



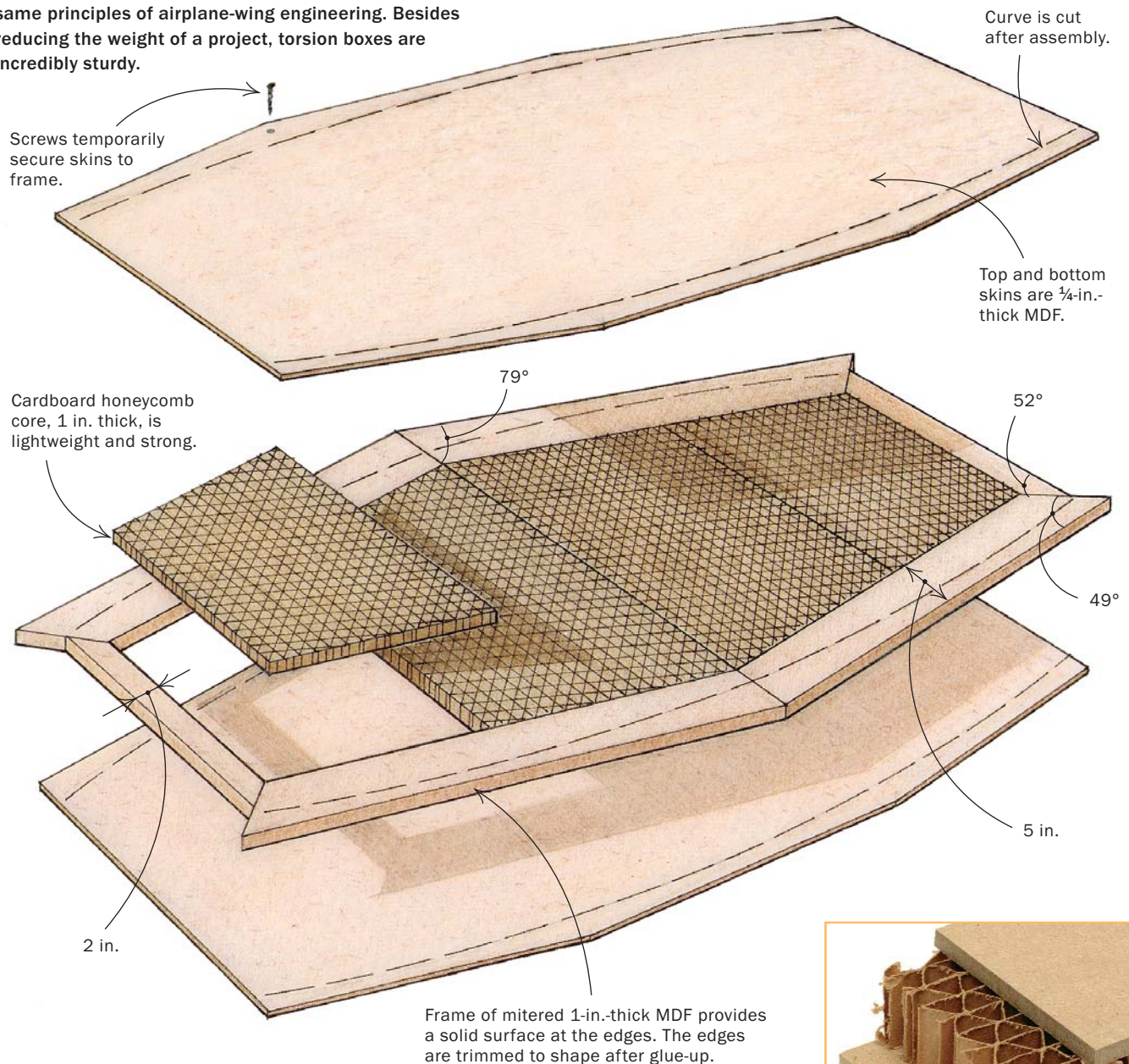
Tackling Large Tabletops

Make a tabletop that's as strong as an airplane wing
using torsion-box construction

BY KIM CARLETON GRAVES

TORSION-BOX CONSTRUCTION

Surprisingly few woodworkers ever consider this method of gluing up skins to a lightweight core, based on the same principles of airplane-wing engineering. Besides reducing the weight of a project, torsion boxes are incredibly sturdy.



SOURCE OF SUPPLY

Resin-impregnated honeycomb is available in 1/2-, 3/4- and 1-in. thicknesses from:

Vacuum Pressing Systems Inc.
553 River Road
Brunswick, ME 04011
(207) 725-0935

Modern engineering has always seemed like magic to me. I find it amazing that skyscrapers don't collapse of their own weight and that bulky airplanes get off the ground and stay airborne. What makes these structures work, of course, are designs that distribute stresses over large areas.

I've wanted to use this principle in building furniture, and recently—after 11 years of making furniture with solid wood or ordinary plywood construction—I decided to build a torsion-box table. A torsion box is

constructed much like an airplane wing, so it has a high strength-to-weight ratio. If I had built this tabletop from solid wood, it would be dimensionally unstable and too heavy to manage. The beauty of torsion-box construction is that it keeps the tabletop lightweight and flat, and it doesn't sag under its own weight.

Because I was making a large, formal dining table, I decided to build what's called a boat shape. The boat shape became popular for conference tables when researchers found that people seated at

CUT THE CORE TO FIT THE FRAME



Dry-fit the core. The cardboard honeycomb, purchased in 2-ft. by 4-ft. pieces, is cut on the table-saw and fitted within the MDF frame.



Cut the skins and frame to rough shape. After snapping a chalkline to the outside miters, the author uses a circular saw to remove much of the waste.

these curved tables could see and hear each other better than they could at long, straight tables. My feeling is that talking to your family and friends at dinner is just as important as talking to your colleagues or clients at meetings.

Anatomy of a torsion box

A torsion box consists of two thin skins glued to a core structure between them. The strength of the box comes from the gluelines, which are very thin individually but add up to a lot of glue surface overall. To make a core structure, you can staple together a simple lattice of wooden strips, which is the best alternative if you don't have a vacuum press. But making a lattice in this way is a lot of work, so I decided to use resin-impregnated cardboard honeycomb instead (see Sources on p. 77). Using this material for the core made the construction process cheaper and faster. Although the honeycomb is made of paper, it has enough glue surface to make a strong bond.

As you can see in the drawing on p. 77, I put an MDF frame around the honeycomb. This frame isn't needed for strength, but it protects the honeycomb from damage in the vacuum press. Also, it's used later to attach the veneer on the built-up edges around the table. Those edges hide the connection between pedestals and tabletop, and they make the tabletop look thicker than it really is.

Because of its shape and size, this table requires considerable care and attention to detail. The base assembly (see the drawing on p. 81) that I designed is quite difficult to make, because the pedestals taper in two directions and are constructed of veneered panels that must be cut with compound miters. For strength, I used plywood for the table subtop and the pedestal top that are screwed together to secure tabletop to base. But the torsion-box top is not difficult to make. Torsion boxes come in many sizes and shapes, and you can use them for parts other than tabletops, such as long unsupported shelves, beds or benches that must carry a lot of weight.

Build the core one layer at a time

Begin by milling strips of medium-density fiberboard (MDF) for the torsion-box frame and the built-up edges. The strips for the ends of the table are only 2 in. wide. For the curved sides, start with 5-in.-wide

strips to allow for the waste that will be cut off later.

Make enough strips to go around the table three times. One set—made of 1-in.-thick MDF—will become the torsion-box frame, and two sets—made of 3/4-in.-thick MDF—are needed for the built-up edges on the underside. After all of the strips have been cut, miter their ends so they fit together into rough outlines of the tabletop, as shown in the drawing. First, make 52° cuts at both ends of the 2-in. strips, then make 49° cuts at one end of each 5-in. strip. Finally, make 79° cuts on the other ends of the 5-in. strips, adjusting the angles as necessary until the strips fit together tightly. Miter cuts leave sharp points on the outer ends of the 5-in. strips. If you trim off these ends, the pieces will be easier to work with.

The top and bottom skins of the tabletop are made of 1/4-in.-thick MDF. You will also need to cut a tabletop-shaped caul made of 1/4-in.-thick melamine, for vacuum pressing, because most glue won't stick to the melamine. To save time, stack two sheets of MDF and one sheet of melamine on your bench and screw them together at the corners. This way you can cut both tabletop skins and the caul at the same time.

On top of this stack, lay out one set of edging strips and trace around the inside and outside with a pencil. Then use a circular saw to cut the tabletop skins and caul to rough shape just outside the outside layout lines.

Assemble and glue up the top a little oversized

Unstack the MDF and melamine sheets, keeping only the sheet of MDF with the edging outlines on your bench. Assemble the 1-in.-thick frame onto it, using the outlines you traced. Hold the frame in place with two drywall screws per piece.

The hexagonal space inside the frame will be filled with honeycomb. Cut the honeycomb to shape using the tablesaw, and lay it into the space. The honeycomb should fit snugly, with no scrunching and no large gaps at the edges.

Put on the top skin of 1/4-in.-thick MDF and then the melamine caul (melamine-side down), making sure all edges align within about 1/8 in. Trim them, if necessary. Round over the top edges and corners of the melamine sheet with a mill file, and disassemble the stack. Easing the edges pre-

GLUE UP THE SKINS



Don't spare the glue. A liberal amount of urea resin glue applied with a squeegee and roller guarantees a rigid bond at the glueline.



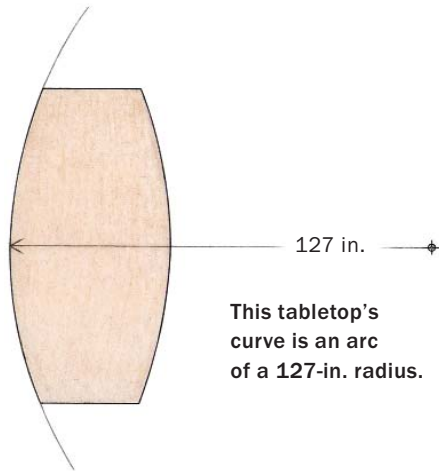
Work from the bottom up. After applying glue to the bottom skin, place the MDF frame and the honeycomb material in place. Fasten the frame to the skin with screws.



It doesn't take a lot of pressure. The honeycomb core requires only about half of the clamping pressure as that used for gluing up veneer.

CUT THE CURVED SHAPE WITH A SAME-SIZE TEMPLATE

Make a curved pattern. To cut the curved edges, make a template with the exact radius required. Cut it with a router mounted on a compass.



Cut the final shape. After glue-up, with the template clamped in place as a guide on the tabletop, the author trims off most of the waste with a jigsaw.



Clean up the curved edge. Without moving the template, he follows the jigsaw cut with a router fitted with a large flush-trimming bit that brings the table edges to their finished contour.

vents puncturing the vacuum bag during the glue-up.

Set up the vacuum press, adjusting the vacuum pump to provide 10 Hg to 15 Hg of pressure, and arrange the torsion box components in an orderly fashion so that you can work quickly. Spread urea resin glue on the entire surface of the bottom skin. Don't skimp on the glue, and don't use regular yellow or white glue, because they have too short an open time and won't give you a rigid glue line.

Position the 1-in.-thick frame, holding it

in place with a couple of 1-in. drywall screws through the skin into each frame piece. Make sure the heads of the screws are below the surface of the skin so that the skin sits flat on the platen. Put the honeycomb core inside the framework. Spread glue onto the bottom of the top skin and place it over the assembly. Screw the assembly together to keep it from slipping around in the vacuum press.

Place the top caul on the torsion box and put the assembly into the vacuum bag. Seal the bag and turn on the pump. Put some

glue into a piece of plastic wrap and press the panel until the glue in the plastic wrap is hard. After pressing, stand up the tabletop so that air can circulate around it overnight and the glue can cure fully. Remove all screws, fill the screw holes, and sand the filled repairs flat to keep them from telegraphing through the veneer.

Cut the final shape to size and build up the edges

This tabletop's curve is an arc of a circle with a 127-in. radius. To cut the arc of a

ANATOMY OF THE BASE

Two pedestals are constructed of tapered plywood panels that were veneered before being cut to size. The panels are joined with compound miters. An apron frame holds the two pedestals together. A pair of plywood subtops connects the base to the tabletop.

Torsion-box tabletop, 48 in. wide by 96 in. long, is 3 in. thick at the outside edges.

Apron end piece is biscuited, glued and screwed to apron side pieces.

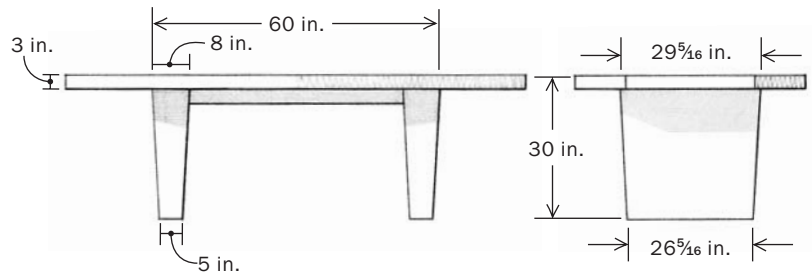
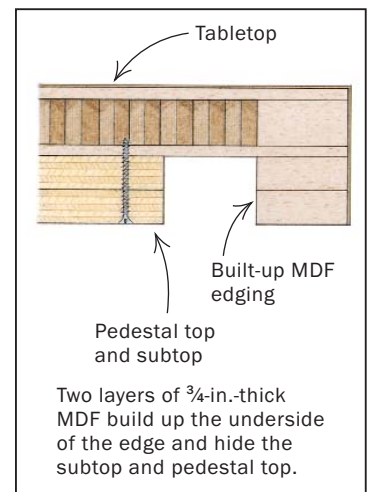
Aprons fit into slots at the inside tops of the pedestals.

Glued corner blocks for added strength

Compound miters at edges

Plywood subtop glued to underside of tabletop.

Plywood pedestal top screwed to apron.



large circle, make a template from 1-in.-thick MDF, using a router on a compass, then pattern-route the tabletop.

You can make the compass from scraps of plywood or MDF attached to a pivot that is screwed or hot-glued to the floor. The MDF sheet for the template should also be secured to the floor. Turn on the router and, making several passes, cut into the template until you're almost all the way through, being careful not to cut into the floor. Place the template on your workbench and cut through the router cut with

a jigsaw, then use a flush-trimming bit to rout off the last bit of waste. Once you've made the template, position it on the tabletop and clamp the template in place. Use a jigsaw to cut out the arcs to within 1/8 in. of the line. Then rout the remainder of the edge, using a top-bearing flush-trimming bit with a 1/2-in. shank.

I book-matched African satinwood veneer for this tabletop, with the grain running the long way to accentuate the table's length. Cutting the veneer 10 in. to 12 in. longer than the tabletop let me save match-

ing veneer to use on the edges of the table ends. The veneer was laid up with urea resin glue and pressed in the vacuum bag. I always use urea resin for gluing veneer to tops and bottoms of tabletops because the hard glue line holds veneers in place better, allowing less creep. □

Kim Carleton Graves is the owner of Carleton Woodworking in Brooklyn, N.Y. He wrote this article with the assistance of Masha Zager. Their book, "Dining Tables," will be published in February 2002 by The Taunton Press.