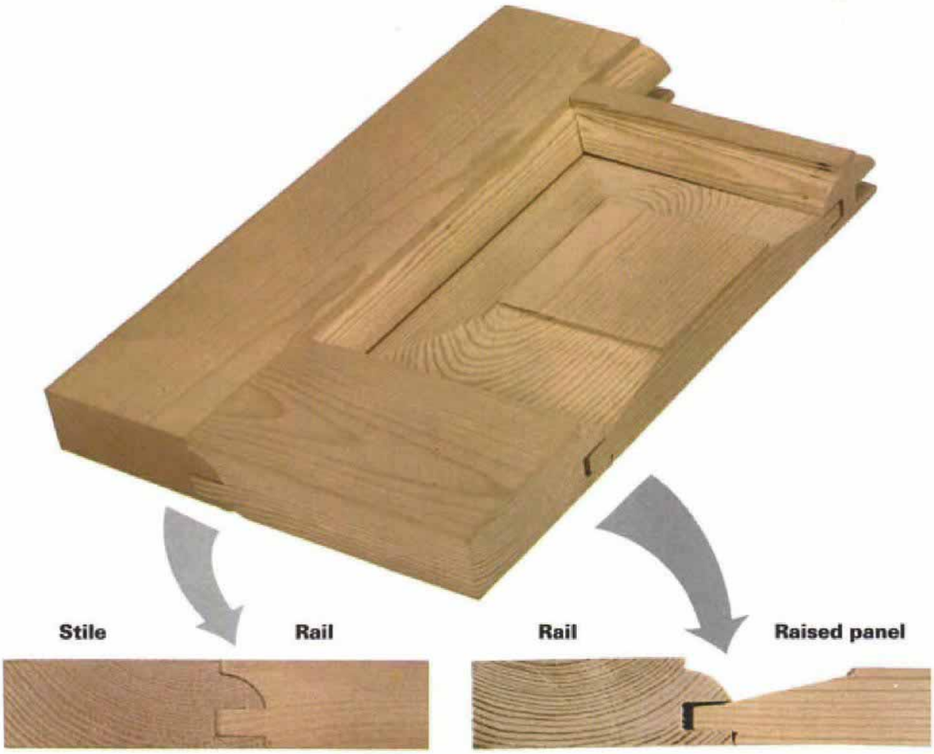


Making Cabinet Doors with Router Bits

The new generation of cope-and-stick bits will make frame-and-panel doors on site

by Jud Peake

Until recently, you had to have a shaper to mill the cope-and-stick profiles commonly found in frame-and-panel doors (photos above). But no more. Several companies now make router bits that can cut cope-and-stick patterns for door frames, along with bits that shape the edges of the panels that fit into the frames (see Sources of supply). Armed with a set of these bits, you can make frame-and-panel doors (or any other millwork that requires a cope and stick, such as divided-lite window sash and wainscoting) with a hefty router mounted in a table.

You might ask, as did I, "So what?"

I work for a company that installs custom kitchens, and for the cabinets we make, we buy the doors from shops that make first-rate frame-and-panel doors for a very reasonable price. Quite simply, they can make them better and faster than I can. So it was with a large measure of skepticism that I tried a set of cope-and-stick router bits.

But after trying them out in my shop and consulting with other carpenters and woodworkers who have used cope-and-stick router bits, I've found three good reasons to own these bits. First of all, if the lead time from a big shop is too long to fit the job schedule, building your own cabinet doors can make economic sense. Second, doors from big shops are reasonably priced only if they are standard shapes—rectangles primarily, with the occasional arched top. If you want to make doors with some complicated shapes in them (bottom photo, right), these bits are a good way to do it. And finally, if you enjoy making cabinets for the fun of it, a set of cope-and-stick router bits will definitely expand your capabilities.

You can do zigzags. Guided by its bearing, the stick and raised-panel bits can follow unorthodox profiles (this door profile required some handwork with chisels).

Photos this page: Robert Marsala

The stick and the cope—A set of cope-and-stick bits does three things: mills the groove for the panel, cuts a decorative profile around the inside edge of the frame and, at least in cabinet doors, cuts the joint that connects the stiles and the rails of the frame. The bits are, in fact, sometimes called stile-and-rail bits by the companies that sell them.

"Stick" is the term used to describe the profile of the frame that has the groove for the panel. The stick also includes the decorative profile—typically a radius or an ogee—that runs around the inside edge of the frame, setting off the panel. Stick profiles are milled into the inside edges of both the rails (the horizontal pieces of the frame) and the stiles (the vertical members).

The "cope" is the exact opposite profile of the stick, and it's cut into the end grain of the rails. The result is a butt joint of sorts, where the rails meet the stiles (left photos, facing page). Structurally, the cope includes a short tenon that fits into the panel groove in the stick profile. This shallow mortise and tenon presents enough face-grain to face-grain contact for the glue to get a good grab on the frame parts.

Router table—The router bits used to make cabinet doors aren't shaper cutters, but somehow calling them bits is misleading. The horizontal raised-panel bit is 3¼ in. in dia., and the cope-and-stick bits are about 1¾ in. in dia. Those are big hunks of steel, folks. To use these bits you need at least a 2-hp router with a ½-in. collet mounted upside down in a router table.

I set up my router table in one wing of my table saw so that I could use the saw's fence and miter-gauge slot. My saw's fence has wood sides and a gap in the center that accommodates the router bit. I put the gap in the center of the fence and mounted the router in the center of the table-saw wing. I reverse the fence whenever I need to use the saw's miter gauge to hold the workpiece as I pass it by the router bit.

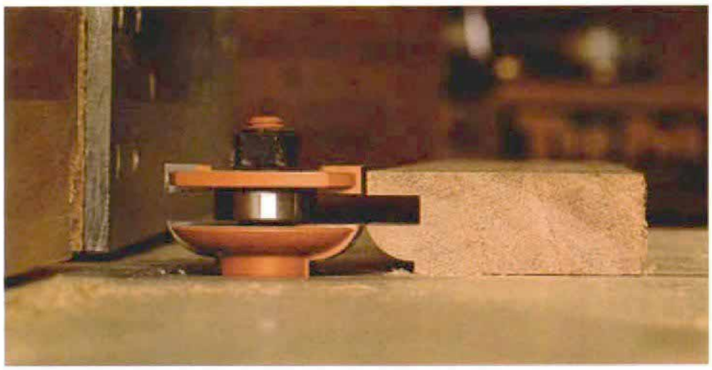
My router table is made of ½-in. birch plywood that I covered with a layer of plastic laminate. The bits I used as I researched this article (CMT Tools; see Sources of supply, p. 61) have 1½-in. long shanks.

A router bit should have at least three quarters of its shank in the collet and never less than ⅝ in. Also, to decrease vibration and to make it easier to remove the bit, don't quite let the bit bottom out in the collet.

The table controls the depth of cut, so hold the material flat against the table as you pass the workpiece by the bit. If you're using a simple profile such as the horizontal raised-panel bit (right photo, p. 60), and the material lifts off the table, you can correct the undercut by making another pass. But if you're using the stick or cope bit, any lifting of the material will result in an overcut. With the stick bit, the panel groove becomes too wide. With the cope bit, the tenon becomes too narrow, and the cope gets sloppy.

Preparing stock—Manufacturers of matched bits recommend that your material be thickness planed and jointed flat and square. But because all of the routing operations are indexed off

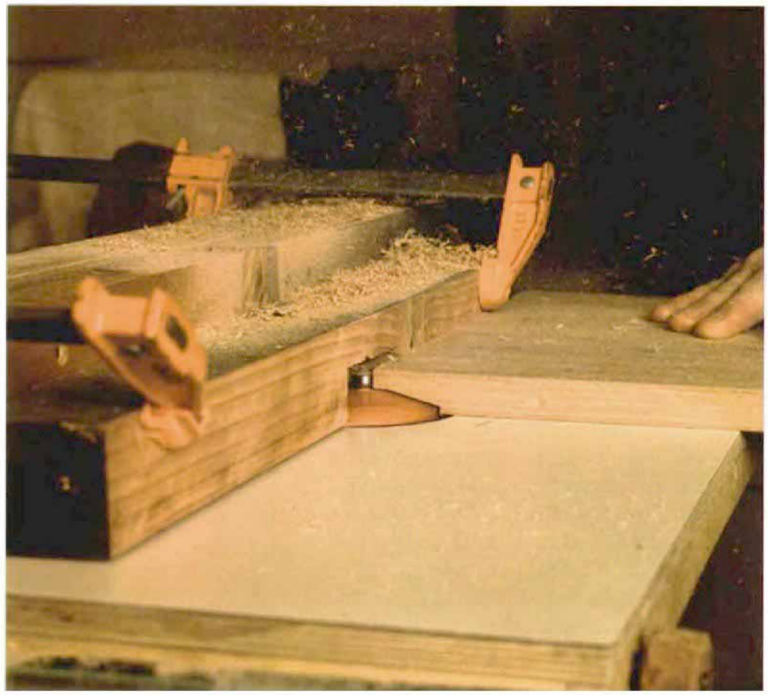
Cutting the stick. With the workpiece facedown on the router table, a rail is passed by the sticking bit. The rail is restrained from lifting by a featherboard hold-down. The curved portion of the cut will be a decorative detail. The groove above it will accept the edge of the raised panel.



Adjusting the cope bit. Fine-tune the height of the coping bit by placing a piece of the stuck rail facedown next to it. The gap in the bit should correspond to the gap in the rail.

Cutting the cope. The ends of the rails are milled with a coping bit to mate with the profile of the stick cut. To keep the end grain from tearing out as the bit exits the work, the author places a backer piece behind the rail. The backer must have the cope profile milled into its edge to nest properly against the workpiece.

Vertical raised-panel bit. An alternative to the 3¼-in. dia. panel-raising bit is this version, which requires that the panel be fed through the cutters while on edge.



Horizontal raised-panel bit. This 3¼-in. dia. bit cuts raised-panel profiles with the workpiece held flat against the router table. Note how the bit is shielded by the wooden auxiliary fence. The plane of the fence should be in line with the bit's bearing. This big bit is designed to turn at 12,000 rpm, so it must be used with a variable-speed router or a speed control.

the face of the material, these requirements—although preferable—might be a little stringent. I've made doors using material just as it came from the supplier, and the doors came out fine.

The ideal thickness for the rails and the stiles is ¾ in., and the perfect thickness for the panels is ⅝ in. When the panel is a little bit thinner than the frame, you can flush up the stiles and the rails on a sanding machine without the panel getting in the way once the door is assembled.

Make a cutlist before preparing any material. When you've got widths and lengths figured out, you can cut around the flaws in the raw materials to use it most effectively. To reduce ambiguity, develop the cutlist from a drawing or a sketch.

The standard width for cabinet-door stiles and rails is 2¼ in. The length of the stiles equals the height of the finished door. In determining the length of the rails, however, you must consider the portion of the coped rails that nests inside the profile of the stiles. With the bits I used, and the 2¼-in. stiles, the length of the rails had to be the width of the door minus 3⅝ in. The panel, on the other hand, had to be 3⅞ in. shorter and 4 in. narrower than the finished door. The instructions that come with the bits will tell you how to determine your overall measurements, so check the numbers for the particular brand of bits you have and adjust them appropriately.

The ⅛-in. difference in the calculation of the panel height compared to panel width allows 1⁄16 in. on both sides of the panel for cross-grain movement (grain running vertically). If you're making a raised-panel drawer front with the grain running horizontally, you'll need to reverse the panel-height vs. panel-width deduction. -

Panels made from multiple boards should be surfaced before routing. If you reinforce the joints between boards in a panel with biscuits, splines or dowels, make sure they are placed so that they won't be exposed when the panel edges are milled.

If you are making several frame-and-panel assemblies, prepare an extra piece in case one of the parts turns up flawed. Also, rip and thickness plane some scraps to be used as test pieces and as milling backers.

Finally, label the backs of stiles and rails. The parts are milled facedown on the router table, and it's easy to thoughtlessly push a piece through faceup. A rail properly stuck facedown, then coped faceup, can't be saved. Likewise, if the stiles are nearly the same length as the rails, it's all too easy to cope a stile by mistake.

Sticking the stiles and the rails—The setup for milling the inside edge of the stiles and the rails—the sticking—is a little arbitrary. The bit wants to be set at a height above the table that provides a solid step before the decorative part of the profile begins on the front, while nevertheless leaving enough material on the back to enclose the panel. The thinner your frame stock, the more of a compromise this choice becomes.

Once you've got the height of the bit set, install a hold-down to keep your material flat on the table (top photo, p. 59). Now you're ready to cut the stick. The bit removes too much material to make the cut in just one pass. Instead, move the fence over the bit so that the bit will remove about half the material with the first pass. Then adjust the fence so that the bit removes almost the rest of the material. The last pass is a cleanup cut to smooth the edges, and it removes very little wood. This last pass should be set up by adjusting the fence with the router off so that the material will appear to touch the guide bearing but won't roll the bearing when pushed past it. Remember to stick the rails as well as the stiles and always to mill with the stock facedown.

Coping the rails—Although the setup for the cope needs to be precise, it is easy to achieve. Notice that the profile of the coping bit—not the cut that it makes but the bit itself—is the same as the profile of the stuck rails and stiles. Lay a piece of the stuck stile facedown on the router table and adjust the bit up or down until the groove in the bit lines up with the groove in the stile (middle photo, p. 59). Now run a test piece and check the fit with a rail or a stile. When you've got it right, cut the cope profile in the long edge of a piece of scrap. The coping bit is, of course, used to cut the ends of the rails. This scrap will be used to back up the cut as you cope the cross-grain ends of the rails (bottom photo, p. 59). Without this backup piece, the bit will tear the fibers of the end grain as it exits the stuck edge of a rail or a stile.

Coping the rails requires a miter gauge or some other right-angle crosscut fixture. I screwed a 1x backer to the miter gauge and extended into the coping bit exactly as far as the rails will reach on their final passes. The backer's flat edge backs up the cope cuts on the rails and the stiles that don't have a stuck edge.

So far, I haven't had any trouble coping the rails without clamps or hold-downs. I take two passes to remove most of the material and one final light pass to clean up the tooled edge. Don't rely on the bearing to control the final pass because it's possible to cut inside the line of the bearing before the bearing is engaged. You can align the end of the rail with the end of the miter-gauge backer to make the final pass, but I find it easier to set my router fence as an end stop. This has the benefit of shrouding most of the bit for extra safety.

Raising panels—I tried both horizontal and vertical bits when it came time to raise the panels ("raise" is the term for cutting the beveled edge around the panels that tucks into the grooves in the frame). There are pros and cons to both styles.

The horizontal bit is too large to spin at the high speeds at which most routers operate. Instead, the horizontal bit needs to turn at 12,000 rpm. Use this bit with a variable-speed router or hook your router to a speed control.

The horizontal bit requires a big gap in the router fence, and it also needs a large cutout in the router table, which will need to be filled with an insert when smaller bits are being used. I made an aluminum insert for my router table and found out the hard way that the insert should be screwed down. When I turned on the router, a blast of air from the router's cooling fan blew the insert upward into the bit.

As you adjust the height of the horizontal raised-panel bit, remember that it's a good idea in the assembled door to have the face of the panel below the face of the assembled frame. It is the height of the bit that determines this relationship. The tongue that is shaped at the perimeter of the panel edge needs to be a shade under ¼ in. (7⁄32 in. to be exact). A perimeter rabbet on the back of the panel can fix the problem if your stock is too thick.

With either the horizontal or the vertical bit, you can advance the cut incrementally by either raising the bit or retreating the fence. I found it easier to fix the bit height and move the fence step by step.

With each step, make the first pass on a cross-grain end of the panel (right photo, facing page). Then systematically rotate the panel 90° at a time. This way, any tearout from the cross-grain cut will be removed in the next long-grain pass. Make sure you don't tilt the panel edge into the bit, producing too deep a cut. Again, on the final pass, set the fence so that the panel only appears to touch the guide bearing.

The vertical bit (left photo, facing page) doesn't require a speed control or a large cutout in your router table. I used the vertical bit with my standard fence, which is 3¼ in. high. That's not quite high enough in my opinion. The cuts I got were a little bit wavy, although they could be cleaned up with a rabbet plane. If I planned to use this bit regularly, I'd make an extra-tall fence—at least 6 in. tall. The tall fence should be continuous over the top of the gap cut for the bit.

You can save yourself some sawdust by precutting a bevel on your panel edges with a table saw. Then make the final shape with a couple of passes with the panel bit. Without precutting, I took four passes on each edge of a panel—three to dimension and one light finish pass.

Even though it requires a variable-speed setup, I prefer the horizontal raised-panel bit. It's easier to hold a panel flat to the table than it is flat to a fence, and the horizontal bit, because it has a bearing, can be used to raise panels that are not rectilinear in shape. The vertical bit can't do curves or the *zigzag* shape I made in my oak doors (bottom right photo, p. 58).

Checking for square. Before he glues up the door, the author checks the assembly for squareness by measuring the diagonals. When the diagonals are equal, the door is square.

Assembling the frame and the panel—All of the routed edges are much easier to sand before the frame and the panel are assembled. I was able to remove some burn marks left in the oak with some light passes with a rabbet plane. This tool also was good for knocking back some unruly cross-grain fuzz on the oak panels. The zigzag door also required some other hand work but not as much as I expected.

Dry-fit the assembly before gluing to make sure the parts fit together (photo above). When you're ready to spread glue, a plumber's flux brush is perfect for getting just the right amount of glue into a cope-and-stick joint. Remember, the panel must be able to expand and contract seasonally, so it shouldn't be glued into its grooves. You can use a couple of small brads on the back of the door to hold the panel in place. Center them top and bottom through the rails into the panel.

Notice that the cope-and-stick joint allows you to slide the rails up and down, between the stiles, thus adjusting the height of the door. Make sure that this dimension is correct, that the assembly is square and that the stiles are flat with the rails. Clamp with bar clamps or pipe clamps.

After the glue has set, you may need to flush up the face of the rail/stile joint. A thickness sander can handle this operation in the least amount of time if you've got a lot of doors to finish. If you don't have access to a thickness sander, you can use a belt sander or a random-orbit sander. With a belt sander, cautiously grind the rails down a little past the joint with the stiles, then sand the stiles up to the joint line. A random-orbit sander is especially good for the final grits, particularly at the rail/stile joints. □

Jud Peaks is a carpenter living in Oakland, Calif. He is a member of Union Local # 713. Photos by Charles Miller except where noted.

Sources of supply

This is a partial list of suppliers that sell cope-and-stick router bits to the public.

CMT, **5425 Beaumont Center Blvd., Suite 900, Tampa, Fla. 33634**
(800) 531-5559

Carb Tech, Trendlines
375 Beacham St., Chelsea, Mass. 02150
(800) 767-9999

Cascade **Tools**
Box 3110, Bellingham, Wash. 98227
(800) 235-0272

Eagle America.
Box 1099, Chardon, Ohio 44024
(800) 872-2511

Freud
Box 7187, High Point, N. C. 27264
(800) 472-7307

Grizzly
2406 Reach Road,
Williamsport, Pa. 17701
(800) 523-4777

MLCS
Box 4053, Rydal, Pa. 19046
(800) 533-9298

Woodhaven
5323 W. Kimberly,
Davenport, Iowa 52806
(800) 344-6657

Woodworker's Supply/Woodtek
1125 Jay Lane, Graham, N. C. 27253
(800) 645-9292