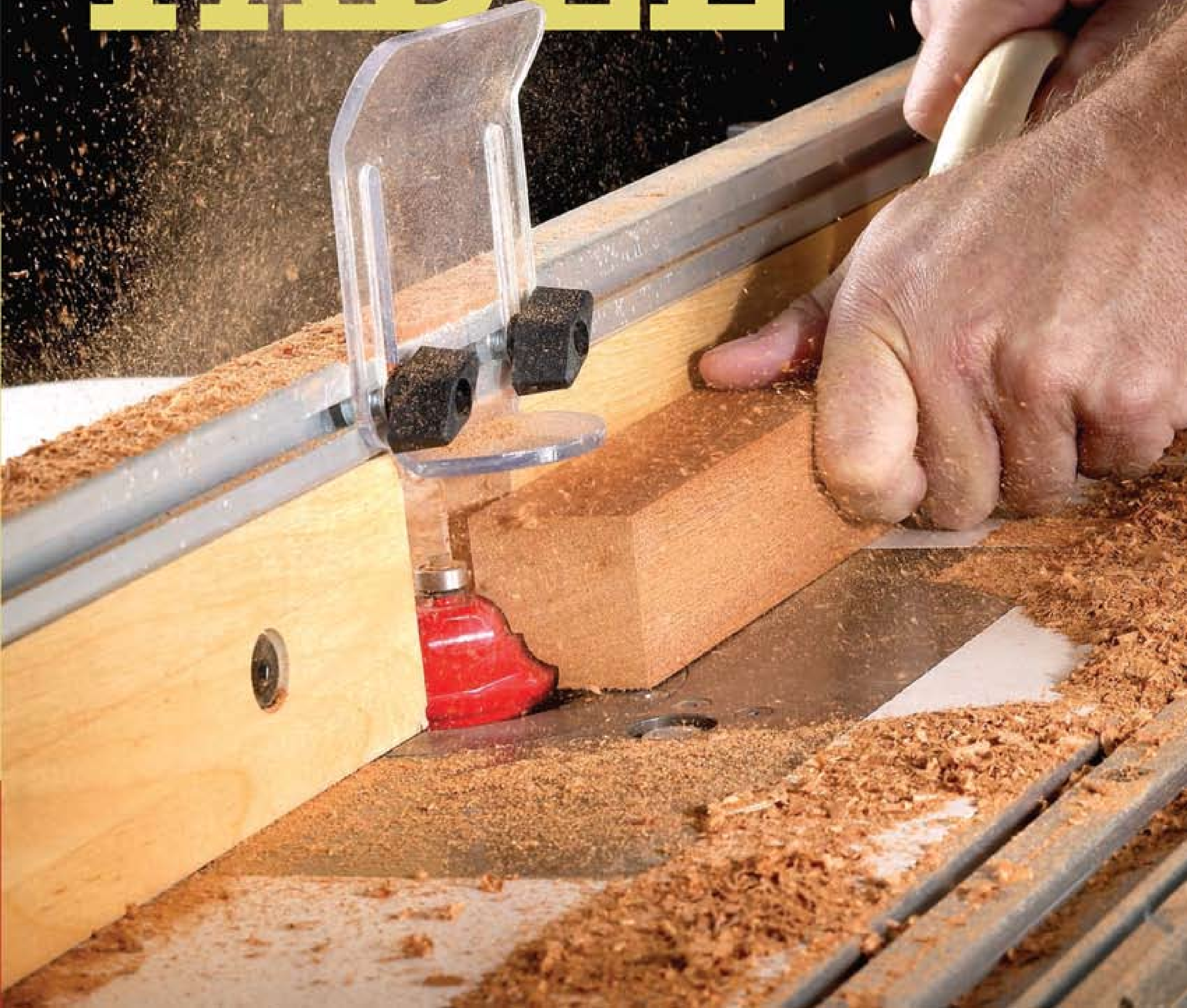
POPULAR WOODWORKING

Bill Hylton's Ultimate Guide to the ROUTER TABLE



Bill Hylton's Ultimate Guide to the ROUTER TABLE

POPULAR WOODWORKING BOOKS
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Read This Important Safety Notice

To prevent accidents, keep safety in mind while you work. Use the safety guards installed on power equipment; they are for your protection. When working on power equipment, keep fingers away from saw blades, wear safety goggles to prevent injuries from flying wood chips and sawdust, wear hearing protection and consider installing a dust vacuum to reduce the amount of airborne sawdust in your woodshop. Don't wear loose clothing, such as neckties or shirts with loose sleeves, or jewelry, such as rings, necklaces or bracelets, when working on power equipment. Tie back long hair to prevent it from getting caught in your equipment. People who are sensitive to certain chemicals should check the chemical content of any product before using it. The authors and editors who compiled this book have tried to make the contents as accurate and correct as possible. Plans, illustrations, photographs and text have been carefully checked. All instructions, plans and projects should be carefully read, studied and understood before beginning construction. Due to the variability of local conditions, construction materials, skill levels, etc., neither the author nor Popular Woodworking Books assumes any responsibility for any accidents, injuries, damages or other losses incurred resulting from the material presented in this book. Prices listed for supplies and equipment were current at the time of publication and are subject to change. Glass shelving should have all edges polished and must be tempered. Untempered glass shelves may shatter and can cause serious bodily injury. Tempered shelves are very strong and if they break will just crumble, minimizing personal injury.

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TO CONVERT	TO	MULTIPLY BY
Inches	Centimeters	2.54
Centimeters	Inches	0.4
Feet	Centimeters	30.5
Centimeters	Feet	0.03
Yards	Meters	0.9
Meters	Yards	1.1

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Bill Hylton is a longtime woodworker and writer, best known for his router books, *Woodworking with the Router* and *Router Magic*. His other books include *Illustrated Cabinetmaking*, and two Popular Woodworking titles, *Bill Hylton's Power Tool Joinery* and *Bill Hylton's Frame & Panel Magic*. He is a frequent contributor to *Popular Woodworking* magazine and *Woodworker's Journal* magazine.

Acknowledgements

This book has been a very long time coming. I want to acknowledge a few people who have been pivotal in its genesis, its long gestation, and now its birth.

I first worked with routers—about 18 years ago—because I was about to write a book on router woodworking. Yes, I believe this is called chutzpah. It worked out well. I had a superlative mentor, Fred Matlack, who ended up being the co-author of the book. We spent about 18 months developing it. That book, *Woodworking with the Router*, has been the standard reference on the topic since it was published (I completely revised and updated it in 2005).

I write that by way of acknowledging the roots of the book you hold in your hands. As an editor of woodworking books, I perceived there was a place for a comprehensive book on router woodworking. And when my last best prospect to be the author turned me down, it was my boss, Jeff Day, who said, "Well, I guess you'll have to write it." So I did, with a lot of help from Fred.

Ever since that time, the router has been a big part of my woodworking. Along the way, I had this idea for a router table user's manual. As I researched and wrote other books and magazine articles, I built up a base of know-how and experience using routers and router tables. I mooched routers, bits and accessories from manufacturers and vendors, tried them, and wrote about them.

So I'm grateful to Jeff, who started me on this road, and to Fred, who continues to be a source of ideas and woodworking know-how. I'm grateful too to the many manufacturers' reps who enable me to work with some of the newest and best routers and bits.

In terms of this router table manual, I'm thankful to Norston Fontaine of Bench Dog and Dan Sherman of Jessem, who provided me with their companies' router tables and router lifts.

I'm grateful for the sufferance of Jim Stack of F+W Publications.

I'm indebted to my friend Donna Chiarelli, a professional photographer, for her photographic guidance, advice and tips—all sound, and all free. I'm also indebted to Mr. Tripod and Mr. Self-Timer for their invaluable assistance in doing the photography. (Too bad they aren't more helpful around the woodshop.)

I'm most grateful, of course to my wife, Judi, who really put up with consequences of my addled work-habits.

Thanks to all.

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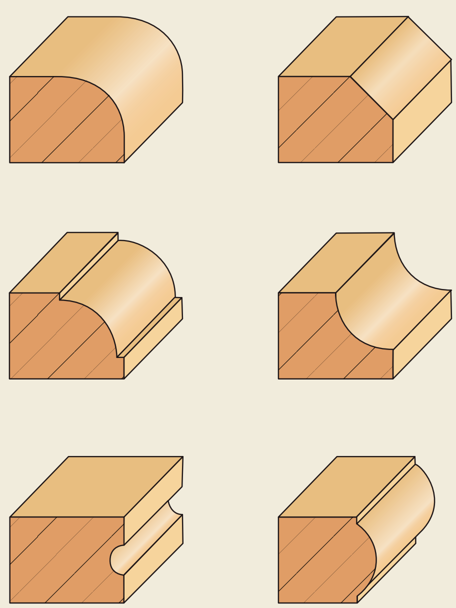
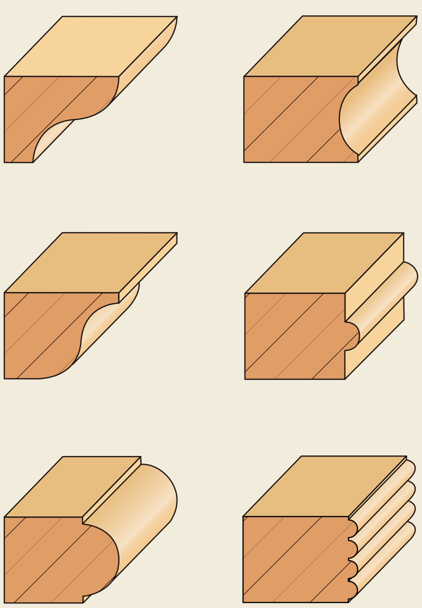




Introduction

This manual has been in my head for nearly a decade. When I first thought about it, the woodworking world was abuzz with router tables and accessories.

But there wasn't a comprehensive router table manual. Sure, every all-purpose router book had a chapter or two devoted to router tables. But everybody knows that the router is woodworking's most versatile power tool, and mounting it in a table doesn't diminish that versatility. You can do more different jobs on the router table than on any other woodshop power tool.

Nevertheless, no stand-alone collection of router table savvy existed. You couldn't find an operator's manual.

As it worked out, one project or another always took precedence, and it wasn't until the spring of 2006 that everything aligned, and I had both an interested publisher and the time to focus on router tables.

I pushed the band saw and the worktables back to the wall and cleared a space in the center of the shop. Into it I rolled three router tables I designed and built myself, plus a Bench Dog router table complete with router lift and a Jessem router table complete with router lift. I clamped a homemade benchtop table at one end of my workbench and my Po'Boy quick-and-dirty table at the other.

I opened the drawers of my bit cabinet, inventoried what I had, and made a list of bits I would need to mooch.

After picking through the lumber stash, I drove the few miles back to Bailey's Wood Products, a third-generation family sawmill operation, to stock up on poplar and maple, pick a couple cherry boards and walnut boards, a stick or two of sassafras, and…ooh…a piece of African mahogany.

Before dressing boards and getting down to the serious business of making noise and dirt, I made a list of techniques and operations I needed to run through, try out, experiment with. I needed to begin with tuning the router tables, making sure the tabletop was flat and true, the fence was straight and square to the tables, the mounting plates were sag-free and flush with the surrounding table surfaces. I had to consciously go through setting up—installing a bit and adjusting it, setting the fence, and doing all the tweaks experienced router-table users do almost automatically. I needed to cut profiles, make some frame-and-panel assemblies, work with templates and cut joints. The to-to list got longer and longer.

Eventually I got that shop time in, and I accumulated more hours than I expected. But there's always more than one way to do something, it seems, and I felt obliged to try.

One essential principle I confirmed is that router table savvy isn't brand or model specific.

Whether shop-built or purchased, freestanding or benchtop, full-featured or rudimentary, router tables all function the same way. You adjust the bit or the fence following the same parameters, regardless of how the adjustment is executed. Feed direction is always the same. Don't dismiss this manual because your router table is, well, different. At base, all router tables are the same, and this manual will apply to yours.

This is *not* a buyer's guide to routers, router tables, bits, lifts or accessories. It is a user's manual. It is *not* a construction plan for any router table. It is a user's manual for all router tables.

Yes, I've included plans for some useful accessories and jigs you can make. These gizmos—a bit guard/dust pickup, a sliding fence (use it instead of your table saw's miter gauge), a fence micro-adjuster, featherboards and so forth—increase the usability of any router table. You won't see stuff—other than bits—to buy. Sure, you can open your wallet and buy some version of most of them, but why buy a jig if you can make it. Most are surprisingly easy to make.

Relatively little of the information here is original. After all, cutting a dado is cutting a dado. Usually the best techniques are the tried and true ones.

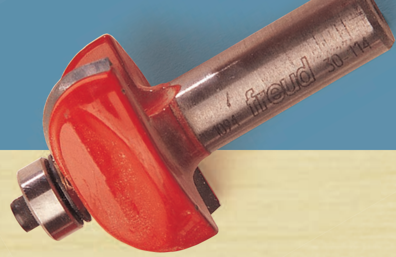
What is original is the logical, thorough, in-depth presentation. I cover those solid, traditional techniques as well as the exciting, new derivations. It's down-to-earth and practical. The information is complete and clearly presented.

And what's presented isn't some speculation. I've tried all these techniques and operations in my own shop. There's nothing in here that I'm not confident about, nothing that I haven't successfully done. This isn't everything I tried, of course. Techniques that proved problematic, excessively involved, too specialized or simply hazardous simply weren't included.

So what you hold in your hands is a shop-tested, comprehensive (though concise) user's manual for your router table. It isn't brand or model specific. Shop-built or purchased, freestanding or benchtop, full-featured or rudimentary, this manual will help you make the fullest possible use of your router table.

The woodworking world is still abuzz with router tables and accessories. But now, at last, you have a user's manual to follow.

Rout on, rout on!



CHAPTER

1 Basic Know-how

The router is a power tool that's revolutionized woodworking. Its versatility is legendary. It's spawned a substantial industry dedicated just to creating, manufacturing and marketing gizmos and accessories that make router woodworking safer, more convenient and increasingly accurate.

Easily the most useful of these accessories is the router table. It turns the portable router into a precision stationary machine. With the router hanging under a table, it's on standby for work, just the way your other shop tools are. You just install the bit, adjust the fence, hit the power and cut.

Getting this tool out of your hands and immobilizing it in the worktable has advantages. For one thing, it's less intimidating. And if it's housed in a cabinet, it can be less noisy. Capturing the dust is easier and more efficient.

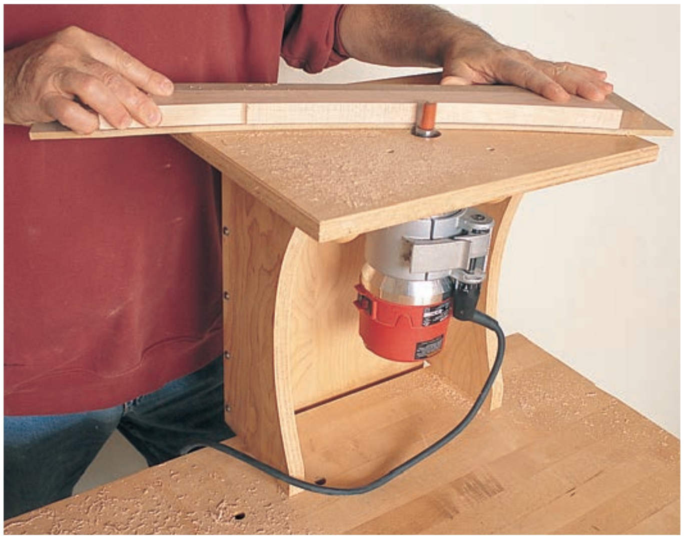
When you work with the router table-mounted, you move the work, not the tool, and that can be more convenient. You don't have to worry about the tool tipping or wobbling during a cut. You can see the cut being made. You don't waste time contriving schemes for securing small or odd-shaped workpieces. Precision is improved.

Topping it off is the capability of using the enormous variety of bits available, everything from $\frac{1}{8}$"-diameter straight bits up to $3\frac{1}{2}$"-diameter panel raisers.

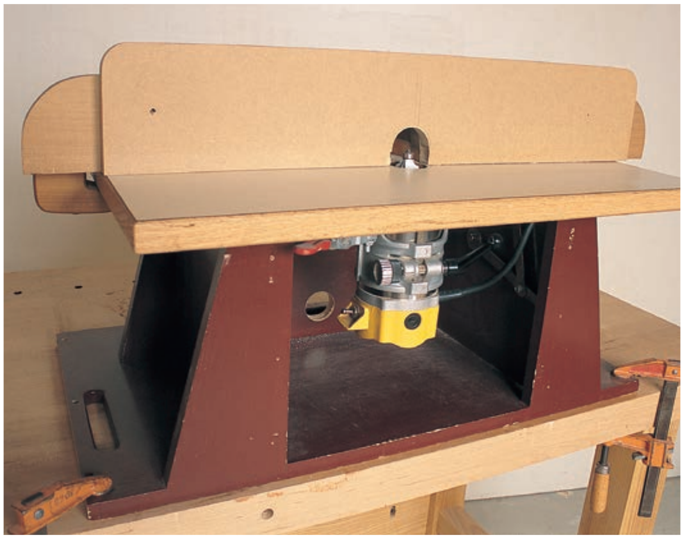
What I love about the router table is that you can make it yourself. It's like building your own workbench. You use woodworking materials and apply your woodworking know-how. The result is something you use regularly, something you're proud to show off.

A router table doesn't have to be expensive at all (see the Po'Boy on the facing page). But that doesn't mean we don't get carried away, investing way too much time and money in router tables. It's all too easy to drop more than a grand

The router table is one of the most-used tools in my shop. Here's my current alpha table, built to suit me and no one else. It's taller than the norm and mounted on casters. The fixed-base router is mounted directly to the tabletop, which is reinforced with a wood frame. The wood and MDF fence is secured with integral clamps, but comes off the table completely in seconds. And of course the cabinet has lots of storage space for bits and frequently used accessories.



A router table doesn't have to be big and fancy. I call this the Po'Boy because it's assembled from four relatively small pieces of $^3/_4$" plywood with a handful of screws. The back extends below the sides so the bench vise can secure it.



Where shop space is limited, a benchtop router table—wheather a commercial model or shop-built—is sensible. Keep it tucked into an out-of-the-way corner, clamp it on the bench when you use it. This table is used for everything from joinery to panel raising.

into a router table with an expansive top, a powerful router and a lift, a sophisticated fence with micrometer adjusters and lots of attachments and a cabinet replete with bit and accessory storage, dust collection and its own electrical system.

For the investment to pay off, you've got to use that table, of course. Using a router table is what this book is about. All router tables function the same way, so it's immaterial whether you are using a Po'Boy type of table, a commercial table or a custom-built table of your own design.

Safe and effective use is your goal.

In the following pages, we'll run through the basics. You'll see how to check and tune your table and fence, something you'll probably do infrequently. But every time you use your router table, you'll be installing a bit and adjusting it and the fence. Here you'll find the setup fundamentals that enable you to achieve accurate cuts every time. You see also how to make controlled and safe cuts. We'll look at a few accessories you can make and use with whatever table you own.

And in subsequent chapters, we'll consider specific, common router table operations: routing profiles, making frame-and-panel assemblies, cutting joints and doing template-guided shaping.

There are many router table configurations.. The commercial table (left) has a router lift and tracks and slots in the top and fence. The custom-made cabinet table (center) features a plunge router hung from a plate in a tilting top. And the open-legged table has a smallish MDF top finished with oil.

Checking Your Basic Setup

To achieve accurate cuts, your router table must be accurate. The tabletop must be flat and free of obstructions (like a misaligned mounting plate). The router mounting plate, if you use one, must be flat and flush with the tabletop. The fence must be straight and square to the tabletop.

How flat is flat? Some router users are fanatic about this, checking with a machinist's precision straightedge and feeler gauges from edge to edge, from front to back and diagonally from corner to corner. You are welcome to do that.

A 4' carpenter's level is satisfactory for evaluating tabletop flatness. Do this with the router in place but without the fence installed. Set the level along the main path first—side-to-side across the bit opening. Check along the front and back edges and along the miter-gauge slot, if there is one. Turn the level and check front to back at spots from one side to the other.

Squat down and sight along the seam between the level and the tabletop. Do you see a crack of light anywhere along that seam? Can you measure the gap between level and tabletop?

My take is that the tabletop is like the sole of a hand plane.

The hand plane sole, experts say, should be basically flat overall. It is essential that the edges, the toe and heel and the perimeter of the throat all be in the same true plane. There should be no spots higher than that plane. But if you have some shallow depressions here and there, that's tolerable.

To translate that into router table terms, you need the edges and the area around the bit to be in the same flat plane. Shallow depressions elsewhere are OK, but not high spots. Clearly, the fewer, smaller and shallower any depressions are, the better.

Having the bit in the center of a depression, which is what you get when a tabletop sags, is surely the worst problem. This definitely will lead to inaccurate cuts, and the little inaccuracies may be hard to trace. Not only will joinery cuts be inconsistent and slightly out of square, so will profiles.

Sag is surprisingly common, even in manufactured tops. Tabletops are commonly plastic laminate-clad MDF, 1" to $1\frac{1}{8}$" thick, with plastic T-molding banding the edges. While MDF is dense and flat, it has no grain at all and sags readily under its own weight.

Finding a dip along a miter gauge slot is not uncommon. The slot severs the plastic laminate, which helps stiffen the top, and weakens the core. And the slot is completely unnecessary. (I've never made a tabletop with a slot, and I've never missed having it.)

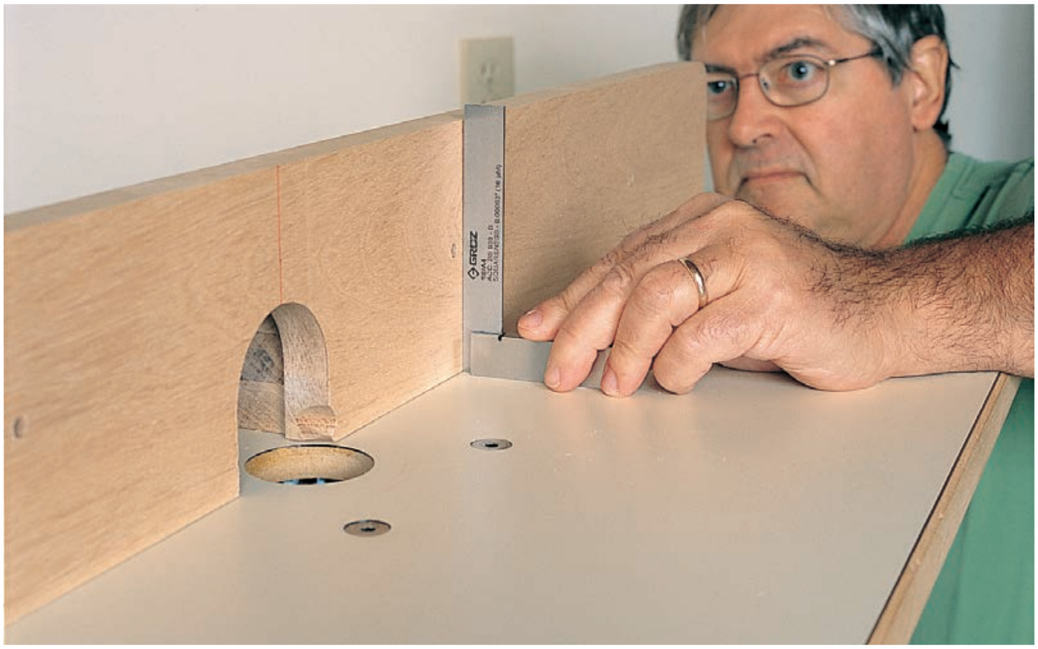
Twist can be a problem. Check the diagonals with the level. If one diagonal is bowed and the other is flat or bowed in the opposite direction, the tabletop is twisted.

If you uncover problems, turn the page to find some tactics to rehabilitate a sagging or warped tabletop.

To check the flatness of a common 2' by 3' router table top, you need a straightedge that's at least 3' long. A 4' carpenter's level is sufficiently straight for the job. Set it on the main path across the table and look carefully for gaps between the tabletop and the level. Repeat the check front to back and diagonally from corner to corner.

The router mounting plate must be flush with the tabletop. Use a sharp-edged scrap block to check this, sliding it over the seam between plate and top. If it catches anywhere along the seam, whether it's moving from plate to top or top to plate, the plate level must be adjusted.

To check the fence, use the carpenter's level or, if you have one, a long straightedge. With the fence locked down along the main feed path, hold the level against the face at the bottom and at the top.



Check the fence face to tabletop alignment with a square. Start at one end and check every few inches all the way across the table. This fence isn't square to the table, though the tabletop is flat and the fence is straight.

Check the Mounting Plate

The conventional method of mounting a router in a table is with a mounting plate, a.k.a. an insert. The plate may be acrylic, polycarbonate or phenolic plastic or aluminum. The plate sets in a rabbeted opening in the tabletop.

The plate needs to be flat and flush with the tabletop. Check the plate's flatness with a straightedge. Check whether or not it is flush with a scrap, sliding it back and forth across the seam between tabletop and plate.

Check the Fence

The most-used guide system on a router table is the fence. To work properly for you, the fence must be perfectly straight from end to end and its face must be perpendicular to the tabletop all along its length.

These characteristics are easy enough to check, but you can't be sure about the fence unless the tabletop is demonstrably flat. The tabletop is the reference surface, so resolve any shortcomings in the top before even checking the fence.

To check the fence, align it across the bit opening and clamp it. Use the level as a straightedge holding it against the fence face along both the top and bottom edges. Look for gaps between the face and the level.

If the fence facing is split, check for misalignment where the halves meet. Slide a sharp-edged scrap back and forth across the seam.

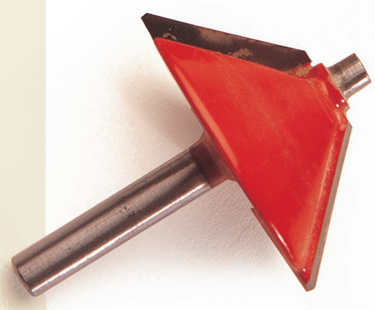
Finally, use a square to check the fence face against the tabletop.

Solutions: Flattening a Tabletop

The best way to keep a tabletop flat is with a rigid frame made of either steel or wood. But the top should be flat before mounting a frame. It isn't a given that you can pull a bowed or warped tabletop flat simply by mounting it on a frame.

To flatten the top, turn it over and prompt it to sag in the other direction. Remove the top from the stand or cabinet and turn it upside down on a flat, true surface with blocks of uniform thickness under the four corners. Lay plywood over the opening for the mounting plate (if there is one). Stack weight—8 to 12 pounds—on the center of the tabletop. It may take only a few hours to settle, but it may take a couple of days. Check the top with the level periodically.

Once the tabletop is flat, mount the frame to keep it flat. You can use lengths of angle iron to form a frame, or you can construct a wooden frame. The metal frame will be shallower, but the wooden one is easier to make and mount. In either case, you need a perimeter frame with stretchers extending front to back as close to the router as possible.



Metal Support Frame

Angle iron is available at most hardware stores or home centers. Choose the 1⁄8" × 1 1⁄2" × 1 1⁄2" size, and check the straightness of the pieces before you buy them.

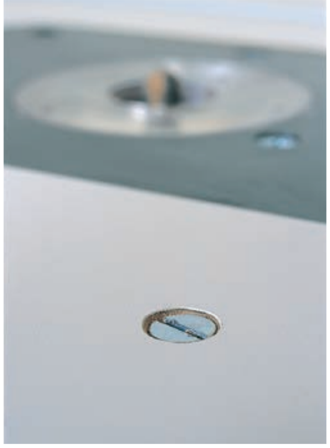
Using a hacksaw, cut pieces to form a perimeter frame and at least two additional reinforcing members flanking the router. The frame pieces don't need to be joined to each other, just to the tabletop.

The frame piece can be fastened to the table in several ways. The obvious being with No.10 or No.12 sheet metal screws. Depending on the top's thickness, they should be 3⁄4" or 1" long. Sheet metal screws are straight-shanked and threaded their entire length. They'll hold better than conventional wood screws in grain-free MDF.

If you choose this option, use a lot of screws, spacing them about 3" apart. Drill clearance holes in the angle iron. In the tabletop, drill pilot holes matching the screw's root diameter. Seat the screws firmly, but don't overdo it and strip out the pilots.

A less obvious technique is to use flathead machine screws. This pocks your tabletop surface with screw heads, but so long as they're countersunk adequately, the impact is strictly cosmetic. Machine screws can be more widely spaced. Use lock or star washers under the nuts to keep them from loosening over time.

If weight hanging from the center of an MDF router table top has caused it to sag, flipping it over and stacking weight in the center should reverse the sag. Set the top on blocks of equal thickness, cover the mounting plate opening with a scrap of plywood, and put some weight on it.



Fastening strips of angle iron to the underside of a tabletop is a low-profile means of keeping it flat. The strips don't actually have to be joined together, but they do need to be straight and fastened securely to the tabletop. Form a perimeter frame and add an extra strip across the table on either side of the router. Flathead machine screws are the best fasteners to use as long as they are countersunk, screw heads on the top surface won't interfere with the free movement of work.

Wooden Support Frame

The ideal wooden frame is made of quarter-sawn stock that's well acclimated to your shop.

Joint and plane the stock carefully and rip it 2½" to 3" wide. Assemble a perimeter frame with rabbet joints, and dado the stretchers that flank the router into the perimeter frame. Make sure the frame is square and use an assembly surface you know is flat and true for the glue-up.

The tabletop can be fastened to a wooden frame by driving screws through its face into the frame. The screws heads will show but it's fast and secure.

A mounting that leaves the tabletop face unblemished is shown here. Use connector bolts, though any long machine screw or bolt could be substituted. Drill clearance holes in the frame, then transfer their locations to the underside of the tabletop. Drill and tap holes in the tabletop; no threaded inserts needed. The threads cut easily without cutting fluid of any kind, and they hold extremely well.

Connector bolts, used to mount the support frame to the tabletop, are available in a limited number of lengths. Measure the bolts you have and drill counterbores in the frame with a Forstner bit, boring deep enough to allow the bolt to extend about ¾" into the tabletop core.

To transfer the bolt hole locations from the frame to the tabletop, align the frame on the underside of the tabletop and clamp it. Insert a ¼" spotter (a.k.a. a transfer punch) into the bolt hole and hit it with a hammer, marking the centerpoint of the hole.

A support frame is often beneficial in keeping a tabletop flat. Especially if the tabletop is mounted on an open stand or if it's hinged, it needs reinforcement. A wooden frame doesn't need to be deep to be effective, and it's a lot easier for a woodworker to build than a metal one.

Tapping the hole in MDF is as easy as turning a bolt into the hole. No cutting fluid is needed. Just don't run the tap too far into the hole or you'll pack dust against the bottom, causing a bulge on the table surface.

Solutions: Adding Plate Levelers

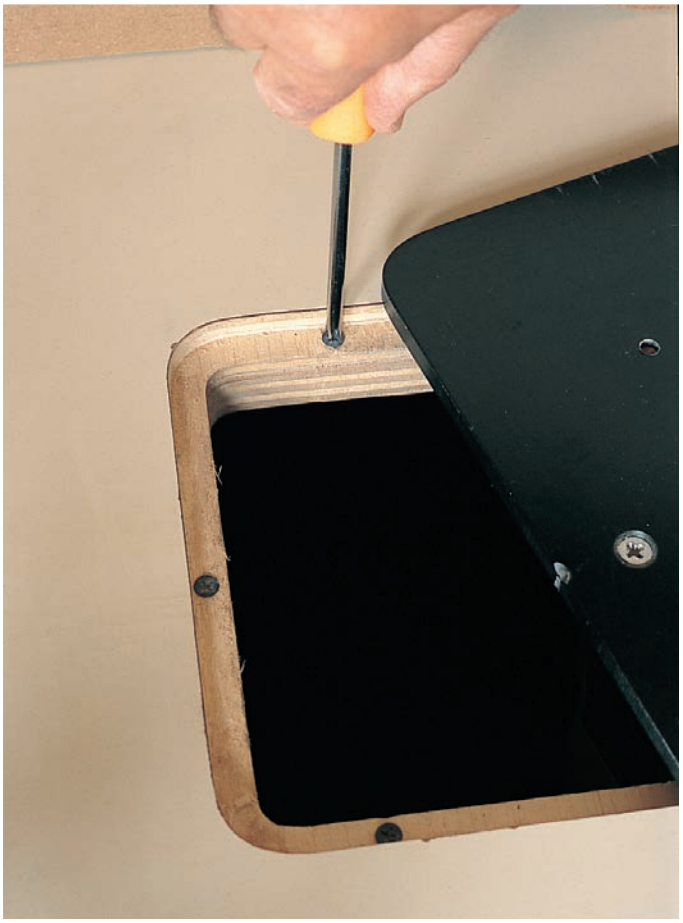
The only permanent fix for a bowed or warped mounting plate is to replace it, buy or make a new one. If you suspect the material is at the root of the problem, by all means use something different. Although many swear by polycarbonate because it's virtually unbreakable, it's very modestly limber and thus is prone to sag. Use phenolic, acrylic or aluminum instead.

Adjusting a plate to bring it flush with the table surface typically is done with leveling screws of some configuration. Factory-made tabletops usually have machine screws extending up through the rabbet around the plate opening. The plate rests on the screw tips. Turn the screws one way or the other to change the plate's elevation.

You can easily add plate adjusters to a table that doesn't have them, as shown in the photos.

To adjust the plate, back any screws except the corners out of play. Begin with the corners on the infeed side. Adjust the plate's elevation there so your test block just snags when sliding from the plate to the table. Switch to the outfeed side and adjust it the same. Then fine tune the plate until both infeed and outfeed edges of the plate are perfectly flush—that is, so you can slide the test block from table to plate and back without snagging.

With the corner screws set, adjust any screws along the plate edges one by one. Raise a screw until the plate rocks on it, then back it off until the rocking stops. Move to the next screw.



A simple, shop-brewed plate leveling system requires only a handful of drywall screws. Drive them into the plate rabbet in the tabletop. The plate rests on the screw heads. Turn the individual screws in or out to level the plate.

Setscrews installed in a plate allow you to level it with it in place. Drill and tap holes in the plate. Before turning in the set screws, drop the plate into the tabletop opening and mark through each with an awl. Push a thumbtack into each awl mark in the rabbet so the set screws have a hard surface to bear against.

Confirmat screws are designed to grip tightly in particleboard and MDF. They also have flat tips. These features make them excellent plate levelers. Drill the appropriate pilot holes in the plate rabbet and drive screws up through them. You'll be able to drop the plate into the opening and level it. The screws won't vibrate loose.

Solutions: Straightening/Squaring a Fence

The fence that is easiest to true is a wooden one (a shop-made fence, in other words). Commercial fences, on the other hand, usually are aluminum extrusions with MDF faces. There are definite limits to what you can do to true one that's not straight and square.

If you built your own fence from solid wood and you didn't use fasteners to assemble it, keeping it straight and square is a matter of jointing. Remove facings and clamps if the fence has them.

First make the base straight. Scribble on the base with a pencil and then run the fence over the jointer. If all the pencil lines are gone, the jointer knives have planed the entire surface and it should be flat and straight. Hold that surface tight against the jointer fence as you joint the fence face. Check base-to-face with a square. If it's square, clamp it to the router table and check again, this time tabletop to fence face.

If you've made your fence of plywood or MDF, or if you bought a fence assembled around an aluminum angle or extrusion, you can't joint it. You must shim it.

Masking tape is the best shim material. It's cheap, readily available—you probably have some in your shop right now—and easy to use. Just apply as many strips as you need to create the thickness that corrects the problem. (Avoid using duct tape. It's prone to creep and is a terrible mess to remove.)

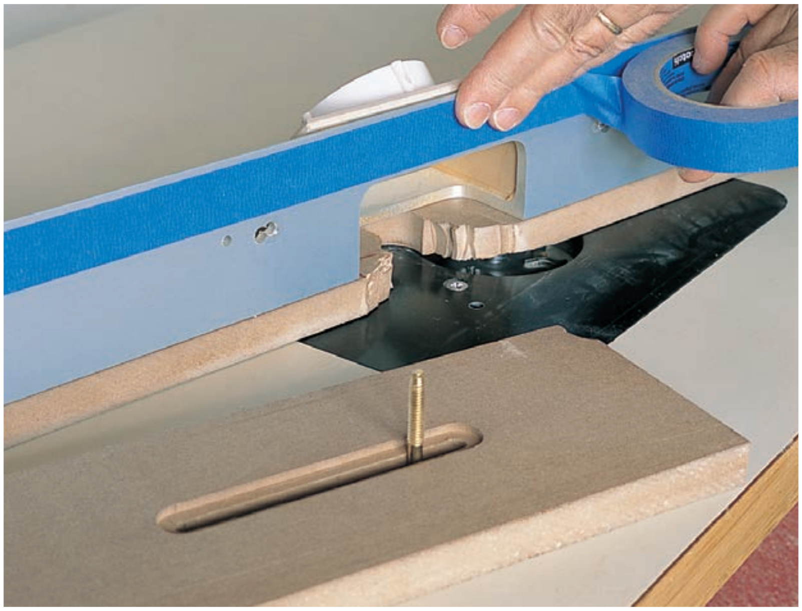
Start with the fence clamped to the table. Check the alignment with a square to determine where the fence is out of square and by how much. Then remove the facings and apply tape to the fence.

If the entire fence is out of square, apply a strip of tape from end to end. Apply it at the top edge if the fence leans back, at the bottom if it leans forward. Apply as many layers as you think necessary to correct the problem. Then remount the facings and check with the square. Repeat this process until the fence is square.

Of course, if the fence is out in only one area, you need to shim only that area.

Once you've squared up the face, check that the fence is straight. Use the level or straightedge for this check. If straightening is needed, apply tape. Put it on top of any you already applied to square the face to the table.

A wooden fence with no fasteners or hardware can be jointed to true it. Run the base surface across the machine to flatten it. When the base is flat, hold it tight to the jointer fence and feed it across the knives to flatten the fence face and square it to the base.



Commercial fences generally are aluminum angles or extrusions with MDF facings. If the face isn't straight or if it isn't square to the tabletop, the only remedy is to apply masking tape to the aluminum behind the facings.

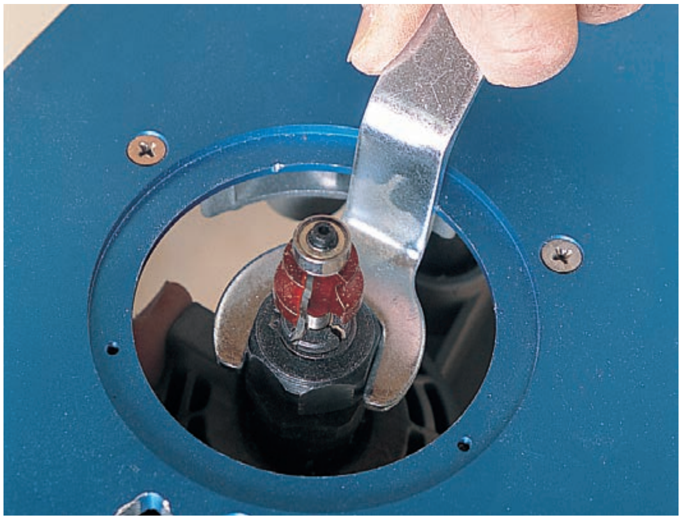
Changing Bits

It wasn't all that long ago that there were only two common ways of getting at a table-mounted router's collet to change bits. One was to fumble around under the table with the wrenchs. The other was to remove the router and its mounting plate (or just the motor, if you were dealing with a fixed-base router) from the table.

Nowadays, you still can use either of those approaches, but you've got other options. If you aren't satisfied with your status quo, keep in mind that most router tables can be modified to accommodate a different router or mounting plate, to tilt up, or to support a router lift.

But don't lose sight of what you are trying to accomplish. It's all too easy to drop $300 plus in something that's designed primarily to make bit changes easier. You can simplify bit changes for a whole lot less.

Unplugging the router before changing bits is a good habit. Table designs don't always make it convenient. If you build your own table, incorporating an outlet beside the router makes it easy to be safe.



After-market bent wrenches are available for selected routers. A step is bent into the wrench handle right at the working end. With the collet raised as high as possible, you can dip the end into a large tabletop bit opening and engage the collet nut while still having a good grasp on the handle. This yields an above-the-table bit change.

Above-the-table bit changing is possible if you use the right router or a premium router lift. Instead of lowering the router motor, raise it until the collet projects through the bit opening in the tabletop. Bit changes are easy. You have an unrestricted view of what you are doing, as well as unrestricted access to the collet with the wrenches.

Chucking the Bit

Changing bits is your opportunity to check the condition of the router's collet and your bits. Avoid problems by staying on top of this routine maintenance.

As you handle any bit, for example, scan the shank and make sure it is clean and polished to a shine. An ordinary abrasive kitchen pad can remove tarnish and keep rust off. As you buff the shank, look for galls, an indication that the bit shank is spinning in the collet. The collet could be worn or you're simply not tightening enough.

Monitor the condition of the bearings on piloted bits—no gunk on them—spinning freely. Replace frozen bearings right away; a frozen bearing will burnish and burn the work's edge.

Look over the carbide. If it is chipped, junk the bit. It may cut satisfactorily, but the chipped area may have fractures not visible to the naked eye. They can lead to further deterioration.

As you actually install the bit in the collet, don't drop it into the collet and allow it to rest against the bottom of the socket. It should be held clear of the bottom. As the collet is forced into the socket by the nut, it will pull the bit shank deeper into the socket. If the shank is bottomed already, it can prevent the collet from seating fully, and that means the shank isn't gripped tightly.

There's no reason why you have to leave the router in the table for bit changes. Pulling the router and mounting plate from the table, or just dropping the motor out of its base, has always been a sensible, convenient approach. With the tool on the tabletop, you have a clear view of the bit and collet and easy wrench access. In addition, it gives you an opportunity to check over the tool.

The tilting top gives you unfettered access to the router without having to remove it from its mounting. With a plunge router, back the motor down the posts to expose the collet, then use the wrenchs. To expedite plunge adjustment, use a $35 crank instead of the more commonplace knob.

A great accessory that fits selected router brands and models is the Eliminator RC chuck. It enables you to change bits in seconds with a hex-key wrench. No need to hold a spindle lock or fumble with an open-end wrench. Hold the bit in one hand and twist the hex key to tighten the collet with the other.

Controlling the Bit Opening

After installing a bit, the first judgment to make regards the bit opening. This doesn't take a lot of thought. Just look at the opening and the bit. If you have a 1⁄4" straight bit centered in a 2"-diameter opening, you've got a bad situation.

This is safety as much as savvy. Having the bit opening closed down around the bit just as closely as possible prevents the work from dipping into the bit opening, snagging the edge, maybe stalling the cut. You don't necessarily need zero clearance, but a big reduction in the size of the opening will make setup easier and operation safer.

Most commercial mounting plates have nesting reducer rings. So do router lifts. Keep those rings close at hand and use them.

If you made your own plate, consider investing additional time in making one with a set of reducer rings. You do this using 3⁄8" clear acrylic. The plate's basic bit opening is 3 1⁄2", large enough to accommodate the largest of panel raisers. The opening has a 1⁄4"-wide by 3⁄16"-deep rabbet around it. The reducers are 4" in diameter and are similarly rabbeted, so they fit into the bit opening and rest flush. The bit openings in the reducers are matched to different, commonly used bit sizes—1⁄4", 1⁄2", 3⁄4", 1", and so on. I even made one that's bored out and rabbeted for template guides.

I used templates to make both the plate and the reducers. Routing the rabbets is simple with a rabbet bit fitted with the appropriate pilot bearing.

If you have a direct-mount tabletop, or if you just don't want to make rings for your shop-made plate, you can make auxiliary tops for the table using 1⁄8" hardboard.

When you need to close down that bit opening, make one by first dropping the router so the bit is below the table. Then lay a piece of hardboard over the tabletop. The fence will usually hold it, but you can stick it down with double-stick tape or a couple of spring clamps. Turn on the router and run your bit up through the hardboard. The bit hole will perfectly match the bit.

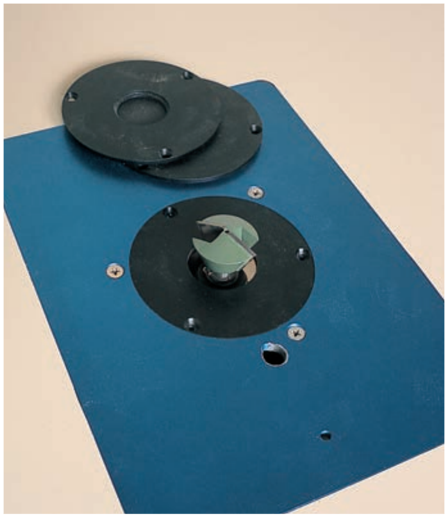
This sort of bit-to-plate-opening mismatch is trouble. The work can catch the far side of the bit opening and tip into the void. If you are lucky, it will only ruin the workpiece.

You can set this auxiliary top aside and use it again and again, every time you use that bit. Just center it by fitting it over the bit, stick it down, set the fence and rout your work.

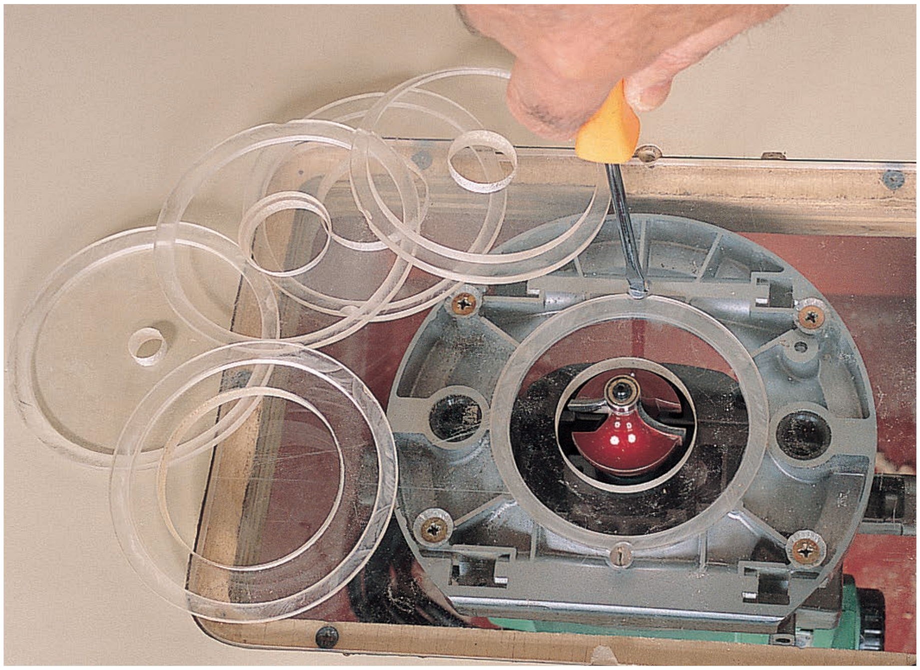
The router tables I've made all have the router offset toward the front (rather than centered in the tabletop). Each auxiliary top has two different opening sizes. I've also used auxiliary tops on tables with router lifts. These need an extra hole to provide access for the crank to the adjuster.

Hardboard is cheap, and at the 1⁄8" thickness, it doesn't rob you of much cutting-depth capacity. As an alternative, you can use 1⁄4" hardboard, MDF or even plywood. As specific needs for zero clearance arise, scan your scraps for something that'll do. In most cases, the auxiliary doesn't really have to cover the entire tabletop, just the feed path.

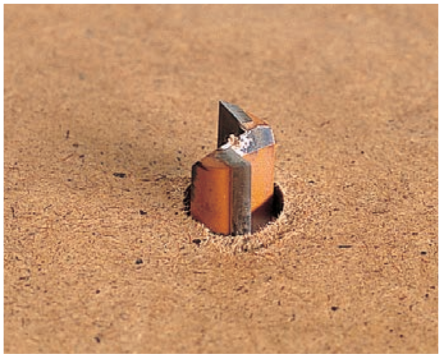
Even when using a guide like the sliding fence, the opening in the tabletop is an issue. A narrow stick like this one is at risk because the floor is disappearing out from under it just as the bit starts battering through. A zero-clearance opening here is essential.



Dozens of brands and models of mounting plates are on the market, made of acrylic plastic, polycarbonate, phenolic, even aluminum or steel. Most have interchangeable reducers that adjust the diameter of the bit opening. Some rings snap into place, others use a twist-lock system, and still others must be secured with screws.



Reducer rings for a mounting plate are as easy to make as the plate itself. Use a couple of small machine screws to hold a reducer in place. Drill and tap holes in the plastic for the screws, positioning them in the seam between plate and ring.



An auxiliary top transforms any router tabletop, bridging miter gauge slots, countersunk screw heads and seams between top and mounting plate, providing a surface interrupted only by the projecting bit. It's a first-rate way of closing down the bit opening (inset). Made of thin hardboard, the top shown matches the tabletop in size and usually is secured by the fence alone.

Setting the Bit Extension

Having installed a bit and closed down the tabletop opening, adjust the height of the bit for the desired cut. How you actually cause the bit to move is irrelevant here. The focus is measuring how far the cutter protrudes above the table and assessing whether it's acceptable.

Sometimes this is an "eyeball" proposition, sometimes it's a measuring task. However you go about it, a test cut is almost always in order. That way you can assess the result and make any adjustment that might be necessary.

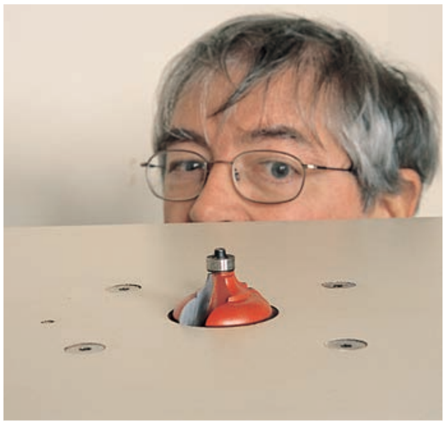
Regardless of approach, you need to hunker down and sight across the tabletop to the bit. Yes, there are some measuring devices that help you set the bit without bending or stooping. But getting your line of sight even with the bit is the most accurate way to do it.

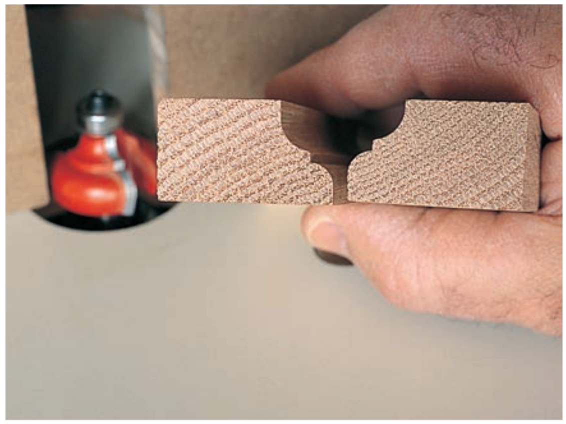
Profile cutters are almost always set by eye and adjusted according to a test cut. You may set or adjust the bit based on a measurement, for example the dimension of a fillet at the edge of the profile, but more commonly, it is a judgment about what looks right.

On the other hand, many joinery cutters are set by measurement. These include straight bits, slot cutters, dovetail bits, rabbeting bits.

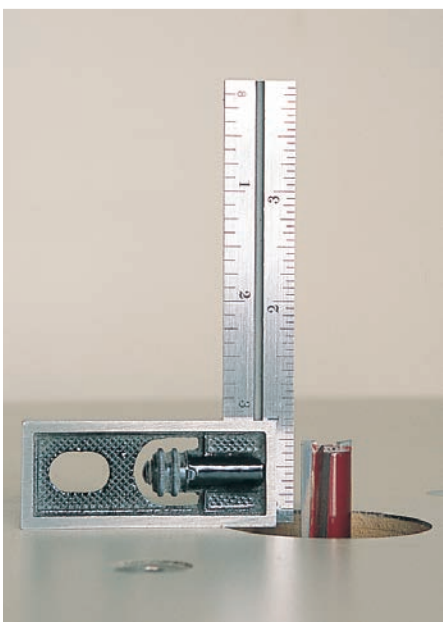
To set these bits, use a ruler or a job-specific gauge rather than a tape measure. In setting the bit height, it's the first inch that's most important. On a tape measure, with its loose hook that obscures some of the graduations, it's the first inch that's least usable for measuring purposes.

Use a practical measuring device like a 6" steel rule or a small square. These devices have a variety of graduations: eighths, sixteenths, thirty-seconds. With my routers, I use a 6" square that I use more often than any other rule or adjustable square.





A profile cutter is set by eye because the cut you want is an aesthetic judgment. Does it look right or not? So you squint across the tabletop to the bit to adjust the height (left). Then you make a test cut and stare at it. Sometimes an adjustment followed by a second test cut is needed to tell you that what you had to begin with was better (right).



Joinery cutters like straight and dovetail bits are set to a specific measurement. Hold a small square or a rule right beside the bit. Hunker down and sight across the tabletop as you adjust the tip of the bit to align with the appropriate graduation on the rule.

A tilting-top router table takes the bending and stooping out of bit setups. With the top tilted up, you can look across the slanted surface to a rule held beside the bit and use the router's adjuster to raise or lower the bit. Lock up the router, lower the top and make your test cut.

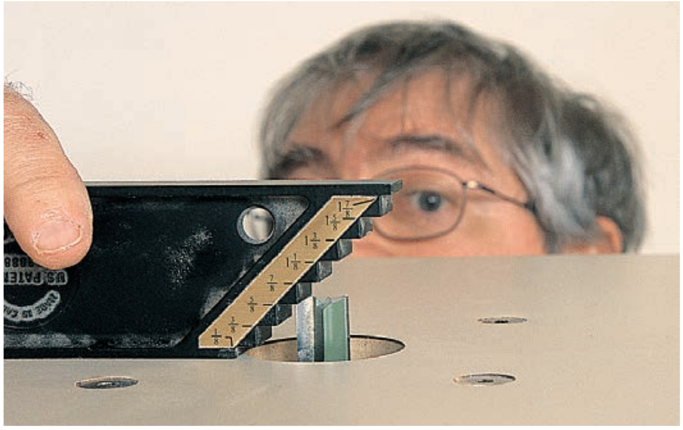
Having the right tool is only part of the job. You have to be able to tuck that tool right up at the bit, and you have to hunker down so your line of sight is even with the bit. Stand the rule right next to it. This is the first moment at which you'll be glad that you closed down that bit opening. It helps you set the rule next to the bit.

A setup gauge is an alternative measurement tool. Several different devices are on the market, some of which are adjustable. Typically, the gauge overhangs the bit. Position it beside the bit, and raise the bit until its tip bumps the gauge.

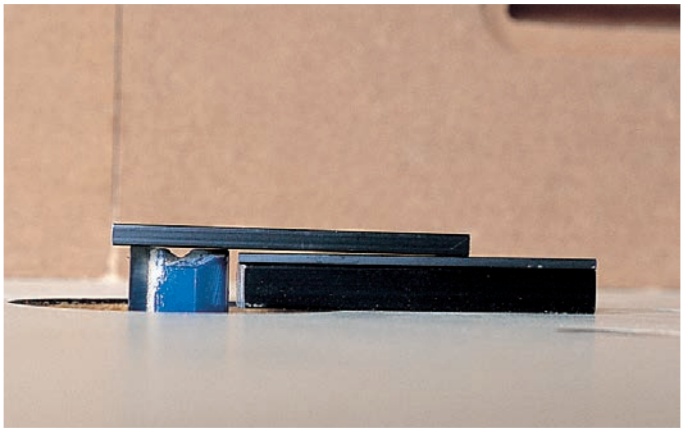
You can cobble up a gauge using a setup block and shims. Long considered machinist's tools, they are being adopted for setups by more and more power-tool woodworkers. The block measures precisely 1" by 2" × 3". The shims range from 1⁄16" thick up to 3⁄4" thick. Stack the block and/or shims to the desired height beside the bit. Place a final shim on top, overhanging the bit. Raise the bit until it touches that last shim.

There's a different sort of setup block you might find useful, and you make it yourself. A few specialized joint-cutting bits—glue joint cutters or lock-miter bits, for example—can be very frustrating to set. Your initial elevation is set by eye. Then cut some test pieces, join them and make adjustments based on how they fit. Eventually, you get the setup dialed in.

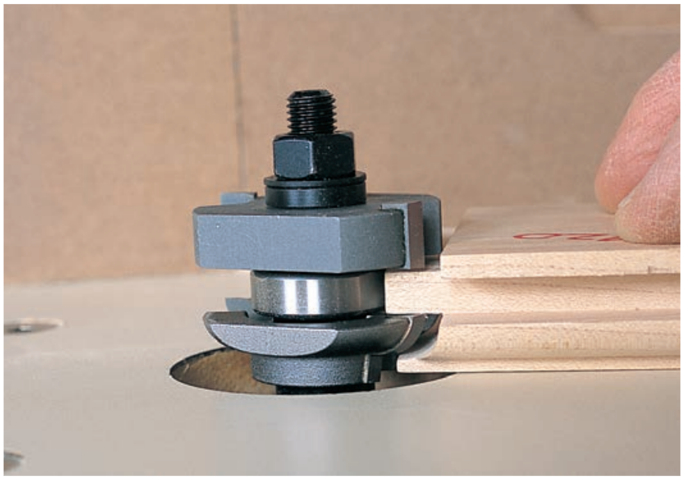
At that point, you make a setup block for the next time you use the bit. It's simply a small sample cut. To use it, you elevate the bit and adjust it up or down until the block nests comfortably into the profile.



A variety of commercial setup gauges are available to help you set bit elevations. With this one, you pick the step labeled with the dimension you want and raise the bit until it contacts that step.



Stack up the precision-thickness shims that add up to the bit height you want. Add one last shim, overhanging the bit. Raise the bit until it contacts the cantilevered shim. Here the bit's just a skoche too high.



A setup block is a sample cut with the bit at the optimal setting. Slide the block's profile through the cutter as you inch the bit up and down. When it passes through without drag, the bit's set. Now you can avoid a sequence of adjustments and test cuts.

Use a finished part as a gauge to set a bit for cutting its mate. So to cut a tenon that'll fit this mortise, set the bit's tip flush with the mortise's cheek. The same technique works for other joints, including the tongue-and-groove and cope-and-stick.

Using a Starting Pin

Making a cut guided by the pilot bearing on the bit is a common router table operation. When the edge being routed is an arc, you can't use the fence. Think of a door with a curved-edge panel.

Actually beginning the cut can be tricky. Think about it: The cut diameter is almost always larger than the pilot. For the pilot to control the cut, it has to contact the wood. But no matter how you come at the bit, the cutting edges engage the wood first.

There's little difficulty when you're routing all around a workpiece. Rather than starting at a corner, sweep in on a long-grained side. Work your way around the piece, ending in the middle of the side where you began.

But what about routing only one edge? You don't want to begin in the middle and back out to the end. That would be a climb cut, something you should never do on the router table.

The alternative is to start right at the corner. What can happen is that the cutting edges flick the workpiece aside before it can contact the pilot. There you are, inching the wood into the bit, when *bam!* it suddenly exits right.

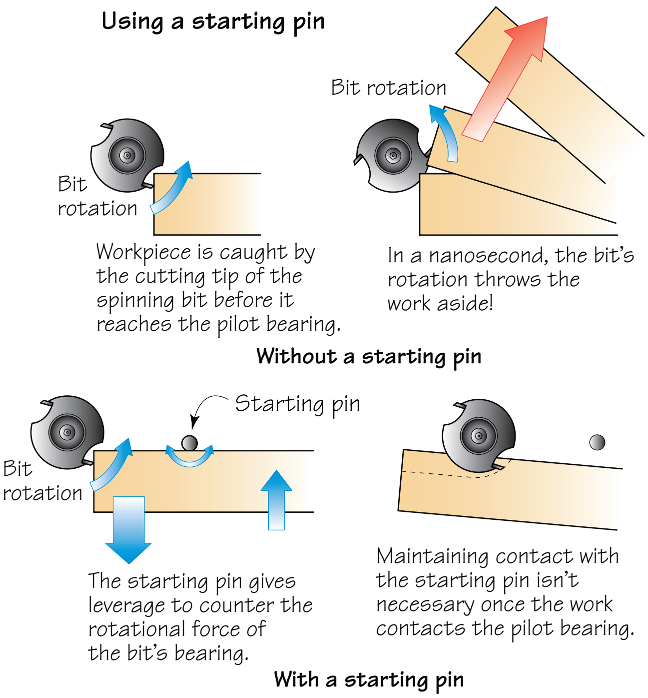
The work can be damaged and if you are startled enough, you can too.

I don't want to overstate the hazard here. The most common result is a workpiece that has a bit of a profile across an end, when what you wanted was a profile only along its edge. Perhaps you have to start over. But it would be cavalier to ignore the potential for injury.

The best way to avoid this experience is to use a starting pin. It's usually a wooden, plastic or metal pin standing about 2" to 4" from the bit. A starting pin is a fulcrum; brace the work against it, then *lever* it into the bit. The pin is stationary, so you can brace the work securely. By giving you leverage, it multiplies the strength of your hold on the wood.

It's called a starting pin because it helps at the beginning of a cut. It is superfluous once the work is in firm contact with the pilot, so if the work comes off it, that's OK.

A starting pin is easy to make. I prefer something that screws into place, so it doesn't wiggle or even disappear unexpectedly. (Drill and tap a hole for it in the tabletop or insert a plate a couple of inches from the bit opening.) Insert a 1/4" machine screw through a nylon or bronze bushing (center). Or buy a shoulder bolt (used to install wheels on lawn mowers) and cut off the hex head with a hacksaw (left). Or make a one-piece pin by turning a tenon on a piece of dowel (right).



A starting pin is a fulcrum. Brace your work against the stationary pin, then pivot it until it contacts the bit. Even if the cutter grabs the work, the pin's position prevents it from shooting the piece to the right, or worse, snatching it from your grasp.

A couple of scraps, clamped to the tabletop, so one braces the other, provide an alternative to a pin. This approach makes it particularly easy to vary the distance between the *pin* and the bit.

Using the starting pin when raising a curved-edge panel is particularly important, given the distance between the tip of the cutter and its pilot bearing. Brace the panel against the pin to begin cutting the curved edge. Pivot the panel on the starting pin until the edge contacts the bearing. Use a pusher to advance the panel's edge along the bearing.

Using the Fence

The fence is the most used router table guidance system. Use it to direct the movement of work to and across the bit, to position a cut, to control how deep the cut is or what its profile will be. It is used with piloted bits and unpiloted bits

Setting the Fence

Positioning the fence is a fundamental setup operation. Set up carefully, but don't get nuts about it. It's easy to waste time trying to get a perfect setup. For the initial setup, close is good enough. Then make a test cut. It's your best means of evaluating the setup and making effective adjustments.

As you begin, bear in mind that you can orient the fence pretty much willy-nilly across the tabletop—side-to-side, front-to-back, diagonally corner-to-corner. The only critical matter is the distance between the bit and the fence.

So slide the fence into rough position by eye and clamp or lock down one end. While the fence doesn't have to be square or parallel to a tabletop edge, the line you measure between bit and fence must be perpendicular to the fence. If you set the handle of a square against the fence's face, you'll get the measurement at the right angle. Slide the tool up to the bit and measure to either the cutting edges or the axis of the bit. Rotate the bit a little with your fingers to align the cutting edges, and get the rule as close as possible to the appropriate edge. When you've captured the desired distance, lock down the second end.

Now make a test cut on a smallish piece of the working stock. Measure the cut if need be, to determine how wide or deep it is or where it is. Perhaps it's something you need to fit to an already cut part, like a tongue to a groove. Maybe you need simply to assess what it looks like.

Based on your assessment, you want to slightly shift the fence position. This is when you make those micro-adjustments. See page 26.

You can position the fence by measurement. Set a small square's handle against the fence and measure to either the cutting edges or the axis of the bit. Make sure you align the cutting edges with the rule and get the rule as close as possible to the appropriate edge.

A straight, knot-free hardwood board makes an excellent fence. But a few simple embellishments—a cutout for a bit and a clear polycarbonate bit guard—make it even better. Secure it to the tabletop with C-clamps.

There's no need for the fence to be parallel to any edge of the table. It just has to be the proper distance from the bit. That makes setup easier, since the fence can be clamped down at any angle.

Where a cut must be a precise distance from the fence, cut a sample and measure the same. Dial calipers—this one is calibrated in fractions rather than decimals—are better for this than a rule. If an adjustment is needed, use the fine-tuning methods described on the following pages.

Fence + Piloted Bit

More often than not, when working with a piloted bit, you use the fence, because beginning and ending a cut is easier and the entire cut is safer.

You won't inadvertently dip around the corner at the end of a cut as you can with only the pilot bearing in control. A long board is more easily steadied and guided by the fence than by just the pilot. You can skim over imperfections in the edge rather than have them transferred into the cut itself. In addition, the fence supports a piece that has to be perched on edge to get the profile you want.

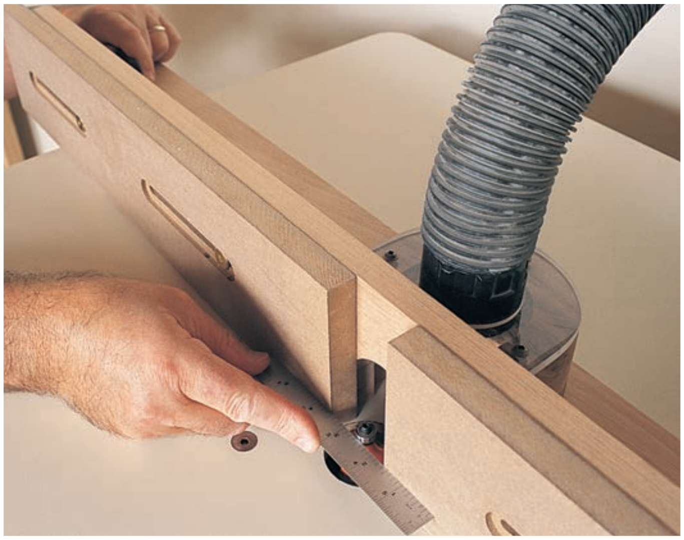
The fence gives you better control of the work and the workpiece. Reduce the workload for the router and bit by adjusting the fence forward of your final setting. Move the fence back in stages so it takes three passes—or more—to achieve the full profile. A light final pass can skim minor chipping out of the cut, without introducing new imperfections.

Not to be overlooked is the safety factor. The fence houses the bit, concealing most of it, thus serving as a guard. It's less hazardous for you the operator.

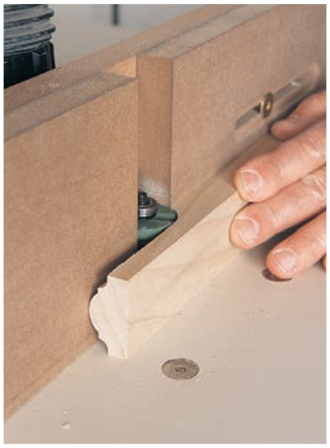
Most fences have a built-in dust collection pickup. It works best with edge-forming bits, which in the main are piloted. If for no other reason than managing the dust generated by a cut, you ought to use the fence.

Positioning the fence properly is quite simple. Bring the fence up around the bit, so most of it is inside the cutout. The pilot must be inside. Lock down one end. As you swing the free end to position the fence, use a straightedge to align the fence face tangent to the bearing.

I like to align the fence so it is just shy of the bearing. That is, I want the bearing out of play. So I slide the straightedge back and forth a little as I move the fence, watching the bearing. Just where the straightedge loses contact and the bearing stops turning is my spot. That's where I lock down the free end of the fence.



Whenever possible, you should use the fence to control a cut, even if the bit has a pilot. To set the fence in this situation, lock down one end and swing it up around the bit. Use a steel rule to bridge the bit cutout and adjust the fence so the pilot just touches the rule. Lock down the free end of the fence, and you are ready to rout.



Routing a profile into the face of a board isn't easy if you depend on the pilot to control the cut. But with the fence controlling the cut, you've got support for the board, and the operation is safe and trouble-free. And you get the profile where you want it.

A fence doesn't have to be straight. This job-specific fence was made to safely raise the arched tops of a big batch of panels. The curve was cut with a router and trammel and the cutout for the pilot was bored with a Forstner bit. Except at the beginning and end of each cut, the bit is shrouded by the panel and the fence.

Micro-adjusting the Fence Position

Homing in on a precise fence position is at least a two-step process: coarse setup and tweak. You've eyeballed a position, made a test cut and adjusted the fence using the square. A second test cut shows you are really close, but need a shift of 1/32", maybe only 1/64".

You can deal easily with this scale of adjustment with any commercial or shop-made fence. Put geometry to work for you. Did you know that moving only one end of your fence gives you adjustment leverage? The distance you move the end of the fence is halved at the center.

In practical terms that means you move the end of the fence 1/16" to alter the fence position 1/32" at the bit. That 1/16" is easier to see on a rule.

You can make a fine adjustment simply by measuring from a pencil line. Here's the drill. You have the fence set and a test cut indicates you need a fractional change. Trace along either the front or back edge of the fence, at the edge of the table. Shift the fence away from the line as you monitor the distance with a rule.

As the desired adjustment gets really fine, the pencil line itself can introduce error. So can the lines etched into your rule. Or the sharpness of your vision

In that situation, use shims and a block to control the adjustment. Put a stop block against the back edge of the fence and clamp it to the tabletop. Unclamp the fence, pull it away from the block and slip a shim in the gap. Push the fence back, pinching the shim against the stop, and clamp the fence. You've moved it the thickness of the shim.

This trick works going either way. You've *closed down* the fence setting by putting in the shim to move the fence away from the block. You can *open up* the fence by putting the shim in when you set the block, then pulling it to set the fence back directly against the block.

For shims I use my business card, which is 11 thousandths thick. Also, I use an index card 8 thousandths thick and printer-paper which is 4 thousandths thick. If you're a tool junkie, this is a good excuse for buying feeler gauges. You can buy a set with 16 to 20 thicknesses for about $20.

To adjust a fence a small amount, scribe a pencil line along the fence—where the fence will be moving away from it—and measure with your rule from that line to the fence. Remember that the distance you move one end of the fence will be halved at the bit.

Shift the fence a controlled distance using shims and a reference block. Shims can range from playing cards and scraps of plastic laminate, to precision-thickness gauge blocks (the brass bars in the photo) and feeler gauges. Set a shim against the fence, the block against the shim, and clamp the block. Loosen the fence, remove the shim, and shift the fence against the block. The movement at the bit will be half the shim's thickness.

Fence Micro-adjuster

This simple accessory enables you to make tiny but accurate adjustments in the fence position. You can use it with any router table fence, whether commercial or shop-made. It works the same way that a reference block with shims does.

Typically, a router table fence is fixed at the ends. To make a small adjustment in fence position, free one end and swing the fence with the fixed end as the pivot. The movement at the middle of the fence, where the bit is, is half that at the free end. Move the fence 1⁄16" out at the end, and the change will be 1⁄32" at the bit.

The micro-adjuster has both 3⁄8" and 1⁄4" screws as the adjusters.

One rotation of the 3⁄8" screw, which has 16 threads per inch, moves the end 1⁄16". A quarter turn moves the end 1⁄64". Halve that and you have an adjustment of 1⁄128" at the bit.

One rotation of the 1⁄4" screw, which has 20 threads per inch, moves the end 50 thousandths of a inch. A quarter turn moves the end just under 13 thousandths. Halve that and you have an adjustment of less than 7 thousands. (Curiously enough, 1⁄128" is between 7 and 8 thousandths. So either adjustment screw yields about the same results.)

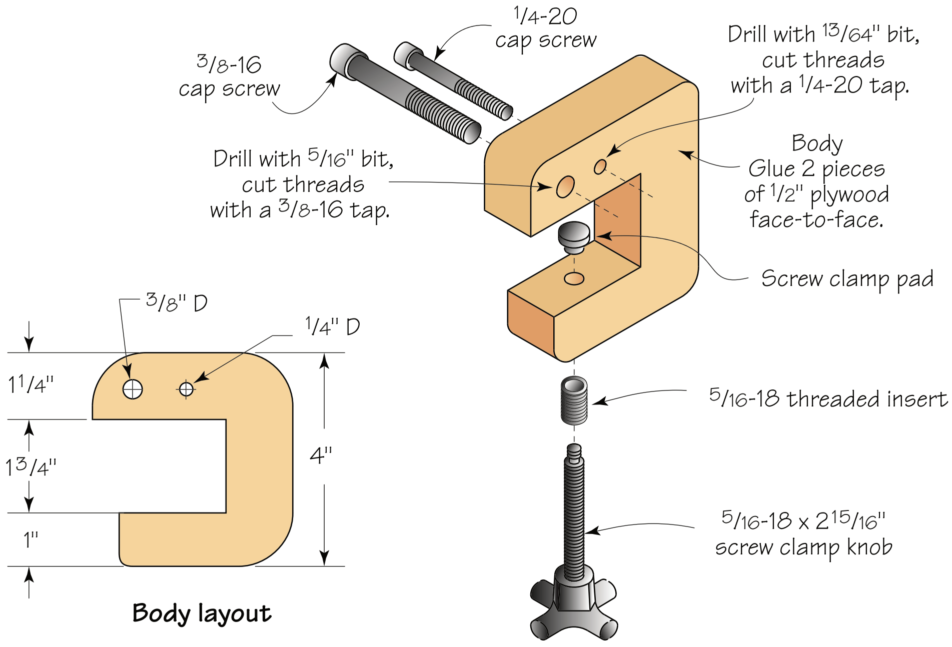
The micro-adjuster is a wooden C-clamp with either a 1⁄4" or a 3⁄8" machine screw (or both) passing through it. Fit the block onto the edge of the tabletop, just a fraction of an inch behind the fence, and tighten the screw knob. Turn the adjuster screw until it contacts the fence.

• To move the fence closer to the bit, loosen the fence clamp and turn the adjustment screw clockwise. That will extend the screw, pushing the fence.

• To move the fence away from the bit, zero the adjuster against the fence. Then turn the screw counterclockwise, backing the end away from the fence. Loosen the fence clamp, push the fence back against the screw and retighten the fence clamp.

This shop-made fence micro-adjuster clamps to the tabletop edge. Place it right behind the fence so the adjusting screw can contact it. To adjust the fence position, you turn the screw in or out. With an L-shaped hex wrench serving as a pointer, it's easy to divide screw rotations into halves, quarters and even eighths.

You can make a low-rent micro-adjuster quickly by drilling and tapping a hole for a 3⁄8-16 bolt in a block of hardwood. Use a C-clamp to secure it to the tabletop just behind the fence.



Feed Direction Savvy

Feed direction savvy is knowing which way to feed the work. Here it is in a nutshell: Push the work against the rotation of the cutter.

When it is up-ended in a table mounting, a router motor spins counterclockwise. If you can't remember, just look at the bit. The angle of the cutting edges will make it clear which way it has to turn to cut. Seeing that, and knowing that you feed the work against the cutter's rotation, should tell you which way to feed the work.

In most router operations, you feed the work from right to left across the cutter. You stand at the right front corner of the table and push the workpiece along the fence until it has cleared the bit to the left.

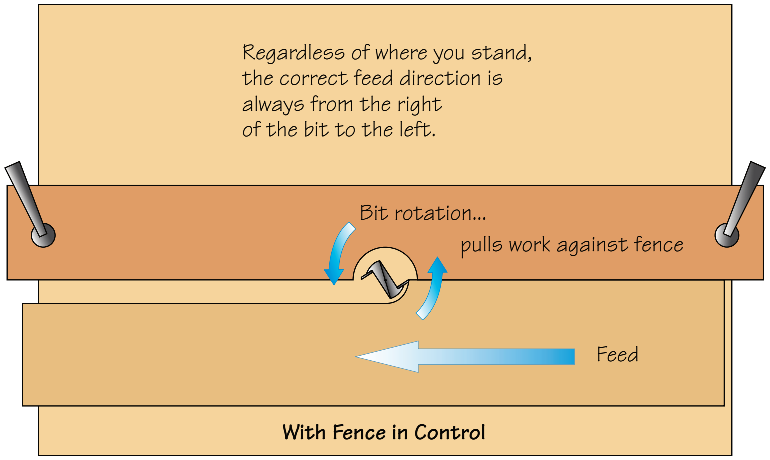
If you use the bit's pilot to control the cut, the feed direction is basically the same. But note in the drawing that you can safely profile all four edges of a workpiece by maneuvering the work clockwise around a pilot bit. The bit is spinning counterclockwise, so by advancing the work clockwise, you are feeding it against the bit rotation.

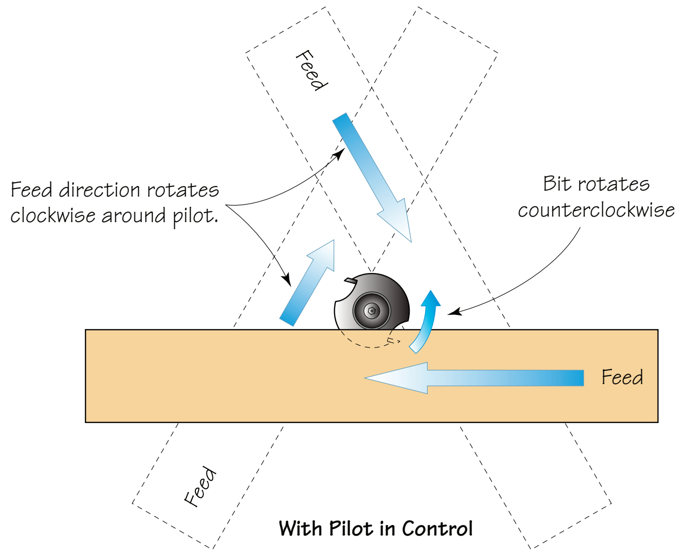
Feeding the work with the cutter's rotation—a process called climb cutting—gives the bit the opportunity to help you move that work. Spinning at 22,000 rpm, it's going to hurry things along, even if it has to pull the work right out of your hands to do it. You don't want this.

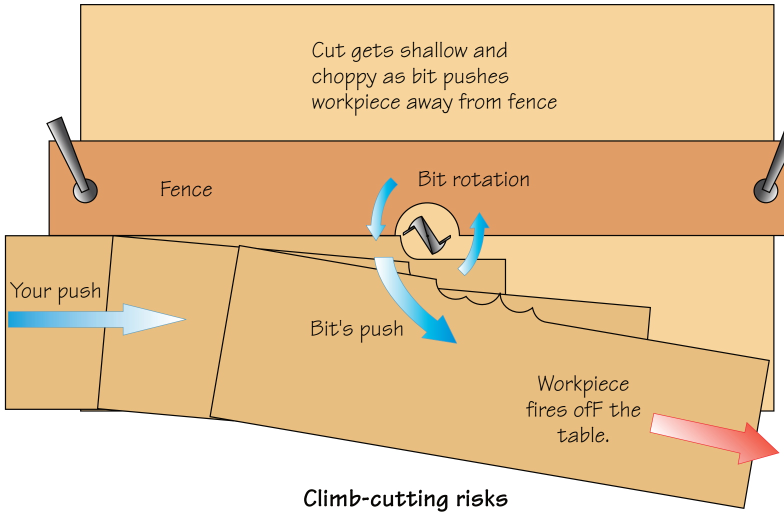
You may occasionally climb cut with your router hand-held. In that situation the cutter moves away from you if it momentarily takes charge of the feed. You aren't in danger so long as you hold onto the router.

But in a table-mounted router, the cutter stays put and the work moves. In a nanosecond, the work is no longer between your hands and the cutter. Nothing is between your hands and the cutter. So my advice is this: At the router table, never climb cut.

Feed direction basics







Climb-cutting risks

Special Hazards

Several setups deserve special attention because you may not recognize them as hazardous. But you want to avoid them.

The first is when the work is trapped between the fence and the cutter. By this I mean that you set the fence one board's width away from the bit, and then feed the board along the fence, routing the exposed edge. This poses three different hazzards.

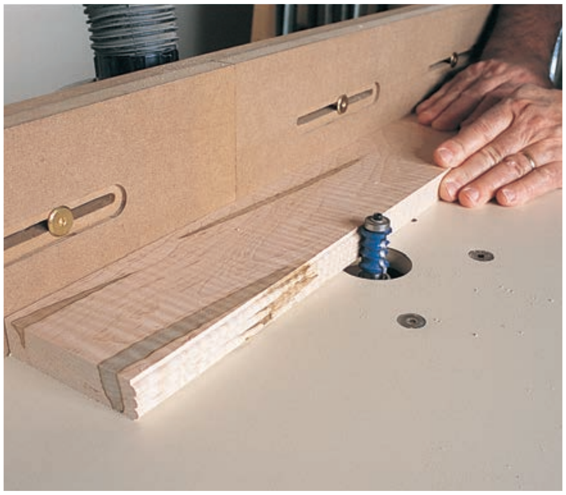
If you feed the board from right to left along the fence with the cutter addressing the near edge, you are making a climb cut. But if you feed from left to right, you invite kickback. It's generally accepted that on the router table you never trap work between the fence and the cutter.

A related gaffe is trapping the work between the cutter and the table. An example here would be raising a slot cutter high enough to rabbet the work's top surface. The hazards are the same as when trapping work between fence and cutter.

The third special hazard can occur when you widen a groove. The second cut may be a climb cut (see the drawing).

The first pass is made right to left, and the bit's rotational forces are contained, resisting the feed and pressing the stock against the fence. To widen the cut, you can move the fence toward you or away from you.

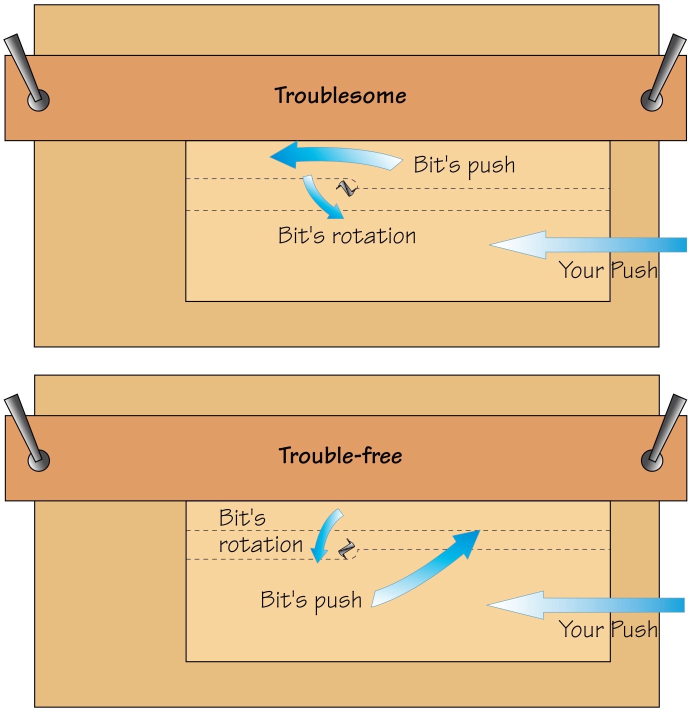
If you move it toward you, the bit will be cutting the side of the groove away from you and that will be a climb cut. It's an easy mistake to make, and it's a breathtaking surprise when that workpiece suddenly shoots off the table. What you must always do in this situation is to back the fence away from the bit. Then the bit will be working the side of the cut closest to you.



Trapping the work between the fence and the cutter is trouble. If you feed the work right to left, it's a climb cut, and the work may be snatched from your control unexpectedly. Feeding left-to-right invites kickback if the piece's edges aren't parallel, if cutter hits a knot or convoluted grain or if the wood begins to break up and splinter. The feed could stall and the cutter could fire the work back at you.

Here's the result of an unintended climb cut. In making a second pass to widen this groove, I shifted the fence toward me. As a result, the bit cut on the side of the groove closest to the fence. The bit snatched the piece and shot it off the tabletop, butchering the cut—and the tip of my pusher—in the process.

Inadvertent climb cut



Feeding right to left when cutting on the fence side of a groove is a climb cut. The bit can snatch the work-piece from your control and fire it right off the table.

Cut on the side of a groove away front the fence. Feed right to left and the bit will push back and against the fence.

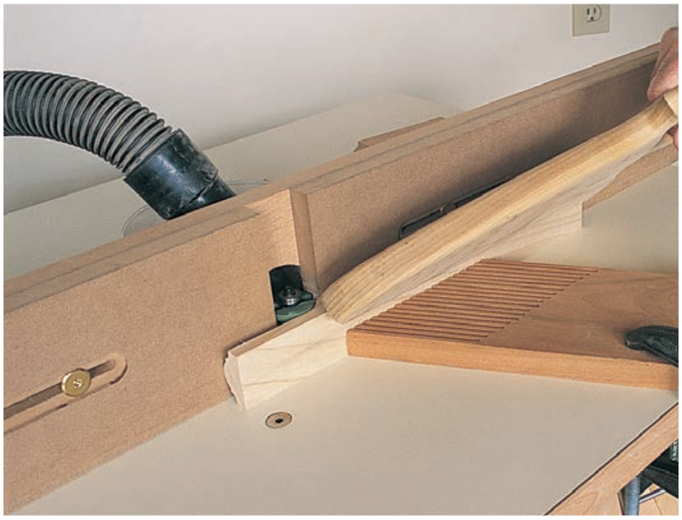
Controlling the Workpiece

The router is a powerful motor with a sharp cutter on one end. To do practical work with it, you've got to establish control. When the router's mounted in a table, the fence or the pilot bearing on the bit are the primary controls. They regulate the scale of the cut and guide the path of the workpiece.

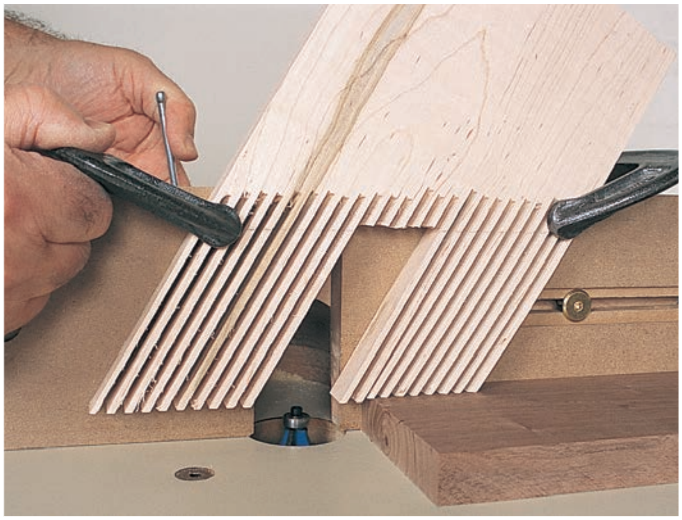
But by themselves, they won't restrain the workpiece and keep it from drifting away from the fence or kicking back if the cutter hits a knot or really digs into some gnarly grain. To exercise this kind of control, you need to use hold-downs, hold-ins and the like. Most of these you can make yourself.

The most familiar device—since it's used on the table saw in addition to the router table—is the featherboard (sometimes called a fingerboard). Properly positioned and adjusted, featherboards keep the work upright against the fence or flat on the table. They free you to simply push the work through the cut. The angled fingers flex to allow the work to advance, but they jam against the work should you try to pull it back toward you. And the bit can't kick it back either.

Handy-dandy plastic featherboards are widely available. They have a lot of appeal because they can be mounted quickly in miter slots and to any fence that has an appropriate slot formed or cut into it. The first finger on such featherboards is shorter than the others, and you use it to set the device. Position the workpiece on the table, against the fence, and move the featherboard into position with that finger alone touching it. Lock down the featherboard, and it should apply just the right amount of pressure to the work.



If you are uneasy about feeding a piece through a cut with your fingers, by all means use featherboards and a pusher for the job. The featherboards maintain consistent downward pressure on the piece, and the pusher moves it, and at the same time keeps your hands well clear of the action.



Each featherboard must be secured with a pair of clamps—C-clamps or F-style clamps are best for this—to prevent it from twisting out of alignment. You can use featherboards on the fence and on the tabletop if the situation warrants.

Cut down on the number of clamps you use to secure featherboards and speed up setup at the same time by tying a pair of featherboards together with a cleat. The arrangement makes it easy to apply downforce on the infeed and outfeed sides of the bit, without stressing the bit itself. Only two clamps secure the tandem.

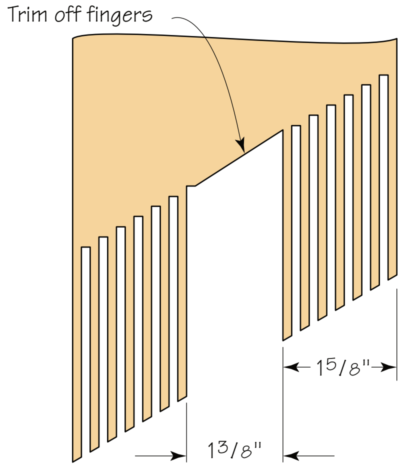
Featherboards

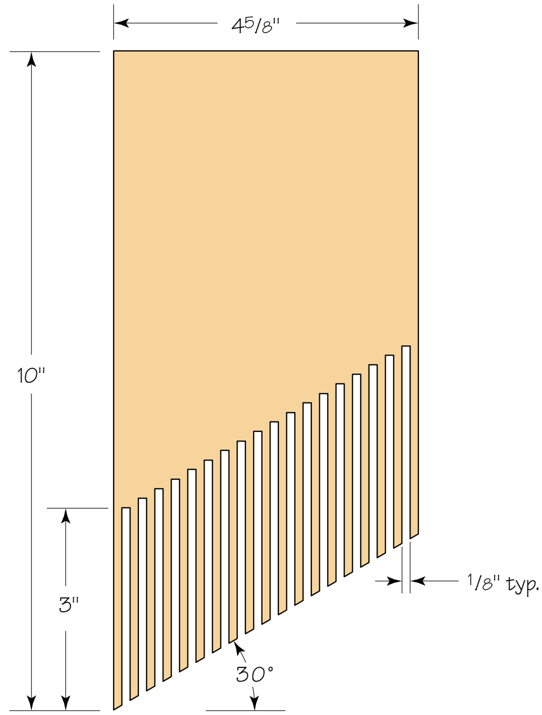
Featherboards are easy to make on the table saw or band saw. You can use scraps, and you can customize them to suit specific jobs—wider, thicker or longer. You can customize the pressure your featherboards exert. Long, thin fingers are more flexible, while short, thick ones are stiffer. The steeper the angle of the featherboard, the more firmly it will hold the work.

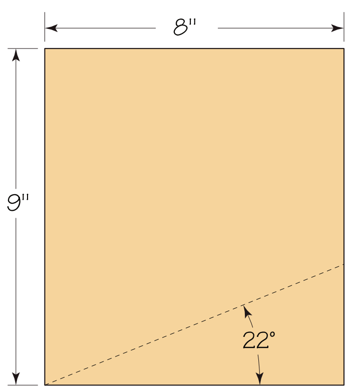
Good all-purpose compromises are 1/8"-thick fingers, spaced 1/8" apart, with a tip angle of about 60°.

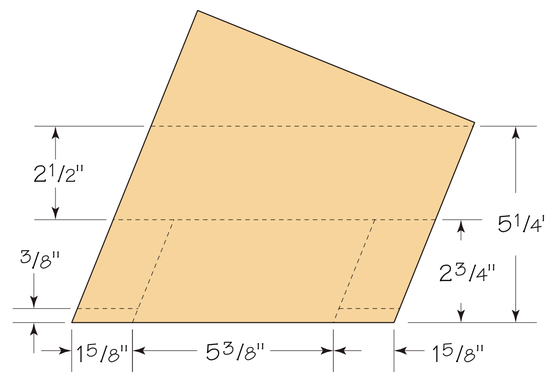
Opt for a springy wood like oak, ash, or hickory and avoid brittle species like poplar and maple.

Cut the featherboard material extra long to make it easier and safer to cut. Miter both ends, then lay out the baseline about 3 1/2" from these cuts. Raise the table saw blade as high as you can, and set the rip fence to cut a 1/8" finger on the left side the board. Feed the board, cutting to the baseline. Pull the board back. Repeat the cut on the other end of the blank. Adjust the fence 1/4" closer to the blade and cut again. Keep repeating until all the fingers are cut. When you are done, crosscut the blank and you'll have two featherboards.



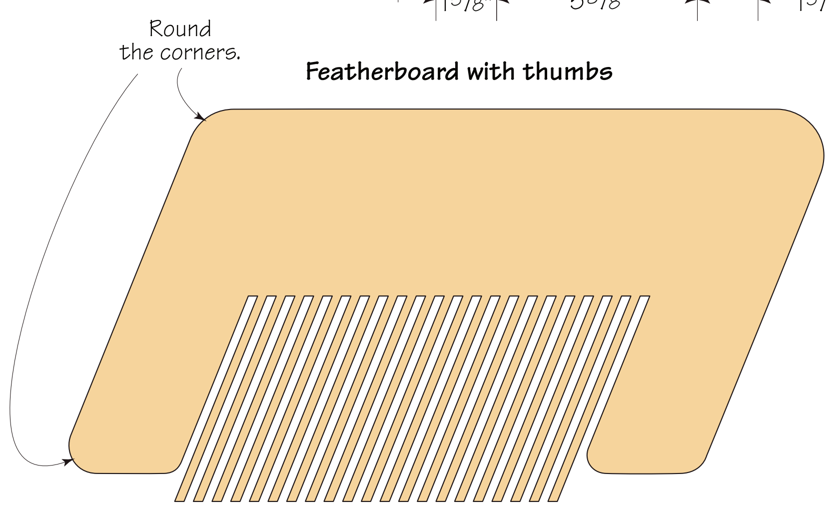






With its pads for clamps flanking the feathers, this featherboard is a little different. It's short enough for you to clamp it to the front of any router table as well as to the fence, and the thumbs eliminate the need to place the clamp jaws on some of the feathers, thus limiting their flexibility.

Featherboard with thumbs



Cross-Grain Routing Sled

Prefer to guide your cross-grain cuts with a device more *formal* than a scrap block of wood? What you need is a sled. It combines the roles of miter gauge, push block, and chip breaker.

There's no slide for a miter gauge slot on the sled. Instead, it's pushed against the fence at the same time it is advanced along the fence. If you'd rather not use the fence, you can extend the base and attach a slide to the underside to ride along the table's edge.

When you use the sled as a chip breaker, the bit will cuts through the work and into the sled's fence. It's easy to make another, so you can make special sleds for different cuts.

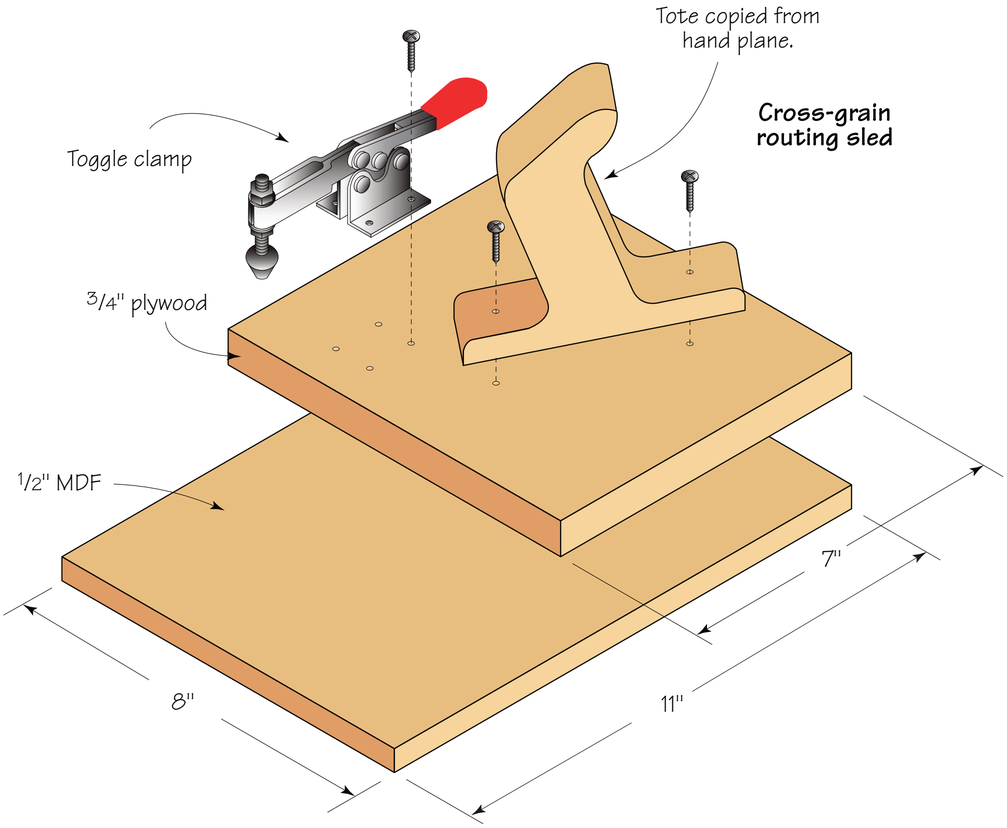
Profiling wide strips and raising panels calls for a pusher that applies pressure over a broad area. This shop-made float-type has a tactile layer—cut from an old computer mouse pad—glued to the sole.

An alternative is to use a separate backup strip between the sled's fence and the workpiece. Hold it in place with carpet tape.

The toggle clamp is a practical feature. It keeps your work firmly in place, freeing both hands to guide the sled. It's positioned to keep the end of the work from bowing up away from the bit, which could give you an irregular cut.

With a V-groove in its sole, this pusher is perfect for router table work. Tilt the pusher so the edge of the work nestles into the groove. The heel hooks the end and allows you to feed the work while simultaneously holding it down on the tabletop and in against the fence.

This cross-routing sled is dedicated to cope cuts. It holds a rail securely for the cut and provides some backup against tearout. A tradeoff: the bit has to be extended an extra 1/2" above the tabletop, not always a simple matter.



Damage-free Cuts

It's a knife in the heart! You look at the profile you've just routed and the edge is all chipped!

While you can't do much to salvage a piece once it's damaged, there are things you can do to prevent chipping and tear-out. The causes are varied—a dull cutter, cutting too aggressively, routing against the grain. You can't always eliminate damage, but you can minimize it.

First, look over your stock, and see if you can work a different edge. Boards with grain that runs off the edge being worked are just prone to chipping.

Make the cut in two or more passes. Move the fence forward, housing more of the bit and limiting the cut. Make a shallow first cut, then shift the fence for a deep second pass. Clean up with a very light final pass.

Finally, examine your fence and see if you can create more of a zero-clearance opening for the bit. A little more backup for the stock can be helpful.

Don't consider a climb cut. Though climb cutting can sometimes be a solution in a hand-held router operation, it is always extremely high-risk on the router table.

A cross-grain cut is likely to end with splinters blown out as the bit exits the wood. If the cut is supposed to extend around the corner and along the grain, the blowout isn't a problem, since the ensuing cut will remove it.

Cross-Grain Blowout

Let's start with blowout on cross-grain cuts. Whenever you rout across end grain, you'll get some degree of splintering as the bit exits the cut. This usually isn't a problem when you're routing all around a piece. Rout across the ends first, letting the two exit corners blow away. Then rout the long-grained edges, which cleans up the splintering.

But suppose you're not routing the long-grained edges. In this situation you need to clamp scrap stock to the edge where the cut will exit. Cut right into the scrap, and it splinters instead of the good stuff.

Cross-grain router cuts usually pass across the narrow end of an oblong workpiece. It's tough to achieve a clean cut by guiding the end along the fence, because the piece tends to *walk*. On top of that, the cut usually ends with splinters being torn out of the long grain as the cutter emerges from the piece. The solution to both these problems is a square pusher—a piece of scrap will do. The pusher stabilizes the work as you advance it along the fence, and it prevents the exit tearout (inset).

Long-grain Splintering

Chips and splinters taken out of a long-grain edge are more vexing and harder to contend with. You're routing along an edge and you can see the wood splintering ahead of the cut. The real problem comes when the grain *runs in* so the split extends beyond the cut's shoulder.

What's really making the splinters? As the cutter arcs across the wood and nears the stock's edge, it's cutting almost perpendicular to the grain. Crosscutting the wood fibers is wood's big weakness—resistance to splitting. There's a point, close to the board's edge, where it suddenly takes less force to split the wood than to cut through it.

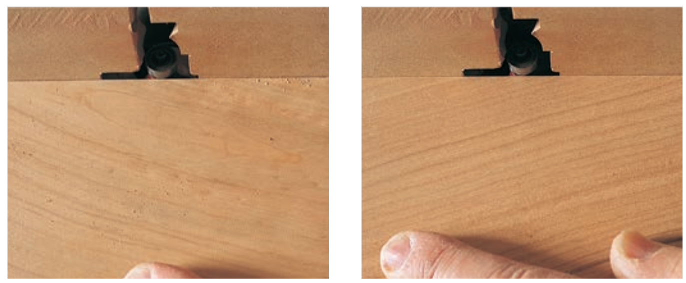
So what can we change to prevent splintering? Either make the bit cut better or make the wood stronger. It's not a joke! We can do both.

A sharp bit cuts more easily than a dull one, so be sure your bit is sharp. In many cases a shearing or spiral bit will cut more easily than a straight one. You don't always have a choice, but check those bit catalogs.

Another tactic is to moderate the exit angle of the cutter. Switch to a large-diameter bit if that's possible. And in any event, reduce the bite. Make the first pass what I call a scoring cut. Set the fence to allow the barest of cuts, only $1/32$", perhaps $1/16$". The cutter glances across the wood fibers and doesn't get enough purchase to dig out an ugly splinter. Reset the fence and make a deeper cut. Perhaps you take three or four passes to complete it.

Anything you can do to *back up* the wood will help it stay together. Holding the wood tight against the fence backs it up. The split begins where the cutting tip clears the wood. Usually, there's a gap in the fence at that very spot. In other words, right at the most vulnerable spot, the wood has no backing. So creating a zero-clearance housing for the bit will help immensely.

Make an aggressive cut with a profile that tapers to a delicate edge, especially on a board with gnarly grain at the edge, and the result just might be disappointing. There are measures you can take to reduce or eliminate chipping on the next piece.



Pay attention to the grain of each board to rout. If you feed a board so the bit is cutting against grain running out the edge, you're likely to get tear-out (left). But flip that board end for end, so you are routing *down* on the grain, and you'll get a smooth, clean profile (right).

One tactic for reducing chipping is to make the first pass a very shallow scoring cut. The shoulders of the profile are defined, but the cutter's exit-angle is sharply diminished, so it doesn't dig long splinters from the edge.

If your workpiece is so gnarly that the usual tricks are ineffective, try making a series of choppy cuts. Brace one end of the board against the fence and push the edge against the spinning bit. Immediately pull it off the bit, advance it an inch or so and repeat the chop cut. When the length is worked, make a conventional right-to-left pass.

Zero-Clearance Tactics

Zeroing out the clearance around bits that are partially housed in the fence is a fundamental technique for improving cut quality and safety. You'll get cleaner cuts with profile-cutters, rabbet bits, cope-and-stick bits, panel raisers and many other bits.

Zero-clearance on the infeed side helps prevent splintering and tear-out. On the outfeed side, it helps eliminate the feed hesitations that result from the work momentarily hanging up on the outfeed edge of the fence opening.

Many fences have two facings. These adjust so you can crowd them in on a small bit, or spread them apart to accommodate a large one. Most are made from MDF, and you can make new ones yourself.

To form a true zero-clearance fit, slide the facings, one at a time, against the bit as it spins. When you switch bits, slide the facings off the fence and trim off the end. Eventually, the strips will become too short to be useful, and you'll have to replace them.

If your fence doesn't have two facings, here's a good zero-clearance tactic that should work on any fence.

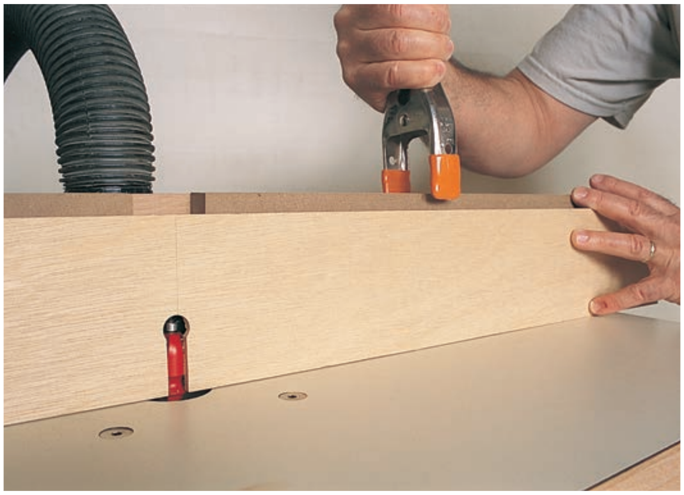
Cut a strip of 1/4" hardboard, MDF or plywood to match the height and length of the fence. Attach the strip to one end of the fence with a spring clamp or the like. Flex it so it's bowed away from the bit. Switch on the router and bring the strip back against the fence. The bit will cut through the strip, and you will have a true zero-clearance fit.

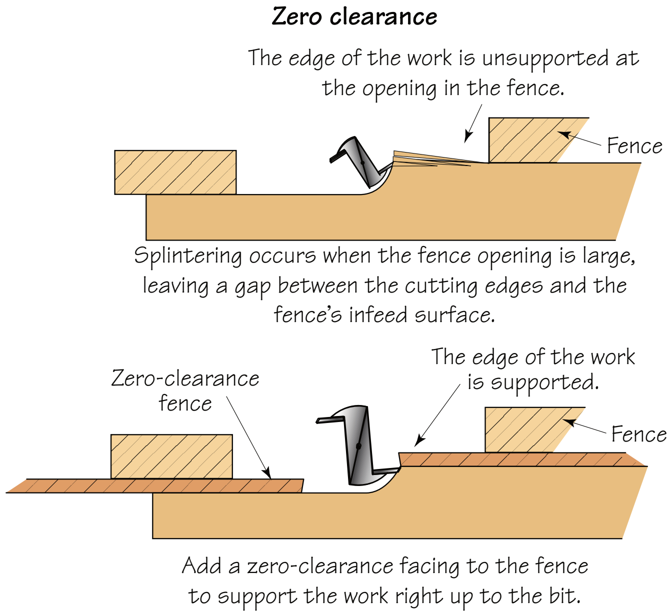
The free end of the strip can be held to the fence with an additional clamp. If the clamps will interfere with the work, use carpet tape or hot-melt glue instead.

You can deal with the pilot bearing—if the bit in play has one—by either cutting a clearance hole for it or by simply removing the bearing from the bit. (Remount the bearing when the cut's done, so you don't misplace it.)

Any of these facings can be turned upside down and used for a second application. You have two different cutouts in each one.

Fences, both purchased and shop-made, often have two facings, one on either side of the bit. These adjust so you can crowd them in on a small bit, or spread apart to accommodate a large one. To form a zero-clearance fit, you just slide the facings, one at a time, against the bit as it spins.





Thin plywood (or hardboard) makes an excellent zero-clearance facing for the fence. Cut a strip as long as the fence and bore a clearance hole for the pilot bearing. Starting with the bit *inside* the fence, swing the fence, allowing the bit to cut through the facing (left). Don't fret about splintering at the outfeed side of the bit; that's inevitable. It's on the infeed side where the zero clearance is needed.

Pacing the Cut

It would be nice if the results of router cuts were consistent, regardless of your pace; you'd be able move the work nice and slow or zip it past the bit and get the same result.

But that's just not the way it works. You must pace the cut to get good results. The pace is set by both the speed at which the router is spinning the bit and the rate at which you feed the work. It is a highly variable realm, and your results may vary.

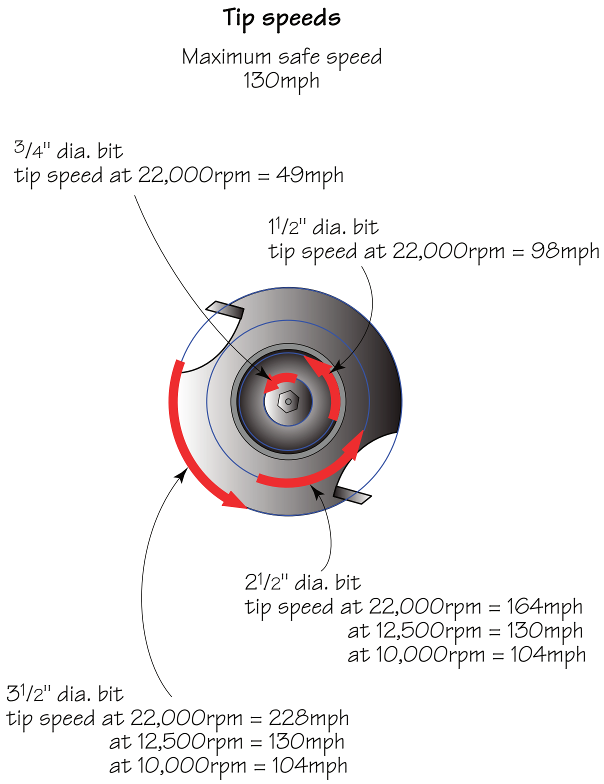
Router Speed

Typically, a router runs at about 22,000 rpm. Consequently, bits are designed to cut most efficiently at this operating speed.

Large-diameter bits are atypical. As the bit's diameter hits about 2", high operating speed becomes a problem. Bit manufacturers stress that large bits should be run only in table-mounted routers and only at sharply reduced rpms. The concern is safety more than cut quality.

Think of it in terms of linear speed. Each point along the cutting edge of a bit is traveling a different distance in each rotation of the bit. The farther out from the center point you go, the faster the point must move. The critical point is the very tip. At 22,000 rpm, the tip of a $^3/_4$"-diameter bit is moving 49 mph, while the tip of a $3^1/_2$" bit is moving 228 mph. A tip speed of 130 mph is probably the safe maximum.

So when bit diameter hits 2", you need to begin turning back the speed. The drawing Tip Speeds (right) provides a handy guide to approach speeds for various bits.



While the need to slow large bits is commonly understood, many router users don't recognize the balance between bit speed and feed rate. To a degree, you can offset the effects of a slow feed by also slowing down the router's rpms.

If you make a stopped or blind slot, for example, the average feed rate is low. You have to plunge the work onto the bit to start the cut and at the end, you have to tip it up off the bit. Dialing back the rpms compensates for the halting pace.

The speed at which you run a bit should be reduced as its diameter increases. You can safely run the $1^1/_2$" and 1" bits (right) at full tilt. Chuck a 2" bit in the router (center) and reduce the speed to 17,500 rpm. Switch to a $2^1/_2$" bit (center left) and shave the rpm to 16,000. And run that horizontal panel-raiser (left) at only 10,000 rpm.

Router bits generally have an anti-kickback design intended specifically to retard the feed rate. The body is just 1⁄16" smaller than the cutting diameter and it has a gullet ahead of the cutting edge that limits the size of chip that can be sliced from the work. The features are most obvious when you compare an old-style panel raiser with the anti-kickback style.

Feed Rate

The pace at which you feed work is critical to the overall cut quality. There are several variables: the material being cut, the amount of material being removed and the type of bit being used.

Excessive restraint is a very common problem. Unsure of how fast to feed the stock, and perhaps a little intimidated by the frenzied sound of the router, a woodworker will cautiously inch the workpiece along the fence. The problem with this is heat. If you allow a bit to dwell in the cut, you allow heat to build up. The cut surface is scorched and burnished. (Some woods, like maple, cherry and red oak, are particularly susceptible to scorching.)

A secondary penalty for a too-slow feed rate is a dull bit. Heat causes the binder that holds the carbide particles together to break down. And that's what causes the carbide cutting tip to dull. A timorous feed rate can kill a bit quickly.

A halting feed is sometimes the consequence of taking too big a bite. You get off to a fast start, then back off as the router starts to bog. You might even stop momentarily to allow the rpms to pick up. The geometry of router bits plays a role here.

Cutters are configured on the basis of what will be driving them. Those designed for CNC routers and shapers are larger in diameter than comparable router bits and lack the chip-limiting configuration common to router bits. These machines don't bog down because they have power to spare and because their cutters are designed with the chip clearance needed for a heavy cut at a fast feed rate.

The router doesn't have comparable power and anti-kickback bit design limits the size of the chip that can be taken in each sweep of the cutting edge. To deal with these limitations, you either reduce the bite or reduce the feed rate. Since a slow feed is bad, it's better to reduce the bite.

A scorched cut like this often results from a slow feed. Sometimes that's a consequence of timidity, but often it's a result of over-aggressiveness. Hogging out a panel in one pass can bog a router. You back off or stop momentarily, the net result is a burned cut surface.

Feeding work aggressively can complete a cut quickly, but it may yield unsatisfactory results.

Staging a Cut

The router is a trimming machine, working best when it's nibbling at the stock.

Sure, you can bulldoze through any sort of cut. And you're sometimes encouraged to do this by experts who disparage moderate cuts as "rubbing off the wood." These people prefer instead to rout on the ragged edge of stall.

But what happens when you try plowing that 1/2"-deep by 3/4"-wide dado in hard maple? The bit starts a shrill, piercing chatter. The motor labors and starts to bog down, losing speed sharply. Your instinct, as the router bogs down, is to stop feeding until the router regains speed. That's okay for the router, but it's hard on the bit. Heat buildup degrades the binder bonding the carbide particles in the bit, and the net result is premature dulling.

Cut quality is another work-load issue. A heavy cut, particularly along an edge, can exacerbate chipping and splintering (see "Damage-Free Cuts").

My goal is to get a good-quality cut as expeditiously as possible without overtaxing the router and the bit. That usually means *staging* a cut by completing it in one, two or more additional passes.

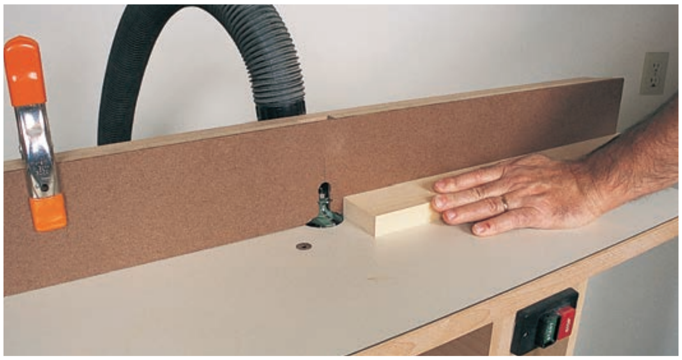
There are two main approaches to staging a cut.

The first option is to elevate the bit in stages, beginning with a shallow cut and making it progressively deeper with multiple passes.

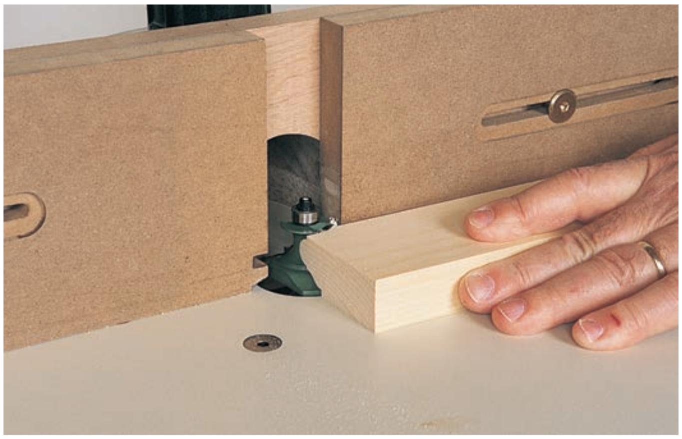
The second option has you stage the fence position. Obviously, this can be used only on edge-forming operations, where the fence plays a role in scaling the cut, not simply in placing it.

I prefer to get everything set up so I can make and evaluate a full cut before starting to cut the real workpieces. After my final test cut, I can back away from one aspect of the setup or the other, but still get back to that final perfect setup.

Here's one good reason for staging cuts. Plowing a 5/8"-deep dovetail groove in a breadboard end—without first wasting the channel with a straight bit—overtaxed this dovetail bit. The cutter twisted off the shank. No physical danger involved, but the bit is now scrap.



Shims clamped to the fence reduce the bit exposure, thus reducing the cut (right). Use two or three shims on the first pass. A single spring clamp on the outfeed end of the fence is all you need, since the pressure you apply to keep the work against the fence will also hold the shims against the infeed side.



The final pass, made with all the shims removed from the fence, is full depth and free of chipping (right).

Using Shims

The shim is my first workaround. I can use one, two or three either on the tabletop to elevate the workpiece, or on the face of the fence to house more of the bit. In either case, less of the bit is exposed with the shims in place, so its cut is reduced.

I use hardboard or MDF (or both) for shims. Use a 1/8" and a 1/4" hardboard shim to stage a cut in 1/8" increments. Use both to reduce the bite by 3/8", then pull the thin one for another pass, then substitute the thin for the thick for a third pass. The final pass is made without the shims entirely.

Again, you can use them on either the tabletop or the fence face. You do need a cutout for the bit, and the shim must be large enough to support the work properly. Secure them with spring clamps, carpet tape, even hot-melt glue. On the tabletop, you can sometimes trap them against the fence and let gravity hold them for it.

Shims on the tabletop are an effective means of staging a grooving cut. You can accurately set a cut-depth before working the good stock. Then lay the shims on the tabletop and secure them with a spring clamp. After each pass remove a shim. The deeper the full cut, the more shims you should use.

Using Stop Blocks

The stop block is my second workaround. It works only with the fence. Butt a block against the back edge of the fence—preferably one on each side—and clamp it to the tabletop. You've captured the fence position. Loosen the fence clamps, edge it forward, then reset the fence clamps. You've reduced the cut for a light first pass. Edge it back in stages, and you can increase the overall cut incrementally.

A very light final pass is often desired to produce the smoothest possible surface, right off the cutter. Insert business-card shims between the fence and the stops on the penultimate pass, then remove them and reset the fence for the final buffing.

Use stop blocks to *memorize* the final-cut fence position. Set a scrap against the fence's back edge on either side of the table and clamp them. For a light scoring pass, move the fence forward (left). Return it to the predetermined final-cut position by sliding it back against the stop blocks (center). The two- (or more) stage cut yields a crisp-edged-rabbet (right) without overworking either router or bit.

Stopped Cuts

A stopped cut is one that begins or ends shy of one end of the work but is through at the other end. A blind cut begins shy of one end and ends shy of the other.

Stopped and blind cuts take a little more setting up than through cuts do. As with any cut, you first have to set the bit and the fence. Beyond that, you have to figure out where to begin and end the cut, then either put temporary marks on the table, fence or clamp stops to the fence so you can make the desired cut.

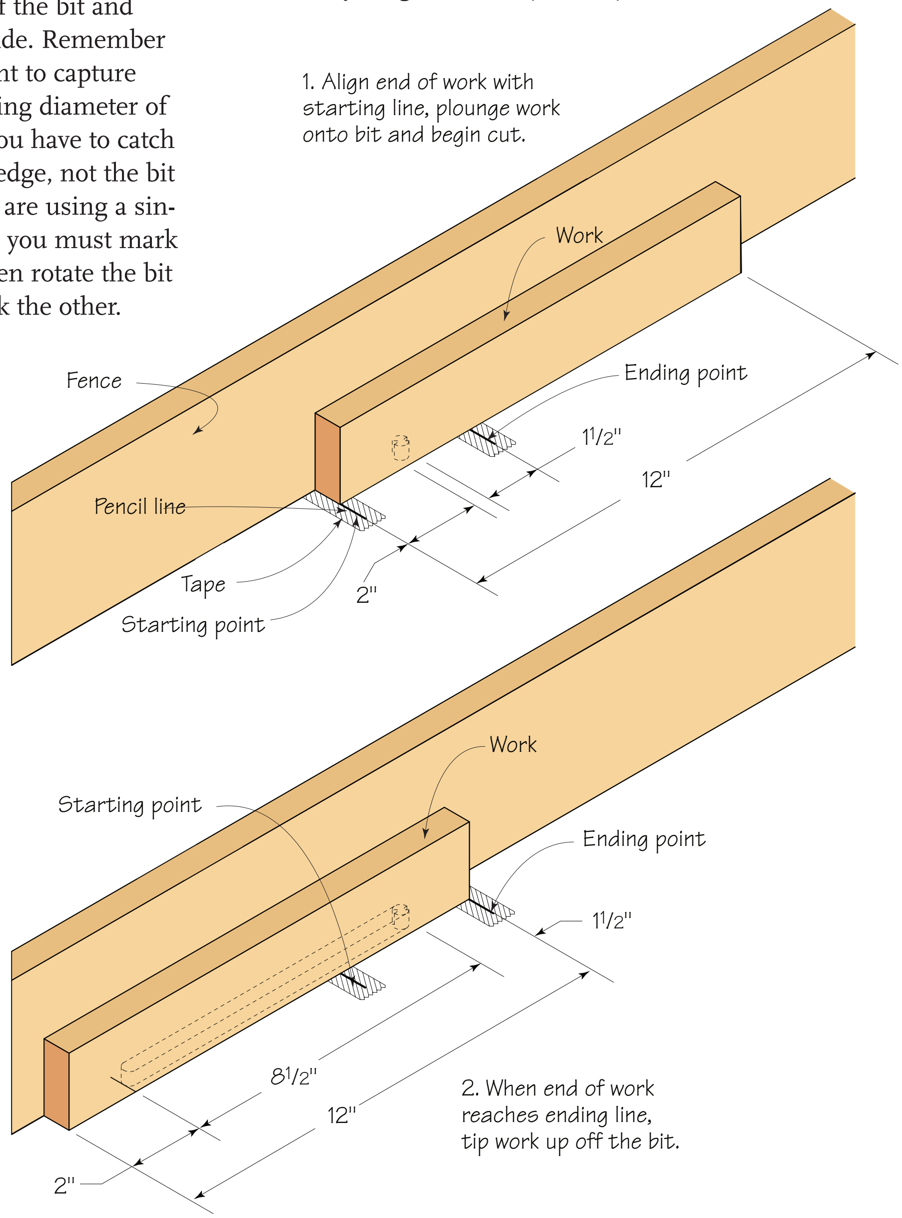
Let me explain one way of doing a blind cut, then offer several variations and alternatives.

Beyond the initial setup, the first step is to lay out the extent of the cut on a sample workpiece. The next step is to mark where the bit is and how big it is, either on the tabletop or on the fence, whichever place will be visible as you make the cut. I usually put the marks on masking tape, so I can remove them when the job is done simply by peeling off the tape. (If the tabletop has a light-colored plastic laminate surface, you can make pencil lines directly on it and erase them when the job's done.)

To make the marks, set a square block of wood tight to the fence and slide it against the bit's cutting edge. Scribe along the block on the tape. Shift it to the other side of the bit and mark that side. Remember that you want to capture the full cutting diameter of the bit, so you have to catch the cutting edge, not the bit body. If you are using a single-flute bit, you must mark one side, then rotate the bit 180° to mark the other.

Being able to "see" the infeed and outfeed edges of the bit is essential when making stopped or blind cuts. The usual routine is to mark the bit tangents on tape applied to the table or fence. Avoid chipping the carbide by using a wood scrap as a square.

A through groove (left) extends from one end through the other. A stopped groove (center) begins at one end but stops short of the other end. And the blind groove (right) begins and ends short of either end of the workpiece.



Making the Cut

Right to left is the proper feed direction. Tip the work so the leading end is above the bit and the trailing end on the tabletop. Line up the starting mark on the work with the mark for the outfeed side of the bit (the one on the left). Plunge the stock onto the spinning bit. Feed the work. As the end-of-cut mark on the stock comes up to the mark at the right of the bit, carefully tip the trailing end of the work off the bit.

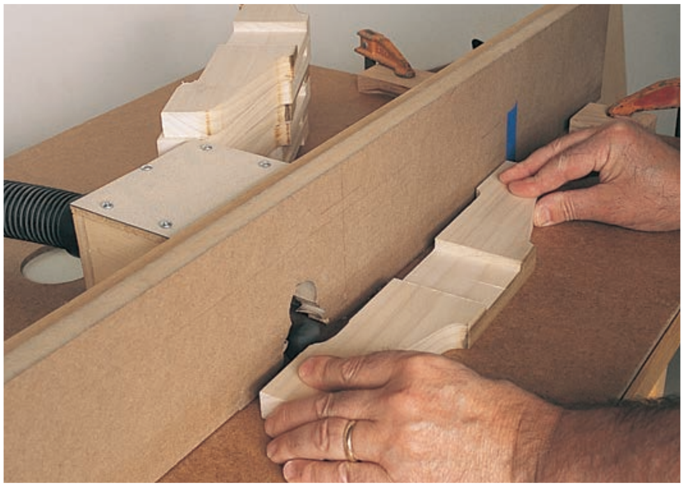
Of course, if you are making an edge cut, you'd leave the work flat on the table, and tip it away from the fence, the beginning and end of the cut. In this operation, marking the bit on the fence is a better bet than on the tabletop.

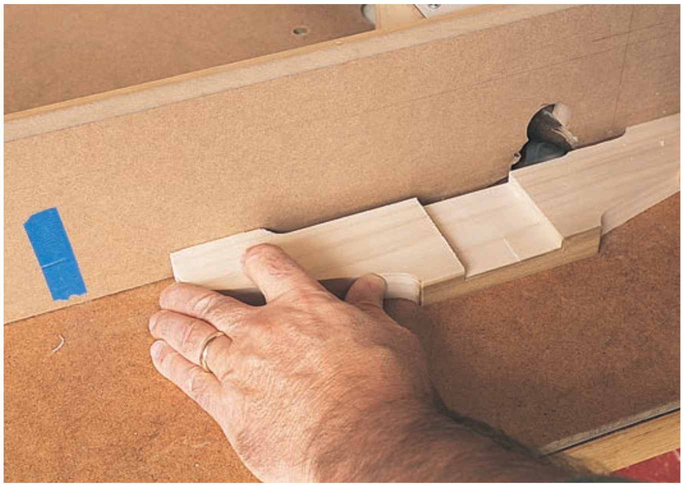
Keep in mind which mark on the table is for starting and which is for ending. Mix them up and you'll have a cut that's two bit-diameters longer than you want.

Variants are for stopped cuts, rather than blind ones. You may begin feeding the work as though making a through cut, but halt the feed and remove the work when the marks align. Or you can plunge the work onto the bit to begin the cut, then feed through the end. Depending on the specifics of the job, you may do some parts one way, and others the second way.

An alternative to marking each workpiece is to place marks on the table (or fence) with which to align the ends of the workpiece as you begin and end the cut. This works if all the parts have the cut beginning or ending at same distance from the work's end.

Begin a blind groove with the trailing end of the work resting on the table and the leading end tipped up above the bit (left). Align the mark on the workpiece with the tape marking that will place the bit inside the groove. Plunge the work down onto the bit and advance it until the end mark aligns with the other tape mark. Tip the work up off the bit (right).





Creating a relief in the bottom of a trestle foot is a simple blind cut. But making feet for a team of shop horses means routing the same cut in piece after piece. Marks on the fence delineate where the foot must align to begin and end the cuts. Line up the toe with the starting line, push the foot against the fence. Feed until the heel lines up with the finish line and pull the foot away from the fence.

Using Stop Blocks

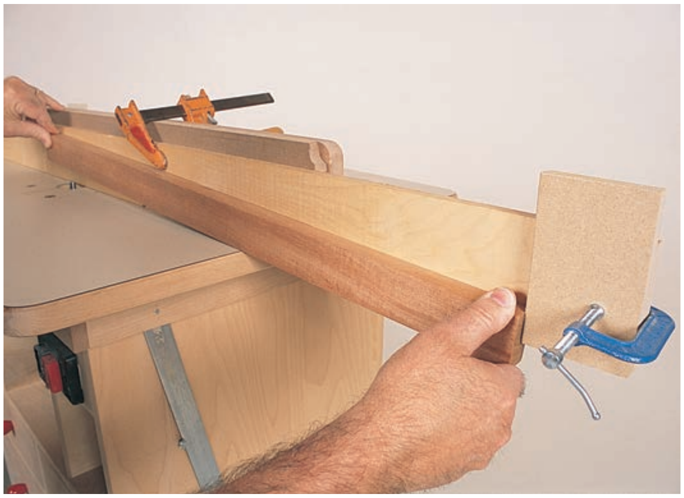
If you have many pieces to rout, stop blocks clamped to the fence or tabletop can expedite the work. Most commercial fences have T-slots for mounting things like stops. I just clamp scraps to whatever fence I'm using.

You can position the stops with a rule, measuring to the right from the left side of the bit to set the starting block, and to the left from the right of the bit to set the stop block. Or, you can use a test piece to position the stops. You don't even have to cut the piece, just lay it out. With the router switched off, set the start mark beside the bit. Place a block gently against the workpiece's trailing end and clamp it to the fence. Advance the workpiece to the end-of-cut position. Place the stop block against the piece's leading end, and clamp it.

To cut your stopped groove, set the piece against the start block, plunge it onto the cutter and feed it until it hits the stop block. Each piece will be the same.

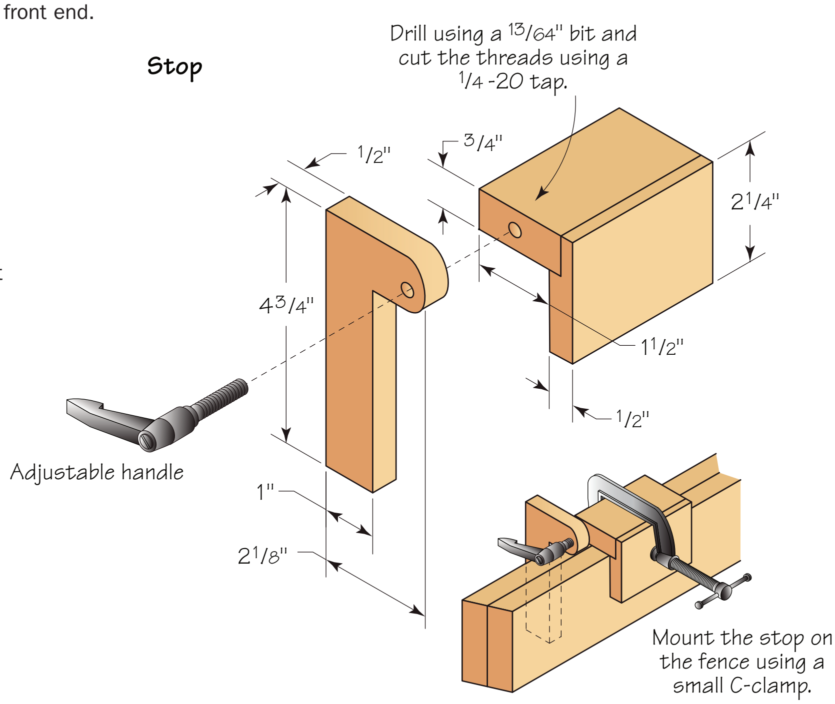
One last tip; if your workpieces are very long, the stops may have to be beyond the ends of the fence. All you have to do is screw the stops to long strips of plywood, then clamp the strips to the fence.

Stop blocks don't have to be fancy or formal. Pluck a scrap or two from your offcuts bins and secure them to the fence with small clamps. With the bit backed just below the table, set a laid-out piece over it, at the beginning of the cut. Set and clamp a stop against its back end. Slide the piece to the cut's end point and set a stop against its front end.



Long cuts in longer workpieces may require you to locate stops beyond the edges of the table. Screw or clamp blocks to strips of plywood and clamp those to the fence.

This stop block can be used on almost any fence. Set it on top of the fence and secure it with an ordinary clamp. The stop arm can be pivoted up so it doesn't hinder a through cut, then dropped down for a stopped or blind cut.



Handling Small Parts

Small workpieces are trouble. Maneuvering them on the table is tricky. Contact with the spinning bit can blow them apart. Take all the precautions you can.

First analyze the size of the work. Set on a table beside the bit, a 6" square part can seem awfully small. Often times, you can do the router cuts on a oversized piece and then cut it to size.

Analyze the setup next. Be sure your bit has a zero-clearance housing. You don't want the small part to hang up on the rim of the bit opening in the tabletop or the fence.

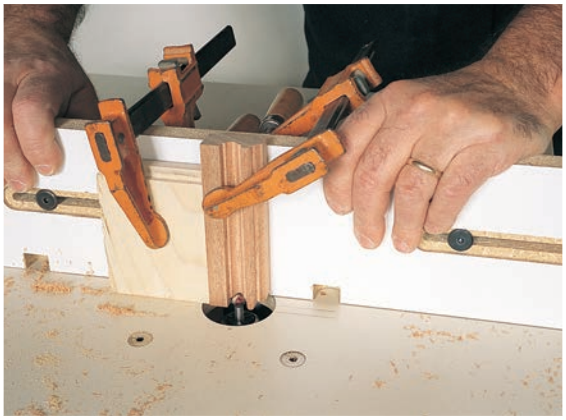
Get yourself a work-holder. Try gripping the workpiece with a wooden hand screw. You can slide the hand screw around on the table. Presenting the work to the bit with your fingers well away from the action. The clamp will add some mass to the workpiece and may absorb some of the vibration. If the clamp should get intimate with the bit, it may suffer, but the bit won't and neither will your fingers.

Finally, let me remind you about the *sweaty palms syndrome*. Working with small pieces often triggers it in me. As I said before, when I hear that whisper in my ear—"Are you *sure* you want to do this?"—I make it a point to listen.

Rather than struggle with a safe and effective way of shaping very small pieces, you can often shape an edge of a much larger piece, then cut the small part free. Here's a batch of drawer pulls formed by rounding the long edges of a board. The grooves become a tongue, and a series of blind coves—finger holds—routed in the underside segment the strip for crosscutting into individual pulls.

To round-over the ends of the pulls and shoulder the tongues, use a sled-style carrier to which you can securely clamp the small part. Slide it along the fence, as shown, to make the cut.

A hand screw is a good way to grip a small piece and feed it through a cut. You can clamp the piece tight without denting it. The clamp is big and heavy enough to provide mass. And should it contact the bit inadvertently, it won't chip the carbide the way a steel clamp would.



The sliding fence can be a good carrier for routing a small part. You can brace the piece against a stop, clamp it so it doesn't wiggle or move, then feed it through the cut. The fence backs up the work, preventing blow-out.

The Miter Gauge Alternative

Here's the sensible router-table alternative to the miter gauge. This sliding fence is designed to move as you cut. It straddles the tabletop from front to back and has guides hugging the tabletop edges. It includes an adjustable backup facing with a stop.

What's wrong with using the miter gauge, you ask? The miter gauge guides crosscuts on the table saw, so you can use it on the router table too.

The difference is in the cutter's axis of rotation. The axis of the bit in a router table is at a right angle to the axis of the saw blade in a table saw. The plane of rotation is different, and that changes the cutting dynamic. On the router table, you need a means to prevent blow-out and to prevent self-feeding as much as you need a guide for the work.

Consider blow-out. When you cut from edge to edge across the grain—making a dado or a rabbet, for example—the outermost wood fibers won't be cut cleanly by the bit as it emerges from the wood. These fibers may simply curl back. But often, the splinters tear out of the edge, defacing it.

Backup material tucked tight against the work is the most reliable blow-out preventative. The adjustable facing of the sliding fence provides that backup.

What do I mean by self-feeding? It's the tendency of bit rotation to move the work as it cuts.

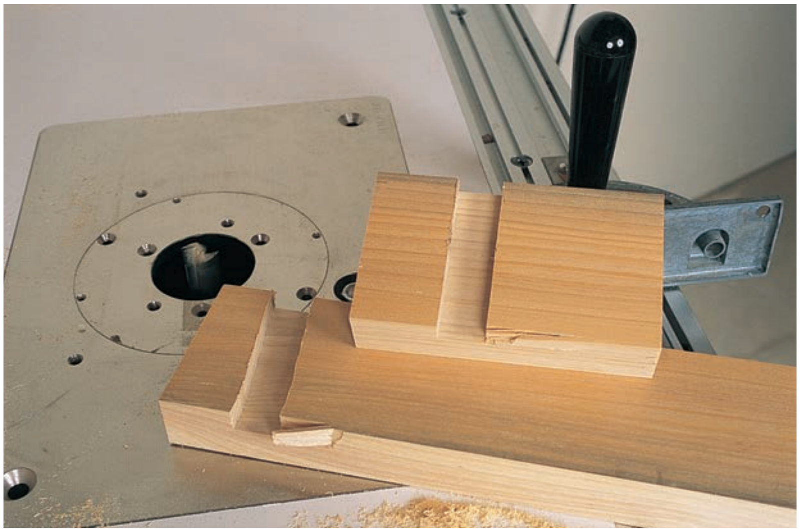
Page back to "Feed Direction Savvy." Note that when you feed work from right to left along the regular fence, you're enlisting this rotational force to help you maintain control of the work and keep it against the fence.

With a miter-gauge-guided cut, the dynamic is your foe. Let's say you want to rout a 3/4"-wide dado across the face of a 3"-wide board. Set it into your miter gauge, and feed it onto the bit. The bit wants to pull the work to the right as it cuts. If your attention wanders or your grip isn't tight, it will pull the work and give you a less than square cut.

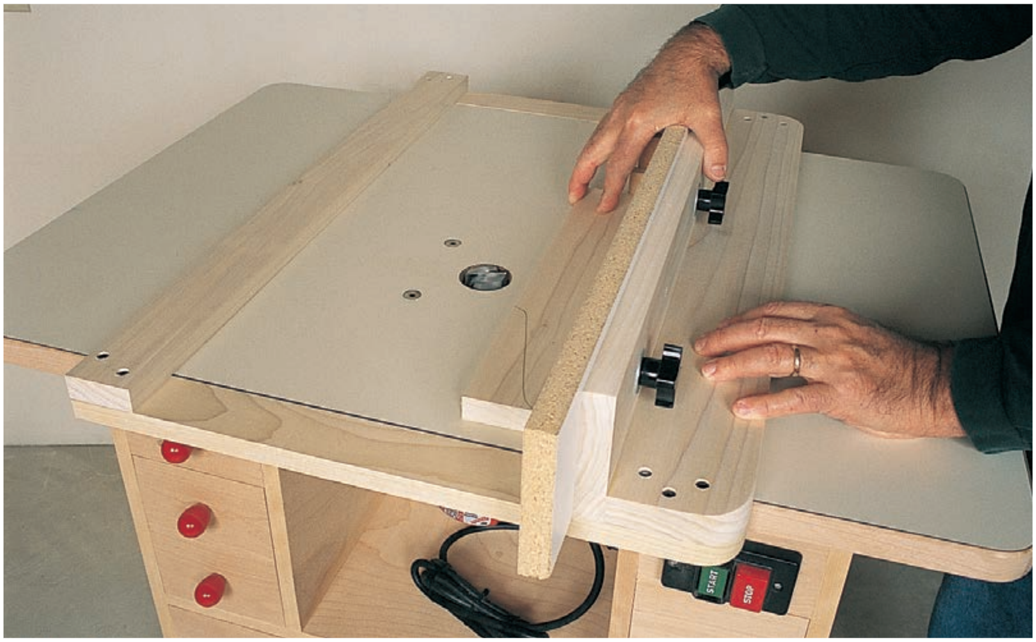
With the end of the work against the sliding fence's stop, however, the bit can't move it.

The adjustable facing can be secured to the sliding fence either with bolts or clamps. Using clamps speeds setup and provides a continuous adjustment range. But clamps might be in the way on certain jobs. Bolts eliminate obstructions but limit the adjustment range.

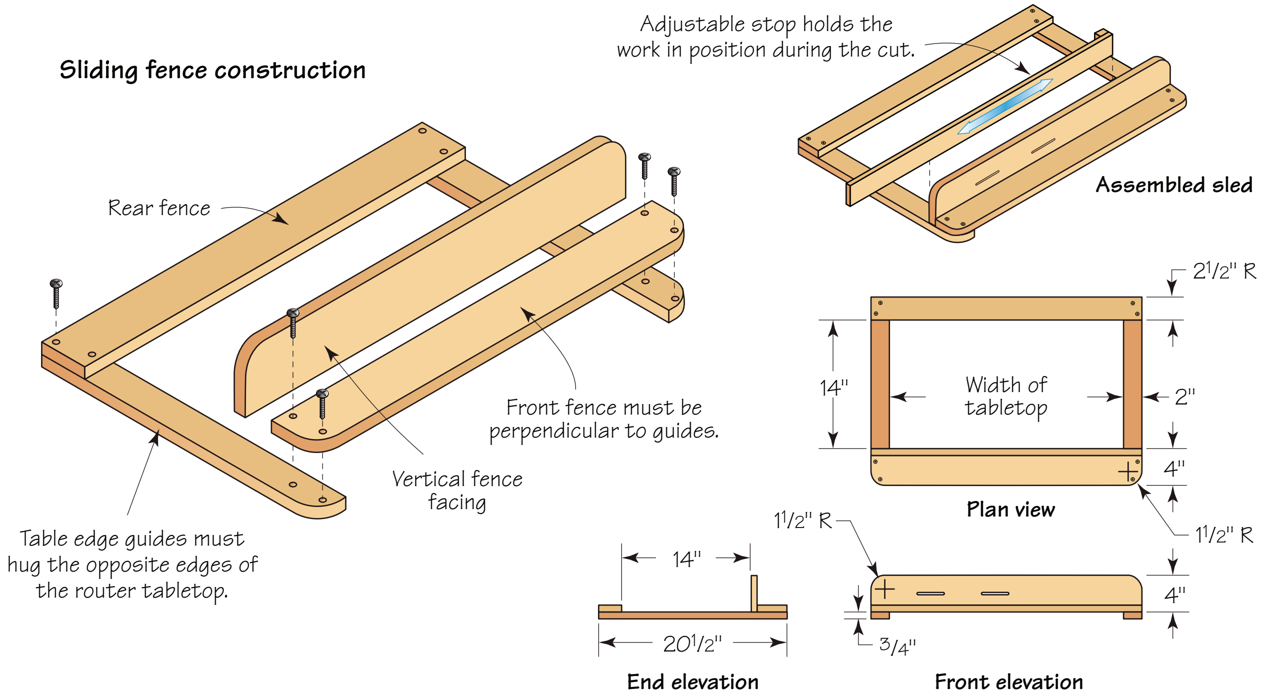
While the sliding fence won't see everyday use, it's invaluable for cutting dadoes, lap joints, tenons, various sliding dovetails, including French dovetailed drawers, and box joints.



Using a miter gauge to guide a dado cut often yields unwanted results. At the least, the bit will blow out chips and splinters as it emerges at the back edge. More likely, the bit's rotation will pull the workpiece as it cuts, producing an out-of-square cut.



The sliding fence supports and guides a workpiece through a cross-grain cut. Its adjustable stop prevents the bit rotation from pulling the work as it cuts. The backup facing prevents blow-out.



The fence's adjustable stop can control the cut width as well as its position. Spacers stacked between the workpiece and the stop shift the piece away from the stop a controlled distance. Make a cut (left). Remove the spacer(s) and make another cut (right), expanding the cut's width.

The sliding fence helps you rout hand-cut through dovetails. The idea is that you rout the tails, as shown, then use the tailboard to lay out the pin board. Regardless of how you rough out the pins, you have to pare and fit them by hand—hence the hand-cut. Here the cuts are being positioned with spacers stacked between the stop and the workpiece.

Dealing with Dust

As any who has used one knows, routers generate an incredible amount of dirt—handfuls of chips and lung-fuls of fine dust. The dirt production doesn't diminish when you mount the router under a table. But the dirt distribution does, and that makes it easier to capture.

The most common dust collection feature is the fence-mounted port for a shop vacuum hose. With it, much of the chips and dust produced during edge-forming cuts can be captured. But as an overall dust-collection system, it's ineffective. The fact is: Most of the dirt goes straight to the floor (or into the router compartment).

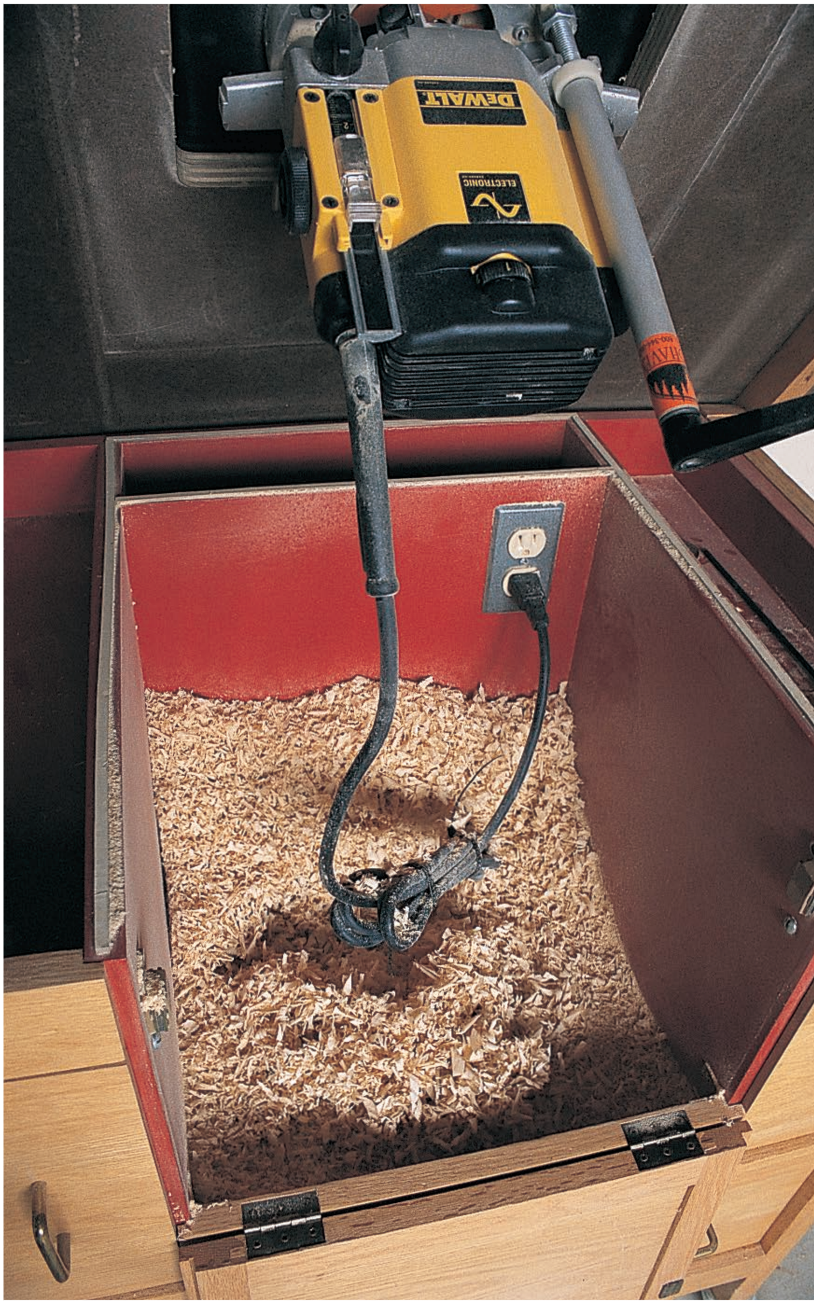
It's a function of bit design. Bits are designed first to cut, then to excavate the waste from the cut. This means that, when chucked in a table-mounted router, the bit pulls the waste out of cut and blows it down over the router. That dust pickup mounted on the table surface isn't going to capture this dirt.

An open-legged router table seldom has any means for collecting dirt blown below the table. The router compartment of a cabinet-style table will capture this dirt. But if the compartment is open—no door, or a door that's left open—it will hold the chips only until they spill onto the floor. A closed one will hold the chips until they smother the router.

At one time, mounds of chips on the floor were a sign of a busy, productive shop. Today's woodworkers are more aware of the impact of dust on their health. In my own shop, I've advanced from that shop-vacuum pickup on the fence to two-level collection—from fence and router compartment—using 4" ducting and a real collector with a high-filtration cartridge. Even many open stands can be fitted with good under-the-table collection.

A bench brush, dust-pan and broom will always be shop essentials, but you can reduce your use of them by having good dust collection in your router table design.

A simple grooving cut sprays dust out of the cut and across the tabletop. The typical dust pickup on the table's surface may capture the dust, but it'll need to be in the cut path.



Raising panels is a job that creates a lot of chips and dust. Without a dust collector pulling the dirt out of the router compartment, you risk smothering your router. And if your router table has an open stand, all this goes on the floor—with the lung-clogging fines dispersed into the air.

There's no better setup than a real dust collector extracting the chips as they are generated, using pickups both above and below the table. A cyclone isn't essential, but something better than a shop vacuum is needed to handle the mess a router table produces.

Collecting the dust under an open-legged table is tough. This rudimentary construction takes advantage of a frame supporting the tabletop. Semicircular baffles at the ends of the frame eliminate corners that collect chips. Plywood closes off the frame, transforming it into a channel. Duct tape seals gaps around the router base.

A fence without a dust pickup deflects the chips coming off the bit onto the tabletop and into your face. Commercial fences all have a port for a shop-vacuum hose behind the bit, and you should install one on a shop-made fence. This pickup is a stack lamination band-sawed and spindle-sanded inside and out, glued to the fence and then closed with a plastic cap bored for a hose connection.

A good collector pulls dust from both the router compartment and the fence. In this setup a 2" hose from the fence joints a 4" hose from the router compartment in a Y-fitting, with a single 4" hose running to the collector.

Bit Guard Dust Pickup

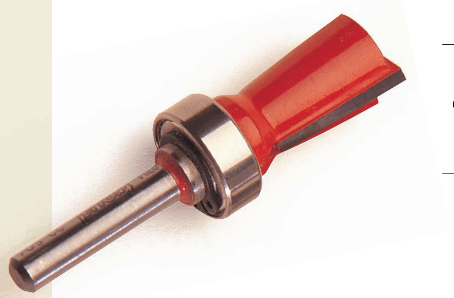
This multipurpose accessory is essential for pilot-controlled operations. It's a dust pickup and bit guard, primarily, but the right-hand vertical edge is shaped to serve as a starting pin. Use it whenever the fence is off the table.

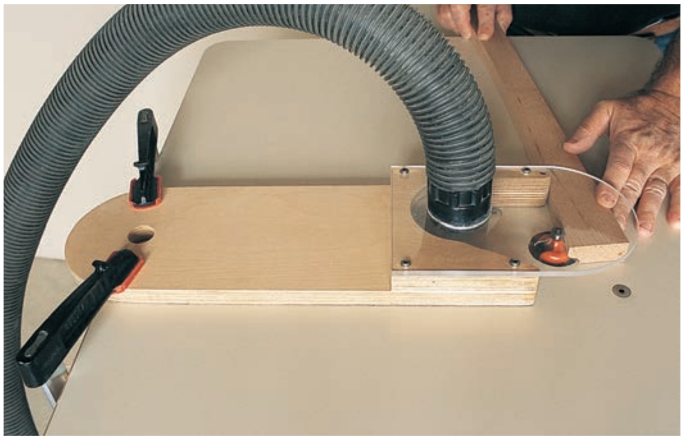
Position the guard over the bit and clamp the base at the back edge of the table. Two clamps are needed to keep it from shifting as you address the starting nose with the workpiece. Plug in the dust collection or shop vacuum hose.

The accessory is easy to make from plywood, MDF or melamine. Use acrylic or polycarbonate for the guard.

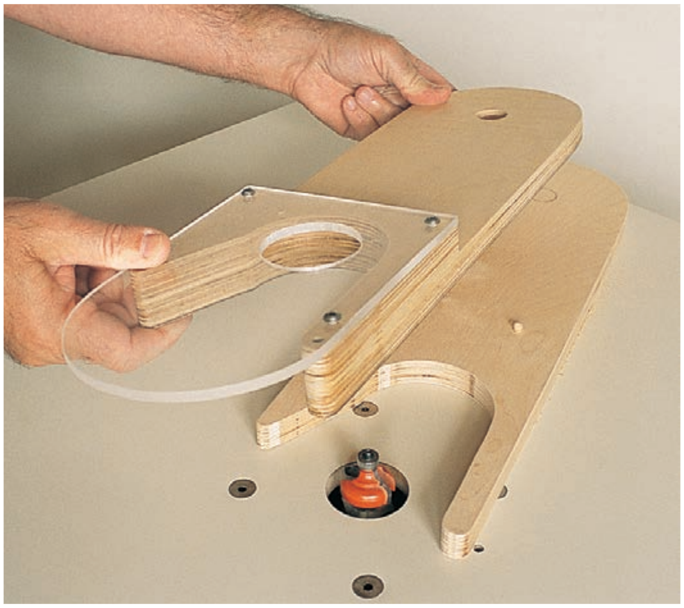
Cut and join the base and riser. The dust pickup works best if there are no inside corners. Begin shaping it by boring a 3½"-diameter hole using a hole saw. Cut the rest of the contour with a jigsaw or on the band saw. Round the noses and smooth the inside of the contour with a sanding drum.

Make the guard and fasten it to the pickup with four screws.



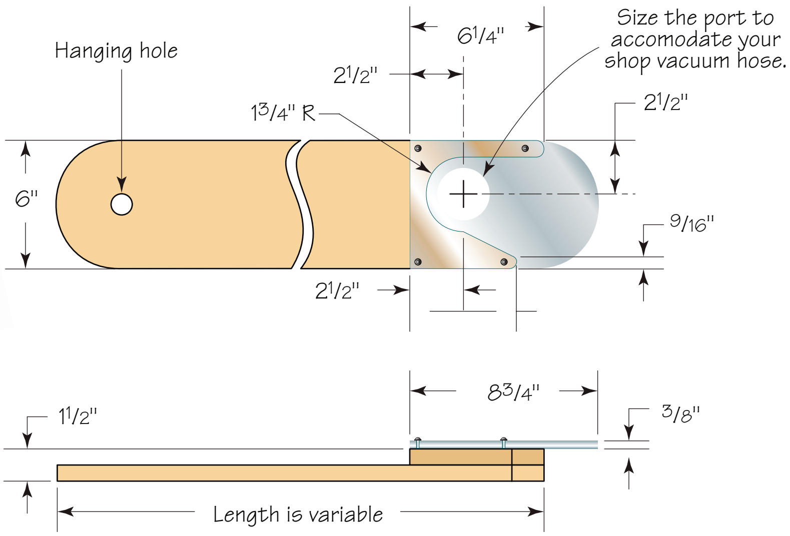


This multipurpose accessory is essential for pilot-controlled cuts on the router table. The leading edge serves as a starting pin. The clear guard keeps your hands out of danger without obscuring the action. In addition, it has a port for a dust collection hose. The curved inside contour corrals the majority of the chips and dust. Set it in position and clamp it at the back edge of the table.



To use the accessory with thick stock, set it on a lift. The lift is a duplicate of the base ply with a couple of pins to index it. The clamps used to fix the accessory to the tabletop keep the separate pieces together.

Bit-guard dust pickup



Dressing the Part

So far, I've covered a lot of guides, accessories and procedures you can use to help you work confidently and safely at a router table. As you get ready to fire up your table-mounted router, be sure you have on your vision, hearing, and respiratory protection.

Hearing Protection

Muffs are the most common hearing protectors used in woodworking shops. All you need is a good pair of passive muffs. These are inexpensive and widely available.

The drawback to passive muffs is human nature. The muffs are across the shop and you think: "it'll only take a sec to make this cut." So you do it without the muffs. Next thing you know, you seldom use them because you are out of the habit.

A possible solution, especially if you enjoy having the radio on, are the muffs with a radio. Muffs like Peltor's Worktunes are true passive hearing protectors. The radio incorporated into them cannot be cranked up enough to damage your hearing.

What about those high-tech sound-cancelling muffs, like those used by target shooters? Save your money. The manufacturers don't recommend them for woodworking.

For some, muffs are annoying but there are alternatives: plugs—foam, wax, and rubber, air-cushioned and even custom earmolds. Foam plugs, are disposable. Plugs are inserted in your ear canals and can be worn the entire day.

Another alternative is canal caps, which in effect are ear plugs on a headband. The pads fit into the ear canal, but not as far as traditional plugs. The headband keeps them in place. You can orient the band so it is under your chin or behind your head, whichever seems most comfortable.

Vision Protection

The router produces a barrage of wood chips and dust, and even if you have good dust collection on your router table, it's advisable to wear eye protection.

All sorts of protective eyewear is available, and not all styles emphasize dorkiness. You can find wrap-around styles that look cool—if that's important to you—and offer excellent protection. I wear glasses, but I've been able to find several different styles that fit over my specs.

Respiratory Protection

The dust that accompanies the chips is another hazard, and it isn't always captured by cobbled-together dust collection setups. These router-produced particles can hang in the air for a long time. The best protection for your respiratory system is to wear some kind of dust mask.

Everyone is familiar with nuisance dust masks. At a good hardware store, you should be able to find a wide selection of masks, including some with a vent intended to prevent the air that escapes around the mask's margins from fogging your glasses. The best I've found are pleated.

Don't be a cheapskate on this. If you're willing to spend $200 to $300 for a router and hundreds more for a router table, invest in top-quality eye, hearing and lung protection.

Hearing protection comes in several forms. Ear plugs may be the least intrusive; you insert them in your ears at the beginning of a shop session and leave them there until you end your workday. Buy foam disposables. Muffs are most common. Get a pair with a radio if you like.

Flying chips can injure your eyes, so safety glasses or goggles are appropriate when you use your router table. Sporty wrap-arounds (center) may make you feel less dorky, but they won't fit over corrective eyeglasses. The style at left will. For the best protection, get goggles that fit tight to your face.

CHAPTER

2 Cutting Profiles

Edge treatments and moldings have enormous and undeniable impact on furniture appearance and on architecture. Collectively, the concave and convex surfaces are called profiles.

Profiles please the eye by easing transitions between parts and surfaces, dividing large open areas and by refining edges, corners and other borders. Then, too, the sizes and shapes of moldings have power. They can enhance (or upset) the visual balance or scale of a piece. Or even create an illusion of motion.

One of the pivotal roles of moldings and decorative treatments in furniture is to define its style. Eighteenth century styles—William and Mary, Queen Anne and Chippendale, often collectively called period furniture—are characterized by, among other things, elaborate moldings and cornices. Many 20th century styles, on the other hand, are notable for their lack of moldings. Nevertheless, even furniture of the simplest style benefits from chamfers and other edge-softening treatments.

The the router table is the ideal small-shop power tool for making moldings for furniture, picture frames and even architecture. A vast array of cutters are available and economical.

Moldings are functional too. They can hide joinery, fasteners, end grain or gaps. Occasionally, they provide a physical connection between separate parts of the construction.

Profiles can be incorporated into furniture by shaping the edges or surfaces of its components or by applying separate moldings. It's not an either-or proposition; you can do both. The effects generally are different. Profiling an edge makes it look thinner, lighter, less bulky. Applying a molding, on the other hand, adds weight and prominence.

Profiles are cut in a variety of ways. Some folks use hand planes. In a high-volume production setting, a shaper or molder will be used. But in most woodworking shops, the router is the primary tool for cutting profiles, and one that's table-mounted is ideal.

With few exceptions, it's easiest to maneuver the piece being profiled across a flat tabletop. You have support for the work (and work stands can expand that support for very long pieces). You've got the fence to control the work's movement for most jobs, and a pilot bearing and starting pin for pieces with curved edges to profile. You can use featherboards to provide additional workpiece control. The router bit is fixed and won't wobble or tip as you work (the way it sometimes does when you slide a handheld router along an edge). You don't have to work around clamps.

But wait, as the pitchman says, there's more! The router table enables you to use the largest bits made as well as those bits without pilots. This is significant, because some profile bits are quite large. Table-edge bits, for example, are almost as big as panel-raisers. Even commonplace bits like roundovers—say in a 3⁄4" or 1" radius size—can exceed 2" in diameter. Commonplace bits like core-boxes and bullnoses, along with some styles of coving bits and architectural molding cutters, don't have pilots.

Yet another reason for doing your profiling jobs on the router table is cleanliness. If you've properly accessorized your router table with dust pickups and have it connected to an effective dust collector, the work is relatively dust-free.

The only profiling I'd do with a handheld router would be the edges of a mammoth panel too big or heavy to be maneuvered along the fence or around the pilot bearing. (You do have to be sensible.)

When you get right down to it, cutting a profile is one of the most elementary router table operations. Choose a cutter, tighten it in the collet, set the desired cutting depth and feed the stock past the bit. It's that simple.

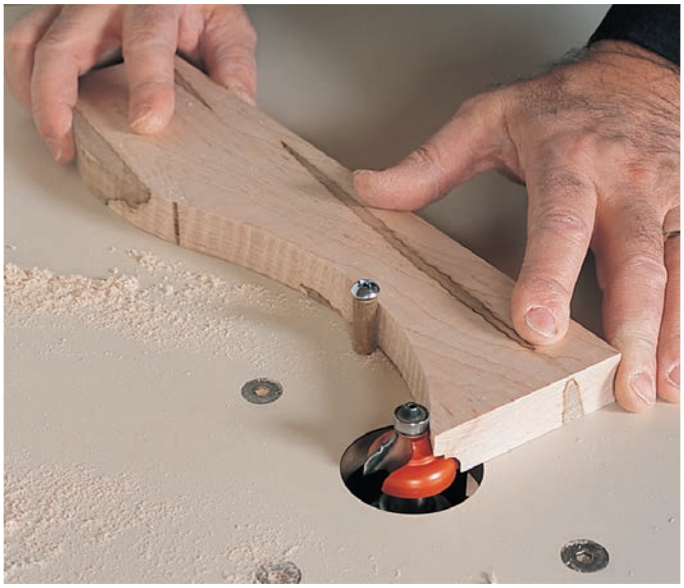
Making a Pilot Controlled Cut

Routing a profile using the pilot-bearing on the bit is a commonplace operation. The pilot isn't necessarily the best control system; use the fence whenever possible. But when the work has a curved edge, the pilot is it.

If you are relatively new to such work, review the preceding chapter. Especially pertinent in profiling successfully is an understanding of these sections: Using a Starting Pin, Feed Direction Savvy, Damage-Free Cuts, Pacing the Cut and Staging the Cut.

When guiding a cut with the pilot bearing, remember to use a starting pin. Brace the work against the starting pin and *lever* it into the bit. Because the pin is stationary, you can brace the work securely as you begin a cut at a corner or at the end of a strip.

When you're routing all around a workpiece, you usually have no difficulty beginning. You can sweep in on a long-grained side, rather than starting at a corner. Work your way around the piece, and end in the middle of the side, where you began.



Not all profile cuts are made on straight pieces. That's why most profiling bits have pilot bearings. When using the bearing alone to guide a cut, be sure to use a starting pin to help you begin the cut safely.

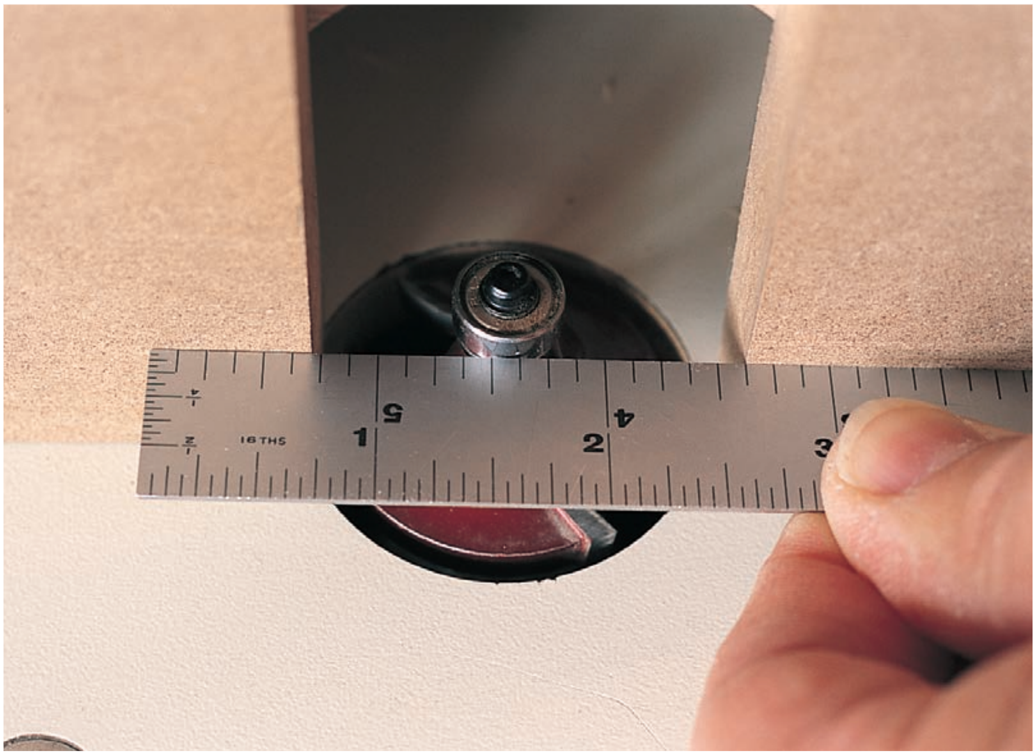
Guiding a profile cut with the pilot bearing allows you to work all the way around a shape without stopping. You can revolve the work (counterclockwise) and address the same segment of the bit. Or as depicted here, you can feed the work in a clockwise orbit around the bit. I started on the other side of the handle, pulling the work along the bit. I eased the handle's end across the bit, and I push the workpiece along the backside of the bit.

Making Fence-guided Profile Cuts

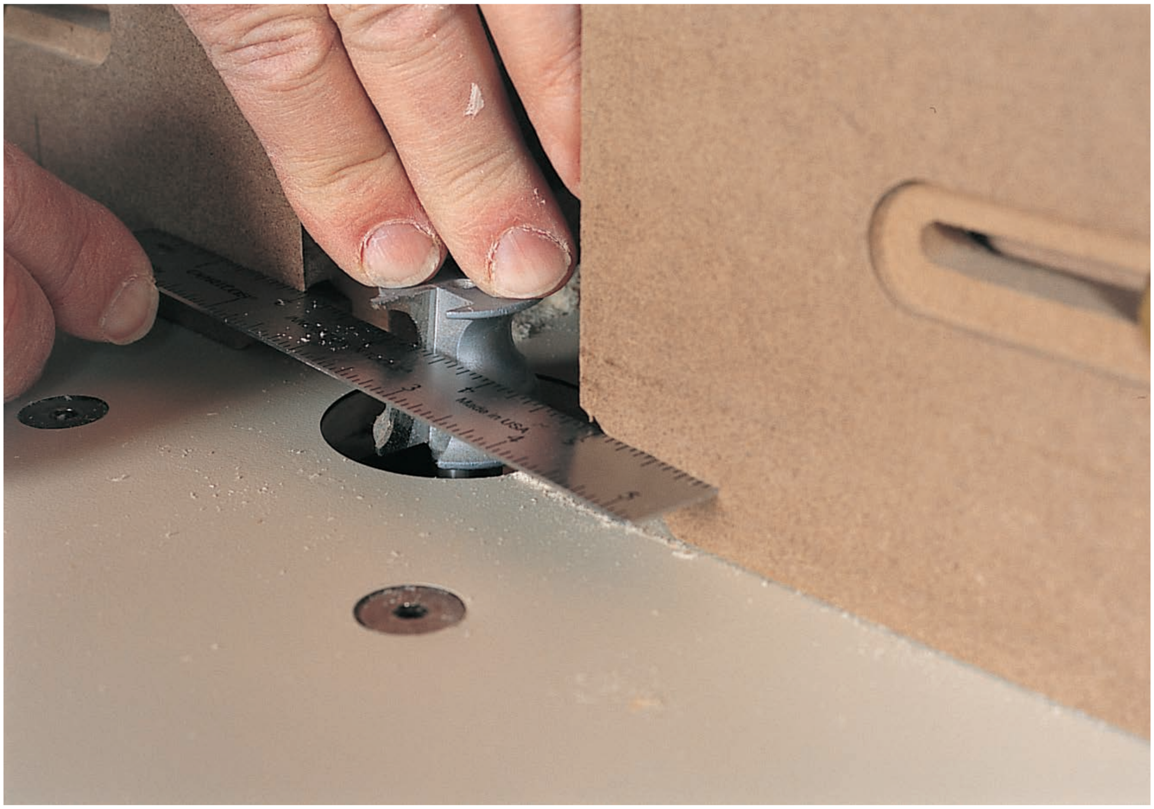
The fence is your best ally in cutting profiles. Surely it's the most-used guide for profiling cuts (as it is in all categories of router table work).

It aids you in cutting with any bit, piloted or non-piloted, small or large. It guides and supports the work. Its positioning usually locates the cut and it sometimes defines the profile produced by limiting the cut to only a portion of the bit. You can use the fence as a tool in staging cuts. By zeroing out the clearance between the fence face and the bit, you can minimize chipping and splintering.

In addition, the fence protects both the bit and your fingers, and it helps contain the dust generated in the cutting process.



The typical profile bit has a pilot bearing. Set the fence tangent to the bearing to get the full profile. The common technique is to slide a small rule back and forth across the fence's bit opening, positioning the fence where the rule brushes the bearing without actually moving it.



Not every profile bit has a pilot bearing. Align the fence tangent to the smallest portion of its cutting diameter. Bridge the fence's bit opening with your rule and turn the bit with your fingers. You want the cutting edge to graze the rule without pulling it.

Sometimes you don't want the full profile of a bit. Here the fence is positioned so the cut yields the cove and full bead without including the quarter-round bead.

Be opportunistic. Using the fence to guide a cut instead of the pilot bearing allows you to remove the bearing and stretch the bit's utility. Without its bearing, this ogee bit can produce a fillet or step next to the curve. Woodworkers in search of a special profile have been known to grind off the stem, allowing that fillet to be wider.

Cutting complex profiles with simple bits sometime requires you to stretch the limits. Here a small-diameter cutter is *cheated* out of the collet. This bit's shank is $1\frac{1}{2}$" long, so there's still an inch of it gripped by the collet.

Profiling work sometimes involves routing grooves as well as edges. The fence is your means of positioning these grooves. You can simplify fluting setups with a work-and-turn routine. Rout a groove, then turn the workpiece around and cut another. The two will be equidistant from the nearest edge.

A Lid Moulding

Use ingenuity. In reproducing the lid molding on an old blanket chest, cutting the small scotia was the biggest challenge. The solution was to chamfer the molding blank, so the groove formed with a core-box bit (in stages) was properly canted in relation to the top, bottom, and back edges. Cuts with round-over and chamfering bits followed, plus some sanding to blend transitions.

A Small Crown Moulding

The profile you need may not be one you can cut with a single bit and your standard fence. The ripple contour of this crown molding for a small reproduction cabinet was created using a Roman ogee bit by tilting the workpiece at 45°. Two beveled boards clamped to the tabletop presented the blank to the bit at the proper angle. An initial cut with a straight bit (top left) made a V-groove for the profile bit's bearing stem (top right).

Making Strip Mouldings—Safely

The word moulding usually conjures an image of spindly sticks with a profile formed on them. You see bundles of these sticks at every home center. You probably don't want those moldings, but maybe you do want to make moldings for your furniture projects or a modest home-improvement project.

Unless you are profiling the edge of a table or cupboard top, you probably are making a molded strip. With that spindly sticks image in mind, how do you do that without waste or risk?

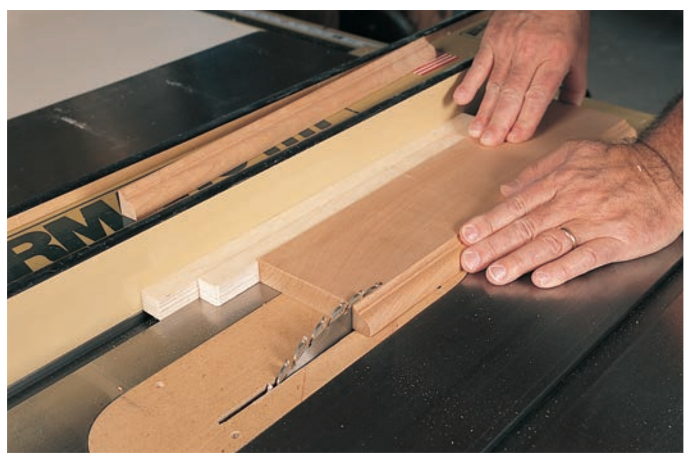
Clearly, you want to avoid routing a 3/4" square stick. That kind of workpiece is difficult to feed through a cut. It's tricky to push, and once it's passed the bit, half of it is gone. Worse, what's gone is the half that was bearing on the tabletop and fence. The dangers are to the work itself—something that slender can easily splinter and split apart—and to your fingers.

The usual procedure is to profile an edge or face of a substantial board, then rip the profile from the workpiece.

Substance is relative, of course. A cove-and-bead profile—something 1/2"-wide and 5/8"-high for a base molding, for example—can be routed safely and efficiently on a board 5/8"-thick and 1 1/2"-wide. Profile both edges, then cut the two molding strips, leaving a 1/4" ripping as waste.

A better approach is to work an even wider board, and consider the material left after ripping the moldings free to be stock for another part of the project.

Whenever possible—even when all you want is a strip molding—it's best to rout profiles on wide boards. Narrow strips are difficult to control, and the profile often removes the support surface the workpiece needs on the outfeed side of the bit.



You've done it right. Your board has a profile routed on each edge. But how can you rip the profiles from the board and be sure that both are the same width? Trapping the profile between the blade and the rip fence is not an approved practice. Cut two gauge sticks equaling the desired molding width plus the kerf width. Use the routed board (top) to set the fence in relation to the blade. To cut the molding from the first edge, fit the first gauge stick between the fence and the workpiece (center). To rip the second edge, fit both gauge sticks between fence and workpiece (bottom).

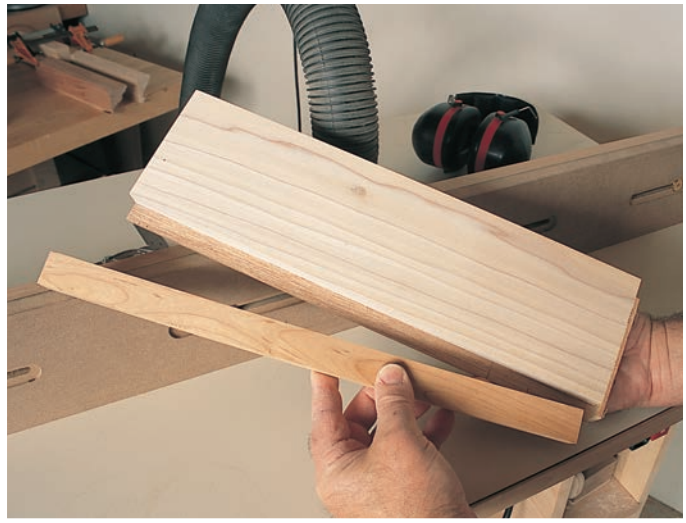
Using a Moulding Pusher

If you must rout a slender strip to produce a moulding, here's a way to do it safely. Make a pusher from scraps. It will keep the stick in proper orientation throughout a cut, give you something substantial to maneuver and keep your hands clear of the real action.

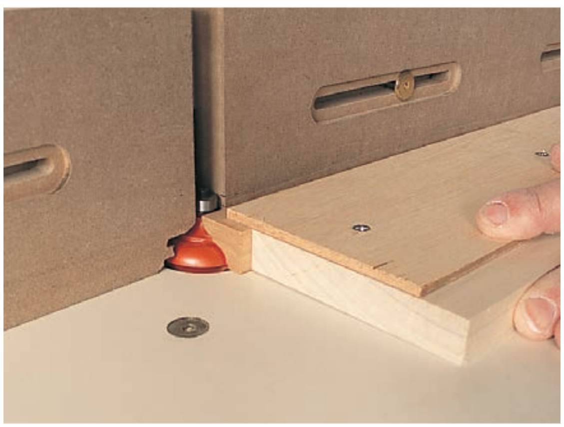
The length of the pusher should match the workpiece length closely, so you shouldn't be feeding a 3'-long stick with a foot-long pusher. The reverse would work—a 3' pusher feeding a 1' molding strip.

The idea is to plane the block about $1/32$" to $1/16$" thinner than the molding blank. That ensures the strip will be held tight against the table. Similarly, the overhang of the cap and tab must be less than the width of the strip, so the work is held tight to the fence (and so the bit doesn't cut into the tab).

You may find such a pusher is a keeper, something you stash with your featherboards and other stock pushers. Or it can be a job-specific gadget.

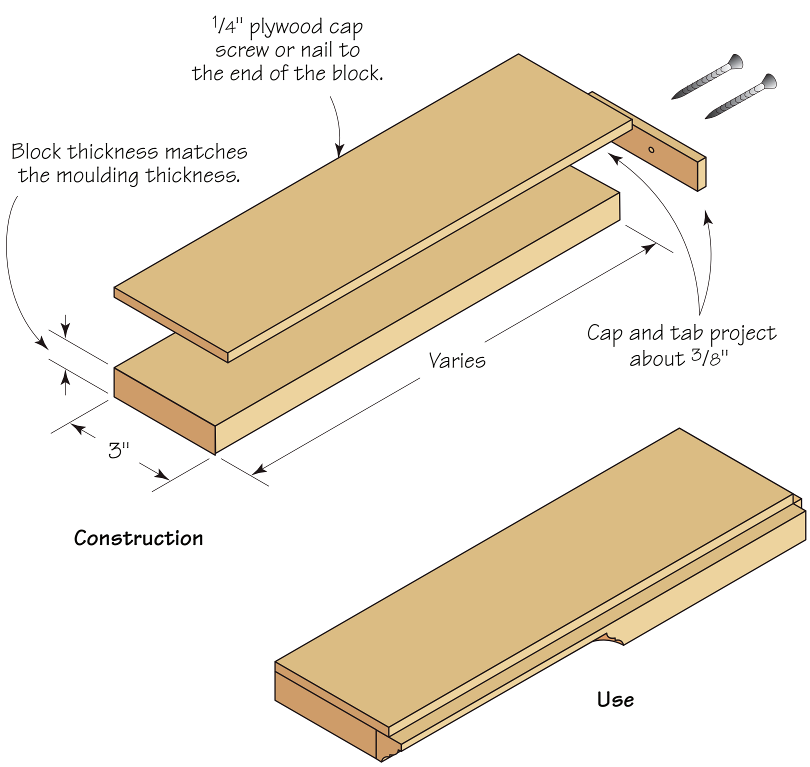


The moulding pusher is simply a block of wood roughly the same length and slightly thinner than the strip you want to profile. A lip against which you lay the strip is formed by a scrap of plywood screwed to the block.



The workpiece doesn't need to be secured with tape or hot-melt glue. With your hand-pressure, the pusher keeps the work against the tabletop and fence as you feed it through the cut. Your hands are well clear of the bit, so you can feed the pusher and work confidently.

Moulding strip push block



The routed moulding is smooth and free of splinters and dwell-marks. It's ready to be glued into place.

Routing Long Mouldings

It's not uncommon for a woodworker to gaze about a room and think, "I bet I can rout some moldings that would spruce up this place." And of course you can.

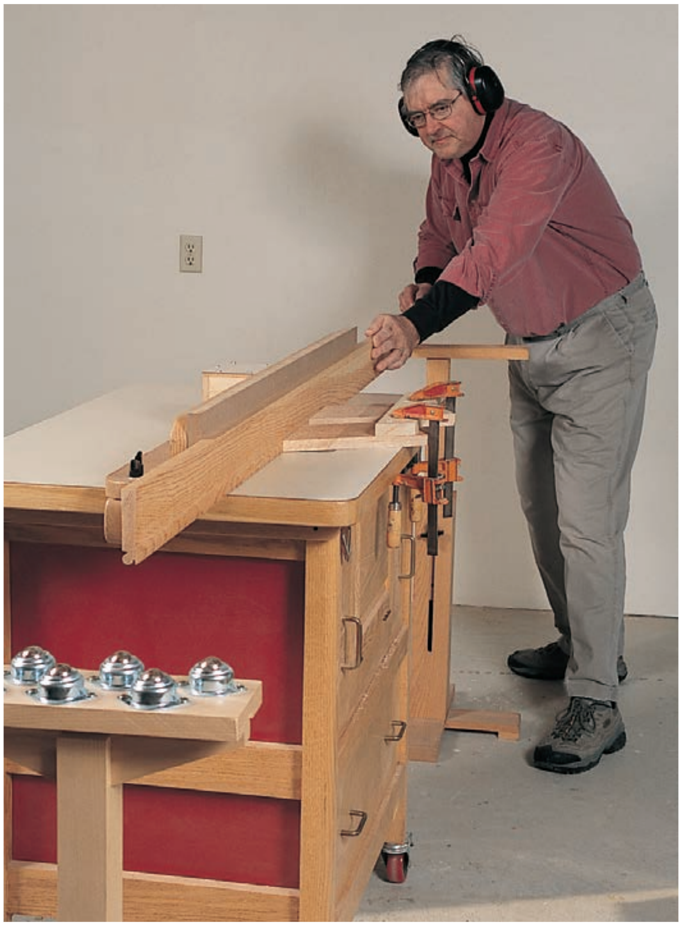
You'll find lots of architectural trim bits. Most of them are either large diameter or especially tall. Many lack pilots. Using them in a table-mounted router is essential.

The obvious challenge in routing long moldings is clearing a feed path. Working a 7' to 8' strip of casing for an architectural door requires 8' of clearance on either side of the bit. To work a 10- to 16-footer for a chair rail, baseboard or crown molding, double that.

Less obvious—until you actually start routing—is the difficulty of maintaining consistent contact between the work and the cutter. You've got to press the stock down against the tabletop and in against the fence, but you've got the ends of the board hanging off the table. And to keep the stock moving, you do have to shift your hands on the work. The nature of leverage is that if you shift a hand to a place where the stock's unsupported, the work will lift at the cutter. Chances are pretty good that the profile will be adversely affected.

Be sensible about using support stands on either side of the router table. Use featherboards to maintain pressure on the stock, keeping it down on the table and tight against the fence.

In addition, it's beneficial to have a helper, so you can keep the stock moving steadily through a cut. Each time you pause in the feed, the bit burnishes the stock, leaving a *dwell mark*. It takes extra work to get rid of these marks, so keep the stock feed steady.



Auxiliary tables or roller stands make the job of routing architectural trim a lot easier. Position a stand on the infeed side and another on the outfeed side. Without the ends of the board flapping, you'll be better able to keep the work in contact with the tabletop and the bit—ensuring a flawless cut.

Routing a profile in a long, relatively flexible strip—casing for a window or door, for example—isn't without its risks. It's easy to inadvertently lever the work off the table. If you're routing a profile like this bead, that minor feed gaff produces a wiggle in the cut that you can't hide. This one's a do-over.

In most situations, you'll find that the best way to achieve clean, flawless profiling cuts is to use featherboards to hold the work both to the fence and against the tabletop. Even if you momentarily let go of the workpiece, it won't drift off the bit or out of the feed path.

Basic Profiles

All mouldings are composed of just a few basic geometric shapes. While you can vary the shapes' sizes and the way they are arranged, you won't invent any new ones.

The ancient Greeks and Romans identified, categorized and named the fundamental shapes of straight and angled planes and of concave and convex curves. The Greeks based any of the curved shapes on the ellipse, and the Romans on the circle. Most of today's stock mouldings and cutters are Roman.

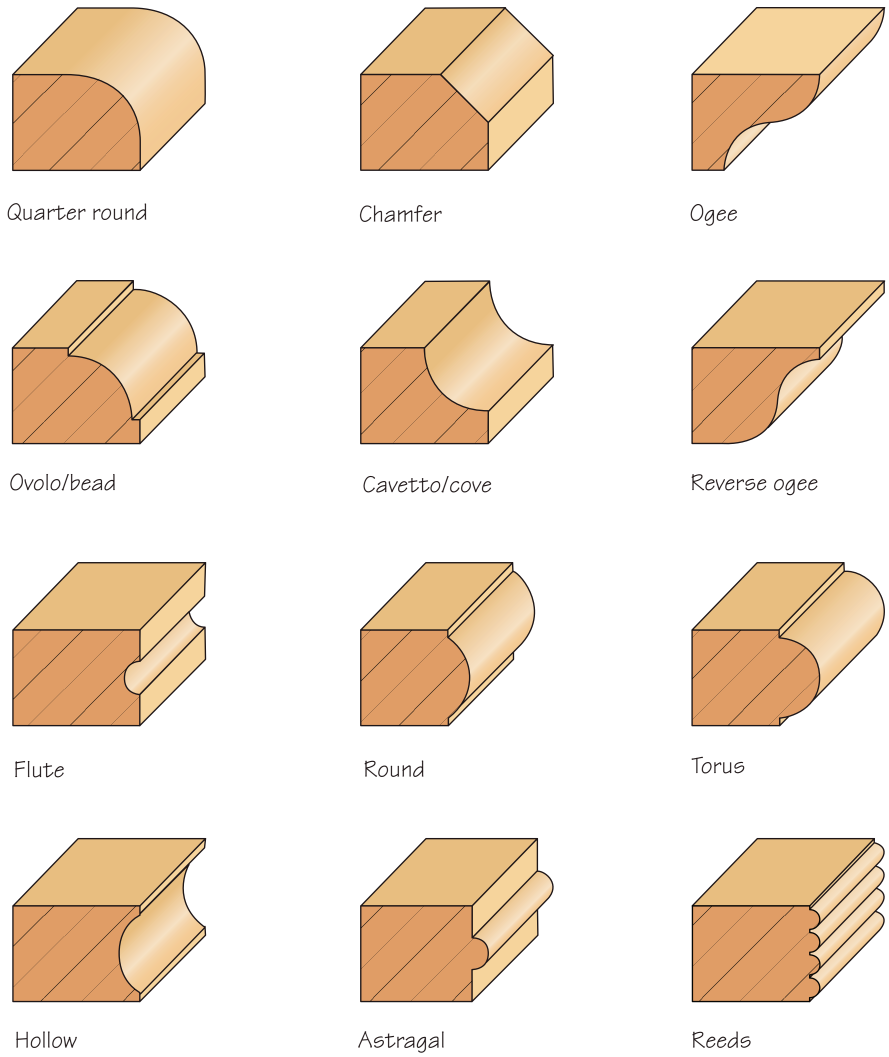
From a production standpoint, mouldings are either simple or complex. A simple moulding is composed of a single basic shape. A complex moulding combines two or more of the basic shapes.

As you design a project, keep in mind that a moulding doesn't have to be a separate strip of wood. You often can rout a profile directly on a tabletop, drawer front, case edge or table leg.

Just a single basic shape can be very effective. Starting with a square edge, for example, you can knock off the corner, or arris, to create a chamfer. You can round the edge to make a quarter-round, or, going a bit further, make an ovolo, which is a quarter-round with a flat at each end of the arc.

The basic shapes can usually be produced in one pass with a single cutter.

Simple moulding profiles



While the most-used simple profile bits—cove, round-over, core-box, Roman ogee, chamfer—are included in most starter bit sets, such sets typically include only a single size of each bit. A well-stocked bit collection will include 5 to 7 sizes of round-overs and core-boxes, two or three angles and sizes of chamfer bits and so on. Get different sizes and break into other styles; bullnose, edge beading, ovolo and ogee.

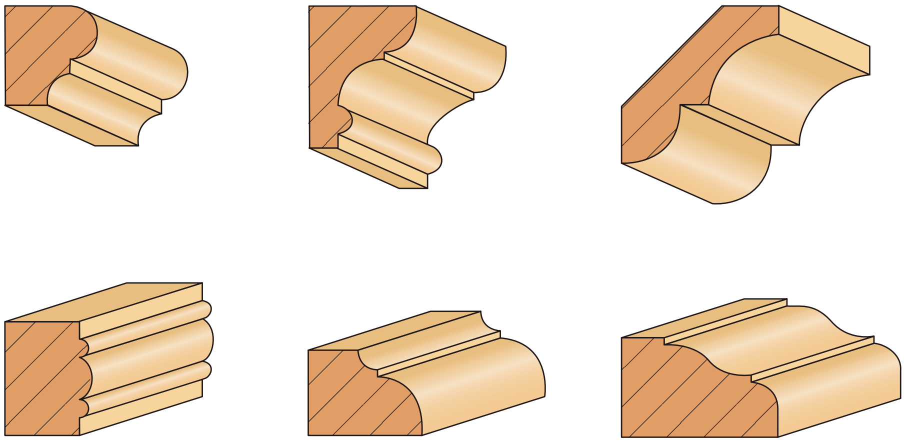
Complex Profiles

A complex moulding combines two or more of the basic shapes. To produce one, work either with a single bit that combines the two basic shapes, or you make separate cuts on the same piece with two different bits.

Take a look at a well-illustrated bit catalog. Many complex-profile bits are available. Such bits save you time; one easy setup, one quick cut. But these bits don't allow you to customize the proportions of the individual forms. Moreover, because they're so available and so easy to use, these bits often blind us to our other options. When I first started in woodworking, for example, I'd look for a single bit to cut a profile close to what I had in mind, rather than focusing on how I could produce the specific profile.

Cutting a specific profile might require passes with two or more bits. This is more work. Not only do you have to choose the bits, you have to plan the order of cuts, and determine how you're going to support the work as you make the cuts. A few tricks may be needed, sure, but mostly it's straightforward routing.

Doing a couple of simple mouldings, such as the two-step, large-scale ogee shown on the facing page, will get you going. Before you know it, you'll be developing your own special patterns and complex combinations.



Complex moulding profiles

An enormous range of complex-profile bits is available, for every application from edging tabletops and casework to routing architectural trim. Such bits enable you to produce a particular complex moulding in a single pass, and some also give you options for capturing different parts of the overall profile by adjusting the bit elevation and/or the fence position.

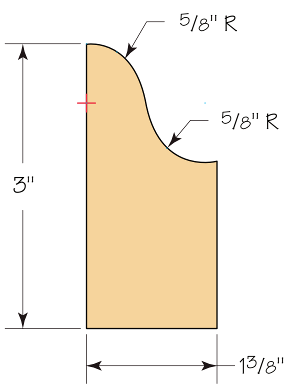
Routing a Large Ogee

The ogee is a one of the basic shapes used in mouldings. Every bit catalog has at least one ogee bit, typically with a 1⁄4" radius for both concave and convex portions of the curve. What you won't see, though, is much range in scale and proportion.

Once in a while, a project needs an ogee of a different scale. So view the profile as a complex one, and cut it with a round-over bit and a core-box bit. Draw the profile actual size, and use it to pick the bits. Cut a blank that's oversize in width and length. If you want, rabbet the long edge to remove the bulk of the waste. Rout the concave cut with a core box bit and the convex cut with a round-over bit. A little sanding blends the two cuts into a continuous S-curve.

Cut the cove with a core-box bit (a.k.a. a roundnose bit), half-concealed by the fence. Obviously, this is not a single-pass cut. You can cut a rabbet first, then use the core-box bit to round the rabbet's inside corner. Or you can stage the cut with the core-box bit, completing it to full depth in three or more passes.

The ogee profile is completed using a round-over bit. The bit must be hyper-extended slightly to make the cut. The trick is to adjust the bit so its cut blends into the previous one; the better you align the cuts, the less sanding you'll have to do.



Ogee profile

Cut with a 11/4" core-box bit and a 5/8" roundover bit.

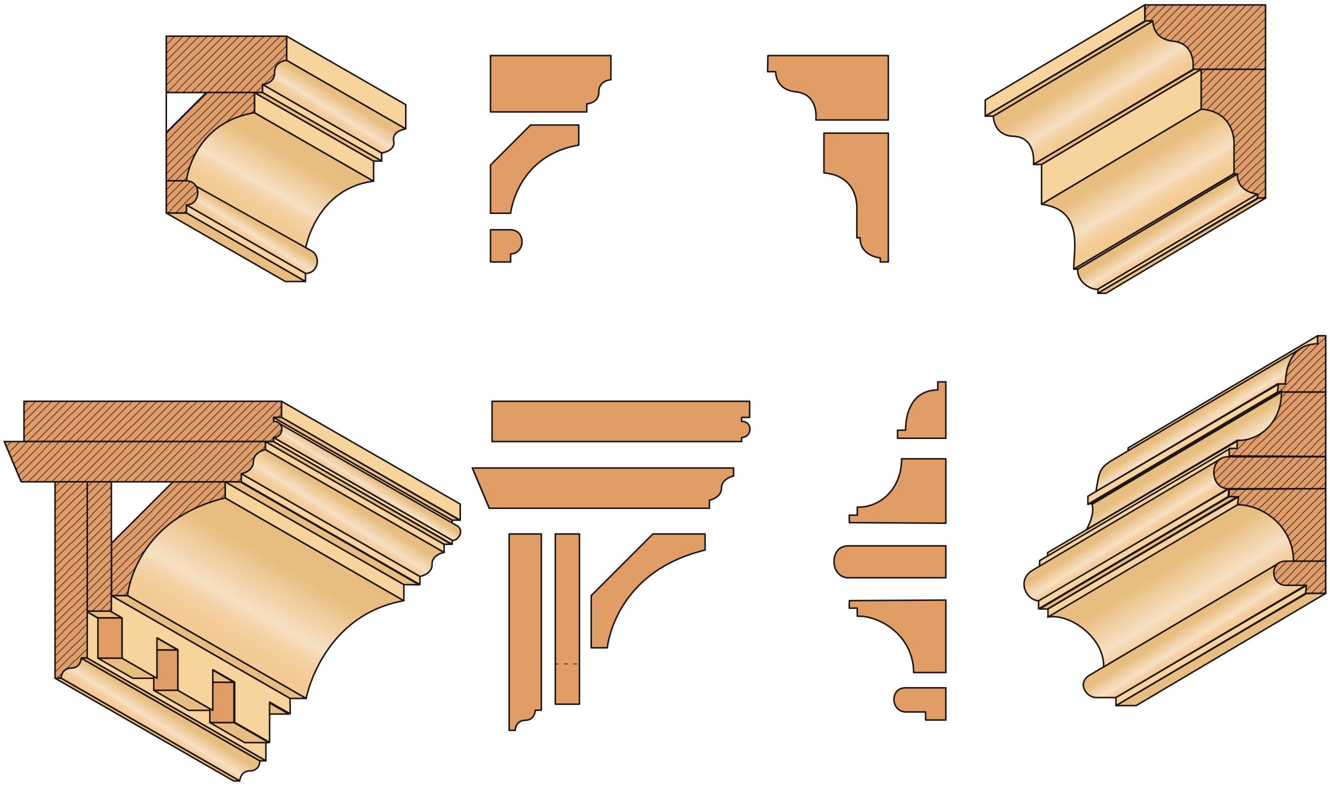
Complete the profile with a little sanding to perfectly blend the two cuts.

Building Up Mouldings

Depending on the sorts of furniture you build, you may require a big moulding with many profiles. The crown for a tall chest, secretary or hutch comes immediately to mind. So too a corner cupboard's elaborate waist moulding. On the previous page, I talked about complex mouldings having two or more of the basic shapes. A crown moulding (a crown is only one type of really big moulding) may have four or five of the basic shapes.

In the ideal, you'd use a single piece of wood for such a moulding. That's a sure way of getting a moulding that's consistent in color and grain.

For a tall case piece, especially those rising above eye level, you need a crown molding of considerable substance, one comprising a series of shapes that appear to loom toward the viewer. To create such moldings, you usually profile several pieces, glue them together and then attach the assembly to the case. Each of these built-up moldings is different, yet all share common shapes—notably coves, ovolos and beads.



Built-up furniture mouldings

But look at the drawing Built-Up Furniture Mouldings. Finding a block of 12/4 stock isn't out of the question, though it'd be expensive. But the practical matter is that using a router and bits rather than a shaper or molder to make any of these mouldings a really tough proposition. The mouldings are so big and have so many elements that router bits can't access every area that must be profiled. In this situation, as the drawing shows, the mouldings are created from several separate strips that are joined together.

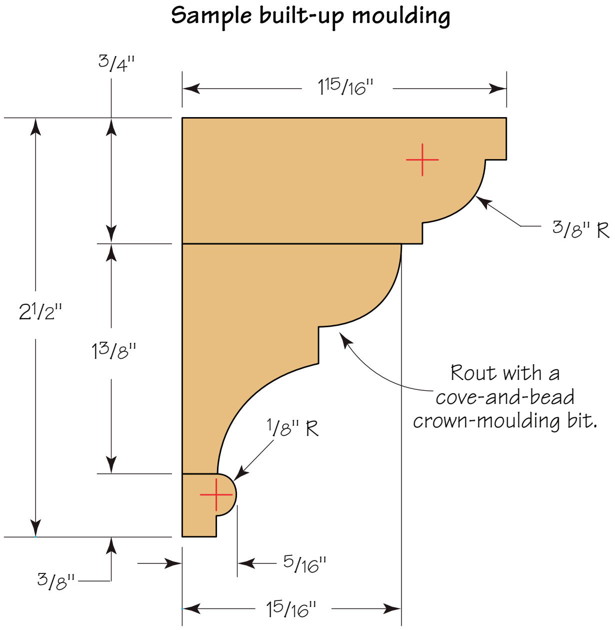
This method is called building-up, and the result is a built-up moulding. This sequence depicts how one of the mouldings can be created.

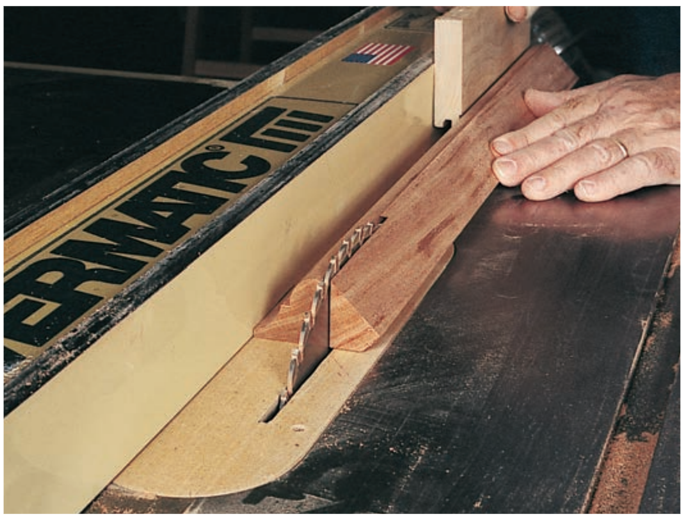
Several of the mouldings shown on page 61 show a large-scale cove right in the center. You can cut this element on the router table, depending on the cove's scale. But you'll have more flexibility in proportioning it, in establishing the width and depth you want, if you cut it on the table saw. This represents just another reason for building up such a moulding.

To match the color and grain of the wood, you simply have to choose your stock carefully. (You want to do that in any event, since clean, damage-free cuts are easiest to produce in straight-grained stock.) A good approach is to begin your big moulding with a block of 12/4 stock, which you rip into two, three or four strips—whatever is appropriate for the project at hand. Mark the strips so you can re-assemble them in sequence. Rout the appropriate profiles on the appropriate strips, and then glue the pieces back together.

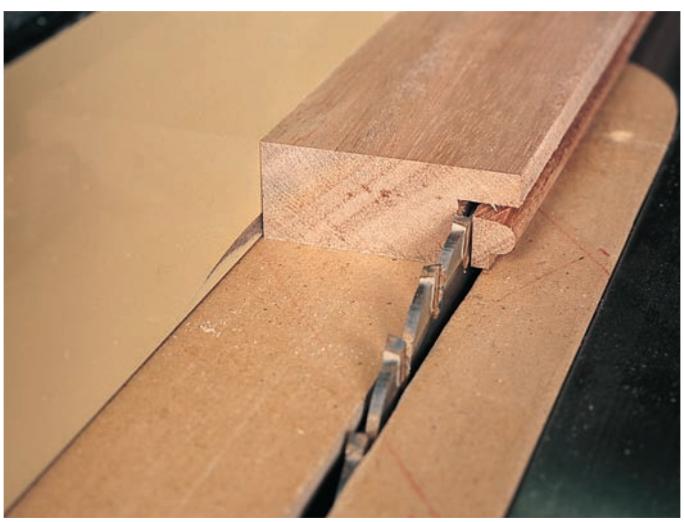
Making a Built-Up Moulding

The bead at the top of the assembly is cut with an ovolo bit, which is a round-over bit without a pilot bearing on its tip. (This particular bit does have a pilot bearing on its shank—for template-guided cuts—but it is out-of-play here.) The fence controls the cut, and particularly the width of the fillet above the bead.

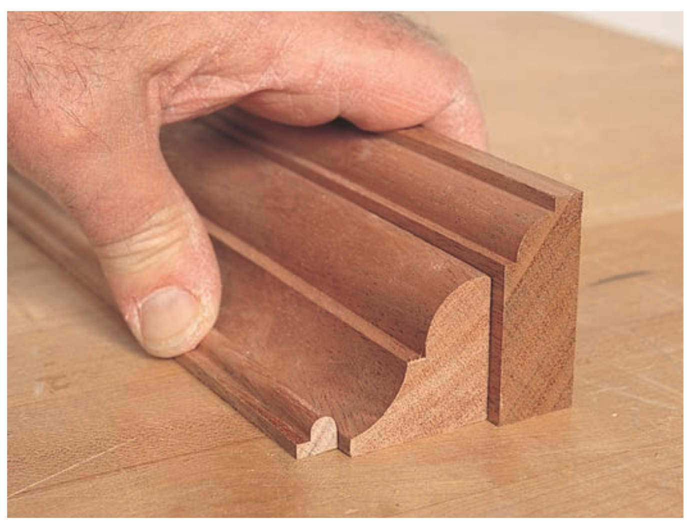




The bead molding is routed with an architectural cove-and-bead bit, which has a cutting height of over 2". There's no pilot on the bit, so the fence controls things. Set the fence tangent to the bit's smallest cutting diameter. Rout the profile on a stout piece of stock (upper left). Bevel-rip the profiled piece with the table saw blade tilted to 45° (above), then rip the piece again with the blade upright and the stock on the beveled face (left). The fillet between the cove and the bead supports a pusher for this cut, so you can feed the workpiece all the way past the blade and out of Kickback Alley.

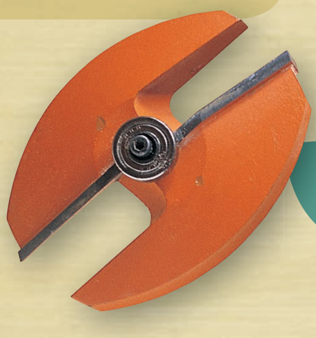


The bead at the bottom of the assembly is routed with an edge-beading bit on a 2"- to 3"-wide 4/4 board. To separate the molding from the blank, you make a shallow cut into the edge, defining the top of the molding. Then you rip it so the profile falls to the outside of the saw blade.



Here are the separate pieces, ready for gluingup. Because the central cove-and-bead element is formed on a solid piece rather than a thin strip, assembly is easy and no blocking or filler pieces are needed. The color and grain are well matched.

CHAPTER 3



Frame and Panel Basics

Frame-and-panel work may be the primary reason woodworkers get involved with router tables. Though it's something most people think of in terms of doors, frame and panel assemblies can be used throughout casework such as for case sides and backs. Frames are used to tie the sides together in a case and simultaneously to support drawers. In architecture, it's been used for paneling as well as door construction.

Framed panels draw the eye. People respond to the interplay of their wood surfaces just as they do to delicate dovetails or graceful cabriole legs. Though frame-and-panel is a basic construction technique, it conveys an aura of craftsmanship.

The router is a pivotal tool in profiling and joining the frame members, and in shaping the panels.

Start with the Frame

The minimal frame consists of two stiles and two rails. The stiles are the vertical elements and the rails the horizontal elements. The frame can have three or more rails, as well as intermediate vertical members called mullions. The edges are embellished with beads, ogees, coves or combinations of these shapes.

Nowadays these frames—for cabinet doors in particular—are assembled with what's known as the cope-and-stick joint (sometimes it's called a cope-and-pattern joint or a stile-and-rail joint). It's a form of the groove and stub tenon, and it's cut on the router table. At the same time that the joinery is cut, the piece is embellished.

The router bit used has two cutters on the shank. One forms a decorative profile on the edge of the frame member and at the same time the other cuts the groove for the panel. The bit is reconfigured (by repositioning these cutters), then used to cut the ends of the rails, forming a tongue and a reverse of the decorative profile. When the cuts

Frame-and-panel construction has been used for centuries to moderate the impact of wood movement in furniture. Doors of all sizes and contours feature this construction, but so do cabinets and chests. Modern router techniques make it easy.

are properly aligned on the workpieces, the tongue fits into the groove and the rail end conforms perfectly to the profile. It's a strong joint.

The terms cope and stick carry over from hand-tool woodworking. Cope is a familiar term, since trim carpenters still cope one trim piece to fit another at an inside corner. The dictionary definition is "to shape one member to conform to the shape of another."

Stick, as used here, isn't in the dictionary. In the old days, a woodworker would clamp—or "stick"—a board to his workbench, then use a profile plane to shape an edge. The process was called sticking.

Making Panels

The raised panel, a natural wood panel with a beveled or shouldered band around its edge is ordinarily used in frame-and-panel construction. The router is the best tool in your shop to use for raising panels. All panel-raising router bits are designed to produce a tongue of the appropriate width. You have an interesting assortment of profiles to choose from.

Preparing the Stock

Cope-and-stick bits are designed to work with 3⁄4" stock. There is some leeway, comfortably about 1⁄16" either way, but as much as 1⁄8" if you really stretch it. The typical sticking bit makes a 5⁄8" cut and leaves a 1⁄8"-wide tongue as the groove's panel-retaining wall. You can shift the position of the cut slightly to reduce the profile width and increase the groove wall's thickness or vice versa. That's the leeway.

When you crosscut the rails, account for the profile and stub tenon. For example, if you are making an 18"-wide door and using 1 3⁄4"wide stiles, the distance between the stiles is 14 1⁄2". But the rails must overlap the sticking profile. If it's 3⁄8" wide, you need to add 3⁄4" to the rail length (3⁄8" for each stile). Stick a rule into the groove and see how deep it is; the depth of the groove will match the profile width. Have extra pieces of stock for testing when setting up the bits.

The standard thickness for panels is 5⁄8". Nevertheless, you can satisfactorily use 3⁄4" stock.

Panel-raising bits are proportioned to produce the optimum relief—not too shallow, not too deep—and the proper tongue thickness (1⁄4" on 5⁄8")-thick stock. If you use 3⁄4" stock for the panel, you undercut the back of the panel. The undercut, a sort of rabbet, reduces the tongue thickness to 1⁄4".

Horizontal bits with undercutters are available, and they are particularly popular with hobbyists. They eliminate the need to plane stock to 5⁄8" for panels. More important, the setup is less finicky. Regardless of the bit's elevation, it produces a tongue on the panel that's the perfect thickness.

Cut quickly with specialized router bits, the cope-and-stick joint looks great and is strong enough for cabinetry applications. The nature of the joint gives you great latitude to adjust the position of the rail along the stile.

Three types of cope-and-stick cutters are (clockwise from the top) the matched pair, the stacked bit, and the assembly. All are available in several profiles: bead, quarter-round, ogee, cove-and-bead (sometimes called classical) and bevel (sometimes called traditional or straight). A 1 1⁄2-hp router can drive these bits, and it can be run at full speed.

A panel-raising bit is serious business. The horizontal bit with an undercutter (center) is as big a cutter as a router can handle. In comparison, even a full-sized (3 1⁄2"-diameter) raiser without the undercutter (right) seems somewhat smaller. Smallest are the vertical bits (left). The horizontal bits are more widely available than the vertical bits, and they are made in a much greater variety of sizes and profiles.

Cutting the Copes

The usual frame-making routine is to cope the rail ends first, then stick all the stiles and rails.

The cope cut is cross-grain. That means you need to back up the work to prevent splinters from being torn from the back edge by the cutter. Depending on the size and number of rails, you can gang them up and feed them past the cutter, pushing them along the fence with a square scrap. The pusher acts as a backup, preventing the splintering.

Some woodworkers prefer to use a more formal guide, like a coping sled. (A sled impacts the bit height setting because you have to accommodate the base's thickness.)

Place the cope cutter in the router's collet to begin setting up. To do this, you'll probably shift the fence back from the bit opening in the tabletop. If you are using an assembly-type bit, you may need to switch the positions of the cutters on the bit arbor.

Establish a height setting. Knowing the industry standards, you won't be wrong to measure 7/16" to 5/8" from the tabletop (or coping sled base) to the corner of the tenon-cutter. You'll get a 1/6" to 3/16"-wide shoulder on the stub tenon.

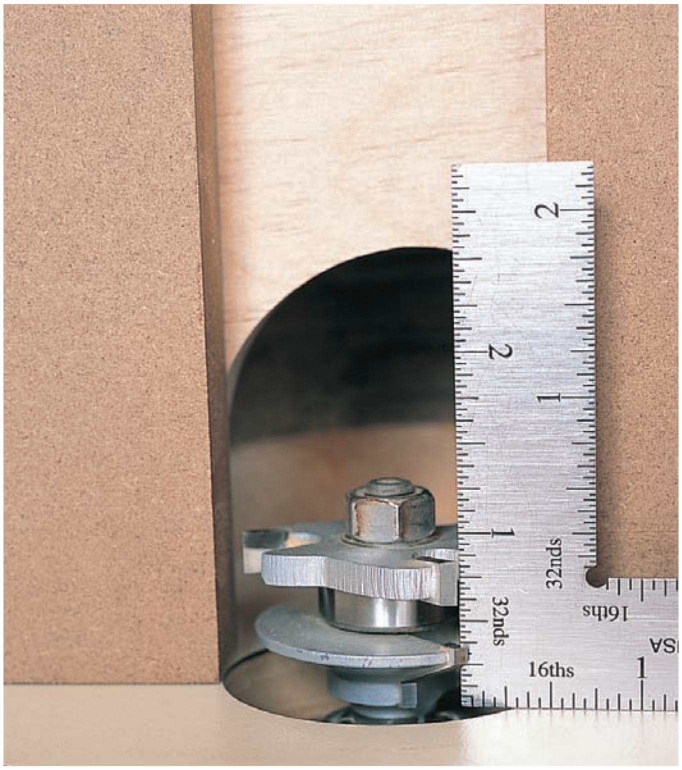
If you've got a setup block—one that came with the bits or one you made—tuck it into the bit and adjust the bit up and down. If you are using a coping sled, you must, of course, set the block on the sled when gauging the bit elevation.

Set the fence next, positioning it tangent to the pilot bearing. Clamp featherboards to the fence, positioning them fore and aft of the bit, where you need the pressure.

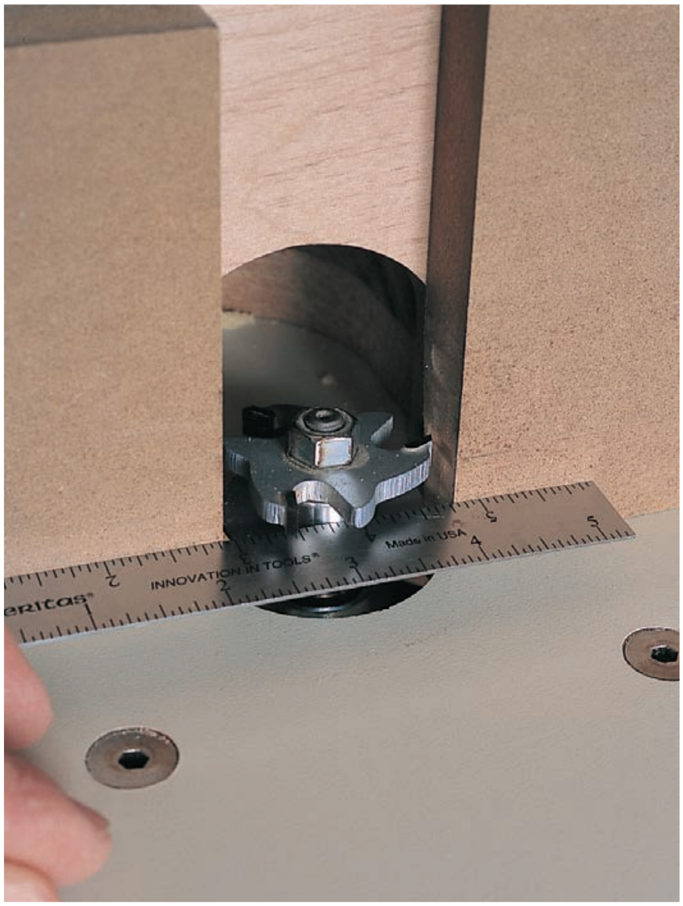
Make a test cut. Look at the cut and assure yourself it's not obviously misaligned.

The cope cuts should be completed in one pass. Repeating a pass can enlarge the cut and create a loose fit. In theory, a second pass can enlarge the cut only if there's some movement in your setup. In practice, there probably is a skoche of movement possible, no matter how stiff your featherboards and how firmly you grip the work.

Pay attention when you turn the rails to cope the second end. You want to turn them, not flip them. Mark the face that's supposed to be up as you make the cope cut. Before you cut, look for the mark.



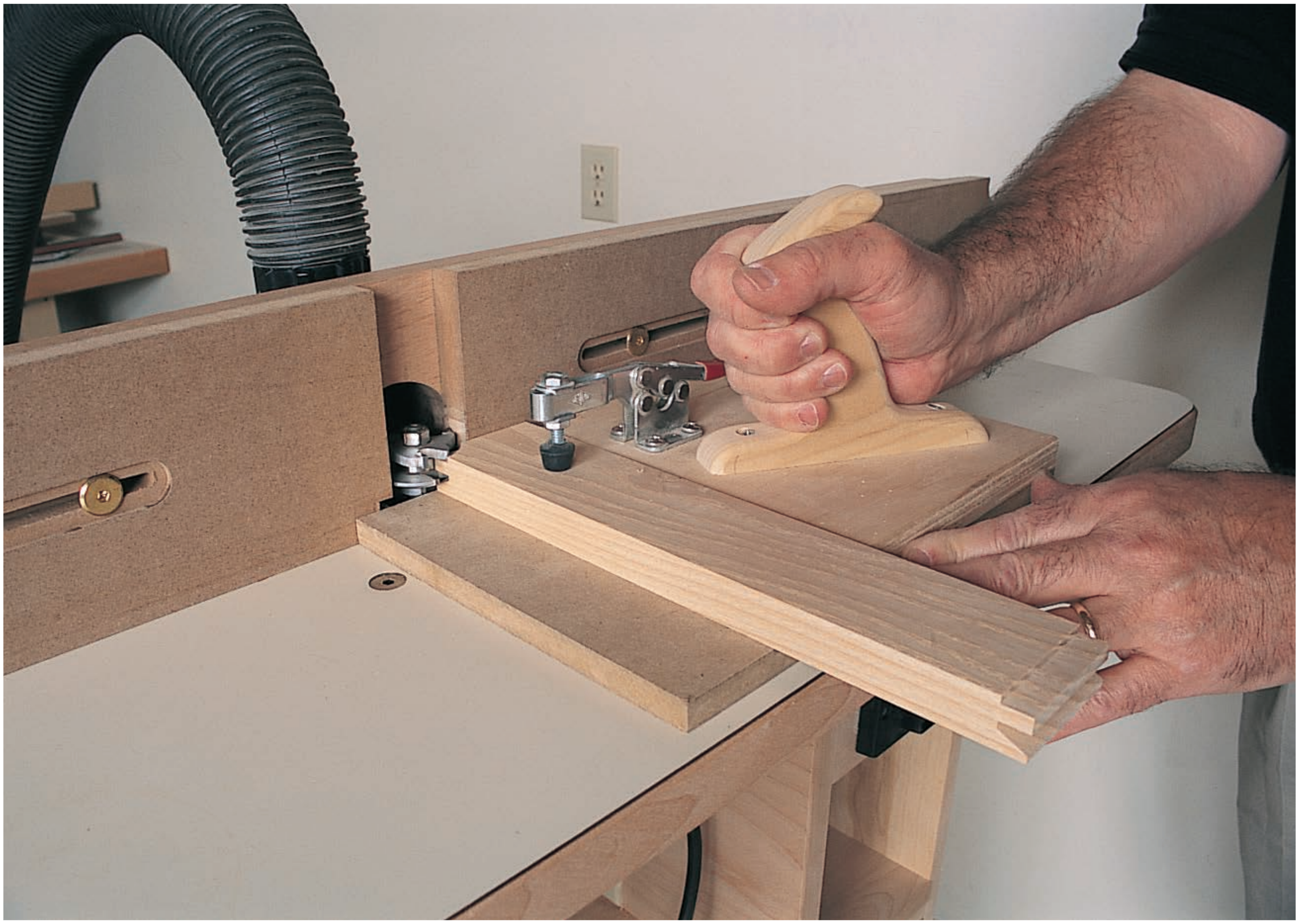
Set the elevation of the cope bit with a setup block or, as here, using a small square. With 3/4" stock, the back shoulder of the stub tenon should be 1/8" plus wide, so set the lower corner of the slot cutter 19/32" to 5/8" from the tabletop.



The face of the fence must be tangent to the bit's pilot bearing. Lock down one end of the fence and swing the free end fractionally as you slide a straightedge back and forth across the fence and bearing. You want the straightedge to graze the bearing without turning it.

You want to get the cope right. It is cut first, and it dictates the alignment of the sticking cut. The sample at right is ideal: the shoulders of both the cope and the stub tenon are proportioned to balance appearance and strength. The center sample's tenon shoulder is too narrow for adequate joint strength, while the narrow cope shoulder on the sample at left sacrifices appearance for the sake of joint strength.

Once the setup is dialed in, rout the copes on the ends of the rails. I don't usually use a coping sled. Ganging up a brace of rails and a wide backup helps keep the rail-ends square against the fence and expedites the work to boot. The tandem featherboards, positioned so the direction pressure is not on the bit but on either side of it, helps keep the work against the tabletop.



A coping sled holds the rail securely for the cut and provides some backup against tearout. It gives you a comfortable, sure grip on the work and keeps your hand out of the bit's way. A tradeoff is that the bit has to be extended an extra $^1/_2$" above the tabletop, which isn't a simple matter on every router table.

Sticking Cuts

After all the rails are coped, rout the sticking on each rail and each stile. Chuck the sticking bit in the router collet, and adjust its height. It's great if you can do this without moving the fence and any featherboards you have set up, but that's not always the case.

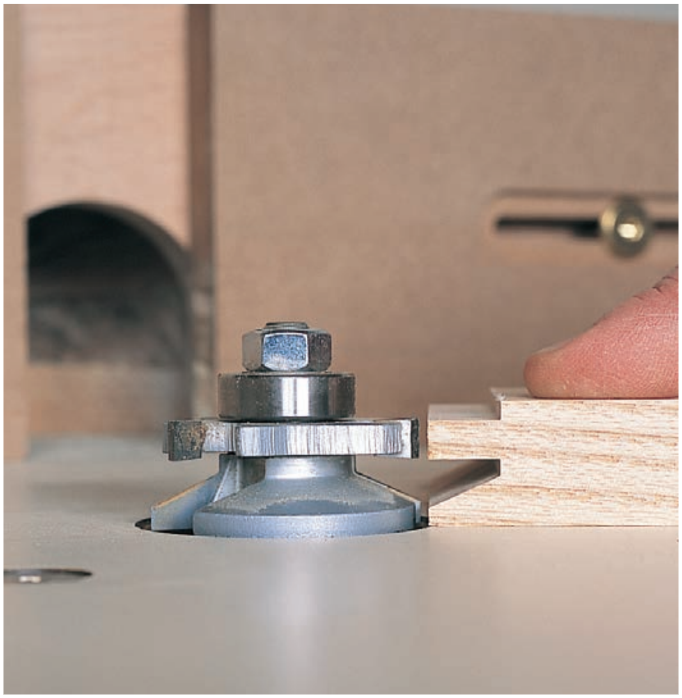
If you have a setup block, use it. Otherwise, set the bit against a coped workpiece. Make a test cut, and fit it to one of the coped rails. You want the surfaces flush, and running your fingers across the seam will tell you if you've achieved that. If some adjustment is necessary, make it and run a new test piece across the bit. Keep adjusting and testing until you have the fit you want dialed in.

Chipping happens all too often during the sticking cut. If you were doing the job with a hand-held router, a climb-cut would be a workable tactic. But you definitely shouldn't try that on a router table.

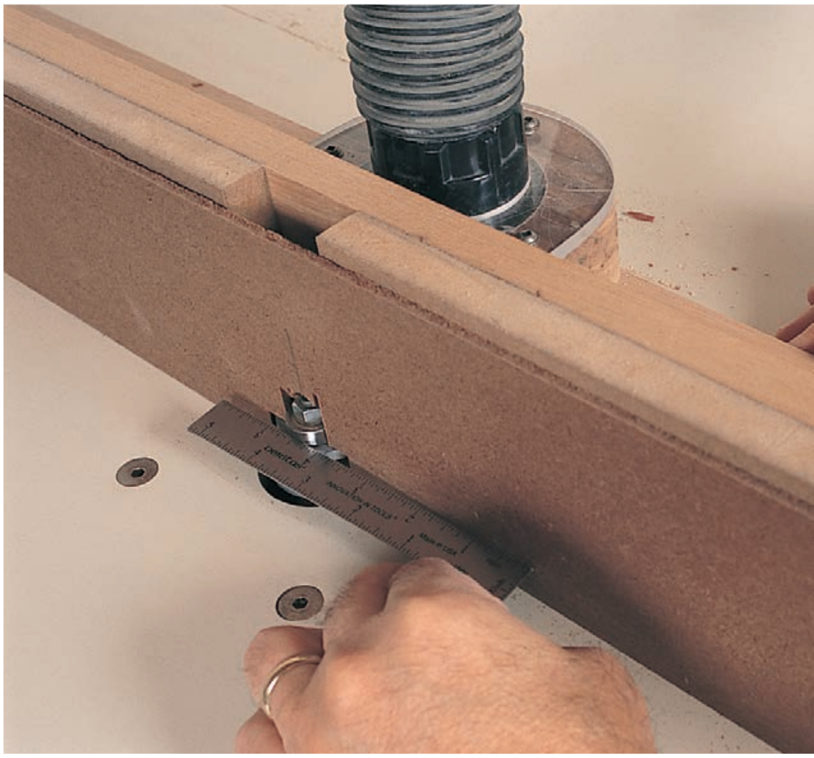
Instead, use a zero-clearance facing. You need the close fit of facing to cutter on the infeed side. If your fence is split, you can feed that half into the spinning bit, right up against the pilot bearing. With a solid fence, use an expendable strip of thin plywood or hardboard to make a zero-clearance opening.

When everything is set up properly, after you've adjusted and micro-adjusted the bit height, created zero-clearance support around the bit, positioned featherboards and done a test cut that resulted in a pleasing fit, rout on. Stick the stiles and the rails.

Use a thin hardboard or plywood facing for the fence, and cut a zero-clearance opening for the bit. Cut an initial opening for the bearing and arbor. Press the outfeed side against the fence, but flex the rest of the plywood and hold it clear of the bit. Switch on the router and roll the facing onto the fence, while the bit cuts through the edges of the opening. Then secure the facing with carpet tape or spring clamps.

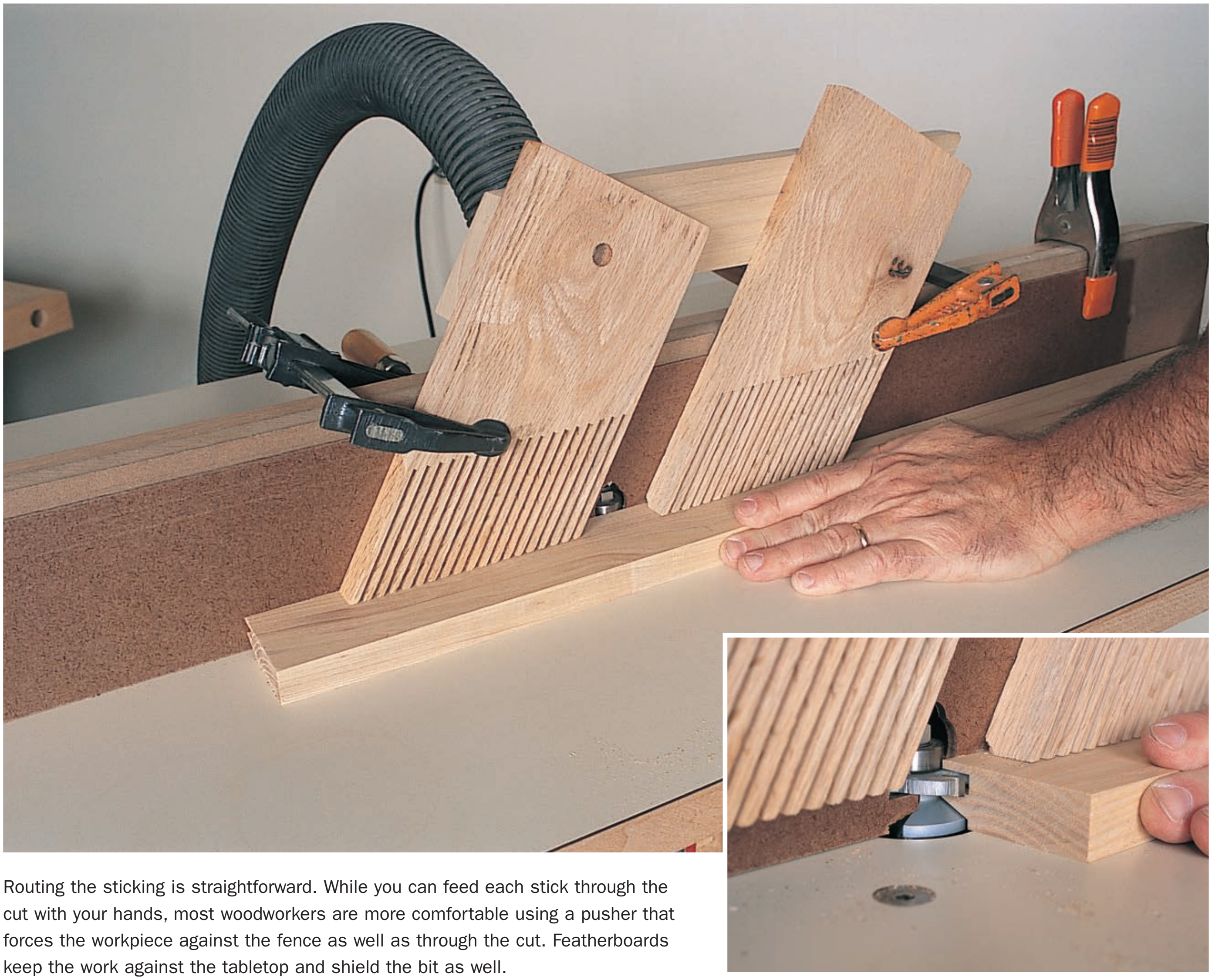


Adjust the elevation of the sticking bit using a rail as a gauge. Align the bit's slotter with the stub tenon.



Position the fence tangent to the bit's pilot bearing. Use a straightedge or small rule that spans the bit opening to set the fence. Slide the rule across the opening; if it contacts and turns the bearing, shift the fence until the rule is just clear of the bearing.

Make a sample sticking cut and fit a coped rail to the sample. The surfaces should be flush, as at left. If the sticking bit is a skoshe too high or too low, the misalignment may not be easily visible (right), but you'll be able to feel it. Assemble this joint, and you'll have to sand the faces of the stiles and the backs of the rails to make the frame surfaces flush.



Routing the sticking is straightforward. While you can feed each stick through the cut with your hands, most woodworkers are more comfortable using a pusher that forces the workpiece against the fence as well as through the cut. Featherboards keep the work against the tabletop and shield the bit as well.

Raising Panels with a Horizontal Bit

Raising panels with a horizontal bit isn't particularly difficult, but it's a heavy job for your router. Before you rip into the work, be sure your router is up to the job.

The typical panel raiser is a big $3\frac{1}{2}$"-dia. bit that requires lots of power to spin, especially when it's actually cutting. In addition, keeping the tip speed under control means you've got to slow it way down, so your router must be equipped with speed control.

The setup and cutting routine I'm about to outline works with any horizontal bit, including those with backcutters. My standard procedure is to raise a panel in at least two passes, removing a roughly equal volume of waste on each pass. Before I cut any good wood, I set up the router table for the final cut. There are ways of reducing the volume of the first pass without losing that final setup.

Install the bit in the router to begin. The bit opening in the table (or mounting plate) must be big enough, of course, and it's best if the opening in the router's base is too.

Many plunge routers—despite having enough power and speed control—don't have the base opening for big bits. You can still use these routers for the job, but the mounting plate's thickness is your only margin for bit-height adjustment. And installing the bit is a hassle. To get the shank in the collet, you have to bottom the motor against the base, and you'll have precious little room to work wrenches on the collet nut.

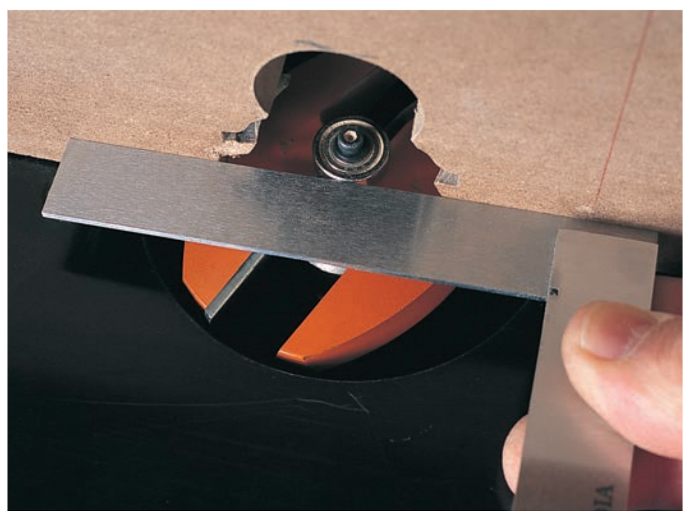
Set an approximate bit height next. You can do this by eye, since it's just an initial setting.

Even if the bit has a pilot, use a fence to guide straight cuts. You have much better control of the work. The standard setup rules apply here. Tailor the fence opening, if at all possible, to conform to the bit contour. Position the fence tangent to the pilot bearing, but make sure the pilot is just out of contact with the work.

Don't forget to dial back the router speed. Set the router to run as slow as possible.

A horizontal bit can be set by measurement if you have a device to gauge the elevation of the cutting edges adjacent to the bearing. Those form the panel's tongue, which must be $\frac{1}{4}$" thick. If you are raising a $\frac{5}{8}$"-thick panel, those edges must be $\frac{3}{8}$" above the table.

Not every router will accommodate a full-size horizontal panel raiser. This plunge router's base doesn't have an opening large enough for the bit. You can still use the bit in the router, but you have to be careful to avoid contact between bit and base.



It's best to use the fence to guide the cut whenever possible. You must position it tangent to the pilot bearing to get the cutter's full profile. Hold a straightedge against the fence as you swing it into position. My ideal is to position the fence just clear of the bearing. Watch the bearing as you slide the straightedge. You want the straightedge to graze the bearing without turning it.

Making the Cuts

To be sure the appearance of the cut is what you want and that the tongue will fit the groove, you must make a test cut or two. The stock you use for the test cuts must be the same thickness as the panels themselves. So make a cut along one edge of a stock sample and evaluate it.

If the bit has a backcutter, the tongue will fit the groove regardless of the bit's height setting. All you need to consider is the cut's appearance. If it looks good, you are ready to cut the good wood. If not, adjust the bit height and make another pass with the sample. Keep alternating adjustments and test cuts until you like what you see.

No backcutter? Although appearance is important, what you really are looking for is a good fit in the panel groove. You can't alter the appearance without changing the fit. The setup routine is the same with this bit: Alternate adjustments with test cuts until you achieve the right fit.

Just before you take up your good stock, you must shift the fence forward about 3⁄8" to reduce the cut on the first pass. You won't lose your tested setup, because in it the fence is tangent to the pilot bearing.

Cut across the end grain first. This cut is most likely to cause tear-out, but any tear-out will almost surely be routed away when you make the long-grain cuts. Work your way around the panel. End grain, long grain, second end grain, second long grain and done.

Make the first, shallow cut on every workpiece. Then shift the fence back so it is tangent to the pilot bearing. Make a second and final pass on every edge of every panel.

The proof of your setup is in the fit of the panel to its groove in the frame. Make a cut on a sample of the panel stock and fit it to an actual frame member. The ideal is a snug press fit.

Staging the cuts, that is, beginning with a shallow initial cut and producing the full profile in progressively deep cuts, isn't absolutely necessary. But it is advisable. I do it by clamping a reference block against the back edge of the fence to capture the final position. Then for the initial cut, I swing one end of the fence forward and away from the block (top), so only the outer tips of the bit extend beyond the fence (bottom). The featherboards move with the fence, of course. You can feed the workpiece by hand or with a push block.

The final pass is made with the fence tangent to the pilot bearing. The panel has a clean bevel, a crisp fillet around the raised field and a tongue that perfectly fits the frame's panel groove. The workpiece handling is the same on each cut in the progression.

Raising Panels with a Vertical Bit

The advantage of the vertical bit is that you can use it with practically any router. High power isn't necessary to keep it spinning under load, and the bit's size allows it to be run at a router's full speed.

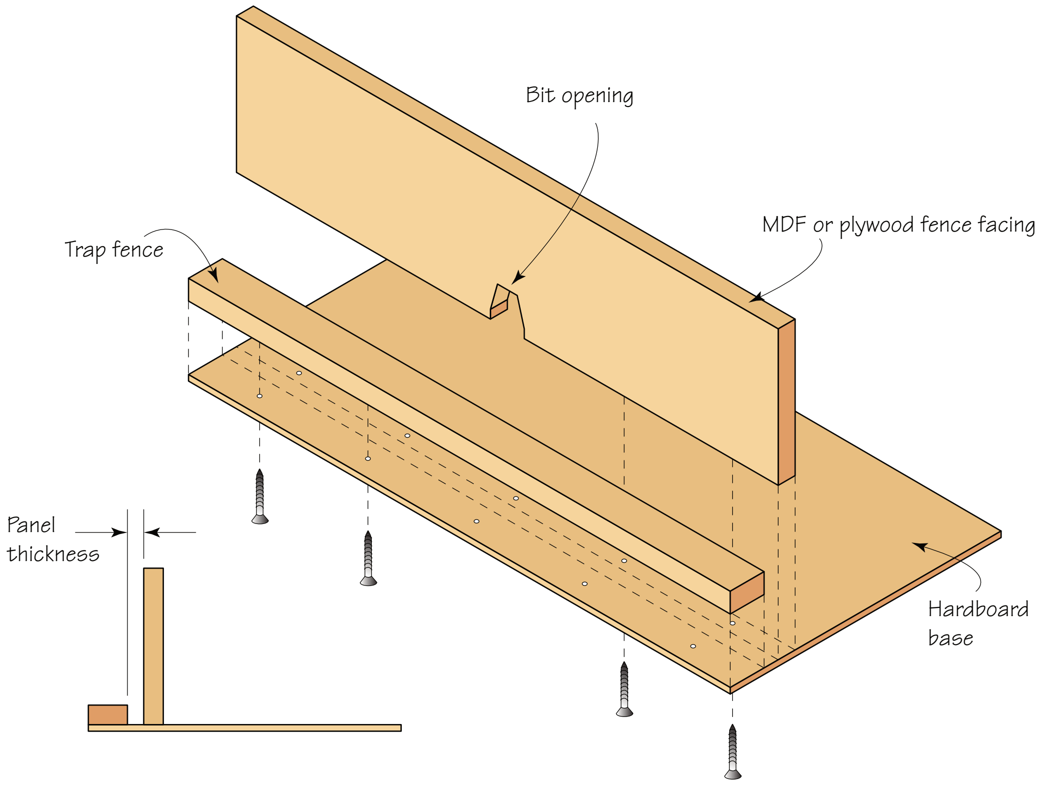
The biggest challenge in using a vertical panel raiser is managing the workpiece. The panel has to be perched on edge and held against the fence. It's common for a very tall fence to be advocated. But I've found that a medium-height fence coupled with a trap fence is the best solution.

The idea is that the trap fence, which is nothing more than a 3⁄4" × 1 1⁄4" strip of wood, is clamped to the tabletop in front of the router-table's fence, creating a channel that's just wide enough for the panel. The trap prevents the bottom edge of the panel from kicking away from the fence, so only modest pressure against the panel keeps it upright.

Because I don't want to move the trap fence and the regular fence separately when staging a cut, I made the fixture shown in the drawing "Trap Fence" that I use in conjunction with the regular fence. The trap and an 8" high MDF fence facing are attached to a hardboard base with a 5⁄8"-wide gap between them. The base extends beyond the facing so it can be slid underneath the regular fence. Shifting the fence shifts the trap fence too.

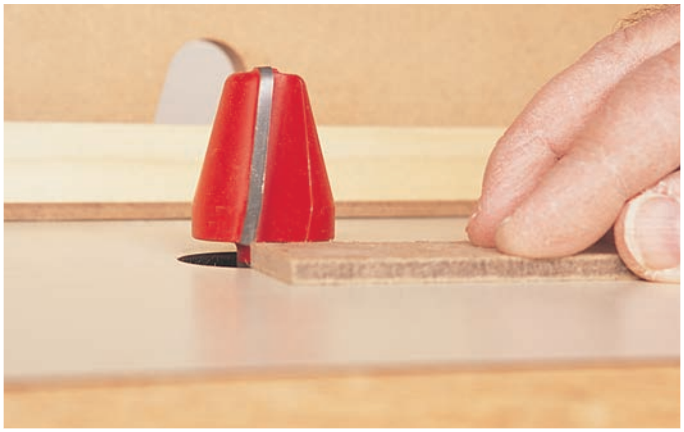
Setup goes like this: Install the bit in the router and adjust the elevation. Be sure you account for the thickness of the trap-fence base. Mount the trap-fence accessory to the regular fence and drop it over the bit. Clamp one end, then measure between the cutting edges and the trap fence as you swing the free end of the fence. The gap width you want is 1⁄4". When you've got it, clamp the free end of the fence. Confirm your setup with a test cut; the tongue formed should be a snug fit in the panel grooves in the rails and stiles. Adjust the fence position as necessary to perfect the fit.

Featherboards are optional with this setup. I usually stage the cuts, and before the final pass, I clamp a featherboard to the table, elevated on a block and positioned to bear against the panel above the bit.



Trap fence

A trap fence keeps the bottom of a panel from kicking out from the fence, so even an extra tall panel is easy to maneuver through a cut. The trap is most convenient to use if it's linked to the fence. The gap between fence and trap is fixed, and when you adjust the fence position, you simultaneously shift the trap's position.



The bit must be fully elevated to produce the entire profile, including the tongue. Use a scrap of the trap-fence base material as a gauge beside the bit. After the height is set, drop the trap-fence fixture over the bit and slide the regular fence into place and fasten the fixture and fence together.

Set the fence with a rule, measuring between the trap fence and the cutting edges of the fat part of the bit. The tongue should be $^{1}/_{4}$" thick, so the gap should be that wide. Make a test cut to confirm the setup and fit it in a sticked frame piece.

On the initial pass especially you can rely on the trap fence alone to control the panel as you cut. Keep your hand pressure high on the panel to lever its bottom edge against the trap fence. Note the blocks clamped to the table behind the fence; they capture the fence position for the final cut.

Before the final pass, when the fence is back against the stops, take a moment to set up a featherboard. To ensure its pressure is above the cut, set it on a block, as shown.

Making Assemblies with Curved Rails

Arch-topped doors are popular. Making them isn't difficult, though more steps are involved than in making regular frame-and-panel doors. Specialized tools or equipment is seldom needed.

One obvious extra step is cutting the curves on the top rail and the panel. To do this, make templates (see "Using Templates". I usually cut them from plywood or MDF using a router and trammel.

For the rails, the template has a concave edge. For the panels, the template has a convex edge. The radii of the two curves are slightly different because the panel fits into the rail's panel groove. When you set up the router and trammel to cut the rail template, the bit is inside the radius. When setting up for the panel template, the radius is 5⁄16" to 3⁄8" longer and the bit is outside the radius.

You can shape the panel when you cut it to size. Trace the template contour on it and saw off the bulk of the waste. Then stick it to the template with carpet tape or hot-melt glue. Trim the edge flush with the template with a pattern bit or a flush-trimming bit.

Cope the ends of the rail before shaping it. To prevent the trailing tip of the rail from breaking away as you shape it (and stick it), tuck a sticked scrap into the cope cuts on either end. Trim and shape the curved edge of the rail the way you did the panel.

Sticking the rail requires you to use the pilot bearing on the bit, rather than the router-table fence, to guide the cut. Use the starting pin to begin the cut, then follow on through with just the bearing.

Likewise, the panel-raising cut is bearing-guided. It can only be done with a horizontal bit. Use a starting pin to help you begin the cut. Obviously, you can't use featherboards.

Stick a curved rail using the pilot bearing to control the cut rather than the fence. Use a starting pin (or the equivalent) at the beginning of the cut. Once the bearing is engaged by the rail, you can drift off the pin without consequence. To prevent the trailing tip of the rail from breaking away, tuck a sticked scrap into the cut to support the tip (above).

Use a starting pin when raising the curved edge of a panel. Brace the panel against the pin, then twist it into the bit to begin the cut. Once the bit's bearing engages the edge of the panel, you can come off the pin. Use a push block to hold the panel down on the tabletop, and at the same time advance the panel through the cut.

Making Frames for Glazing

To transform a cope-and-stick joint for a wooden panel into one that will accommodate a pane of glass, you need a rabbet instead of a groove. A simple alteration to the cope bit and an extra step at the table saw make this easy to accomplish.

To supplant the groove-sized stub tenon with a rabbet-filling block, remove the slot cutter from the coping bit. You can do this with most two-bit sets and with bits that are reversible assemblies.

Loosen and remove the arbor nut from the bit, and pull off the slotter. It's easy to do with the bit secured in the router collet, so you can keep the bit from turning when you attack the arbor nut with your wrench. Use a sleeve-type spacer or stack of washers to take up the vacated space on the arbor and replace the nut. Leave the bearing in place. And that's all it takes.

Set the bit in your router table, adjust the height, position the fence and cope those rails. The cut will be nothing more than the negative of the profile.

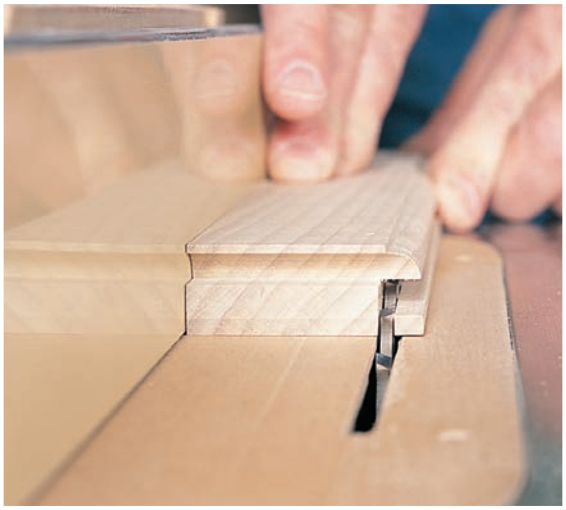
The sticking cuts are made with the standard bit. No alterations needed. Set the bit and fence, then make the cuts. After these cuts are completed, go to the table saw and rip the back shoulder from the panel groove, transforming it into a rabbet. Be careful not to make the rabbet deeper than the groove. You won't get a tight joint.

Assembly follows. To secure the glass, you can use glazing compound or slender wooden strips that you glue in place or fasten with brads.

The upshot is that the same bits you use for frame and raised-panel cabinetry work can be your primary cutters for frame and glass pane cabinetry work.

Cut joinery for rabbeted frames with a common pair of cope-and-stick bits. Remove the slotter from the cope bit and replace it on the arbor with a sleeve-type spacer or a stack of washers. A cut with it will produce a cope and a blocky tenon to fill the rabbet.

Cope the rail ends first, just as you do in making a wood-panel door with this joinery. Use a square-ended block to push the workpiece through the cut and to back up the good stock, so exit blow-out doesn't damage the frame part.

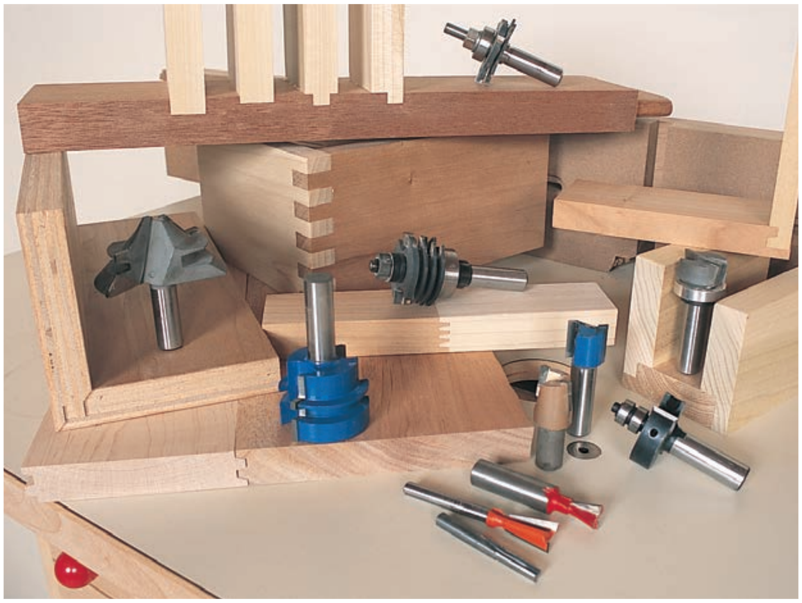


Rout the rails and stiles with the sticking bit unaltered. Then rip each piece on the table saw to open the panel groove, transforming it into a rabbet. Align the cut with the bottom of the panel groove. Cut any deeper and the ends of the rails won't seat tight against the rabbet's shoulder.

Make profiled retainers for your glazing by sticking the edges of narrow strips, then ripping the profile free. Miter the ends and glue them into the frame to secure the glass panes.

CHAPTER 4

Cutting Joints



Dadoes, rabbets, laps, sliding dovetails and many other commonplace joints are easy to cut accurately on the router table. Beyond those, you can cut a selection of unique-to-the-router table joints like lock miters, finger joints, drawer locks and glue joints.

The router is universally known as a joint-cutting marvel. Hang it under a table and that doesn't change.

A fact you confront early on in woodworking is that there's no uniformity to pieces that must be cut to make joints.

The router table can accommodate more one joint-cutting setups than any other single tool.

• Its broad, flat working surface provides support for a variety of workpiece sizes, from rails for small doors to sides for tall bookcases.

• It can accommodate a huge assortment of cutters—including some specialized joinery cutters that bit manufacturers implore you to use only in a router table.

• You've got the means to adjust the elevation of any of those bits in tiny, tiny fractions of an inch. (How tiny those fractions are depends to a considerable degree on the router and adjustment system your table is equipped with.)

• You've got a fixed fence that adjusts with incredible precision to help control the size of a cut, to guide a workpiece through a cut, to help collect the dust generated by the cutting process and to shield the bit and protect your hands and fingers.

• You've got sleds and a moveable fence—either a sliding fence or a miter gauge—to guide workpieces through cuts.

• You can easily use featherboards and various pushers to give you additional control over a joint-cutting operation.

In addition to all that, the router table enables you in most situations to create a fixed setup so you can cut a high volume of uniform parts. Tedious part-by-part layout can be eliminated. Painstaking joint-by-joint fitting can be avoided.

As you progress through this chapter, you'll see that you can do anything from jointing the edges of boards (and even abrasive materials like plywood, particleboard, and plastics) to cutting traditional joints like dadoes, rabbets, sliding dovetails and half-laps. Machine-age constructions like box joints, finger joints, lock miters, glue joints and drawer locks are the almost exclusive province of the router table.

Being Practical About Mortising

Mortises and dovetails (through and half-blind, not sliding) are important joints, and while they can be cut on the router table, in my opinion it's not efficient or practical. Let me explain.

For a cabinet door, a mortise ought to be 1" to 1¼" deep and, depending on the frame stock width, about 1½" long. You'll have a mortise at each end of every stile, and ideally, you want them centered across the stock's edge. Presumably, if you are making one door (four mortises), you're making two doors (eight mortises). Or more.

On the router table, you'll cut each mortise as a blind groove. With the stock against the fence, lift the leading end, slide the piece forward to an alignment point, then plunge it down onto the bit, beginning the cut. Feed the work an inch or so, then lift the trailing end of the piece to stop the cut and get the stock off the bit.

To locate and size each mortise, you need to lay out the extents of every joint. In addition, you must mark the tangents of the bit on the tabletop and/or the fence.

Can you use stop blocks? Yes, presuming several things: the mortises begin the same distance from each end of the stile, all are the same length and that you are able to precisely center the cut on the edge of the stock.

You should not cut deeper than ¼" to 5⁄16" per pass. At minimum then, you should make four passes, with some kind of adjustment—either removing a shim from the tabletop or jacking up the bit another 5⁄16"—between passes.

Do you make a pass on every mortise before making an adjustment? Or do you cycle through the adjustments for each mortise, completing it before moving to the next? Either way, this routine is a lot more fussy than routing mortises with a plunge router and a good mortising jig.

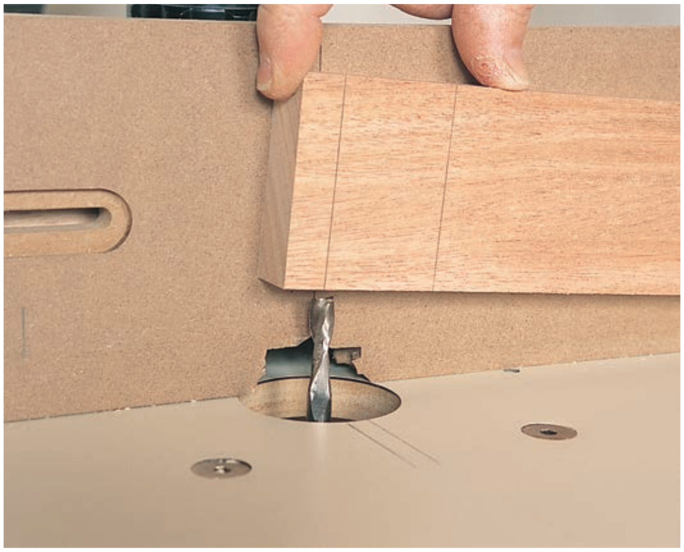
A safety issue that needs to be broached is that the bit that's generally considered optimal for mortising is the up-spiral. There are a couple of reasons to use it: it augers chips out of the cut and because of the way it cuts—slicing rather than chopping—it reduces strain on the equipment.

The drawback in this application—mortising on the router table—is its propensity to pull itself into the cut, just the way a sharp twist drill bit does. This isn't usually a problem when the cut is ½" deep. But it becomes a significant problem when you cut deeper.

What the bit will do is pull itself out of the collet. You probably won't notice it. In the best case, you'll have some mortises that are deeper than you planned. In an extreme case, it can pull completely out of the collet. You don't want that.

The upshot is that yes, you can do mortises on the router table, but it's risky and inefficient. Far better ways are available to you. I don't recommend router-table mortising.

Don't shun your router table because you won't do mortises and dovetails on it. Don't shun the joints either. Instead, focus on mastering all the joints you can do on the router table. And continue to rout mortises and dovetails as you have in the past.



It's tempting to try routing mortises the way you'd rout a short blind groove. But it's risky and hardly practical. The bit here is extended to complete a 1¼"-deep mortise; such a cut should be made in four or five stages. That means making either a bit adjustment or a shim swap four or five times for each mortise. There are better ways to do the job.

The Katie jig can be set up to use on the router table. Stand the pinboard on one side, the tailboard on the other, and clamp everything together. Big handgrips allow you to easily maneuver the jig. You rout the tails with a dovetail bit, the pins with a straight bit, so you need to change bits.

Jointing Edges

The butted edge joint may be *the* fundamental joint in woodworking.

Any time you need a solid-wood panel more than 6"or 8"-wide, you create it by gluing two or more narrow boards edge-to-edge. Casework, table-tops, door panels, drawer fronts, shelves, headboards and footboards all require boards or panels of a width that outstrip available stock and the capacity of shop machinery.

The most widely used form of edge joint couldn't be simpler. Two boards with straight, square edges and some glue. Everyone agrees that a properly fitted gluejoint is stronger than the wood. If you cut and assemble this joint right, the individual boards will split before the joint will.

You can prepare stock for such edge to edge glue-ups on the router table. But more than that, you can prepare the edges of materials like plywood and MDF for edge-banding. You wouldn't do this on your jointer.

What's the best bit for jointing? Almost any straight bit can be used, though you really ought to limit yourself to those with 1⁄2" shanks.

My instinctive choice is something like a 1" diameter straight with 2"-long cutting edges. It will joint stock up to 8/4. And at that diameter, the cutting edges exit the cut at a shallow angle and that produces a good cut finish.

A good choice for jointing materials with thin surface veneers is a compression bit, a.k.a. an up-and-down spiral. It's designed to cut through sheet goods without lifting chips from either face.

But don't be put off from router-table jointing if these bits aren't in your bit collection. A commonplace straight bit, such as the 3⁄4" cutter, will do fine with materials up to its 1" cutting capacity.

The router may be the safest tool for surfacing small workpieces. Maybe the piece is small and blocky. Maybe it's thin. These are the pieces that the jointer tends to jerk around or demolish, mauling your fingers in the process. Avoid this hazard—joint the piece on the router table.

The router table is the perfect setup for jointing plywood or MDF edges before applying edge banding. A carbide-tipped bit will mill such abrasive materials without burning up. The jointed edge will be straight and crisp.

Most any straight bit on a 1⁄2" shank is suitable for jointing. Given a choice, go with the large diameter bit. The longer the cutting edges, the thicker the stock you can work. And for veneered materials, try a compression bit.

Jointing Setup

To joint on a router table, you need a jointing fence. Like the jointer's tables, the router table's fence needs infeed and outfeed sections that are slightly offset from each other. This supports the work both before the bit trims away stock and after. Though offset, the two sections do need to be parallel.

The simplest jointing fence begins as a strip of 3/4" plywood or MDF. The factory edge of either material will be straight and true, so you use that edge as the guide edge. Cut a bit notch into that edge. To create the offset between infeed and outfeed halves, cement a strip of plastic laminate to the edge left of the bit.

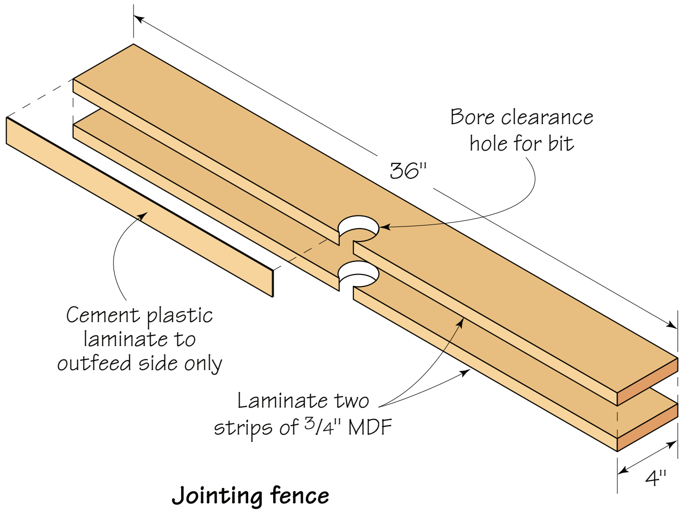
A thicker version, made by gluing two strips of plywood or MDF face to face, is shown in the drawing.

If your table's fence has split facings, you don't need a separate jointing fence. Simply shim out the outfeed facing. With such fences, you can vary the bite—to some extent—by varying the shim material. Use thin card stock, or slightly thicker posterboard or thicker plastic laminate, or—if you're feeling really aggressive—1/8" hardboard.

Set the fence by lining up the outfeed half of the fence tangent to the cutting edge of the bit. Hold a straightedge against that half of the fence and, with the router unplugged, turn the bit with your fingers. You want the cutting edges to just brush the straightedge but not move it.

Make a partial test cut. That is, start jointing, and after cutting about 6" or 8", turn off the router and assess the setup. If the board is tight against the infeed face but clear of the outfeed face, the fence must be brought forward. If you don't get that far, if the board catches on the outfeed edge of the bit notch, the fence must be moved back. The required fence adjustments are going to be tiny, so use your microadjuster or reference block and shims.

Once the fence is positioned, you are set up to joint your good stock.



Jointing fence

Align the jointing fence's outfeed half tangent to the bit's cutting edges. Hold a straightedge against that face and turn the bit with your fingers (unplug the router first) to judge the alignment. The edges should brush the rule but not pull it.

Test the fence alignment. Cut a few inches, then kill the power. Hold the board tight against the infeed side and the cut edge should be tight against the outfeed side. If you can slip any feeler gauge between the cut edge and the fence, you need to tweak the fence. Otherwise, your edge won't be straight, and you'll get snipe at the end of the cut.

Any router table fence with a split facing—that is, with separate infeed and outfeed halves—can be transformed into a jointing fence. Shim the outfeed half with a piece of posterboard between the fence itself and the facing.

Splining Edges

One of the best butted-joint reinforcement techniques is the spline. You can spline all sorts of joints—edge-to-edge, bevel-to-bevel, miter-to-miter.

Cut grooves (or call them slots, if you prefer) in the adjoining edges and fit a strip of plywood or hardwood into the joint as you glue it up. The spline strengthens the joint by providing a mechanical lock and by expanding the glue area. It makes the boards easier to align and clamp during glue-up.

The grooving operation is perfectly suited to the router table. You can use either a straight bit or a slot cutter. Routing a through groove in an edge is the easiest operation. A stopped/blind groove is a little more difficult. And dealing with a beveled edge or mitered end is the most challenging. But it can be done.

Choose your spline first, because the thickness of the spline will dictate cutter size. Plywood seems like the perfect material for splines. But 1⁄4" plywood is undersized. It's too thin to fit well in a 1⁄4"-wide slot, so it won't align an edge to edge joint.

Bit makers aren't entirely blind to this problem. You can buy a 15⁄64" slot cutter intended specifically to cut slots for plywood. You can also find 7⁄32" and 5mm straight bits.

The straight bit is in every router-user's collection, and that's its primary advantage. The straight bit also has the advantage of producing a square-ended stopped groove (as opposed to the arc-ended type formed by slot cutters).

But it has some limitations. For splining you generally want a cut width of 1⁄4" or less. It's the *or less* that is problematic for straights. Unless your groove is under 5⁄16" deep, you need to stage it. On top of that, you have to cut with the workpiece on edge against the fence.

The slot cutter is usually an assembly, consisting of an arbor, a cutter and a pilot bearing. Cutter size is specified in terms of the width of kerf it makes, and sizes range from 1⁄16" up to 1⁄4". Remove the arbor nut and you can switch the cutter (or add a second one to expand the cut width beyond 1⁄4").

The advantages of the slot cutter are its ability to produce a 1⁄2"-deep groove in a single, swift pass and the flat-on-the-table orientation of the workpiece. You can reduce the cut depth with the fence.

The groove is 1⁄4" wide, but despite that dimension designation, the plywood isn't. This mismatch can't be glued. Look for a 7⁄32" or a 5mm bit if you must use plywood for splines.

Splines are a great way to reinforce case miters (top), frame miters (center) and edge to edge joints (bottom). Rout the grooves for the splines on the router table.

Grooves for splines can be cut with either straight bits or slot cutters. For deep through cuts, the slot cutter has the advantage. The straight bit is the better choice for a stopped or blind cut.

A stopped groove routed with a slot cutter ends with an arc, but one cut with a straight bit is square. For splining an edge to edge joint, either cutter is satisfactory. But for a short cut in a flat miter, the straight is a better choice.

Routing Spline Grooves

Routing square-edged boards is straightforward. You keep the work flat on the table when using a slotter, but upright against the fence with a straight bit.

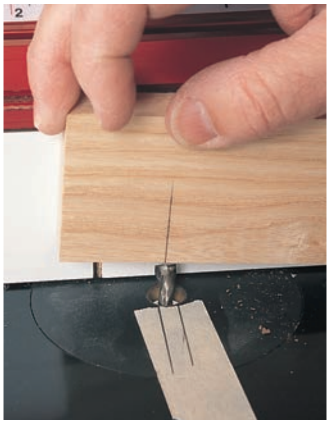
A flat miter is square edged, though you probably don't immediately think of it that way because of the cant of the workpiece. Just use a pusher that's angled exactly like the miter. A workpiece will lean forward when you slot one end and will lean back when you slot the other. Use the same pusher for both cuts; simply roll it over between cuts.

Rather than get too worked up with trying to center the slot, just mark a reference face of each board. Always keep that face up through all machining and assembly stages. The slots will all be the same distance from that face, so when the splines are inserted and the boards joined, their reference faces will be flush.

The starting point for a successful splined miter joint (whether an edge miter or an end miter) is an accurate bevel on the stock, whether 45° for a right-angle joint, or 30° or $22\frac{1}{2}$° for six- or eight-sided assemblies.

With the workpieces beveled, lay out the spline groove on one piece. To avoid weakening the bevel tips, locate the spline slot very close to the joint's inside corner. No more than $\frac{1}{8}$" from it. This placement simultaneously allows a $\frac{3}{8}$"-deep cut without weakening the stock.

Working at the router table, you must first address what cutter you'll use and how you'll handle the workpiece. Whatever cutter you use, you need a fence that's canted at the same angle as the edge miter. If you use a straight bit, the bevel must be flat on the tabletop. If you use a slot cutter, the bevel surface must be perpendicular to the tabletop.



Whether you are using a slot cutter (left) or a straight bit (right), you begin a blind groove by plunging the edge of the workpiece onto the cutter. Is it easier to do with the work against the fence or flat on the tabletop? Choose your orientation. Line up the end of the work with tape on the outfeed side of the table/fence to start and on the infeed side to end the cut.

Grooving a frame miter for a spline is like working an edge; it just seems different because the work is angled and isn't as easy to maneuver. Use a scrap of plywood cut to a complementary angle as a pusher.

A slanted support enables you to groove a beveled edge. Use the regular fence to trap the work so it doesn't slide down the sloped support. The groove should be located near the inside of the beveled edge.

Dadoes and Grooves

A dado is a flat-bottomed channel cut across the grain of the wood. (When it runs with the grain, the channel is called a groove.) It's a very basic cut.

In casework of any size, the dado is prime-choice joinery. You cut a dado or groove into one board, and the mating board fits into it. It follows that hoary woodworking adage, "Use the simplest joint that will work."

It certainly works. The dado joint has a centuries-long history of use in cabinetmaking.

The dado doesn't have to be deep to create a strong joint. One-eighth inch is deep enough in solid wood, 1/4" in plywood, MDF or particleboard. Just this shallow channel helps align the parts during assembly, and the ledge it creates is enough to support the weight of a shelf and everything loaded on it. The dado also prevents the shelf from cupping.

Keep a couple of criteria in mind. To end up with a strong joint, you need to make a cut of the correct width. The bottom needs to be smooth and flat, the sides perpendicular. If the cut is too wide, glue isn't going to compensate; the joint will be weak. Get the fit right.

The router has an advantage here because bits are accurately sized. You don't have to make test cuts to hone in on standard dimensions of 1/2" or 5/8". Even a dado for plywood is do-able because bits sized specifically for the material are widely available. Changing from one bit to another is quick and easy.

On the other hand, customizing a dado to an oddball dimension can be troublesome.

Many, many router bits lend themselves to dadoing and grooving. How do you decide what to use?

The most basic straights are double-flute. An enormous variety of sizes are available. Some manufacturers list 50 or more of these bits in diameters ranging from 1/16" to 2", with flute lengths from 1/4" to 2 1/2". Even metric sizes are available.

If you have a choice, use the shortest length that will make the cut. For dadoes, choose the one with the 3/4"-long flutes. That's plenty long for cuts that'll seldom exceed a 1/2" depth.

The dado is long-established as an excellent, easy-to-cut casework joint. The cut doesn't need to be deep to be effective, but it must be closely fitted. Variants include the dado and rabbet.

One is a dado, and one is a groove. Both were cut with the same bit. The cross-grain cut is the dado, the long-grain cut is the groove.

The range of bits that can cut dadoes and grooves is almost endless. Use the shortest, heaviest-shanked bit that will produce the desired cut. For veneered materials (like plywood), a downshear bit (right) is least likely to chip the edges.

Making the Cut

On a router table, grooving and dadoing is much like making these cuts with the table saw. But a router table is small compared to the typical table saw with its expansive right extension and outfeed table. So it isn't exactly the same.

Since grain typically parallel's a board's long dimension, routing grooves is straightforward. Set up the bit, position the fence and feed the board through the cut. The process is the same for face grooves and for edge grooves.

But routing dadoes (those cross-grain cuts) is less straightforward. Try guiding the workpiece's short dimension edge along the fence to rout a dado. It works where the cut is close to the end, as the dado in a drawer side for the drawer back. Use a square-ended push block to keep the work square to the fence as you feed it and to back up the cut.

But you seldom can get the fence far enough from the bit to rout dadoes in a case side. And if you could, you'd have a tough time preventing the part from *walking* along the fence. That doesn't mean you can't dado these project parts on the router table.

Use the sliding fence. The sliding fence offers the advantages of the table saw crosscut sled. Setup is simple, the operation is easy and the results are clean and precise.

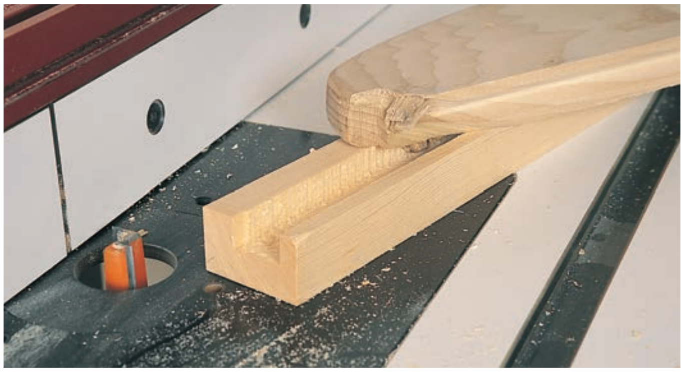
You do need to use the sliding fence's stop to position the work, because the stop also prevents the bit from moving the work. The bit in a table-mounted router is spinning counterclockwise, and it will pull work to the right. Put the stop on the right to counteract that dynamic. (It's the equivalent of positioning the fence on the right.)

The stop has the secondary function of positioning cuts consistently from workpiece to workpiece. Depending upon the size of the work, the stop might have to be extended a foot or more beyond the fence.

Routing grooves in a drawer sides for the bottoms and dadoes for drawer backs is a good router table job. The cuts are close to edges, so you can guide them with the fence. And the workpiece is a maneuverable size. When routing dadoes, use a push block—just a square scrap—to stabilize the work and back up the cut, preventing tearout as the bit emerges from the cut.

Panels as large as cabinet sides can be dadoed on a router table using the sliding fence. A stop clamped to the fence locates the cut and immobilizes the work. The stop must be adjusted for a dado in a new location.

Routing a groove is as basic a router table operation as there is. Set the bit height, position and lock the fence, and feed the stock along the fence. Dust collection is a trial, since the dirt shoots out of the cut and there's no good way to capture it.



Here's the result of an unintended climb cut when widening a groove on the router table. The cut was botched when the bit snatched the strip and fired it off the table.

Rabbets

A rabbet is one of the joinery cuts the router does best. It's really an edge treatment, done with a piloted bit. Select the rabbet bit with the correct cutting width, chuck it in the router, set the depth of cut and rout. That's all there is to it.

But there's more to the repertoire of rabbet cuts than can be executed with a rabbet bit. There are extra deep (or extra wide) rabbets, rabbets in curved shapes, rabbets in narrow edges.

Nevertheless, that rabbet bit is the first choice for the average rabbeting operation. Because it has a pilot, set is minimized. Your only adjustments are the depth-of-cut and the angle of attack. The measurement between the bit's cutting edge and its pilot governs what I call the width of the rabbet.

To alter the width of the rabbet with such bits, you can do two things. One is that you can change your angle of attack, as shown in the drawing (bottom of this page). This can be a useful approach, since it can change the dimension over which you have control, while preserving the simplicity of setup and operation that pilot bits provide.

The other thing you can do is to change the pilot bearing. Every bit manufacturer sells separate bearings, and in the case of rabbet bits, they package sets that will give you many different cut widths from one bit.

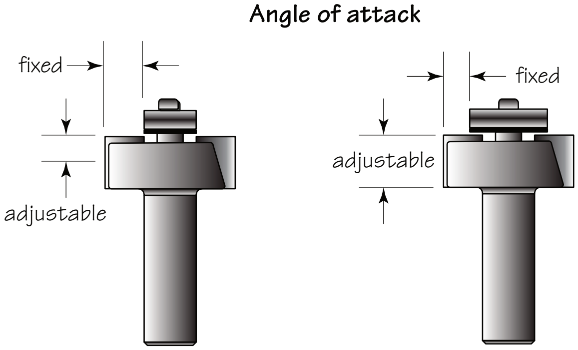
Two other bits—straight and mortising—cut rabbets nicely on the router table. Both are very flexible. After tightening one of these bits in the collet, set the fence to expose only enough of it to make the desired rabbet.

The advantage of this approach is that you can produce an odd ball rabbet, such as one to perfectly accommodate a piece of plywood.

The rabbet is the basis for a variety of joints, including the single rabbet, the double rabbet, the shiplap, and the dado-and-rabbet.

A rabbet bit with set of interchangeable pilot bearings sets up quickly and produces a variety of specific-width rabbets. Straight bits you may already have and use for other cuts will also produce rabbets on straight stock. A mortising bit, effectively a rabbet bit without the pilot, also cuts clean rabbets.

While the rabbet bit has some limitations, it is easy to set up, cutting predictable widths without time-consuming test cuts, Rabbeting curved work is something only a piloted rabbet bit can do.



Use a stock sample to set the bit exposure for a single rabbet. Hold the scrap against the fence as you swing it into position and use your fingers to ensure the bit's cutting edges are flush with the stock's face.

By using an unpiloted bit with the fence (instead of a piloted bit), you can greatly increase the width of rabbet you can cut. Though only half of this $1^1/_2$"-diameter mortising bit is engaged, the rabbet being formed is half again as wide as the maximum you can cut with a piloted bit.

Cut a deep (or wide) rabbet with a long straight bit by standing the work on end (or on edge) against the fence. The cut width is limited only by the bit's length. Featherboards will steady stock for a long-grain cut, but only if they bear against it above the cut.

Forced to rout a wide rabbet with a relative small straight bit? After the initial pass, stick shims to the tabletop with carpet tape. Placed on either side of the bit, they'll to support the work and prevent you from inadvertently ruining the piece by tipping it down on the bit.

Avoid splintered edges when you rout rabbets; make the first pass a very shallow scoring cut. While you might climb cut this with a hand-held router, such cuts are hazardous on the router table. Instead, set the fence to allow the barest of cuts. only $^1/_{32}$", perhaps $^1/_{16}$". Then reset the fence and cut the rabbet to whatever depth you desire.

Wide (Deep) Rabbets

For purposes of this discussion, a wide rabbet is one that's more than $^1/_2$" wide, the maximum possible using a piloted cutter. Here you need to use a straight bit or a mortising bit.

As the cut gets wider—wide to the point that you have to make three or four passes to complete it—you have to keep the uncut surface of the piece tight against the table. And if the ultimate cut is wider than the remaining uncut surface, then the last pass or two can be dicey. Pressure on the wrong area of the work can cause it to tip, gouging it.

One solution is to treat the rabbet as a wide dado or groove. Cut the workpiece over-wide or over-long (whichever is appropriate). Leave a ridge of unrouted stock at the outer edge of the cut to support the work. After the router cut is done, rip off the ridge on the table saw, reducing the work to width and turning the dado into a rabbet.

An alternative is to use carpet tape to stick a couple of shims to the router table at the fence after making the first pass. The shims support the work as you make subsequent passes.

Still another approach is to deal with the rabbet as a deep cut. Use a straight bit. Stand the work on edge against the fence and feed it past the bit. The longer the bit, the wider (or deeper) the rabbet.

Shiplap

The shiplap is an underappreciated variant of the rabbet joint. Applications are somewhat limited, but where it works, it's a dandy. Use it for solid-wood cabinet backs and chest bottoms, and for vertical-board siding.

Consider these advantages:

• It cuts quickly, since there's only one setup for both halves of the joint.

• No gaps open between boards, regardless of season. One board overlaps its neighbor.

Working out the joint dimensions is easy. One dimension of the cut is always equal to half the thickness dimension.

The second dimension is up to you. A good all-purpose width of overlap is 3/8". That's enough to prevent wood shrinkage from opening gaps between boards unless they are wide or the stock is wet. The wider the tongue formed by the rabbet, the more frail and subject to splitting it is. A 1/4"-wide cut yields a stronger tongue, but you may sacrifice the benefit of the overlap with a very narrow cut.

To adjust the cut depth, make a test cut, cut the sample in half and fit the resulting pieces together. If one face is offset from the other, use the depth bar of a dial caliper to determine what it is. Your cut adjustment should be half that measurement.

Make a second test cut to assess the result of your adjustment. If further adjustment is warranted, make it.

A shiplap joint is formed by overlapping rabbets cut into opposite faces of adjoining boards. The rabbets are quickly cut, precision is irrelevant, yet they serve a valid purpose.

As a halving joint, the shiplap is easy (in concept) to fit. Cut a rabbet on a sample of the working stock, crosscut it and fit the joint together. If the pieces aren't flush, measure the offset with the depth bar of dial calipers. Raise or lower the bit by half the offset.

Chamfers and beads can be routed along the margins of the ship lap to mask the seasonal change in the gap between boards. Chamfers can be cut on both the rabbet's shoulder and the back edge of its tip so the assembled joint has a V-groove appearance. The bead must be only on the shoulder; it'll weaken the tongue.

With the setup established, cut the workpieces. Usually, you cut one edge, roll the board over and rout the other edge.

Embellishments: Like the tongue and groove, the shiplap can be embellished with bevels and coves and beads. These are intended to dress up the surfaces, creating interesting shadow lines and aesthetics. But these embellishments also mask the seam between boards.

The caveat is to place these cuts where they won't degrade the joint. The obvious threat here is a bead that weakens the tongue.

Mitered Rabbet

The mitered rabbet is one of those joints you see in drawings but seldom see in real projects. That's a shame. It's a good joint and it isn't difficult to cut on the router table.

The joint's benefits are its clean appearance, its improved stress resistance over a plain miter and its ease of assembly.

You can cut the joint on the table saw, but it's easier to do on the router table. You need a chamfering bit and a bit to cut rabbets.

Here's the sequence.

Cut a rabbet on one piece that is half the stock's thickness in depth and the full stock thickness in width.

Cut a rabbet on the mating piece that's half the stock thickness of both depth and width.

Make sure the rabbets are perfect before advancing to the next setup.

Switch to a chamfer bit and raise it above the table. The photos show a good routine for setting the chamfer bit and fence. But here's a slightly different way you might try: Use the square rabbet to set the fence position. Slide the end of the piece, rabbet up, under the bit body. You want the outer tip of the cutting edge against the shoulder of the rabbet and the fence against the end of the piece. When the fence is locked down, lower the bit until it contacts the bottom of the rabbet.

Cut a bevel across the tip of each rabbet.

For casework, the mitered rabbet is an improvement over the simple miter. It looks like a miter, but each half of the joint has a shoulder to make the joint easier to assemble and clamp.

The key to a properly fitting joint is to scale the rabbets accurately. Begin by adjusting the bit height just as you would for cutting a shiplap (bottom). For half of each joint, you cut a rabbet as wide as the mating piece is thick (center). The other half of each joint requires the width of the rabbet to match its depth (top).

The miters are routed with a chamfering bit. Adjust the bit height against a rabbeted piece. The tip of the slanted cutting edge must align with the bottom of the rabbet.

Set the fence after the bit height is set. Position a rabbeted piece beside the bit as shown and adjust the fence to align the tip of the cutting edge with the bottom of the rabbet.

Both the wide (left) and narrow (right) rabbets are mitered with the same bit and fence settings. Be sure to back up the workpiece to prevent splintering as the bit exits the cut.

Dovetail Rabbet

The dovetail rabbet is an alternative to the more familiar rabbet joint. Simple to make on the router table, the joint comes together neat and square. It's more resistant to racking than a conventional rabbet joint.

You can cut the joint with a single setup on the router table, or you can customize it. The single-setup approach is a halving process. The same volume of waste is removed from each piece, so half the joint is on one piece and half on the other. If you want to remove more from one piece than the other, you are customizing the joint. Easily do-able, but not with one setup.

To cut the joint on 3/4" stock, you need at least a 3/4" dovetail bit. The 1/2" bit, which is the most common size, is just a little too small to give you a satisfactory joint. The bit's angle is irrelevant, since you use it for both cuts. The bit height is irrelevant to the fit of the joint; pick a height that looks right. The fence position is what makes the joint come together perfectly.

Cut one half of the joint with the work flat on the tabletop. Stand its mate on end and slide it along the fence. The fence position is the same for both cuts. When the fence is set properly, the bit makes the same cut in both pieces. What could be simpler?

If you want to change the joint proportions, Cut half the joint, placing the shoulder where you want it. Then adjust the fence to produce a mating cut. On the router table, no bit-height adjustment should be necessary, just a fence adjustment. You'll have to find the fit through test cuts. But even with this approach, cut one piece flat on the tabletop, the mate on end against the fence.

Cutting a dovetail rabbet joint is easiest as a one-setup, two-pass operation. The first pass is made with the workpiece (the side of a case) flat on the tabletop. To make the second cut for the joint, stand the workpiece—the case top or bottom—on end and brace it against the fence. Back up the work to keep it square and to prevent the bit from blowing out the edge.

As a "designer" joint, the dovetail rabbet looks just a little different, just a little more stylish than the rabbet joint you're used to. The zig-zag interlock enables a well-fitted one to resist some stresses just a little better too.

Positioning the fence is critical. Make sample cuts, assemble and evaluate the joint and tweak the fence. The bottom sample indicates you need to move the fence to house more of the bit. The middle sample indicates you need to move the fence to expose more of the bit. The top sample is right on.

Box Joint

The box joint is a sort of square-cut through dovetail. It's used in the same situations as the dovetail—assembling boxes, drawers, and casework. It has fair mechanical strength, but what it does is generate a long-grain to long-grain glue area (the sort of glue area that yields the strongest bonding).

Look at a box-jointed object and imagine it dismantled. The ends of the parts are comb-like, with uniform pins and notches. The pins on one board fit into the notches on its mate, and vice versa. So the joint's making is all about cutting a series of notches to form a series of pins.

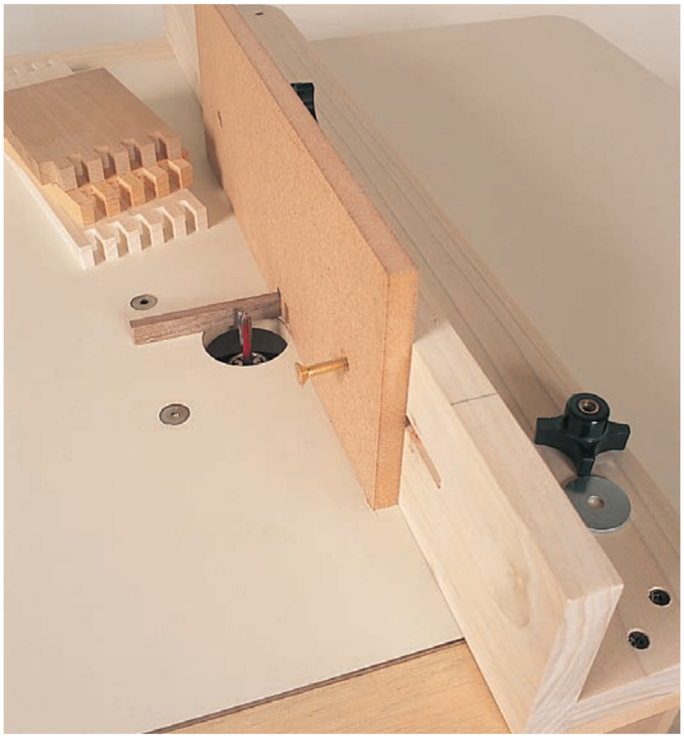
The trick to cutting box joints is a jig (see the drawing) that attaches to the sliding fence (see page 45) or to a miter gauge. What the jig does is position the work so the notches are separated by pins the same size as the cuts. The critical element the key, is a little stick of hardwood. It's custom-made, so it fits the cut exactly. The jig is attached to the sliding fence with bolts in slots so you can shift the jig left or right to adjust the spacing of the cuts.

To make the jig, use plywood or MDF for the facing. The key should always be a hard wood. It's subjected to a lot of wear, and if it's too soft, it will deform and throw off the accuracy of your cuts. The pins won't mesh, in other words.

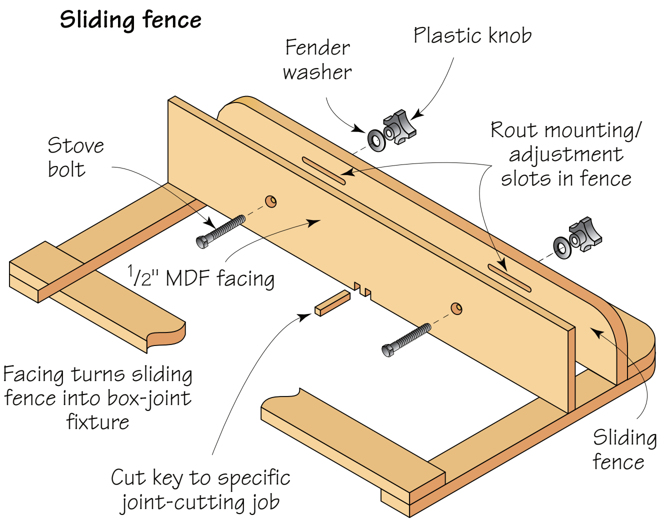
The initial step is to reconcile the notch width and the width of the workpieces. You really want to begin and end each array of pins with a full pin or notch. To accomplish this, the width of the boards should be evenly divisible by the notch width. If this isn't the case, then it's best to change the width of either the notch or the boards.

Stock thickness has no bearing on pin thickness. You can use 1/4" pins on 3/4" stock, for example, or 1/2" pins on 3/8" stock. What stock thickness does impact is the pin length. The bit elevation must equal the stock thickness.

The box joint has good mechanical strength and its many pins create lots of long-grain—to—long-grain gluing area. Thin pins are more work to cut, but they yield a stronger joint.



Box joint jigs are all basically the same. This one consists of an MDF facing that mounts on the sliding fence with bolts and plastic knobs. Set it up fresh for each job by notching the facing and installing a hardwood key.



Setting Up the Jig

Chuck the bit you've chosen in the router. Using a scrap of the working stock as a gauge, adjust the bit height.

Mount the jig facing to the sliding fence. Cut through the facing with the bit.

Now make a key that just fits the notch. Rip a stick close to the required thickness and hand-plane it to fit. When it fits, cut it in two and glue one piece into the notch. Use the second piece to position the jig. Set it against the bit and slide the key in the facing against it. The gap between the cutter and the key now equals the bit diameter.

Now cut a test joint. Stand two stock samples in the jig, edges snug against the key. Cut a slot through both. Jump the slot over the key. Cut another slot. Jump the new slot over the key. Repeat the process until all the pins are formed.

Fit the joint together (offset them if need be to align pins with slots). If the pins won't go into the slots, the key is too far from the bit. If the pins are loose in the slots, the key is too close to the bit.

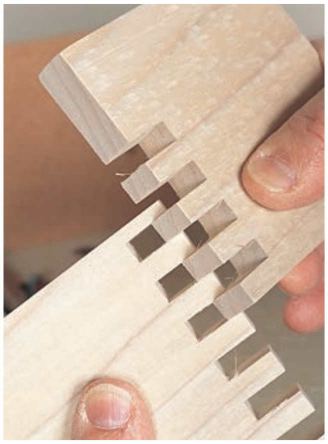
Tweak the setup. Use dial calipers to measure a pin and a slot. Half the difference between these measurements is the amount you move the facing.

If the slot is bigger than the pin, move the key away from the bit. Set a block against the key and clamp it to the tabletop. Loosen the facing, slip a feeler gauge between the block and the key and relock the facing. Remove the block.


Cutting a notch for the key (left) is the first step in setting up the box joint jig. Make a key strip, hand-planing it to achieve a tight press-fit in the notch. Cut the strip into two pieces: one is the key, the second is a setup gauge. Hold the loose key against the router bit as you slide the facing and key up to it (right). You want the keys to just kiss, rather than jamming them together.


Stand the test-cut stock on end, tight against the key. Push the jig across the cutter and make the first notch (left). After each cut, step the work to the right, fitting the freshly cut notch over the key. Each cut matches the width of the key, and leaves a pin of the same thickness between notches. Step-and-repeat until you've cut pins across the full width of the work.

Its easy to micro-adjust (in thousands of and inch) your jig setup. Measure a pin and a slot with dial calipers and subtract one measurement from the other to determine the thickness of what feeler gauge to use. Fit the gauge between the jig facing and a reference block clamped to the fence to make the adjustment.



Cutting the full layout across both pieces isn't necessary to test the fit. If the setup is significantly off, fitting three or four pins will expose it.

If the pin is bigger than the slot, move the key closer to the bit. Clamp the block to the jig with the feeler gauge between it and the key. Loosen the facing, remove the gauge and reset the facing with the key tight against the block. Then remove the block.

A second set of cuts will confirm the accuracy of your adjustment.

Cutting the Joints

There's no reason to cut the parts one at a time. It's repetitive, tedious work, so do anything you can to expedite it.

If your joint layout begins with a pin and ends with a slot, you can cut sides and ends simultaneously. Four parts in a stack. As with the test cut, align the parts in the stack, stand them on the tabletop, upright against the back. Butt the edges against the key. Cut. Step the stack over the key and cut. Step and cut again. Repeat until the last slot is cut.

If one piece begins and ends with pins, the mate will begin and end with slots. They must be cut in sequence. You can pair up parts of a box, but you can't cut all four parts at once.

Start with the piece that begins and ends with pins. Cut the slots in it. After the last slot has been cut, step that slot over the key. Stand the mating piece beside it, edge to edge. Cut. Remove the first piece and slide its mate to the right, the slot over the key. Cut again. Step and cut until all the slots are completed.

The elevation of the cutter should match the stock thickness. The top joint was formed with the cutter too low, while for the lower joint, the cutter was too high. In the middle is the just-right setting.

In a joint with a dozen or more pins, be wary of cumulative error. A discrepancy of $^1/_{128}$" doesn't have a significant impact when the joint has six pins. But double or triple that number and you may have a joint that won't close. The bigger the joint, the more exacting your setup must be.

When the joint on a piece begins and ends with a pin, you need to use it to begin cutting its mate, which begins and ends with notches. Step the last notch of the first workpiece over the key. Butt the mating workpiece against it and cut. Then set the first piece aside and continue notching the second.

It's possible to slot several parts at the same time. This can expedite production. Note that if your joint's layout begins with a pin and ends with a notch, both sides and ends are alike, so you can rout all four parts of a box at the same time.

Laps

Notch one member to accommodate the full thickness of another and you have a lap joint. Notch both members, each to take half the thickness of the other, and you have a half-lap.

Within these two broad categories are many variations. End laps, cross laps, T-laps, edge laps. All of these can be cut successfully on the router table.

Half-laps can be used for all sorts of flat frames. Doors, for example, but also face frames, web frames and picture frames. It can be used in post and rail constructions to join rails or aprons to legs in worktables.

The joint can be very strong if properly made. The shoulder(s) of the half-lap provide resistance to twisting. In addition, the laps provide plenty of long-grain to long-grain gluing surface.

End Laps

The end lap is the easiest lap to cut. It can be done a couple of different ways on the router table.

If you are working fairly narrow stock, 2" or less, you can use a long straight bit and cut the pieces by standing them on end against the fence. Anything wider than 2" outstrips the cutting length of the longest straight bits you'll find. You can stretch the reach by cheating it out of the collet, but that's done only at some risk.

Install the bit and adjust its extension to match the stock width. Move the fence into position, housing the bit almost entirely. Make only a very shallow cut, so expose just 1/8" of it.

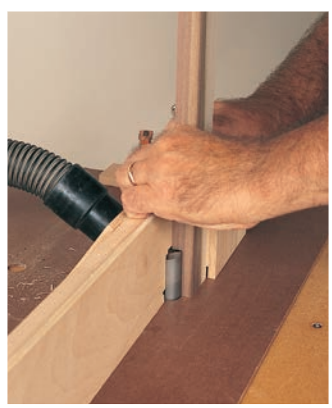
Support and back up the workpiece with a scrap—one that's flat, true and square. Slide the work and backup block through the cut. Move the fence back slightly and make another pass. Repeat this cut-and-adjust routine until you've reached the desired depth.

If you're cutting several identical laps, I'd suggest making a cut on every piece before shifting the fence to expose more of the bit. That works better (for me) than adjusting the fence two or three times for each individual workpiece.

A half-lap joint is strong, versatile, and easy to cut. To make one, you cut recesses in both mating pieces, then fit them together, forming an X, L, or T.

An ordinary straight bit is fine for cutting laps with the sliding fence. Use the largest diameter straight you have. Even better is a mortising bit. Another option for end laps is a long straight bit. Again, a large diameter bit is better than a small one.

A half-lap can be cut with a very long straight bit, if you have one. Lay a part to be lapped beside the bit and adjust the bit extension to match its width.



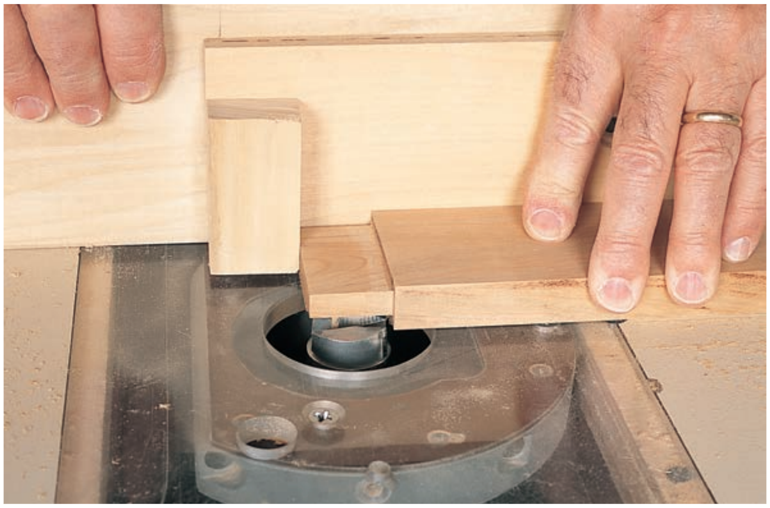
Cut the lap with the piece on end and backed up with a scrap pusher. The lap, straight from the cut, is smooth and will glue exceptionally well.

A Better Approach

A more flexible way to rout end laps is with a straight bit or a mortising bit and the sliding fence (see page 45 for the fence plan). The size of the lap isn't limited by the size of the bit you use. Cut with the stock flat on the table.

This sliding fence is a shop-made accessory that straddles the tabletop from front to back and has guides underneath that hug the table's edges. Unlike the regular fence, you move this one to guide a piece through a cut.

Bolted or clamped to the fence is a consumable facing with a stop block fastened at the right end. By loosening the bolts or clamps, adjust the facing to move the stop toward or away from the bit. For this operation, that stop controls the width of the cut.



Forming tenons with crisp shoulders and smooth cheeks and edges isn't difficult with the sliding fence. The process is the same as cutting laps, but the cut depth is reduced. Cut a cheek, then roll the work and cut an edge. Another roll presents the second face to the bit for a cheek cut.

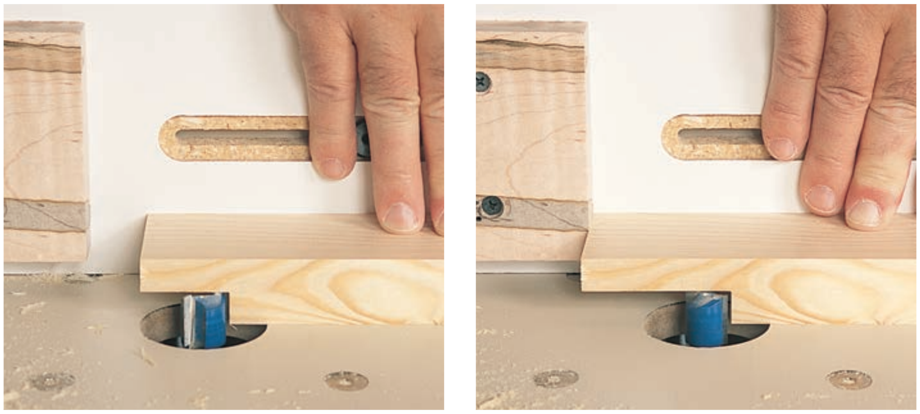
You can use most any straight bit to cut the lap, but I prefer what's variously called a planer, mortising or bottom-cleaning bit.

To set up the stop, install the bit and adjust its height for the cut. Slide the fence up to the bit, free the facing and slide the stop close to the bit. Use a piece of the working stock as a gauge to position the stop (see photo bottom left). Clamp the facing to the fence.

Be mindful of the amount of material you remove in a pass. You don't necessarily want to hog out a 3/8"-deep cut in a single pass, especially if you are using a 1 1/4"- to 1 1/2"-diameter bit.

Form the full cut in small steps. The first pass should be about 1/4"-wide, produced by holding the workpiece well clear of the stop, so only 1/4" of it extends over the bit. Make pass after pass, shifting the workpiece closer and closer to the stop. One last pass with the workpiece dead against the stop and your lap is completed.

The easiest, most accurate way to set the sliding fence's stop for an end lap uses a piece of the working stock as a gauge. Hold the stock against the stop and slide both to align the stock's far edge with the bit's cutting edges.



The easiest way to stage a cut with the sliding fence is to nibble into the cut from the end. Set the bit to the correct setting for the full-depth cut. Hold the workpiece clear of the stop and cut a narrow rabbet across the end. Move the work closer to the stop for the second pass (left), then butt it against the stop for the final pass (right). (Yes, the process generates a lot of dirt!)

Cross Laps

These approaches work well for the end lap, but what about a lap in the middle of a board? That's called a cross lap. Assemble two cross laps to get a cross lap joint. Assemble an end lap and a cross lap to get a T-lap.

For this cut, use the sliding fence approach. Assuming the lap's width exceeds the cutter diameter, use spacers between the workpiece and the adjustable stop to control the cut width.

To set up the sliding fence, lay out the lap on your workpiece and extend the lines onto the edge of the stock.

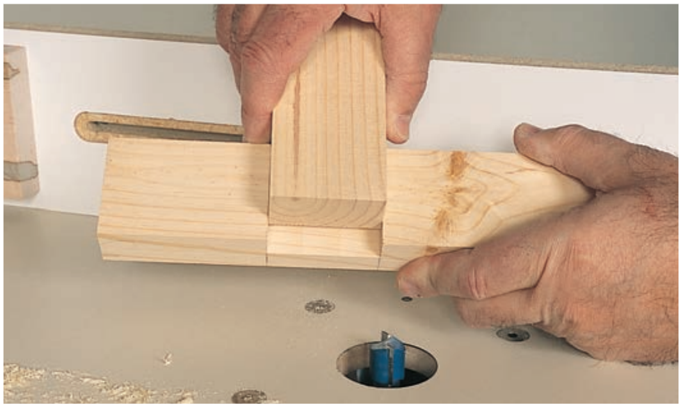
Install the bit, and adjust the cut depth. With the end lap, you can set the bit for the final depth and make a series of narrow cuts. But when cutting a cross lap, at least the first pass has to be the full width of the bit. Using spacers thinner than the bit diameter allow you to reduce the bite on subsequent cuts.

Position the stop next. Adjust it so you are cutting the left margin of the lap when the work is against the stop. Now determine the spacer dimension. Align the right margin of the lap with the bit—make sure you have the bit inside the cut—and measure between the end of the workpiece and the stop. That's how thick the spacer must be. To parse the total width into three or four cuts, divide the total spacer thickness into two or three pieces.

Make a test of the full cutting sequence. Cut first with all the spacers between the stop and the work. Then remove one and make another cut. Repeat until you cut with the work directly against the stop. Check the fit of the joint. If the total cut is too wide, you must pare down the total spacer thickness.

Once you have the fit right, go ahead and cut the laps.

Spacers inserted between the sliding fence's stop block and the work's end shift the workpiece so the bit will align with the right shoulder of the intended lap. Make the first cut with all the spacers in place (left). Remove them one at a time and make a cut. On the final pass, the workpiece should be butted directly against the stop (right).



Test the fit of the mating piece in the newly cut cross lap. Too tight? Move the stop to your right and increase the total thickness of the spacers by twice the amount you moved the stop. Too loose? Move the stop to your left and decrease the total thickness of the spacers by twice the amount you moved the stop. (If you do the first without doing the second, you'll simply shift the position of the lap without changing the width of it.)

An edge lap is a cross lap that cuts through edges rather than faces. It's the joint used to create egg crate-like drawer dividers, for example. You rout them the same way you rout cross laps. Typically, the cuts are narrower but deeper.

Sliding Dovetails

The sliding dovetail joint is a hybrid of the dado and dovetail joints. One mating piece has a groove, and the other has a tongue; the tongue fits in the groove. Because both the groove walls and the tongue sides are angled like the dovetail, the joint has to be assembled by sliding the tongue into the groove.

Mechanical strength is the joint's advantage. Even without glue, the mating pieces stay linked together, so assembly routines are simplified.

Router-cut sliding dovetails link parts together, with or without glue, so they have a multitude of users. Both the tails and the grooves can be easily cut on the router table.

Choosing a Bit

Dovetail bits are made in a variety of diameters and angles. The 1/2" diameter 14° bit on a 1/4" shank is the most common bit since that's what most half-blind dovetail jigs require. However, you can now buy bits with 7° tapers, as well as with 7 1/2°, 8° and 9° tapers.

While you can buy bits that are larger and smaller than 1/2" diameter, that size is optimum for stock between 5/8" and 7/8" thick.

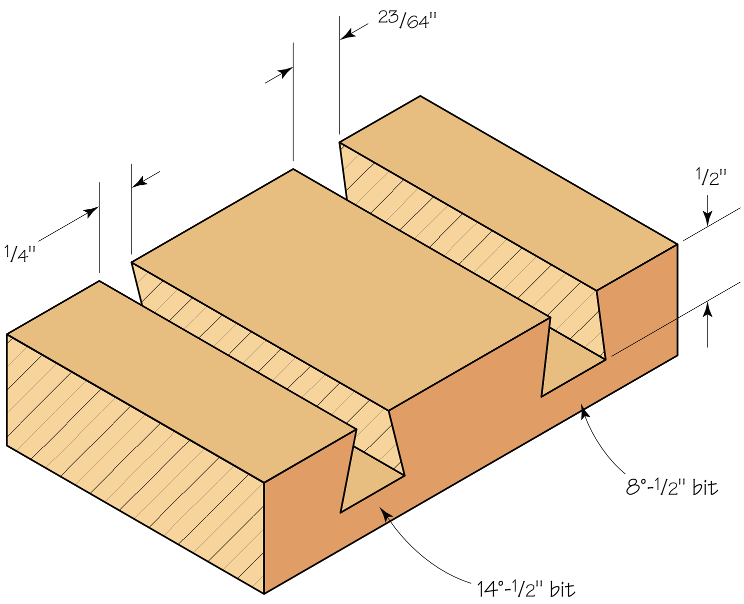
Scaling the Joint

For casework, a shallow sliding dovetail—say 1/8" deep—is all you need. Even in a dado joint, that depth is sufficient. Add the dovetail angle and you reap the mechanical blessings it confers. Yet that cut depth is easy for any router in a single pass.

The groove in a breadboard end, on the other hand, should be as deep as you can make it without compromising the groove-wall thickness or the thickness at the base of the tail.

Length must be considered when scaling a sliding dovetail. The longer a joint is, the more problematic it is to fit. In casework, you would do well to avoid a sliding dovetail that's the full width of a side. It's one thing to assemble an 8" or 9" sliding dovetail that joins a shelf to a side and quite another to assemble one 16" to 18" long.

Dovetail bits are made in a wide variety of diameters, roughly from 1/4" up to 1". Angles range from 7° to 14°.



The steeper the dovetail angle, the less material you have at the waist of the tail. This has little impact in casework, where the cut is shallow. But in apron-to-leg or breadboard-end applications, a shallow dovetail angle means the tail can penetrate deeper without becoming too frail at the waist.

Routing Dovetail Grooves

A dovetail groove has to be cut in one pass at full depth. There's no such thing as doing it in multiple passes at increasing depths. If the dovetail groove is shallow—a 1/8"-deep slot in casework—you can rout it in a single pass.

The way to stage a deep cut is to rout first with a straight bit that matches the dovetail's waist diameter, cutting about 1/16" shy of the final depth. Then you switch to the dovetail bit and run the workpiece across it.

Let's look first at the shallow dovetail cut, done straightaway with the dovetail bit. This cut is likely to be for casework, which means it'll be a cross-grain cut.

Though a cut close to the end can be guided by the fence and a backup block, the sliding fence is the best guide. With it, you're able to cut slots rather far removed from either end of the workpiece, and you are able to rout stopped slots with very little risk to you or the work. You do have to use the positioning stop to ensure your cut is both square and properly located.

Routing a dovetail groove in an edge depends on the regular fence as the guide. Here is where you'll likely need to stage the cut.

Normally, the groove is centered on the edge. To center it, make a pass in each direction. That is, cut the groove, then turn the piece around and make a second pass.

A potential problem is preserving your fence setup when switching bits. If you have to move the fence off a mounting plate or reducing insert to swap bits, memorize the fence position by setting stops against its face and clamping them to the tabletop. You can back the fence off the plate, change bits and return it to its original placement.

Do your setup and make test cuts to ensure that you're content with the result before cutting the real workpieces. Save the test cut for fitting the tail.

Control the length of a stopped dovetail slot with a block clamped to the tabletop. With the work against the positioning stop, feed into the cut. When the rear fence hits the stop, back out of the cut.

Cut dovetail slots for casework using the sliding fence. If the cut depth is reasonably shallow, you can rout it in a single pass. The fence's stop both locates the cut and holds the work in position so the cut is square.

Edge grooves are best done on the router table. Set the fence so the bit is as close to center on the edge as possible. Reduce stress on the dovetail bit by plowing a groove with a straight bit (left). Switch to the dovetail bit. Make a cut, spin the work around and make a second cut (right). This will center the groove. Note that dust collection at the fence doesn't pick up the debris generated by grooving cuts like these.

Cutting a Tail

This is always done across an end or along an edge. It is most commonly done on the router table. There are some alternatives, but it is fast and easy on the router table, so let's focus on that approach.

Use the same bit for the tails as you used for the slots. This guarantees the geometry will match.

Close down the bit openings in the tabletop and fence as much as possible. For the tabletop opening, use the appropriate reducer in your router mounting plate, or a 1/8" hardboard auxiliary tabletop. For the fence, either close split facings against the bit, or apply a one-piece auxiliary facing and cut a zero-clearance opening with the bit.

Set the height of the bit above the table to match the depth of the groove or slot. If you cut the slots on the router table, move directly from that to the tail cut without changing the bit setting. If you cut the slots with a portable router, use your cut sample as an aid in setting the bit height. Prove the setting with test cuts.

Bring the fence into position, housing all but the very edge of the bit in the fence. Depending upon the size and proportions of the workpiece, you may want to add a tall facing to the fence. This may be worthwhile to you if you're working something like a tabletop or chest lid, although I've found a well-placed featherboard (and my regular fence) is all I need for even these big pieces.

Cut a tail on a narrow piece like a drawer divider by standing it on end, backing it up with a scrap block and advancing it along the fence. The backup block minimizes exit splintering and helps stabilize the work, reducing its tendency to walk along the fence. Make a cut, spin the work 180° and cut again to form the tail.

For a stopped slot, trim one edge of the tail. Simply turn the piece to register its edge against the fence. Use the backup block, and cut.

The tail—this one intended for a stopped slot—has crisp, uniform-width shoulders on three sides. To nest the end of the tail against the end of the slot, pare the sharp corners with a chisel.

One well-placed featherboard will stabilize even a large panel standing on end. The featherboard is aligned just ahead of the bit, and it is elevated with a block underneath so it's pressing above the cut. The fence is the one I use regularly; something taller isn't necessary.

Glue Joint

Developed for high-volume production glue-ups, the glue joint is a halving joint. You have a single setup of bit height and fence position. One board is routed face up, the other face down. If the setup is just right, the two boards will come together with their faces flush.

Gluing up is a cinch. Because of the interlock, the boards can't shift up or down. The gluing surface is expanded too.

The joint was originally cut on shaper, but the cutter's been scaled down for router table use. Because it's typically under 2" in diameter, it can be run at full tilt (22,000 rpm). But it's a substantial bit and removes a major amount of stock, so lots of horsepower is a requisite.

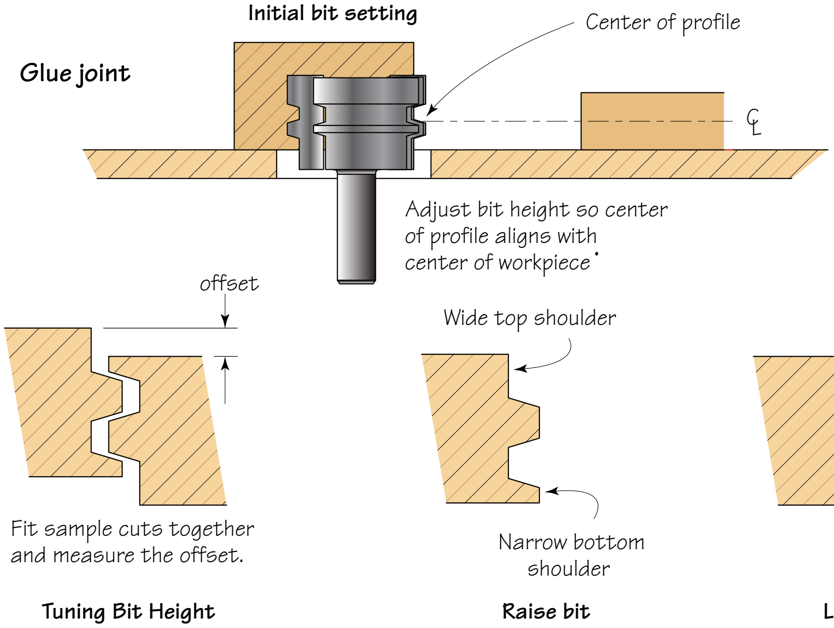
Preliminaries

Prepare the stock well. It's especially important that it be flat and a consistent thickness. If the thickness varies from board to board, the faces won't come flush when you assemble the joint. Any bowing can lead to a misaligned cut.

Surely you've done panel glue-ups. You've dealt with setting the boards side-by-side, finding the best-looking arrangement, then marking them for assembly. What may be new is marking them for the joinery cuts.

All but two of the boards in a glue-up must be routed on both edges. (The outermost boards are routed only on one edge.) The routine usually is to rout one edge with the face down, the second edge with the face up. To prevent mix-ups (routing both edges with the face down) mark one end of each board to remind you which face goes against the table for a cut. Arrowheads are all you should need; an up arrow at one edge, a down arrow at the other. Number the boards in sequence to supplement your triangle on the face of the panel.

The glue joint is perfect for edge joining multiple boards because it's self aligning. Simply add glue and clamp the assembly together.



Sequencing boards for a glue-up is a common procedure. Some extra marking is helpful when you are joining them with a routed glue joint. On the ends, number them in sequence and mark up and down arrows at each edge. This tells you which face should be up for routing an edge. Usually, you rout an edge, then roll the board over before routing the second edge.

Cutting the Joint

Here's the setup sequence for the standard routed glue joint.

1. Eyeball a bit height setting. Do this by marking the stock center line on a setup sample and setting it beside the bit. Then raise and lower the bit to visually align its center-point as best you can with the mark. The center of the bit profile is indicated in the drawing.

2. Set up your router table fence for jointing. You can offset the outfeed half of a split-face fence by inserting a shim between it and the fence body. Or you can use the jointing fence shown on page 79.

3. Align the fence. The outfeed half of the fence must be tangent to the small-diameter cutting edge. Check it with a straightedge held against the outfeed side and across the cutting edge (see photo upper right).

4. Confirm the fence setting with a partial test cut. Cut several inches and switch off the router. Check if the routed edge is in contact with the fence. If you can slip a piece of paper or a feeler gauge between the stock and the fence, you need to move the fence forward that amount.

Get the fence positioned precisely before moving to the next phase of the setup.

5. Fine-tune the bit height. Cut a short piece of the working stock. Cut it in half and fit the parts together. If the faces are not flush, measure the offset with a dial caliper. You need to change the bit height by half the offset.

How do you know whether to raise or lower the bit?

Look at the cut as it comes off the bit. If the shoulder at the bottom is wider than the shoulder at the top, the bit must be lowered. If it is the opposite, wide shoulder at the top, narrow shoulder at the bottom, raise the bit.

6. Make a final test cut to confirm the setup, then rout the joinery.

Set the gluejoint bit height by eye initially. Mark the center of the work, and align the sweet spot on the gluejoint bit with your mark. While the height probably won't be perfect, it'll get the setup process started.

Check the fence setting next. Cut several inches of a stock sample and stop. If the fence position is correct, as it is here, both the cut and uncut edges will be in contact with the fence. If there's any gap between the cut edge and the fence (even a paper-thin one), the fence must be inched back to eliminate it. If the fence is too far back, the sample hits the edge of the outfeed fence facing.

After shimming the outfeed half of the fence, align that side tangent to the cutting edges of the bit's smallest diameter. to find the correct alignment, use a straightedge and turn the bit by hand (unplug the router first). You want the cutting edge to graze the rule without actually moving the rule.

Cut a test joint. If the faces are flush, your setup is dead-on. If there's a step, measure it with the depth bar of a machinist's calipers. The adjustment to make is half the measurement.

Off-Center Joint

Here's a great shortcut to take if you have only a small number of boards to work (three or four for a single panel). Instead of laboring over the setup, let the joint be off-center.

Here's how it works. You cut half the joint at whatever your initial bit-height setting is. Then you make an adjustment to produce a cut that complements the first, and cut the second half of each joint. You end up with an off-center joint.

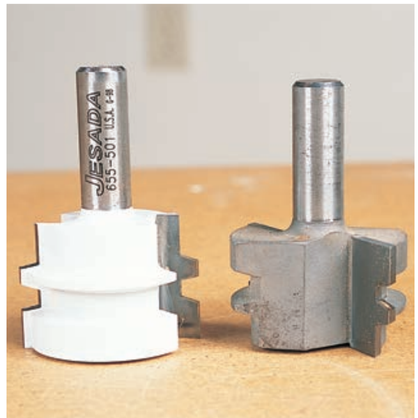
The off-center joint skips the final, infinitesimal bit height adjustment, which can be frustrating to dial in. If your initial height setting yields an offset of 1/16", leave it. Cut half of each joint at that setup (in other words, cut all the up arrow edges).

Having done that, raise (or lower) the bit the full offset amount. Make a test cut and see how it fits with one of the workpieces. If the faces are flush, machine the second half of each joint (i.e. all the down arrow edges).

The logic of the standard approach is that of fast production. You want to handle each board only once. Pick it up, mill one edge, roll it over and mill the second, then set it aside. So you take extra time tuning the bit height. Then you simply go.

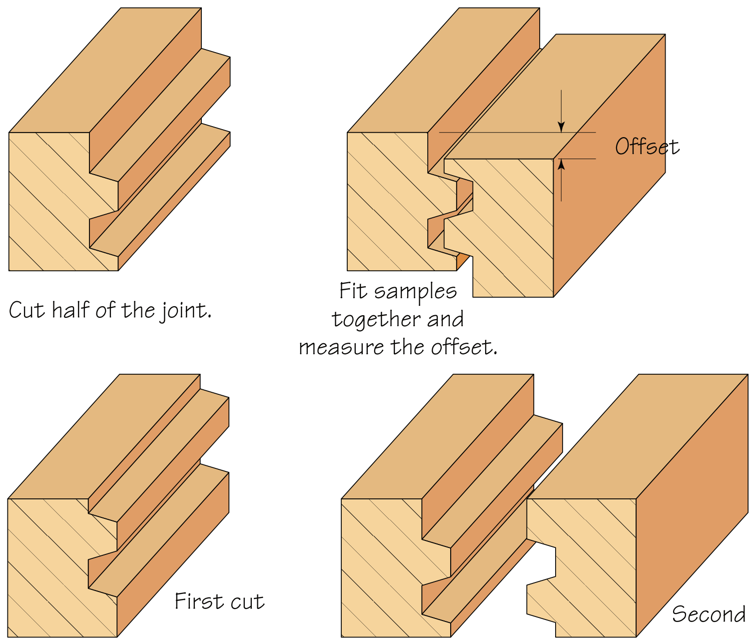
The logic of the second approach is aimed at simplifying (somewhat) the setup. The adjustment you make between the first half of the joint and the second is more coarse and, presumably, easier to hit without trial-and-error micro-adjusting. But it can also be seen as doubling the work-handling, since each board must be picked up, milled, then set aside two times.

Either approach is legitimate and either yields a strong joint. Take the one that works for you.



The gluejoint bit is available in two configurations. Most common is the form having the small diameter at the shank and the large diameter at the tip. It cuts edge to edge joints only. The other form has the large diameter at the shank, the small at the tip. With this bit, you can rout both edge-to-edge and edge-to-face joints.

Off-center joint



An off-center joint (above) works as well as a centered joint. It's easier to set up, too. After cutting one edge, you flip the piece over and use it as shown (left) to adjust the bit up or down for the mating cut. The trade-off is that you must handle each board twice, once when routing the first edge, then again after adjusting the bit for the second cut.

Lock Miter

The routed lock miter is a joint that simultaneously intrigues and frustrates many woodworkers. It combines the clean appearance of the miter joint with a mechanical interlock that makes assembly easy and increases the joint's strength.

It's a halving joint, meaning that one setup of a single bit cuts both halves of the joint. Lay one panel flat on the tabletop and slide it along the fence to rout it. Stand the mating panel on edge, face against the fence, to make the cut.

The straightforward nature of the cuts, coupled with the joint's strength, ease of assembly and finished appearance all contribute to the intrigue. It's the setup that drives many woodworkers over the edge.

The lock miter bit is available in several sizes. The most common is very big—as much as 3" in diameter. It needs to be run at reduced rpms in a high powered router.

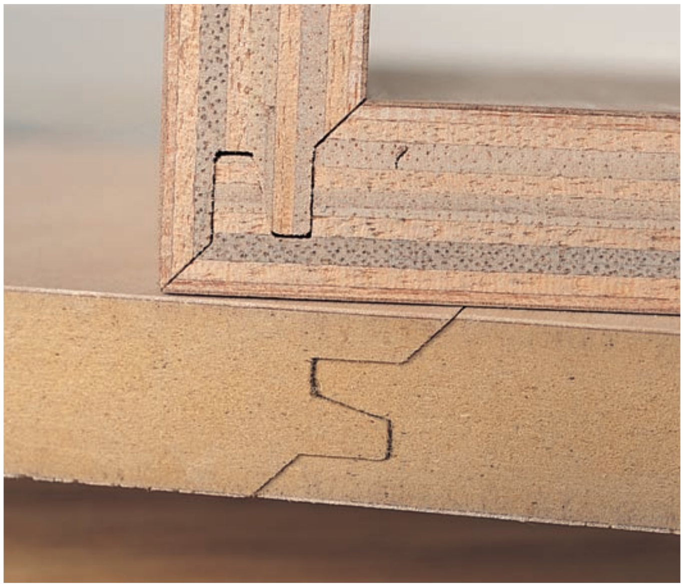
As they say, it's easy to set up if you know how. So here's how. There are three steps:

1. Make gross settings of both the bit height and the fence position.
2. Tweak the bit height by making and evaluating test cuts.
3. Dial in the fence position, again by making and evaluating test cuts.

Mark these words: Do the bit height, get it right. Only then do you adjust the fence.

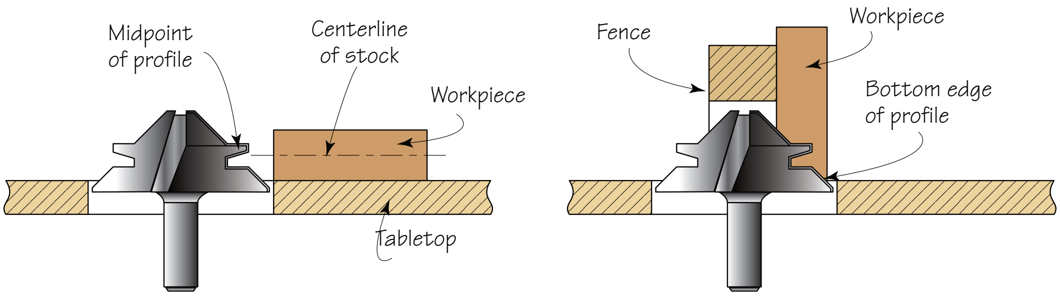
The joint is sensitive to stock thickness. A setup that's spot-on for nominal 3/4" plywood probably won't be right for wood that's really 3/4".

Before you set up, prepare your stock, including extra material for test cuts. It's far better, at least the first couple of times you use the bit, to set aside more scrap than you think you can possibly need. Once you've set up successfully, and really understand how you got the setting (don't discount beginner's luck!), then you can get by with fewer setup samples.

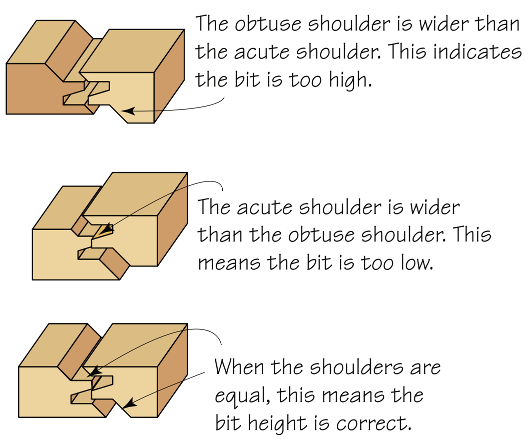


The lock miter is both unobtrusive and strong. The face view is clean, but the edge reveals its mechanical interlock. The bonus is that the joint can be either right-angle—the most common form—or flat.

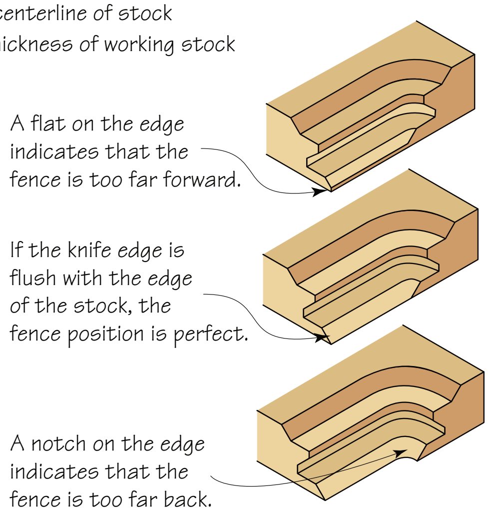
Setting Up Lock Miter Bit



1. Set bit height, aligning midpoint of profile with centerline of stock
2. Set the fence back from bottom of profile by thickness of working stock



Tuning bit height



Tuning fence position

Step 1: Setting the Bit and Fence

The key in setting the bit height is lining up the midpoint of the bit with the center of the stock. The midpoint of the bit is on the very slightly angled edge of the interlock (it's labeled in the drawing on page 101).

Mark the centerline on a scrap piece of the working stock, set it right beside the bit and line them up by eye.

Move the fence into position. Stand a piece of the working stock behind the bit and sight along the fence to the bit. Your objective is to align the stock with the profile's bottom edge (see the drawing). It's better at this stage to have the fence too far forward rather than too far back.

Step 2: Tweaking the Bit Height

Make a test cut with the sample flat on the table. Cut it in half, turn one of the pieces over and join the two. Most likely, the faces will be offset and an adjustment will be needed.

Don't get distracted by the profile as you assess the sample cut. You may not have the full bevel, but that's a function of the fence position. It doesn't affect the vertical adjustment, so ignore it for now.

Measure the offset using the depth bar of a dial caliper. Raise or lower the bit half the measurement. How do you know whether to raise the bit or lower it? Read the sample joint, as shown in the drawing. Note that when the bit is properly centered the shoulders above and below the cog will be equal.

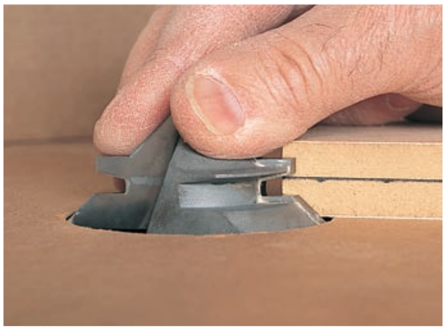
Once the bit setting is established, focus on the fence.

Step 3: Tweaking the Fence Position

The bit's cutting edge is angled at 45°, so its exposure, measured vertically and horizontally must match the thickness of the working stock. The bit is set and the fence position now is the only variable.

Cut a scrap of the working stock, feeding only a few inches into the cut. Examine your cut and compare it to the drawing. If the fence is set too far back, a cut will remove too much stock and alter the length or width of the workpiece. If it is too far forward, you won't get the full miter.

Adjust the fence and make another test cut. When you have the fence set, proceed to the real workpieces.



Set the initial height of the bit with a stock sample on which a centerline's been marked. Align the sweet spot on the bit with the centerline by eye. You may be slightly off, but it's a good starting point.

Eyeball the initial fence setting. Stand a piece of the working stock against the fence and sight across the bit to it. Align the bottom edge of the stock with the lower end of the bit's cutting edge.

Use a test cut to adjust the bit height precisely. Halve the sample and fit the resulting two pieces together. The top sample tells you to raise the bit, while the middle sample says lower it. Measure the offset with a dial caliper's depth bar and adjust the bit by half that. The bottom sample is on the money.

A second round of test cuts tells you how to adjust the fence position. Make this round of cuts only after the bit height is established. With its square edge, the bottom sample indicates the fence must be moved back. The middle sample is being narrowed by the cut, indicating the fence must be moved forward. The top sample is on the money.

Cutting the Joints

Before you cut the good material, make sure the bit opening in the fence is as close to zero-clearance as you can make it. This is especially helpful if you are working plywood or veneered MDF. Several approaches are detailed on page 35.

Cutting the joint is relatively easy once the router table is set up. The typical right-angle joint is produced by routing one part flat on the tabletop, and the mating piece standing on edge against the fence.

The cuts are heavy since each addresses the full width of the stock. Two measures can be taken to reduce your router's workload.

You can chamfer the edges to be routed to reduce the waste. Just don't saw a full bevel because you won't get the full profile when you rout. The bit will groove a beveled edge but can't produce the mating cog because the necessary stock's been sawed away.

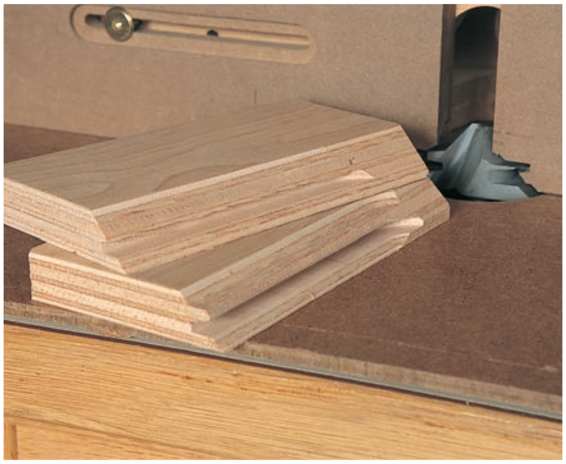
A better alternative is to stage the cuts. The lock miter is not a profile that must be cut in a single pass. You can work progressively to the final cut depth. Here's how:

You've got the final fence position. Capture it with a pair of stops clamped to the tabletop behind the fence. Tuck them against the fence's back edge and clamp them securely. Then pull the fence forward, off the blocks. Make a cut on each workpiece. Push the fence back against the stops, and make a second and final pass on each workpiece.

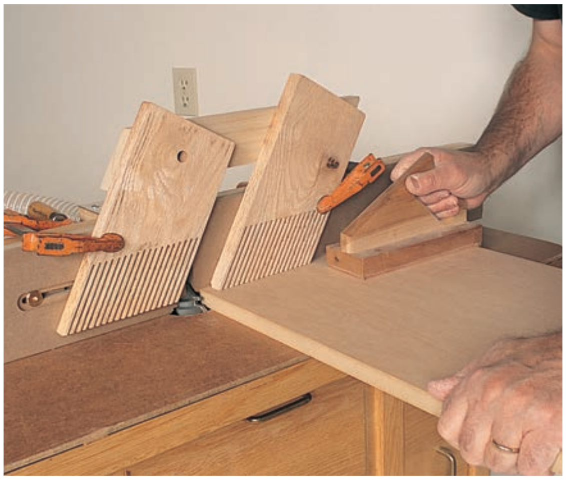
A decision to make concurrently is whether or not to use featherboards when working with relatively small parts. Cabinet parts will prompt me to get them out.

Bear in mind that featherboards aren't a reliable means of compensating for slightly unflat workpieces. If you apply enough pressure with a featherboard to straighten a slight bow in the stock, you are probably applying enough pressure to make feeding the stock very difficult.

Make sure the bit opening in the fence is as close to zero clearance as you can make it, especially at the infeed side of the bit. This will minimize chipping and tear-out by supporting the wood where the cutting edge exits it.



You're often advised to saw a bevel on the edge of your work to reduce the cutting load on your router and bit. Be wary. The lock miter bit will groove a beveled piece but won't produce the mating cog (top sample). That's no good! If the piece is only chamfered, on the other hand, you'll get both the groove and the cog (bottom sample).



Half of each lock miter joint is cut with the work flat on the router table top. A pusher holds the work down while it advances it across the bit.

Stand the work on end flat against the fence to rout the other half of the joint. A tandem featherboard, applying pressure on either side of the bit, keeps the panel against the fence, obviating the need for a tall fence facing.

Finger Joint

The finger joint is a positive-negative interlock, in which tapered projections (the fingers) on one piece fit into tapered grooves in the other. It's used to assemble pieces end-to-end, and it's an alternative to the routed glue joint for edge to edge applications.

The profile expands the glue area threefold. More important, when cut across the grain, the joint creates long-grain surfaces that glue far better than end-grain surfaces.

The joint is created with a special bit. Adjust the height of the bit to center the profile on the stock edge. Rout one workpiece with the show face up and the other piece with it down. When the bit height is correct, the two pieces slide together with their faces perfectly flush.

Two styles of finger joint bits are available. One is a solid bit, the other an assembly.

The Solid Bit

The solid bit has two cutting edges, each with four tapered fingers. Because the edges are offset, the bit cuts eight slots in one pass.

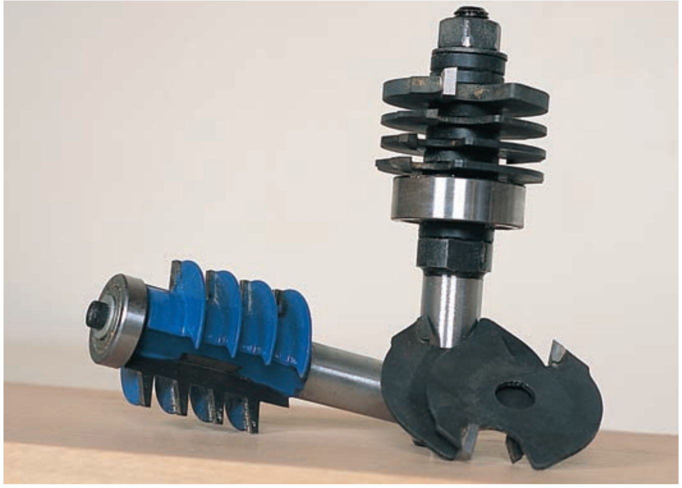
Some bits have a pilot bearing on the top that's a big help in positioning the fence—just set it tangent to the bearing. Bits without a bearing should be used with a jointing fence. See "Jointing Edges" for details.

Here's a good approach to dialing in the bit height. Jack up the bit so the bottom cutting finger is $1/16$" above the table. Make a cut on a scrap of the working stock. Compare your cut with the initial cuts in the drawing. You want a cut that, as it comes off the bit, has a finger on the bottom and a shoulder at the top.

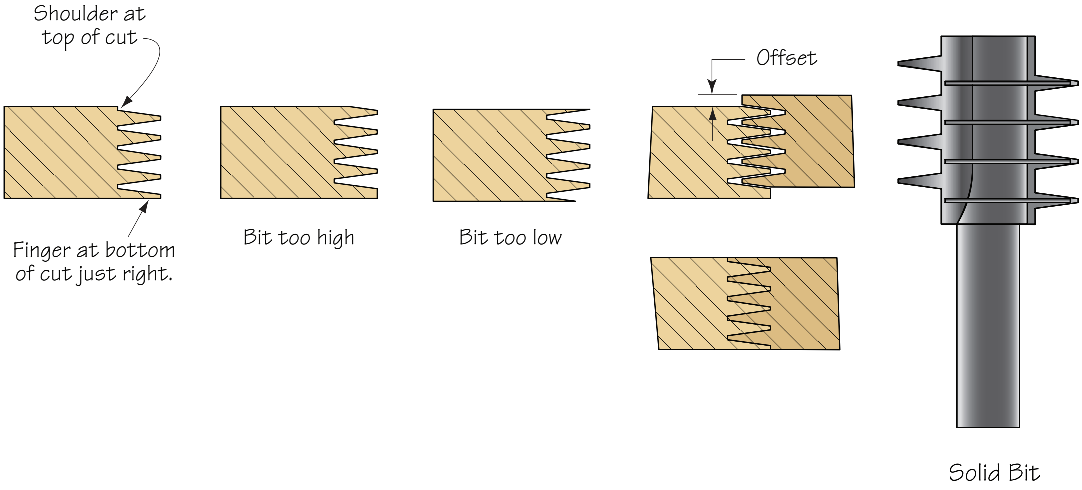
If necessary, adjust the bit height and cut a new sample. If it looks right, cut it in half, turn one piece over and assemble the two pieces. You want the faces flush. If there's offset, measure it with the depth bar of a dial caliper and change the bit height one-half the offset.

If the shoulder is high, raise the bit. If the shoulder is low, lower the bit.

The finger joint is most familiar in end-to-end joinery but it is a strong joint for edge-to-edge applications as well, ensuring mating boards align perfectly flush and expanding the glue surface. The joint cut by an adjustable assembly has fewer fingers but fairly broad shoulders, while the solid bit's joint is all fingers and slots.



Choose either of two router bits for cutting finger joints. The solid bit (left) is less costly. Because it is one piece, you won't frustrate yourself trying to micro-adjust the spacing of the fingers. The adjustable assembly, on the other hand, must be configured according to the thickness of the stock being worked. For $3/4$" stock, you remove three of the finger cutters and spacers.



The Assembly

The assembly used to cut the joint includes five individual finger cutters, an abutting-edge cutter, a pilot bearing, along with a 1/2" shank arbor, shims, spacers and washers.

Assemble the bit components based on the thickness of stock being worked. Do this with the arbor chucked in the router. Remove the spindle nut and stack the required components on the spindle, beginning with the bearing. It is always at the bottom, next to the shank. The abutting-edge cutter is on the top and is always used.

The latter cutter is actually about two thousandths smaller in diameter than the finger cutters. The grooves between fingers are deeper than the shoulder. This provides space for surplus glue at the tip of each finger.

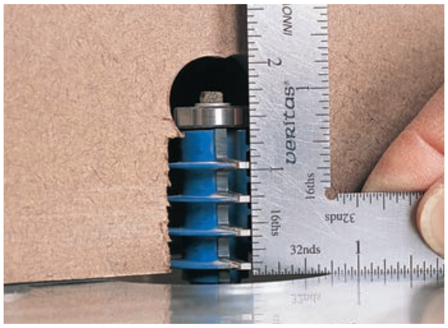
The cut forms a shoulder at the top of the profile that's offset from the one at the bottom. When the profile is centered on the edge, these shoulders are equal in width. When assembled, the faces of the adjoining boards will be flush.

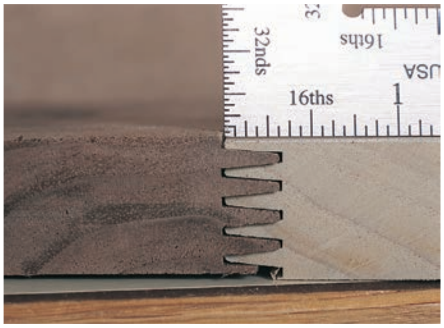
Adjust the initial height using a rule, setting the lowest finger cutter 3/16" above the table. Position the fence tangent to the bearing, and make a test cut. Cut the piece in half, flip one half over and assemble the joint. If the pieces are offset, measure it and raise or lower the bit (see the drawing) half the offset. When you have a test cut you like, proceed to the real workpieces.

Cutting the Joinery

Cutting the actual joinery is much the same, whether for an edge-to-edge or end-to-end glue-up. When you rout across the grain, you need to back up the work with an expendable scrap.

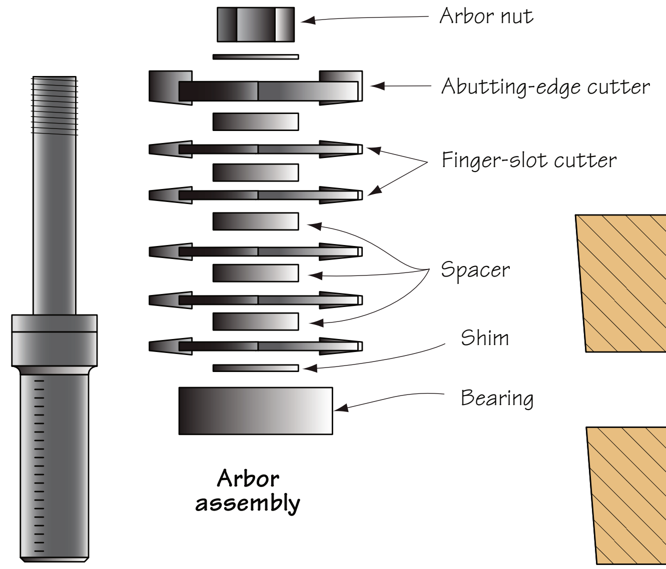
Mark a reference face on each board. Rout one piece with the reference face up, and the mate with the marked face down. If you are routing both ends or both edges of a board, it's the convention to do one end/edge with the marked face up, the second end/edge face down. Typically, you rout one end/edge, then roll or flip the board and do the second.

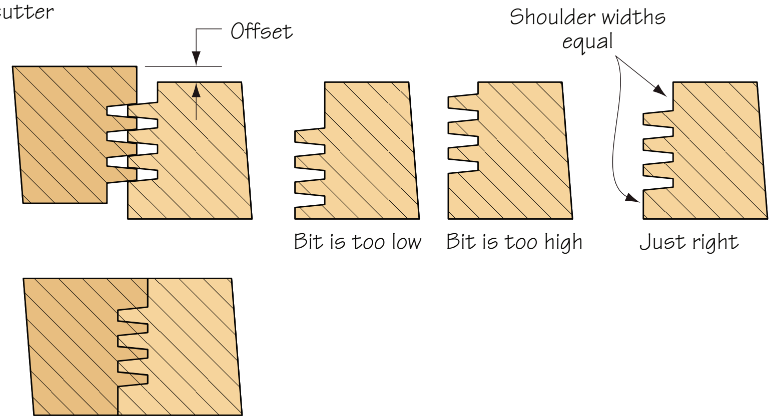




The solid finger-joint bit is tricky to adjust the first time you use it. Try this: elevate the cutting edges above the table, then lower the bit until the bottom-most finger cutter is just 1/16" above the table. The initial test cut (right) will have a finger on the bottom.

The finger joint is often used to assemble pieces end to end. Use a backup block as a pusher. It keeps the narrow workpiece from walking along the fence and it prevents splintering on the backside when the cutter breaks out of the cut.





Drawer Lock

A couple of hundred years ago, drawers were assembled with dovetails. But it's the 21st century now. We don't have time to cut dovetails. We need something that can be cut fast and assembled quickly.

The drawer lock joint is just the ticket. It has an interlock that holds the front and sides together (and/or the back and sides) and it resists the main stresses administered to a drawer. The finished drawer won't have the pizzazz of one assembled with dovetails, but it goes together a whole lot faster.

What makes the drawer lock so efficient is that you use a single bit to cut all the joinery for a drawer, including the groove for the bottom. You dial in the height setting and forget it. Only the fence needs to be shifted between two positions in the course of the work.

The bit is small; high power and speed control aren't required.

Setting Up

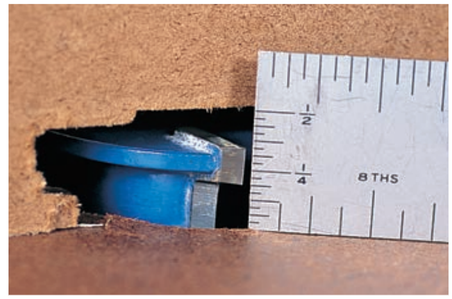
As a starting point, elevate the bit about 3/8" to 7/16" above the tabletop. Slide the fence into position and adjust it so it is tangent to the small cutting diameter. Just the tab should protrude from the fence.

Make cuts in the edges of two pieces of the working stock, turn them over and fit them together. While the pieces won't be flush, the interlock should be nice and tight. If it is, you've got the setup just right.

If the fit is loose, raise the bit to tighten it. If the fit is too tight, lower the bit to loosen it.

Once you have the setting, you are ready to make drawers. This setup is used to cut the sides and rout the parts for the bottom. To cut the fronts and backs, more of the bit must be exposed. Assuming you want flush-fitting drawer boxes, use a piece of the side stock as a gauge. Hold it against the fence and move the fence until the protruding tab is flush with the exposed face of the stock sample.

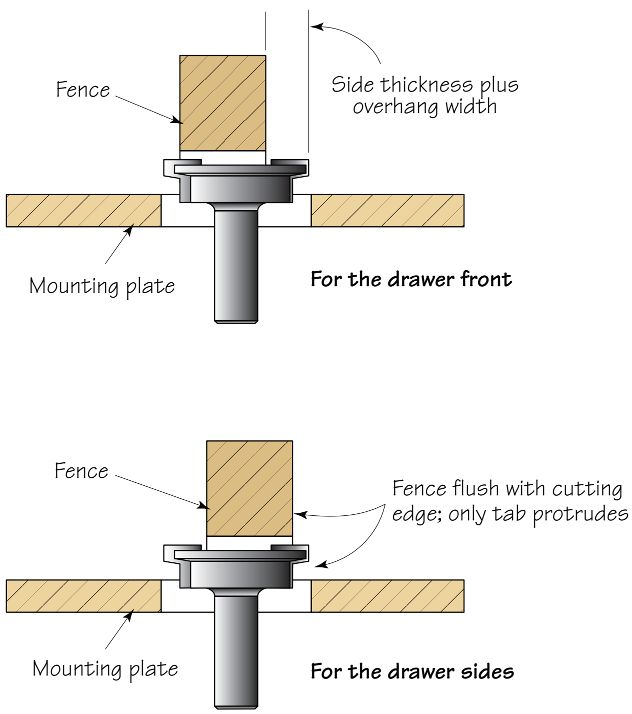
You don't need to limit your use of the drawer lock to utilitarian constructions. The joint works for lipped as well as flush drawers.



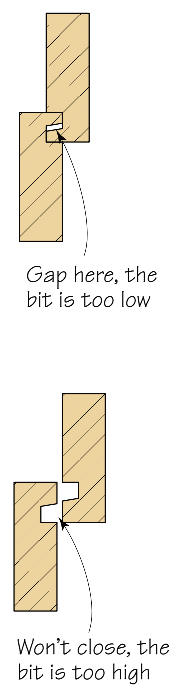
Use a rule to set the initial height of the drawer lock bit. The setting shown is a good starting point.

To rout the sides, set the fence tangent to the small diameter of the bit, leaving just the tab protruding. Check the setting with a rule.

Setting the fence



Tuning the bit height



Cutting the Joinery

Before routing, crosscut the parts the final lengths but leave them over-wide. Stock thickness has an impact on length. If you are using 1/2" stock, for example, the sides generally will be about 1/8" shorter than the desired drawer length (front to back). Make sample joints from scraps of the working stock to determine how much to adjust the lengths of the sides.

Leaving the parts a little wide is a practical work-around to the blowout that's common to cross-grain cuts. After cutting the lock joints, rip the parts to the final widths. You may opt to rout wide blanks and rip two or three parts from each.

Here's a workable joinery-cutting routine:

First, rout the sides. Stand a side on end, inside face against the fence and slide it across the bit. Cut one end, then the other. I've never found a tall fence to be necessary, even with long sides, nor do I bother with featherboards. Do use them if you prefer.

Next, rout the fronts and back. Adjust the fence position first. The work rests flat on the tabletop, its end butted against the fence. A square scrap used as a pusher helps keep the work moving evenly—and squarely—along the fence.

Stock thicknesses do not impact the fit of the joints. You can mix 3/4"-thick fronts with 1/2"-thick backs, routing all with the same setup. But cutting a front that overhangs the sides requires the fence to be set further back—add the overhang dimension to the side thickness when setting the fence.

Now, rip the parts to their final widths.

Next, rout the groove for the bottom. Return the fence to the side-cutting position. Cut from end to end. Because of the way the joints go together, the groove won't be visible.

Finally, mill the bottom to fit the groove. Keep the bit and fence setting as they are. Lay the 1/4" bottom material face down on the tabletop. The bit's protruding tab mills a chamfer along the edge as you feed the bottom along the fence. Cut all four edges.

Stand a side on end against the fence and feed it across the bit. The zero-clearance fence surface minimizes chip-out and prevents catches in the work's movement through the cut. Back up the work with a square scrap.

Use a scrap of the side stock to reposition the fence for the joinery cuts in the fronts and backs. The tip of the cutting edge must be flush with the scrap's surface. This ensures the nose of the end piece will overlap the end grain of the side piece when the joint is assembled.

Lay a drawer end—either the front or the back—flat on the tabletop, its end butted against the fence. Feed it across the bit. Use a back-up block to keep the workpiece square to the fence throughout the cut and to minimize tear-out.

Use the drawer-lock bit to cut the bottom groove and chamfer the edges of the bottom panel. You'll get a tight, rattle-free fit.

Tongue and Groove

The tongue and groove is a traditional edge-to-edge joint. The edge of one board has a groove. A matching tongue is formed on the edge of the mating board. The tongue goes into the groove, and the boards are joined. It's an edge joint with a mechanical interlock.

The joint is used in building construction wherever boards or panels need to be butted edge-to-edge quickly and have their surfaces come flush. In furniture-making, the tongue and groove is excellent for edge to edge glue-ups.

Cutting the Joint

The general rule for scaling a tongue and groove calls for a square tongue that's roughly one-third of the stock thickness and centered on the edge. Working with 3⁄4" stock, that plays out to a 1⁄4"-thick by 1⁄4"-long tongue and a matching groove. A longer tongue—one that's 1⁄2" long—is prone to break at the shoulder. Likewise, the walls of a deep groove may crack.

But a tongue and groove for a panel glue-up—to register and align the faces—requires only a 1⁄8" tongue.

The joint should be a firm press fit: if you have to knock the pieces together, then struggle to pull them apart, the joint's too tight. On the other hand, you don't want the tongue to rattle in the groove. This is especially true where the joint is intended to register and align the faces during assembly.

There's no hard rule on which element of the joint you cut first. I prefer to make the groove first; it's easier to fit the tongue to it than the other way around. If you opt for the opposite, fine.

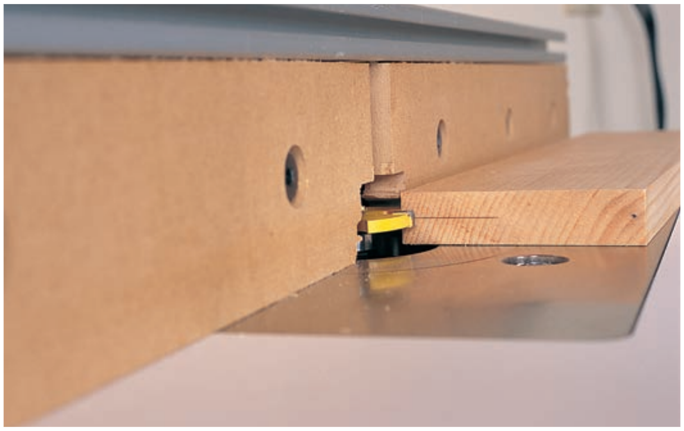
Tongue-and-groove stock (center) available at most building centers doesn't fit nearly as well as the sort you cut yourself. For a glue-free application (top), scale the joint so the boards can shrink without having the tongue completely withdraw from the groove. For a glue-up (bottom), where the tongue and groove serves primarily to align the faces, keep the tongue short.

Set the router table fence for grooving with a straight bit. With one end of the fence secured, swing the free end to align the centerline on a sample workpiece with the bit's center. Note that both the fence and the tabletop have auxiliary coverings to downsize or eliminate the bit openings, thus forestalling workpiece hangups.

You can cut tongue-and-groove joints with either a straight bit or a slot cutter. It's best to limit the straight to joints with a tongue and groove 1⁄4" or wider. The slotter cuts less than 1⁄4"-wide grooves easily, but you can combine two cutters on the arbor for wider grooves.

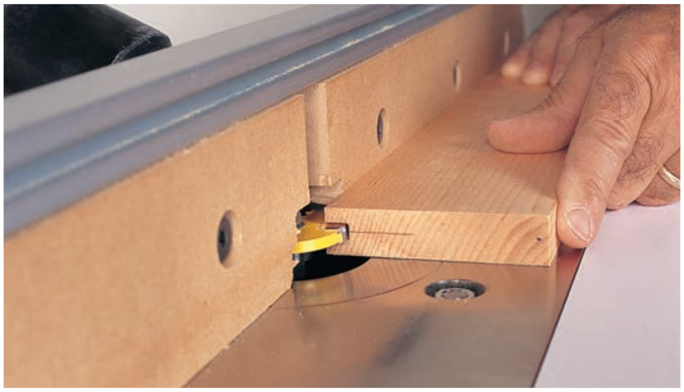
When you're using a straight bit, repositioning the fence for cutting tongues can be an optical challenge. Sight across the bit to the grooved sample to make an initial setting. Cut a sample tongue, check how it fits the groove, and adjust the fence position if necessary.

Two passes form the tongue. Note that the cut is on the fence side of the work.



In a tongue-and-groove joint, fit is more important than precise dimension. Eyeball the slot cutter elevation against a centerline marked on a work sample. When it looks centered, that as close as it needs to be.

Use the fence rather than the slotter's pilot bearing to govern the depth of the groove. Typically, you can establish this by the eyeball method—rather than precise measurement—since the same fence position is used for both grooving and tongue-forming cuts.



With a slot cutter, the work rests flat on the tabletop throughout the cut. Center the cut accurately in the usual way: make passes referencing both faces. The second pass will probably widen the groove slightly, but it will center the groove.

Always make the tongue-forming cuts with the cutter lowered to the table, rather than trapping the work between it and the table. As with the other tool setups, you use a grooved sample for the initial setting. (This table has a router lift that features a topside adjuster.)

Using a Straight Bit

The straight bit is commonplace and versatile. Surely you already have a suitable size for this job.

Unless you are cutting an unusually deep groove or working exceptionally hard stock, you should be able to plow the groove in a single pass.

The cut controls are these: the bit's extension above the tabletop governs the tongue length/groove depth. Fence position controls lateral placement of the cut. You cut both elements with the work on edge, face tight against the fence.

Here's the setup sequence and cutting routine:

- Install the bit and set its extension for the desired groove depth.
- Position the fence for the grooving cut using stock marked with a centerline.
- Rout the grooves, centering them most easily by making two passes.
- Reposition the fence for the tongue cuts.
- Rout the tongue by making two passes on each workpiece.

Using a Slot Cutter

A slot cutter will cut a full-depth groove easily. It's a good choice for thin stock, since a variety of cutters under 1/4" wide are available. But making a groove wider than 1/4" requires an assembly with two or more cutters on its arbor.

When cutting with a slotter, the tongue length and groove depth is controlled by the pilot bearing or the fence, while the position of the cuts on the edge of the work is controlled by the bit extension adjustment. All the cuts are made with the work flat on the tabletop.

Here's the setup sequence and cutting routine:

- Install the slot cutter and set its elevation against stock marked with a centerline.
- Position the fence for the desired groove depth.
- Rout the grooves, centering them most easily by making two passes.
- Reposition the cutter for the tongue cuts.
- Rout the tongue by making two passes on each workpiece.

Spline and Dovetail Keys

Miters (whether case or flat) can be reinforced and decorated with keys. They are often called mock dovetails and mock box joints and when completed, they do look a little like dovetails or box joints. I doubt, though, that a woodworker will mistake them for the real thing.

Here's how it works:

- You assemble the joints, whether a frame, a small box, or a big case.
- Set the piece in a carrier on the router table and run it across the bit, cutting a slot for a key.
- Shift the piece left or right in the carrier as necessary to cut multiple slots.
- Cut splines or dovetail pins and glue them into the slots.
- Trim the keys flush.

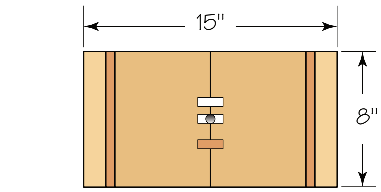
Before you begin, you need a carrier for the work. There's one basic style for case miters and a slightly different one for frames (see page 113).

The casework carrier is just a big V-block that stands the work on its corner so you can cut through it. A key in the jig helps you position the slots consistently. For the first cut, the work is butted against the key. But for the second and subsequent cuts, the previous cut is indexed over the key.

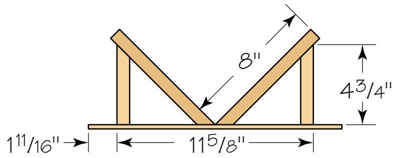
The drawing shows a basic carrier for boxes and small chests. You can make it out of modest-size scraps of plywood or MDF. It's designed to be set onto a bit, then trapped between 1/4" thick fences clamped to the tabletop. These keep it centered on the bit, but allow the work to overhang either side of the carrier without interference.

The cutting slot is cut with the only bit you'll always use with the jig. Set the router table fence to center the slot. Plunge the carrier onto the spinning bit. Slide the jig forward, cutting a slot through both supports. Lift the back end of the jig up off the bit and switch off the router.

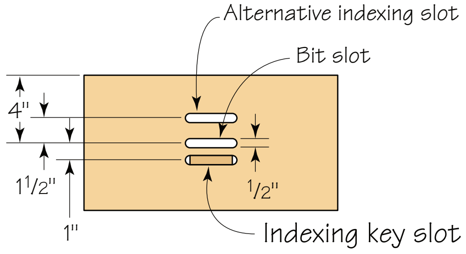
Keys, whether square, rectangular, or dovetail-shaped, add a visual embellishment to mitered assemblies like boxes and frames. Beyond that, the keys reinforce the joints.



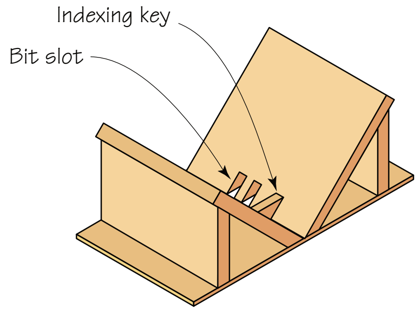
Plan view



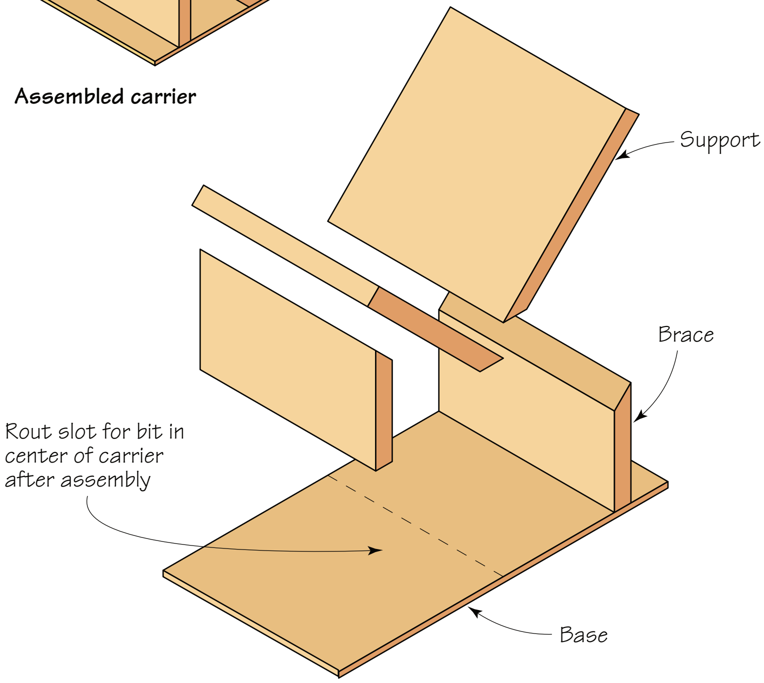
Side view



Bottom view



Assembled carrier



Small casework carrier

Slotting on the Table

Decide what spacing you want between the slots. Cut a key slot to one side (or the other) of the cutting slot. Then make a key from a hardwood and plane it to a tight press-fit in the key slot. If you want to produce a second spacing, you can add another key slot on the opposite side of the bit.

Resist the temptation to use different bits with a jig. The supports back up your slotting cuts, preventing splintering in the work as the bit breaks through. If you use a small-diameter bit with a jig already slotted by a big cutter, you will have splintering problems.

Now you are ready to put the jig to work. Setup begins with the correct bit. Chuck it in the router and set the carrier over it. Adjust the bit height and be sure the carrier is centered on the bit. Then set a fence against the carrier base and clamp it. The jig should slide back and forth along the fence without catching on the bit as it passes through the slots in the supports. Clamp the second fence to the table.

To cut the slots, you rest the assembled box in the jig, with one edge butted against the key. With the router switched on, push and pull the jig, cutting the first slot. Step the work to the left, dropping the cut over the key. Make another cut, step the work left so the new cut is over the key, and make a third cut.

You just repeat this process over and over until the job is done.

In the ideal situation, one of your pre-established spacings will suit the work at hand. But you may need to make the first cut without the key in place, so you can alter to space from the work's edge to the first key. If this is the case, you can use carpet tape to stick a temporary stop in the jig for the first cut. I'd suggest making that first cut on all four corners of the box before pulling out the temporary stop and reinserting the key to finish out the job.

The carrier for routing slots for keys is just a large V-block. It holds an assembled box so cuts can be made through its corners. Thin trap fences position the jig on the router table but allow a box to overhang the jig without interference. The strip of wood visible beside the bit (right) is the secret behind cutting uniformly spaced slots. A newly cut slot in the work fits over that key, positioning the work for the next slot.

Routing key slots is simple but repetitive. Pull the carrier clear of the bit and set the assembled box into it. One edge must be tight against the key (right). Push the jig across the bit, cutting the first slot. Step the newly cut slot onto the key and make the next cut. Repeat until all the slots are cut in one corner. Then rotate the box a quarter-turn and start over.

Fitting the Keys

Once the slots are cut, the keys must be made.

Cutting splines (keys for slots cut with a straight bit) is a table saw task. Rip strips of stock to the appropriate thickness, and if necessary, plane them to fit. Crosscut the strips into bits and glue a bit into each slot. The project will look ratty until the glue dries and you can trim the keys.

Cutting dovetail keys is a router-table chore. Use the same bit that cut the slots. First, cut a sample slot in a short piece of scrap.

Then cut a tail along the edge of a board. House most of the bit in the fence, and feed the stock along the fence, scoring the side. Turn the board around and score the other side. Viewed from the end, the result is a tail.

In a trial-and-error process, start with an oversized tail and methodically trim it down. Move the fence back to expose a little more of the bit and recut both sides of the board. Fit the tail to the slot in the scrap. Adjust the fence again, if necessary, and recut.

When you've got a good fit, rip the tail from the board. Then cut another tail and rip it from the board. Repeat the process until you have enough key stock. Next, cut the stock into short keys, and glue a key into each slot.

When the glue dries, the keys must be trimmed flush. The usual technique is to saw off the keys as close to the surface of the workpiece as possible without scuffing it. Then trim the remaining stubs flush with a chisel. Work from the corner in, so you don't tear out splinters of the keys, or sand the stubs flush using a belt sander. A file or coarse sandpaper wrapped around a block of wood also works well.

Slotting a Flat Frame

A spline or dovetail key is a great way to strengthen and embellish the miter joint commonly used for light frames—picture frames and face frames. To key a frame's corners, slot them one by one using a simple carrier on the router table. A key is glued in each cut and then trimmed flush.

The carrier can be oriented upright against the fence to cut with straight or dovetail bits or flat on the tabletop with a slot cutter.

For dovetail keys, you can use any size or angle of dovetail bit. The 7° and 8° bits do give you slightly more cut depth than the 14° variety.

For a spline key, slot cutters are faster because you can cut full depth in one pass, whereas with a straight bit, you may have to stage a cut. They also give you a more usable selection of widths. Cutters as thin as 1⁄16" are available. A narrow kerf allows you to double the splines, even in standard 3⁄4" stock. Once you get below 1⁄4", straight bits tend to be frail.

With a slot cutter, the standard cutting depth is 1⁄2". If you can remove the pilot bearing, you can increase the cut depth slightly. With a straight bit, on

Dovetail keys are cut on the router table, usually using stock that contrasts with the box. Cut the key strips parallel to the grain of the stock.

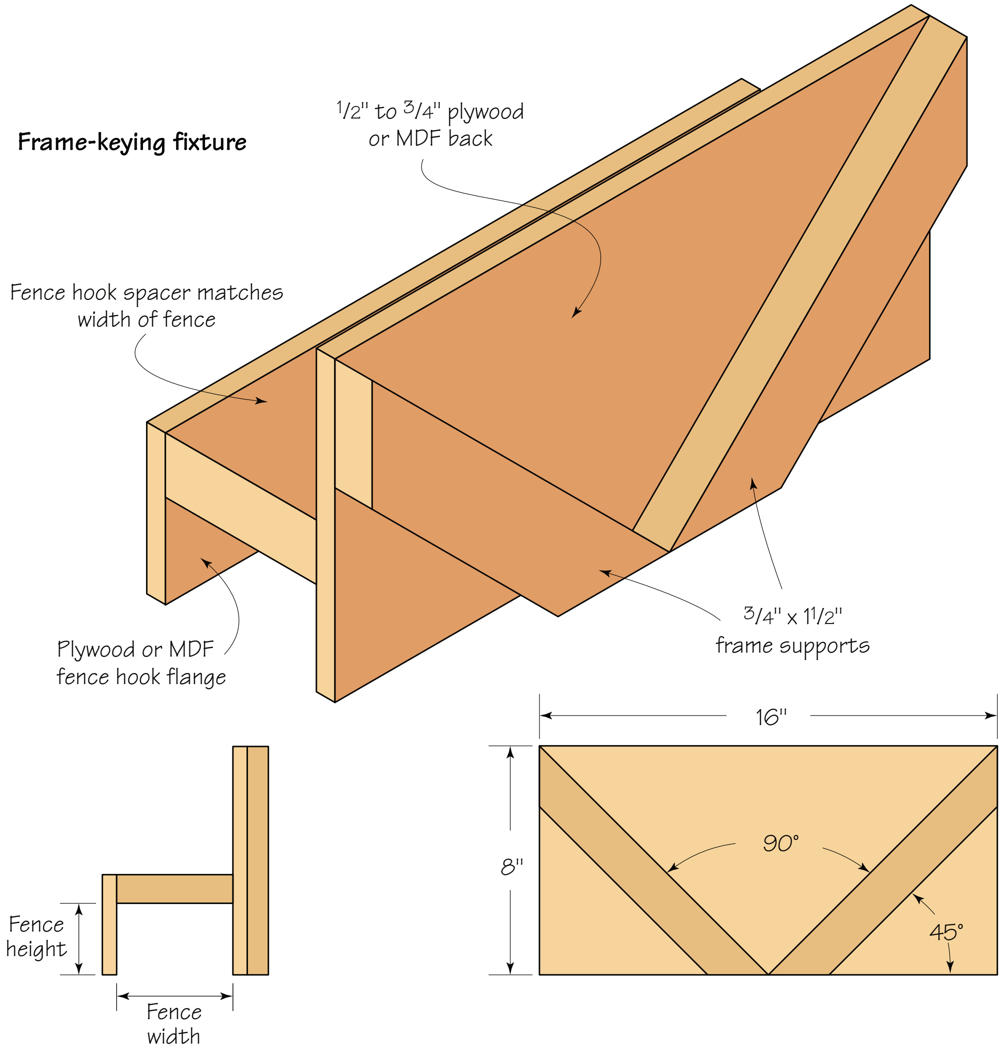
Cut your key strips into short keys, then glue a key into each slot. Clamping isn't necessary.

the other hand, you can get greater depth so long as you are willing to stage the cut.

The drawing shows the carrier's construction. Miter the ends of the two frame supports, then glue and screw them to a plywood or MDF back. The supports must be at right angles to each other. In this simple form, it can be used flat on the router table. If you use the jig upright, braced against the fence, add the fence hook to it.

However you orient the jig, the frame is set into it, and perhaps clamped with a spring clamp or two. Adjust the cutter height and the fence position. Hold the jig and frame against the fence and make the cut.

To center a cut, make two passes, flipping the frame over between them. You can use the same technique to cut a pair of slots. Cut one slot in a joint, turn the frame over, then cut the second slot.



Rout a slot for a dovetail key with the frame-splining carrier upright against the fence. To keep the frame from tipping away from the fence, attach a catch fence to the jig. To prevent splintering of the frame, limit your use of a carrier to a particular bit and height fitting (use the carrier to set up the bit and fence). Use the frame-splining carrier flat on the tabletop to rout slots for spline keys. A slot cutter makes the cut. Locate the slot using the router's height adjustment and control the cut's depth with the fence.

Cut the protruding tip of each key as close to the frame surface as you can. I do this at the band saw. Then sand or hand-plane them perfectly flush.

CHAPTER

5 Using Templates

In woodworking, a template is a pattern that guides a cutting tool. That tool usually is a router, either hand-held or table-mounted. And the template is one of the router's most powerful accessories.

Too often woodworkers dismiss template work as a process for high-volume production. But don't dismiss the value of that when you need to make more than one of any shaped part: two sides for a bookcase, four matching legs for a table or chest for example.

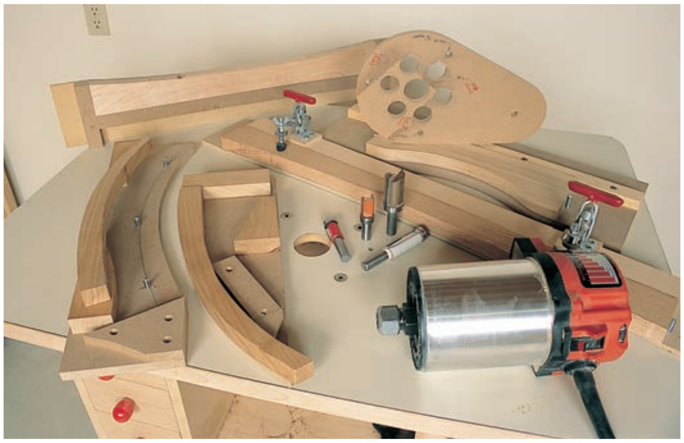
Don't dismiss the value of a template in making just one shaped part either. Are you working with an expensive wood? Do you have *the* perfect board for the part? Are you going to band-saw a curve, then sand to smooth the cut edge and make the curve fair?

It might be faster to cut the curve in an inexpensive, easily worked material like MDF or hardboard. Then use that edge to guide a router as it cuts the contour in your expensive hardwood. If you botch the initial cut, or you just can't quite get the curve right, you've wasted some time, but you haven't wasted that one perfect board.

With a hand-held router, you can use templates for a wide variety of operations, including joinery cuts like dovetails and mortises. On the router table, templates are used almost exclusively to shape the contours of parts.

The advantage of the router table approach is that you avoid the sometimes troublesome need to clamp and reclamp the work so you can access all edges with the router bit. On the router table, you guide the workpiece/template around the stationary, but spinning, bit.

In this chapter, we'll look at the bits necessary for the work. We'll investigate the potential pitfalls, offer some tricks for avoiding them and we'll look at the characteristics and construction of simple, functional templates.



Templates play a key role in creating all sorts of parts for woodworking projects. The template-guided cut is often easier to make on the router table than with the router hand-held.

With a well-designed and fixtured template, routing a stack of identical parts is fast. To ensure chip-free cuts, this template has only half the overall contour for symmetrical trestle-foot plies. You rout one edge, then flip the workpiece to rout the other half. Fences locate the work on the template and toggle clamps secure it for the cut.

Bits for Template Work

On the router table, template work is done either with a flush-trimming bit or a pattern bit. You can find many variations on these two bits.

A flush-trimmer is a straight bit with a pilot bearing on the tip. The bearing diameter matches the bit's cutting diameter. (If it didn't, the bit wouldn't be a flush-trimmer!) Nearly every general-purpose bit set includes a 1/2"-diameter flush trimmer, and this is certainly the most common size.

A pattern bit is a straight bit with a pilot bearing mounted on the shank. Presuming you want the bit to make a cut in the workpiece that duplicates the template, the bearing diameter must match the bit's cutting diameter. The cutting diameter has to be distinctly larger than the shank diameter.

If you expect to do more than the occasional template job, you should consider investing in a bit or two specifically designed for the work. Depending on the contours you tackle, you should have bits of other styles. Points to consider in selecting either style are diameter and length.

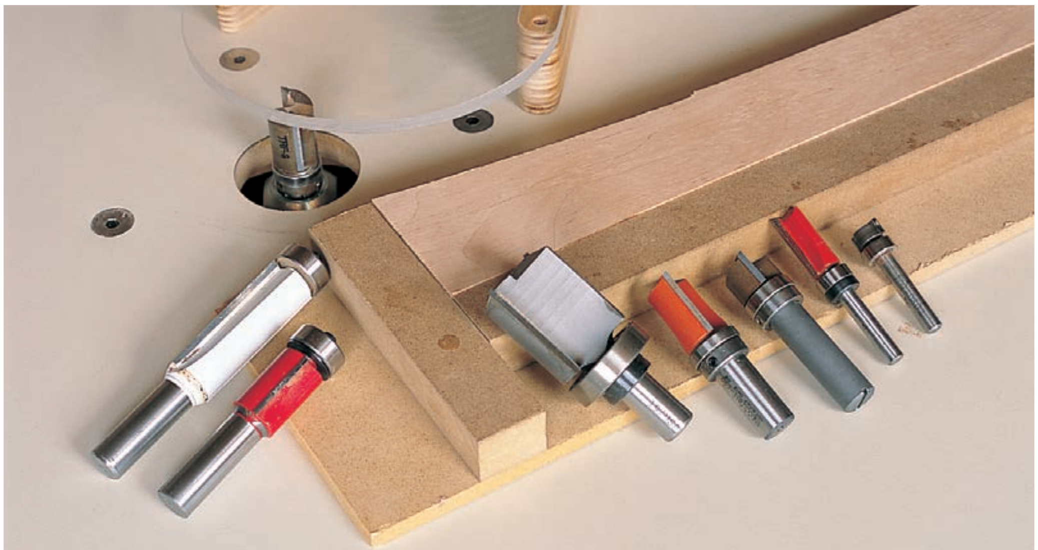
When assessing length, remember the axiom: Always use the shortest bit that will do the job. Excessive length amplifies vibration and deflection, which degrade the cut and can lead to tool breakage. The upshot is that you ought to have bits of two or three different lengths.

With a flush-trimmer, you are always using the very tip of the bit. If you must use a long flush-trimmer when you are working 1/2"- or 3/4"-thick stock (because that's all you have) the cut quality may be sub-par.

The effect is moderated somewhat with pattern bits because you are using the section of the bit, regardless of length, that's closest to the collet. But on the other hand, a mismatch between cutter and template-workpiece thickness exposes the excess cutting length above the work. That's a hazard.

Though large diameter bits tend to cost more, they are better choices for template work. As we'll see, a large diameter bit is less likely to cause splintering than a small diameter one.

The truth is that as the bits increase in length, they grow proportionally larger in diameter.



Flush-trimming bits (left) and pattern bits (right) are used for template work on the router table. You can get either type in a wide variety of lengths and diameters.

A flush-trimming bit is characterized by the pilot-bearing on the tip. Because of the pilot's location, you must locate the template on top of the work. Exposure of the cutting edges is minimized, which is good from a safety standpoint.

A pattern bit has its pilot bearing mounted on the shank. The template rides on the tabletop with the work on top of it. This allows you to use toggle clamps to secure the work, but forces you to expose the full length of the cutting edges, regardless of the thickness of the work.

Cutting Issues

A majority of template operations are trouble-free. I've used this rout-around template to shape the back posts for several porch rockers. After band-sawing the stock to rough shape, I stick it to the template with carpet tape. The post is shaped with a flush-trim bit on the router table, and mortises for the backrest rails are excavated with a plunge router guided by the windows in the template.

Doing template-guided routing on the router table is safe and reliable, giving good results. It's a technique you should try.

Cut the workpiece to roughly match to the template's contour. Join it to the template. Set up the bit and a starting pin, and make provisions to capture as much of the dust as possible. Switch on the router and begin routing, feeding the work clockwise past the bit. The template edge rides against the bearing, and the cutting edges slice the workpiece to perfectly match the template contour.

Typically, this works just fine. But every so often, and always when you least expect it, you get bushwhacked. The work jerks frighteningly, and you hear an awful crack. When your heart restarts, you look at your wood, and it's now scrap.

This is the deepest of template work's pits, and you've fallen in. Take heart! I've been there, and I've seen craftsmen I respect highly take the tumble too. If you understand the cause, you can usually design your template and plan your cutting routine to keep you out of trouble. (And practice is always beneficial!)

The problem is the grain. As much as possible, you want the cutting edges sweeping down on the grain. If they sweep up, the wood can chip and even split. This business of cutting down and up the grain may seem to be an odd consideration.

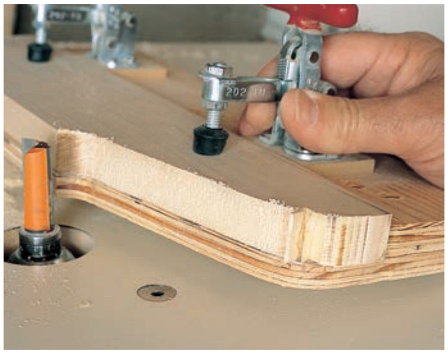
But we often worry about that when jointing and planing. You run a board across the jointer and find the freshly cut edge slightly rough and chipped. So you spin the board around and rejoint it. The edge now is smooth. What made the difference? The slope of the grain as it was addressed by the cutter.

It's like rubbing your hand across a rug. Move your hand one way and you raise the nap. Move it the opposite way, and you lay it down. You want the router bit's cutting edges to be laying down the nap, not raising it.

The situation is most dire when you rout obliquely across the grain, as you do when working a curve. The cut shown in the drawing "Avoiding Edge Damage" presents quite a dilemma. You always want to feed the work against the bit rotation, especially so on the router table. So you are limited to a clockwise (right to left) feed. As you begin the cut, the cutting edges sweep down on the grain. But halfway through, they begin sweeping up across the grain. The cut edge will be rough, perhaps with nasty chips dug out. And as the cutter nears the end of the arc, where there's little support for the wood, a chunk may split off.

The chronology will vary. You may have a trouble spot at the beginning of the cut. You may be bamboozled by the subtly of the curve or the line of the grain. On the facing page are photos of four damaged pieces, each an example of this dynamic. In each instance, I successfully routed a new part with a change of approach.

The point is that template work on the router table is generally easy and rewarding. There are limitations on what you can do, and there are pitfalls. Practice and experience carry you a long way.

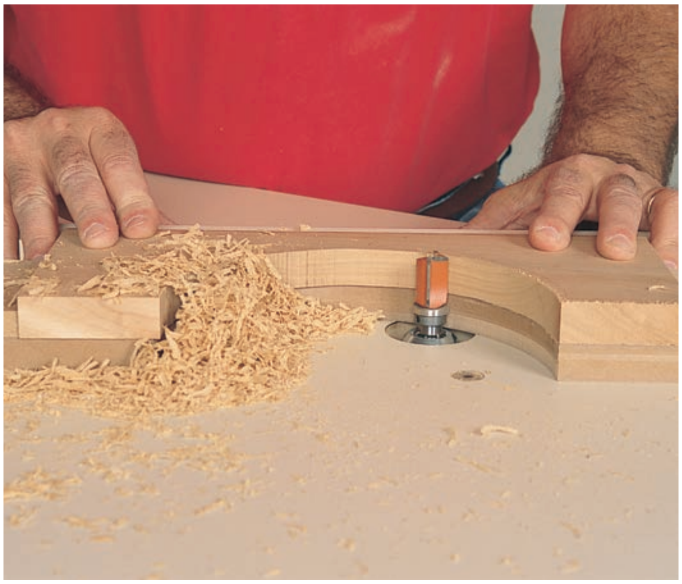


Routing uphill across the grain produces a rough finish at best, a chunked, and thus ruined, part at worst. This is the first template I made to shape the back posts for porch rockers (see page 114). One pass drove home the point: this half of the template won't ever produce a usable edge. The part is symmetrical, so both halves can be cut on the right-hand, downhill, portion.

This plaque presents several challenges: abrupt switches from long grain to end grain and thick, dense stock. Its relatively small size puts your hands close to the bit. An inappropriately large bit and a poorly chosen starting point doomed this operation. Switching to a $^1/_2$" flush trimmer allowed me to rout a replacement plaque without incident.

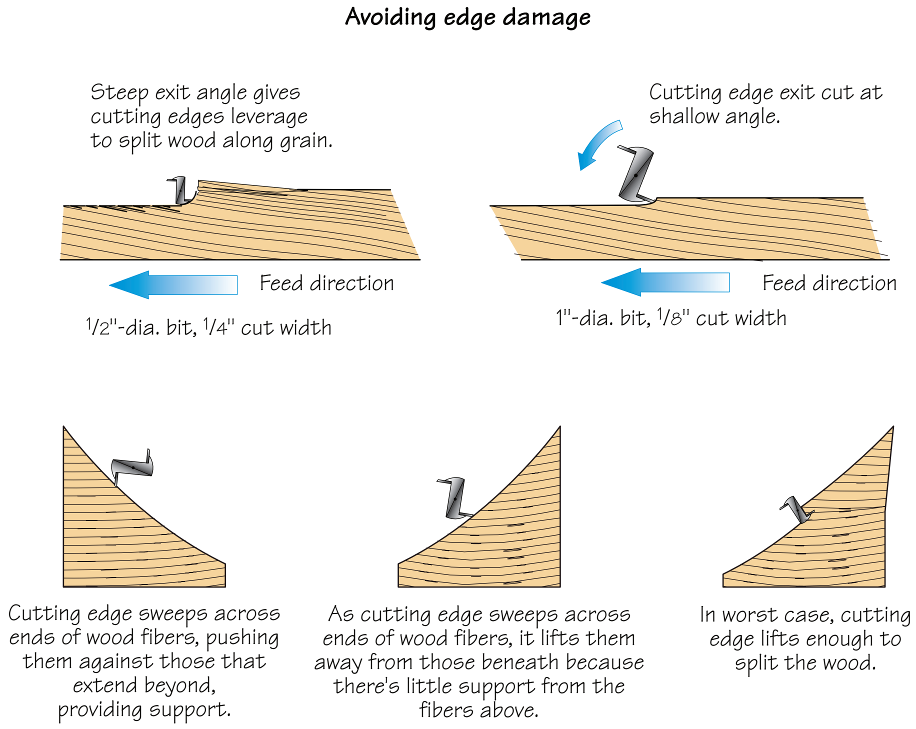
Whenever you rout across the grain, you risk this sort of damage. In this instance, the work was face down with the template on top, and the bit's cutting edges were sweeping obliquely across end grain, against the nap, on the downhill side of the arc. As the cut carried close to the straight edge of the workpiece, there was nothing behind the wood fibers to hold them in place. A substantial shard simply split away along the grain, and the rail is now scrap.

Being fixated on a particular template mounting resulted in this desk leg being wrecked. (And after a lot of work had been invested in it too!) In addition to the twin mortises you can see, the leg has twin mortises in the face to which the template is attached. Because holes in that face would be hidden in the final assembly, I opted to screw the template to the leg. But that mounting meant that on half the legs, the bit's cutting edges would contact the end grain first and sweep outward. It follows the wood split along the grain. The solution was to rout half the legs with the pattern bit and half with a flush-trimmer.



An arc like this presents a problem. To avoid destructive tearout when shaping curves, always rout down across the grain. But here you have to rout uphill at least halfway. The solution is to rout half the arc with a pattern bit, cutting down (left). Then turn the work over, switch to a flush-trimming bit, and complete the arc, still cutting down (right). The feed is the same direction for both cuts, from my right to my left.

A bit with two bearings is just the ticket when template-routing curved contours. Instead of switching back and forth between a flush-trimmer and a pattern bit, just raise and lower a two-bearing bit. You can buy such bits, or make your own by adding a bearing to the shank of a flush-trimmer.



Offset Pattern Bits

A common source of template-routing trouble is biting off more than can be chewed. The usual routine is to cut the workpiece to within 1⁄8" of the template contour, then rout it to perfectly match the template.

The difficult part is cutting close to the line without cutting beyond it. To be safe, we usually err toward the waste side, leaving a lot more than 1⁄8" for the router to trim. That makes for a heavy cut, which increases the risk of tearout.

A smart tactic here is to stage the routing using offset pattern bits. Pattern bits are the ones with a bearing mounted on the shank (as opposed to the tip). Most makers have them in a variety of sizes and lengths. But the pilot bearing is always matched to the cutting diameter of the bit.

An offset pattern bit has a bearing larger than the cutting diameter. Routing with this sort of bit leaves the work offset from the template by half the difference between the cutting diameter and the bearing diameter. Thus you can trim a workpiece to match a template in two moderate cuts, rather than one big one. The risk of damage to the work is reduced.

Yes, you do need to switch bits between cuts (unless you have two router tables). That's a small inconvenience in my opinion. (And okay. I do have two router tables.)

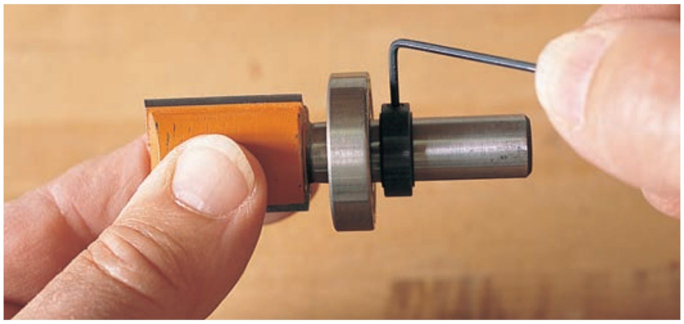
So as far as I know, only one bit maker markets offset pattern bits. Paso Robles Carbide has a five-bit template set, which includes two pairs of matched offset and flush pattern bits. (See bottom photo.)

An offset pattern bit is so easy to make that you don't really need to buy one. Select a straight bit with a cutting diameter larger than its shank diameter. Get a bearing with an inside diameter matching the shank and an outside diameter that's 1⁄8" larger than the bit's cutting diameter. Slide the bearing onto the shank as far as it will go, secure it with a collar and a set screw.

Cutting with this bit will leave a uniform 1⁄16" of material to be trimmed in a final pass with a flush pattern bit.

How about flush-trimming bits? The possibilities are the same. For example, buy a 5⁄8" bearing for your 1⁄2" flush-trimmer, or a 7⁄8" bearing for your 3⁄4" flush-trimmer. Infinity markets a package of bearings for flush-trimming bits that give you a variety of offset options.

An offset pattern bit takes the worry out of sawing close to the contour line traced from your template. If you saw to within 1⁄8" or 3⁄16" of it, you're fine. Guide the template and work along the offset pattern bit to trim a manageable amount of the excess, leaving 1⁄16" to be trimmed on the final pass with a flush bit.



Any straight bit with a cutting diameter larger than its shank diameter has the potential to be a pattern or offset pattern bit. Slide a bearing onto the shank and secure it with a collar. A pattern bit needs a bearing matching the bit's cutting diameter. A bearing 1⁄8" larger than the cut diameter makes an offset pattern bit.

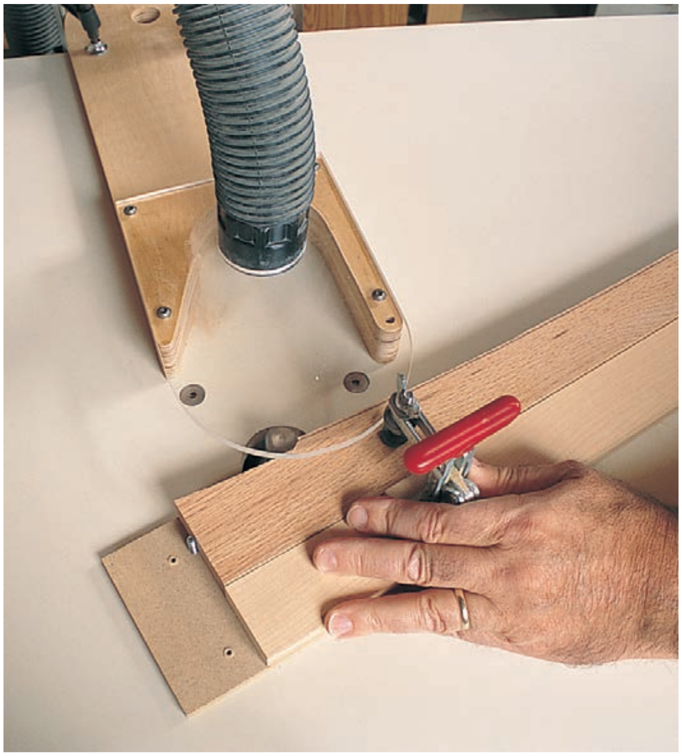
Paso Robles Carbide (PRC) sells a 5-piece pattern bit set that includes two offset pattern bits. The bit in the center is the loner, 3⁄4"-diameter pattern bit with a 1⁄2" cutting length. The others are paired for two-stage template work. One bit in each pair has an oversize bearing, the other a bearing matched to the cutting diameter. The larger pair (right) have a 1 1⁄8" cutting diameter with a 1 5⁄8" cutting length. The smaller pair (left) have a 3⁄4" cutting diameter and a 7⁄8" cutting length.

Controlling Dust

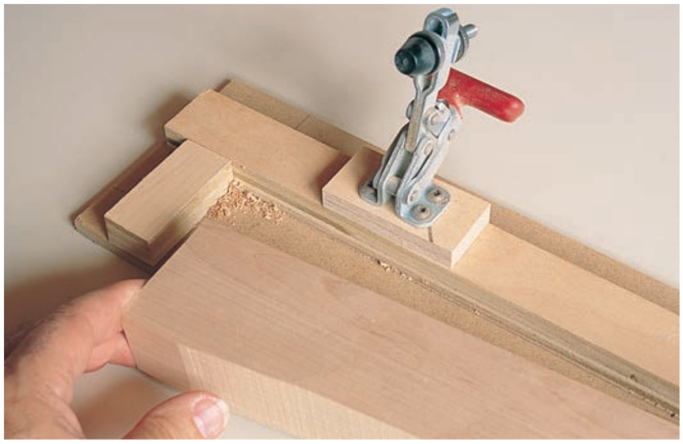
Dust and chips are problems endemic to router use. Because template work on the router table is pilot-controlled, you don't use the fence. In all too many shops, that means the chips and dust spew from the cut across the tabletop and into the air.

Beyond being messy, this is a health hazard. And it can create accuracy problems as well. Make the effort to capture as much of the dirt as you can right at the source. It isn't all the difficult.

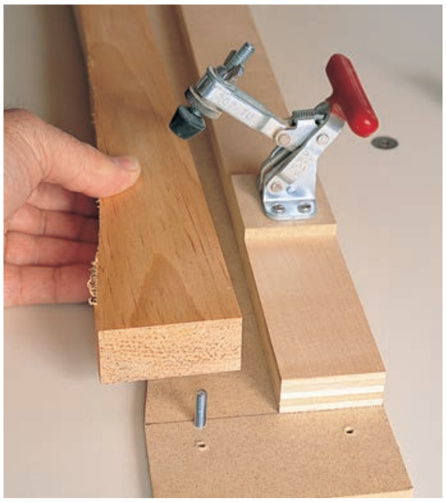
Template work always involves a piloted bit, so a fence is never used. In too many instances, removing the fence also removes the dust pickup. Dust and chips go everywhere and what you see here is the least of it. The really fine stuff floats in the air and you inhale it with each breath.



You can't see the dust but you can see the bit spinning and the cut being made. Where wood is being cut, there's dust. In this instance, it's disappearing up the vacuum hose as quickly as it's produced, leaving no mess and far fewer particles in the air.



Chips and dust have a way of settling into unexpected places. Trapped along the fences on a template, chips prevent a blank from seating properly. You end up with a batch of parts that are just slightly different from one another.



Using pins in place of solid fences circumvents the worst of the dust-and-chips problem—those inside corners. Here the pin is a flathead machine screw. Drill and countersink a hole through the MDF template, then tap it. Drive in the screw and it stays in place.

Materials for Templates

A good template, especially one you expect to keep and use another time, is flat and stable with crisp, dense edges. Bear in mind that you want the template to lay on the workpiece (or vice versa), making full contact, without clamping to force contact. You also want edges that won't dent, crush or distort under the pressure of a pilot bearing.

Keep these criteria in mind as you select a template material. And add to the list that the template material should be easy to work using power and hand tools, reasonably inexpensive and readily available.

My favorite material for templates is medium density fiberboard (MDF). To make it, a batter of wood dust and glue is compressed under high heat into dense sheets. The finished product is flat and smooth, with burnished faces. It's heavy, about half again as heavy as a comparable piece of plywood. Because it's made of dust, it turns to powder when you machine it. I mean *powder*.

But on the plus side, MDF's flatness, density and stability make it a particularly fine material for templates. Any template you make from it will be flat. Its edges are far easier to work than plywood's. You can quickly smooth a band-sawed cut with a cabinetmaker's rasp, a file or even coarse sandpaper. Nevertheless, a router bit's pilot bearing won't compress that edge (or dive into a void between plies). As a bonus, MDF's color allows you see penciled layout lines and notes.

If the template is going to be a keeper, seal it with quick-drying shellac or water-based polyurethane to prevent it from absorbing moisture. Left unsealed, MDF will wick up moisture and swell.

You can usually find full sheets of 3⁄4" (and sometimes 1⁄2") MDF at large home centers. It is surprisingly inexpensive. A wholesale plywood distributor—look under "plywood" in the Yellow Pages—will likely stock MDF in 1⁄4", 3⁄8" and a myriad of other thicknesses. Many wholesalers will sell retail on a cash-and-carry basis.

For 1⁄4"-thick templates, hardboard is a decent choice. (Masonite is a brand of hardboard.) It's inexpensive and readily available at home centers. It's dense, and with a little effort, you can get a good edge. I say "a little effort," because the edge does tend to fuzz when sawed. But it works easily with rasps and files and cleans up with sandpaper. The edge is crisp and won't dent or distort under pilot-bearing pressure.

One drawback is its color. It's so dark that penciled layout lines can be difficult to see. If the layout is intricate, try working on paper, then bonding the paper to the hardboard with spray adhesive.

Plywood works, but it has quite a few disadvantages and drawbacks. It isn't always flat, and it isn't always inexpensive, especially not the grades best suited for templates. When you cut it, the surface veneers chip and splinter, leaving fuzzy, potentially inaccurate edges. Moreover, the edges are not easily worked with a rasp, file or sandpaper. Plywood often has voids in its interior plies, and when they emerge at the edge, they are hazards. If a bearing dips into one, you've got both a botched workpiece and a botched template.

Particleboard, and I include melamine (coated MDF) here, also works. It is available in a range of thicknesses, and it is inexpensive. But the particles it's made of are coarse, and it isn't particularly dense. Consequently, its edges are tough to smooth, and they are easily dented by pilot bearings.

The best template materials are available and cheap. You want something that's flat, that has a firm edge and that is easily cut. Here are some of the best choices: (top to bottom) 1⁄4", 1⁄2" and 3⁄4" MDF, 1⁄4" hardboard, 3⁄4", 1⁄2" and 1⁄4" plywood, particleboard and melamine. I favor the MDF. It's cheap, flat, void-free, cuts easily (though its dust is awful) and has a crisp, durable edge.

Designing Templates

Designing a template is about contriving a way to cut—accurately and safely—the contour you want on as many pieces as you want with a minimum of fuss. It involves pulling together what you know about bits, potential cutting problems and ways to circumvent them and the materials suitable for templates.

Templates don't have to be fancy. Some are made as one-use throwaway items. These are the ones you cobble up using materials from the scrap bin. If you ordinarily work with decent materials, then your scraps will make good templates. But scraps being scraps, you won't regret tossing the template when its job is done.

If you're making a template for the first time, keep it simple. For example, use an existing part as the template.

In some cases, the first of the actual parts can double as the pattern. If you expect to toss the template as soon as the actual parts are all made, this approach is sensible. All the time you invest goes into actual parts; none goes into template-making alone. And overall, the time spent is probably reduced slightly.

Before you actually make a template, it's helpful to visualize using it. Picture each step, from mounting the work on the template, to feeding it along the bit, to separating the work from template. With experience, you'll do this without a lot of conscious planning, and it will work out perfectly. But you'll also recognize those occasional special instances that do require conscious planning—and perhaps some experimentation—to formulate a workable, successful approach.

Here are the kinds of questions you need to ask yourself:

How many parts will you make with the template? How durable does it need to be? Will fixturing expedite the overall operation?

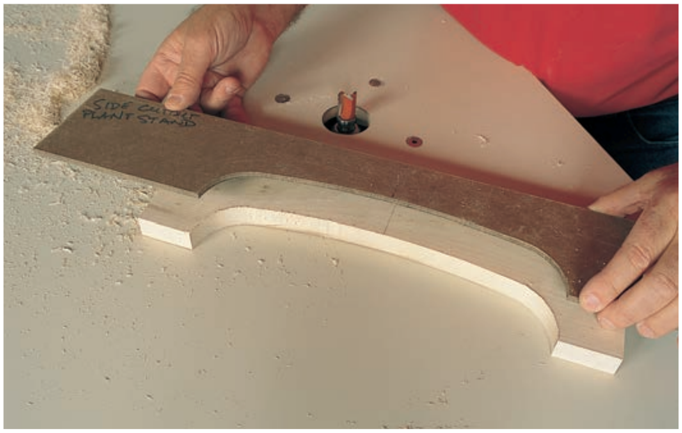
How big is the workpiece? How will you maneuver it through the cut? Which bit (or bits) will you use?

Can you combine several cuts in one template? Conversely, can you divide a single cut into two or more segments?

Your answers help you hone in on a configuration, the setup and your work sequence.

A rout-around is what I call this style of template. It's the exact shape of the part you want. Stick it to the work and slide it along the bit, routing completely in a continuous maneuver. Such templates often do more than govern the shape. This MDF template for making offset baseplates guides the plate-shaping cut on the router table. At the drill press, it locates holes for mounting screws, a knob, and the bit opening.

Sometimes the best template is the very object you want to duplicate. For example, I needed an extra base ply for the bit guard-dust pickup (see "Controling Dust") so I could use it when working 8/4 stock. After tracing the contour and band-sawing close to the line, I stuck the new ply to the original with carpet tape. Routing it to match perfectly was quick and easy (but messy—no dust collection).



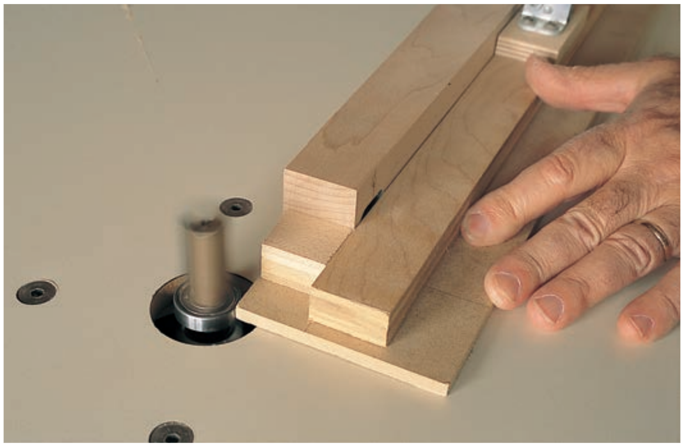
Keep any template as simple as possible. This toe-kick cutout is used both on tall side panels and the baseboard shown. A hardboard template works for both applications. Carpet tape secures it to the work, and alignment is achieved using a centerline and the bottom edges of the template and work.

Full-scale layout comes next. Maybe it's something you draw freehand—or you use French curves or a flexible curve or a layout bow. A trammel can help you draw, and even cut, arcs. You can do this design work on paper and transfer it to the template stock. But you may also work right on the stock.

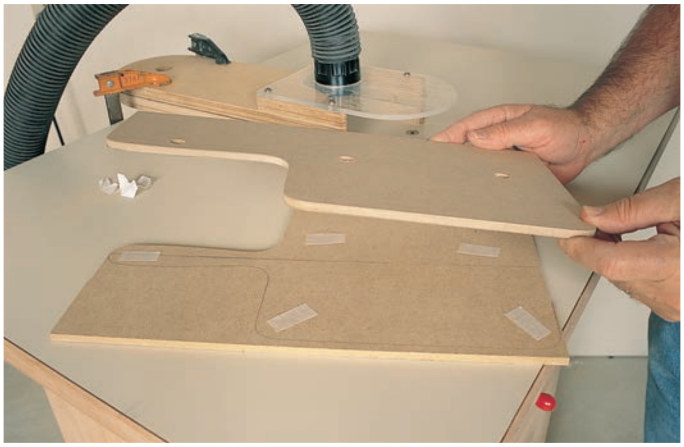
You can cut the template with a variety of tools. The router ought to be your first choice, since a bit will make a smoother cut than any saw blade; you shouldn't have to do so much sanding. You can guide a router along a fence for straight cuts, or swing it on a trammel for fixed-radius curves. The band saw and the jigsaw are invaluable in cutting freehand curves.

A spindle sander (or a drill-press with a sanding drum) is invaluable for smoothing edges. So are files of various shapes. The sanding and filing can take a lot of time, but it's usually time well spent. The finer the edge on your template, the better your final work will be.

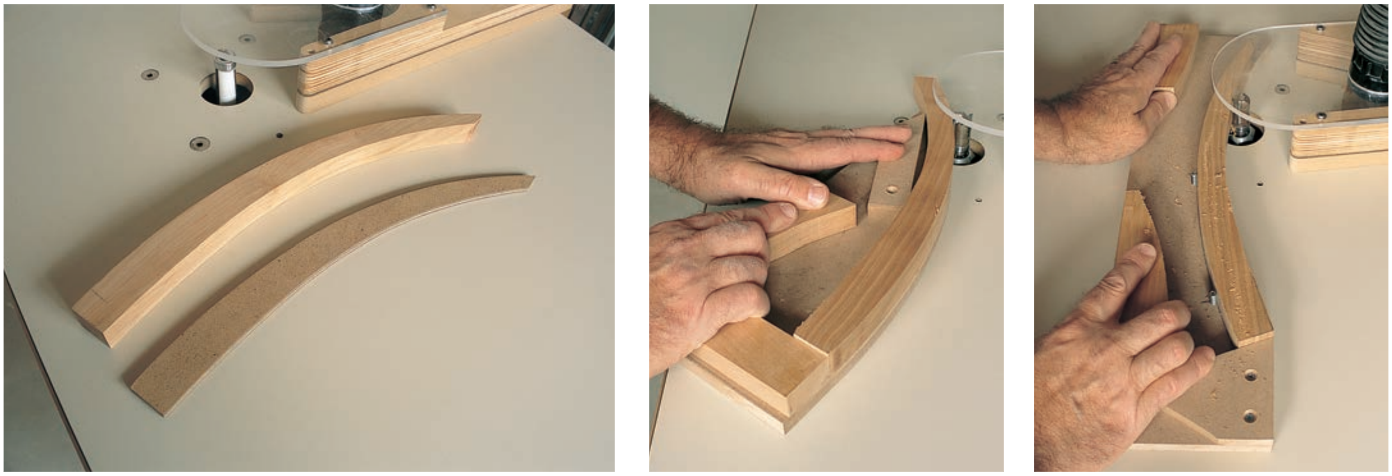
Remember, a smooth edge is the goal. No wiggles, no bumps, no creases. Little imperfections telegraph directly into the work. Depending on the nature of the imperfection and the size of the guide, the flaw can be glaring.



Extend the guide edge of your template so it is longer than the actual cut. This allows you to bring just the template edge into contact with the bit's pilot bearing, to begin a cut. With the template against the bearing, you have control and can safely advance the work so the cutting edges do their work.



Using a template is sometimes the most simple and accurate way to create a template for a symmetrical shape. To produce a template for a cutting board, I laid out, cut and carefully sanded a master template for half the contour. After shaping half the final template, I turned the master over, aligned its centerline with one on the final template, stuck the templates together, then routed the second half.



Making a batch of small parts safely often requires more than one template. The small curved slat shown (left) is a good example. The slat is too slender to be routed using a rout-around template. But you do need a pattern to lay out the slat blanks, and making that pattern from hardboard rather than cardboard simplifies making the working templates. Use it to make a convex template (center) and a concave template (right). Bandsaw a slat blank and stick it to the convex template with carpet tape. Position fences—they need only contact the blank at three places to locate it—and attach them to the template. After shaping the blank's convex edge, stick it to the concave template. Mount fences (machine screws are used here) to locate the blank. Rout the concave edge. (The extra blocks attached to the templates are scraps of the working stock; they allow the templates to be inverted and used with a flush-trimming bit.)

Fixturing a Template

A critical decision to make about your template is how it will be mounted on the work (or vice versa). It's not one you want to postpone until after you've cut and refined the template. If you are going to mount fences and clamps, you have to provide space for them from the start.

Safety is as important in making templates as is simplicity and accuracy. Any template you use should make the job safer to do. How you fixture a template plays a primary role in safety. You want to bind the work and template securely together. You want to ensure the template is big enough and weighty enough to endure the forces involved in routing. And you need safe hand-holds.

A template for a full perimeter cut, what I call a rout-around, can usually be held to the work with carpet tape or hot-melt glue. This allows you to work with both flush-trim and pattern bits.

A template for forming a single edge is easy to deal with as well. You can get by with your eyes and fingers as your means of aligning template and workpiece with one another. Often registration lines on either the template or the workpiece (or both) help with alignment. Here again, carpet tape or hot-melt glue may be the best means of joining template and work.

A slightly faster mounting option, if you are using a flush-trim bit, which requires the template to be on top, is brads. You won't have to spend time peeling the backing off carpet tape, then stripping the tape off the work or template. But you will have tiny holes in the work (hidden in the piece's back).

If you are shaping multiple pieces with a template, you want to expedite the positioning and clamping of the work as much as possible. Fences ensure the workpieces are positioned consistently, so after the routing is done, each will be identical. So long as the fences are no thicker (higher) than the work, you can flip-flop between having the template on top or underneath, thus allowing you to use either flush-trimming or pattern bits.

Toggle clamps are the best option for clamping work to a template, especially when routing multiples. The drawback is that the template must be on the bottom, thus limiting you to pattern bits. As we've seen, that can be a problem if you have a non-symmetrical curve.

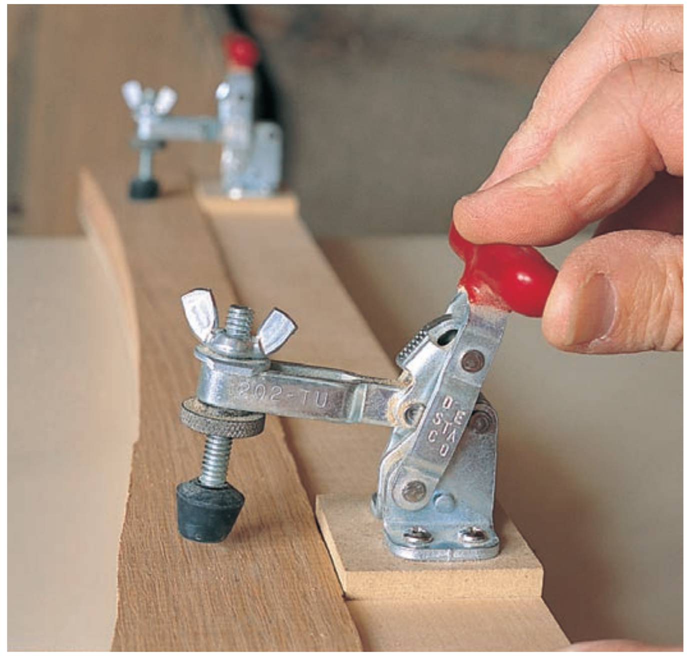
Look at the examples shown on these pages and experiment a little. You can do it.

A fence or two ensure that each part is identically shaped. The template at upper left has fences to position the blank in relation to the contoured edge as well as trap the ends. At right is a template with only one fence; each workpiece must be aligned with penciled lines. The third template has a fence, but pins the trap the ends of the blank.

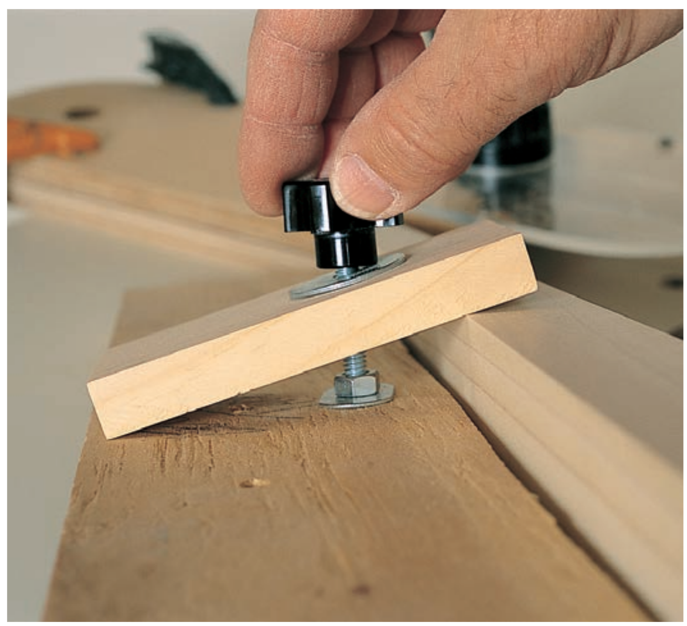
Continuous fences are sometimes more trouble than they're worth. Three or four contact points are usually all you need. On the concave-curve template (at top of photo), the blank butts against the base fence and its convex edge contacts just the corners of the MDF fence. On the convex-curve template (at bottom of photo), the blank fits against machine screws. Carpet tape secures the blanks.

If the template will be on top and tiny holes in the work don't matter (for example, they'll be hidden inside an assembly), you can use small nails or brads to fasten a template and workpiece together.

Carpet tape is the magic that bonds a template and a workpiece securely together, yet allow them to part without trauma. Get good tape (top). The fabric-based tape holds far more securely than the film type. (Read the package carefully—types aren't always differentiated clearly.) Apply the tape to dust-free surfaces. Long strips aren't necessary. A few well-placed patches will do the trick (center). Align the blank and the template and press them together. Take the time to squeeze with a clamp at each patch's location to seal the bond (bottom).



Toggle clamps are slick. A flick snaps a toggle closed, cinching your workpiece tightly in place. Another flick pops it open, instantly freeing the piece. I recommend you replace the standard spindle with a slightly longer one so the clamp accommodates a greater range of stock thicknesses. Replace the spindle's hex nuts in favor of a check nut and a wing nut. Then you can make tool-free spindle adjustments.



A serviceable clamp can be fashioned from a machine screw, knob (or wing nut) and a scrap of wood. You don't need a great deal of pressure to keep a workpiece in place on a template with fences.

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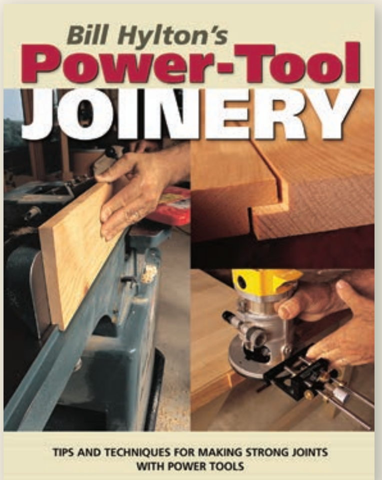

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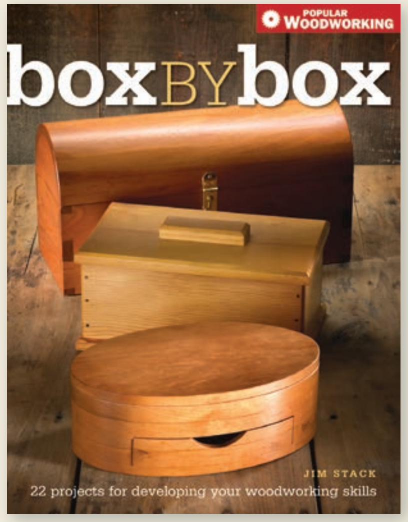

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