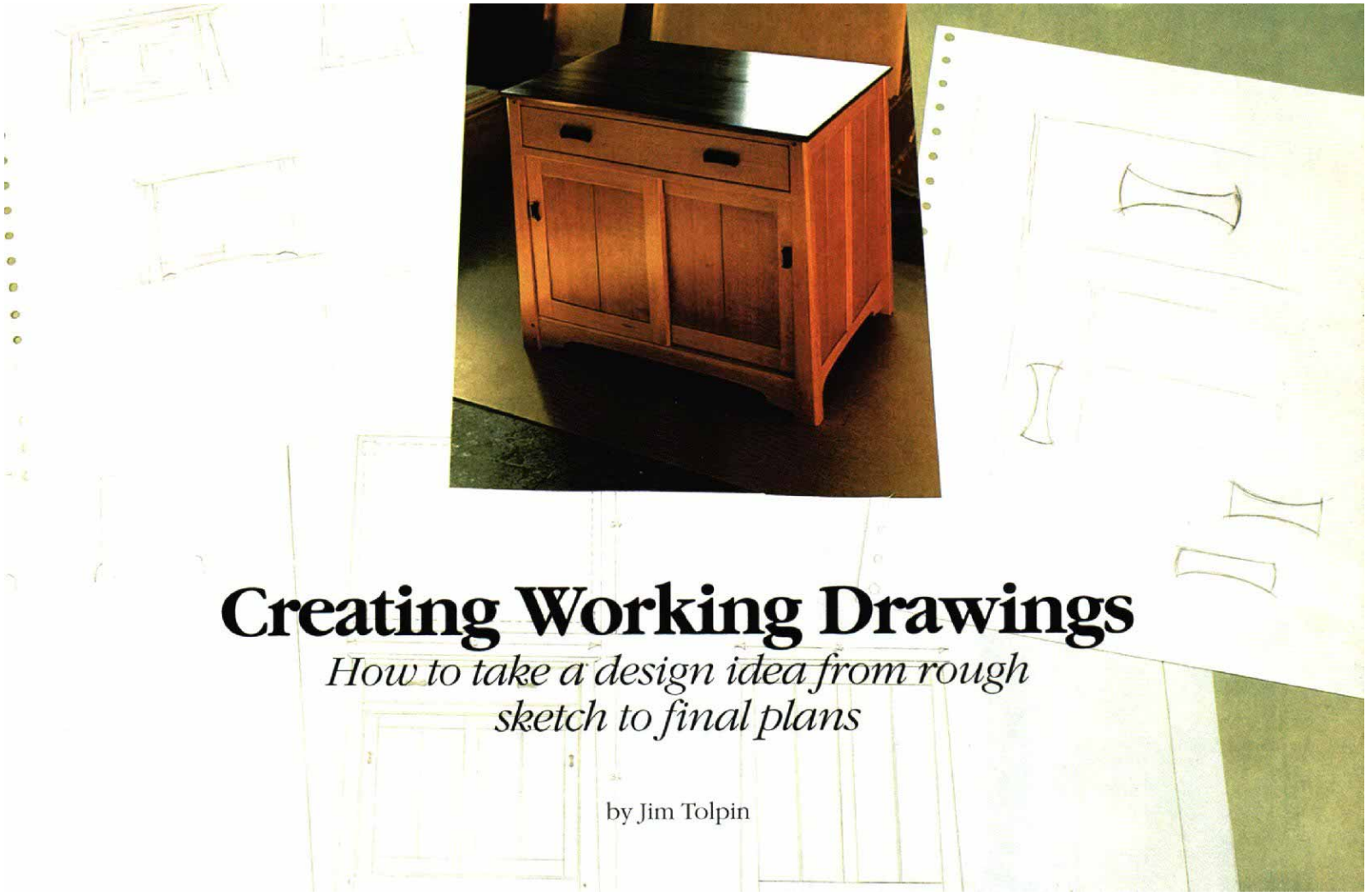


Creating Working Drawings

How to take a design idea from rough sketch to final plans

by Jim Tolpin

Loose concept sketching fosters creativity *and allows you to refine your rough idea to the point where you're ready to create a three-view drawing and then an isometric projection. From there it's not all that far to full-scale drawings and to creating something with wood. The time spent getting a drawing right will pay for itself many times over.*

For much of my woodworking career, I dreaded the drawing stage of a project. It was always a daunting, tedious process that only put off the true fun—shaping real wood into real objects. After erasing a misplaced or poorly drawn line for the umpteenth time, I'd often think that I could have built the darn thing in the time it took to do the drawings. Considering the way I was producing drawings, I was probably right.

Today, however, I thoroughly enjoy the drawing process, and I relish seeing my ideas first come to life on paper. I've learned to appreciate the unlimited design freedom afforded by freehand concept sketching, as well as the ability to express my ideas clearly and precisely with more refined drawing techniques. The difference in my attitude came from learning to use the right tools and techniques. In this article, I'll share what I've learned about materials and techniques and explain how you can take your design ideas from rough, raw images to refined, scale working drawings. Here's an overview.

I begin the drawing process by first creating a series of concept sketches that show the object in a roughly accurate perspective view—in other words, the way the object would appear to your eyes. Choosing the sketch that comes closest to my design goal, I commit its dimensions to a scaled-down, three-view drawing—an orthographic projection. This gives me a way to see the parts of the piece in their true proportion to one another. But because this type of drawing limits me to viewing each face independently from the others, I will often go on to draw an assembled view of the drawing—an isometric projection. This drawing shows me how all the parts relate to one another, and it gives me an accurate feel for how a piece will look when it's built.

Concept sketching

This is where the fun begins. You get your first look at the project-to-be, and you can work out the bugs in the overall look of the piece without laboring over the details. Approach concept sketching by giving your hand free rein to draw and redraw any inspiration that comes to mind (see the photo above). This is not the time to worry about crisp lines, perfect symmetry, properly scaled proportions or fair curves. You can take care of all that later when you produce the mechanical drawings. Do not, however, go on from sketching to drafting until you have something you really like. It's too time-consuming to make major design changes at the drafting stage.

A ring-bound artist's sketchbook is the best place to do your concept sketching. Choose a soft (#2 or # 2½) lead pencil with a pink-tipped eraser. Avoid using harder pencils because their lines are difficult to erase from typical sketchbook paper. Keep a half-dozen or so well-sharpened pencils handy as you sketch. You don't want a dull pencil to interrupt the flow of your creative juices. Hold the pencil lightly, keeping your wrist loose and flexible. When sketching out a long line, allow your arm to move with your hand. And finally, get in the habit of turning the sketchbook to accommodate the natural sweep of your wrist when drawing angled lines.

One of the benefits of doing freehand concept sketches is that

Photos: Vincent Laurence

you can easily create a series of "what-if" views. Instead of redrawing the form over and over again, simply trace it onto a piece of translucent paper, leaving out the areas that will be changed in the what-if views. Or you can photocopy as many basic outlines as you'd like, and then flesh them out with your new design ideas.

From concept sketch to orthographic drawing

Once you have settled on a concept sketch that comes closest to representing your idea, it's time to assign some dimensions to the project. By setting out the design to scale in a mechanical drawing, you can see clearly how the size and shape of components relate to one another. Methods and sequences of joinery also become more obvious. These working drawings are a bridge between your freehand concept sketches and a master cut list.

Equipment—buying the right stuff—Luckily, the type of equipment a woodworker needs to produce adequate working drawings is relatively simple and inexpensive. Unless you do a lot of room-sized architectural millwork, a 2-ft. by 3-ft. board will provide plenty of space for rendering projects in a suitable scale. This board can be nothing more than a flat piece of plywood set on a desktop, but to make it more comfortable to work at, tilt up the back of the board 3 or 4 in. Adding a piece of drafting-board vinyl (available through most office-supply stores) smooths the drawing surface and will allow holes left behind by compass points to self-heal. To pinch pennies, you can cover the board with a ⅛-in. sheet of corrugated cardboard, but pin holes and pencil grooves will soon telegraph through to the drawings.

You can draw consistently parallel lines and angles with templates and a simple T-square, but I highly recommend spending a bit more money and setting yourself up with a sliding parallel rule fixed to a cable ran along either side of the board. These rules are widely available for well under $100—a small price for the frustration one will save you. This is supposed to be fun, remember.

You can further reduce drawing-board madness by using only high-grade (16 to 20 lb.), fine-grained vellum paper for mechanical drawings. Unlike sketch paper, vellum erases easily with a standard pink gum eraser, leaving behind a smooth, smudge-free surface. The vellum is also translucent, letting you trace over prototype sketches, speeding the drawing of repetitive elements.

Other pieces of equipment you'll need for mechanical drawing include the following:

Pencils—Forget wood pencils. They're time-consuming, messy to sharpen, and because their width changes as they dull, they make lines of uneven thickness. Instead, get a set of three mechanical pencils (3mm, 5mm and 7mm) and use an HB grade lead. It will dull quickly, but it will produce a dark line that reproduces well in a copy machine, eliminating the need to ink the drawing.

Erasers—On vellum paper, the classic pink gum eraser works as well as any. To make fine corrections, use pencil-type erasers in conjunction with eraser shields (see the photo at right).

Ruler—I use an architect's scale rule for laying out dimensioned lines. I prefer a flat ruler with eight scales rather than the twelve-scale triangular rulers, which I find more difficult to mark dimensions from. To keep the edges of a rule smooth and clean, use it *only* to mark dimensions, never as a straightedge for drawing lines—that's what a parallel rule and angle templates are for.

Angle templates—To start out, get an 8-in. 45° to 45°, an 8-in. 30° to 60° and an adjustable-angle template. Later, you'll want to add a 4-in. version of this set for drawing small details. I like my templates in green or orange, so I can readily find them amid the papers strewn about the drawing board.

Shape templates—Circles, ellipses, squares and rectangles, as well as a variety of other shapes, are available on templates. I also use French-curve templates and their larger cousins, ship's curves, to draw in curves of progressively changing radii.

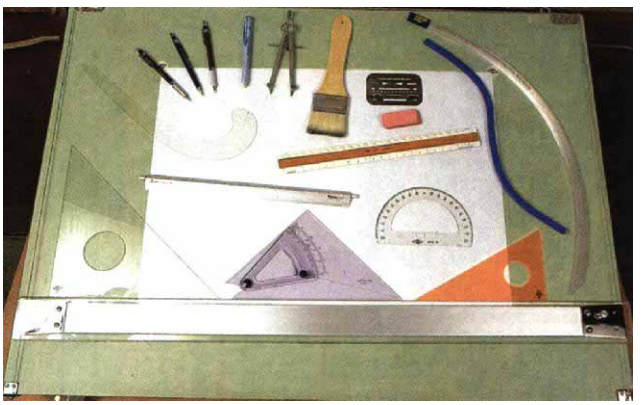
Adjustable curves—To draw curves between fixed points, I use either a flexible lead bar or a plastic slip curve. If the curve is very large, I'll bend a 3⁄16-in.-sq. length of straight-grained wood to the marks while I trace a line against its edge.

Protractor—I use a 4-in.-radius protractor to draw angles from a baseline.

Compass—A pencil compass is useful for drawing circles.

Drafting basics—Unless you move on from woodworking to designing and building space shuttles, you won't need to learn more than the most basic drafting skills and conventions to produce quick, accurate and easy-to-read working drawings. The skills are mostly common sense: Make sure your board is free of lead and eraser debris before taping paper to it. Align the bottom of the paper to the parallel rule, and then secure it to the board with a small piece of tape in each corner. Keep a scrap piece of paper between your hand and the drawing to avoid smudging your work. And never wipe away eraser debris with your hand—always use a brush.

Once you establish a baseline, draw any degree angle to it using either angle templates or a protractor and straightedge. Begin the angled line precisely on a dimension mark by first holding the pencil to the mark and then sliding the template or straightedge to it. If you reverse this process, parallax can play tricks on your eyes, causing you to misjudge the placement of the pencil. Draw out a waver-free line by tilting the pencil slightly into the corner formed between the edge of the template and the paper.



Drawing supplies used by the author *include, clockwise from lower left, a 45° to 45° angle template, a metal architect's rule, a ship's curve (a large version of a French curve), mechanical pencils in three sizes (3mm, 5mm and 7mm), a pencil-style eraser, a compass, a dust brush, an eraser shield, a pink eraser, a flat architect's rule, a lead flexible curve, a plastic adjustable curve, an orange 30° to 60° angle template, a protractor and an adjustable angle template.*

A mechanical drawing is nothing more than a happy meeting of lines that indicate the outlines of an object and where measurements are being made to. Unless these lines vary in some way, however, the drawing can be difficult to read. Figure 1 on p. 80 shows how lines with different meanings are conventionally rendered in mechanical drawings. Note that dimensions are not given a unit symbol. This would only crowd the drawing. Instead, a note in the legend box tells you what units are represented by the dimension numbers.

A three-view drawing—The first type of working drawing I produce from a concept sketch (or from dimensions taken from a

Fig. 1: Lines used in working drawings

Lines of different thickness help to distinguish different meanings in working drawings. Here are some of the most common line types.

Border line and legend box (.7 mm)

Working line (.5 mm)

Hidden line (.3 mm)

Dimension line (.3 mm)

Extension line (.3 mm)

Centerline (.3 mm)

Cutting plane (.5 mm)

Fig. 4: Setting in dimension lines

Note: The overall dimension—the height in this case—is drawn to the outside of all other dimensions. In general, the smallest dimensions are kept closest to the object.

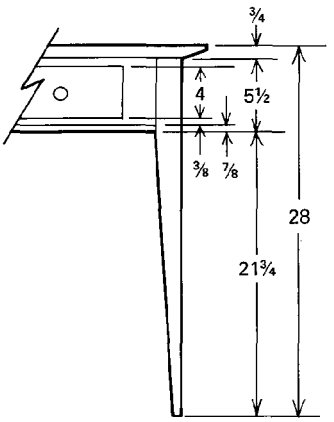
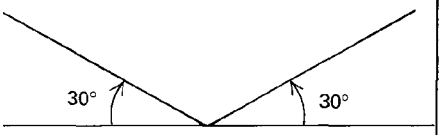
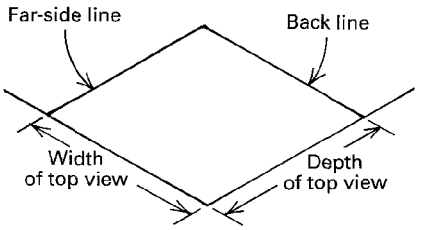


Fig. 5: Creating an isometric projection

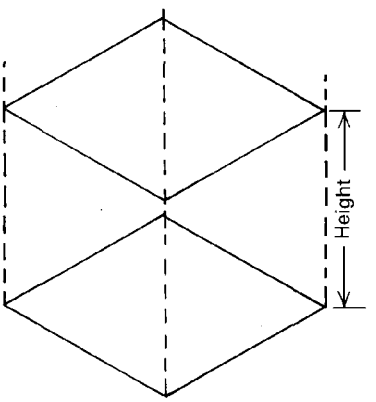
Step 1: Create two angled baselines, each at 30° to your original horizontal baseline.



Step 2: Draw in the "footprint" of the top view along the angled baselines. Extend the view back into the isometric projection by drawing the back and the far-side lines. Keep these lines parallel to the angled baselines.



Step 3: Establish the actual top view by extending vertical lines up from the corners of the footprint. Measure up along the line to the overall height of the front view. Draw in the outline of the top view parallel to the angled baselines.



Step 4: Now simply draw in the piece of furniture using the dimensions from your orthographic drawing.

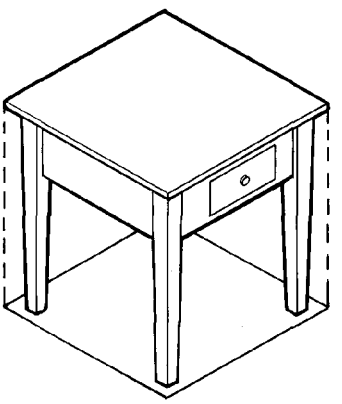


Fig. 2: Setting out a three-view orthographic drawing

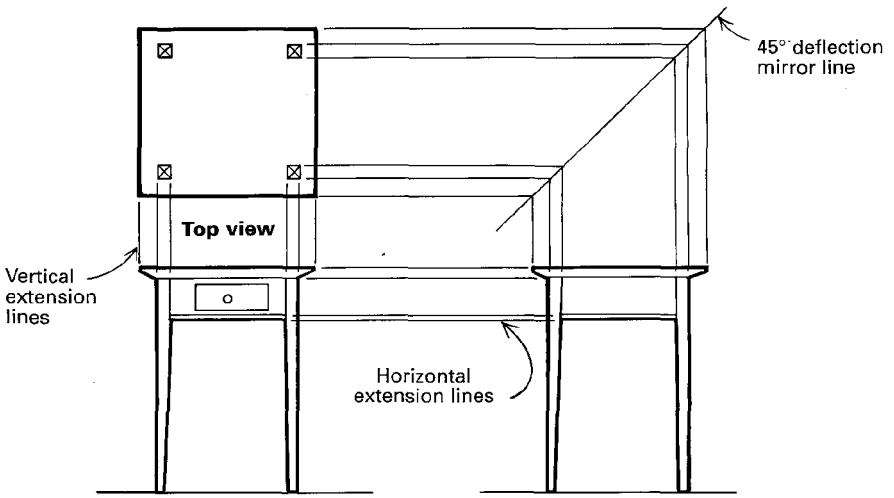
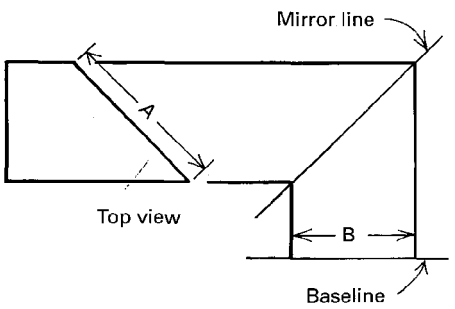
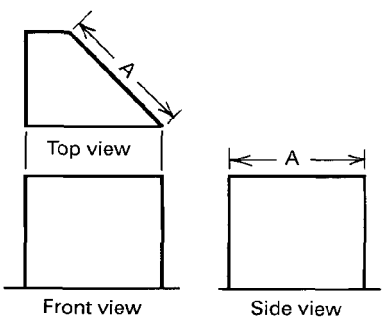


Fig. 3: Producing a side view of an angled side

Problem: You cannot use mirror line to project side of top view to baseline because distance B is foreshortened to look as though it's less than distance A.



Solution: Use an architect's rule or a compass to measure distance A and transfer distance directly to horizontal line extended over from front view. Drop lines to baseline from distance marks.



Drawings: Maria Meleschnig

photo or some other source) is a three-view (orthographic) projection. I tape a copy of my final concept sketch (or a combination of sketches) to the top of my drafting board and then attach a piece of vellum to the board. I draw a thick (.7mm) borderline around the perimeter and a legend box in the lower right-hand corner. Within this box, I record my name and a copyright symbol (©), followed by the date and the name of the client, if any. If the piece has a name, or if it is a reproduction, I will title it accordingly. Finally, I indicate the scale and units of measurement used in the drawing.

Unless the project is very large, such as a floor-to-ceiling entertainment center, I use ¼ in. to represent 1 in. This reduction allows me to fit the front, side and top views onto one sheet without creating a cluttered drawing that's difficult to read. I use two scales on my architect's rule to lay out the dimensions: the ¼ scale and the 3 scale. Although the ¼ scale is useful for representing full-inch increments, its divisions are in twelfths (because this scale is designed primarily to equate ¼ in. to 1 ft.), which is not a convenient scale for fractions of an inch. For fractions, I use the 3 scale, where a ¼ in. segment is broken down into eight divisions, each representing ⅛ in.

After drawing a horizontal baseline about 2 in. up from the lower border of the paper, I lay out the rough positions of the three views with a light pencil line. As a right-hander, I find it more comfortable to draw from left to right, so I place the front view in the lower left-hand corner of the drawing, the top view above and the side view to the right (see figure 2 on the facing page).

I do the front view first, constantly referring to the concept sketch (or to dimension notes) as I draw in the outline of the form with light lines. I generally trust my eye to judge whether proportions are correct. When I'm satisfied with this light pencil rendering, I darken in the outline with 0.5mm working lines.

I draw the top view next, extending lines up vertically from the front view to define the widths. I ascertain the positions and depths of the various elements by again referring to my sketches or notes. Next I create the side view. Only one is necessary unless the piece is asymmetrical. With the front and top views already completed, the dimensions of the side view are already established in the drawing. To draw this view, I need only extend over the outlines of the other two views until they intersect over the baseline to the right of the front view. As you can see in figure 3 on the facing page, I reflect the top view's extension lines down to the baseline with a 45° mirror line.

A note of caution: reflecting extension lines from a top view across a mirror line works only if the side of an object is perpendicular to its front. At any other angle, reflected lines create a foreshortened view. Although this is technically correct in a true orthographic projection, it makes more sense to draw the angled side so that the length of its side remains true to scale. Skip the top view reflection and scale the depth dimensions directly from the architect's rule or with a compass (see figure 3).

I finish the three-view drawing by penciling in all my dimensions, working my way out from the smallest elements of the components, to the components themselves, to the overall size of the structure (see figure 4). Then I draw in the fine details shown in my concept sketches: curved or molded corners or edges, knobs, pulls and the like. I rarely bother with cross sections or detail blowups in my three-view drawings. Instead, I wait to do these on a full-scale rendering. If I need this kind of information, I want it actual size, so I can transfer the information directly onto a story pole, or measuring stick. I do label all the parts on the three-view drawing, so I can refer to them in the bill of materials and cut lists.

From three-view drawing to isometric projection

The advantage of an isometric projection is that it shows you how the various faces of an object will relate to one another. And because an isometric doesn't diminish or foreshorten dimensions as does a vanishing-point perspective drawing, all the views of this working drawing remain true to scale, making it simple to draw and easy to take off scaled dimensions (see figure 5).

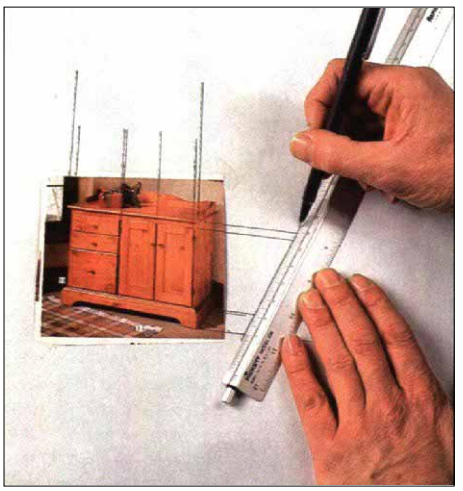
Once I've created the isometric cube that establishes the perimeter of the piece of furniture I'm drawing, I fill in the three views by transferring scaled measurements from the three-view drawing, being careful to orient the lines parallel to the 30° baselines. You may find it helpful to place isometric grid paper under the vellum as an aid to sketching in some details. When you're finished filling in the details of the piece, erase the extension lines used to raise the structure, and you're done. □

Jim Tolpin is a writer and woodworker in Port Townsend, Wash.

Developing a three-view drawing from a photograph

It's possible to develop scaled views of a piece of furniture from nothing more than a photograph. It helps, of course, if you know the overall dimensions of the piece, but some detective work—such as scaling dimensions from familiar objects in the photo—can often provide enough clues. The picture should be as free from distortion as possible (no wide-angle shots) and should offer a three-quarter view, which lets you see the front, side and top of the piece.

To determine the dimensions of doors, drawers and other elements of the piece, affix the photo to the center of a piece of vellum paper with double-faced tape. Use a straightedge to extend lines out from the overall width and height of the piece. Then lay an architect's rule between the two lines that represent the overall dimension of the piece (see the photo at left). Usually, you'll have to angle the rule to get the scaled dimension to fall between the lines. Use whatever scale allows you to correlate the overall dimensions of the piece to a reasonable, divisible section of the rule.



Draw this angled reference line, and then extend over the outlines of the internal elements. To find their dimensions, simply consult the same scale on the rule. Repeat this procedure to find the dimension of elements within the other planes of the photograph. Once you've established all the dimensions for all elements of the piece, use this information to create a three-view drawing of the piece from which you can create a cut list. ***—J.T.***