

HIGH STYLE PLUS UTILITY IN A CONTEMPORARY ZIGZAG

BY DAVID DUNDAS

It was a revolutionary design in the 1930s, but not everyone can afford to sit on a piece of art. We work the best features of the original Zigzag chair into a stylish and completely accessible chair you can actually pull up to the dinner table.



The original Zigzag chair designed by Dutch architect Gerrit Rietveld in the 1930s is an iconic piece of artwork. The cantilevered, Z-shaped chair looked deceptively simple but employed masterful joinery and was hailed as a sublime example of minimalist design. It was not a chair you would want to use for, say, everyday dining.

Nevertheless, with modern adhesives and joinery techniques, it is feasible to build a comfortable upholstered dining chair both reminiscent of Rietveld's Zigzag and strong enough for everyday use. Our chair's cantilevered frame also gives it a slight comfortable springiness.

To withstand structural stresses, the chair's side assemblies must be made from a strong hardwood such as jarrah, maple or white oak. The seat cross-rails and the slip-seat frame can be made from a secondary hardwood. The chair's miter joints are reinforced and locked with floating tenons, epoxied, and pinned with brass screws. We designed this chair to be built using the Festool Domino tenon joiner.

Getting started

The visible parts of the chair can be made from an 8' board of 6"-wide 6/4 hardwood. Plane the board to a thickness of 1³/₈" and rip it into three lengths 1³/₄" wide. For ease of handling, cut the three lengths in half to yield six 4' lengths. Plane and joint each 4' piece so as to finish 1³/₈" x 1⁹/₁₆" ensuring that all the faces are square to one another.

Crosscut the parts for the feet, legs, seat side rails, back stiles, and back rails from the 4' lengths according to the cut list. It is easier to achieve a consistent length for the matching parts if you clamp a stop to a crosscut sled or use a miter gauge with a long fence and an adjustable stop. Mark out 38" radius curves on the top edges of the back

rails, and bandsaw away the waste from their front faces. Use a random-orbit sander with progressively finer sanding disks to smooth and fair the curves.

The hidden parts, the seat rails and the seat frame components, are made from an 8' board of $\frac{3}{4}$ " x $2\frac{1}{2}$ " secondary hardwood. Since the angle to be cut for the miters is 67.5° , you will need to make a supplementary 22.5° jig to achieve the correct angle (see sidebar).

Cutting the miters

Make the 22.5° jig for cutting the miters on the feet, legs, and the front end of the seat side rails. Before starting the cut, ensure that the broader ($1\frac{1}{16}$ ") face of the workpiece is flat on the saw's table (Fig. 1). Set aside the 22.5° offcuts for later use as wedges to facilitate clamping at the glueup stage. The 49° miters for the back stiles are cut without the jig by setting the miter gauge to 41° and clamping the rear face of the back stiles and the bottom face of the seat side rail against the miter gauge fence.

Marking out and milling the mortises

It is important to remember, when marking out the positions of the mortises on the components of the side assemblies, that the assemblies are mirror images rather than identical. It is worth laying out the parts and marking the matching miters before marking the mortise centers on the reference face (the face on which the Domino's fence will rest).

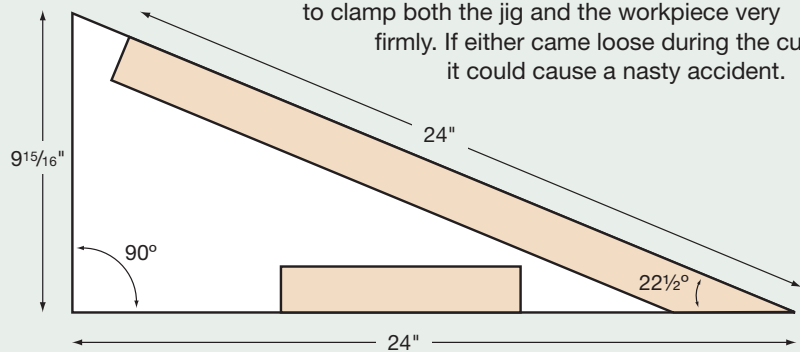
You are now ready to mill the mortises in the side assembly components except for the miter locking tenons, which will be milled after the leg miters have been glued up. All of the chair's mortises are milled using the narrow width setting on the Domino joiner. Also, all of the chair's mortises are cut with the 6mm-diameter Domino cutter, except those that reinforce the miter at the bottom of the back stiles, for which the 10mm cutter is used. The height of the Domino's fence is set using the dimensions given in millime-

MAKE A JIG FOR CUTTING LEG MITERS

Cut a right-angled triangle from $\frac{1}{2}$ " plywood with a base 24" long and a height of $9\frac{15}{16}$ ". Mill a hardwood cleat $1\frac{1}{2}$ " square and 36" long. Cut an 8" length from the cleat, and glue and screw it flush with the base of the plywood triangle. Cut 24" from the remainder of the cleat, and mark out a 22.5° miter on one of its ends. Cut away the 22.5° wedge of waste with a backsaw, and plane the miter face to the marked line. Then glue and screw the mitered cleat flush with the hypotenuse of the triangle. Square the outer faces of the cleats by running the jig over the jointer with the jig's base against the fence.

Set your miter gauge to an angle of 45° , and clamp the jig to its fence, adjusting the position of the jig so that the mitered end of the cleat barely grazes the table saw's blade as the miter gauge is moved forward in its slot. I used a Kreg miter gauge, which has a suitably long fence, but if you have a standard miter gauge, you will need to attach an auxiliary fence to it. Align the end of the workpiece with the mitered end of the cleat and clamp

it to the jig with a hand-screw clamp. It is essential to clamp both the jig and the workpiece very firmly. If either came loose during the cut, it could cause a nasty accident.



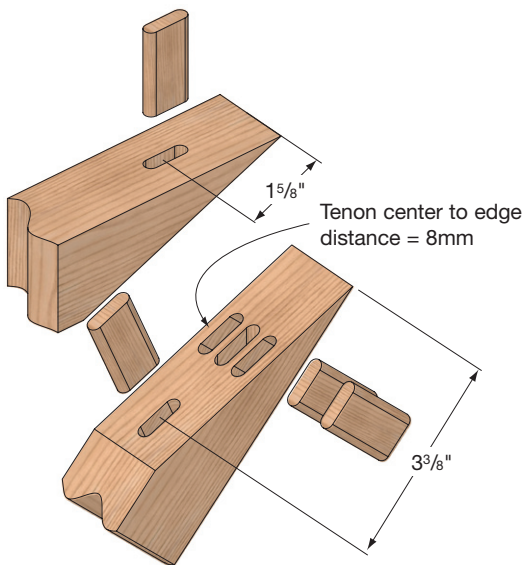
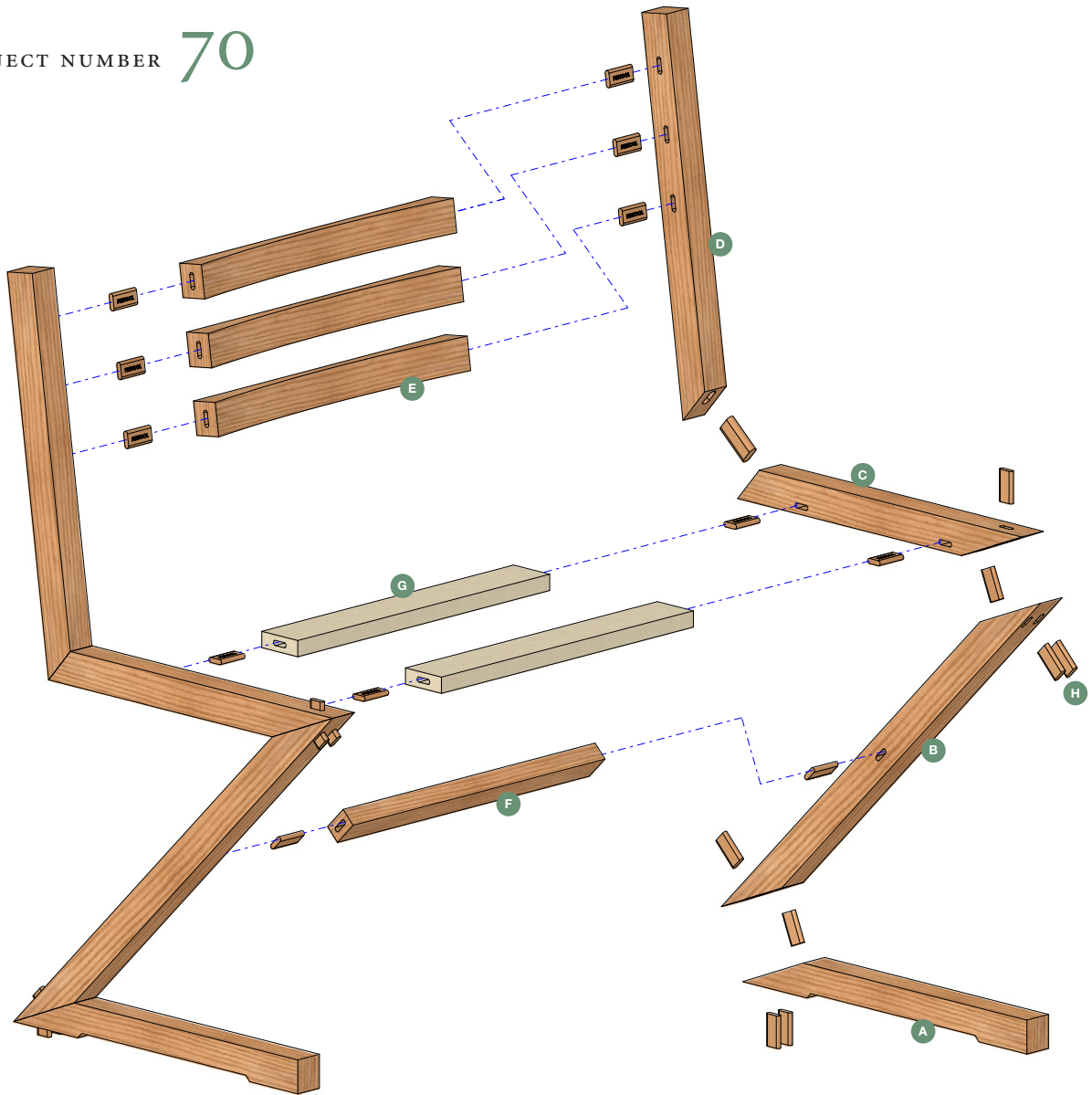
ters in the figures, so that the mortises are cut at the required distance from their respective reference faces. All the chair's mortises are 20mm deep, except for those for the locking tenons, which are 28mm deep, and those for the back stile miter, which are 25mm deep.

In order to achieve a perfect joint, the Domino's fence must lie perfectly flat on the workpiece, so that the mortise is milled exactly perpendicular to the face. To help ensure that the machine's fence remained flat during

the cut, I clamped a cleat behind the workpiece so the fence would have a broad surface to rest on (Fig. 2). Although this procedure slows the milling of the mortises a little, it is essential to avoid the risk of cutting any mortise at the wrong angle.

To mill the mortises in the end-grain of the back rails, seat rails and stretcher, you need to attach the narrow frame accessory (Fig. 3) to the Domino's fence to hold the machine steady during the cut. The mortises in the end





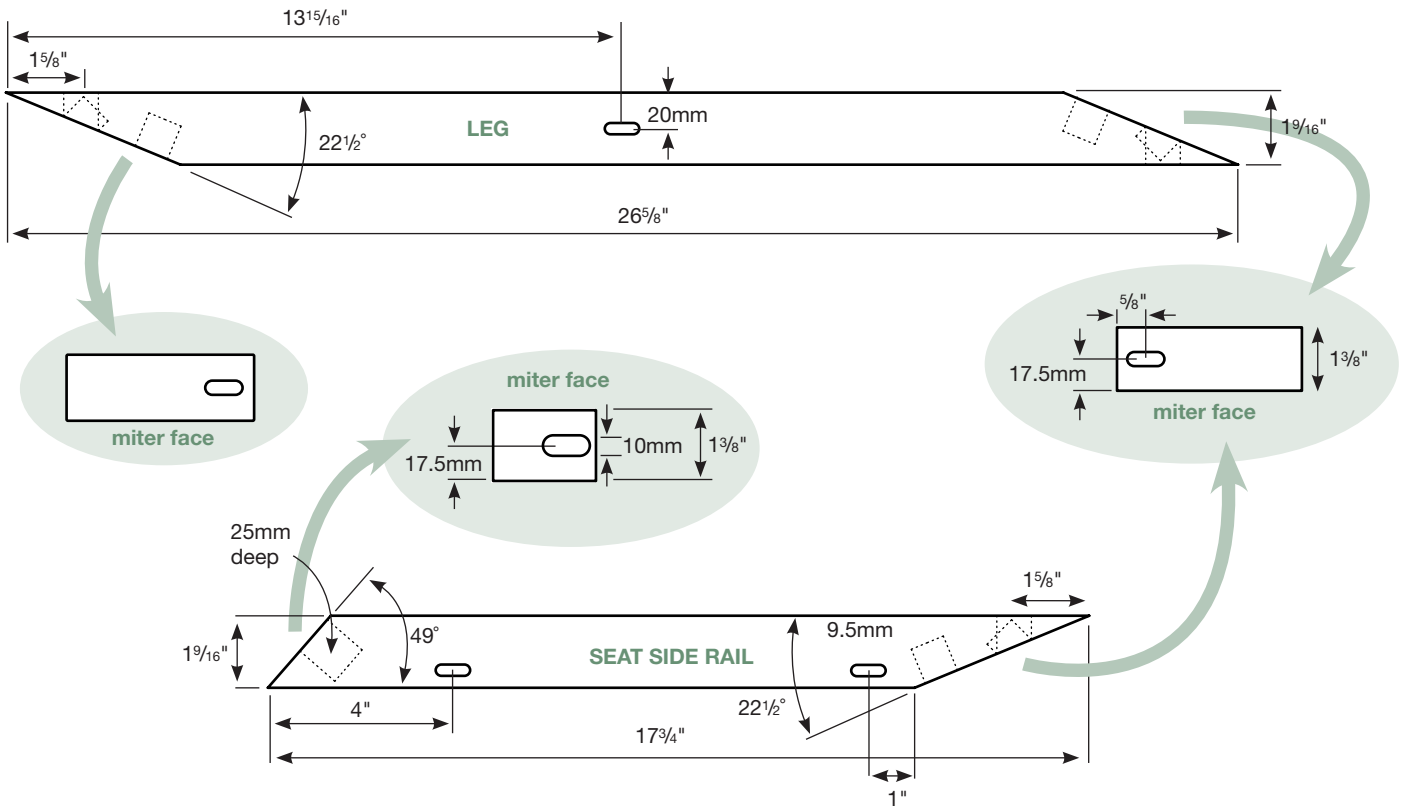
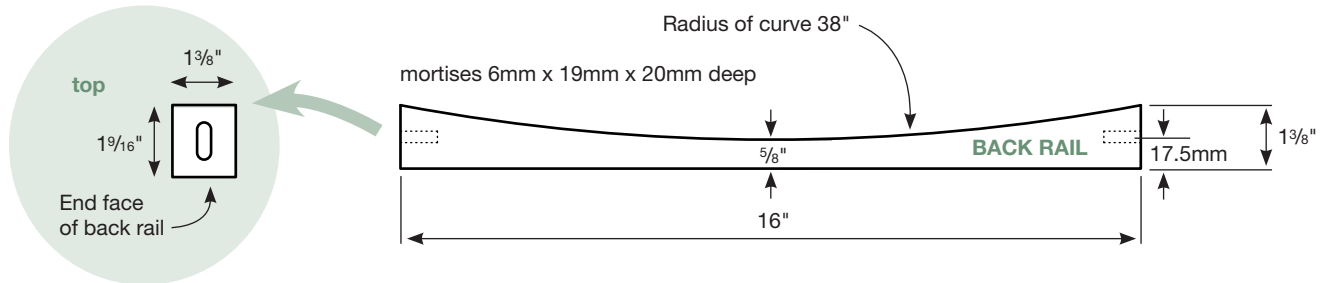
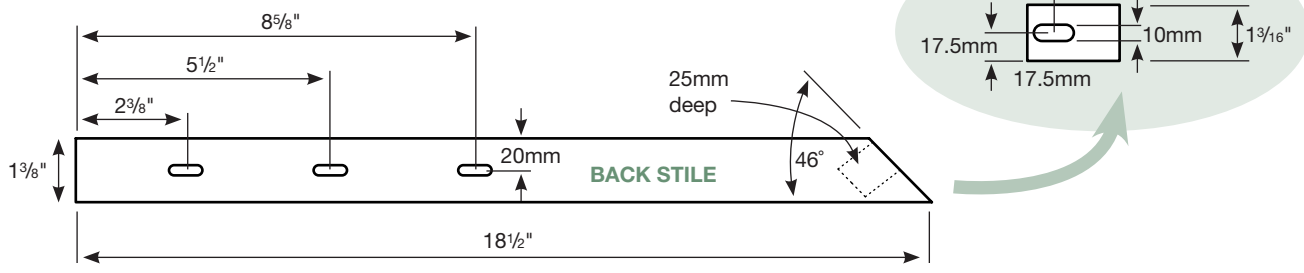
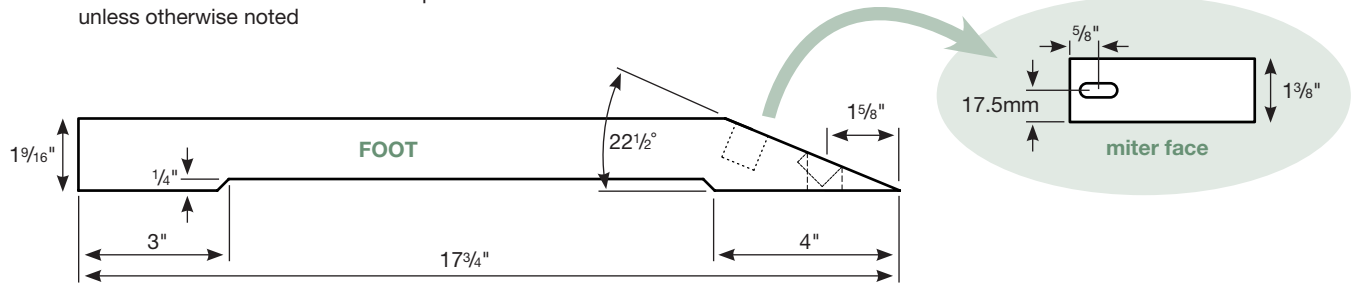
TOOLS, HARDWARE & MATERIALS

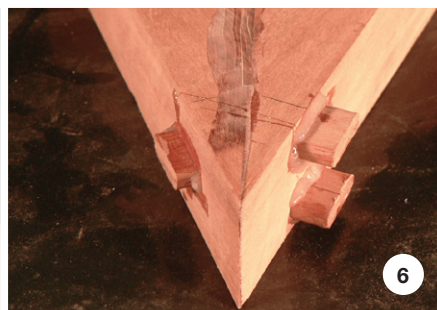
Festool Domino joiner, festool.com
 6 x 19 x 40mm Domino (16)
 10 x 23 x 50mm Domino (2)
 1 1/2" #8 brass wood screws (12)
 Minwax wipe-on polyurethane

CUT LIST

A Foot (2)	1 3/8" x 1 9/16" x 17 3/4"
B Leg (2)	1 3/8" x 1 9/16" x 26 5/8"
C Seat side rail (2)	1 3/8" x 1 9/16" x 17 3/4"
D Back stile (2)	1 3/8" x 1 9/16" x 18 1/2"
E Back rail (3)	1 3/8" x 1 9/16" x 16"
F Stretcher	7/8" x 1 3/8" x 16"
G Seat rail (2)	3/4" x 2 1/4" x 16"
Seat frame, side rail (2) - not illus.	5/8" x 2" x 17 1/4"
Seat frame, back/front rail (2) - not illus.	5/8" x 2" x 11 3/4"
H Locking tenon stock	6mm x 19mm x 500mm

mortises 6mm x 19mm x 20mm deep
unless otherwise noted





grain of the back rails, seat rails, and stretcher are all centered in their end faces.

Gluing the side assemblies

Before you start to glue up the side

assemblies, bandsaw the waste from the underside of the feet and sand all the parts (Fig. 4) to 150-grit. Glue 100-grit sandpaper to the 22.5° wedge offcuts to prevent slippage when the clamps are tightened.

The glueup is done in several stages, using a gap-filling epoxy with a gel consistency and a hardener that will allow plenty of time for assembly. It's easy to clean up after using epoxy if you spread carnauba wax in the areas that you expect squeeze-out to occur. The epoxy won't stick to it and the wax can be removed with mineral spirits

before you apply your final finish.

First, the 22.5° miters are glued up (Fig. 5) using a Domino in mortise B to ensure precise alignment of the joint. When the epoxy has set, the squeeze-out is cleaned up, and mortises J and K are milled; the locking tenons, shop-made from the same hardwood as the chair parts, are then glued in place (Fig. 6). When the glue has set, cut away the projecting portions of the locking tenons and sand them level.

Drill 1¼"-deep 7/64" pilot holes (Fig. 7) for the #8 brass screws; smear the screws with epoxy and drive them home, taking care not to split the wood by driving them too hard against the bottoms of their pilot holes. When the epoxy has set, the heads of the screws are sawn off and the screw shanks are filed (wrap the tip of the file with masking tape to prevent marring) and sanded level.

Before gluing the 49° miters (Fig. 8), cut away the tips of the 22.5° miters, removing about 3/8". After the sides are glued up you can gently round this front edge with a smooth file and sandpaper. Make four 8° wedges out of scrap to facilitate clamping the 49° miters. Finally, when the 49° miter joints have been glued up, drill pilot holes for screws to pin their reinforcing 20 x 50mm Dominoes, and glue them in place. Cut off the screw heads and file and sand their shanks level as before.

Gluing the rails

After sanding each of the side assemblies, lay one assembly on its outer face and insert epoxy into the mortises for the cross rails. Push 6 x 40mm Dominoes into the mortises and stand the back rails, seat rails, and stretcher vertically in position. Insert epoxy and Dominoes into the top end mortises of the rails; insert epoxy into the mortises in the second side assembly, and then get a helper to assist in fitting the assembly onto the Dominoes projecting from the ends of the rails. When the second assembly has been pushed home, stand the chair upright with its

feet on a level surface and clamp it until the epoxy has set (Fig. 9).

When set, clean away the epoxy squeeze-out, give the chair a final sanding and finish with four coats of Minwax Wipe-on Poly. Fig. 10 shows a close-up of a finished miter joint.

Making the seat frame

Mill mortises for 6 x 40mm Dominoes in the ends of the front and back rails of the seat frame and in the inner faces of the frame's side rails. The back and front rails of the seat frame are glued between its side rails. I took the frame to a professional upholsterer to get it upholstered with foam on elastic webbing and covered with black leather. There should be 1/8" clearance on either side of the seat frame to accommodate the thickness of the leather.

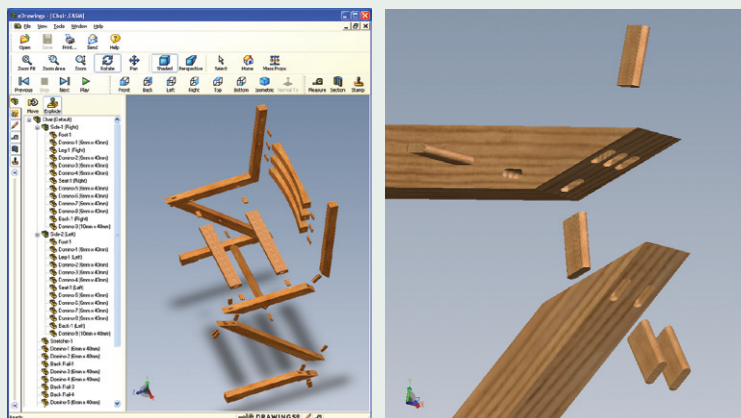
In order to be certain that the chair was strong enough to withstand the stresses of frequent use, it was tested by placing a board across its side rails and having three people with a total weight of 576 lbs. stand on the board. The rear ends of the side rails were depressed by 1/2" under the load, but sprang back to their original position when the load was removed, and the joints remained intact. 🌱



AMAZING DETAIL WITH FREE SOFTWARE

HAVE YOU EVER HAD A HARD TIME following drawings for projects that you'd like to build? Are there times when you would like to see hidden details? The eDrawings viewer is a universal CAD and solid model viewer that will let you open a wide range of two- and three-dimensional files. One such file, containing the Zigzag dining chair from this article, is available for you to download at woodcraftmagazine.com. The file includes the viewer as well as the model file, so there is nothing more to install on your computer.

You will be able to rotate, pan, and zoom into the 3-D image with your mouse. You will also be able to make the project explode and collapse, cut it in half with a section view, and even take measurements directly off the model!



Navigation Tips

- When you need to return the model to its original state, click on the Home button.
- To see the parts outlined because it makes the edges more distinct, go to the View menu and click on Show Edges When Shaded.
- To rotate your view around the model, click and hold your middle mouse button (or mouse wheel) as you move the mouse.
- To zoom in and out, move the mouse to the center of what you want to see, and spin the mouse wheel. If you don't have a wheel, click on the Zoom button and click-and-drag the mouse up or down to zoom.
- If you want to see details that are obscured by another part, right-click on the part and a popup menu will appear. You can make the part transparent or hide it completely.

Parts List, Move, Measure, and Explosion

Open the Feature Manager Tab by clicking the icon on the left side of your screen.

- The items listed are the parts and subassemblies that make up the chair. Clicking on any of these items will highlight the part or assembly in the model view.
- To see details that are obscured by a part, click on the Move icon, then drag the part with your mouse. Double-click on the moved part to return to its original position.
- Extract measurements by clicking the Measure icon, and clicking on a part.
- The great thing about the eDrawings viewer is that you can watch the assembly of parts explode and collapse to match the drawing in the magazine. Click on the Explode icon. Click it again to bring the chair parts back together.

The eDrawings viewer has many more features, so to learn more, check out the built-in help file. To download the free viewer separately, visit solidworks.com.

Download your free copy of the Zigzag chair and viewer in the projects section at WoodcraftMagazine.com.

David Dundas

David was an exploration geologist in Tanzania, England, and Australia. Since retiring in 1995, he has indulged his passion for furniture making, with a particular interest in designing and building chairs.



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