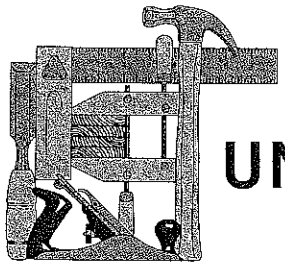


UNIT 2

PLANNING

Efficient planning helps us to solve problems, avoid mistakes, and use correct techniques. After studying this unit, you will be able to identify basic product design considerations. In addition, you will be able to clearly define the design problem. You will also be able to prepare a sketch, a bill of materials, and a plan of procedure.

DESIGN CONSIDERATIONS

Several factors play a role in the design of a product. These factors include: function or usefulness of the product, kind of wood that is to be used, size and proportion of the product, expected durability of the product, and cost.

FUNCTION OR USEFULNESS

You should ask yourself several questions about the function or usefulness of a product when designing it. Is the product needed or is it something that you just want to make? Will the product perform well for the purpose for which it is intended? For example, products intended for use outdoors should be made from a wood that is weather resistant, such as redwood. A bookshelf should be designed to hold books of the desired size and quantity.

KIND OF WOOD

The kind of wood to be used for a product is largely dependent on the use, function, and finish of the product. If an opaque finish is planned, an inexpensive wood could probably be used. It could have a poor grain pattern as long as it could hold paint well. Basswood, pine, spruce, and poplar are good woods to use if an opaque finish is planned. If a natural or transparent stained finish is to be used, a wood with a desirable color and grain pattern should be chosen. Birch, oak, walnut, maple, and cherry are a few of the fine woods that are enriched by finishing. Refer to Fig. 1-21 in the previous chapter to see the color and grain pattern of these woods.

SIZE

A product should be constructed to the proper size for its intended purpose. Furniture and cabinets are generally constructed to standard dimensions. A coffee table is usually 16-18 inches high. A chair is usually 18 inches from the floor to its seat. A bathroom vanity is often 31 inches high and a kitchen base cabinet is 36 inches high. Furniture catalogs and brochures will detail standard sizes of furniture and cabinets.

PROPORTION

Proportion is the ratio of the dimensions of a product. An odd ratio, such as 1/3 or 2/5 is generally more pleasing than an even ratio, such as 1/4 and 1/2. To determine the ratio, place the shorter dimension over the longer dimension and reduce to lowest terms. For example, a coffee table measuring 18 inches wide and 42 inches long has a size ratio of 18/42 or 3/7.

DURABILITY

A product is usually only made strong enough to fulfill its purpose to avoid giving it a heavy and awkward appearance. A box for light storage purposes, for example, could be built with 1/4 inch stock. The following questions should be asked:

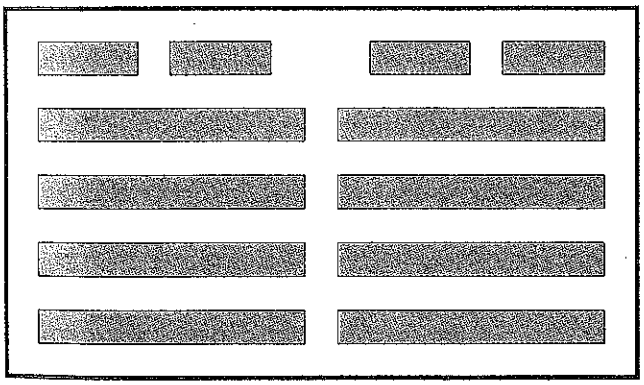
- Is the product designed to fit its surroundings?
- Can it be built with a minimum of time and effort?

- Is it durable enough to withstand any forces that will be placed upon it?
- Are the most appropriate materials being used?

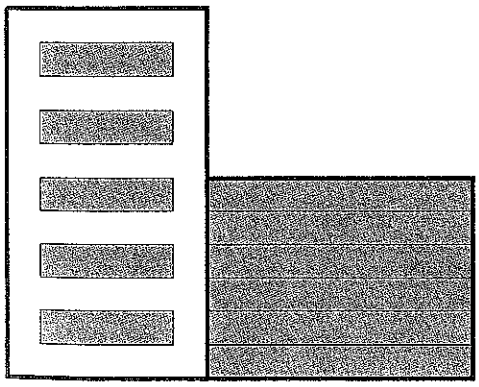
OTHER CONSIDERATIONS

Economy, balance, and harmony are other factors that should be considered when designing a product. Will the product be worth the necessary time and effort? Do the parts blend well together? Does it have eye appeal?

BALANCE is very important in determining how people perceive a design. Two types of balance can be used when designing a product–formal balance and informal balance. See Fig. 2-1. FORMAL BALANCE is obtained when all of the elements on one side of a design are "mirror images" of the elements on the other side. Formal balance gives a design an even appearance. INFORMAL BALANCE is achieved when the elements of a design are different on each side. This creates an uneven appearance.



FORMAL BALANCE



INFORMAL BALANCE

Fig. 2-1. Two types of balance.

HARMONY is the organization of all design elements so that the product is viewed as one piece. All elements must fit together properly to give the product a feeling of unity.

FURNITURE STYLES

Some of the best designers and artists of their time have developed furniture styles that are known by the period during which the furniture was created. Furniture styles created in Europe, particularly during the 18th and 19th centuries, are sometimes known as Traditional and French Provincial. Queen Anne and Louis XIV furniture styles are named for the rulers who ordered the furniture built. Sheraton and Chippendale styles are named for the designers who originated the furniture. Other popular styles of period furniture are Colonial and Early American. Contemporary (modern) furniture reflects the thinking of our present day designers. Contemporary furniture is simple furniture consisting of smooth, trim lines.

STEPS IN PLANNING A PRODUCT

Many steps are involved in the design and construction of a product. Each of the steps depends on decisions that were made in the previous step or steps. Do not overlook any of the steps, or make a quick decision in any of the steps. The more thought and time that is put into each one of these steps will reduce the number of errors or problems that may occur. The steps in designing a product follow:

1. Identify the problem.
2. Sketch the product in its simplest form.
3. Determine the resources that you have available.
4. Determine what tools and equipment will be required to build the product.
5. Prepare a working drawing.
6. Construct the product.
7. Determine the overall success of your product.

IDENTIFY THE PROBLEM

The identification of the problem is one of the most difficult steps in the overall design of a product. State the problem in its simplest terms. The problem may be as simple as choosing a product design from several books or catalogs,

or as complex as designing a storage/work unit for a computer. Do not choose a product that is too difficult to construct. A well-made simple product is better than a complex product that results in nothing more than a pile of lumber.

Unit 22 provides several product ideas and information to aid in selecting and planning worthwhile products. Products with varying degrees of difficulty are included. Products should be selected that can be made with a minimum of effort and can be completed in the allotted time. Select products that match your own interests. Use your imagination when designing products. Developing more than one design for a product will allow you to compare designs and make improvements. You will feel a keen sense of satisfaction when a design is developed that is different and pleasing. Design suggestions may also be obtained by visiting shops and stores that specialize in wood products such as furniture, gift items, and novelties. There are also many excellent books and magazines that provide product plans, techniques, and other information for the beginning or skilled woodworker.

SKETCH THE PRODUCT

When the product has been determined, the next step is to sketch the product in its simplest form using a pencil. A pencil allows you to make changes in the design. Pictorial (three-dimensional) sketches should first be sketched to give you an idea of how the parts of the product fit together.

When drawing a pictorial sketch, first draw the front of the product and then draw the top and sides of it. Fig. 2-2 shows a pictorial sketch of a jewelry box. Sketch the object lines freehand, and then darken them with a pencil and straightedge. Do not be concerned with the details at this time unless a particular problem, such as a joint detail, must be kept in mind throughout the design process. This step is frequently omitted only to find out later the design was not in it simplest form.

DETERMINE THE AVAILABLE RESOURCES

The third step in the design process is to determine resources. Resources are defined as anything available for use in making the product,

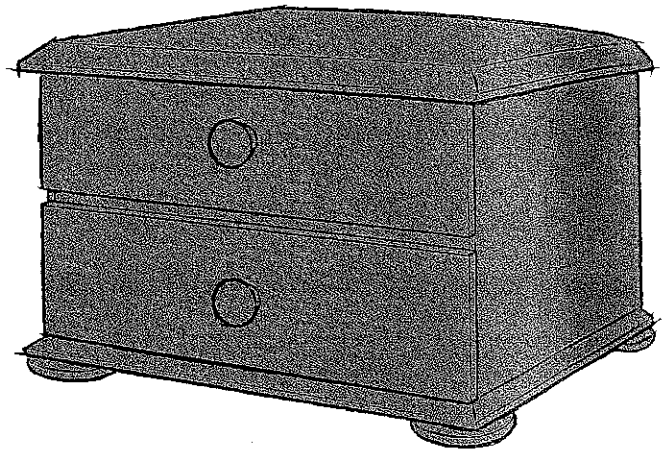


Fig. 2-2. Pictorial sketch of a jewelry box.

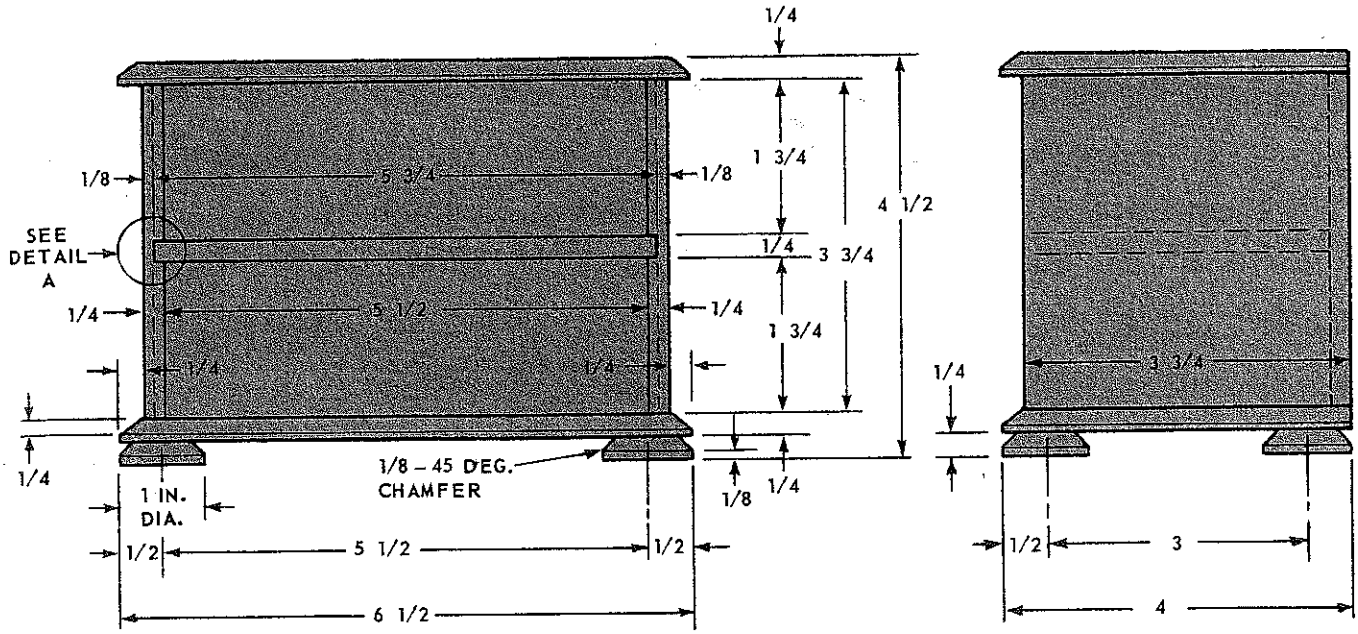
including personal skill, available tools and materials (their condition and accessories), and finishing capabilities. If the product is to be used for resale, packaging, marketing, inventory control, product storage, and cash flow should also be considered.

Personal skill usually improves with experience, and can be evaluated after review of previously completed work. Nothing is more frustrating than to have purchased materials and supplies, only to find basic knowledge is lacking or to find someone else doing the same product faster and better.

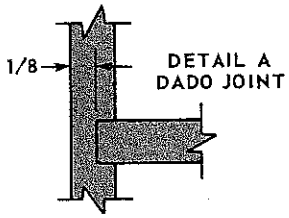
Available materials should not be a problem if a product is designed properly. The list of woods, veneers, adhesives, hardware, etc., available is almost endless. However, hard-to-find materials and supplies may cost more than you had expected. If the desired item must be ordered, allow enough lead time for delivery.

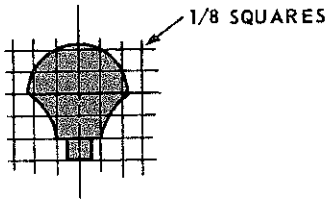
DETERMINE AVAILABLE TOOLS AND EQUIPMENT

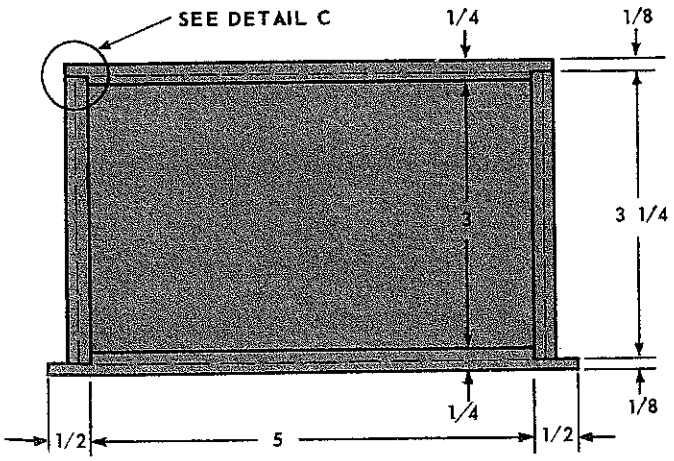
The fourth factor to consider when designing a product is available tools and equipment. Review and list the equipment that will be required to build the product. Compare this list to the tools and equipment available in the shop. If the tools or equipment required to build the product are not available, determine whether different tools can be used. For example, rough-sawn 4/4 lumber generally should not be purchased if a planer is not available to smooth the surfaces. However, you may be able to use a hand plane to smooth the stock. A less obvious

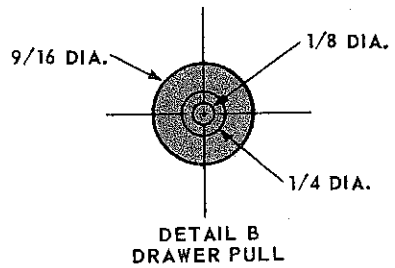


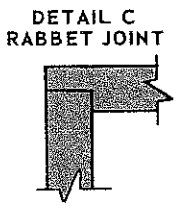
A–CARCASS DETAIL

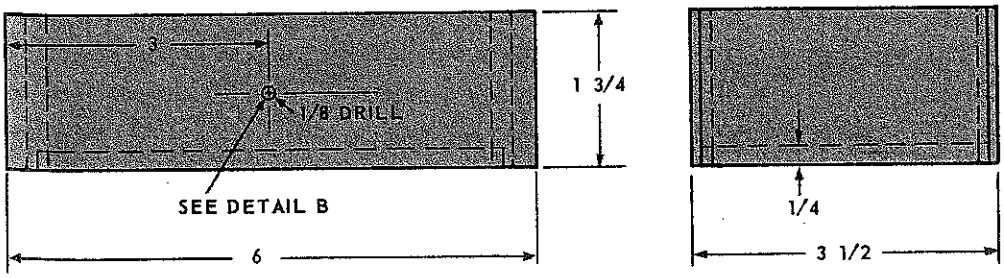












B–DRAWER AND PULL DETAIL

Fig. 2-3. Working drawing for a jewelry box. A–Carcass detail. B–Drawer and pull detail.

tool consideration is in designing joints. Do not plan on a locking miter joint if a shaper or router with the proper cutters is not available.

The last element to consider in this step is finishing capabilities. There are many options for a good-quality finish. Some finishes only require a rag or a disposable brush, while others require a moisture-controlled spray area with filtration and high-tech spray equipment. Some finishes may explode under certain conditions (such as when a light switch is turned on), while others are totally safe in all conditions.

PREPARE A WORKING DRAWING

When you have established what resources you have available, revise the sketch to include the overall size, joints, drawers, and other details. Fig. 2-3 shows a working drawing for a jewelry box. Prepare a WORKING DRAWING that indicates the exact size and other details necessary to construct the product. Select a scale for the working drawing that will show the necessary detail. Full-size plans may be required for some products.

A final working drawing may be drawn to scale using grid paper. This usually consists of two or more views. Detailed views (often enlarged) are used to show types of joints and shapes of special or irregular parts.

Figs. 2-4 and 2-5 show the completed jewelry box and provide alternate designs for the jewelry box. Many other designs are possible.

Fig. 2-4. Completed jewelry box.

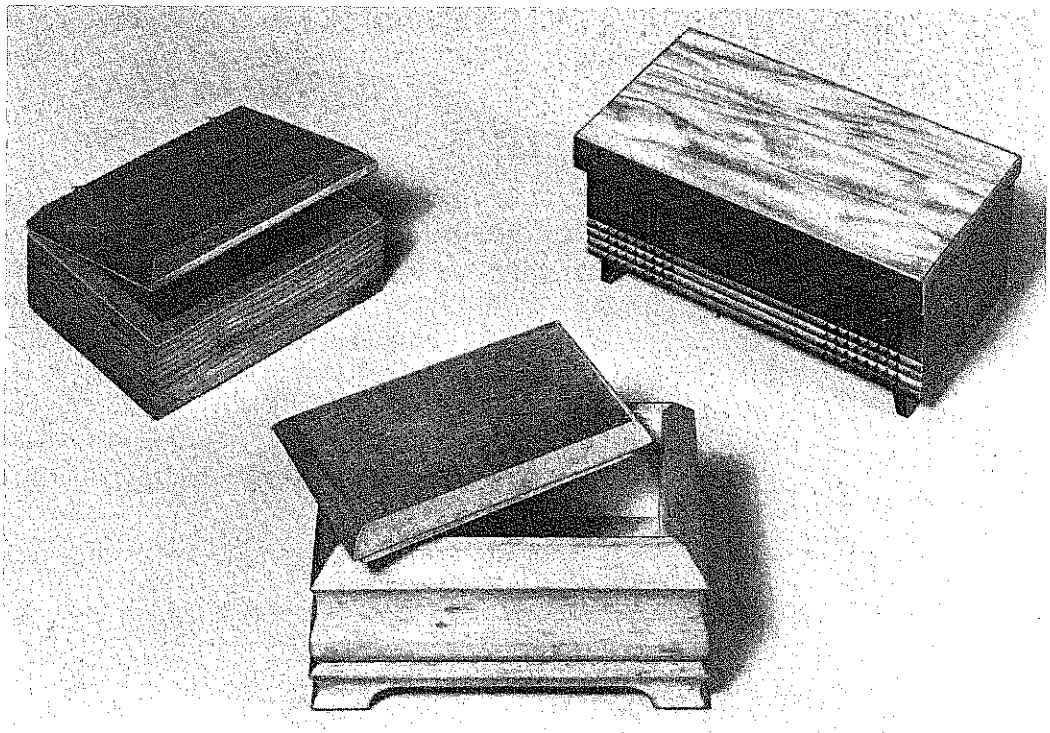


Fig. 2-5. Alternate styles of jewelry boxes.

A BILL OF MATERIALS should then be developed from the working drawings. This should include every item required to complete the product, including all hardware and finishing materials. Both the rough and finish sizes of all stock should be clearly indicated. A sketch of the uncut stock with cutting plans for the finished pieces is commonly used to reduce waste or to avoid an improper cut.

Computing Lumber Measure

Lumber dimensions are listed in the order of thickness (T), width (W), and length (L). The THICKNESS is the distance that is perpendicular to both the width and length. The WIDTH is the distance across the grain of the wood. The LENGTH is the distance along the grain of the wood.

The BOARD FOOT is the basic unit of measure for all lumber. A board foot is equal to a piece of lumber measuring 1-inch or less in thickness, 12-inches wide, and 12-inches (1 foot) long. Nominal (rough-sawn) sizes are used in computing board feet. Lumber that is 1-inch thick or less is considered to be 1 inch. For example, a board that is 1/4-inch thick is considered to be 1-inch thick when computing board feet. Lumber that is thicker than 1 inch is rounded up to the next quarter inch. For example, a board that is 1 1/8-inches thick is figured to be 1 1/4-inches thick, and a board that measures 1 3/8-inches thick is figured as a 1 1/2-inches thick.

A formula for computing board feet for small pieces of lumber is Board feet (Bd. ft.) equals the number of pieces times the thickness (in inches), times the width (in inches), times the length (in inches) divided by 144. The number 144 is the number of square inches in a square foot. If there is more than one piece of lumber, multiply the number of board feet by the number of pieces. The board foot formula is usually shown as:

$$\text{Bd. ft.} = \frac{\text{no. of pcs.} \times T'' \times W'' \times L''}{144}$$

EXAMPLE: Compute the board foot measure of 3 pieces of wood measuring 1/2" x 6" x 9".

Substituting in the above formula:

$$\text{Bd. ft.} = \frac{3 \text{ pcs.} \times 1'' \times 6'' \times 9''}{144}$$

$$\text{Bd. ft.} = 1.125$$

Large pieces of wood are computed as follows:

Board feet equals the number of pieces times the thickness (in inches) times the width (in inches) times the length (in feet) divided by 12. The board foot formula is usually shown as:

$$\text{Bd. ft.} = \frac{\text{no. of pcs.} \times T'' \times W'' \times L'}{12}$$

EXAMPLE: Compute the board foot measure of 2 pieces of wood measuring 1 1/4-inches thick by 4-inches wide by 4-feet long.

Substituting in the previous formula:

$$\text{Bd. ft.} = \frac{2 \text{ pcs.} \times 1.25'' \times 4'' \times 4'}{12}$$

$$\text{Bd. ft.} = 3.33$$

Note: It may be easier to figure board feet as square feet first, and then multiply by the thickness of the board. Remember to multiply feet by feet and inches by inches.

EXAMPLE: Compute the board foot measure of 1 piece of white pine that measures 3/4" thick by 4-inches wide by 3-feet long.

Substituting in the formula to compute square feet:

$4/12 \times 3' = 1$ sq. ft.

Substituting in the formula to compute board feet:

1 pc. $\times$ 1 sq. ft. $\times$ 1" (T) = 1 Bd. ft.

Another method used to measure and sell wood products is SQUARE FEET. Square foot measure is usually applied to sheet stock, such as plywood and paneling. It can also apply to milled lumber, such as tongue and groove flooring.

The area, or square feet, of a piece of stock is calculated by multiplying the length by the width. The length and width must be measured in feet, not length in feet and width in inches.

EXAMPLE: Compute the number of square feet in a sheet of paneling measuring 4' x 4'.

Substituting in the formula to compute square feet:

$4' \times 4' = 16$ sq. ft.

The final method of measurement used in woodworking is RUNNING FEET, or LINEAL FEET. This measurement is nothing more than the actual length of the material given in feet. Most milled lumber, such as molding, is measured and sold by running feet.

Preparing the Bill of Materials

The working drawing is used to determine the dimensions of the stock to prepare a bill of materials. Rough and finish dimensions are given in the bill of materials. Fig. 2-6 shows a bill of materials for the jewelry box. Board foot measure and costs are computed based on the rough size dimensions. Rough size dimensions allow for extra stock to be removed in trimming and smoothing the parts to the finished sizes. The following guidelines should be followed when figuring rough size dimensions:

Add 1/16-1/8 inch to the finish size thickness.
Add 1/4 inch to the finish size width.
Add 1/2 inch to the finish size length.

Making a Stock Cutting List

A STOCK CUTTING LIST is made by grouping similar rough sizes of stock given in the bill of materials. The dimensions listed in the stock cutting list are rough sizes only, Fig. 2-7. The stock cutting list allows you to conserve both time and materials.

CONSTRUCT THE PRODUCT

The next step in the process is to construct the product. Planning does not stop here; continue to think through the entire product. List the steps needed to build the product using a plan of procedure. This will allow for a smoother flow of the tasks at hand. Good planning will allow many tasks to be performed at one time. For example, shaping activities may proceed while another part of the product is being glued. If you have a tight budget or a cash flow problem, it may be necessary to purchase certain parts of the product as needed. This can only be accomplished by thorough planning.

BILL OF MATERIALS

NAME CHARLES E. HARPER PLANNING DATE MARCH 15 COMPLETION DATE APRIL 22

PROJECT JEWELRY BOX TOOLS NEEDED: TRY SQUARE, MARKING GAUGE HAND SAWS, HAND PLANES, HAND DRILL & BIT, CHISELS, CLAW HAMMER & CLAMPS

STOCK LIST:

No. of Pcs.	Name of Part	Size in Inches (Rough)	Size in Inches (Finish)	Kind of Wood	Bd. Ft.	Bd. Ft. Cost	Cost
2	TOP & BOTTOM (CARCASS)	3/8 × 4 1/4 × 7	1/4 × 4 × 6 1/2	WALNUT	.41	$3.15	$1.29
2	ENDS (CARCASS)	3/8 × 4 1/4 × 4 1/4	1/4 × 3 3/4 × 3 3/4	"	.25	3.15	.79
1	SHELF (CARCASS)	3/8 × 3 3/4 × 6 1/4	1/4 × 3 1/2 × 5 3/4	"	.16	3.15	.50
1	BACK (CARCASS)	1/4 × 4 × 6 1/4	1/4 × 3 3/4 × 5 3/4	WAL. PLY GIS	.17 SQ. FT.	1.72	.29
4	FEET (CARCASS)	3/4 × 1 1/4 × 1 1/4	1/4 × 1 DIA.	WALNUT	.04	3.15	.13
2	FRONTS (DRAWER)	3/8 × 2 × 6 1/2	1/4 × 1 3/4 × 6	"	.17	3.15	.54
2	BACKS (DRAWER)	3/8 × 2 × 6	1/4 × 1 3/4 × 5 1/2	"	.16	3.15	.50
4	SIDES (DRAWER)	3/8 × 2 × 3 3/4	1/4 × 1 3/4 × 3 1/4	"	.21	3.15	.66
2	BOTTOMS (DRAWER)	1/4 × 3 1/4 × 5 1/2	1/4 × 3 × 5	WAL. PLY GIS	.25 SQ. FT.	1.72 SQ. FT.	.33
2	PULLS (DRAWER)	3/4 × 3/4 × 1 1/4	9/16 DIA. × 5/8	WALNUT	.013	1.2 1.70	.04
						TOTAL STOCK COST	5.17

HARDWARE AND OTHER MATERIALS:

No. of Pcs.	Description	Size	Unit	Unit Cost	Cost
4	FLAT HEAD SCREWS	NO. 4 × 1/2"	EACH	$.02	.08
36	WIRE BRADS	GAUGE NO. 18 × 3/4"	EACH		.15
	LIQUID WHITE GLUE				.25
	SAND PAPER	60, 100, AND 150 GRITS			1.50
	FINISH				1.50
				TOTAL HARDWARE & MISC.	$3.48
				TOTAL PROJECT COST	$8.65

Fig. 2-6. Bill of materials for a jewelry box.

PCS.	NAMES OF PARTS	SIZE	MATERIAL
1	Top, bottom, ends and shelf (carcass)	3/8'' x 4 1/4'' x 30''	Walnut
1	Fronts, backs and sides (drawer)	3/8'' x 4'' x 20''	Walnut
1	Back (carcass) and bottoms (drawer)	1/4'' x 4'' x 18''	Walnut Plywood GIS
1	Feet (carcass)	3/4'' x 1 1/4'' x 5 1/4''	Walnut
1	Pulls (carcass)	3/4'' x 3/4'' x 3''	Walnut

Fig. 2-7. Stock cutting list for a jewelry box.

Preparing a Plan of Procedure

A PLAN OF PROCEDURE enables you to "think through" the processes needed to construct a product before you actually start working. This enables work to be organized so time and material can be saved, and also to detect minor errors in the drawing, bill of materials, or stock cutting list. Mistakes are much easier to change on paper than with materials. In addition, ways to improve a product design or construction can also be found. A plan of procedure should be made in outline form with enough information to indicate procedures involved.

Plan of Procedure for the Jewelry Box

1. Check your working drawing, bill of materials, and stock cutting list carefully.
2. Select and cut stock given in your stock cutting list. Try to find already-cut stock near the correct sizes.
3. Make carcass parts.
   a. Plane the stock to finish thickness.
   b. Saw parts to rough sizes.
   c. Plane and saw parts to finish sizes.
   d. Saw and chisel dados in ends to receive the shelf.
   e. Chamfer edges on the top and bottom.
4. Make carcass feet.
5. Assemble carcass with glue and wire brads or clamps. Attach the feet with screws.
6. Make drawer fronts, backs and sides.
   a. Plane stock to finish thickness.
   b. Saw parts to rough sizes.
   c. Plane and saw parts to finish sizes.
   d. Cut rabbet joints at each end of the fronts and backs to receive the sides. Then cut rabbet joints along the bottom edges to receive the bottoms.
   e. Drill 1/8 in. hole in each drawer front to receive the pulls.
7. Make the drawer pulls.
8. Cut plywood to finish sizes to fit the drawer bottoms and carcass back.
9. Assemble drawers with glue and wire brads or clamps. Install the drawer pulls.
10. Smooth surfaces and edges with 60, 100, and 150 grit sandpaper.
11. Apply finish.
    a. Raise grain, let dry, then smooth again with 150 grit sandpaper.
    b. Apply paste wood filler, let dry until it begins to turn dull then remove excess filler by rubbing ACROSS the grain and let dry.
    c. Sand filler coat lightly with 220 grit sandpaper, then apply a coat of sealer and allow to dry.
    d. Sand sealer coat lightly with 220 grit sandpaper, then apply two coats of topcoat finish.
    e. Rub final topcoat with rubbing oil and rottenstone or pumice.
    f. Wax.
12. Attach the carcass back with glue and wire brads or clamps.

DETERMINE YOUR SUCCESS

This last step is frequently overlooked, but it is essential if you want to continually grow and develop skills in woodworking. Consider the obvious–does product fulfill the needs of the original problem identified? If yes, then there is success, but it is necessary to evaluate other factors to determine the degree of success. What is the overall appearance? Is the finish adequate? Are the joints tight? Was the cost and effort reasonable? This kind of evaluation allows for modification of future products and personal growth as a woodworker.

Tool Selection

Tools must be shared and properly cared for so that everyone receives the greatest benefit from their use. Always return tools to the storage center after use. Fig. 2-8 shows a typical storage cabinet for tools.

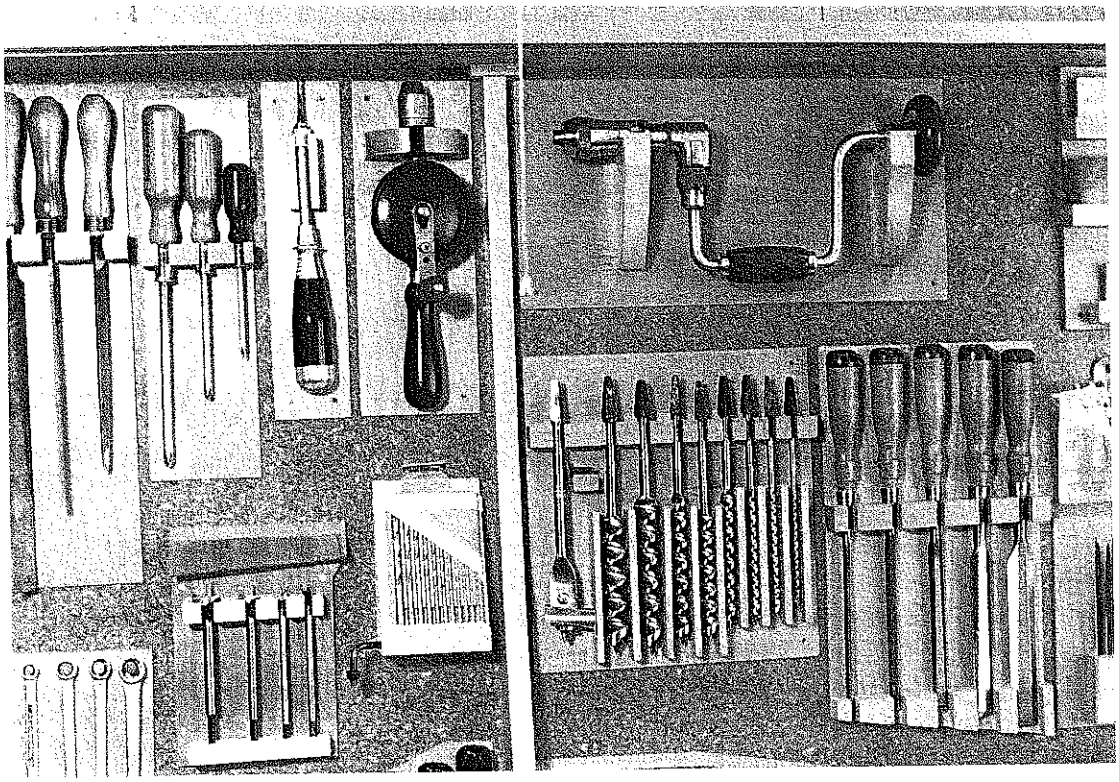


Fig. 2-8. Typical tool storage cabinet.

TEST YOUR KNOWLEDGE, Unit 2

Please do not write in this text. Place your answers on a separate sheet of paper.

1. List three important factors that should be considered when designing products to be constructed in the shop.
2. Queen Anne and Louis XIV furniture is named for the _____ who first ordered that type of furniture to be built.
3. _____ furniture reflects the thinking of present day designers.
4. Planning in the school laboratory involves selecting a product and developing and refining its _____.
5. A working drawing provides shapes and _____ of a product.
6. List the three units of measure for lumber and sheet stock.
7. Calculate the total board foot measure for 3 pieces of stock measuring 1/2" x 6" x 24".
8. Lumber less than 1-inch thick is figured the same as if it were _____ inch thick.
9. Calculate the number of square feet in a sheet of plywood measuring 1/2" x 4' x 8'.
10. _____ size dimensions allow for extra stock to be removed in smoothing parts to finish sizes.
11. The processes used to construct a product are listed in the _____.
12. The _____ size of materials is listed in the stock cutting list.

ACTIVITIES

1. Prepare a short report on a famous furniture designer.
2. How do we decide whether something has good or bad design? Make a chart showing characteristics of good and bad design.
3. Choose a product that you would like to make. Make several pencil sketches of the product along with alternate design suggestions.
4. Select several small pieces of wood and compute the board foot measure in each piece. Compute the cost of each piece based on current prices.