No. 3 Common, No. 4 Common, and No. 5 Common.

Each association or organization has a similar type of classfication, with variations for each kind of timber. *Wood Handbook 72* of the Forest Products Laboratory, U.S. Department of Agriculture, Washington, D.C., gives a very detailed description of lumber grading. Volumes have been written on this subject.

Surfaces. Rough, *S2S*, and *S4S* are terms indicating the treatment which lumber has had. *Rough* means that the lumber is in the rough as it came from the mill and has not been planed. *S2S* tells you that it has been planed on the two surfaces, or faces. *S4S* indicates that it has been planed on all four sides, both surfaces and edges. S2S and S4S are common in the treatment of yard lumber.

Methods of Drying Air-dried (AD) means that the lumber has been dried through natural evaporation in the air. The time required varies from weeks to months, depending on the type of lumber and the degree of dryness required. *Kiln-dried* (KD) refers to lumber which has been artificially dried in a kiln. The time required for kiln drying is much shorter.

Methods of Cutting. Plain-sawing and *quarter-sawing* are the principal methods of cutting logs into boards. Quarter-sawing is the more expensive because of the way the cutting has to be done. Refer to Unit 63, *Trees and Forests* for further information and for illustration of these two methods of cutting.

PLYWOOD

Plywood is the result of gluing and pressing thin sheets of wood together. Unit 66, *The Manufacture and Use of Veneer and Plywood*, gives more information on plywood. This product provides more strength by weight than steel does. Panels of plywood are usually made up of three, five, or seven plies, or thicknesses. Plywood is priced by the square foot. The price depends upon the thickness, the kind of veneer, or wood sheet used on the surfaces, and the gluing or bonding agent. Standard-sized plywoods vary in thickness from 1/8 to 3/4 inch. Generally plywood up to 3/8 inch in thickness has three plies; in thicker panels there are five plies, or sometimes seven.

Exterior construction, marine, and aircraft plywoods use a water-resistant phenolic glue or bonding agent which makes them waterproof.

Types and Grades of Plywood. Fir and hardwood are two of the most common types of plywood. The two most common grades of fir plywood are termed *Sound 1 Side* and *Sound 2 Sides*. Fir face veneers are divided into four grades: A, B, C, and D. The A grade is the best. The quality of the fir-plywood panel is expressed by stating the grades of both surface veneers; for example, A–D. This means that the face veneer is of the best grade or quality (A) and that the back veneer is of the poorest quality. (D). A–A means that both faces are of the best quality.

Fir plywood for exterior use is branded EXT on one end. Ponderosa pine plywood is manufactured under different grading rules, but they are similar to fir-plywood rules. The description is generally the same.

Hardwood plywood is usually graded as *Good 1 Side* (G1S) and *Good 2 Sides* (G2S). These terms refer to the face veneers. G1S indicates that one of the surfaces is of superior quality. G2S indicates that both are superior, G2S plywood panels usually have the same face veneer.

When you buy plywood, you should always indicate the number of pieces; the thickness, width, and length; the number of plies; the kind of wood preferred on the face side; and the grade desired.

BOARD-FOOT MEASURE

After the type of lumber has been selected, you should make an estimate of the amount needed. This will show the rough, or stock, size of the lumber. You will also figure the number of board feet (bd ft) in each piece, in groups of like pieces, and the total number of board feet. You can then estimate the cost of the project by multiplying *the total number of board feet* by *the cost per board foot.*

When the length is given in linear, or running, *feet*, use the following formula:

$$\frac{\text{No. of pcs} \times \text{thickness, in.} \times \text{width, in.} \times \text{length, feet}}{12} = \text{bd ft}$$

or

$$\frac{\#\ \text{Pcs} \times T'' \times W'' \times L'}{12} = \text{bd ft}$$

Example: To find the board feet in three pieces, 1″ × 10″ × 4′:

$$\frac{\not{3} \times 1 \times 10 \times \not{4}}{\not{12}_{\not{3}}} = 10 \text{ bd ft}$$

When the length is given in linear, or running, inches, use this formula:

$$\frac{\text{No. of pcs} \times \text{thickness, in.} \times \text{width, in.} \times \text{length, in.}}{12 \times 12} = \text{bd ft}$$

Example: To find the board feet in four pieces, 1 × 8 × 18 inches:

$$\frac{4 \times 1 \times 8 \times 18}{12 \times 12} = 4 \text{ bd ft}$$

ESTIMATING FINISHES

The different kinds of materials and types of finishes make estimating the cost of finishes a difficult problem. However, many woodworkers figure that the cost of the finishes averages 20 percent of the cost of the lumber.

Section 5 describes and illustrates many of the accepted methods of applying a variety of finishes. Included are the popular wipe-on finishes, as well as numerous finishes which produce modern bleached effects. Brush and spray-gun techniques are described for applying shellac, varnish, lacquer, and enamel. This variety will influence the method of estimating costs.

OTHER COSTS

There will be several additional items to figure in the total cost of a project. These items may include sandpaper, steel wool, nails, screws, other fastenings, and various pieces of special hardware. The cost will depend upon the purchase price and the number used.

Discussion Topics

1. What is a board foot?
2. Explain the meaning of the following lumber terms: (*a*) rough, (*b*) S2S, (*c*) S4S, (*d*) FAS, (*e*) AD, (*f*) KD, (*g*) No. 1 Common, (*h*) A–D, (*i*) hardwood, (*j*) softwood, and (*k*) plywood.
3. Prepare a lumber bill for a project which will list the following information: (*a*) kind of wood, (*b*) number of pieces, (*c*) sizes of pieces, (*d*) grade of lumber, (*e*) surface teatment, and (*f*) condition of lumber.
   Example: Walnut – 6 pcs – 1″ × 6″ × 8′ – FAS – S2S – KD.
4. Describe two methods for drying lumber. how much drying time is required in each of these processes? How are the names of these methods abbreviated?

Practical Problems

Work out these problems in your notebook. Do not write in this book.

No. of pieces	Thickness	Width	Length	Board feet	Kind of wood	Cost per foot, cents	Total cost
1	1″	12″	3′	?	Poplar	45	?
1	1″	6″	12′	?	Walnut	80	?
5	2″	10″	7′4″	?	Honduras mahogany	78	?
4	1/4″	48″	96″	?	Fir plywood	24	?
7	2″	2″	30″	?	Red gum	34	?
6	1/2″	10″	40″	?	Yellow pine	18	?
3	3/4″	36″	72″	?	White-oak plywood	55	?
16	2″	4″	14′	?	Yellow pine	22	?

unit

5

Planning your procedure

You should have a carefully-thought-out plan before you build anything. The man who builds a house or business building gives attention to all the details of his construction problems. The proper materials, tools, and equipment must be ready at the right time. He knows that his building will be finished on time only if these things are planned.

The dentist or doctor approaches his problems with a careful analysis of the steps needed to get successful results. By doing this he saves time and effort. He does not always write out his plan of procedure in detail, but during his training it was necessary to plan each step on paper.

The project or experiment which you want to develop is a problem, and every problem requires a solution. Fill out your plan sheet so that you can solve the problem of creating something from wood.

Many types of plan, or order-of-procedure, forms include information which constitutes a set of specifications for doing a job. The information called for on most plan sheets includes: (1) the working drawing, complete with construction details and dimensions, or reference to where such data may be found; (2) a list of the steps, or processes, to be followed in building the object (in construction this is often referred to as the order of procedure); (3) a listing of all of the materials which are necessary to complete the work, including hardware and finishing materials (the figuring of materials was described in Unit 4, *Purchasing and Measuring Lumber*); (4) the tools and machines necessary to perform the numerous steps or operations listed in number 2 above (these tools and machines may be determined by studying the appropriate procedures presented in the units in this text); (5) the sources or references which were used to obtain the specific ideas; and (6) the estimated and the actual time required to complete the activity, which determines your efficiency rating. Your efficiency rating is calculated by dividing the estimated time into the actual time. Such a personal efficiency rating often yields some surprising results. This device can be used to improve your efficiency, both in estimating the time needed and in the actual time spent in the construction processes. Figure 5-1 is one form of a student plan sheet which contains the numerous factors necessary for constructing and finishing a project.

Discussion Topics

1. Make a list of ten professions in which planning a procedure in advance is necessary.
2. Name eight mistakes you might have made in your project or activity if you had not planned it beforehand.
3. Mention at least six factors which you must consider in planning.
4. Prepare a plan sheet for one of the projects shown in Section 9. Use the plan sheet shown in Fig. 5-1, or one suggested by your teacher.

Industrial Arts Woodworking

STUDENT'S PLAN SHEET

Student's Name____________________Class____________________

Name of Project________Date Started_______Date Completed_______

Estimated Time______________Actual Time_________________

Personal Efficiency: Actual Time ÷ Estimated Time = __________%

Source of the Drawing_______________________________________

Materials Required

No. of Pieces	Description of Piece	Sizes	Kind of Wood or Other Materials	Board Feet	Unit Cost	Extended Cost

Total Cost_______________

Tools:

1.	5.	9.
2.	6.	10.
3.	7.	11.
4.	8.	12.

Order of Procedure:

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.
13.
14.

Approved____________________

Fig. 5–1. Student's plan sheet.

unit 6

Safety

The saying "An ounce of prevention is worth a pound of cure" applies to safety in the school inustrial-arts laboratory, the industrial shop, and the home workshop. Tools and machinery have been developed to save time and do more accurate work. They can be used safely only if they are properly cared for and understood. Whether they are helpful or harmful depends on you.

National Safety Council studies of school-shop accidents show that more happen in the forenoon around ten o'clock than at any other time of day. These studies also show that there are more accidents on Wednesday than on any other day of the week, except those days around vacations.

Safety Rules

The safety rules listed in this unit are generally for the use of hand tools. Safe practices in the use of portable electric tools and power machinery are included in Sections 3 and 4 for reference as you use these machines.

Body Care.

1. Never depend upon your back muscles in lifting something heavy. Get someone to help you, and then lift with your leg and arm muscles.
2. Test the sharpness of tools on wood or paper, not on your hand.
3. Be careful when using your thumb as a guide in crosscutting and ripping.
4. Always cut outward, away from your body, when using a knife.
5. Make sure your hands are not in front of sharp-edged tools that are in use.
6. Use safety goggles or a face shield when doing any operation which might endanger your eyes.

Clothing.

1. Dress properly for work in the laboratory. It may often be desirable to wear an apron or coveralls over your clothing.
2. Tuck in your tie and roll up your sleeves. Get them out of the way, so they will not interfere with your work or get caught in machines.

Tools.

1. Lay tools to be used in a neat arrangement on the bench top. Place the cutting edges *away* from you. Do not let them rub against each other. Be very careful that sharp tools do not extend over the edges of the bench.
2. Keep screwdriver points properly pointed. This will prevent injury to hands and to wood fiber (Fig. 19–5).
3. See that handles are securely fastened on planes, hammers, and mallets.
4. Make certain that all files have handles.
5. *Use tools properly for their intended purpose.* Do not attempt to pry with a file, screwdriver, or wood chisel.
6. Do not carry tools in your pockets.

Materials.

1. Whenever possible, tighten material in a vise before working with it. Hold it securely.
2. Put waste pieces of lumber in the scrap box or in the storage rack.
3. Put the oily rags used for finishing in closed metal containers to prevent possible fires.

Hand tools, such as wood chisels, saws, knives, planes, and files should be used carefully. If these tools are dull, they can slip.

STANDARD STUDENT ACCIDENT REPORT FORM
Part A. Information on ALL Accidents

1. Name: ______ Home Address: ______
2. School: ______ Sex: M ☐; F ☐. Age: ____ Grade or classification: ______
3. Time accident occurred: Hour ______ A.M.; ______ P.M. Date: ______
4. Place of Accident: School Building ☐ School Grounds ☐ To or from School ☐ Home ☐ Elsewhere ☐

5. NATURE OF INJURY

Abrasion	____	Fracture	____
Amputation	____	Laceration	____
Asphyxiation	____	Poisoning	____
Bite	____	Puncture	____
Bruise	____	Scalds	____
Burn	____	Scratches	____
Concussion	____	Shock (el.)	____
Cut	____	Sprain	____
Dislocation	____		
Other (specify) ______			

PART OF BODY INJURED

Abdomen	____	Foot	____
Ankle	____	Hand	____
Arm	____	Head	____
Back	____	Knee	____
Chest	____	Leg	____
Ear	____	Mouth	____
Elbow	____	Nose	____
Eye	____	Scalp	____
Face	____	Tooth	____
Finger	____	Wrist	____
Other (specify) ______			

DESCRIPTION OF THE ACCIDENT

How did accident happen? What was student doing? Where was student? List specifically unsafe acts and unsafe conditions existing. Specify any tool, machine or equipment involved. ______

6. Degree of Injury: Death ☐ Permanent Impairment ☐ Temporary Disability ☐ Nondisabling ☐
7. Total number of days lost from school: ______ (To be filled in when student returns to school)

Part B. Additional Information on School Jurisdiction Accidents

8. Teacher in charge when accident occurred (Enter name): ______
Present at scene of accident: No: ______ Yes: ______

9. IMMEDIATE ACTION TAKEN

First-aid treatment ____ By (Name): ______
Sent to school nurse ____ By (Name): ______
Sent home ____ By (Name): ______
Sent to physician ____ By (Name): ______
Physician's Name: ______
Sent to hospital ____ By (Name): ______
Name of hospital: ______

10. Was a parent or other individual notified? No: ___ Yes: ___ When: ______ How: ______
Name of individual notified: ______
By whom? (Enter name): ______
11. Witnesses: 1. Name: ______ Address: ______
2. Name: ______ Address: ______

12. LOCATION

	Specify Activity		Specify Activity
Athletic field	______	Locker	______
Auditorium	______	Pool	______
Cafeteria	______	Sch. grounds	______
Classroom	______	______ shop	______
Corridor	______	Showers	______
Dressing room	______	Stairs	______
Gymnasium	______	Toilets and washrooms	______
Home Econ.	______		
Laboratories	______	Other (specify)	______

Remarks

What recommendations do you have for preventing other accidents of this type? ______

Signed: Principal: ______ Teacher: ______

Fig. 6–1. Report form. *(National Safety Council.)*

Studies show that fewer accidents occur with sharp than with dull tools.

Machine and portable power tools are safe when used properly. Particular caution should be observed when using the jointer, circular saw, wood lathe, grinder, band saw, and drill press.

Report any accident. All shop accidents should be reported on a form. Figure 6–1 shows the standard form prepared by the National Safety Council.

Learn the Safety Rules which are listed on page 32.

SHOP COURTESY

1. Report an accident at once so that first aid can be given.
2. Warn others to stay out of your way when you handle long pieces of lumber.
3. Do not run in the shop, laboratory, or home workshop. It is dangerous.
4. Carry only a few tools at a time.
5. Do not play in the woodworking shop or laboratory. It can be dangerous to you and your classmates.
6. Do not talk and work at the same time. Concentrate on what you are doing.

Discussion Topics

1. Why should we observe safety rules in shops and laboratories?
2. Explain why hand tools cause twice as many injuries as machine tools.
3. Why should reports of accidents be made to school officials and to the National Safety Council?
4. Name at least three advantages in wearing proper clothing or protective covering in the woodworking shop or laboratory.
5. Give three reasons why you should practice shop courtesy.

SECTION 2/PRODUCTION WITH HAND TOOLS

unit 7

Measuring and laying out lumber

Accurate measurement is a skill which must be learned in experimenting and working with wood. The foot (′) and the inch (″) are measurements which are used in most industrial laboratories, shops, and industries. Practically all measuring tools used in woodworking are divided into inches and halves, quarters, eighths, and sixteenths of an inch. Figure 7–1 shows these divisions.

TOOLS

Tools often used to measure and lay out are the wooden or steel bench rule (Fig. 7–2), steel square (7–3), try square (Fig. 7–4), combination square (Fig. 7–5), extension rule (Fig. 7–6), flexible steel tape rule (Fig.

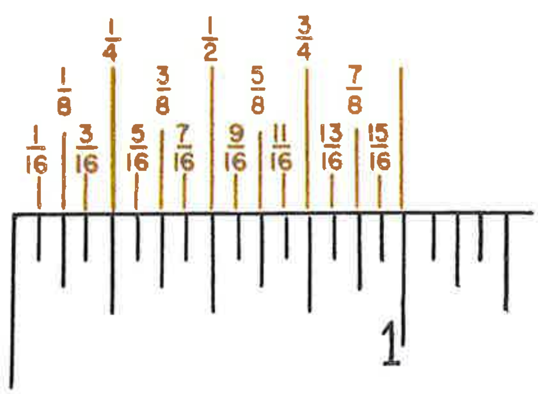


Fig. 7–1. Divisions of an inch.

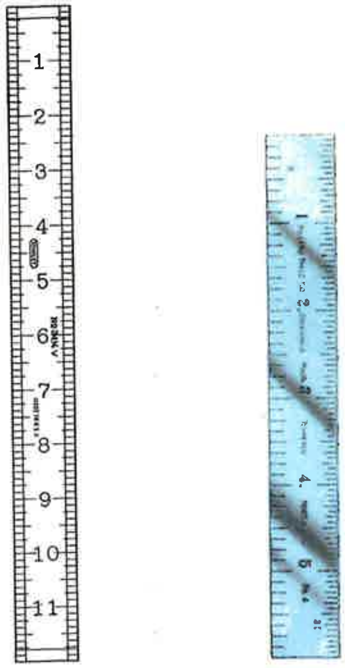


Fig. 7–2. A wooden and a steel bench rule.

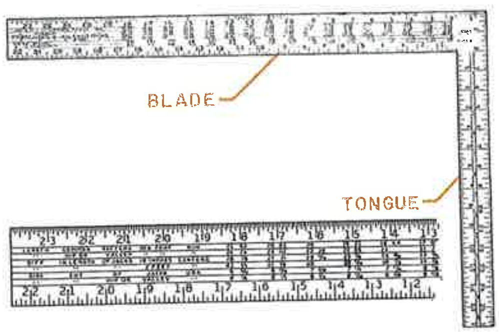


Fig. 7–3. Carpenter's steel square. Notice a section of the roofing table which appears on the blade.

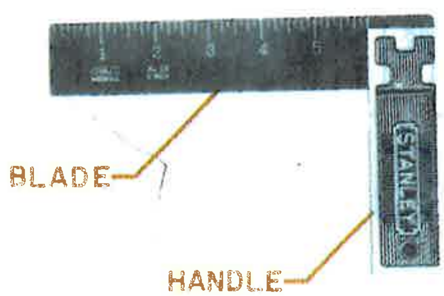


Fig. 7–4. Six-inch try square.

Fig. 7–5. Combination square.

7–7), steel tape (Fig. 7–8), bevel (Fig. 7–9), angle dividers (Fig. 7–10), marking gage (Fig. 7–11), butt gage (Fig. 7–12), level (Fig. 7–13), plumb bob (Fig. 7–14), chalk line reel (Fig. 7–15), marking knife (Fig. 7–16), and scoring tool (Fig. 7–17).

Wooden or Steel Bench Rule. One of the most frequently use tools is the 6-, 12-, or 24-inch wooden or steel bench rule (Fig. 7–2). The front is usually marked in divisions of eighths of an inch; the back in sixteenths.

Steel Square. This square usually has a 24-inch blade and a 16-inch tongue (Fig. 7–3). It is used in bench-, cabinet-, and carpentry-work to measure, to square lines, and to test large surfaces for *wind*,* or twist. It also tests for squareness in assembly and in laying out rafters, roof framing, and stairs. There are several mathematical tables on the two arms of the square; these give useful information.

Try Square. The try square (Fig. 7–4) is one of the tools most often used for squaring, testing, and measuring. It is generally made of steel, but sometimes has a handle of wood.

Combination Square. This tool (Fig. 7–5) may be used for marking and checking squareness, 45- and 90- degree angles, and to test vertical and horizontal levelness.

Extension Rule. The extension rule (Fig. 7–6) usually extends to a 6- or 8- foot length.

*A glossary of technical terms used in the field of woodworking begins on page 416.

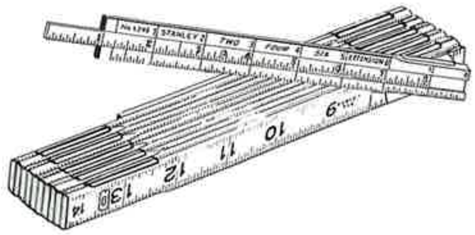


Fig. 7–6. Six-foot extension rule.

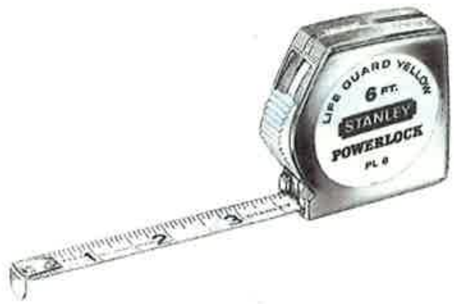


Fig. 7–7. Six-foot flexible steel tape rule.

Fig. 7–8. Fifty-foot steel tape.

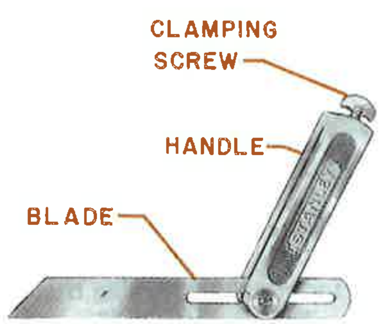


Fig. 7–9. Sliding bevel.

It is generally made of wood, but sometimes is of lightweight metal. It is useful for measuring long pieces.

Flexible Steel Tape Rule. A 6-, 8-, or 10-foot flexible steel tape rule (Fig. 7–7) is handy for either outside or inside measuring.

Steel Tape. The steel tape (Fig. 7–8) is available in 50- or 100-foot lengths. It is used to measure long boards and in carpentry.

Bevel. This tool (Fig. 7–9) looks like a try square, but has a movable blade which can be set to lay out any angle. It is also used to check chamfers, bevels, or angles.

Angle Dividers. This is a most useful instrument (Fig. 7–10) for bisecting angles and for fitting molding and inside trim.

Marking Gage. The marking gage (Fig. 7–11) is used to mark a line parallel to a given edge or end. It is made of either wood or metal. The point of the metal spur or pin must be kept sharp at all times.

Butt Gage. The butt gage (Fig. 7–12) is used to mark mortises when hanging doors.

Level. The level in the upper part of Fig. 7–13 may be framed in aluminum or wood. Levels of this type are from 18 to 28 inches long. The lower one shown in this

Fig. 7–10. Seven and one-half-inch-length angle dividers.

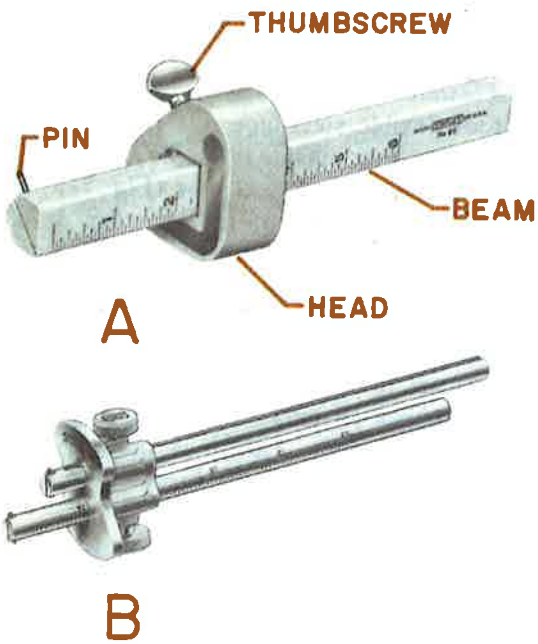


Fig. 7–11. Marking gages: (A) wooden, (B) double-beam steel.

Fig. 7–12. Butt gage.

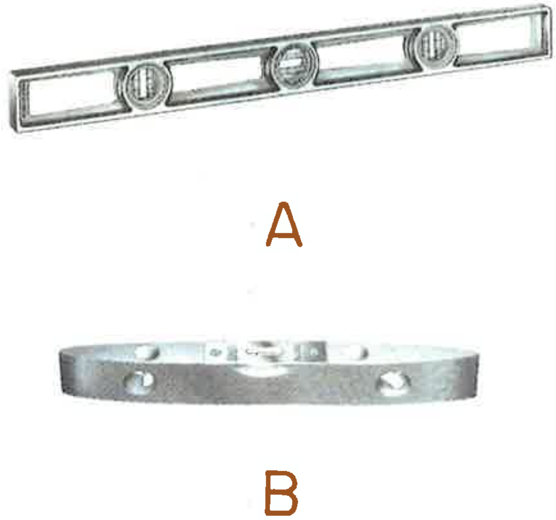


Fig. 7–13. Levels: (A) 24-inch aluminum, (B) 9-inch torpedo.

Fig. 7–14. Twelve-ounce plumb bob.

figure is 9 inches long and is called a *torpedo* level because of its design. Both types are especially useful in building cabinetwork or when doing carpentry which must be level and accurate.

Plumb Bob. The plumb bob (Fig. 7–14) is most adaptable for building construction. It is used for *plumbing* (getting true vertical alignment). The size varies from 5 to 12 ounces.

Chalk Line Reel. The type of reel shown in Fig. 7–15 contains 50 to 100 feet of cord. It is used to mark long, straight lines with chalk.

Marking Knife. The marking knife (Fig. 7–16) may be used for very accurate marking across the grain, or fiber, of wood. It also cuts and whittles.

Scoring Tool. The scoring tool in Fig. 7–17 is used to mark and *score* (cut lightly) plastic laminates and composition building materials.

LAYING OUT LENGTHS

1. Select a board which has the fewest checks or cracks (Fig. 7–18).

2. Square a line across the end of the board at a place which will avoid end checks or cracks (Fig. 7–18). Place the blade of the square firmly against the edge of the board. Mark the line against the tongue of the square on the broad surface of the board. The mark will be at a 90-degree angle with the edge (Fig. 7–19).

Fig. 7–16. Retractable-blade marking knife.

Fig. 7–17. Scoring tool.

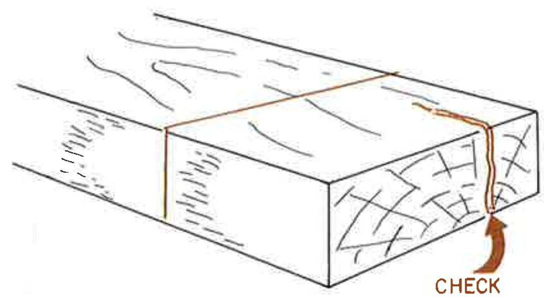


Fig. 7–18. Board marked to avoid checks or cracks.

Fig. 7–15. Fifty-foot chalk line reel.

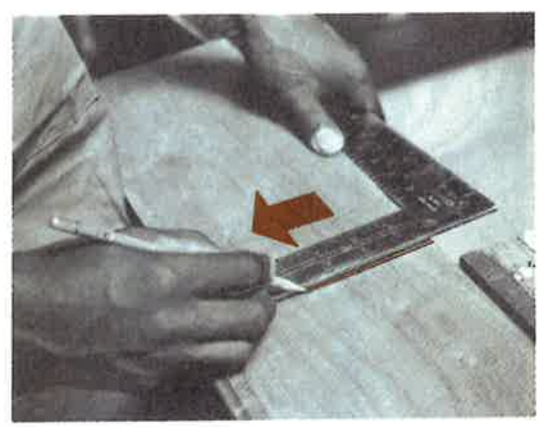


Fig. 7–19. Squaring a line across a board.

Fig. 7–20. Laying out a measurement with the rule on edge.

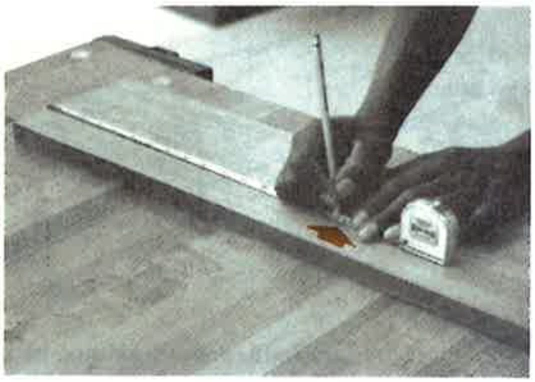


Fig. 7–21. Laying out a measurement with a flexible rule.

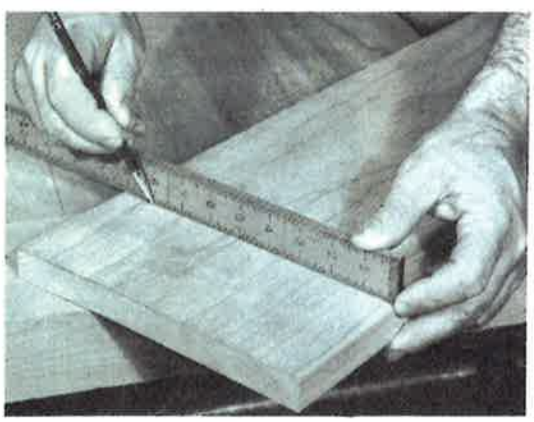


Fig. 7–22. Measuring for width.

3. Lay out the length you want with a suitable measuring rule (Figs. 7–20 and 7–21). Mark it with a sharp pencil or knife. To get a more accurate measurement place the rule on its edge, as in Fig. 7–20.

4. Square the line just marked by following the procedure in step 2.

LAYING OUT WIDTHS

1. Measure and mark the width you want with any of the measuring tools (Figs. 7–20 through 7–22). Divide and mark a board into any number of equal widths. Lay the rule edgewise across the board in a diagonal position, as shown in Fig. 7–23.

2. Mark the width layout on the board by either of the methods shown in Figs. 7–24 and 7–25.

GAGING WIDTH AND THICKNESS

1. Set the marking gage to the distance you want marked.

2. Check the setting against a rule to make certain that it is accurate (Fig. 7–26).

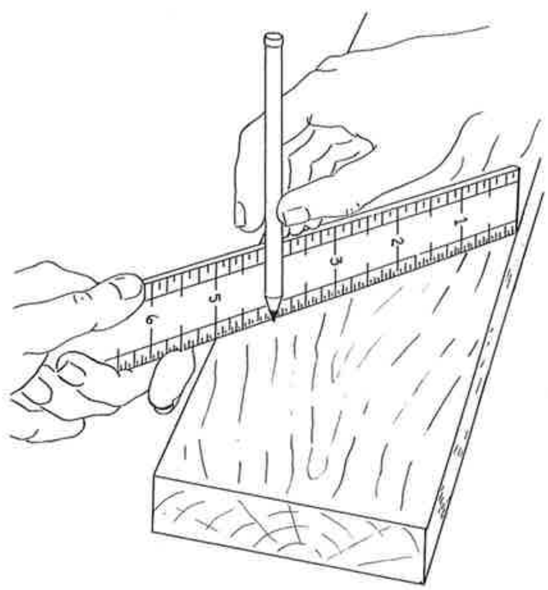


Fig. 7–23. Dividing a board into equal parts.

Fig. 7–24. Rule and pencil used as a marking gage.

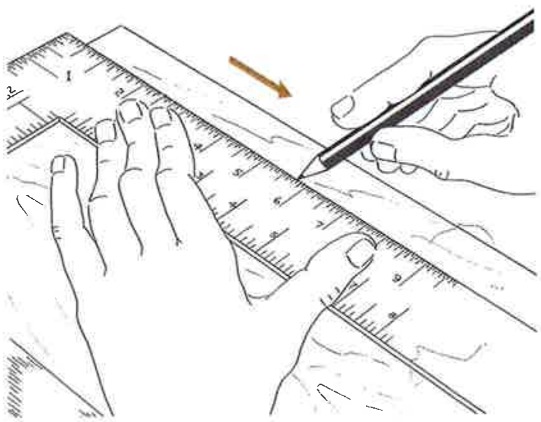


Fig. 7–25. Marking a line along a straightedge.

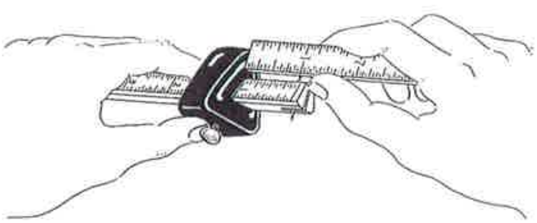


Fig. 7–26. Checking measurement of the marking gage against a rule.

3. Push the marking gage forward on the wood to make the marking (Fig. 7–27). Hold the head of the gage firmly against the edge of the board while you scribe, or mark, a light line.

Many craftsmen prefer to gage lines and distances with a sharp-pointed pencil instead of with a marking gage. The objection to the marking gage is that the spur point makes a dent, or groove, in the edge or face of the piece of wood, or tears the fibers of the wood when the marking gage is used across the end of the board.

Fig. 7–27. Pushing the marking gage to scribe a line.

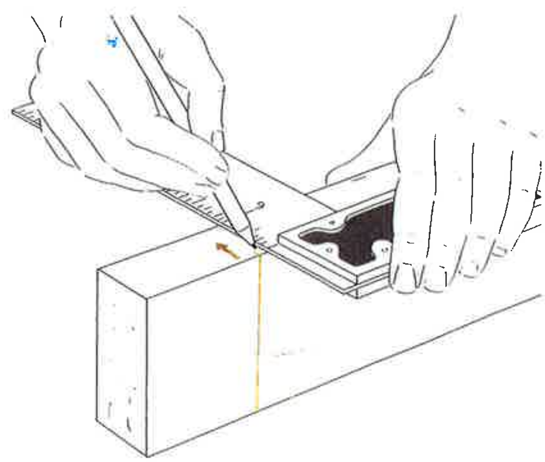


Fig. 7–28. Extending the line along an edge.

LAYING OUT LINES

Mark a line around the edge of the board by continuing the face line (Fig. 7–28). Hold the handle of the try square firmly against the broad side, or face, of the board while you mark along the blade (Fig. 7–28).

LAYING OUT ANGLES

1. Adjust the bevel to the angle you want (Fig. 7–29); then fasten the screw on the handle. This layout tool is especially useful for any acute angle (less than 90 degrees) or obtuse angle (over 90 degrees). You may set the angle of the bevel by using a protractor (Fig. 7–30).

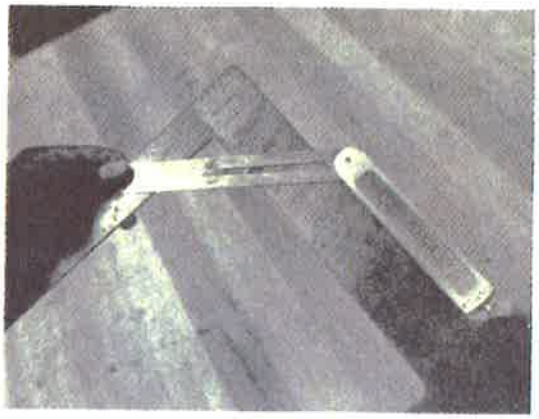


Fig. 7–29. Adjusting the bevel to the desired angle against a square.

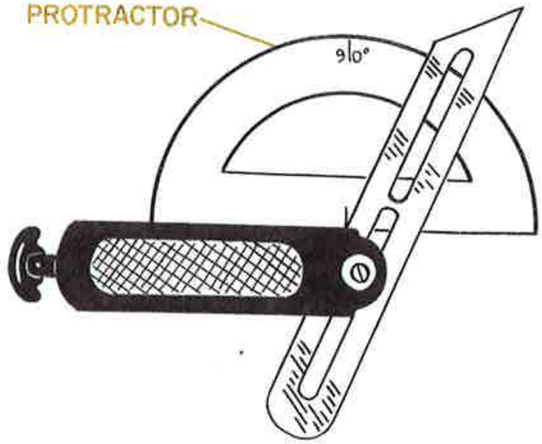


Fig. 7–30. Adjusting the bevel to the desired angle against a protractor.

2. Hold the handle firmly against the face or edge of the board. Mark along the edge of the blade. This is like the method of marking with a try square.

A sharp-pointed pencil will make a suitable marked line.

Discussion Topics

1. How many eighths ($^1/_8$) are there in $1^3/_8$ inches?
2. Name seven tools used for measuring.
3. What tool is used to lay out angles?
4. Why should you check the measurement of a marking gage against a rule? How is this done?
5. Why do you place a rule on its edge when measuring?
6. Describe at least two methods by which you can divide an 8-inch board in five equal widths.
7. Should the marking gage be pushed away from or pulled toward you? Explain.
8. Explain when and how you would use the following tools; angle dividers, butt gage, level, plumb bob, chalk line reel, and scoring tool.

unit

8

Sawing across or with the grain of the wood

The saw is one of the oldest tools known. The most primitive form dates back to the Stone Age. A stone with ragged edges was used for cutting. The operation of the modern steel saw is very similar to that of the ragged flint one. The steel saw, however, has been developed into a very accurate cutting tool.

TOOLS

Woodworkers' saws are the crosscut saw, the ripsaw, the backsaw, and the dovetail saw. Figure 8-1 shows a typical panel handsaw with the parts identified.

The length of the blade in inches tells the size of the saw. The 24- and 26-inch lengths are the more popular sizes. The number of points per inch, as shown in Figs. 8-2 and 8-3, makes the coarseness or fineness of a saw. This number is usually stamped on the heel of the saw blade near the handle. There is always one more point per inch than there are teeth. For example, a saw that has eight points per inch will have seven teeth per inch. A coarse saw is better for doing fast work and for cutting green, or undried, lumber. A fine one does smother, more accurate cutting on seasoned, or dried, wood.

Crosscut Saw. This saw is used to cut across the grain, or fiber, of the wood (Fig. 8-4). The teeth are set, or adjusted, and filed as shown in Fig. 8-5. They cut into the wood to make the *kerf*, or saw cut. See Fig. 8-4.

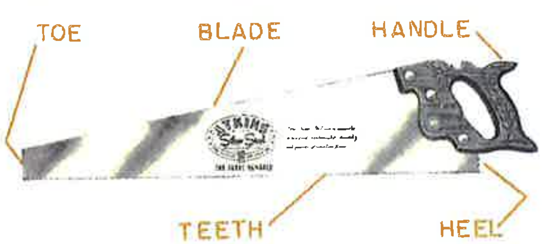


Fig. 8-1. A panel handsaw.

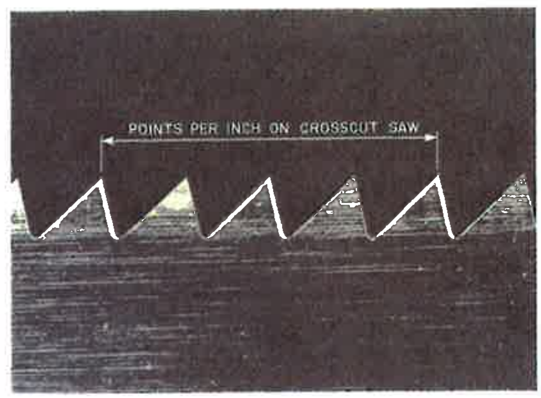


Fig. 8-2. Five points per inch on a crosscut saw.

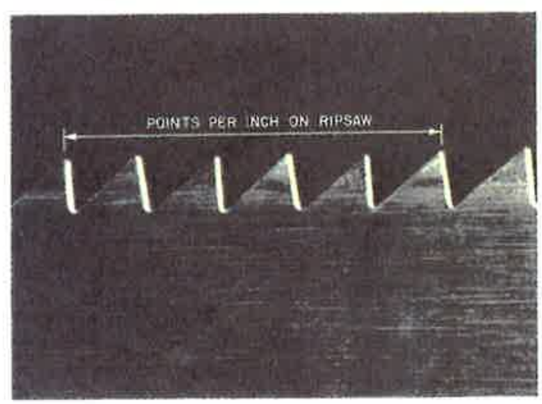


Fig. 8-3. Six points per inch on a ripsaw.

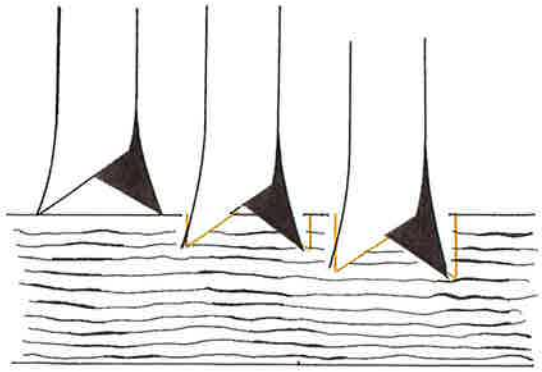


Fig. 8–4. Cutting action of crosscut-saw teeth.

Fig. 8–5. Cutting edges of crosscut-saw teeth.

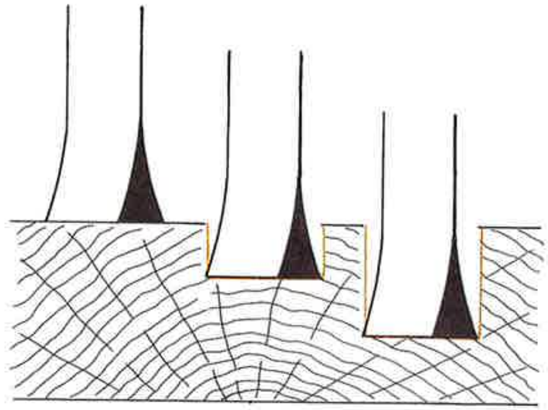


Fig. 8–6. Cutting action of ripsaw teeth.

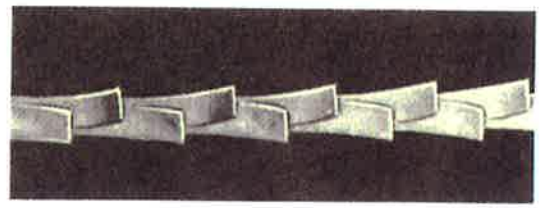


Fig. 8–7. Cutting edges of ripsaw teeth.

The teeth of a saw are *set*. That is, every other tooth is bent to the right; the alternate teeth are bent to the left. This makes the saw kerf wider than the thickness of the saw blade. It prevents the saw from sticking in the kerf. Saw teeth should always be kept sharp and properly set. Eight to ten points per inch cut easily.

Ripsaw. A ripsaw is used for ripping or cutting with the grain of the wood (Fig. 8–6). The teeth are large, and cut into the wood with short, chisel-like jabs. Figure 8–7 shows how the teeth of a ripsaw are filed and set. Figure 8–6 shows the manner in which this saw cuts into the wood to make the kerf. Five to seven points per inch cut easily.

Backsaw. Figure 8–8 shows a thin crosscut saw with fine teeth. The blade is stiffened by a thick back. A popular length for the backsaw is 14 inches, with thirteen points per inch. This saw is used for very fine work.

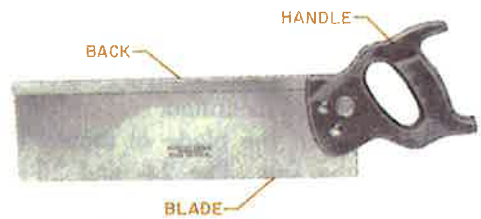


Fig. 8–8. A 14-inch backsaw.

Fig. 8–9. Dovetail saw.

Dovetail Saw. This saw (Fig. 8–9) is extremely thin and is used in joint making and fine cabinet work.

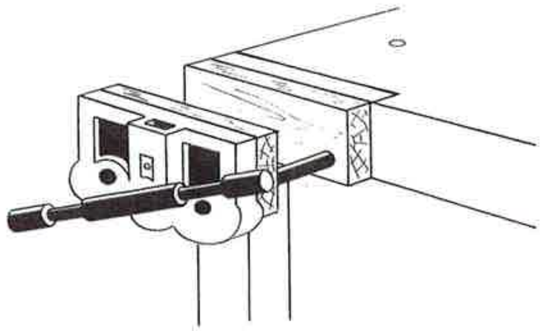


Fig. 8–10. Woodworker's bench vise.

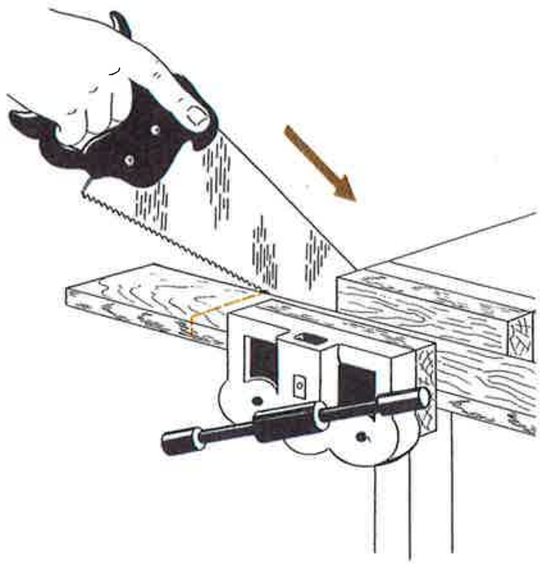


Fig. 8–11. Board held in a woodworker's bench vise for crosscutting.

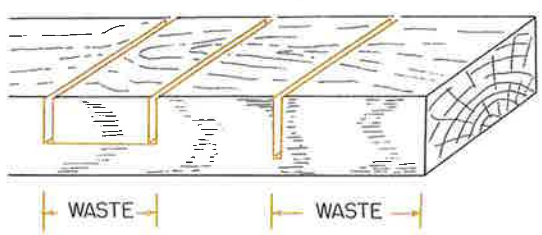


Fig. 8–12. Waste portions of a board.

Vise. A woodworker's bench vise holds lumber to be sawed. Before using this vise, make sure that you understand how it works by looking at Fig. 8–10. Figure 8–11 shows it in use.

CROSSCUTTING

1. Lay out and mark the board to be cut. See Unit 7.
2. Fasten the board in a bench vise if it can be held this way (Fig. 8–11). Wider or longer boards which cannot be firmly held in a vise should be laid across sawhorses (Fig. 8–14).
3. Place the heel (Fig. 8–1) of the crosscut saw near the cutting line on the *waste* side of the wood (Fig. 8–12). Pull it, while you guide it with the left thumb (Fig. 8–13).
4. Make several short strokes. Test these cuts with a try square. Do this to see that the saw blade is cutting at right angles to the surface of the board (Fig. 8–14).
5. Continue cutting. Use long strokes. Cut at about a 45-degree angle to the board (Fig. 8–15). The direction of the cut may be changed by twisting the handle slightly in the direction of the line marked on the board.

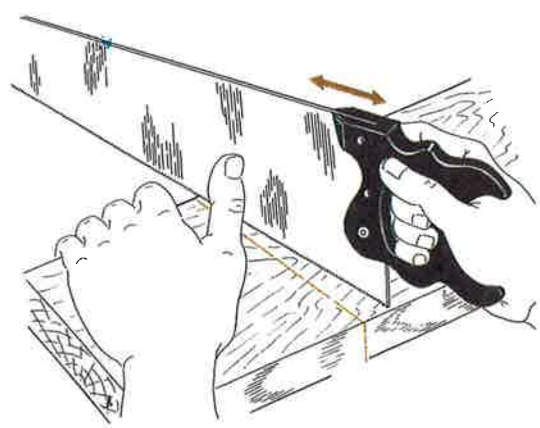


Fig. 8–13. Starting the cut across the grain of the wood.

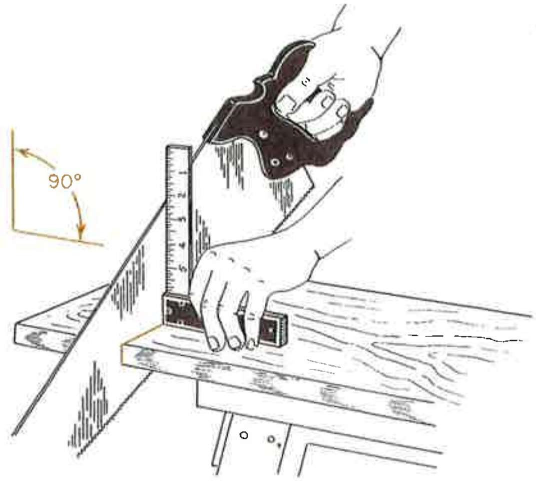


Fig. 8–14. Testing a saw cut with a try square.

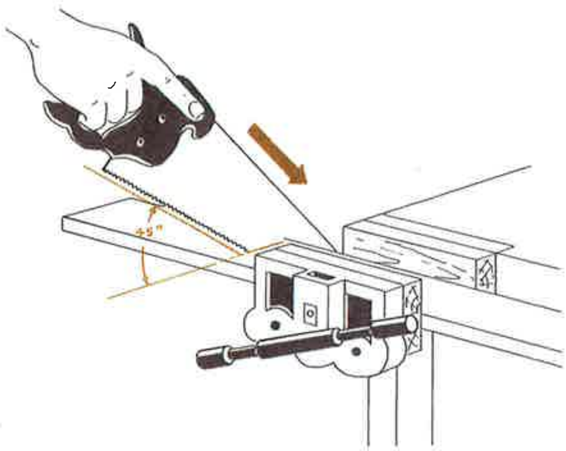


Fig. 8–15. Proper angle of the saw for crosscutting.

Fig. 8–16. Crosscutting a board held in a bench vise.

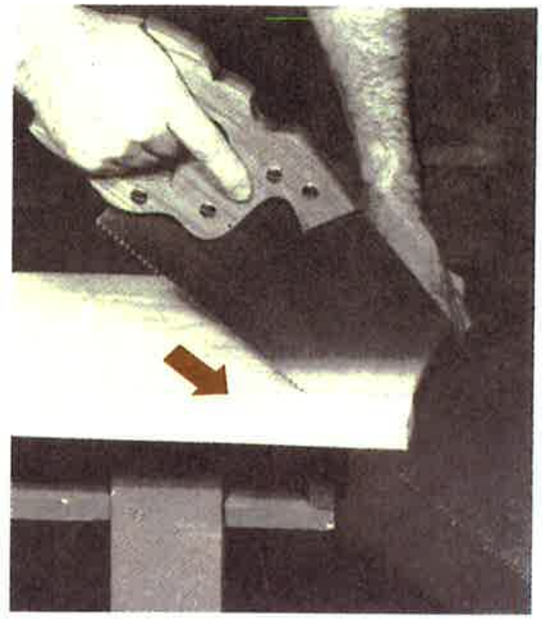


Fig. 8–17. Ripping a board on a sawhorse.

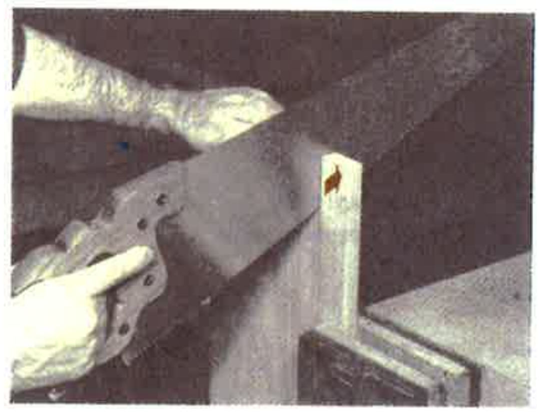


Fig. 8–18. Ripping a board in a vise.

6. Finish sawing. Use short, easy strokes. Hold the end of the lumber to be cut off with your left hand (Fig. 8–16). This keeps the wood from splitting or breaking from its own weight.

RIPPING

1. Mark the lumber to be sawed or ripped. See Unit 7.
2. Hold the board on a sawhorse if possible (Fig. 8–17). Ripping in a vise is also satisfactory (Fig. 8–18).
3. Start ripping in much the same manner as in step 3 under "Crosscutting." Begin the cut by pulling the ripsaw back. Hold the cutting edge at an angle of about 60 degrees to the surface (Fig. 8–17 and 8–18). Be sure that the cut is on the waste side of the board.
4. Continue ripping the board with short, easy strokes.

FINE, OR CABINET, SAWING

1. Lay out and mark the board for cutting.
2. Fasten the board in a vise (Fig. 8–19). You may also hold it firmly against a bench hook (Fig. 8–20).
3. Start cutting with the backsaw the same way you did for crosscutting.
4. Continue cutting with short, easy strokes until the board has been cut. Hold the waste portion with your left hand to keep it from splitting.

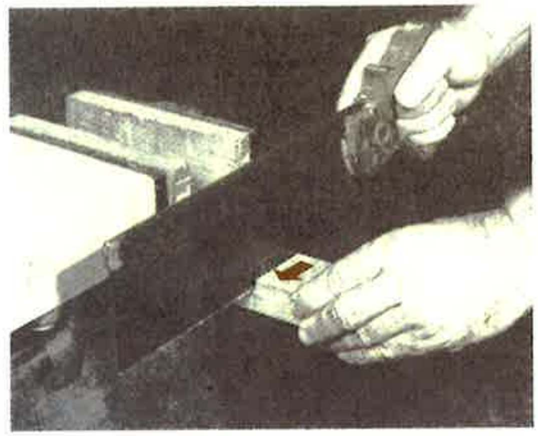


Fig. 8–19. Holding a board in a bench vise while cutting with a backsaw.

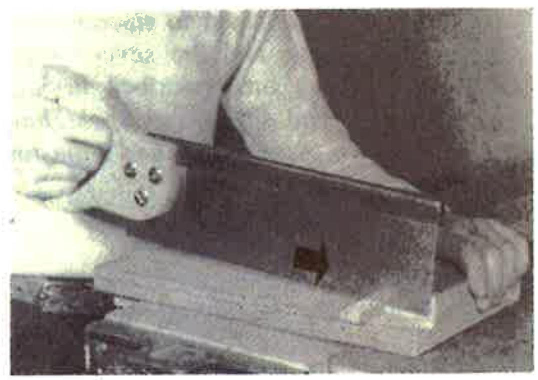


Fig. 8–20. Cutting a board with the backsaw on a bench hook.

Discussion Topics

1. What are the main differences between the crosscut saw and the ripsaw?
2. What does the number stamped on the heel of the saw mean?
3. Why should the final strokes in sawing be short ones?
4. Why must the teeth of a saw be set? What does this mean?
5. Should the saw be pulled or pushed when starting a cut? ~~Why~~?
6. How is wood held for cutting with a crosscut saw or a ripsaw?

unit 9

Assembling and adjusting planes

The plane is a very useful tool for the woodworker. Although there are several types of planes, the assembly, adjustment, and general handling are alike. Common types of planes are the jack, smooth, jointer, block, rabbet, and router. Figure 9–1 shows the main parts of a plane.

Other tools often used to smooth wood are the spokeshave and the several types of scrapers. They are described in Unit 12, *Assembling and Adjusting a Spokeshave* and in Unit 16, *Assembling and Adjusting Scrapers*.

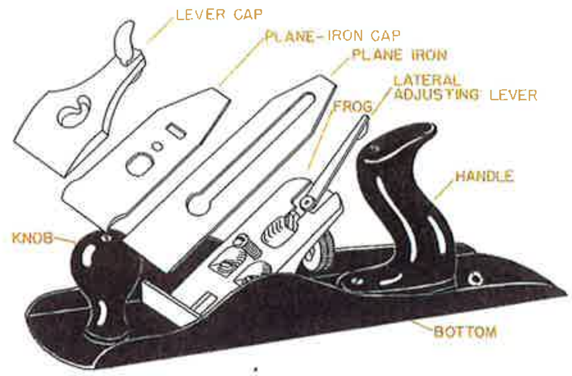


Fig. 9–1. Parts of a plane.

PLANES

The following descriptions and illustrations of planes will help you choose the best one for your working needs.

Jack Plane. This plane (Fig. 9–2) is the most used because of its size and usefulness. It will do the work of the smooth, jointer, and block planes. It is about 14 inches long with a 2-inch cutter blade.

Fig. 9–2. Jack plane.

Junior Jack Plane. The junior jack plane (not illustrated) is narrower and shorter than the jack plane, but otherwise is just like it. The bottom is about 10 inches long. It is light in weight and is used by grade and junior high school students.

Smooth Plane. This plane (Fig. 9–3) is exactly like the jack plane except that the bottom is only 9 inches long, with a 2-inch blade. It does fine, or exact, work.

Fig. 9–3. Smooth plane.

Fig. 9–4. Jointer plane.

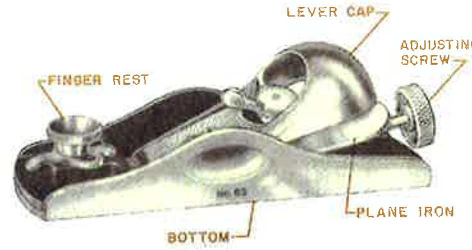


Fig. 9–5. Block plane.

Jointer Plane. The jointer plane (Fig 9–4) looks like the jack plane. The difference is that the bottom is from 18 to 22 inches long with a 2⅜-inch blade. It is used most often for planing the edges of long boards.

Block Plane. This plane (Fig. 9–5) is made somewhat differently from the jack plane, but is adjusted in the same way. The length is approximately 7 inches with a 1⅝-inch blade. The blade is at a more acute angle to the plane bottom than the blades in other planes. It is ideal for planing end grain or for easy handling of many small jobs.

Rabbet Plane. The rabbet plane illustrated in Fig. 9–6 is described as "bullnose" because of the way it looks. It is from 4 to 6 inches long. The plane works like the block plane, but is narrower. The 1-inch plane iron is near the front of the bottom to make it easy to plane in close places. The rabbet plane is often used for dressing, or shaping, tenons to fit snugly into mortises, and for dressing other places that are hard to get into. The plane iron extends through both sides of the plane, making it possible to plane along a corner.

Duplex Rabbet Plane. This rabbet plane (Fig. 9–7) has two seats for the cutter; one for regular work, the other for bullnose (close) planing. It is fitted with a spur and a removable depth gage. It also has an adjustable fence which can be used on either side. It is approximately 8 inches in length, with

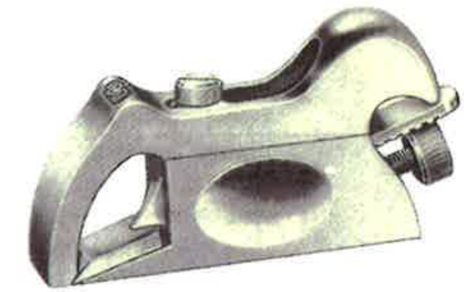


Fig. 9–6. Rabbet plane.

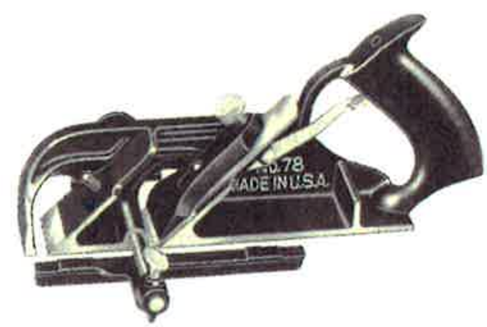


Fig. 9–7. Duplex rabbet plane.

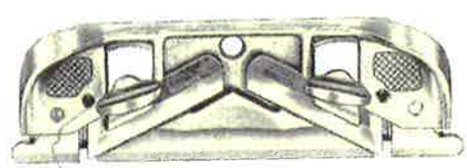


Fig. 9–8. Side rabbet plane.

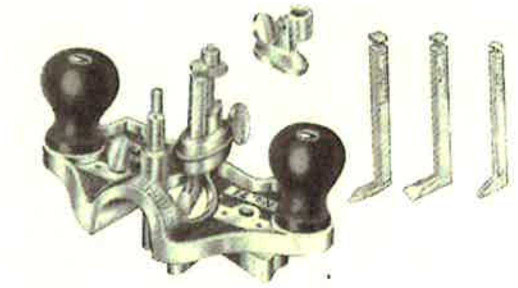


Fig. 9–9. Open-throat router plane.

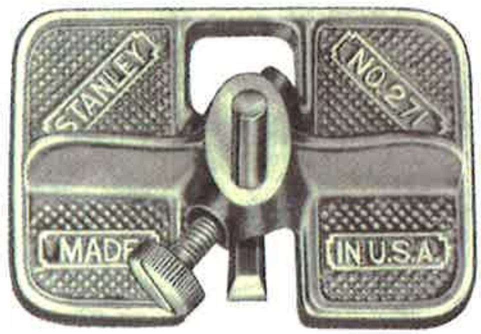


Fig. 9–10. Small router plane.

Fig. 9–11. Small trimming plane.

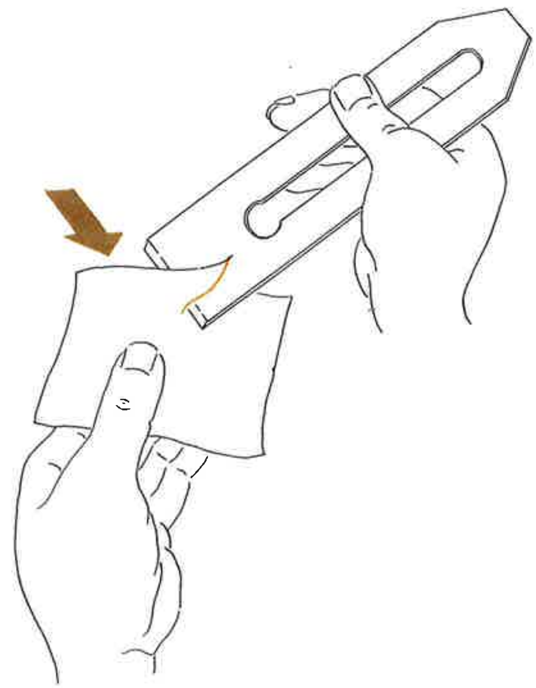


Fig. 9–12. Testing the cutting edge on a piece of paper to determine the sharpness of a plane iron.

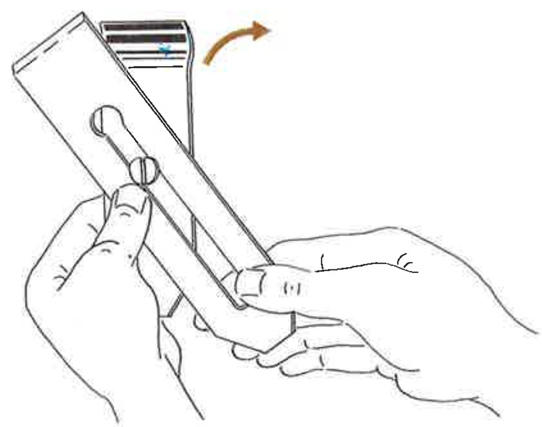


Fig. 9–13. Assembling the plane-iron cap and plane iron.

a $1\frac{1}{2}$-inch cutter blade. Its use is similar to that of the rabbet plane (Fig. 9–6), except it is more versatile because of the many attachments.

Side Rabbet Plane. A plane of this type (Fig. 9–8) is used to trim dadoes, molding, and grooves. It is $5\frac{1}{2}$ inches long; the cutter blade is $\frac{1}{2}$ inch wide.

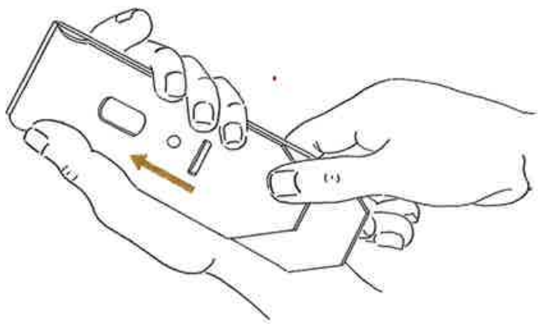


Fig. 9–14. Aligning the plane-iron cap and plane iron.

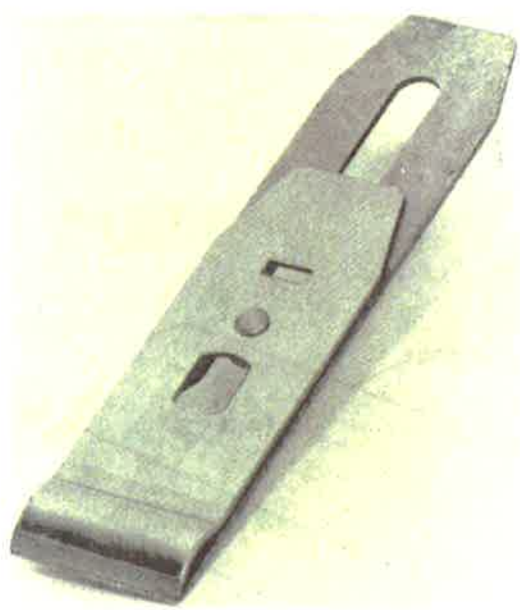


Fig. 9–15. Assembled plane iron and cap.

Open-Throat Router Plane. Figure 9–9 shows an open throat router plane with three types of cutters which come with it. It is used for surfacing (smoothing) the bottom of grooves or other depressions parallel with the surface of the board.

Small Router Plane. The small router plane (Fig. 9–10) is useful for very narrow work such as inlay and cutting dadoes for shelves. It is only 3 inches long; the cutter blade is $\frac{1}{4}$ inch wide.

Small Trimming Plane. This small, light plane (Fig. 9–11) is handy for miscellaneous light work and model building. It fits into the palm of the hand. The length is $3\frac{1}{2}$ inches; the cutter blade is 1 inch wide.

ASSEMBLING AND ADJUSTING

Assembling and adjusting a plane are not difficult if you follow the instructions given here. Learn to look at the illustrations and understand what is being shown.

Assembling.

1. Test the plane iron for sharpness (Fig. 9–12). It should cut paper easily with a shearing, or side, cut.

2. Place the plane-iron cap on the flat side of the plane iron with the screw in the slot (Fig. 9–13).

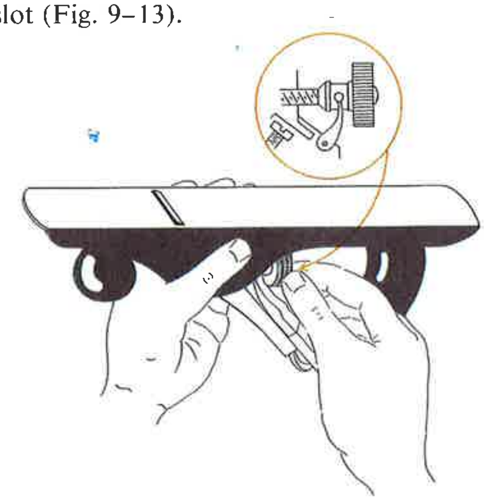


Fig. 9–16. Adjusting the plane iron for cutting depth.

3. Pull the plane-iron cap back and turn it straight with the plane iron (Fig. 9–14).

4. Slide the cap toward the cutting edge of the plane iron. Never push the cap over the edge of the blade (see Fig. 9–14).

5. Adjust and tighten the cap with a screwdriver. The cap should be about 1/16 inch from the cutting edge of the blade (Fig. 9–15).

6. Place the blade and plane-iron cap in the plane. Put the plane iron with its bevel side down on the frog. Be sure that the plane iron is properly placed on the lateral adjusting lever (see Fig. 9–1).

7. Lay the lever cap over the plane-iron assembly so that the screw slides in the slot (see Fig. 9–1).

8. Tighten the lever cap to hold the entire assembly. Figure 9–2 shows the lever cap in its proper position.

Adjusting.

1. Move the plane iron with the lateral adjusting lever until the cutting edge is parallel with the bottom of the plane.

2. Set the cutting depth with the adjustment nut near the handle. Move the nut right or left until you get the correct depth (Fig. 9–16).

Discussion Topics

1. List six parts of a plane. ~~Describe the use of each.~~
2. What type of plane is the most popular with woodworkers?
3. Name at least five types of planes. Tell how each may be used.
4. ~~Show how to assemble and adjust a jack plane.~~

---

unit 10

Planing

Planing surfaces, edges, and ends accurately with a hand plane requires skill and a sharp plane iron, or blade. Squaring stock, or lumber, will provide basic experience. A board has been *squared* when all the surfaces are square to each other and are true, or accu-

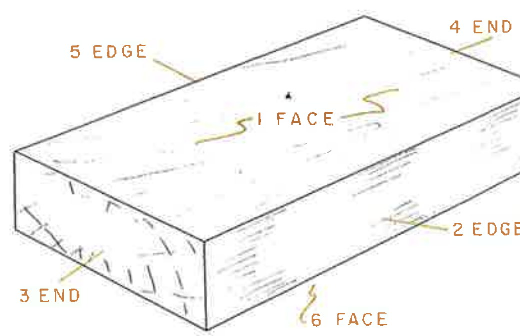


Fig. 10–1. Steps in planing a board.

rate, and smooth. All the pieces in a project will fit together properly if each part has been squared to the dimensions in the drawing. Figure 10–1 shows *by number* a sequence, or order, for the steps to be taken when you square a board.

TOOLS

The tools used in planing and squaring lumber have already been illustrated and described in previous units of this book. They are the jack plane, try square, steel square, marking gage, rule, crosscut saw, ripsaw, and backsaw.

PLANING THE FIRST SURFACE

1. Select the best surface, or face, of the board (see Fig. 10–1). If the board has not been cut to approximate length, refer to Unit 7, *Measuring and Laying Out Lumber* and to Unit 8, *Sawing Across or With the Grain of the Wood.*
2. Place the board on the bench and fasten it between the vise dog and a bench or board stop (Figs. 10–2 and 10–3). Place the board so that you can plane in the direction of the grain, or fiber, of the wood.
3. Adjust the cutting depth of the plane iron so that it will cut evenly and not too deep.
4. Plane the surface until it is clean and smooth (Fig. 10–4).

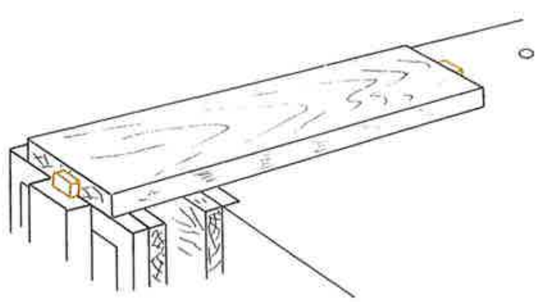


Fig. 10–2. Board fastened on bench against a bench stop, ready for planing.

Fig. 10–3. Bench or board stop.

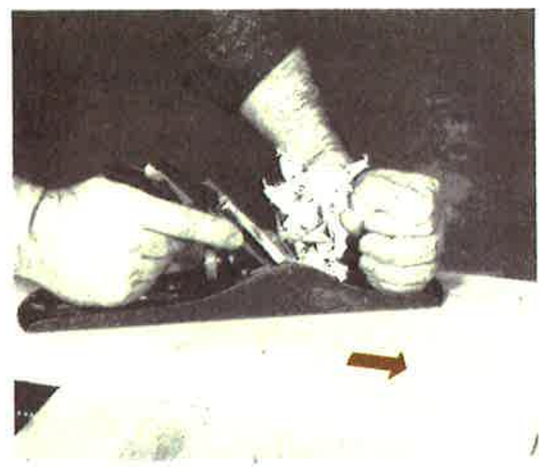


Fig. 10–4. Planing a surface.

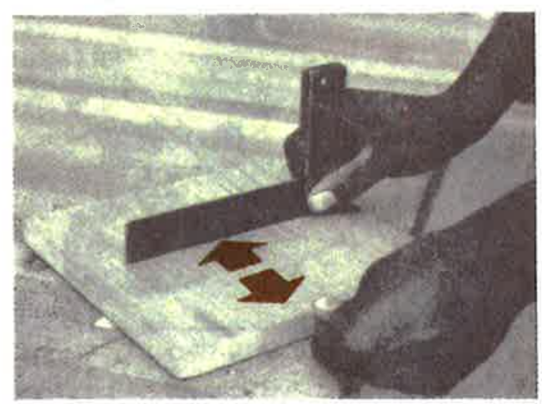


Fig. 10–5. Testing for flatness.

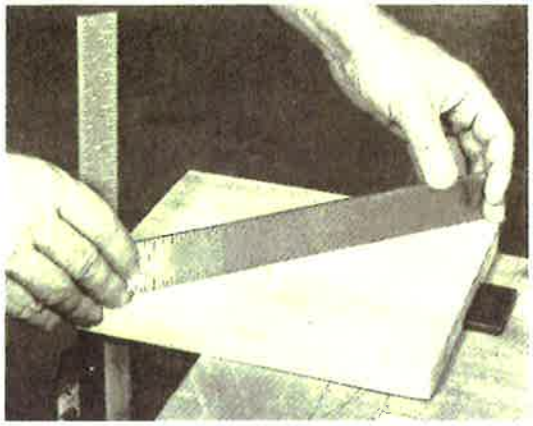


Fig. 10–6. Testing diagonally for a wind.

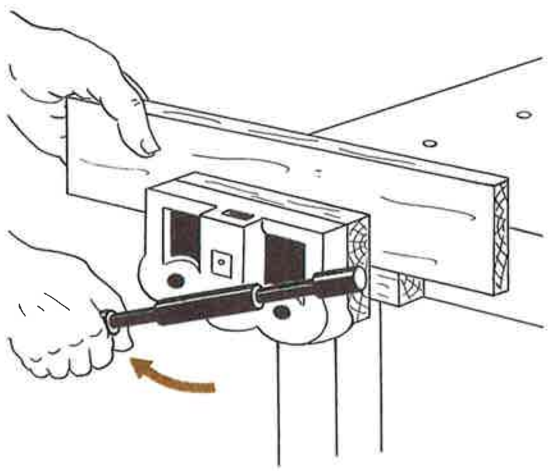


Fig. 10–7. Fastening a board in a vise for edge planing.

5. Test the surface for flatness with the blade of a try square or with the tongue of a framing square (Fig. 10–5). The entire blade should touch the surface throughout the board.

6. Test the surface diagonally across the board to detect a *wind*, or twist (see Fig. 10–6). You may have to use a longer straight-edge such as a framing square.

PLANING THE FIRST EDGE

1. Select the best edge of the board. This will probably be the one requiring the least amount of planing.

2. Fasten the board in a vise with the selected edge up. The direction of the grain should be away from you (Figs. 10–7 and 10–8).

3. Plane the edge until it is square with the *working face*, or planed surface (see Fig. 10–8). Notice where to put pressure on the plane for starting and finishing the stroke.

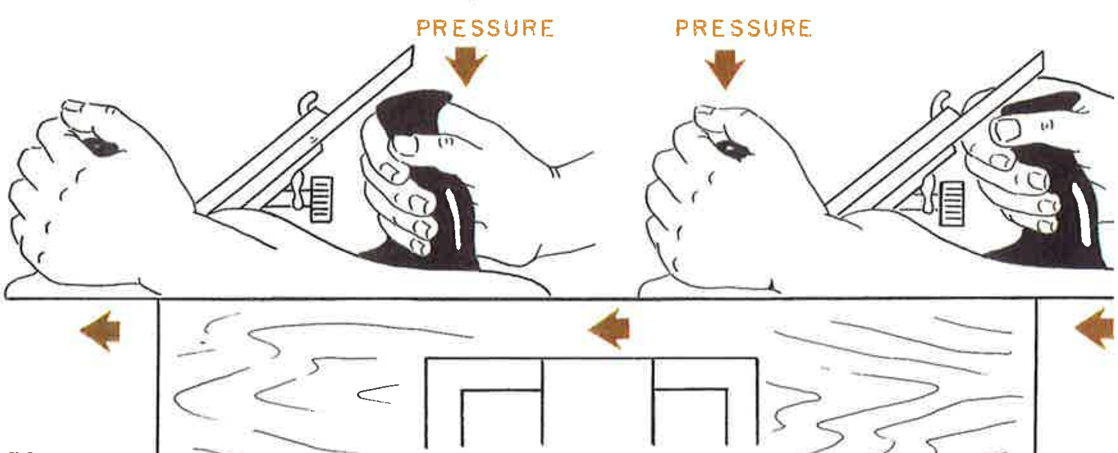
4. Test the edge with the face for squareness (Fig. 10–9).

PLANING THE FIRST END

1. Select the best end of the board.

2. Fasten the board in a vise with the selected end up (see Fig. 10–13).

Fig. 10–8. Planing an edge.



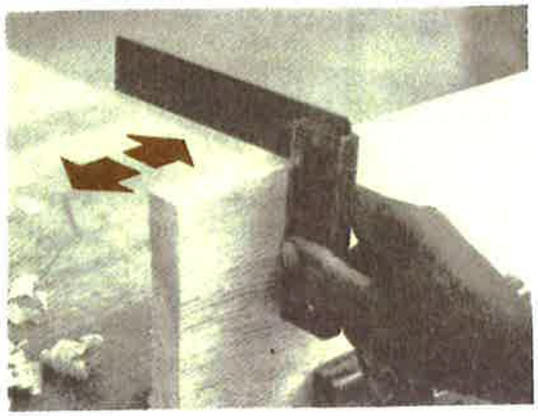


Fig. 10–9. Testing an edge for squareness.

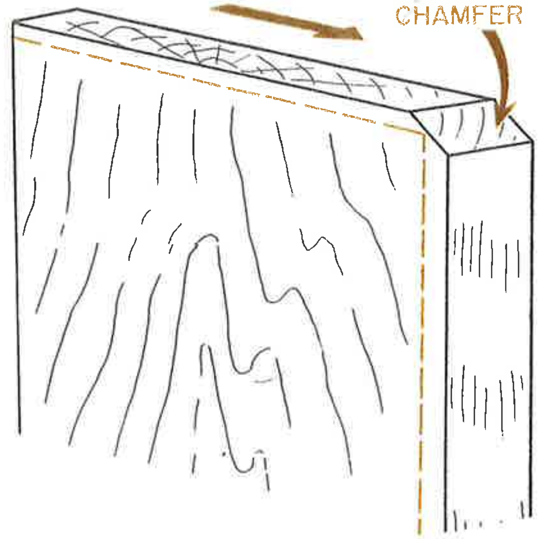


Fig. 10–10. Chamfering an end for end planing.

3. Choose the method you will use in planing the end. Follow one of these three steps, a, b, or c:

a. Cut the end to make a chamfer as shown in Fig. 10–10. See Unit 11, *Shaping a Chamfer and a Bevel*, for details of a chamfer. This should be cut from the unfinished edge. You may then plane in the direction of the arrow without splitting the edge.

b. Clamp a narrow piece of scrap wood against the unfinished edge (see Fig. 10–11). Plane in the direction of the arrow. This prevents splintering the outer edge.

c. Plane two-thirds of the distance across the end from one side, and then reverse the direction. The opposite edge will not split off if the plane is lifted before the blade goes completely across (Fig. 10–12). Use a block plane on very narrow boards.

4. Plane the end until it is square with the planed surface and edge (Fig. 10–13). Hold a wide board in a vise with a hand screw clamp. Fasten it to the board so that the clamp rests flat on the bench top.

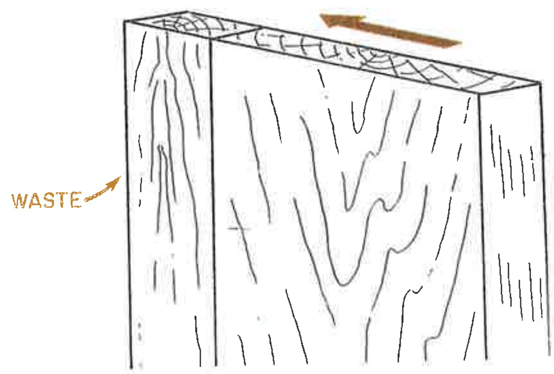
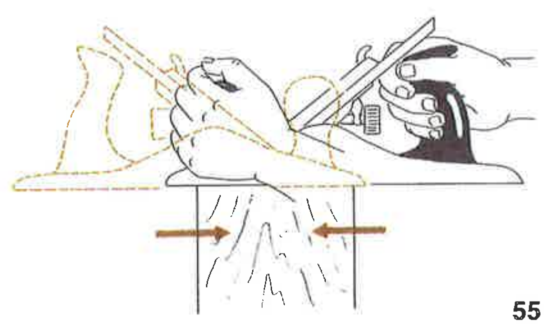


Fig. 10–11. Adding a piece of scrap stock for end planing.

Fig. 10–12. Planing end grain from both directions.



5. Test the end for squareness to the working face (see Fig. 10–14). Test it for squareness to the planed edge (see Figs. 10–15 and 10–16). This may be done with a try square on a narrow board or with a framing square on a wider one.

PLANING THE OPPOSITE END

1. Measure the board for the length needed, and mark it (Fig. 10–17). Allow an extra 1/16 inch for sawing and planing.

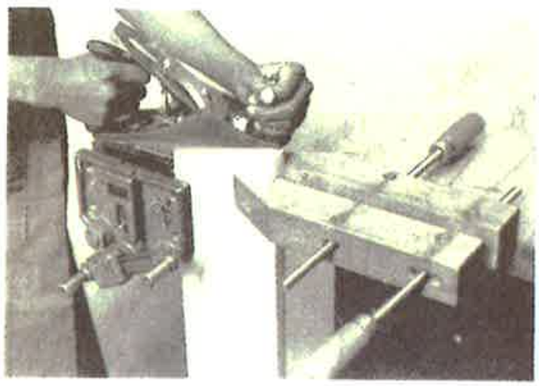


Fig. 10–13. Planing the end of a wide board.

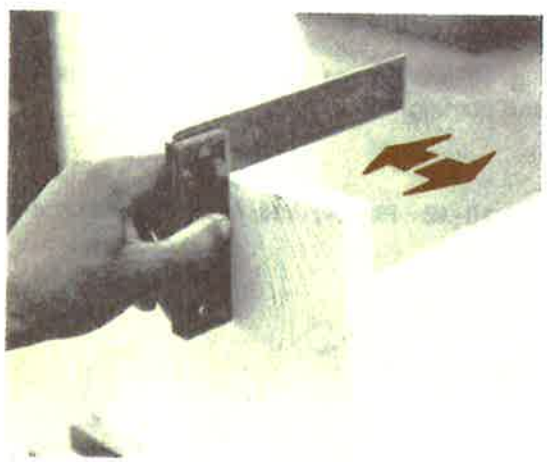


Fig. 10–14. Testing squareness of an end to the surface.

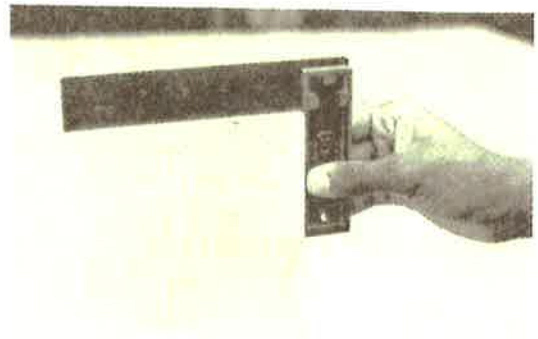


Fig. 10–15. Testing squareness of an end with a try square.

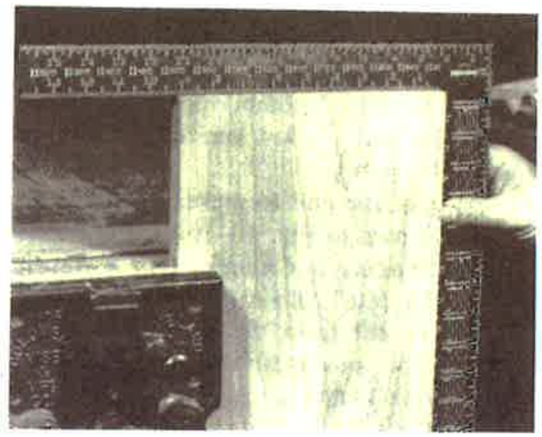


Fig. 10–16. Testing squareness of an end with a framing square.

Fig. 10–17. Measuring a board for length.

2. Mark the length square with the planed edge (see Fig. 7–19).

3. Cut off the extra lumber with a cross-cut saw or a backsaw. Figure 10–18 shows how you can make this cut with a backsaw on a bench hook.

4. Plane the cut end to the line so that it will be square with both the planed face and edge. Test for squareness. See the fifth step under "Planing the First End."

PLANING THE OPPOSITE EDGE

1. Measure and mark the board very carefully for width. Refer to the first step under "Planing the Opposite End."

2. Cut off the extra lumber, if necessary, with a ripsaw. Be careful to do this only when the waste is approximately $3/8$ inch or more. Remember to allow $1/16$ inch for planing to the line.

3. Plane this edge to the line so that it will be square with the working face, or surface, and also square with both ends.

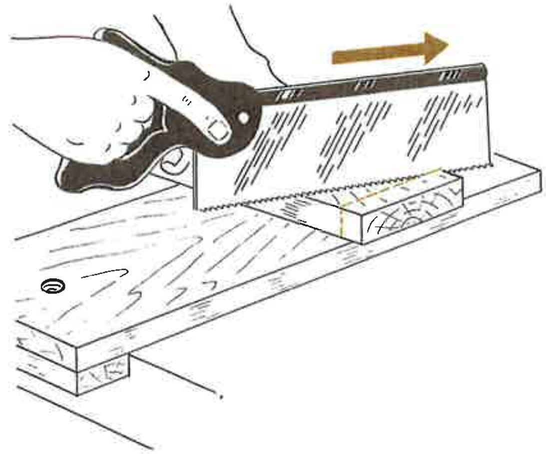


Fig. 10–18. Sawing a board to length with a backsaw on a bench hook.

PLANING THE LAST SURFACE

1. Mark the board for thickness with the marking gage (see Fig. 7–27.) Put the gage line on both edges and ends.

2. Plane this last surface to the gage line. Test it for squareness and smoothness.

Discussion Topics

1. Summarize the six general steps for planing a board. Why should this order be followed?
2. When would the ends of a board not have to be planed?
3. Is it possible to plane a board to the required thickness and still not have the faces true, or accurate? Explain.
4. How would you test a board to make sure that the surface was true?
5. How would you hold a wide board in a vise while planing the end grain?
6. What are three methods of planing the end grain?
7. What is meant by a working face?
8. What is meant by a wind in a board?
9. When you place a plane on a bench, why should it always be placed on its side?
10. What will happen to a planed surface or edge if the plane iron has a nick?

---

unit 11

Shaping a chamfer and a bevel

A chamfer is a means of decorating an edge. A bevel may be either an edge treatment in itself or a way to fit two boards together at an angle. The chamfer and the bevel look somewhat alike. Figure 11–1 shows the difference. The chamfer is usually planed to a 45-degree angle, while the bevel may be at any angle.

TOOLS

The tools generally used for making either a chamfer or a bevel are the sliding bevel and a jack or a block plane. Each of these has been shown and discussed in earlier units.

LAYING OUT A CHAMFER AND A BEVEL

1. Gage, or mark, the line or lines lightly with the marking gage or sharp pencil to outline the chamfer or bevel. Figure 11–2 shows how to draw a gage line with a pencil. Gaging with a pencil is better because sometimes the spur point of the marking gage cuts and damages the surface grain.

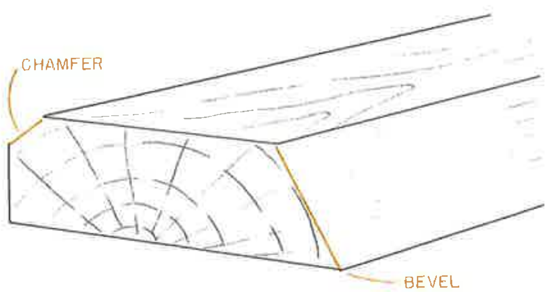


Fig. 11–1. Chamfer and bevel.

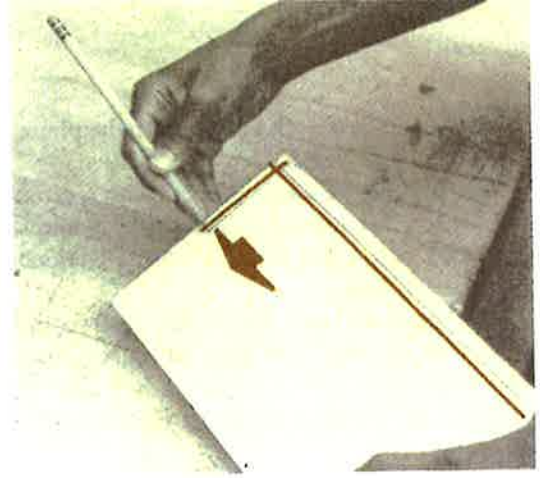


Fig. 11–2. Gaging a line with a pencil.

Fig. 11–3. Planing a chamfer.

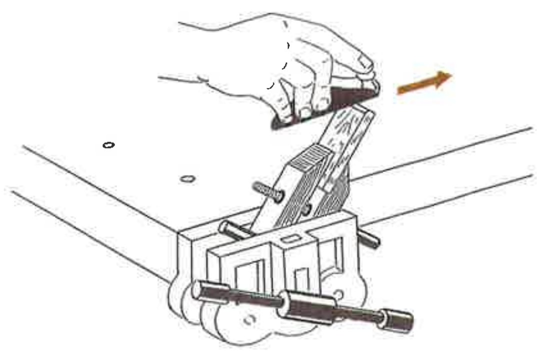


Fig. 11–4. Planing a chamfer on a small block of wood.

Fig. 11–5. Testing the angle of a chamfer with a sliding bevel.

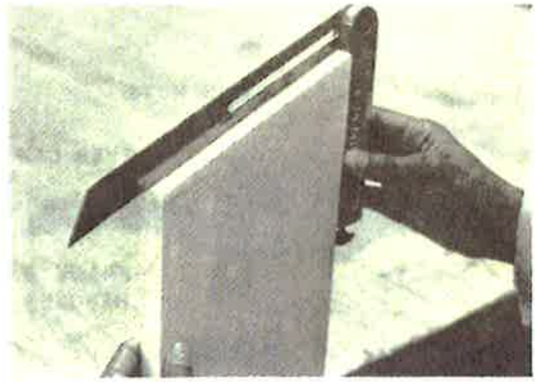


Fig. 11–6. Testing the angle of a bevel with a sliding bevel.

2. Set the bevel to the desired angle and check the outlined chamfer or bevel.

PLANING AND TESTING

1. Fasten the board in a vise (Fig. 11–3).
2. Plane the chamfer or bevel (Fig. 11–3).

If the board or block is small, fasten it in a hand-screw clamp which is held in a vise (Fig. 11–4). It may then be planed with a small block plane.

3. Test the angle of the chamfer or bevel with a sliding bevel (Figs. 11–5 and 11–6).

Discussion Topics

1. Illustrate the difference between a chamfer and a bevel.
2. What tool is used to test the angle of a chamfer? Of a bevel?

unit 12
Assembling and adjusting a spokeshave

The spokeshave (Fig. 12–1) is a tool for cutting and shaping. It was used many years ago for making spokes for wheels, hence its name. Today it is used mostly for forming curved edges on boards. Such curved edges are either *concave* (inward) or *convex* (outward). In craft work it is used to make such projects as the bows and hulls of model boats.

The cutting blade of the spokeshave is sharpened like the plane iron. You may either push or pull this tool, whichever is easier.

Follow these steps for assembling and adjusting a spokeshave:

1. Test the blade for sharpness. Refer to Fig. 9–12, since the cutting edge should be as sharp as that of a plane iron.
2. Place the blade carefully into the spokeshave frame; make sure that the slots of the blade will fit on the adjusting nuts.

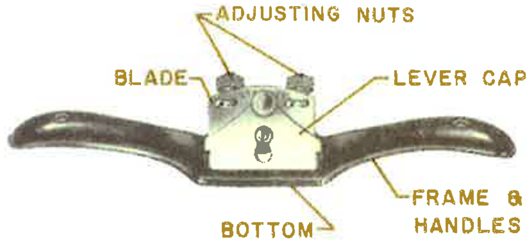


Fig. 12–1. Adjustable spokeshave.

3. Place the lever cap over the blade. Slide it under the lever-cap screw.
4. Tighten the blade with the thumb-screw.
5. Adjust for the proper cutting depth with the adjusting nuts (Fig. 12–1).
6. Test the cutting depth on a piece of scrap wood.

Discussion Topics

1. How did the spokeshave get its name?
2. Where and why do you use the spoke-shave?
3. How is the spokeshave similar to a plane?
4. Should you push or pull a spokeshave?
5. How is the spokeshave adjusted?

unit 13 Laying out irregular pieces and curves

Pieces that make up a project are often irregular or curved in shape. Because of this, you should know how to enlarge a pattern. Usually working drawings in books are drawn to a scale which fits the page, often to one-fourth of the actual size. The dimensions, however, are given in full size. To make irregular or curved pieces in the full size, you must enlarge the drawing. You should also learn how to draw a hexagon, or six-sided figure, an octagon, or eight-sided figure, and an ellipse, or oval. It is also essential to know how to lay out distances and regular curves with dividers.

TOOLS

The following tools are needed for laying out:

Dividers. This layout tool is used by both wood- and metalworkers (Fig. 13–1). You use it to lay out small circles; for dividing spaces equally; for scribing, or marking, arcs; and for transferring measurements. A compass may be used for the same purpose.

Trammel Points. These are used for laying out large arcs and circles (Fig. 13–2). Another means of scribing a large arc is to tie a piece of string to a pencil, which can serve as a compass.

Rule. This measuring device has been discussed in Unit 7, *Measuring and Laying Out Lumber.*

Fig. 13–1. Wing dividers.

Fig. 13–2. Trammel points.

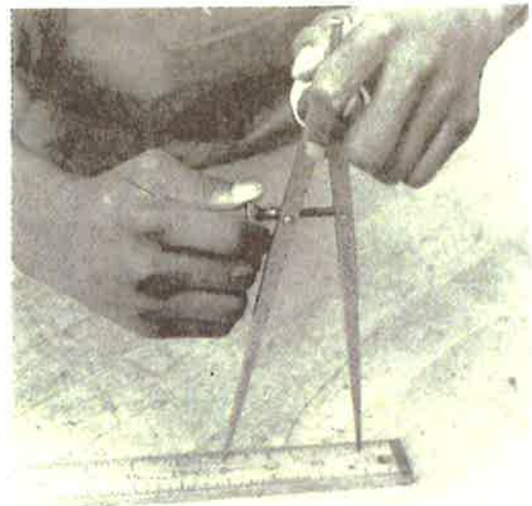


Fig. 13–3. Setting spring dividers for a desired distance. Here they are set for 3 inches.

CURVES, ARCS, AND CIRCLES

1. Set the dividers, compass, or trammel points to the desired radius of the arc, curve, or circle. When dividers are used to set distances, one leg is placed on an inch mark of a rule. The other leg is then placed on a mark far enough away to make the distance desired (see Fig. 13–3). On most dividers, this distance is kept by locking the thumbscrew.

2. Scribe the arc, curve, or circle as shown in Fig. 13–4. Note that a heavy piece of paper or cardboard has been placed under the stationary leg to protect the wood surface.

EQUAL DISTANCES

1. Set the dividers for the distance that is to be duplicated or stepped off.

2. Lay out, or step off, these equal distances as shown in Fig. 13–5.

HEXAGON (SIX-SIDED FIGURE)

1. Decide what length you want for one side of the hexagon.

2. Set a compass or dividers for a radius of the same length as the side in step 1.

Fig. 13–4. Scribing an arc with dividers. Note the piece of cardboard under the stationary leg to protect the wood grain.

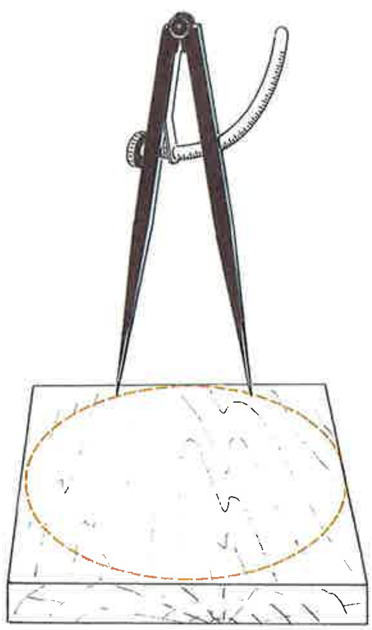


Fig. 13–5. Stepping off equal distances with dividers.

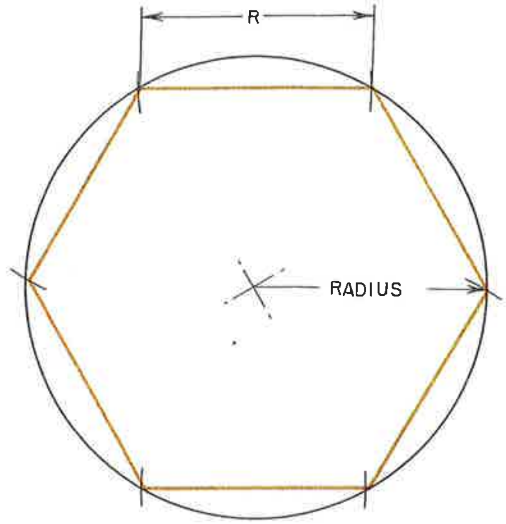


Fig. 13–6. Hexagon (R = radius).

3. Draw a circle, using the radius set in step 2. Do this directly on the wood, or on paper or cardboard. The paper or cardboard may serve as a *template*, or pattern.

4. Step off equal distances with the dividers on the circumference of the circle by using the radius described in step 2 (Fig. 13–6).

5. Connect the intersecting points on the circumference with straight lines (Fig. 13–6). These will make the hexagon.

OCTAGON (EIGHT-SIDED FIGURE)

1. Determine the overall width of the octagon. This will be the distance from one side to the opposite side.

2. Lay out a square this size.

3. Set the dividers or compass for a distance equal to one-half the length of a diagonal of the square. The diagonal is a line extending from opposite corners. In Fig. 13–7, the diagonals are lines *AD* and *BC*.

4. Set the points of the dividers on points *A* and *O* (Fig. 13–7). Use point *A* as the center.

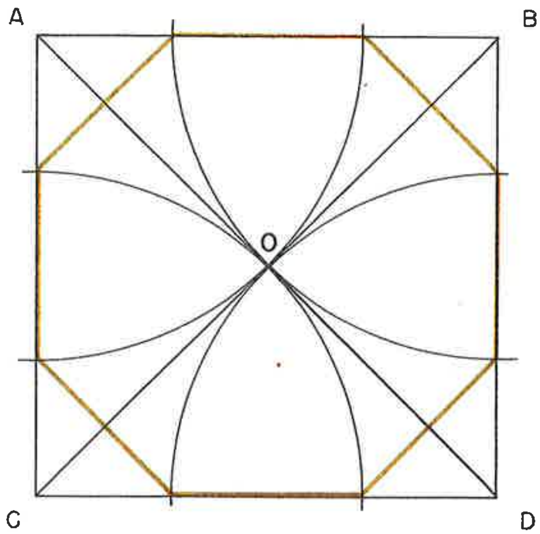


Fig. 13–7. Octagon.

5. Scribe an arc intersecting, or crossing, the sides of the square.

6. Repeat step 5 from the other three corners, *B*, *C*, and *D*.

7. Draw straight lines joining the intersecting points on the sides of the square (Fig. 13–7). This makes the octagon.

ELLIPSE (OVAL)

1. Decide on the desired width and length of the ellipse (Fig. 13–8).

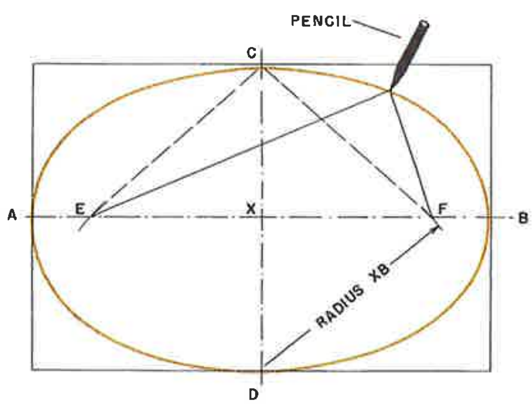


Fig. 13–8. Drawing an ellipse.

2. Draw a rectangle with sides representing the width and length of the ellipse (Fig. 13–8). Draw this directly on the wood or on a suitable template.

3. Divide the rectangle *through the center* with horizontal line *AB* and vertical line *CD* (Fig. 13–8).

4. Set the dividers to one-half the length of line *AB*. This makes radius *XB* (see Fig. 13–8).

5. Place one point of the dividers on point *D*. Draw an arc which cuts lines *AB* at *E* and *F* (Fig. 13–8).

6. Place brads, thumbtacks, or pins at points *C*, *E*, and *F* (Fig. 13–8).

7. Fasten a string around points *C*, *E*, and *F* to form a triangle, as shown in Fig. 13–8.

8. Remove the brad from point *C*.

9. Place a pencil against the string, starting at point *C*, and draw half of the ellipse *A*, *C*, *B* (Fig. 13–8).

10. Repeat step 9 with the pencil point beginning at *D*. This will complete the ellipse (Fig. 13–8).

11. Remove the brads, thumbtacks, and string. You have formed the ellipse.

Another method of making an ellipse involves the use of a compass and a rule. This method is explained in most of the drawing books.

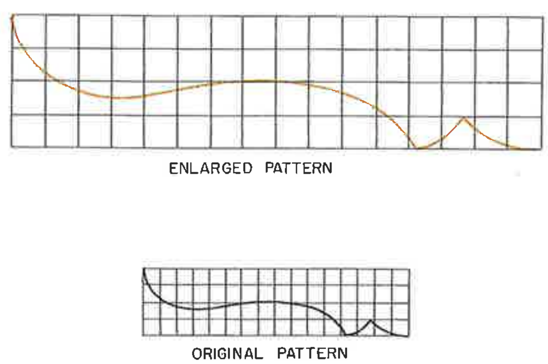


Fig. 13–9. Enlarging a pattern.

ENLARGING AND TRANSFERRING

1. Decide on the portion of the drawing which needs to be drawn full scale (Fig. 13–9).

2. Draw vertical and horizontal lines 1/4 inch apart over the section to be enlarged, if the drawing has not already been graphed in this manner. This instruction assumes that the drawing was made to the scale in which 1/4 inch equals 1 inch. If the scale is different, draw the graph accordingly (Fig. 13–9).

3. Lay out 1-inch squares on a large sheet of kraft or wrapping paper or on cardboard. This makes the enlarged graph.

4. Sketch on the full-size, enlarged graph the points were the design intersects with the squares in the working drawing (Fig. 13–9).

5. Connect these points freehand until the full-size pattern looks like the reduced, or scale, working drawing (Fig. 13–9).

6. Cut out the paper or cardboard for the full-size pattern. Figure 13–9 shows a template, or pattern, which has been enlarged.

Discussion Topics

1. Why is it desirable to place a piece of cardboard under the stationary leg of the dividers when scribing an arc or circle on a piece of wood?
2. Draw each of the following: (a) a hexagon, (b) an octagon, (c) an ellipse. Which is the easiest?
3. Describe the procedure for enlarging a pattern.
4. List at least three uses for dividers.
5. Give an example where trammel points might be used.
6. Describe: (a) a hexagon, (b) an octagon, (c) an ellipse.

unit 14

Cutting out and forming irregular pieces and curves

To cut out and form irregular pieces and curves, you must know what tools to use and how to use them. You should also know which tools will do the best work for each process.

TOOLS

The following tools are essential for cutting and forming irregular pieces:

Coping Saw. The coping saw, shown in Fig. 14–1, is especially useful for cutting small stock, such as thin boards or pieces of plywood.

Compass Saw. Figure 14–2 pictures this saw. There is also a *keyhole saw*, which looks similar and is sometimes considered a fine compass saw. The compass saw is useful for cutting interior curves where a turning saw or a coping saw cannot be used. The cut is usually started by boring a hole near the line to be cut.

Spokeshave. This tool was illustrated and discussed in Unit 12 *Assembling and Adjusting a Spokeshave*.

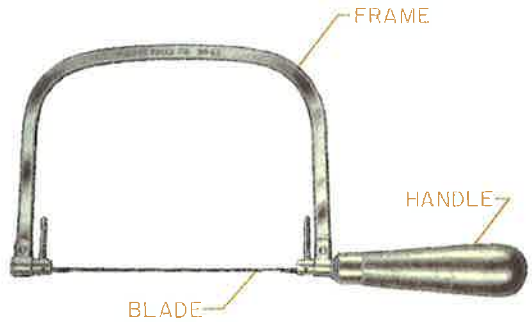


Fig. 14–1. Coping saw.

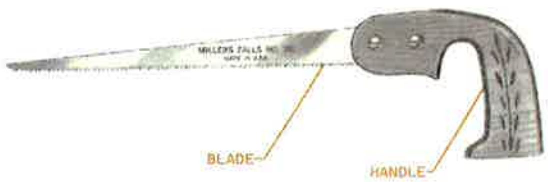


Fig. 14–2. Compass saw.

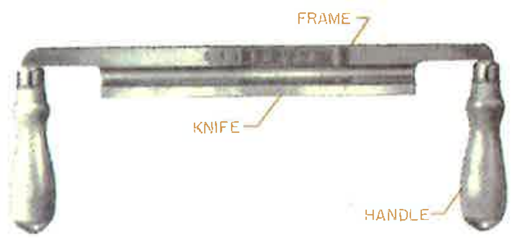


Fig. 14–3. Drawknife.

Drawknife. The drawknife (Fig. 14–3) has a blade approximately 10 to 12 inches long, with a handle on each end.

Caution: Handle this tool carefully.

Skilled workmen use it effectively for removing large amounts of stock rapidly. It is used to trim stock and in building model boats and canoe paddles.

Wood, or Cabinet, Files. The common shapes of files used by the woodworker are flat, half-round, round, and triangular (Fig. 14–4). They come in many lengths, from 4

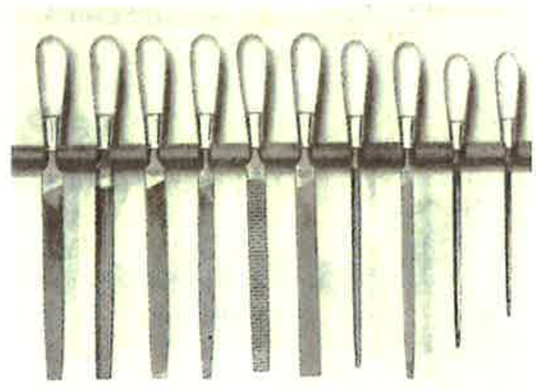


Fig. 14–4. This photograph shows the important practices of placing handles on files and placing the files in the proper rack. From left to right, the names of the files are: flat, half-round, mill, triangular or three-square, half-round wood rasp, hand, round, slim taper, extra-slim taper, double-extra-slim taper. *(Nicholson File Company.)*

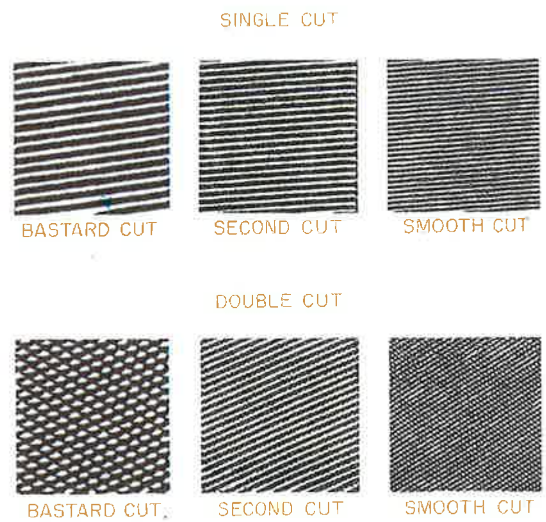


Fig. 14–5. Patterns of teeth on single- and double-cut files.

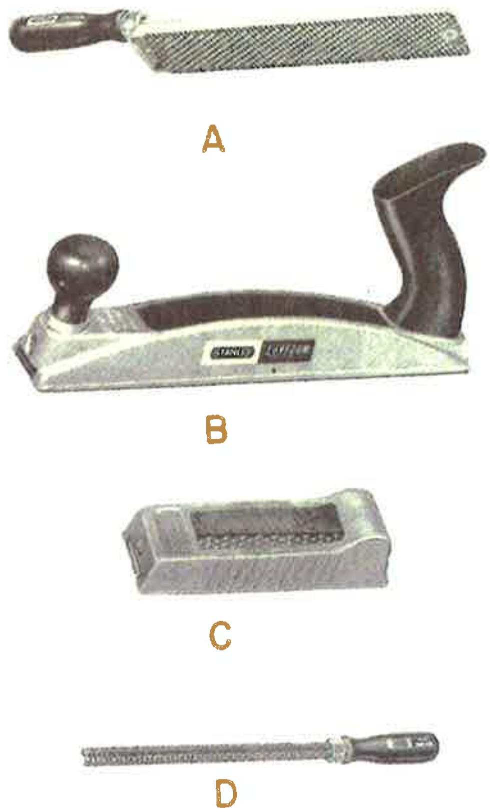


Fig. 14–6. Surface- and edge-forming tools: (A) file, (B) plane forming tool, (C) block-plane forming tool, and (D) round.

to 14 inches. Files are used for smoothing edges and small curves. The cutting surface consists of rows of teeth which run in parallel lines diagonally across the surface. Figure 14–5 illustrates the patterns of teeth on single- and double-cut files.

Figure 14–6 shows file-type cutting tools. They cut faster than other forming tools.

Pointers on the Use of Files.

1. See that there is a handle on every file.
2. Keep files from rubbing together or against other tools.

Surface- and Edge-forming Tools. The forming tools shown in Fig. 14–6 serve as files or as modifications of planes. The replaceable, inexpensive steel blades will plane,

Fig. 14–7. File cleaner.

Fig. 14–8. Tracing a pattern on wood around a template.

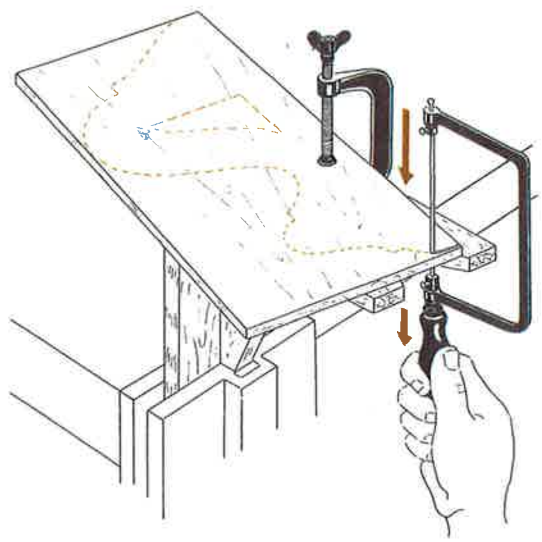


Fig. 14–9. Sawing on a V block.

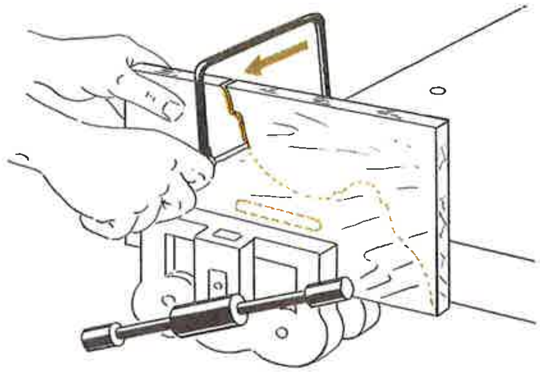


Fig. 14-10. Cutting with a coping saw.

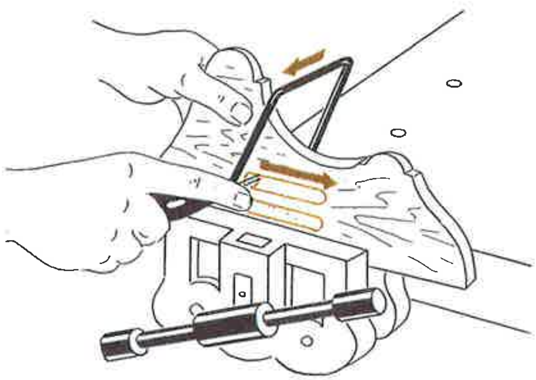


Fig. 14-11. Sawing a pierced design with a coping saw.

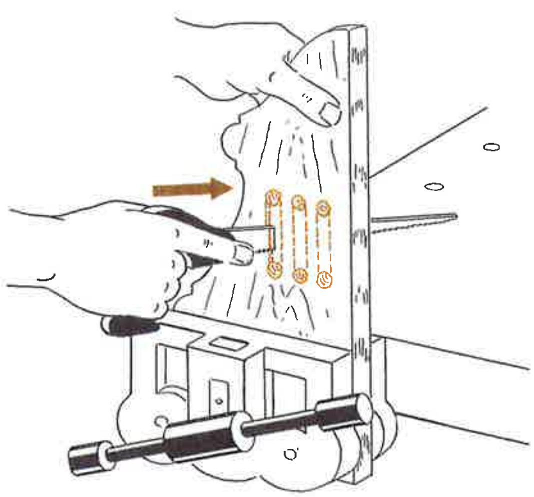


Fig. 14-12. Cutting with a compass saw.

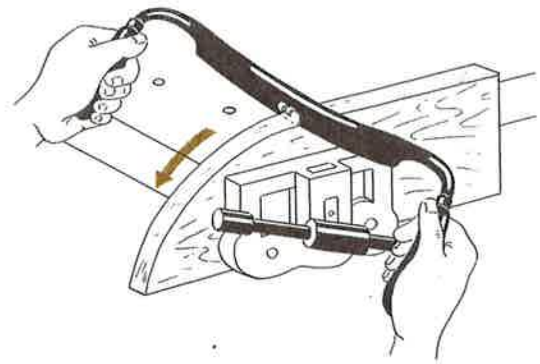


Fig. 14-13. Cutting with a drawknife.

file, and shape wood, soft metals, and plastics. Either tool works fast for fitting, trimming, smoothing, and shaving. The cutting edge of the blade has its own throat through which the cuttings pass.

File Cleaner. The file cleaner, or file card (Fig. 14-7), has steel bristles which are used for cleaning the teeth on a file (see Fig. 14-20).

CUTTING WITH A COPING SAW

1. Lay out the irregular design or pattern. You may make it directly on the wood or trace around a template (Fig. 14-8).

2. Place the wood on a V block or jig, and hold it securely with the hand or with a hand clamp (Fig. 14-9). Hold the V block or jig in a vise, or fasten it directly to a bench top.

Usually the blade of the coping saw is inserted with the teeth pointing toward the handle. This prevents the possibility of buckling, or kinking.

Clamp heavier stock in a bench vise and cut as shown in Fig. 14-10.

3. Grasp the stock securely with the left hand and saw with firm strokes (Fig. 14-10). The first stroke will be a pull.

4. For a pierced, or perforated, design, bore or drill a small hole on the waste part

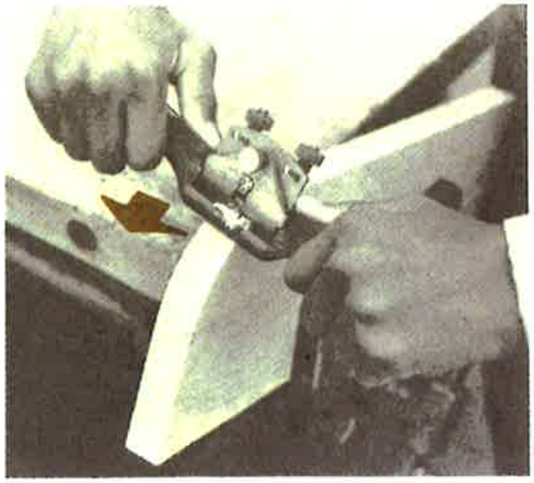


Fig. 14–14. Pushing the spokeshave to smooth a convex edge.

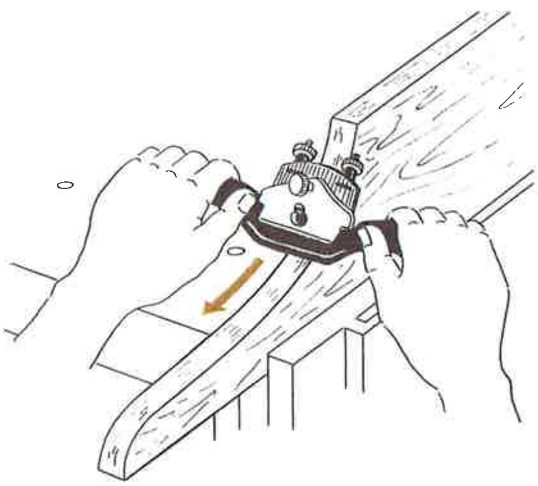


Fig. 14–15. Pulling the spokeshave to smooth concave curves.

of the stock near the line. Remove the blade from the frame, insert it through the hole, and fasten it securely to the frame again before sawing.

5. Saw out the pierced design as shown in Fig. 14–11.

Check the cut which you have made with the pattern.

CUTTING WITH A COMPASS SAW

1. Transfer the design to, or draw it on, the wood.
2. Start the saw kerf, or cut, in the same way you start a crosscut kerf (see Unit 8). Saw slightly outside the line, on the waste portion of the wood. The stock can then be dressed down to exact size.
3. Continue cutting. Use the narrow end of the blade for sharp turns.
4. When cutting inside curves and to irregular lines, bore a hole for starting the cut as shown in Fig. 14–12.

SHAPING WITH A DRAWKNIFE

1. Test the cutting edge of the drawknife for sharpness. Test it as you test the plane iron (see Fig. 9–12).
2. Fasten the stock securely in a bench vise.
3. Look at the grain of the wood and determine the direction in which you will cut. Always cut in the direction of the grain to avoid splitting the wood.
4. Hold the drawknife firmly with both hands, with the bevel turned down.
5. Carefully cut away the waste portion of the wood with short strokes, pulling toward the body (Fig. 14–13). Adjust the depth of the cut by twisting the wrists. A cleaner cut may be made with a shearing stroke. For this stroke, hold one handle slightly ahead of the other.

CAUTION: Be very careful in using the drawknife. The sharp edge can be dangerous.

6. Continue cutting until the waste stock has been almost entirely removed. It may then be shaped further with a spokeshave (Fig. 14–14), a file (Fig. 14–16), or a chisel (Fig. 15–9).

Fig. 14–16. Filing a convex curve.

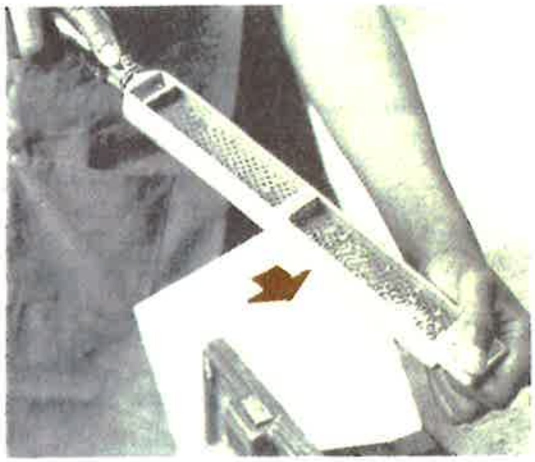


Fig. 14–17. Dressing a convex curve with a forming tool.

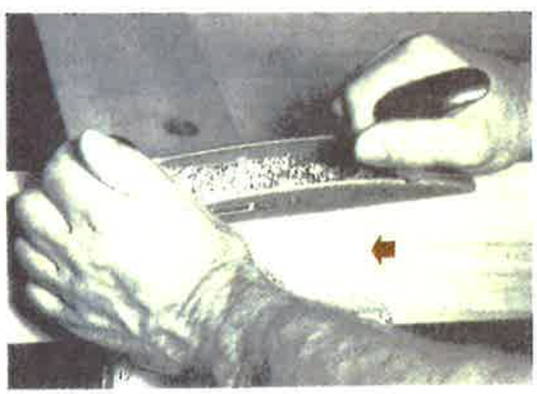


Fig. 14–18. Dressing an edge with a plane forming tool.

Fig. 14–19. Dressing an edge with a block-plane forming tool.

FORMING WITH THE SPOKESHAVE

1. Adjust the cutting edge of the spokeshave for uniform depth.
2. Clamp stock securely in a bench vise.
3. Smooth the curved edge with the spokeshave to the exact pattern line (Figs. 14–14 and 14–15). This tool is used effectively by either pushing or pulling.

FORMING WITH THE FILE AND SURFACE-FORMING TOOLS

1. Select a medium-coarse wood file of the desired shape for the first smoothing. Use the file for forming only if other tools cannot be used.
2. Fasten the stock securely in a bench vise.
3. Push the file or forming tool across the edge of the wood with a forward and side motion (Figs. 14–16 through 14–19).

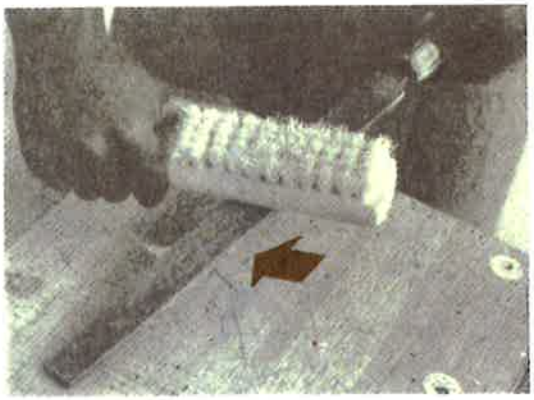


Fig. 14–20. Cleaning the file with a file cleaner.

This gives a shearing cut which prevents splintering of the opposite edge. File the edges of plywood carefully. They break and splinter easily.

4. Continue filing the irregular edge with a medium-coarse file until you get a semi-smooth finish.

5. Finish smoothing the edge curve with a smooth-cut file.

6. Test the irregular edge with a try square for squareness with the surface.

7. Clean the files with a file cleaner (Fig. 14–20). Cleaning files frequently keeps the cutting edges in better condition.

Discussion Topics

1. Name two types of handsaws which can be used for cutting irregular curves.
2. Should the teeth point toward or away from the handle when you use a coping saw?
3. What is the chief purpose of the drawknife?
4. How can the depth of the cut be controlled when using a drawknife?
5. What is the difference between the single- and the double-cut file?
6. Why do you use a file cleaner?
7. List two types of surface-forming tools. Explain how to replace blades.

unit 15

Cutting and trimming with a chisel

Accurate cutting, fitting, shaping, and surface decoration are done with sharp and correctly beveled wood chisels. Wood chisels are pictured in Fig. 15–1.

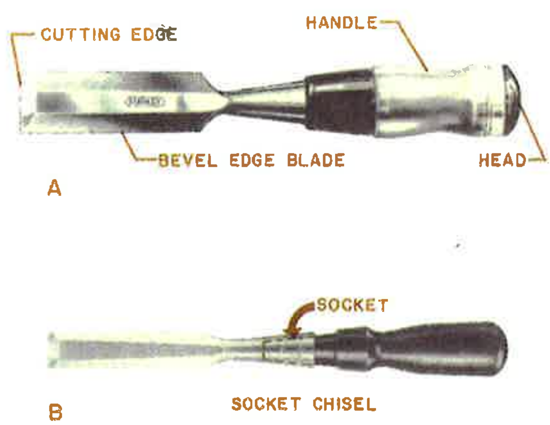


Fig. 15–1. Wood chisels: (A) tang butt, and (B) socket.

TOOLS

Take the greatest care when you cut and trim with chisels and gouges. Remember that the wood chisel is the cause of more injuries than all other hand tools.

Chisels. Wood chisels are generally classified in two types, socket and tang (Fig. 15–1). The names indicate how the handle is fastened to the blade. Socket chisels are firmer. Both types have a beveled cutting edge. The width of the blade determines the size of the wood chisel. The range is from 1/8 to 1 inch by eighths, and from 1 to 2 inches by fourths.

Gouges. Gouges are chisels used for grooving, for shaping edges, and for model-making. There are two types of gouges. One has the bevel on the inside of the blade (Fig. 15–2); the other has it on the outside (Fig. 15–3). The blades of all gouges are concave (hollowed). They vary from 1/4 to 2 inches in width.

Wooden or Fiber Mallet. Use the mallet for additional pressure when you are chiseling (see Fig. 15–4).

HORIZONTAL CHISELING

1. Fasten the wood firmly in a bench vise.

2. Push the chisel with one hand and guide the blade with the other (Fig. 15–5). Use the forefinger and thumb of the guide hand as a brake. Be sure that the bevel of the chisel is turned *up* when it is used in this way. The chisel must be kept very sharp to get a clean cut. Always cut away from you.

3. Continue to make thin cuts, taking care to stop each time before reaching the opposite side. When you are cutting across a board, as in a half-lap joint, you should protect the grain on the opposite side. The three steps to follow are shown in the inset in Fig. 15–5. These will guide you in making a clean cut.

Fig. 15–2. Inside-bevel socket gouge.

Fig. 15–3. Outside-bevel socket gouge.

Fig. 15–4. Soft-face mallet.

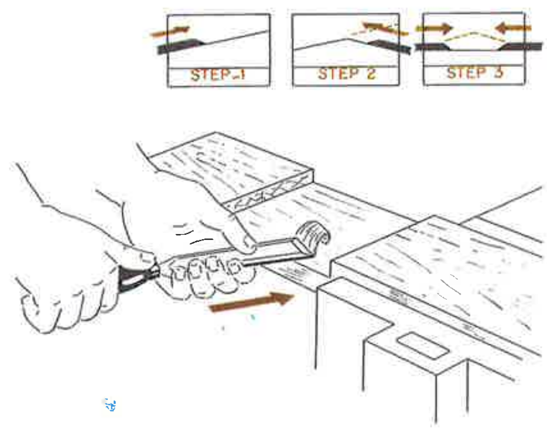


Fig. 15–5. Horizontal chiseling.

VERTICAL CHISELING

1. Fasten the wood securely in a bench vise (Fig. 15–6). You can also hold it firmly on a bench hook.

2. Hold the flat side of the chisel against the wood in a vertical, or upright, position.

3. Hold the chisel with one hand and guide the blade with the other (Fig. 15–6). The guide hand serves as a brake.

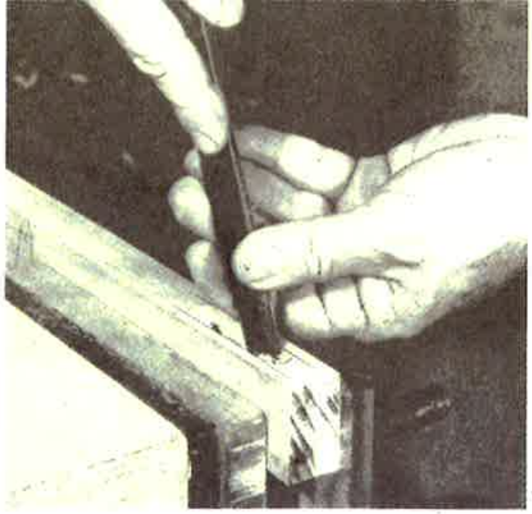


Fig. 15–6. Vertical chiseling. As you push the chisel with one hand, guide the blade with the other.

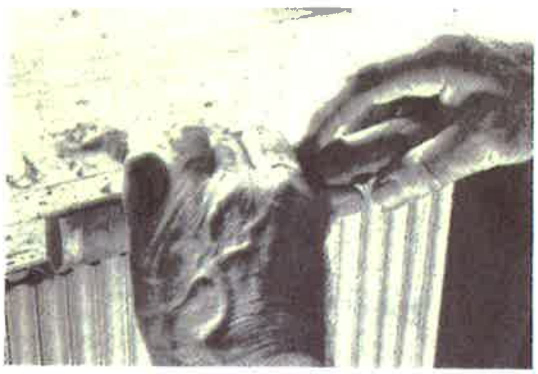


Fig. 15–7. Furniture craftsmen handle wood chisels with skill.

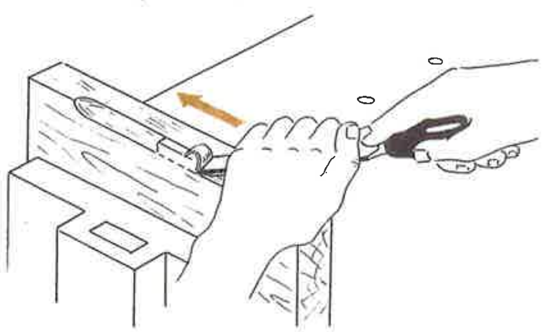


Fig. 15–8. Cutting a stop chamfer with a chisel.

CAUTION: Never place your hand in front of the chisel while you are using it.

4. Push the chisel and apply a shearing cut as shown in Figs. 15–6 and 15–7.

5. Use a wooden or fiber mallet only when necessary to drive the chisel for cutting out mortises. It takes practice to control a chisel cut when you drive it with a mallet. Make a trial cut on a piece of scrap wood to learn how hard to hit the chisel.

CUTTING STOP CHAMFERS

1. Mark the width and length of the stop chamfer with a pencil on the edge of the board.

2. Fasten the board firmly in a bench vise.

3. Cut or pare by starting at one end of the stop chamfer (Fig. 15–8). Make thin cuts about one-half the length of the chamfer.

4. Continue with light cuts until the pencil line is reached.

5. Reverse the board in the vise, and cut the other half of the chamfer from the opposite end in the same way.

Fig. 15–9. Trimming a convex curve with a chisel. Use a series of short strokes.

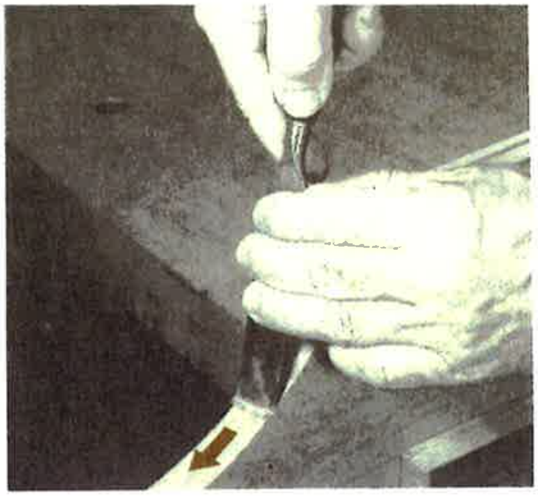


Fig. 15–10. Trimming a concave edge with a chisel. Note the beveled side is against the wood.

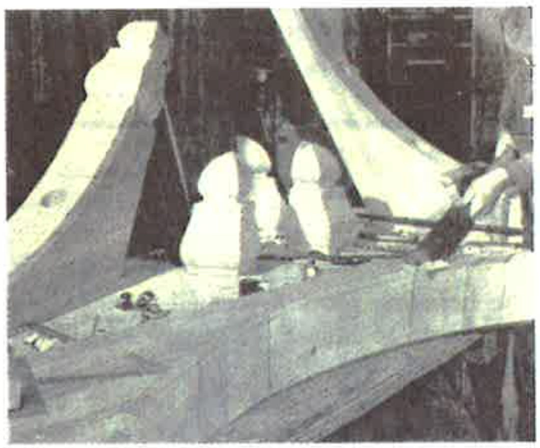


Fig. 15–11. Cutting a chamfer on a laminated corbel (weight-supporting member). This piece will form a part of a wooden truss.

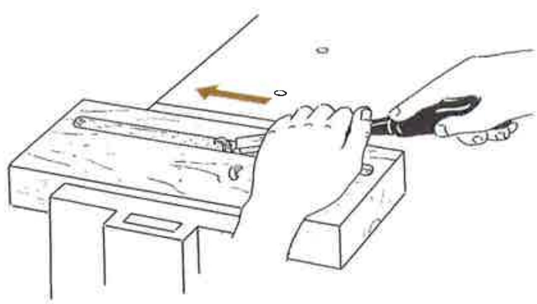


Fig. 15–12. Cutting a groove in a surface.

Fig. 15–13. Carving a chair leg.

Fig. 15–14. A carved galloping horse scuptured from walnut. (*Fine Hardwoods Association.*)

CURVED CHISELING

1. Fasten the wood securely in a bench vise.

2. When you cut a round corner, push the chisel in a shearing motion. Use a series of short strokes (Fig. 15–9). Be sure that the bevel edge of the chisel is turned *up*.

3. On a concave edge, trim by holding the bevel side of the chisel against the wood. Push the chisel with the right hand (Figs. 15–10 and 15–11). Use the left hand to hold the chisel against the work. Always cut in the direction of the grain.

GROOVING

Grooves may be cut in boards with a gouge as shown in Fig. 15–12. Internal carving or cutting can also be done with this same tool (Figs. 15–13 and 15–14).

Discussion Topics

1. Name the two general classifications of wood chisels.
2. What is the purpose of a gouge? How should this tool be sharpened?
3. Why should you grind small nicks out of the cutting edges of chisels and gouges?
4. Explain the differences and uses of wood and cold chisels.

unit 16

Assembling and adjusting scrapers

Scrapers are used to smooth wood that is difficult to dress with a plane. They are particularly effective on irregular-grained, knotty, and burly lumber. The action of the scraper edge differs from the cut made by a plane or spokeshave. It scrapes by means of a filed or a burred, or turned, edge. See Unit 28, *Caring For and Sharpening Tools*.

TOOLS

The scraping tools described in this unit are simple to adjust. They are equally as easy to use.

Hand Scraper. The two shapes most used in hand scrapers are the rectangular (Fig. 16–1) and the swan neck. Hand scrapers are thin, flexible pieces of high-grade steel. When sharpened properly, they will make thin shavings. They are either pulled or pushed, depending on the job. No assembly is needed since the blade is held in the hands.

Cabinet Scraper. This is a metal frame with two handles which holds a scraper blade (Fig. 16–2). It is perhaps the most common scraper frame. You push it, as illustrated in the following unit, *Smoothing a Surface by Scraping*.

Pull Scraper. The pull scraper, sometimes referred to as the two-edge scraper,

Fig. 16–1. Hand scraper blade.

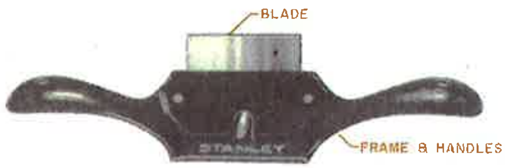


Fig. 16–2. Cabinet scraper.

is shown in Fig. 16–3. It is pulled rather than pushed on the wood.

Scraper Plane. Perhaps the least used of the three scraper frames described here is the scraper plane. It looks like a smooth plane, except that the blade is held forward for a scraping action.

ASSEMBLING AND ADJUSTING

The following instructions are typical for any of the scraper frames:

1. Test the blade for the proper filed or burred edge. See Unit 28, *Caring For and Sharpening Tools.*

2. Place and tighten the blade in its proper position in the frame (Fig. 16–3). This position will vary slightly with the different types of scraper frames.

Place the blade so that the filed or the burred edge will produce a shaving. This is a very simple adjustment. It is not necessary to go into detail for each type of frame.

3. Adjust the blade for depth of scraping with the thumbnut or thumbscrew, depending upon the type of scraper you use (Fig. 16–4).

Fig. 16–3. A two-edge, or pull, scraper.

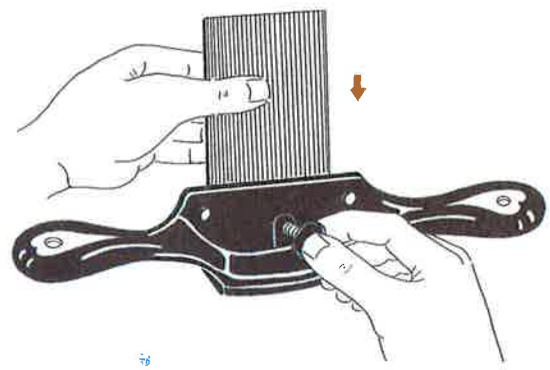


Fig. 16–4. Adjusting a cabinet scraper for depth of scraping action.

Discussion Topics

1. Why and where do you use scrapers?
2. Name two shapes of hand scrapers.
3. Is the scraper blade pulled or pushed?
4. Name three kinds of scraper frames. How did they get their names?
5. What is the most common scraper frame?
6. How do you adjust the blade in a scraper frame?

unit

17

Smoothing a surface by scraping

Surfaces and edges of a wooden board should be scraped if the grain is burly or knotty. The scraper produces a very fine surface. It will remove most irregularities and blemishes that may have been left by the plane. The scraper differs from a chisel or plane in that it does the work with a scraping edge.

Scrapers work very well in the final dressing of cedar. The knots in this wood make hand planing very difficult. The effectiveness of scraping will depend upon the sharpness of the scraper edge. See Unit 28, *Caring For and Sharpening Tools.*

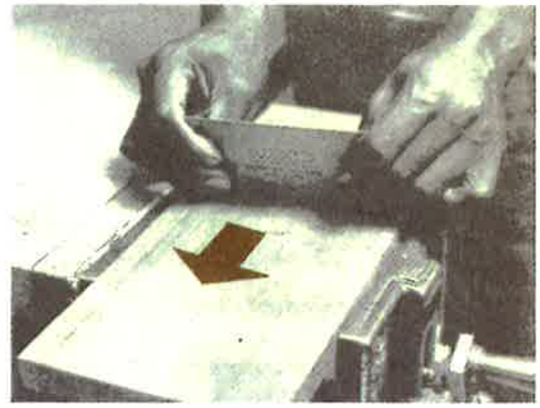


Fig. 17–1. Scraping a surface with a hand scraper.

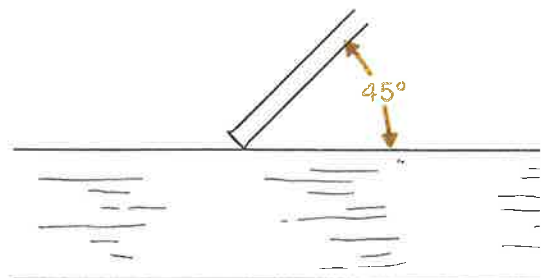


Fig. 17–2. Angle for handscraping.

HANDSCRAPING

1. Grasp the scraper blade firmly between the thumb and fingers (Fig. 17–1). Spring it to a slight curve. Hold the blade at an angle of approximately 45 degrees (Fig. 17–2).

2. Pull the scraper blade toward you if it is more convenient (Fig. 17–3).

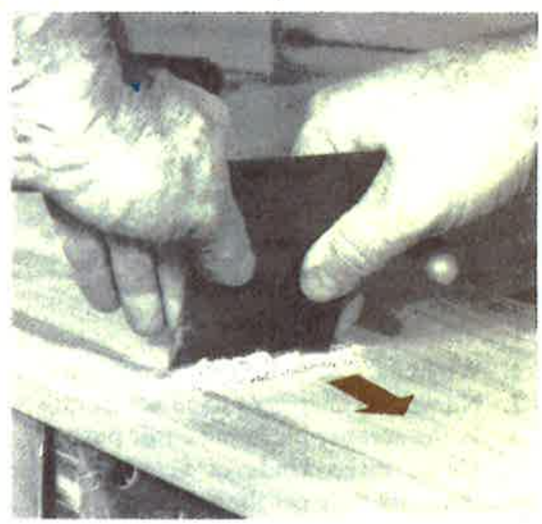


Fig. 17–3. Pulling a scraper blade.

SMOOTHING WITH A CABINET SCRAPER

1. Assemble and adjust the blade in its proper place in the cabinet-scraper body. See Unit 16, *Assembling and Adjusting Scrapers*, for the correct adjustment. The blade should be sharp.

2. Hold the scraper handles firmly, with the thumbs pressing on the frame behind the blade (Fig. 17–4).

Fig. 17–4. Smoothing a surface with a cabinet scraper.

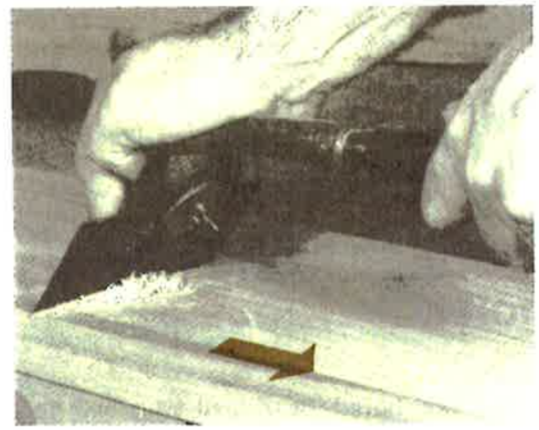


Fig. 17–5. Smoothing a surface with a pull scraper.

3. Try the scraper on a piece of wood and adjust it further if necessary. The cabinet scraper should produce a fine, thin, even shaving (Fig. 17–4).

4. Scrape the surface of the wood, being very careful to use long, even strokes. Be sure to work with the grain. Hold the cabinet scraper at a slight angle so that it will produce a shearing cut (Fig. 17–4).

5. Continue scraping until the entire surface has been smoothed evenly.

The pull, or two-edge, scraper, shown in Fig. 17–5, is ideal when you must scrape toward you. The pull scraper is described in Unit 16.

Discussion Topics

1. Why is it often necessary to scrape surfaces of wood?
2. What makes the scraper blade produce fine shavings?
3. At approximately what angle should you hold the hand scraper?
4. What is wrong with the scraper blade when it produces only dust?

unit

18

Boring and drilling holes

Holes are bored or drilled in wood for screws, bolts, dowels, internal sawing, and ornamentation. Types of bits used for boring or drilling include several kinds of auger bits, the twist drill, iron drill, expansive bit, Foerstner bit, door-lock bit, straight-shank drill, and the drill point for the push drill.

A depth gage is a supplementary tool that is useful when you bore holes to a given depth. Study the depth gages which are illustrated and described on pages 80 and 81 before attempting to bore a hole to a specified depth.

TOOLS

The descriptions and illustrations which follow will guide you in the proper selection of bits and other tools.

Brace. The brace (Fig. 18–1) is used with any of the bits which have a square *tang*, or shank (see Fig. 18–5). The corner brace illustrated in Fig. 18–2 is used for boring in corners and against walls and beams.

Hand Drill. The hand drill is used for drilling holes ⅜ inch or less in diameter (Fig. 18–3). The straight-shank drill (Fig. 18–14) should be used with the hand drill.

Push Drill. The push drill (Fig. 18–4) is often used instead of the hand drill.

Auger Bits. The auger bit (Fig. 18–5) varies in length from 7 to 10 inches, with one exception: the dowel auger bit is only

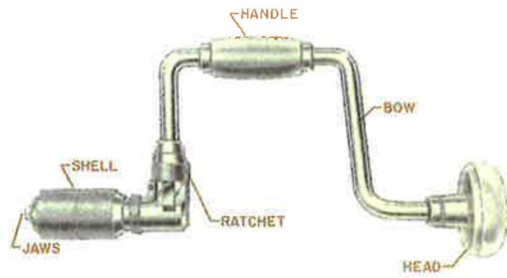


Fig. 18–1. Brace.

Fig. 18–2. Corner brace.

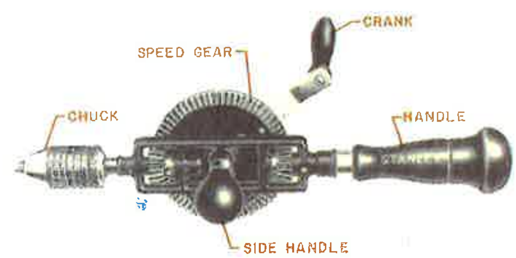


Fig. 18–3. Hand drill.

Fig. 18–4. Push drill.

Fig. 18–5. Solid-center auger bit.

5 inches long (Fig. 18–6). Auger bits are sized by sixteenths of an inch. They range from 1/4 to 1 inch in diameter. The number stamped on the square tang indicates the bit size in sixteenths of an inch. For example, a bit with "11" stamped on it will cut a hole 11/16 inch in diameter. One marked "6" will cut a 3/8-inch hole, because it is listed at 6/16 inch.

A single-thread auger bit is illustrated in Fig. 18–7. It bores a hole in the same manner as the solid-center auger bit in Fig. 18–5. Figure 18–8 is a single-spur auger car bit. It varies in length from 18 to 29 inches, and is used mostly in building-construction work where holes must be bored deeper than can be done with a regular type of auger bit.

Twist Drills. The twist drill (Fig. 18–9) makes holes for screws, nails, and bolts. Twist drills are sized by thirty-seconds and sixty-fourths of an inch, and range from 1/8 to 1/2 inch in diameter. This drill has a square tang to fit the brace, and may be used instead of a drill bit.

Iron Drill. The iron drill (Fig. 18–10) drills holes in metal as well as in wood. These drills are sized in thirty-seconds of an inch, and range from 1/16 to 5/8 inch in diameter.

Expansive Bit. The expansive bit (Fig. 18–11) has a scale on the movable spur or cutter. Holes larger than 1 inch in diameter are bored with the adjustable expansive bit. These bits are available with various cutters to bore holes from 1 to 4 inches in diameter.

Foerstner Bit. The Foerstner bit (Fig. 18–12) does many boring operations which the auger bit cannot do. It is made to bore a hole to any depth without breaking through the wood. These bits are available in sizes ranging from 1/4 to 2 inches in diameter and are numbered for size in the same way as auger bits.

Fig. 18–6. Solid-center dowel auger bit.

Fig. 18–7. Single-thread point auger bit.

Fig. 18–8. Single-spur auger car bit.

Fig. 18–9. Twist drill.

Fig. 18–10. Iron drill.

Fig. 18–11. Expansive bit with extra cutter.

Fig. 18–12. Foerstner bit.

Fig. 18–13. Door-lock bit.

Fig. 18–14. Straight-shank drill.

Fig. 18–15. Drill point for push drill.

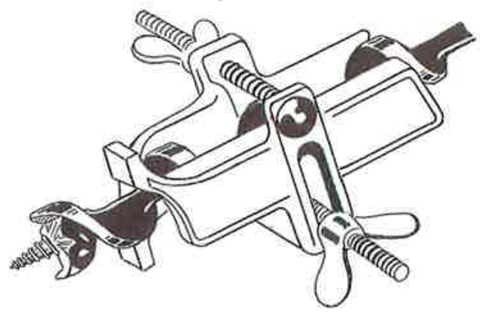


Fig. 18–16. Adjustable metal depth gage.

Door-lock Bit. The door-lock bit (Fig. 18–13) is used mainly by carpenters and cabinet workers to bore holes for tubular door locks and other shallow, large holes. The bit sizes vary from $1\frac{5}{8}$ to $2\frac{1}{8}$ inches in diameter.

Straight-shank Drill. The straight-shank drill (Fig. 18–14) is gaged for the diameter of the holes to be drilled. It uses any one of three systems: fractional, decimal, or lettered. The fractional is the most common for woodworking and is the most easily read. Fractional-size drills are marked in sixty-fourths of an inch. The smallest size is $\frac{1}{16}$ inch. Woodworkers generally have an assortment up to $\frac{1}{2}$ inch.

Drill Point for Push Drill. This type of bit (Fig. 18–15) fits into the automatic drill (Fig. 18–4). It is used for drilling small holes. Sizes vary from $\frac{1}{16}$ to $\frac{11}{64}$ inch.

Depth Gage. The depth gages shown in Figs. 18–16 through 18–18 are necessary when you bore holes to specified depths. You can make a very simple gage by bor-

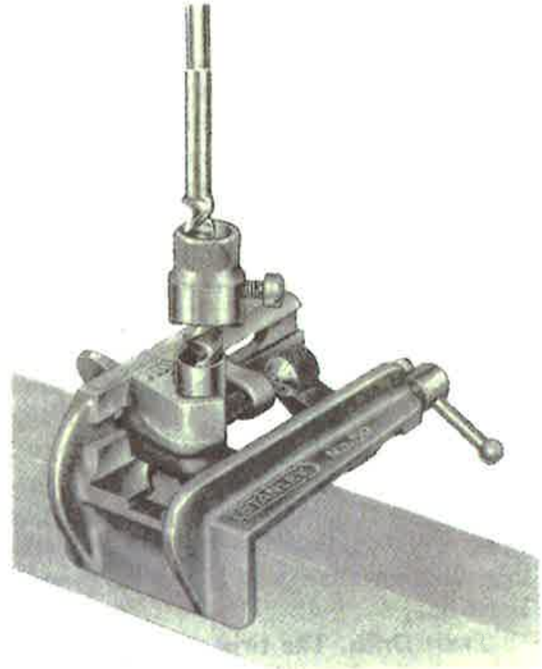


Fig. 18–17. Adjustable depth gage with doweling jig.

Fig. 18–18. Adjustable depth gage.

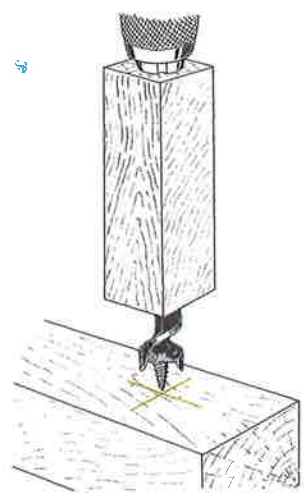


Fig. 18–19. Wooden bit gage.

Fig. 18–20. Scratch awl.

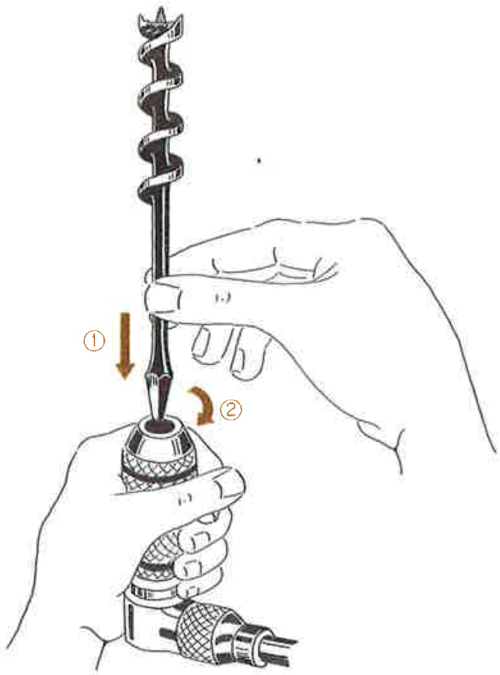


Fig. 18–21. Putting an auger bit into the brace chuck.

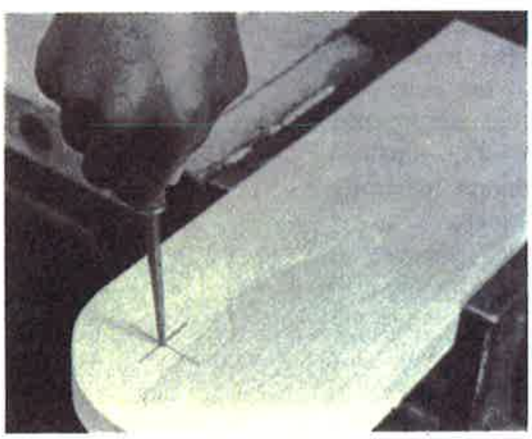


Fig. 18–22. Starting the hole with an awl.

ing a hole through a piece of wood lengthwise (Fig. 18–19).

Scratch Awl. Figure 18–20 shows a scratch awl. It is helpful for starting a hole, as shown in Fig. 18–22, so that boring and drilling bits will have a center when beginning a hole.

BORING A HOLE

1. Select the correct size of square-shank auger bit or other bit for boring into wood.
2. Open the chuck by grasping the shell and turning the handle to the left. Keep turning until the jaws are open wide enough to hold the tapered shank of the bit. Place the bit in the chuck of the brace (Fig. 18–21).

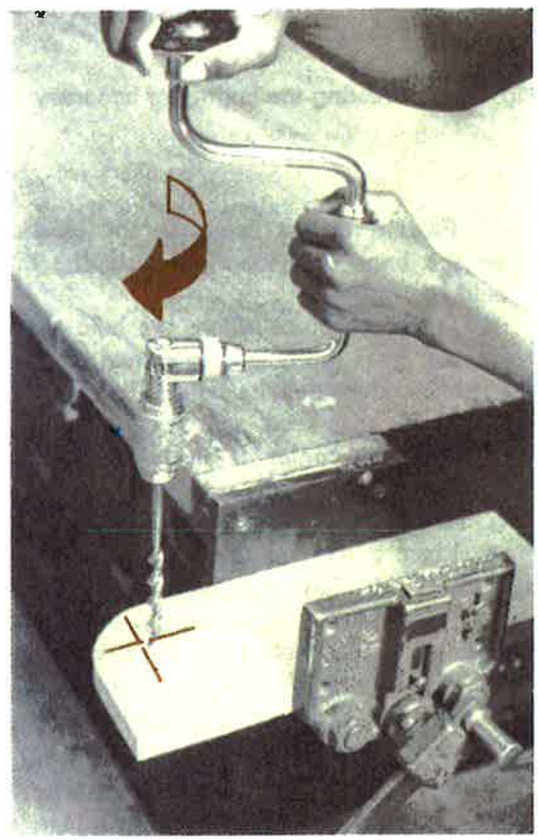


Fig. 18–23. Boring a hole vertically.

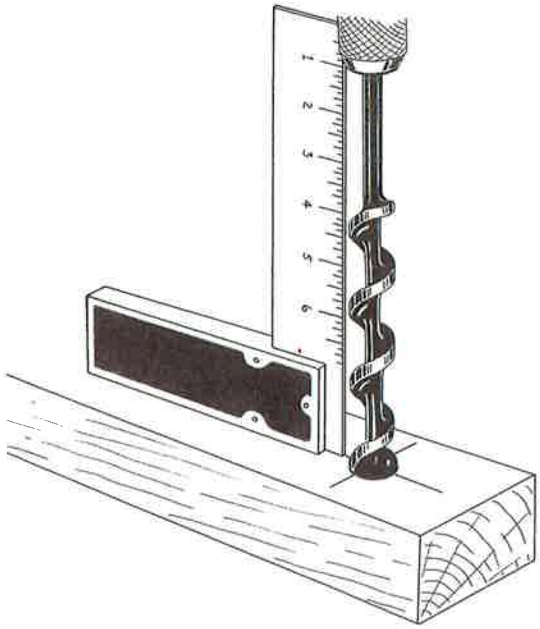


Fig. 18–24. Testing the boring for accuracy.

3. Fasten the bit firmly in the chuck. Turn the handle to the right until the bit is held securely.

4. Mark the place where the hole is to be bored. Start the hole with an awl to give the feed screw a definite hold (Fig. 18–22).

5. Place the feed screw at the spot marked for the center of the hole. Make a few turns with the brace to start the hole (Fig. 18–23).

6. Place a try square on the wood and against the bit. This is to make certain that the hole is being bored at right angles to the surface of the work (Fig. 18–24).

7. Bore carefully until the point of the feed screw begins to come through on the back of the work (Fig. 18–25, step 1).

8. Remove the bit from the hole by reversing the direction of the boring.

9. Bore through from the back of the work to make the hole clean-cut and with-

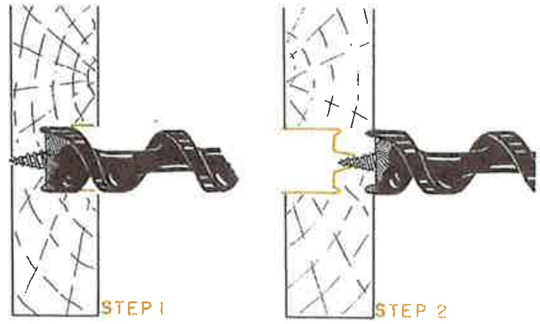


Fig. 18–25. Step 1: Correct procedure in boring a hole. Step 2: Boring a clean-cut hole.

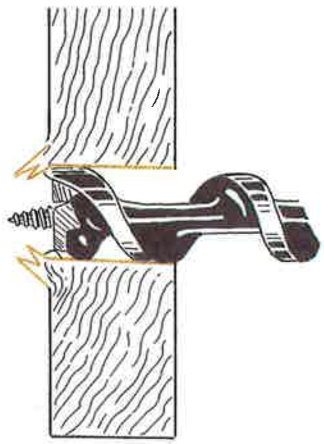


Fig. 18–26. Incorrect boring of a hole.

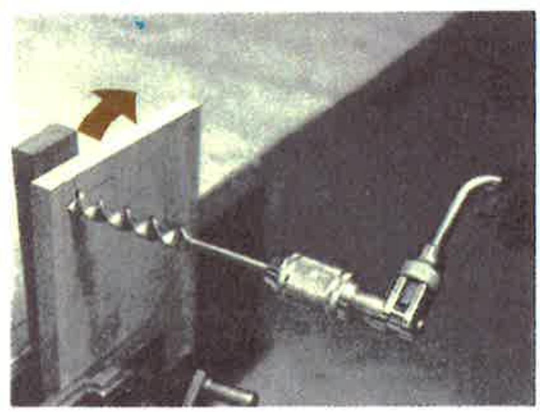


Fig. 18–27. Boring a hole with the aid of a piece of scrap wood.

out splinters (Fig. 18–25, step 2). Figure 18–26 shows what will happen if the bit goes completely through the wood.

Another method of boring a hole without splintering the back is shown in Fig. 18–27. Holes bored with an expansive bit should be backed up with a piece of scrap wood held behind the board.

When you bore holes for dowel joints, use a regular shortened dowel auger bit with the dowel jig.

BORING TO A SPECIFIED DEPTH

1. Fasten a square-tang bit of the desired diameter in a brace. See steps 2 and 3 of "Boring a Hole," above.
2. Fasten the adjustable metal depth gage (Figs. 18–16 through 18–18) on the bit to regulate the depth of the hole. The wooden depth gage illustrated in Fig. 18–19 can also be used.
3. Check this depth against a rule.
4. Bore the hole until the depth gage stops the boring action.
5. Remove the bit and clear loose wood particles out of the hole.

DRILLING A HOLE

1. Select a straight-shank drill bit of the desired diameter. The push drill can be used instead.
2. Fasten the straight-shank drill bit in the hand-drill chuck. Do this the same way you fasten an auger bit in the brace. The push-drill bit is held in a special chuck. Refer to the instructions which accompany the push drill for fastening it as well as for using it.
3. Locate and mark the hole with an awl.
4. Place the bit on the mark. Hold the drill steady while turning the crank at a moderate, constant speed (Fig. 18–28).

A hole is drilled with a push drill as shown in Fig. 18–29.

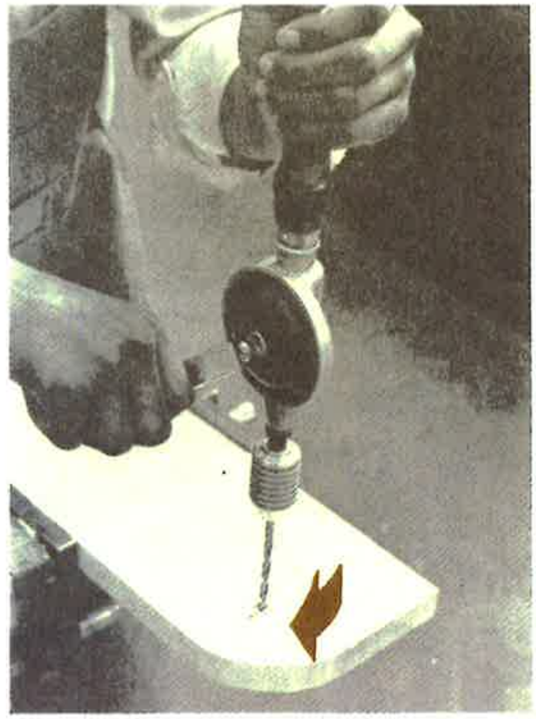


Fig. 18–28. Drilling a hole with a hand drill.

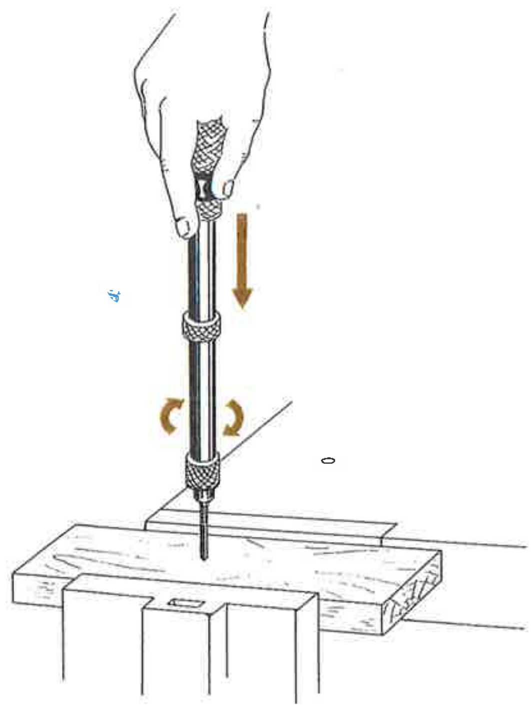


Fig. 18–29. Drilling a hole with a push drill.

Discussion Topics

1. What is the difference between an auger bit and a drill bit?
2. What does the number stamped on the tang of an auger bit mean? What are the sizes of these bits: 5, 6, and 7?
3. List six other types of bits and give their uses.
4. Describe two ways to bore a hole through a board without splitting the back.
5. How can you make a depth gage?

unit 19

Fastening with screws

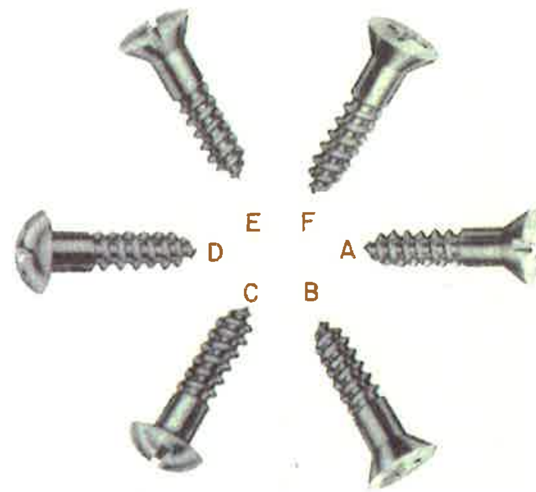


Fig. 19–1. Wood screws: (A) flat-head slotted, (B) flathead Phillips, (C) round-head slotted, (D) round-head Phillips, (E) oval-head slotted, and (F) oval-head Phillips.

Screws are used to fasten boards and assemble projects. A project which has been fastened with screws can be easily taken apart and re-assembled. Screws are superior to nails as wood fasteners because they are more permanent, hold better, and may be tightened easily.

The most common screws for joining wood are shown in Fig. 19–1. These are the *round-head*, *flat-head*, and *oval-head screws*. The first two are used most often in woodworking. Screws with a slotted head have been used for a long time. A more recent type is the *Phillips-head screw*. It gives a neater appearance and has a stronger head. This type also is available with a round, flat, or oval head.

Screws vary in length from 1/4 to 6 inches. In gage, or size, they are graded from 0 to 24, according to the diameter of the shank. Most are made of mild steel. Screws are also made of brass for use where humidity is a problem, as in the assembly of boats.

Flat-head screws of mild steel generally have a bright finish. This type is usually abbreviated as FHB (flat head, bright). However, it is sometimes referred to as flat head, steel. Round-head steel screws are often finished in a dull blue. Screws are also available with various plated finishes.

Screws are sold by the dozen in variety stores and hardware stores. They are packaged by the factory in boxes of 100 or one gross (144). The boxes are labeled, as in Fig. 19-2, to show the length, type, material, and quantity (1 gross or 100), and the diameter of the shank. The order and form in which the information is given may, however, vary from the example shown here. Look at several box labels to see if you understand them correctly. Figure 19-3 pictures a variety of other commonly used fasteners and bolts.

TOOLS

The tools used for fastening with screws are the many types of screwdrivers (Figs. 19-4 through 19-11), screwdriver bits (Figs. 19-12 through 19-14), countersink bits

Fig. 19-2. Factory packages of screws.

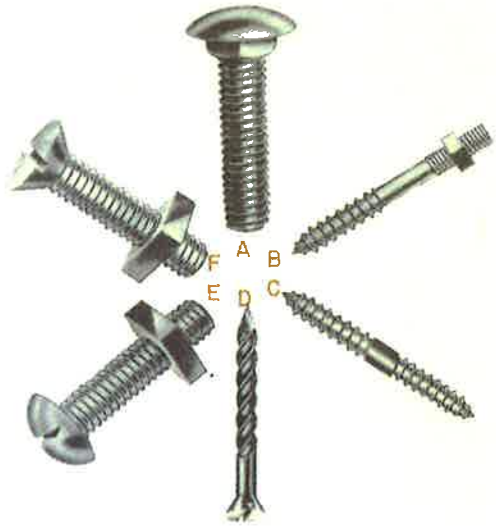


Fig. 19-3. Fasteners and bolts: (A) carriage bolt, (B) hanger bolt, (C) dowel screw, (D) wood drive screw, (E) round-head stove bolt, and (F) flat-head stove bolt.

Fig. 19-4. Standard-blade screwdriver.

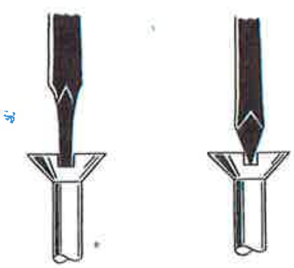


Fig. 19-5. Correctly and incorrectly shaped screwdriver tips.

Fig. 19-6. Screwdriver for Phillips recessed-head screws.

Fig. 19-7. Screwdriver for clutch-head screws.

Fig. 19-8. Spiral-ratchet screwdriver.

Fig. 19-9. Stubby screwdriver with regular tip.

Fig. 19-10. Stubby screwdriver with Phillips-head tip.

Fig. 19-11. Two types of offset screwdrivers to fit slotted and Phillips-head screws.

Fig. 19-12. Screwdriver bit for straight-slotted screws.

(Figs. 19-15 through 19-17), and combination wood-drill and countersink bits (Figs. 19-18 and 19-19).

Standard-blade Screwdriver. This screwdriver (Fig. 19-4) is available in blade lengths varying from 3 to 12 inches, and is the most commonly used. The tips of the sizes are shaped to fit slots of screws shown in Table 19-1. The tip should always be shaped to fit the slots of the screws. Screwdrivers and bits shown in Figs. 19-4, 19-8, 19-9, the upper view in 19-11, 19-12, and 19-14 have tips pointed as shown on the left in Fig. 19-5.

Screwdriver for Phillips Recessed-head Screws. The screwdriver illustrated in Fig. 19-6 has the tip shaped to fit the several kinds of Phillips recessed-head screws, shown in Fig. 19-1. This screwdriver varies in size, similar to the one described above.

Screwdriver for Clutch-head Screws. Figure 19-7 shows a screwdriver with a special type of point to fit screws used on many electrical appliances, such as refrigerators, deepfreeze units, and other appliances. Its size also varies according to the screw sizes.

Spiral-ratchet Screwdriver. Figure 19-8 depicts an automatic screwdriver with right- and left-handed adjustments. It will drive or draw screws by pushing down on the handle, or it can be set rigid as an ordinary screwdriver. The movement is changed instantly by a simple shifter device. There are usually three bits with varying tip widths which come with it (see Fig. 19-14).

Stubby Screwdriver with Regular Tip. The short screwdriver in Fig. 19-9 comes in lengths from 1 to 1¾ inches. There are different tip sizes obtainable. It is used where space is limited.

Stubby Screwdriver with Phillips-head Tip. This screwdriver (Fig. 19-10) is very similar to the one in Fig. 19-9, except for the tip which is designed to fit Phillips-head screws, as illustrated in Fig. 19-1.

Offset Screwdriver. Figure 19–11 shows two offset screwdrivers. The upper one is designed for regular-slot screws; the lower one has tips to fit Phillips-head screws. This tool has lengths from 3 to 6 inches.

Screwdriver Bit for Straight-slotted Screws. The bit shown in Fig. 19–12 is designed for use with the brace shown in Fig. 18–1. Its overall length is 5 inches. It is available in tip widths varying from 3/16 to 1/2 inch to fit different sizes of slotted screws.

Screwdriver Bit for Phillips-head Screws. This tool (Fig. 19–13) has basically the same specifications as the one in Fig. 19–12. The exception is the tip, which does not vary as greatly in size.

Spiral-ratchet Screwdriver Bit. There are three tip widths of bits (Fig. 19–14) to fit the spiral-ratchet screwdriver shown in Fig. 19–8. These tip widths vary from 7/32 to 9/32 inch. The overall length is approximately 4 inches. This bit is also available to fit the Phillips recessed-head screw.

Countersink Bits. The countersink bit (Fig. 19–15) has a tapered square tang to fit a brace. The cutting edge is capable of countersinking up to 3/4 inch diameter.

Figure 19–16 shows a countersink bit that has a 1/4-inch shank for use either in a hand or an electric drill, or in a drill press. The cutting edge of this bit will countersink to 1/2 inch. The countersink bit illustrated in Fig. 19–17 is designed to fit the spiral-ratchet screwdriver shown in Fig. 19–8.

Combination Wood-drill and Countersink Bits. Figure 19–18 illustrates a combination wood-drill and countersink bit. It cuts holes for the screw thread, screw shank clearance, and countersinks flat-head screws all in one operation. There are many sizes available to accommodate sizes from 3/4-inch No. 6 screws to 2-inch No. 12 length screws.

Figure 19–19 shows a combination tool which performs three operations. It prepares wood for screws without marring the sur-

Fig. 19–13. Screwdriver bit for Phillips-head screws.

Fig. 19–14. Spiral-ratchet screwdriver bit.

Fig. 19–15. Countersink bit to fit a brace.

Fig. 19–16. Countersink bit with a round shank.

Fig. 19–17. Countersink bit to fit a spiral-ratchet screwdriver.

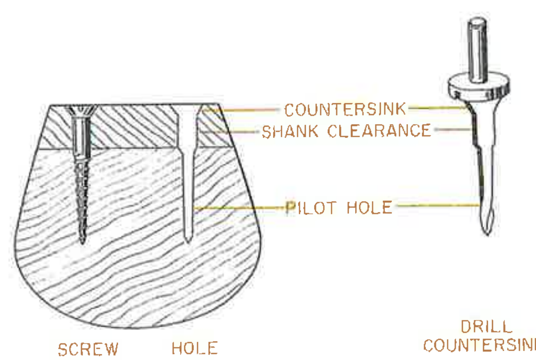


Fig. 19–18. Combination wood-drill and countersink bit.

Table 19–1. SIZES OF BITS OR DRILLS TO BORE HOLES FOR WOOD SCREWS

NUMBER (GAGE) OF SCREW	APPROXIMATE DIAMETER OF SCREW SHANK	FIRST HOLE (SHANK): Twist-drill size	FIRST HOLE (SHANK): Auger-bit number	SECOND HOLE (PILOT): Twist-drill size	SECOND HOLE (PILOT): Auger-bit number
1	5/64	5/64	–	–	–
2	3/32	3/32	–	1/16	–
3	3/32	7/64	–	1/16	–
4	7/64	7/64	–	5/64	–
5	1/8	1/8	–	5/64	–
6	9/64	9/64	–	3/32	–
7	5/32	5/32	–	7/64	–
8	11/64	11/64	–	7/64	–
9	11/64	3/16	–	1/8	–
10	3/16	3/16	–	1/8	–
12	7/32	7/32	4	9/64	–
14	15/64	1/4	4	5/32	–
16	17/64	17/64	5	3/16	–
18	19/64	19/64	5	13/64	4

face, cuts the shank hole, and also counterbores ready for a plug or filling compound. Bits shown in Figs. 19–18 and 19–19 have 1/4-inch diameter shanks to fit most power and hand drills.

Table 19–1 gives the neccessary information for the selection of screws, drills, auger bits, and shank and pilot holes.

FASTENING BOARDS WITH SCREWS

1. Mark the location for the screw hole. A mark with an awl makes an excellent beginning for drilling a hole (Fig. 18–22).

2. Select the correct size of bit for drilling or boring the shank hole (Table 19–1). The size of the bit should be large enough to clear the shank of the screw. Where possible, you can get a better alignment when the boards to be fastened are placed in position and the pilot hole (sometimes called the anchor hole) is drilled through both. You can then enlarge one hole to the screw-shank size.

If you plan to use the combination drill and countersink (Figs. 19–18 and 19–19), it will take the place of steps 2, 3, 4, 5, and 6.

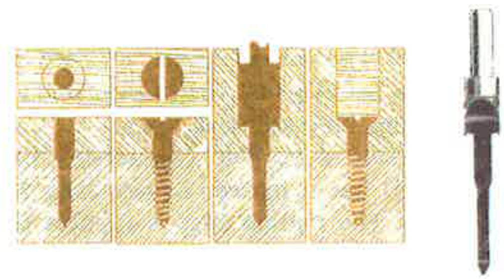
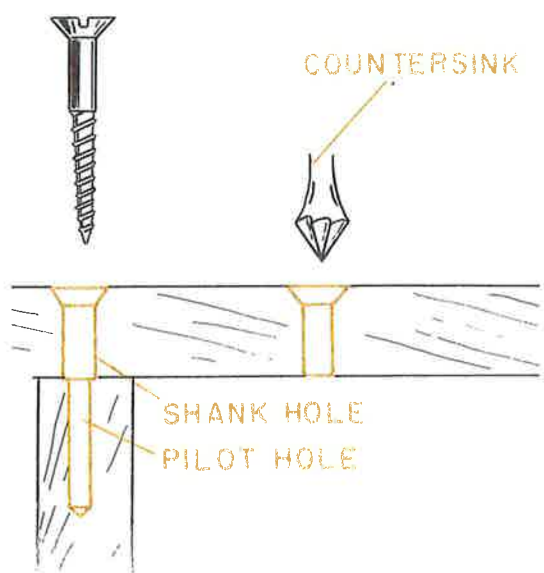


Fig. 19–19. Combination wood-drill, countersink, and counterbore bit.

Fig. 19–20. Shank and pilot holes.



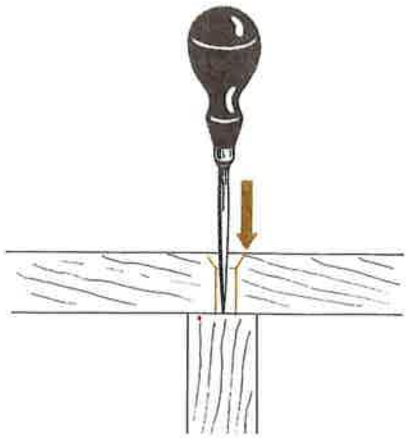


Fig. 19-21. Marking for the pilot hole.

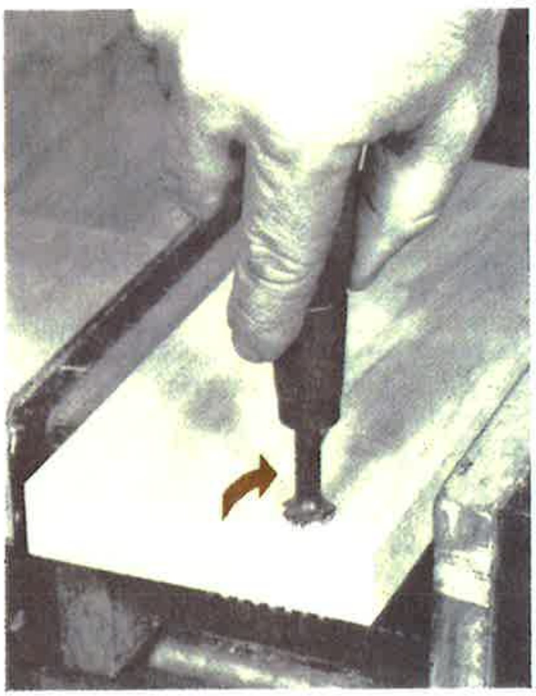
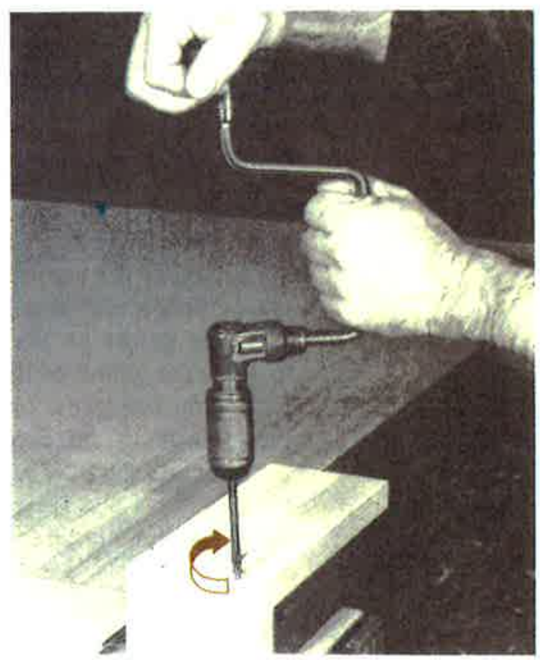


Fig. 19-22. Countersinking for a flat-head screw. Note that the countersink bit is fastened into a file handle.

Fig. 19-23. Driving a screw with a screwdriver.

Fig. 19-24. Driving a screw with a screwdriver bit and brace.



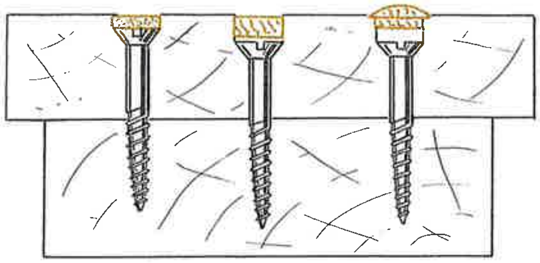


Fig. 19–25. Methods of recessing flat-head screws.

3. Fasten the bit in the brace or the drill in the hand drill. Make the shank hole (Fig. 19–20).

4. Place boards for the joint in position. Mark the location of the pilot hole with an awl (Fig. 19–21).

5. Bore or drill the pilot hole.

6. Countersink the shank hole if a flat- or oval-head screw is to be used (Fig. 19–22). Do not countersink too deep. A countersink bit fitted into a file handle makes a good countersink tool.

7. Select a screwdriver which fits the slot of the screw snugly. The tip should be ground properly (Fig. 19–5).

8. Fasten the screw with a screwdriver (Fig. 19–23), or use a screwdriver bit and brace (Fig. 19–24). Hold the screwdriver firmly and in line with the screw. This will keep it from slipping out of the screw slot. A screw will turn more easily if it is coated with soap, wax, or paraffin.

9. Sometimes the screw is to be hidden with wood plastic or covered with a wooden button or plug. In that case, you must set, or sink, the head in the wood as shown in Fig. 19–25. Standard-size wooden plugs are available commercially, or you can make them.

Discussion Topics

1. What information must you have in order to purchase the correct type and size of screw?
2. Name three of the most common types of slotted screws used in woodworking. Where would each be used?
3. What do the large numbers on the labels in Fig. 19–2 signify?
4. Name two methods of packaging screws.
5. What are two advantages in using Phillips-head screws?
6. What is the purpose of the shank and pilot holes?
7. What tool do you use on the shank hole to make a flat-head screw flush, or even, with the wood?