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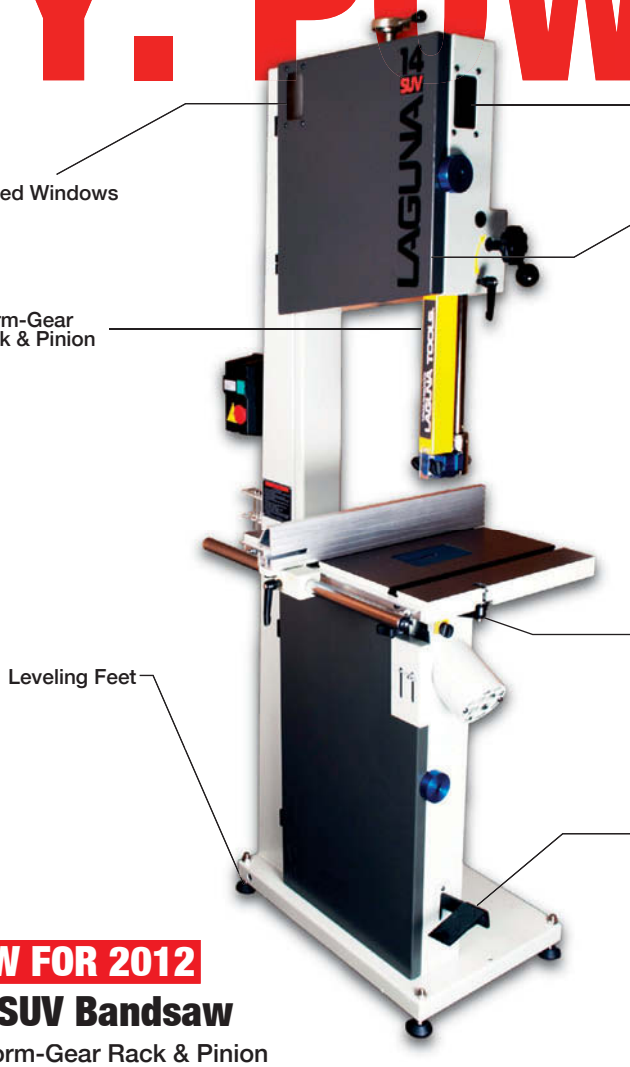

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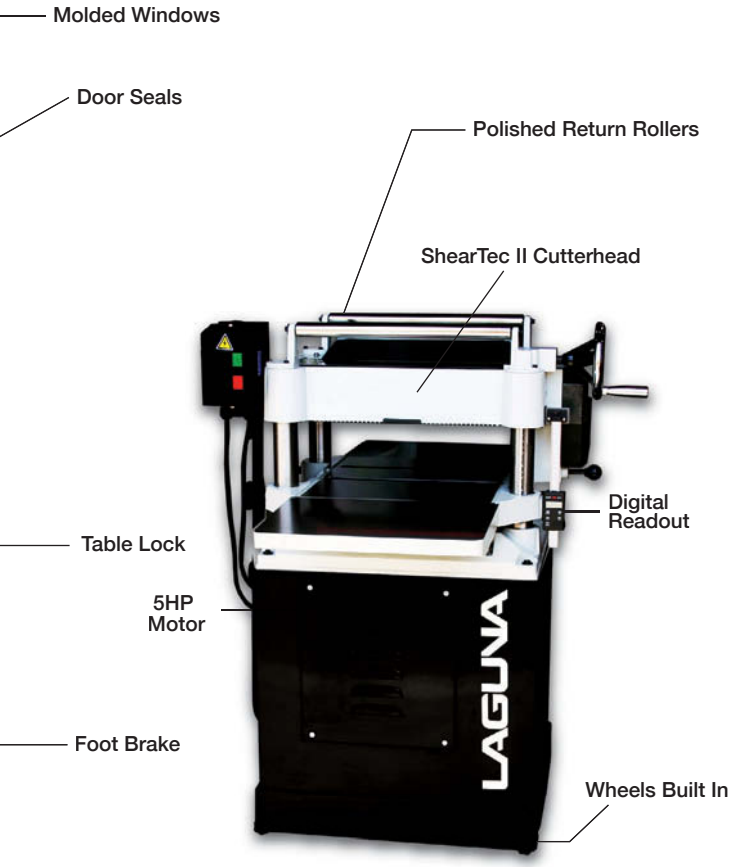

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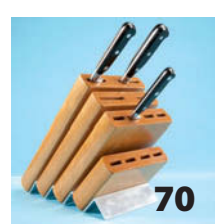

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Features

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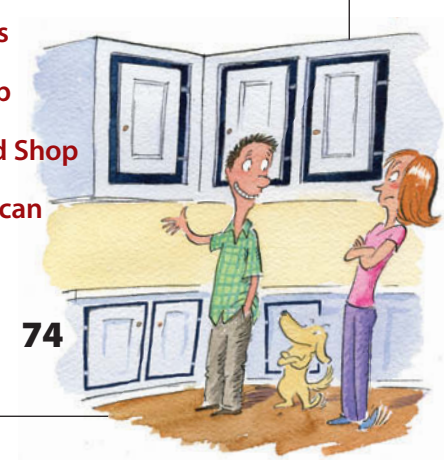

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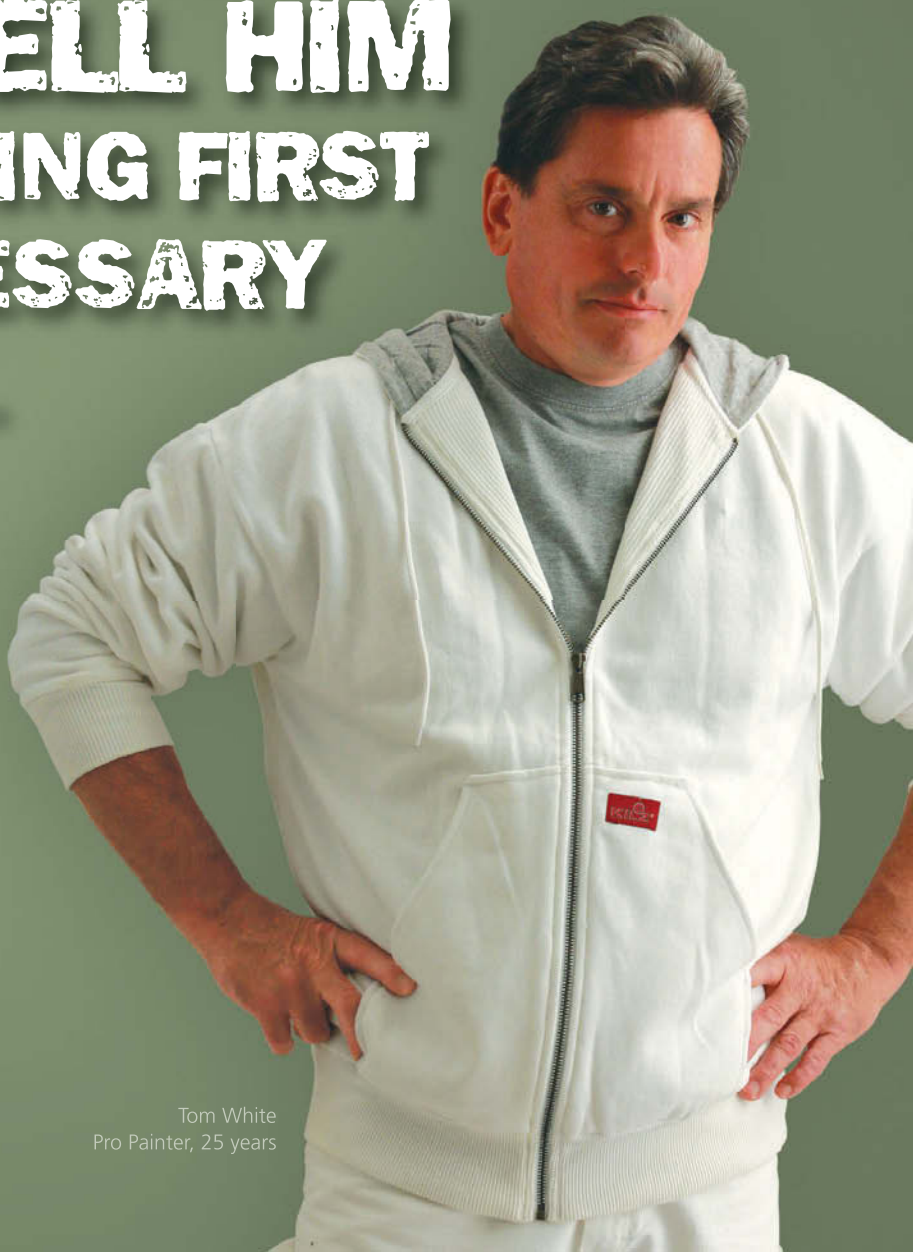

Tom White
Pro Painter, 25 years

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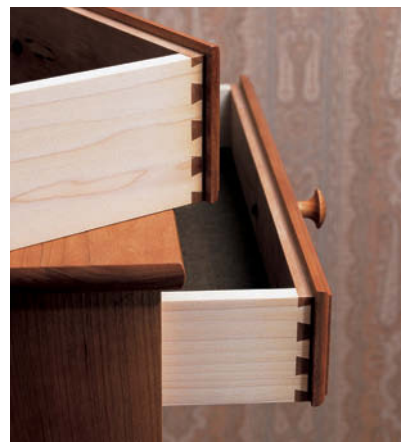

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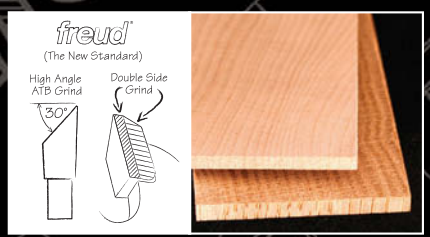
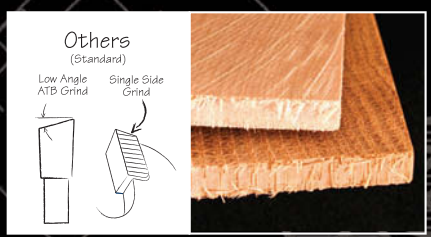
Freud's Fusion Tooth Design vs. Others





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Glue-Up Cauls

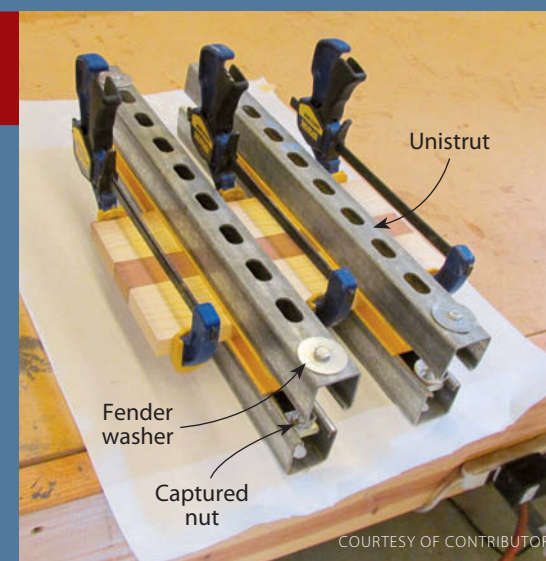
Terrific Tip!

HERE'S A SURE-FIRE method to ensure flat glue-ups of any size: Use cauls, top and bottom, made from Unistrut. Unistrut is steel channel made for light-duty structural support in electrical and plumbing work. Sometimes called Superstrut, it's available in the electrical department of many home centers in 10' lengths.

Glue plastic strips on the open side of the Unistrut to keep the metal from denting or staining the wood. Any plastic will do, but wood glue won't stick to it. I cut an old plastic sign into strips and adhered it with Shoe Goo (this stuff seems to stick to anything!).

To clamp the Unistruts together and force the glue-up flat, use 1/4–20 bolts, fender washers and the captured nuts made for Unistruts. Called Nylon Cone nuts, they're rectangular 1/4-20 nuts that slide inside the Unistrut. The nylon cones hold the nuts in place for threading the bolts; I highly recommend them. Use a cordless drill with a 7/16" nut driver to tighten the bolts.

Ken Marble



SOURCE

Shoe Goo, amazon.com, Eclectic Shoe Goo, clear, 3.7 oz., $4.10.

Plane Polish

OLD WOODEN PLANES are usually coated with a layer of grime that obscures their true beauty. I clean them using a homemade solution that removes the dirt and grease without damaging the wood's patina.

Make the solution from 1 part boiled linseed oil, 1 part Murphy's Oil Soap and 2 parts Minwax paste wax. Pour 1/4 cup oil and 1/4 cup soap into a jelly jar. Then add 1/2 cup wax, a little at a time. Stir while you're mixing—I use a paint mixer (a metal rod with small paddles on the end) chucked in a drill to speed up the process.

Apply the solution with 0000 steel wool. Rub it around a bit, then remove it with a paper towel. Repeat a few times, then polish with a rag and more solution, followed by a dry rag.

Tom Caspar

See how you can make this polish at **AmericanWoodworker.com/WebExtras**

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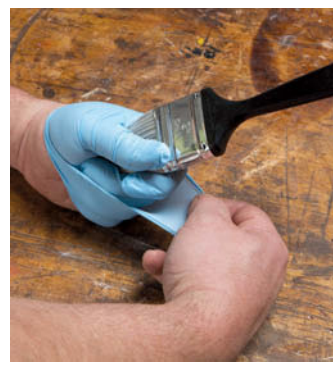


TO AVOID CLEANING your brush between coats, wrap it in a glove. I always wear disposable gloves while finishing, so after one coat, I just hold the bristles and pull the glove inside-out, over the brush. My hands stay free of finish and the brush stays soft, ready for the next coat.

If you secure the glove around the handle with a rubber band, the brush will stay soft for at least 24 hours.

Alan Schaffter

Staple for Stack-Sanding

SANDING IDENTICAL PARTS is much easier when they're stacked together. I usually use double-stick tape to keep the parts aligned, but when I ran out of tape the other day, I tried stapling the ends of the pieces instead. It worked great! The staples were easy to remove with a pair of pliers.

Serge Duclos

Universal Drawer Holder

WHEN I MAKE DOVETAILED DRAWERS, I usually plane the sides to even up the joints and fine-tune the drawer's fit. Years ago, I found that you can't accurately plane a side unless it's fully supported from underneath. This jig does just that and easily adjusts to fit drawers from 8" to 20" long.

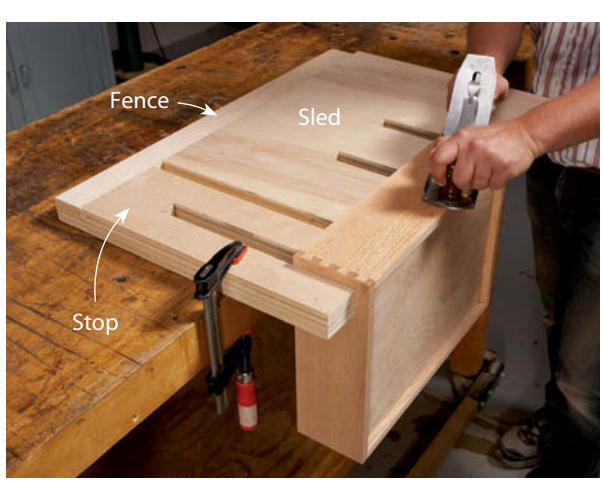
Here's the problem: Without support, the side can bend as you push down on the plane. Either the plane won't cut in the middle of the board, or when you're done planing and the side springs back, its surface is *convex* from end to end—not flat. Weird, isn't it?

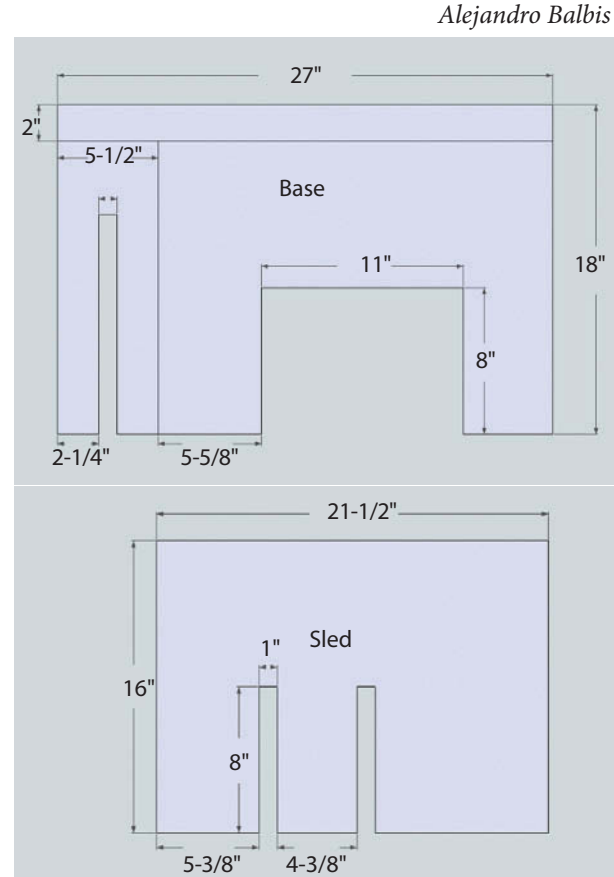
I used to cut a support board to custom-fit each drawer, but this jig is much handier. It's composed of two parts: a base, which sits on the bench, and a sled, which slides on top of the base. (A runner between the two isn't necessary.)

Both parts are 3/4" plywood. The base is two layers thick; the top layer consists of a stop that the drawer butts against and a fence that guides and retains the sled. The stop has one slot for holding the drawer's front, while the sled has two slots for holding the drawer's back, depending on the drawer's length.

Use two clamps to hold the jig down to the bench. Place one clamp on the stop; put the other clamp on the far end of the sled after you've mounted the drawer. If you don't need to plane your drawers, this jig is perfect for sanding them, too.

Alejandro Balbis





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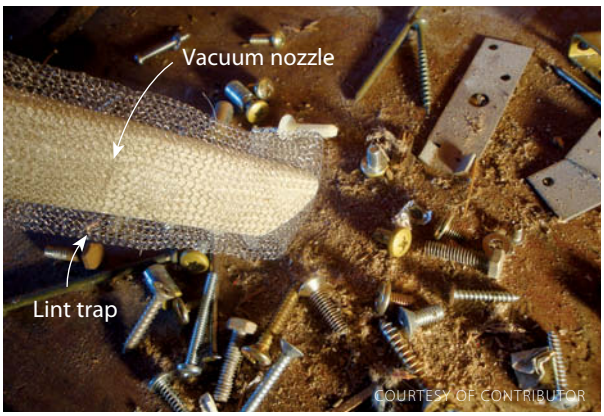
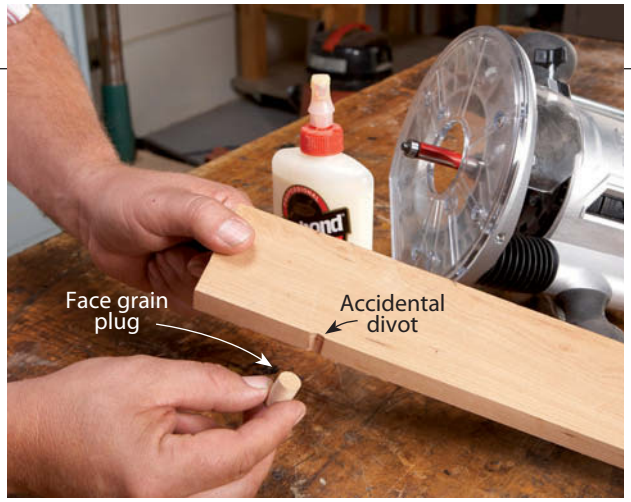


Bench and Drawer Cleanup

WHEN MY BENCH'S TOOL TRAY fills up with sawdust and hardware, I've found that vacuuming is the easiest way to clean it. To keep the hardware from going into the vacuum, I cover its nozzle with a washing machine lint trap.

Lint traps are made for washing machine drain hoses and are available pretty much anywhere you buy laundry detergent.

Gary Pardo Sr.



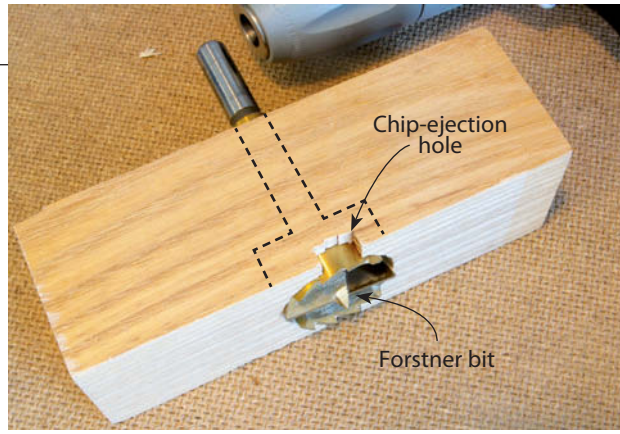
Plug-Cutter Routing Fix

HERE'S A SIMPLE, INVISIBLE REPAIR for an all too common mistake. Say you're flush-trimming a board and, for whatever reason, your router's bearing dips into a dent and makes an unwanted divot. If you have a set of plug cutters, you'll be back in business in no time.

Just cut a face-grain plug that's the same diameter as the router bit and glue it into the divot. Make sure you orient the grain of the plug to match the grain of your workpiece.

When the glue dries, trim the plug flush. No one will ever know it's there.

Yoav Liberman



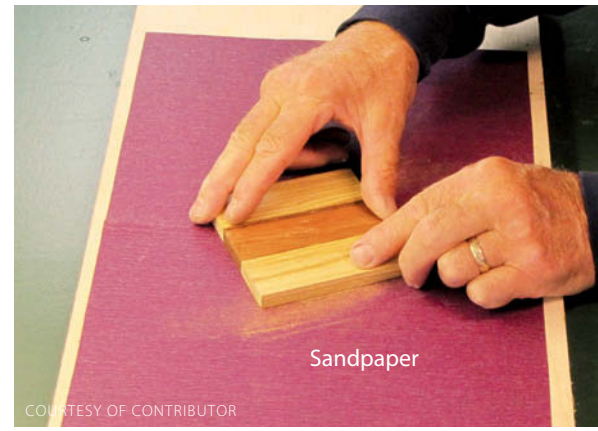
Freehand Forstner

HOW DO YOU DRILL a perfectly flat, shallow hole with a Forstner bit when you can't use a drill press? That's the bind I found myself in—the project was already assembled. It wouldn't fit on my drill press. When in trouble, I always say, build a jig.

This jig is just a block of wood that traps the bit. To make the jig, chuck the bit in a drill press and drill a shallow hole in the block. Drill a second hole the diameter of the bit's shank all the way through the block. Saw a notch by the shallow hole so chips can escape.

To use the jig, slide it over the bit and install the bit in your drill. Slide the block up the shank to position the bit. Hold or clamp the block to your workpiece and drill away.

Charles Mak



Small Parts Jointer

WHEN I GLUED UP a few small scraps to make some coasters, naturally they weren't flat. I tried using a random orbit sander to even them up, but that didn't work very well. Sanding by hand on a flat board did the trick.

I cut a 12" x 24" piece of 3/4" plywood, and using spray adhesive, glued two sheets of 80 grit sandpaper on one side and two sheets of 120 grit sandpaper on the other side. This flattening tool works so well that I've given it a permanent home in my shop.

Bill Wells

By Randy Johnson

Linker Logs Project

Have fun while learning to fabricate with plywood.

ALTHOUGH LINKER LOGS are made with the aid of a computer—once complete, they're a great way to get kids (and parents) off the computer for an afternoon of old-fashioned fort building and pretend. The techniques shown here—including pre-finishing the plywood, programming correct joint tolerances, arranging parts, locating hold-downs and placing tabs—can also be used for other plywood projects. The inspiration for making these building planks comes from a story titled "Plywood Play Planks" that appeared in the December 1953 issue of Mechanix Illustrated magazine. The original designers used 3/4" plywood and a dado blade to cut the joints. That technique can still be used, but using a CNC provides more freedom when designing the shape of the planks. Bill Young (a ShopBot guru from Virginia) adapted the idea for the CNC by creating a wide variety of planks, all with a standard notch spacing. The playhouse shown below is similar to the original Mechanix Illustrated design—but I added the puppet theater window and marquee board. Also check out the Blanket Hut on page 18, with with its custom barrel vault roof .

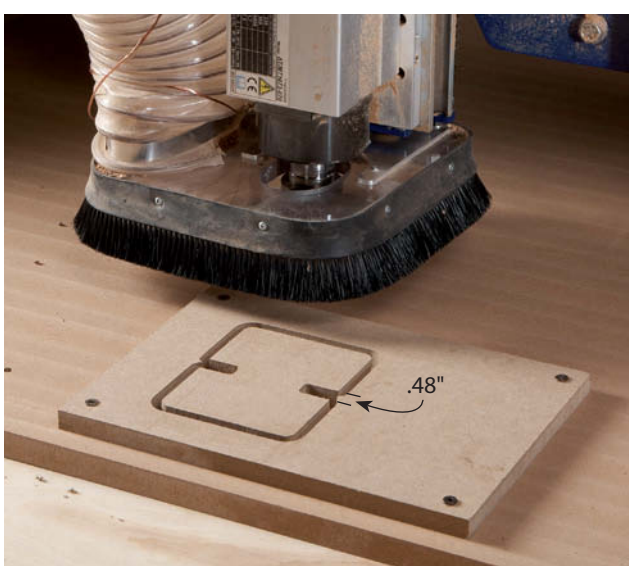
PHOTOGRAPHY: JASON ZENTNER

Start by finishing

A coat of shellac followed by a water-based topcoat provides a durable finish for Linker Logs—and most other plywood projects. Finishing a sheet of plywood is much easier than finishing dozens of individual pieces, so applying the finish first makes lots of sense. Shellac dries quickly and seals the wood so the water-based topcoat won't raise the grain, and gives the plywood a nice amber tone. See "Pre-finishing Plywood" (page 68) to learn more about finishing plywood.

Measure the plywood

The thickness of the plywood must be consistent so the cross-lap joints that fit properly. I recommend a tolerance between sheets of plus or minus .005". Most good-quality AC or AB sanded plywood will be consistently sized. The sheets of 1/2" plywood that I used to make this playhouse measured .47" thick. Measuring after applying the finish ensures the most accurate measurement.

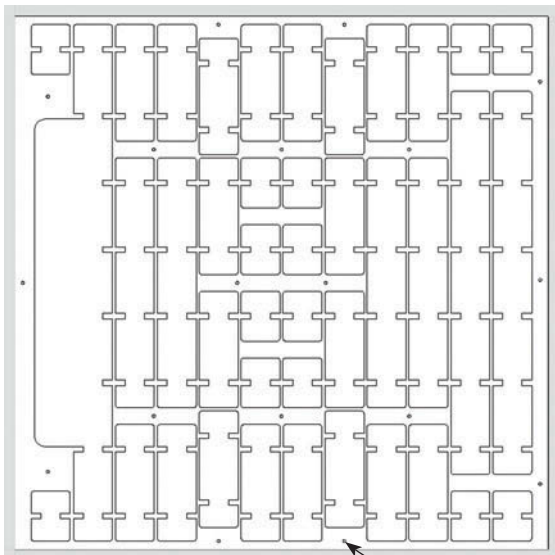


Cut a single part to test the joint

Rout a test part. When you test the fit in the next step, the width of the notch is the only thing that matters, so you can make the test part out of almost anything. I used 1/2" MDF. The test notch measured .48" wide, which should provide the desired .01" clearance when the cross-lap joint is assembled.

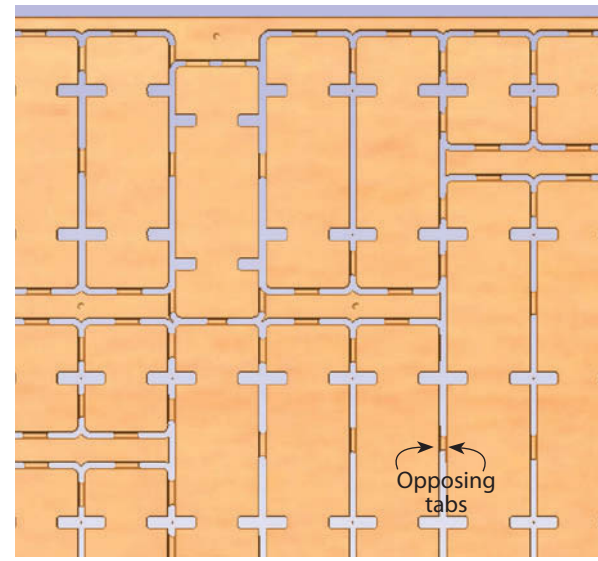
Check the joint's fit

A mechanic's feeler gauge works well to measure the gap between the parts of the cross-lap joint. Ideally, this gap will be .01", but anything from .005" to .015" is acceptable and will hold the Linker Logs together while still allowing them to be easily assembled and disassembled.



Nest parts and locate screws

Most CNC design programs include a "parts nesting" feature that automatically fits multiple parts to the plywood. The Linker Log parts shown here are nested .27" inches apart—slightly larger than the 1/4" bit that will cut them out. Once the parts are nested you can still move them around to attain the exact layout you want. This allows you to safely locate the hold-down screws that secure the plywood sheet.

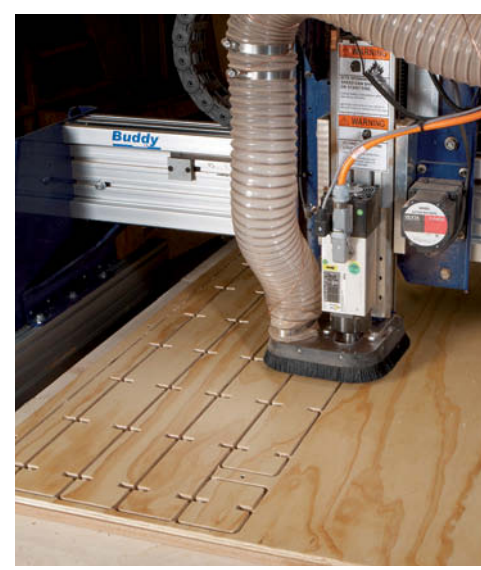


Add connecting tabs

The next step is to add tabs between the parts to keep them attached during routing. Since there is no waste material between most of the parts, tabs need to be added opposite of each other. The tabs added here measure .1" thick x 1" long. An alternative to adding tabs is to adjust the routing depth to leave a thin layer of material (a skin) at the bottom of the kerf. A skin of .05" would work fine for this project.

Secure the plywood with screws

Program the CNC to mark the location of each anchoring screw with a shallow plunge cut. Locating the screws in your drawing and transferring them to the plywood guarantees that the router bit won't run into the screws while cutting the parts.



Use a down spiral bit

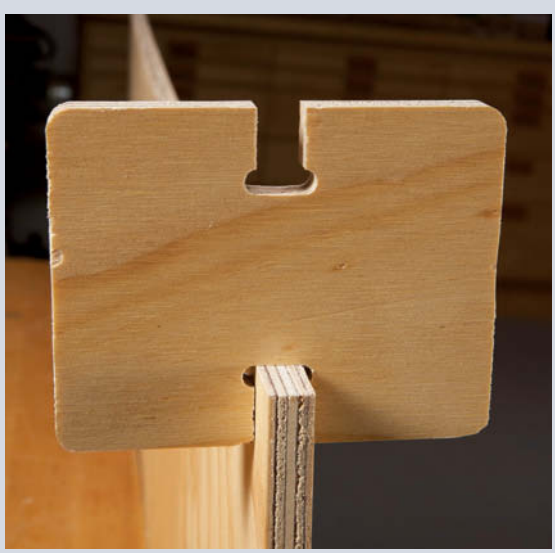
A down-cut spiral bit pushes the wood down while cutting, so it leaves a nice, clean edge at the top of the plywood. The bottom of the cut is also clean, because the spoil board under the plywood prevents blow-out.

Separate and roundover in one step

Remove the connecting tabs. A straight flush-trim bit works well for this, but I used an Amana 1/8" roundover bit (#MR0112) with a miniature bearing. This bit removed the tabs and rounded the sharp edges. It also allowed the joints to fit fully together, because the logs' rounded-over edges match the rounded inside corners of their CNC-routed notches. I left the edges and notches unfinished.

Blanket Hut

A twist on the blanket-over-a-table fort that all kids seem to enjoy, this design features rounded gable ends and half-planks for rafters. Vectric Aspire, .dxf, Autodesk 123D and SketchUp plans for the two playhouses shown in this article can be found at **AmericanWoodworker.com/CNC.** Additional plank designs that included angles and curves can be found at **LinkerLogs.com.** You supply the kids.



Alternate T-bone notch

If you want to keep the plywood edges square, use a "t-bone" notch design. Most CNC drawing programs have a built-in tool that lets you quickly add the right size "t-bone" to your joints. As you can see, this modification lets the plywood fully seat in the bottom of the notch.

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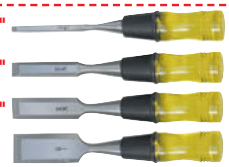

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Veritas Bench Chisels

A BENCH CHISEL is probably the only type of chisel most woodworkers require. It's used to pare dovetails, chop mortises and for every job in between.

Some bench chisels are definitely a cut above the rest. Here's a new entry in the high-end class from Lee Valley, makers of Veritas tools. The new Veritas chisels are comparable to Lie-Nielsen and Stanley Sweetheart chisels; they're a bit pricey, but you'll never need another set.

The back of a chisel must be absolutely flat for accurate paring. Fresh out of the package, most chisels aren't flat enough for my taste, so I expect to spend up to an hour to lap the back of each one. Not so with the Veritas chisels. Their backs are so flat that you'll be done in no time, a huge saving in time and frustration if you're working on a complete set.

The blades are made from O1 steel (Rc 58-60). Lee Valley also carries plane blades made from harder A2 steel (Rc 60-62), but chose O1 for these chisels so they will be easier to sharpen. That's good news for those of you who sharpen on sandpaper, which cuts slower than ceramic or diamond stones.

The sides of the Veritas chisels taper right down to a point. Fully tapered sides allow you to sharpen Veritas, Lie-Nielsen and Sweetheart chisels using an inexpensive side-clamping honing jig. Ironically, many less expensive chisels won't fit in the jig because their sides are too square.

Tapered sides that come down to a point are ideal for cleaning out the corners of dovetails. The sides of Lie-Nielsen and Sweetheart chisels don't quite come to a point, but they're close. Awhile ago, I carefully ground the sides of my Lie-Nielsens and Sweethearts to come to a point, but it takes a steady hand. The Veritas chisels are ready to go.

The maple handles of the Veritas chisels have shallow flats to quickly register the tool in your hand and help prevent it from rolling off your bench. I love that!

Veritas bench chisels come in five sizes: 1/4", 3/8", 1/2", 3/4" and 1". The 1/4" and 3/8" sizes have a 30° bevel, while the other sizes have a 25° bevel. This puzzled me, but an engineer at Lee Valley said, "Narrower edges are subject to a greater concentration of force when driven by a mallet," so their bevel angle should be steeper. All sizes come with a 2° micro bevel and are sharp enough to make shavings right away.

SOURCE

• Lee Valley & Veritas, leevalley.com, 800-871-8158, Veritas Bench Chisels, Set of 5, #05S20.50, $295; 1/4", #05S20.04, $59; 3/8", #05S20.06, $59; 1/2", #05S20.08, $64; 3/4", #05S20.12, $69; 1", #05S20.16, $74.

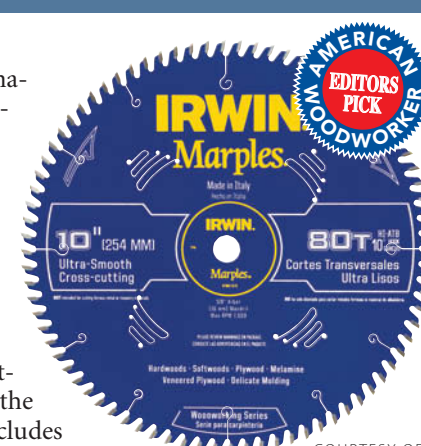
The Blue Blades March In

YOU'LL BE SEEING a whole bunch of new 10" thin-kerf saw blades in stores pretty soon: the blue Marples line, from Irwin. They're squarely aimed at the serious woodworker.

The blades feature generously sized carbide tips for multiple resharpenings, a plate that is "precision tensioned" to minimize vibration, and a non-stick coating to reduce friction and gumming and make the blade easier to clean.

Why go thin-kerf? Irwin gives two reasons. First, thin-kerf blades require less power because they remove less wood. This is ideal for 120 volt saws, whose motors max out at about 1-1/2 hp. Second, thin-kerf blades create less sawdust, a benefit everybody will enjoy. Irwin says their new manufacturing process produces a thin-kerf blade that will run as smooth as a standard-kerf blade.

Marples blades are available for rip, general purpose, combination, fine cross-cutting and ultra-smooth cross-cutting operations. They also make blades for cutting laminate, melamine and non-ferrous metals. In addition, the Marples line includes 12" blades for miter saws and an 8" stacked dado set.



COURTESY OF MANUFACTURER

SOURCE

Irwin Tools, irwin.com, 800-464-7946, Irwin Marples Woodworking Series Circular Saw Blades, $28-$100; 8" Dado set, $130.

EDITOR: TOM CASPAR • PHOTOGRAPHY: JASON ZENTNER UNLESS NOTED

Cadillac Coping Sled

A GOOD COPING SLED is a must for cope and stick routing. A great coping sled is icing on the cake, and that's what Infinity has achieved with their industrial-quality Professional Coping Sled. Hands down, it's the nicest I've used.

A coping sled holds your work at a right angle to the bit. When you're routing tenons on the ends of a rail, for example, you'd use a coping sled. The beefier it is, the better, because routing end grain is tough work. Every feature of the Professional sled is built on a large scale. It's made from 3/8" thick aluminum and weighs 8 lbs. Its base is 7" wide, 11" long and will hold stock up to 6-1/2" wide.

Whoever designed Infinity's sled must have coped a lot of doors in a professional cabinet shop. The padded handles are generously sized and angled just right. Coarse abrasive paper on top of the sled keeps parts from slipping. The sled has *three* extra-large toggle clamps. (I used the two rear clamps to hold a backer board. This arrangement makes it extremely easy to insert a new backer board when I adjusted or changed a bit.) As far as I know, no other coping sled has a three-clamp design.

Here's one more unusual but brilliant feature: The sled is equipped with a 3/8" thick Lexan guard plate that can also be used as a bearing surface against your router table's fence. On most sleds, the workpiece and backer board are all that bear against the fence. If both pieces are narrow, this arrangement can be pretty unstable. Infinity's guard plate gives you a whopping 13" of bearing surface.

The sled is pre-drilled for an optional miter bar. I like using the miter bar on my router table, because it holds the sled rock steady. I'll also use the sled and miter bar on my tablesaw, to dado tenons.

SOURCE

Infinity Cutting Tools, infinitytools.com, 877-872-2487, Professional Coping Sled, #COP-100, $180; Precision Miter Bar – 9-7/8" x 3/4", #COP-MB1, $20.

Hide Your Trash Can

HARDWARE FROM REV-A-SHELF for hiding a trash can behind a cabinet door now has a soft-close feature. You just give the door a nudge and it gently closes without slamming.

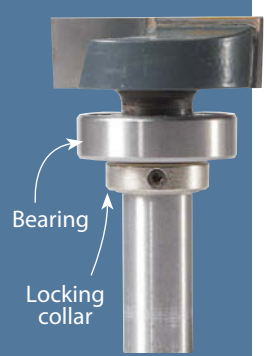
The hardware can be used to retrofit an existing door or can be built into a new cabinet. Included with the kit are 150lb. ball-bearing drawer slides, drawer slide mounting hardware, a door mounting bracket, wood tray with cut-outs and two bins.

The hardware is available in either single-unit (35 or 50 qt.) or double unit (two 27, 35 or 50 qt.) arrangements. It comes in three different widths and depths.

SOURCE

Rev-A-Shelf, rev-a-shelf.com, 800-626-1126, Top-Mount Pull-Out Waste Containers with Soft-Close, $156 - $200.

Rabbeting Bit Accessory



I GOT IN A PICKLE the other day when I needed to rout a curved rabbet that was 9/32" wide. None of the bearings with my rabbet bit set would work. There's a classic solution to this problem: You can place a bearing—of any outside dimension—on the shaft of a rabbeting bit, then hold the bearing in place with a locking collar from Whiteside, the bit manufacturer. Ride the bearing against a template and you're all set.

Locking collars are available for 1/4" or 1/2" shank bits. Bearings with a 1/4" or 1/2" ID and ODs of many different sizes are available from McMaster-Carr (mcmaster.com).

SOURCE

Whiteside Machine Co., whitesiderouterbits.com, 800-225-3928, Bearing Lock Collar 1/4", #LC-1/4, $3; Bearing Lock Collar 1/2", #LC-1/2, $3.

Extra-Large Loose Tenons

BIG PARTS require big joinery. The success of Festool's Domino joiner, a portable machine that makes small-scale loose-tenon joints, has prompted Festool to up the ante. The new Domino XL makes much larger joints—large enough for almost any project.

If you consider the original Domino to be the equivalent of a biscuit joiner, the XL is like a mortising machine. But unlike a stationary machine, you can easily park the XL on a shelf or take it directly to a large workpiece.

The XL doesn't replace the original Domino, however. Using different bits, the original Domino cuts mortises for tenons that are 4, 5, 6, 8 and 10mm thick; the XL cuts mortises for tenons that are 8, 10, 12 and 14 mm thick. (Only a 12mm bit comes with the machine, however. The rest are accessories.) Nicely engineered loose-tenon stock is available from Festool.

The XL lives up to Festool's reputation for making well-engineered, intuitive tools with tight tolerances and excellent dust collection. The height, depth and angle adjustments are straightforward and precise. Bit changing is a snap.

Locating mortises near an end or in the middle of a board is easy. For a corner joint, you use one of three retractable pins located on the tool's face. For a joint far from an edge, you use a cursor centered on the bit.

Accessories for the Domino XL include a Trim Stop for repeatable mortising in the ends of narrow workpieces and a Cross Stop for repeatable hole spacing between 100mm and 200mm. Both accessories are included with the XL Joiner Set.

SOURCE

Festool, festoolusa.com, festooldomino.com, 888-337-8600, Domino XL DF 700 Joiner, #574 422, $1200; Domino XL DF 700 Joiner Set, #574 447, $1250.

Versatile Small Cyclone

WHEN WE POLLED woodworkers about which tool they were likely to buy next year, the most common answer was, "A dust collector!" If you're in the hunt and have a shop with limited space, here's a new compact cyclone from Oneida that's well worth a closer look.

The Dust Cobra is only 20" in diameter and stands 4' tall, but has a 17-gallon drum. You can use it as a stationary machine or add casters to wheel it around the shop. It runs on 120 volts and pulls a maximum of 15 amps.

The Dust Cobra is more versatile than a one or two-bag standard dust collector or a vacuum. A standard collector works well with planers, jointers or tablesaws—tools with large dust ports that require high air flow; a vacuum works well with router tables, sanders or biscuit joiners—tools with small dust ports that require high static pressure. According to Oneida, the Dust Cobra can handle both. In fact, it could serve as your entire dust collection system.

You'll need a few adapters, though, to accommodate the Dust Cobra's 2-1/2" dust port. You should also count on using separate circuits for the Dust Cobra and other power tools.

Emptying the waste from the Dust Cobra is a mixed bag. On the plus side—and it's a very big plus—you can line the drum with a plastic trash bag. You can't use plastic bags with many other cyclones, though. Unless you somehow secure the bag on these machines, it gets sucked up into the machine's exhaust stack. The Dust Cobra has a small vacuum hose connected to the drum in order to hold the bag tight to the drum.

On the downside, there's no easy way to tell when the Dust Cobra's drum is full. And you must lift off the 35 lb. motor and cyclone unit to empty the drum.

The Dust Cobra features a new system for cleaning a cyclone's filter. While the machine is running, you just close the blast gate and pull on a lever to momentarily reverse the airflow. Clever!

COURTESY OF MANUFACTURER

The base model Dust Cobra includes a HEPA filter, 5 plastic bags and a nylon hose strap. A step-up version includes a caster kit, Dust Sentry bin-level indicator, 10 plastic bags and 25' of 2-1/2" hose.

SOURCE

Oneida Air Systems, oneida-air.com, 800-732-4065, The Dust Cobra, #XCK010000A, $788; Vortex Dust Cobra Cyclonic Dust Containment System, #XCK010000A-IND, $1124.

Matt Bickford

Trading Wall Street for molding planes.

by Yoav S. Liberman

MATT BICKFORD'S STORY is quite unusual for a guy in his thirties. He used to be a "market maker" in one of the most competitive environments in the world of finance, living in a big city (Philadelphia) and drinking coffee constantly—"just to stay alert," he recalls. And then, kaboom! He leaves Dow Jones behind, moves his family to a small village in Connecticut and sets up shop making wooden molding planes.

A late bloomer

Many woodworkers discover woodworking early in life. Not so with Matt. Although he grew up around reproductions of early 19th-century furniture, played with puzzles and built things with his father (an engineer), Matt didn't develop an attraction to woodworking until much later. His first serious connection occurred when he visited Don Boulé, a cabinetmaker in Haddam Neck, Connecticut, and an old family friend of Matt's wife. During one of their vacations in Haddam Neck, Matt was invited to Don's shop, where he saw a magnificent sleigh bed with ornate details and carved finials. That bed changed Matt's life.

One of the bed's massive side rails was almost completed, but the other rail was unfinished—laid out, but waiting to be carved. "I was hooked at that moment,"

Molding planes allow duplication of virtually any profile.

EDITOR: TIM JOHNSON | PHOTOGRAPHY: YOAV LIBERMAN, UNLESS NOTED

MATT BICKFORD

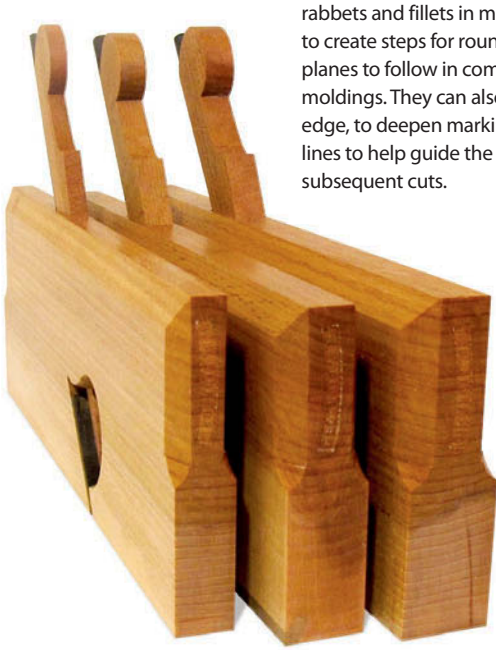
Round and hollow molding planes are sold in pairs and available in widths ranging from 1/16" to 1-1/2" radius. They're used individually or in combination to shape the curved surfaces of moldings such as quarter-rounds, coves, bullnoses, side beads, ogees, astragals and ovolos.

Matt says. "Up until then I had no idea how sophisticated and beautiful the art of furniture making is, how pieces are built and what's involved in making them. Before, I just took things for granted, like using a computer without knowing how it works or what goes on beneath the keyboard."

Seeing Matt's excitement, Don invited him into his house to view the rest of the collection that he and his son Chris had been building over the years. Matt was so taken by the evening's events that he stopped to buy a tablesaw—his first woodworking tool—on the way home.

On his next vacation to Haddam Neck, and the many that followed, Matt became a de facto apprentice in the Boulé shop, gradually developing skills and learning to appreciate tools and techniques. His days were spent helping with whatever was on Don's to-do list, from sanding and knocking out corners to jointing and planing. In the evenings Don tutored Matt via private lessons in fine woodworking techniques such as hand-cut dovetails, carving and turning. "We worked during the day and 'hobbied' at night" Matt recalls. "Ten years later, we still do the same thing."

When Matt started to study woodworking, his goal was to make a Chippendale chair like one he'd seen in Don's shop. "When you see a highly curved handmade Chippendale chair for the first time, and all you used to know was machine-made Queen Anne furniture, your base for appreciating taste, style and craftsmanship is forever shifted," he states. Matt chooses to build tour de force period reproduction pieces. Taking on such challenging work is a great way to continuously develop and refine one's skills in the art of furniture making, he says.



MATT BICKFORD

Rabbet planes are used to make rabbets and fillets in moldings and to create steps for round and hollow planes to follow in complex contoured moldings. They can also be used on edge, to deepen marking gauge lines to help guide the alignment of subsequent cuts.

A plane maker

As Matt grew more immersed in the craft of woodworking, he found that he needed more and more dedicated router bits to correctly mill the molded edges that were required to accurately reproduce each period piece. He also discovered that many of the original drawings and actual moldings on genuine period pieces required shaped details that didn't exist in the fixed canon of commercial carbide-bit profiles. "The idea of spending $30 or $130 dollars on a new bit that's only close to the edge that I want is discouraging," he says. "Making a tall case clock or a large secretary that has a wide crown molding with eight different steps is out of the question; it would cost hundreds of dollars for shaper knives to run 4 feet of molding that you'll never use again."

So, Matt decided to try the tools cabinetmakers had used for centuries: molding planes. "You can put them to work to make a really elaborate compound molding that includes six, seven or eight steps," he says, intently. "Then, on another occasion, you can incorporate some or all of the planes to make a totally different profile. With a set of molding planes, you can do so many things!"

Matt started buying molding planes online and at flea markets. As he began to realize their potential, he started to think about making them from scratch. It just so happened that as Matt was contemplating making his own planes, Lie-Nielsen Toolworks released three items that made it possible: a DVD on how to make molding planes, tapered tool-steel plane-iron blanks, and floats, the tools used to cut, flatten and smooth the bedding for the plane iron and other critical parts of a wooden plane.

Two other coincidences occurred on Matt's journey to becoming a plane maker. As a member of a Philadelphia woodworking club, he had started to give demos on traditional woodworking techniques, including the

continued

MATT BICKFORD

Dedicated molding planes allow cutting a specific profile with a single plane. This plane cuts a 3/4" ogee with a fillet.

use of molding planes. One night, Chuck Bender, a local period furniture maker who was a guest at the meeting, saw Matt's planes and asked if Matt would make him a set. Matt declined, but a year or so later, Chuck saw Matt again and repeated his request. Coincidentally, Matt had just decided to leave his stock market job and move to Connecticut. At this watershed moment, Matt became a plane maker.

Making a molding plane

Matt's shop is at home in Haddam Neck, divided between the basement ("My dungeon," he laughs), where he mills the wood for his planes, and his upstairs studio, where the plane fabrication takes place. The Bickford family—Matt and his wife have three boys—resides between the two shop levels.

Matt makes most of his planes from quartersawn American beech, a dense hardwood with an important characteristic for wooden plane makers: beech uniformly expands and contracts throughout the plane's body with seasonal changes in humidity. Thus, a beech plane will not become thinner in the middle than at the ends, deforming its geometry and degrading its performance. Cherry and other fruitwoods share this characteristic, which makes them good substitutes.

Matt initially shapes the wooden blanks with machines, but he spends most of the production time using handsaws, chisels and floats to shape the planes' details, parts and subtle ornamentation (**Photos 1–6**). Each of Matt's planes includes a beautiful escapement, an artfully shaped opening above the blade that directs the shavings out and away from the tool. For the blades, Matt uses Lie-Nielson O1 tapered tool-steel iron blanks, which he individually shapes, hardens and sharpens for each plane. In his premium rabbet planes, Matt embeds (or "boxes") a persimmon end-grain ledge to protect the plane's edge from long-term wear.

Using molding planes

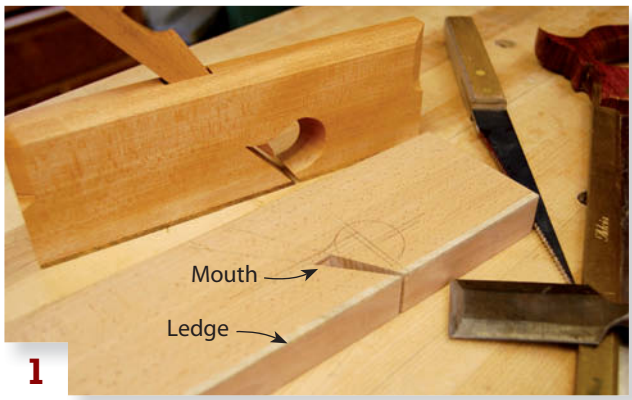
Molding planes cut flat, groove, cove and bead profiles, which are combined to make moldings of all shapes and sizes. According to Matt, two rounds, two hollows and a rabbet plane make versatile starter set.

One basic profile, the rabbet, is also used to stage the creation of more complex profiles. To cut a rabbet, place the molding blank on a long board that's clamped to the bench. (Supporting the blank along its entire length allows creating moldings from even the thinnest and most delicate stock.) Use a bench dog or install two screws at the end of the blank to keep it from moving as you plane.

Start by using a marking gauge to establish the rabbet's width. Then follow this line to cut a tiny groove parallel to the edge—Matt calls this the "gauge line." Place the edge of the rabbet plane on the gauge line, tilt the plane and make one or two strokes to create a V-groove.

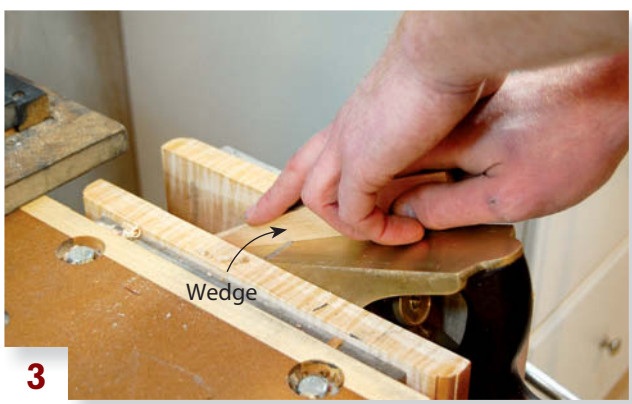
Next, stand the plane vertically and plane end-to-end to form the rabbet. "Use your fingers underneath the plane to act as fences to control the rabbet's width," Matt says. "The grooved gauge line provides room for error." Complete the job by laying the rabbet plane on its side in the rabbet and using it to clean the rabbet's shoulder and cut it flush with the gauge line.

Creating a more complex molded profile is a process of incremental reduction, according to Matt. He draws the molding's profile on the end of a blank. Then he uses the profile's transition points and a rabbet plane to create a series of steps that remove most of the waste. Once the steps are established, they're left as fillets or shaped with round or hollow planes to form the molding's convex or concave profiles.

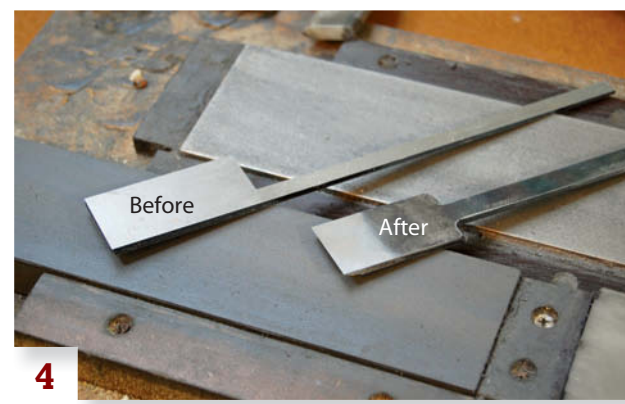


To make a rabbet plane, the first step is to protect the edge from wear by embedding a ledge of end-grain persimmon. Then the mouth for the blade is precisely cut at the proper angle.

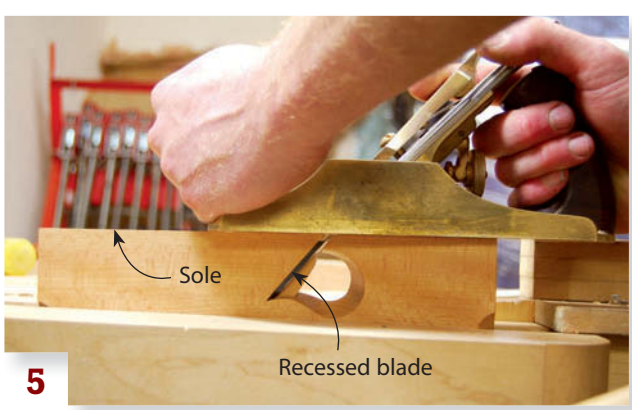
The housing for the blade's shaft and the wooden wedge that secures it is drilled and then carefully shaped with tools called "floats" that are specifically made for this critical work.



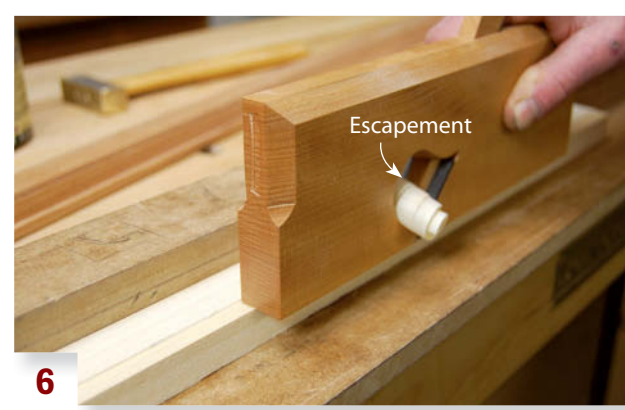
The plane's wedge is tapered to fit the housing so it will lock the blade's shaft in position.



The plane iron blank is shaped, hardened and sharpened to form the blade.



The plane's sole is flattened with its blade installed, but recessed.



During use, the escapement funnels shavings out and away.

Visit **msbickford.com** to learn more about Matt's molding planes. Matt's new book *Mouldings in Practice*, published by Lost Art Press, is now available.

See Matt's molding planes in action at **AmericanWoodworker.com/WebExtras**

Yoav S. Liberman is a studio furniture maker, teacher and tool inventor who works primarily with found objects and discarded wood. He resides in New York, where he manages the woodshop at Robert Lighton Furniture and teaches furniture making at 3rdWard, Brooklyn.

Canoe Shop

A custom-built shop for custom-built boats.

MY BOAT SHOP is the result of years of frustration. I used to build cedar-strip canoes and sea kayaks in an attached 1-1/2 car garage and was constantly fighting both the confined space and the shop dust that kept migrating into the house. So, when I retired and had a bit of extra time, I had a local builder construct the shop and then finished the interior space myself. Now I have lots of open space to work around 18' long boats, a high ceiling, and no internal support posts to avoid while maneuvering the long cedar strips that I use. Everything else in the shop reads "boatbuilding," too. Along one wall I built a long workbench to fabricate decorative accent strips for the boats. I installed fluorescent lighting above the bench to complement the natural light from all the windows and doors. The white ceiling helps, too.

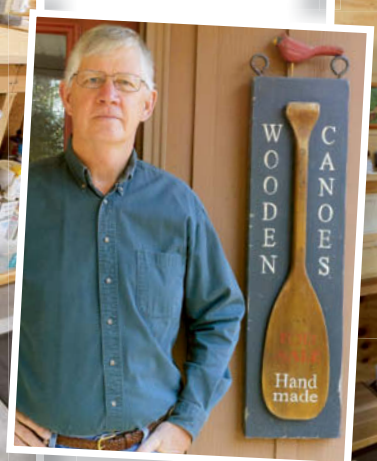
Under the bench, my fiberglassing tools and epoxy are close at hand. The small parts and odd surfaces that go with boatbuilding require that I have at least one of virtually every type of clamp you can imagine. I store most of them, as well as sanding and sharpening supplies, in plastic restaurant bus trays—a trick I learned from a story in *American Woodworker*; it's a simple and efficient system for storing small items.

A rack on the opposite wall stores the long cedar strips and accent woods. I park my portable and stationary tools below this rack; they're all on mobile bases, so they can easily be wheeled into action as necessary. The space above the shop is a stand-up attic for storing molds, scrap wood and stuff I don't use everyday.

Double front doors with no outside step make it easy to move boats and materials in and out. They also allow setting up tools near the doors or rolling them outside when I have to rout end-to-end bead and cove profiles on very long strips. A lean-to style covered porch for storing boats or drying lumber adjoins the shop. It's also a great place to work outside on nice days.

Clear-coat fiberglassing of the boats requires a narrow and con-

EDITORS: DAVID RADTKE AND TIM JOHNSON | PHOTOGRAPHY: COURTESY OF GENE BURRESON



Build a shop storage cabinet with restaurant bus trays at **AmericanWoodworker.com/WebExtras**

sistent temperature range. Here in coastal Virginia we get hot, humid summers and cool winters, so the shop needs both cooling and heating. Originally, I planned to buy a wood stove and install central air, but the cost was prohibitive. So, instead, I settled on a ductless mini-split heat pump system that's common throughout Europe and Australia. This system has an external compressor that connects to a single internal unit, which in my shop hangs above the bench. It provides adequate heat in winter and plenty of cooling and humidity control in the summer. A ceiling fan helps circulate the air year-round.

My shop also has a few creature comforts (after all I am retired), including a bookcase, a rocking chair and a speaker system that connects to my iPod.

I've built a 17' sea kayak in my new shop and I'm just finishing a 17' canoe. I build mainly for the enjoyment and sell the boats for a bit above cost. I've also become known locally for restoring wood trim on commercial fiberglass canoes. I'm thoroughly enjoying retirement, mainly because I have a great canoe shop.

Gene Burreson
Gloucester, Virginia

Tell Us About Your Shop

Send us photos of your shop, a layout drawing and a description of what makes your shop interesting. Tell us what you make in it and what makes your shop important to you. If "My Shop" features your shop, you'll receive $100.

E-mail your entry to **myshop@americanwoodworker.com** with digital photos attached. Or mail your description with digital photos on a disc to My Shop, American Woodworker, 1285 Corporate Center Drive, Suite 180, Eagan, MN 55121. Please include your phone number. Submissions cannot be returned and become our property upon acceptance and payment. We may edit submissions and use them in all print and electronic media.

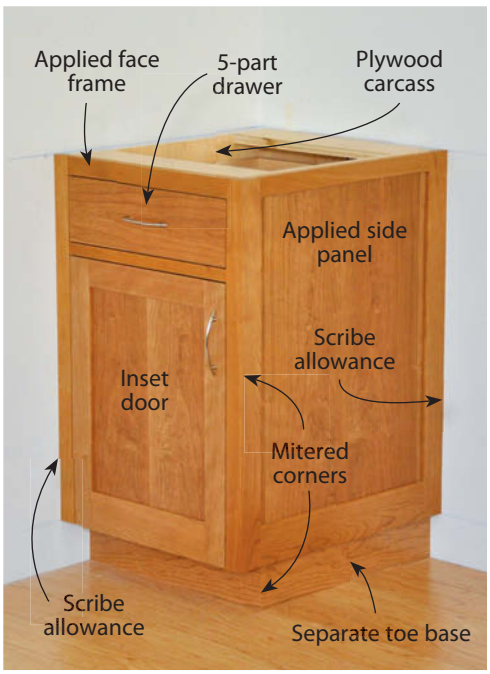
Cabinet-Building Essentials

by Greg Larson

Classic appearance with 32mm system simplicity.

PHOTO BY MARC GRENIER

ASK TEN WOODWORKERS how to build kitchen cabinets and you'll get eleven answers. So where do you start? At the New England School of Architectural Woodworking (NESAW), we've consolidated industry's "best practices" to create a simple and efficient method of building cabinets that works for professionals as well as home woodworkers. This method combines classic face frame styling with the benefits of frameless construction and the 32mm system. In this story I'll show how to build the single base cabinet shown here. Building this model cabinet demonstrates everything you'll need to know about the process we use, so you'll be able to custom-build your own cabinets.



Efficient construction

The cabinet actually consists of four separate components: a base (called the "toe base"), a box (the "carcass"), a face frame, and a side panel (these last two are the "facing"). This construction method is very efficient. Building the toe base and carcass separately allows getting six carcass sides from a sheet of plywood. Leveling the toe base is easy, because there's no cabinet to get in the way. Once the toe base is leveled, the carcass simply sits on top and is anchored to the wall. For runs of cabinets—the heart of most kitchen cabinetry—you just build plywood carcasses, fasten them together, and apply the facing. Each run of base cabinets requires only one long toe base.

Another key feature is that the carcass sides are flush with the inside edges of the face frame. This allows using Euro hinges and drawer slides without the time-consuming task of building out the cabinet's insides to make them flush with the face frame. Note also that there's no lower face frame rail. This allows using the bottom of the carcass as a doorstop and provides more space inside the cabinet (where every inch counts). The cabinet's 1/2" thick back adds extra strength and rigidity and allows it to be anchored by screwing directly through the back into the wall.

Standard kitchen base cabinets are 24" deep and 36" high to the top of the countertop. Our sample cabinet is 34-3/4" high, which assumes a 1-1/4" thick granite countertop; a standard laminate countertop may require blocking underneath to raise it to the desired height.

Start with the lumber

Select boards with the straightest grain for the door stiles and rails (C1–C3, Fig. E, page 36, and Cutting List, page 36). Rough mill this stock and sticker it for as long as possible before milling it to final thickness and width. It's very important that the doors stay flat; using straight grain lumber, milling it in stages, and letting it rest in between stages helps accomplish this goal.

Choose boards with the next-straightest grain to use for

EDITOR: TIM JOHNSON | PHOTOGRAPHY: MARGARET LARSON OR NICK NOYES, UNLESS NOTED | ILLUSTRATION: FRANK ROHRBACH

Start by boring system holes in the carcass sides. These cabinets are based on the 32mm system. A spacer clamped flush with the bottom indexes the jig.

Cut biscuit slots in the carcass sides using a stop marked with the slot locations to register the biscuit joiner. Make sure the carcass side is firmly held against the stop when you cut the slots.

Cut matching biscuit slots in both ends of the carcass bottom, using the same marked stop. Make sure the bottom is firmly clamped to the table to avoid alignment issues.

Screw together the carcass after applying glue and installing the biscuits. Pre-drill the screw holes to avoid splitting the plywood. Measure diagonally to make sure the carcass is square.

face frames and side panel frames—the appearance of wild-grained parts in the frames may detract from the panels or doors they enclose. This stock should also be milled in stages and allowed to rest.

Mill the face frame and side panel parts (E1–E4; F1–F4, Fig. A) to final thickness and width, but leave them oversize in length. Note that these parts are 13/16" thick and that the stiles for each assembly are different widths. The extra thickness allows placing a 1/16" thick bumper between the 3/4" thick door and the cabinet to ensure the door closes flush with the face frame. The two wider stiles in each assembly include 1/2" scribe allowances that allow cutting them to match the profile of an uneven wall. The ability to incorporate scribe allowances that allow you to seamlessly fit cabinets to the walls is one of the many advantages of building your own cabinets.

Pre-finished plywood

We use pre-finished plywood for the carcasses so we don't have to spend time finishing the insides. This is particularly important if you're spray finishing, because you don't have to drag the assembled boxes back and forth to the spray room. It also eliminates overspray and blowback problems that can crop up when spraying cabinet interiors. If you can't find pre-finished plywood, or want to use another species for the cabinet interiors, you can still pre-finish it (see "Pre-finishing Plywood," page 68).

Cut all the parts

Start by breaking down the plywood and cutting the carcass sides, bottom and stretchers (B1–B3). At this point, leave the bottom and sides oversize in both width and length, and the stretchers oversized in length. Glue 1/8" thick solid wood edging (B4) in the same species as your plywood to the front edge of the bottom; this edging will be exposed when the door is open and serves as a door stop when it closes. Thin veneered edge banding won't provide sufficient protection.

Trim the edging flush with both faces of the plywood, taking care not to damage the finish. Then rout a 45° bevel on its top edge to avoid damage caused by putting items in and out of the cabinet. Start the bevel exactly at the glue joint between the edging and the plywood. Apply several coats of wipe-on polyurethane to the edging before you assemble the carcass.

Cut the carcass bottom, sides and stretchers to final dimensions along with all of the facing parts. The face frame rails (E3, E4) have to be exactly the same length as the carcass bottom and stretchers (B2, B3), and the face frame and

Fig. A
Base Cabinet Exploded View

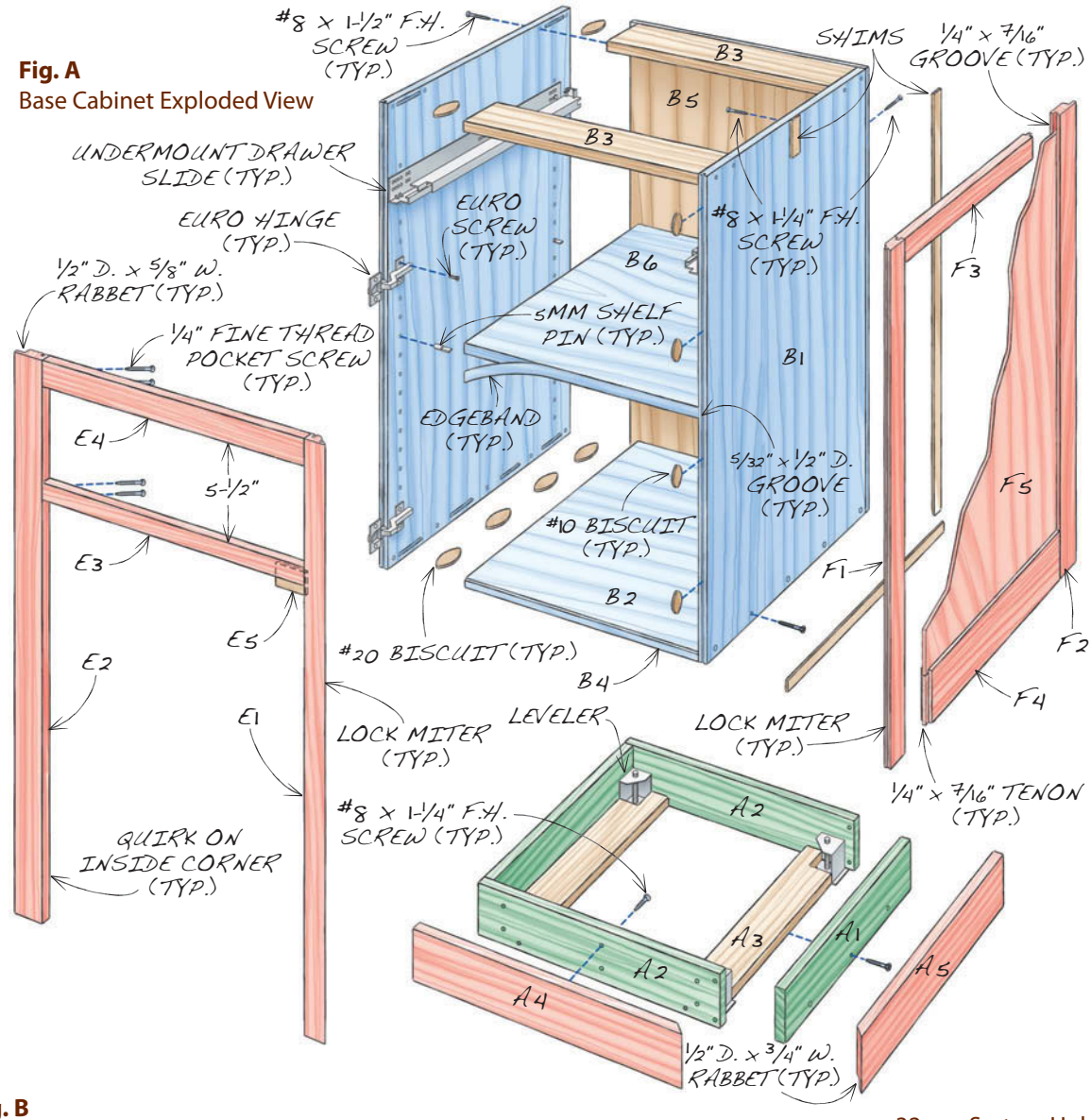


Fig. B
Top View (showing lock miter, quirk and scribe allowance)

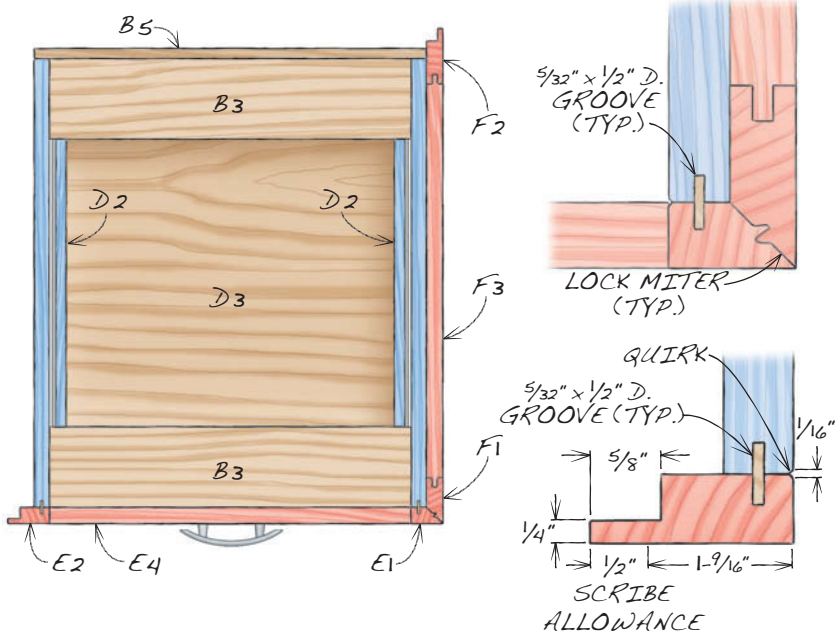
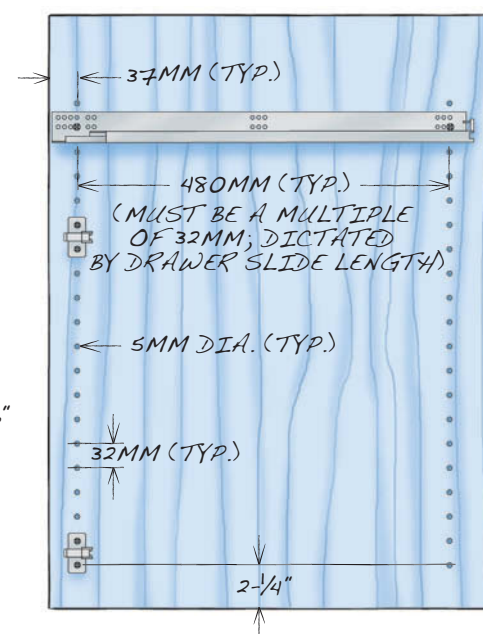
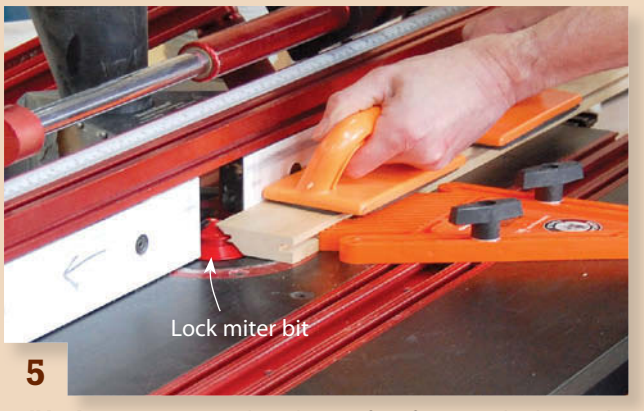


Fig.C
32mm System Hole Layout





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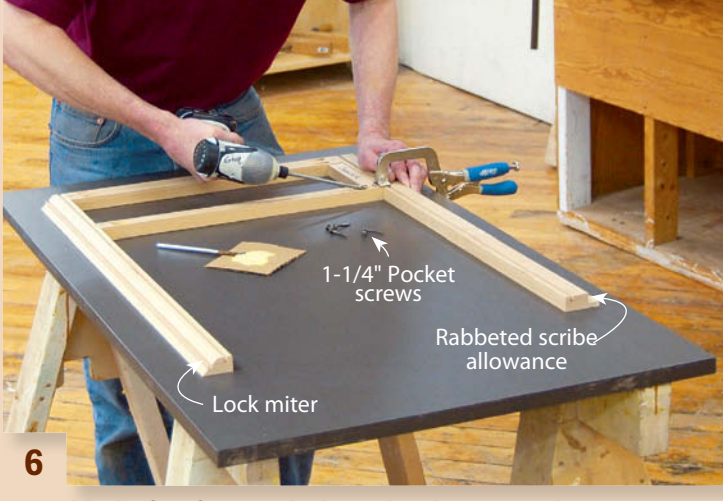
Mill lock miter joints in the adjacent face frame and side panel stiles. Using miters to join the cabinet's facing components creates beautiful seamless corners—a hallmark of fine cabinetry.

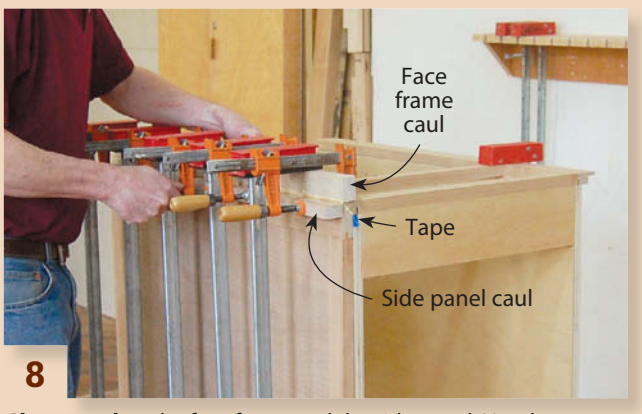


6

Assemble the face frame with glue and pocket screws. Clamp the frame to a flat surface to ensure good alignment, taking care not to damage the lock miter.

7

Glue together the side panel. Protect its delicate lock-mitered edge by using a spacer and shop-made clamping blocks with the reverse profile.



8

Glue together the face frame and the side panel. Use the carcass as a positioning guide and cauls to ensure a tight-fitting lock miter joint. Tape the carcass so it doesn't stick to the joint.

side panel stiles (E1, E2; F1, F2) are exactly the same length as the carcass sides (B1), so it makes sense to cut them all at the same time, using the same stops.

Cut the side panel rails (F3, F4) to final dimensions now, too. Then use a stile-and-rail set to rout tongue-and-groove joints in the side panel's stiles and rails. Rout the grooves first, then the tongues. The set I use adjusts to fit the thickness of the plywood panel (see Sources, page 39).

Mill quirks, grooves and holes

Clearly mark the carcass sides and stretchers, indicating left and right sides, and the front and top edges. Use a 45° chamfer bit to rout a tiny bevel (about 1/32" wide) on the inside front edge of both carcass sides and the inside edge of both face frame stiles (Fig. B). This detail, called a "quirk," disguises any slight misalignment when the face frame is glued to the carcass.

Next, use a router table equipped with a 5/32" wing cutter to rout full-length grooves in the front edges of the carcass sides and in the backs of the face frame stiles. These grooves will be used to align the face frame with the carcass during glue-up. Reference off of the inside face of both pieces to ensure proper alignment and size the grooves' depth to accommodate #10 biscuits.

The 5mm dia. system holes are used to mount the hinge plates, drawer slides and shelf pins. For the hardware to work properly you need to follow a few basic rules, which include drilling the front row of holes 37mm from the carcass front and the back row of holes a multiple of 32mm from the front row (480mm in this case; Fig C). It's best to keep your layout in metric units. I prefer to use a jig such as the Veritas 32 Cabinetmaking System to drill the holes, especially when I'm building a lot of cabinets (**Photo 1** and Sources). Clamp a 2-1/4" spacer flush with the bottom of the carcass side to index the jig, so the holes are always consistently offset from the bottom edge on both sides.

Assemble the carcass

The carcass assembles with butt joints, using biscuits for positioning and screws for strength. Mill #20 biscuit slots in the face of the carcass sides (**Photo 2**). Mill matching slots in the ends of the stretchers and bottom (**Photo 3**). Use four biscuits to fasten the bottom and one biscuit centered in both ends of each stretcher. Per Architectural Woodwork Institute (AWI) standards, locate the biscuit slots a maximum of 2" on center from the edge of the side and no more than 6" apart.

Mark the biscuit locations on the outside of both carcass

sides. Then dry-assemble and clamp the carcass while it's laying on its back on a flat surface. Make sure all of the joints come together and are flush. Then pre-drill countersunk holes for #8 x 1-1/2" screws in the sides to connect the bottom and stretchers, making sure to avoid the biscuit locations. Disassemble the carcass and apply glue to the biscuits. Then reassemble, clamp and screw the carcass together (**Photo 4**). Once the screws are in, immediately remove the clamps and install the back (B5). Check for square by measuring the diagonals of the carcass' front opening—they should be within 1/16" of each other, preferably closer. Fasten the back using #8 x 1-1/4" screws every 4" on center. This is particularly important when building an upper cabinet, as the back is what supports the cabinet when it's fastened to the wall.

Install iron-on maple edgeband on the adjustable shelves (B6) before cutting them to final dimensions.

Fig. D Drawer

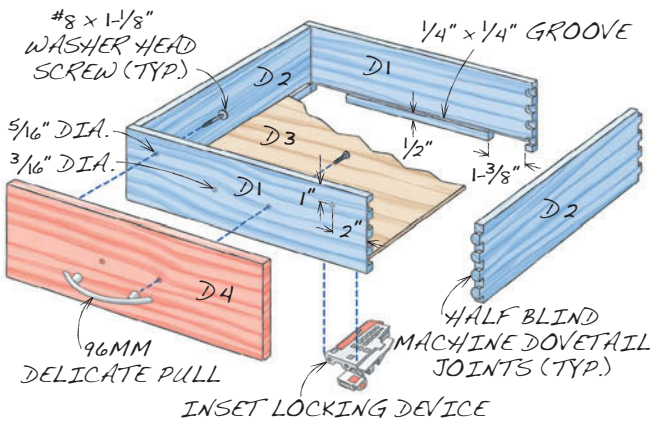
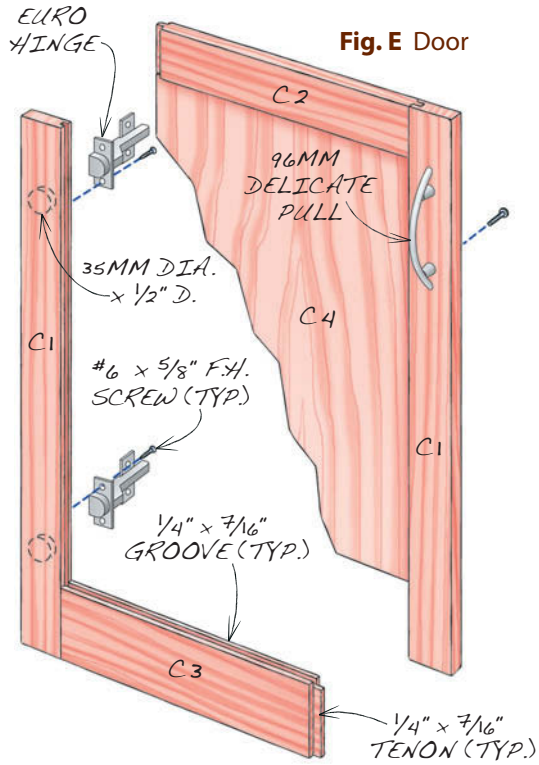


Fig. E Door



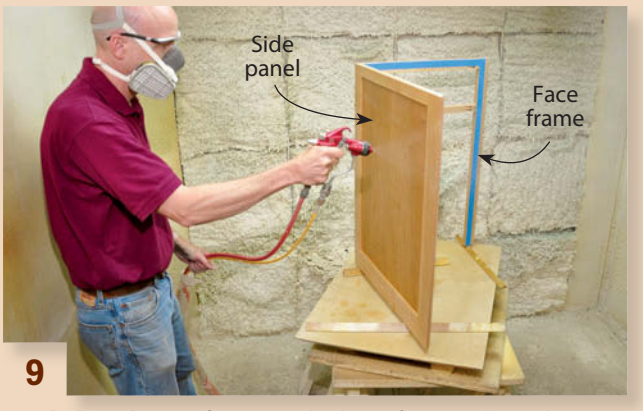
Cutting List: Base Kitchen Cabinet

Overall Dimensions: 34-3/4" H x 21-1/2" W x 24-1/2" D (a)

Section	Part	Name	Qty.	Material	Th x W x L
Toe Base					4" x 19-3/4" x 21"(d)
	A1	Side	2	Plywood (b)	3/4" x 3-1/2" x 18-3/4" (d)
	A2	Front/back	2	Plywood (b)	3/4" x 3-1/2" x 19" (d)
	A3	Stretcher	2	Plywood (b)	3/4" x 3" x 18-3/4"
	A4	Applied front	1	Cherry	3/4" x 4-1/2" x 21" (d, e)
	A5	Applied side	1	Cherry	3/4" x 4-1/2" x 22" (d, e)
Carcass					30-3/4" x 19-3/8" x 22-11/16"
	B1	Side	2	Maple plywood (c)	3/4" x 22-3/16" x 30-3/4"
	B2	Bottom	1	Maple plywood (c)	3/4" x 22-3/16" x 17-7/8" (f)
	B3	Stretcher	2	Maple plywood (c)	3/4" x 4" x 17-7/8"
	B4	Edging	1	Maple	1/8" x 3/4" x 17-7/8"
	B5	Back	1	Maple plywood (c)	1/2" x 19-3/8" x 30-3/4"
	B6	Shelf	1	Maple plywood (c)	3/4" x 21-15/16" x 17-5/8"
Door					3/4" x 17-7/8" x 22-3/4" (g)
	C1	Stile	2	Cherry	3/4" x 2-5/16" x 22-3/4" (h)
	C2	Upper rail	1	Cherry	3/4" x 2-5/16" x 14-1/8" (h, j)
	C3	Lower rail	1	Cherry	3/4" x 3-5/16" x 14-1/8" (h, j)
	C4	Panel	1	Cherry plywood	1/2" x 14-1/16" x 17-15/16"
Drawer					5-5/16" x 17-11/16" x 21-3/4"
	D1	Front/back	2	Maple	1/2" x 4-1/4" x 17-1/4" (k)
	D2	Side	2	Maple	1/2" x 4-1/4" x 20-3/4"(l)
	D3	Bottom	1	Maple plywood	1/4" x 16-3/4" x 20-1/2"
	D4	Applied front	1	Cherry	3/4" x 5-1/2" x 17-7/8" (g)
Face Frame					13/16" x 21-1/2" x 30-3/4"
	E1	Right stile	1	Cherry	13/16" x 1-9/16" x 30-3/4" (m)
	E2	Left stile	1	Cherry	13/16" x 2-1/16" x 30-3/4" (n)
	E3	Mid rail	1	Cherry	13/16" x 1" x 17-7/8"
	E4	Upper rail	1	Cherry	13/16" x 1-1/2" x 17-7/8"
	E5	Door stop	1	Cherry	1/4" x 1-3/8" x 1-1/4"
Side Panel					13/16"x 24-1/2" x 30-3/4"
	F1	Front stile	1	Cherry	13/16" x 2-1/4" x 30-3/4" (h, m)
	F2	Rear stile	1	Cherry	13/16" x 2-3/4" x 30-3/4" (h, n)
	F3	Upper rail	1	Cherry	13/16" x 1-1/2" x 20-3/8" (h, j)
	F4	Lower rail	1	Cherry	13/16" x 3-1/4" x 20-3/8" (h, j)
	F5	Panel	1	Cherry plywood	1/4" x 20-5/16" x 26-9/16"

Notes:

a) Width and depth dimensions include 1/2" scribe allowances; the allowances that are built-in depend on how much the walls are out of plumb.
b) Any type of veneer-core plywood.
c) Pre-finished veneer-core plywood.
d) Width is nominal; it varies depending on how much the floor slopes.
e) Oversize in length to allow mitering and fitting to wall; includes 1/2" in extra width for scribe allowance.
f) Width includes 1/8" front hard maple edging (B4).
g) Size to exactly fit the opening, then trim to leave 3/32" gaps all around.
h) One edge has 1/4" x 7/16" groove.
j) Length includes 7/16" long tenons on both ends.
k) Undermount slides require that the drawer box front and back are 5/8" shorter than the length of the cabinet's drawer opening.
l) Length is dependent on your dovetail jig; overall finished drawer box length must be exactly 21".
m) One edge is mitered. Cut E1 and F1 side-by-side from the same piece of wood, so the grain wraps around the mitered corner.
n) Includes 1/2" in extra width for scribe allowance; may be more or less, depending on how out of plumb the wall is.



Finish the cabinet's facing. End cabinet facings (shown here) consist of mitered face frames and side panels. Facing for interior cabinet runs consist of face frames only.

Attach the facing to the carcasss by gluing only the face frame. Remove squeeze-out before it hardens. The carcass' undersize plywood leaves a gap that keeps the side panel from binding.

Install a full-length shim to maintain an even gap and keep the side panel parallel with the carcass. Then fasten the panel at the back, using pocket screws along its entire length.

Use the system holes to mount the drawer and door hardware. Building the inside of the cabinet flush with the face frame significantly simplifies the process.

Allow for scribing

The face frame and side panel each contain one stile that's wider than the other by 1/2"—a typical scribe allowance—so you can cut the stile to perfectly match a wall that isn't straight. To determine just how much width to add for a scribe allowance, it's important to check the wall that the cabinet will attach to. If the wall is out more than 1/2" from top to bottom, you'll have to add that much more width to the stile. Make sure to add at least 1/4" more width than you think you'll need—it's better to have more than enough than not enough.

Rabbeting the scribe allowance eases installation by leaving much less material to remove (Fig. B). Rout the rabbet 1/8" wider than the scribe allowance you've added (5/8" for a 1/2" scribe, for example). When you cut the rabbet, leave the tongue that remains on the face about 1/4" thick.

Rout the rabbet in the back edge of the face frame's extra-wide left stile (E2) now, prior to assembly. However, to make clamping easier during glue-up, wait until after the side panel has been glued together to rout the rabbet in its extra-wide rear stile (F2).

Rout lock miters

Whenever the face frames and side panels meet, I use a miter joint. This gives the cabinets the look of high-quality furniture. Using a butt joint is much easier, but getting a pleasing match of both color and grain is more difficult. With a mitered joint, I can cut both stiles from the same piece of wood and wrap the grain around the corner.

Cut the long miters on the router table using a lock miter bit (**Photo 5** and Sources). With a lock miter bit, you must run one piece horizontally and one vertically. In this case, running the face frame stile (E1) vertically makes the clamping process a bit easier down the road. When a lock miter bit is properly set up, you don't need to change the fence or bit height when you switch pieces.

Learn how to use a lock miter bit at **AmericanWoodworker.com/WebExtras**

Assemble the facing

Assemble the face frame using 1-1/4" fine-thread pocket screws (**Photo 6**). To avoid damaging the mitered edge, do not finish-sand this assembly until it has been glued to the side panel.

Glue and clamp the side panel assembly, using shop-made clamping blocks and a spacer to protect the lock-mitered edge (**Photo 7**). The clamping blocks are the mirror

image of the lock miter. The spacer keeps the clamps away from the miter's knife edge. Remove squeezed-out glue before it hardens. Rabbet the scribe allowance in the rear stile (F2) after removing the clamps. As before, do not finish-sand this assembly until it has been glued to the face frame.

Glue the lock miter joint between the face frame and the side panel, using the carcass as a convenient jig to support both pieces (**Photo 8**). Tape the front corner of the carcass so it doesn't get glued to the mitered facing assembly. Use clamping cauls to ensure a tight joint. When the glue has dried, finish-sand the mitered assembly and tape off the back of the face frame where it will contact the carcass, to ensure good glue adhesion later. Then apply the finish (**Photo 9**). At NESAW, we spray one coat of Zinsser SealCoat dewaxed shellac, followed by two coats of ML Campbell Aqualente water-based lacquer.

Attach the facing

Glue on the pre-finished facing assembly, using biscuits installed in the routed grooves to align the carcass sides with the inside edges of the face frame stiles (**Photo 10**). To avoid damaging the finish, make sure the clamping cauls are smooth and free of debris, and immediately remove squeezed-out glue from the quirks, the tiny bevels in the joints between the face frame and the carcass sides. A toothbrush works great for this.

Because the carcass' veneer-core plywood is undersize in thickness, gluing the facing to the carcass as described above leaves a gap that keeps the side panel from binding. Install shims sized to maintain this gap evenly along the panel's length. Then attach the side panel to the carcass, using 1-1/4" fine-thread pocket screws through the back and along the bottom edge (**Photo 11**). At the top edge, attach the side panel at the midpoint of the carcass. Install a shim and then screw directly through the carcass into the panel's upper rail, using #8 x 1-1/4" screws.

Glue and screw a door stop (E5) to the back of the face frame's mid rail, so it protrudes 3/8" into the upper right corner of the door opening. Stopping the door at both the top and bottom keeps the door from twisting due to the force of the European hinges. Apply finish to the door stop and any areas on the back of the face frame that weren't finished earlier.

Build the door

Mill the door stiles and rails (C1–C3) to final dimensions. Note that the bottom rail is wider than the top rail. This helps to ground the cabinet, as there is no bottom face frame rail. Size these parts so the glued-up door will be the same size as the opening. Use the same stile-and-rail set you used for the side panel to cut the tongue and groove joints. Cut the panel (C4) and glue up the door (see "Make a Frame and Panel Cabinet Door," page 40).

Trim the door to fit the opening in the cabinet and then install it using Euro-style hinges (see "How to Install a Cabinet Door," page 45 and Sources). Remove the door to sand and finish it. Then install the pull (see Sources).

Build the drawer

The drawer consists of a dovetailed box with an applied front (D1–D4, Fig D). It rides on drawer slides that hide under the box, so they're invisible when the drawer is open (see Sources). I use a dovetailing jig to make the drawer box (see "How to Make a Cabinet Drawer Box," page 49).

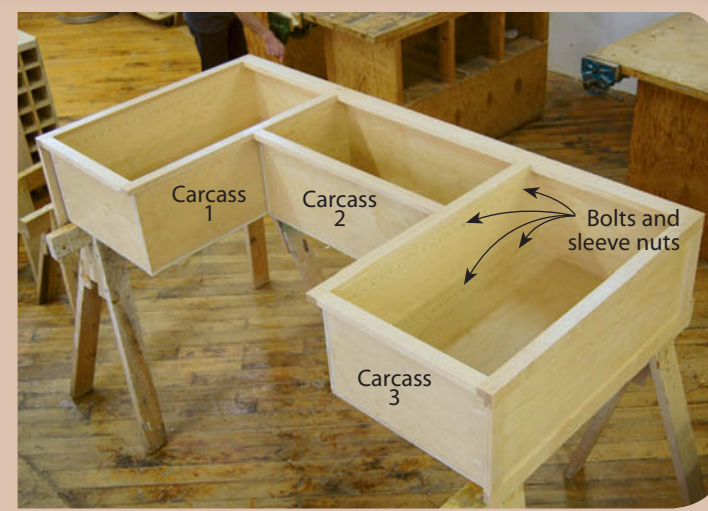
The drawer box must be accurately sized to accommodate the undermount slides. The 21" Blum slides we use require the outside length of the drawer box to be exactly 21". Likewise, our 1/2" thick drawer-box sides require the box to be exactly 5/8" narrower than the cabinet's drawer opening. Also, the drawer bottom must be exactly 1/2" above the bottom of the drawer side.

The undermount slides mount inside the cabinet (**Photo 12**). Then you modify the drawer box and install inset locking devices that attach it to the slide (see "How to Install a Cabinet Drawer," page 59). Once the drawer box is installed, you fit the applied front to the opening and then fasten it to the box using special washer-head screws (see Sources). Sand and finish the drawer box and its applied front after you've fitted them to the cabinet. Mount the pull after the cabinet has been installed.

Complex Cabinets Made Easy

To make a run of cabinets, build separate plywood carcasses and fasten them together using the 32mm system holes. Drill all the way through matching system holes at the top and bottom of adjacent carcasses. Install shims between the carcasses so they'll mount flush with the face frame's 1-1/2" wide internal stiles. Connect the carcasses using sleeve nuts and truss head bolts (see Sources, page 39). Then glue on the face frame.

As shown here, upper cabinet face frames and side panels extend below the carcasses to create valences for under-cabinet lighting. After installation, 1/4" plywood skins are added to cover the exposed carcass bottoms. This cabinet is designed to go over a stove; a microwave oven will hide the rest of its exposed carcasses.



Build the toe base

The toe base's frame will be covered by solid wood facing (A4, A5), so you can build it using nearly any 3/4" thick veneer-core plywood. The long toe bases used under cabinet runs contain multiple stretchers that resemble the rungs of a ladder.

A standard toe base is 4" high, so cut the frame's front, back and sides (A1, A2) narrower, as necessary, to accommodate shimming to an out-of-level floor. In this case, they're sized at 3-1/2" (see "Installing Cabinets," page 62). Screw the frame together after pre-drilling for #8 x 1-1/2" screws; no glue is necessary. Levelers installed in each corner make installation easier and faster (**Photo 13** and Sources). Notch the stretchers (A3) and install them. Cut the facing parts oversize in length for now—they'll be cut to final width and length during installation. Rout a 1/2" x 3/4" rabbet in the bottom edge of each part to make it easier to scribe to the floor. Then sand and finish the facing parts.

Assemble the cabinet's toe base. Building the toe base and carcass separately simplifies construction, eases installation and uses materials efficiently. Screw together the sides and ends, mount the levelers and then install the stretchers.

Upper cabinet variations

Like the base cabinet, the upper cabinet consists of a plywood carcass with solid wood facing, but it differs from the base cabinet in these important ways: Its face frame has a bottom rail, its door rails are the same width, and its face frame and side panel(s) extend beyond the carcass to create a valence for under-cabinet lighting (see **Photo**, opposite page). Finally, a 1/4" plywood skin of the same species as the facing covers the bottom of the carcass. Finished the same as the rest of the cabinet, this skin is scribed to the wall and attached with construction adhesive and pin nails after the cabinet is installed.

See the upper cabinet plans and cutting list at **AmericanWoodworker.com/WebExtras**

SOURCES

- Lee Valley & Veritas, leevalley.com, Veritas 32 Cabinetmaking Deluxe System, #05J06.02, $329.
- McFeely's, mcfeelys.com, 800-871-8158, Euro Screws, 5mm x 13mm, #0513-ECS-C, $5.70 per box of 100 screws; Undercut Flat Head Screws, #6 x 5/8", #0605-FPU-C, $2.65 per box of 100; Super Round Washer Head Screws, #8 x 1-1/8", 0811-SRZ-C, $7.35 per box of 100.
- HomeDecorHardware.com, homedecorhardware.com, 877-765-4052, Base Leveler, #Hafele-USA-637.37.904, $14.74 per set of 4 (two L, two R); Shelf Pin, 5mm, nickel-plated, #Hafele-USA-282.04.711, $0.20 ea.; Sleeve Nut, M4, 5mm x 35mm, #267.01.717, $0.72 ea.; Truss Head Screw, M4 x 15mm, #022.34.157, $5.98 per box 100.
- Woodworker's Hardware, wwhardware.com, 800-383-0130, Blum Tandem 562H Full-Extension Undermount Drawer Slide w/ Blumotion, 21", #B562H 5330B, $23.12 per pair; Blum Inset Locking Device, #BT51.1700PV, $8.08 per pair (one L, one R); Blum Tandem Boring Template, #BT65.1000.02, $53.34; Blum Clip-Top 110º Inset/Self Closing Hinge w/ Blumotion, #B071B3750, $5.29 each; Blum Hinge Plate, Cam Ht. Adj., 0mm offset, #B173H9100, $1.10 ea. (one required per Hinge); Blum #2 Pozi Screw Driver, #B POZI, $8.33; 35mm Economy Carbide Bit, #MD1026, $16.61.
- Kitchen Cabinet Hardware, kitchen-cabinet-hardware.com, 800-530-8245, Delicate Pull, 96mm, #P84729-SN, $3.29.

Greg Larson is the owner/director of the New England School of Architectural Woodworking (NESAW), located in Easthampton, MA. A board member of the Woodwork Career Alliance (WCA) and the New England Architectural Woodworking Institute (NEAWI), Greg has been involved in woodworking for over 25 years.

NESAW offers a nine-month cabinetmaking career-training program, designed to prepare students of all skill levels for immediate employment or self-employment in the cabinetmaking industry. While the program's primary focus is on the development of safe, repeatable cabinetmaking skills, it also teaches students how to efficiently maximize their time, materials and budget. Students also have the option to learn the basics of cabinet design on AutoCAD and SketchUp. More information is available at www.nesaw.com.

Greg and his wife, Margaret, also run The Workbench, a hobbyist school that offers night, weekend and summer workshops in woodworking, home improvement and gardening. A schedule of all workshops can be found at workbenchschool.com.

New England School of
Architectural Woodworking

Make a Frame and Panel Cabinet Door

by Tom Caspar

A tongue-and-groove router bit set gets the job done fast.

WHEN YOU LEARN how to make cabinet doors, you will have mastered one of the basic skills in woodworking. Doors come in many variations—some have molded edges, arched tops or raised solid-wood panels—but to get started, it's a good idea to start with a basic design: the tongue-and-groove, plywood-panel door.

To save set-up time, we suggest using a set of adjustable router bits (see below, and Sources, page 43). Bits that aren't adjustable work fine, but require more trial-and-error cuts to make joints that fit tight.

Whether you purchase pre-milled wood for the doors, or mill the wood yourself, be certain that it is flat, straight and without twist. If the wood is warped in any way, you can't make a door that's flat, and if it's not flat, it won't hang properly. This may seem obvious, but it bears repeating—and applies to all the parts after they're cut to final size, too.

Plan on making each door at least 1/8" larger in length and width than its final size. You may need this margin to deal with a door opening that's slightly out of square, or if the door itself is not square.

We used two special bits to make this door. Both bits are adjustable to accommodate panels of different thickness.

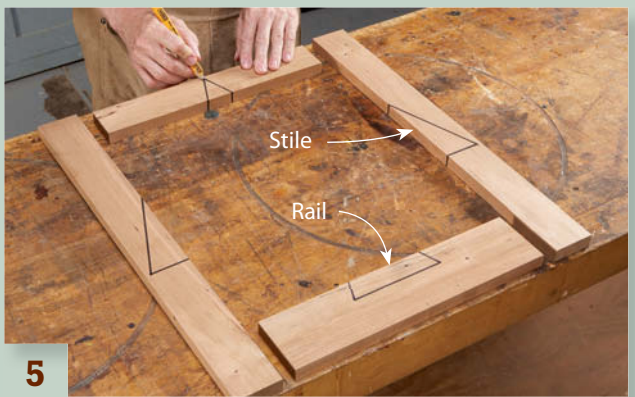
PHOTOGRAPHY: JASON ZENTNER

Begin by measuring the exact thickness of the 1/4" plywood you will use for the door's panel. This plywood is 1/64" undersized, which is typical.

Take apart the two-piece groove bit. Add a washer of the appropriate thickness to make a groove that will fit the plywood.

Position the bit so the lower cutter is 1/4" above the router table.

Use a straightedge to position the fence flush with the bit's bearing.



Mark the stiles and rails with a cabinetmaker's triangle. Mark the face and inside edge of each piece.

Mill all the pieces 3/4" thick, rip them to width and cut them to length. (Be sure to add the lengths of both tongues when you crosscut the rails. The tongues made by this router bit set are 3/8" long, so you'll need to add a total of 3/4".)

Set up the groove bit

When you build a tongue-and-groove door, you cut the grooves first, then the tongues. The place to start, then, is to figure out exactly how wide the grooves should be. You'll want the grooves to be just wide enough to fit the plywood you're using for the door panel, but no more.

As you probably know, 1/4" plywood really isn't 1/4" thick. It's thinner, and the exact thickness varies from sheet to sheet. To measure your plywood, cut a piece that is at least 1" wider and longer than you'll need for the door panel. Be sure to remove at least 1/4" from the factory edges—plywood is often extra thin here. Measure the plywood's thickness with a caliper (**Photo 1**; see Sources).

Install the groove bit in your router table and tighten it in the router's collet. Use a wrench to remove the nut on top of the bit. Remove the stack of washers under the nut, then the bearing and top cutter. Place one or more washers on top of the lower cutter (**Photo 2**). (The total thickness of these spacers will depend on the thickness of your plywood—refer to the chart that comes with the router bits.) Reassemble the bit.

Position the bit so the lower cutter is 1/4" above the router table (**Photo 3**). Position the fence so it's flush with the bit's bearing (**Photo 4**).

Mark the stiles and rails

It's essential to mark all the pieces of your door in a way that leaves no room for error. You'll need to indicate the face side of each piece, the inside edge of each piece and distinguish the left stile from the right stile.

Cabinetmakers figured out a system for doing this a long time ago—they marked each piece with one portion of a triangle (**Photo 5**). Extend the face marks down the inside edge of each piece.

Rout the grooves

For safety, install a featherboard (see Sources) or a guard on your router table. A featherboard is preferable because it presses the workpiece tight to the table, ensuring a straight groove.

The safest way to feed the stiles and rails across the router table is to use a pair of push pads (**Photo 6**; see Sources). When you cut the grooves, be sure that the face sides are down and the inside edges are against the fence.

It's a good idea to rout a test piece first to be sure that the groove is the correct width (**Photo 7**). When you assemble the door, the panel will have to slide down the groove, so the

6

Rout grooves in the stiles and rails, face side down. Place two pieces side by side to make it easier to balance push pads on the wood.

7

Test the groove's fit. The pieces you routed should slide easily along the plywood.

8

Take apart the tongue bit and add a washer of the same thickness that you added to the groove bit.

9

Position the bit so the cutters exactly line up with a groove. The workpiece sits face-side down in a coping sled.

10

The coping sled we'll use runs in the router table's miter slot, so the fence must be parallel to the slot. Position the fence flush with the bit's bearing.

11

Rout tongues on the ends of both rails, face-side down. Use a backer board to prevent chip-out.

fit can't be too tight. You'll also be gluing the panel into the grooves, so it can't be too loose.

Rout the tongues

Remove the groove bit from the router table and install the tongue bit. Remove the nut, the stack of washers and top cutter from the bit. Place a washer or two—of the same thickness you used with the groove bit—on top of the bearing (**Photo 8**). That's all it takes to make a tongue that will precisely fit the groove.

You'll need a coping sled for routing the tongues. There are many types of coping sleds (you can buy one or make one yourself), but they all perform the same task. A coping sled holds the workpiece steady, like a miter gauge. The body of the sled rides on the router table; the rail sits on top of the sled.

To set the tongue bit at the proper height, place a rail face down on the sled. Butt the rail up to the bit, then align the bit with the groove in the rail (**Photo 9**). It pays to be fussy about this setting, so it's best to test it on some scrap pieces before you rout the rails for your door.

We used a top-of-the-line coping sled to make this door (see "Well-Equipped Shop," page 22, and Sources). It has one unusual feature—it runs on an optional miter bar, like a miter gauge. This prevents the sled from wiggling as you cut a tongue. That's an important benefit, because this cut must be absolutely straight to make a tight joint. Of course, your router table must have a miter slot to take advantage of this feature.

Setting the router table's fence for this type of coping sled is a bit more complicated than normal (**Photo 10**). First, the fence must be in line with the bit's bearing—this applies to all sleds. Second, the fence must be parallel to the miter slot—this is not necessary for a sled without a miter bar. To make the fence parallel, position it flush with the bit first, but don't tighten it down. Place a combination square in the miter slot opposite the bit and extend the square's blade to touch the fence. Lock the blade, then slide the square along the slot, reposition the fence as needed, double-check everything and tighten the fence.

Rout tongues on the ends of both rails (**Photo 11**). Be sure that the face sides are down. Test the joint's fit (**Photo 12**). The tongue will automatically fit the groove, but if the face sides aren't flush, adjust the height of the tongue bit.

Size the door panel

Assemble the door, without glue, and measure the size of the opening in both directions (**Photo 13**). To size the door panel, you'll add to these measurements the depth of both grooves (3/8" each) and subtract 1/16", for clearance.

12

Test the joint. If the tongue bit is the correct height, the rail and stile should be flush. The tongue automatically fits the groove.

13

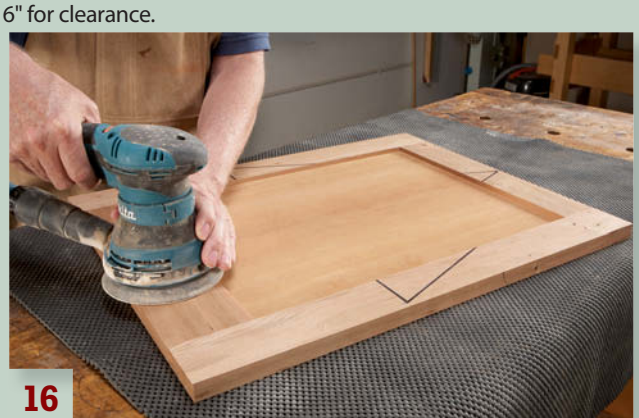
Measure the distance between the rails and stiles to size the door panel. The block by the ruler's end stands in for the depth of two grooves, less 1/16" for clearance.

14

Glue the rails to just one stile. Make sure the door is square by measuring from corner to corner, both ways.

15

Glue the panel and the remaining stile. The panel is only glued to the stiles; you don't have to glue it to the rails.



16

Sand the joints flush. To ensure they're even, draw pencil lines across each joint and sand until all the lines disappear.

Tip It's all too easy to make a math error, so here's an alternative. Make a block whose thickness is the sum of two grooves minus the clearance (in this case, 11/16"). Place the block on the door when you measure the opening and you'll get an instant reading for the panel's size, without any arithmetic.

Cut the door panel to size. Ease its edges and corners with sandpaper and sand both sides. In addition, sand the inside edges of the rails. Sand the inside edges of the stiles, too, but stay away from the portions that will butt the rails.

Glue the door

Aligning the joints side to side is a bit tricky, so it's a good idea to glue the door in two stages.

First, glue the rails to one of the stiles (**Photo 14**). Make sure the outer sides of the rails are flush with the ends of the stiles. Put the other stile in place (without glue!), clamp and measure from corner to corner, both ways. If the measurements aren't identical, the door isn't square. To bring the door into square, skew one or both clamps a little bit and measure again. Clean off the excess glue and set the door aside for an hour or so.

During the second stage, you'll glue the panel to both stiles (**Photo 15**). This adds enormous strength to the door. You may want to glue the panel into the rails as well, but this complicates the gluing process, creates more squeeze-out to clean up and isn't strictly necessary.

To start the second stage, brush glue into the stile that's glued to the rails. Slip in the panel, then clean up any squeeze-out. Brush glue along the length of the second stile. Slide the stile in place, make sure it's even with the sides of the rails and clamp.

Let the glue dry overnight, then sand the joints even, front and back (**Photo 16**). Sand all the surfaces of the stiles and rails, too.

SOURCES

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- Rockler, rockler.com, 800-279-4441, 6" Fractional Dial Caliper, #36575, $49.99; Bench Dog Featherboard, #29799, $16.79; Bench Dog Ultra Push-Bloc, #42790, $7.99 ea.
- Infinity Tools, infinitytools.com, 877-872-2487, Professional Coping Sled, COP-100, $160; Precision 3/4" Miter Bar, COP-MB1, $19.90.

Learn how to make cope-and-stick arched-top doors with raised panels at **AmericanWoodworker.com/WebExtras**

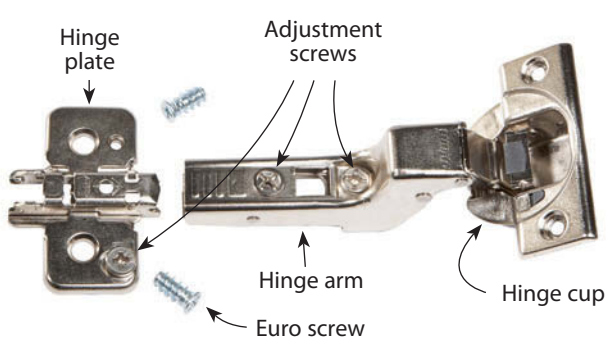
How to Install a Cabinet Door

Dial in a perfect fit with even gaps all around.

by Greg Larson

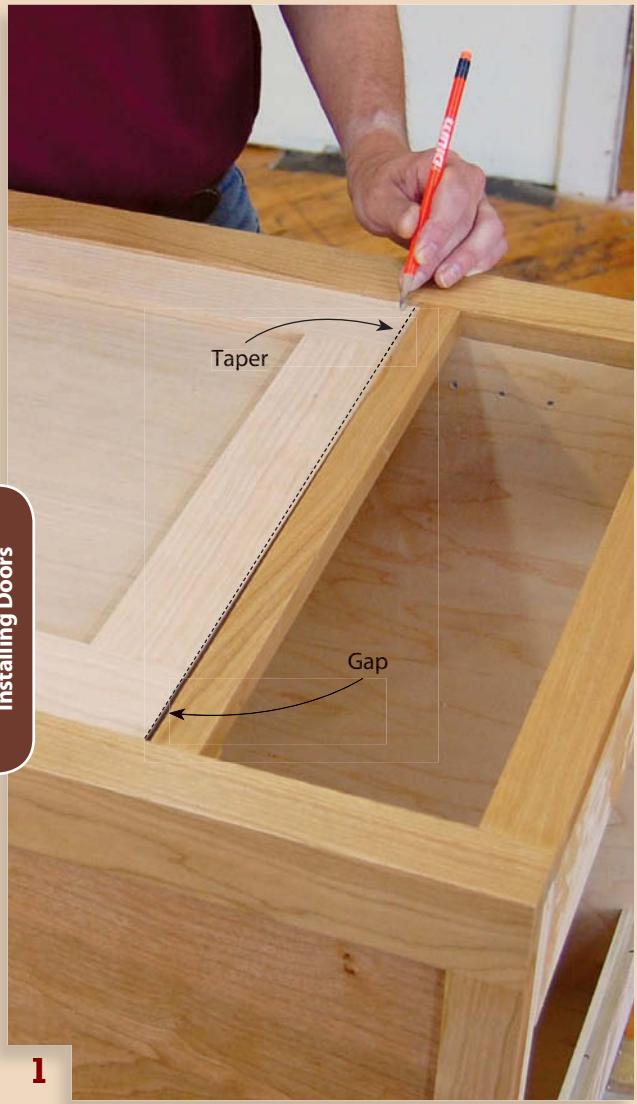
IF YOU'VE EVER installed cabinet doors using traditional butt hinges, you know what a pain in the butt they are to work with. That's why Euro-style hinges have become so popular in the cabinet industry. Euro hinges allow you to quickly adjust the gaps around an inset door, compensate for any irregularities and re-adjust the gaps in the future if the doors sag or the cabinets settle. Some hinges even come with an integrated soft-close feature, such as the Blum hinges we'll install (see "Euro Hinge Anatomy," below and Sources, page 47). Euro hinges are designed to work with the 32mm system, so if you follow the system rules for boring the mounting holes, your door installation will kick butt.

EDITOR: TIM JOHNSON | PHOTOGRAPHY: NICK NOYES OR MARGARET LARSON

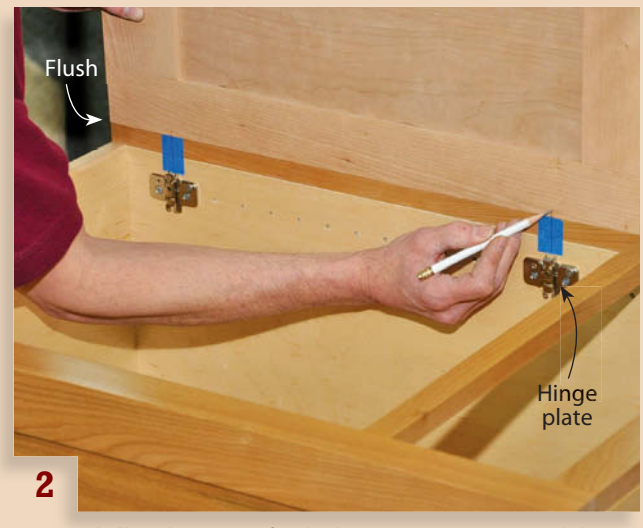


Euro Hinge Anatomy

Two-part Euro-style hinges make it easy to install an inset door and adjust its fit in the opening. The hinge plates mount on the cabinet with Euro screws; the hinges mount on the door with #6 x 5/8" flat-head screws. To install the door you just snap the hinge arms onto the hinge plates. Once the door is installed, adjustment screws on the hinge arm move the door in and out and side to side. An adjustment screw on the hinge plate moves the door up and down.



Fit the door to the face frame. To eliminate an uneven gap like this one, simply taper the door's top edge in the opposite direction.



Locate drilling locations for the hinge cups. First, extend the hinge plate centerlines. Then stand the door on edge, flush with the bottom of the face frame, to transfer the lines.

Fit the door

I always build inset doors to the same dimensions as the door openings and then trim them to fit, with even gaps all around. If the door or face frame openings aren't perfectly square, the doors have extra material for trimming, so that the gaps are even. Trust me, everyone will notice if the gaps are uneven, but no one will notice if the door isn't perfectly square. Industry standards allow gaps up to 1/8", but I prefer smaller 3/32" gaps.

Start by trimming the door to snugly fit the opening by jointing one or both of its stiles until it barely slips between the face frame without binding. Then check the door's fit: While holding one of its stiles flush against the face frame, butt the door up against the mid rail. If no gap appears, the door and opening are square.

If an uneven gap appears you'll need to trim the top of the door (**Photo 1**). Mark the top for tapering while holding the door in position as before, with one stile against the face frame. I use an edge sander to trim the top edge, as is common in a production shop. But you can also use your jointer or a router with a flush-trim bit and a board with a straight edge.

Remove as little as possible to make the uneven gap at the top disappear. Then trim the door until all the gaps are 3/32" wide and its bottom edge is flush with the bottom of the carcass. I use the jointer (set to remove 1/32" or less) for trimming and 3/32" thick spacers to verify that the doors are properly sized (see **Photo**, page 45, at top).

Install the hinge plates

Euro hinges consist of a hinge plate and the hinge itself. Hinge plates come in different thicknesses to allow "building out" the hinge if the inside of the cabinet is recessed behind the face frame. The construction method shown here allows using #0 hinge plates, because the inside of the carcass is flush with the face frame (see "Cabinet-Building Essentials," page 32). Mount the hinge plates in the appropriate system holes using 5mm x 13mm Euro screws (see Sources). The system holes were drilled in the carcass sides prior to assembly; the Euro screws are designed to fit the system's 5mm holes. Before mounting each hinge plate, make sure its vertical adjustment is centered.

Install the hinges

Most standard Euro hinges mount in a 35mm hole drilled into the door. This hole must be properly located for the hinge to function correctly and to insure adequate adjustment in all directions. Use the center point of each hinge plate to transfer the hole locations to the door (**Photo 2**). Use a square to extend the line to the edge of the face frame stile. Make sure the door is flush with the bottom of the face frame when you transfer the marks—this ensures the top gap will be correct. Use a square to extend the marks onto the door—they represent the center lines for drilling the hinge-cup holes. To mark doors for top cabinets, simply center them between the face frame's top and bottom rails.

Consult the hinge manufacturer's instructions to deter-

mine the appropriate distance from the edge of the door to the edge of the hinge-cup hole. Typically called the "tab," this is the distance required to obtain the desired gap (or "reveal") while allowing the hinge's full adjustment. Note that this spec is measured to the edge of the hole, not to its center. To obtain the 3/32" gaps we want with the inset hinges we're using, Blum specifies a 5mm tab.

Install a 35mm Forstner bit (see Sources) and use the specified tab to set the fence. Then index the fence at the bit's center. With the machine off, lower the bit onto a piece of scrap until the bit's center marks the wood. Without moving the scrap piece, use a square to transfer the mark to the fence. Then simply line up the marks on the door with the index line on the fence and drill holes deep enough to fully seat the hinge cup—usually 1/2" deep (**Photo 3**). I always drill a hole in a test piece, mount the hinge and test it on the cabinet to verify that there's enough in-and-out and front-to-back adjustment before drilling the actual cabinet doors.

After drilling the holes, mount the hinges using a straight piece of scrap wood to align them parallel to the edge of the door (**Photo 4**). Drill pilot holes for the #6 x 5/8" mounting screws using a self-centering bit (see Sources).

Mount the door

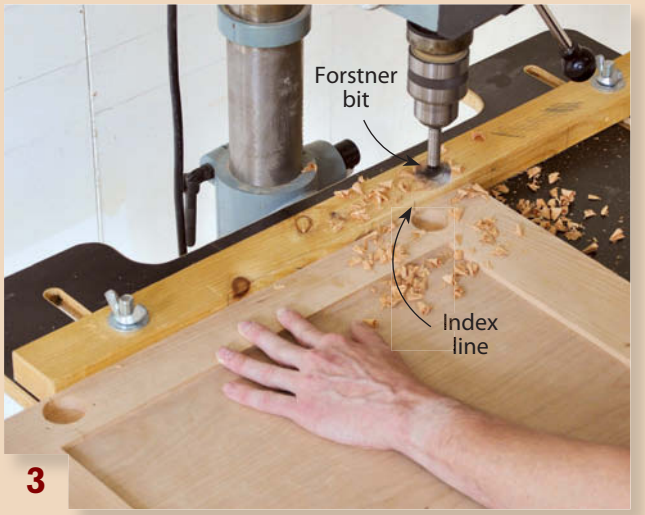
Clip the hinge arms onto the hinge plates and adjust the door's fit (**Photo 5**). The hinge plates we're installing have a cam adjustment that moves the door up or down, so it's easy to make fine adjustments. Make sure to adjust both hinge plates. Adjust the side-to-side and in-and-out screws on the hinge arm as necessary until the gaps around the door are even and the door is flush with the face frame. The adjustment screws look like they have Phillips heads, but they're actually Posi-drive screws, so use a Posi-drive screwdriver to avoid stripping them (see Sources).

Remove the hinge cups before applying finish to the door. Mark both the hinge cup and the hole in the door, so that the hinge gets installed back in the same spot after finishing. This reduces the amount of readjustment you'll have to do later.

SOURCES

- McFeely's, mcfeelys.com, 800-871-8158, Euro Screws, 5mm x 13mm, #0513-ECS-C, $5.70 per box of 100 screws; Undercut Flat Head Screws, #6 x 5/8", #0605-FPU-C, $2.65 per box of 100; Self-centering bit, #6, #VIX-0764, $9.40.
- Woodworker's Hardware, wwhardware.com, 800-383-0130, Blum Clip-Top 110º Inset/Self Closing Hinge w/ Blumotion, #B071B3750, $5.29 each; Blum Hinge Plate, Cam Ht. Adj., 0mm offset, #B173H9100, $1.10 ea. (one required per Hinge); Blum #2 Pozi Screw Driver, #B POZI, $8.33; 35mm Economy Carbide Bit, #MD1026, $16.61.
- Kitchen Cabinet Hardware, kitchen-cabinet-hardware.com, 800-530-8245, Delicate Pull, 96mm, #P84729-SN, $3.29.

See how to mount inset doors using butt hinges
AmericanWoodworker.com/WebExtras



3

Drill holes in the door for the hinge cups. Align the index lines you've drawn on the door with a line on the fence that marks the bit's centerpoint.

4

Install the hinges. Insert each hinge cup in its hole. Then use a scrap board with a straight edge to align the hinges parallel with the edge of the door.

5

Mount the door by clipping the hinge cup arms onto the hinge plates. Then use the adjustment screws on each hinge to center the door in the opening and make it flush with the face frame.

How to Make a Cabinet Drawer Box

A dovetail jig enables anyone to make a classy drawer.

by Tom Caspar

PHOTOGRAPHY: JASON ZENTNER | ILLUSTRATION: FRANK ROHRBACH

AS A WOODWORKER, what's the first thing you notice when you open a drawer? The way it's put together, of course.

A cabinet drawer made with half-blind dovetails really stands out. While a drawer that runs on metal slides doesn't need the strength of dovetailed joints, dovetails clearly say, "This drawer was built by a crafsman."

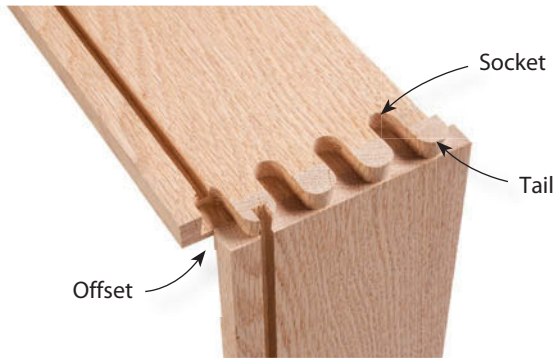
In this article, you'll learn how to use a typical half-blind dovetail jig to make a standard drawer box. (It's called a "box" because the front of the drawer—what you see on the outside of the cabinet—is applied later.) Let's start with the anatomy of a box, then move on to setting up the jig.

The Box

Here's an exploded view of a typical drawer box. The front and back pieces have **sockets** cut into them; both are the same length. These pieces extend the full width of the drawer box.

The side pieces have **tails** formed on their ends. If all pieces are 1/2" thick—typical for a drawer box—the sides are cut 1/4" shorter than the overall depth of the box.

A typical drawer box has an **applied front** and a 1/4" plywood bottom trapped in a **groove**. The groove runs around all four sides of the box.

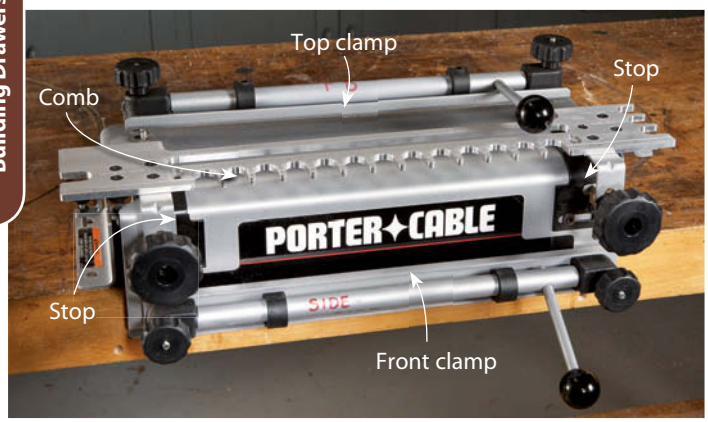


The Joint

Here's what a typical half-blind dovetail joint looks like, unfolded. These boards are in the same orientation as they sit in the jig.

Tracing around the rounded fingers of the comb produces a series of **sockets** and **tails.** They're exactly the same width; when you assemble the two pieces, they'll automatically fit together.

The pieces will also align with each other, top and bottom, because they're **offset** by the right amount when you clamp them in the jig. The jig's **stops** create this offset.



The Jig

Most half-blind jigs have essentially the same parts. The most important one is the **comb**. Using a router equipped with a dovetail bit and a template guide, you trace around the comb to make the joint.

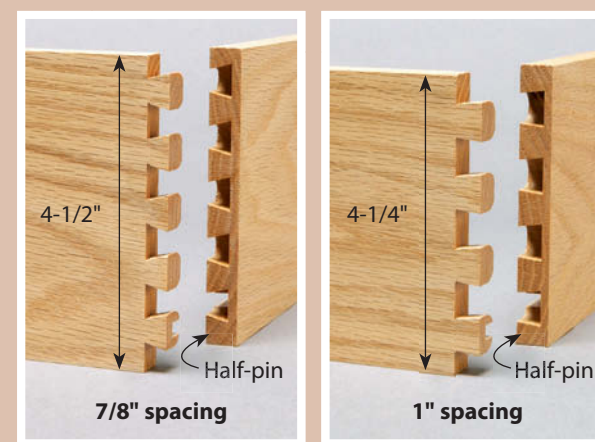
You always rout two boards at the same time. One is held horizontally by the **top clamp**; the other is held vertically by the **front clamp**. The clamps on this jig operate on a cam. Rotating each handle pushes a long clamping bar against the workpiece.

Most jigs have a pair of **stops** that position both workpieces left or right—relative to the comb.

Your Jig's Spacing

On some jigs, the distance between the dovetails is 7/8"; on other jigs, it's 1". This is an important number when you're figuring out how wide the sides of your drawers should be. Why? Dovetail joints look best when they have half-pins at top and bottom. This rule limits the widths you can choose from. They will be increments of 7/8" or 1", depending on your jig, plus the spaces alloted for the half-pins.

Fortunately, when you're building drawer boxes that ride on slides and have applied fronts, the width of the drawer sides can be up to 1" less than the opening in the cabinet. For our model cabinet (see "Cabinet-Building Essentials," page 32), we used a 1" jig and made the sides 4-1/4" wide. If you have a 7/8" jig, make the sides 4-1/2" high. In addition, make the bottom half-pin extra-wide, so the drawer-bottom groove runs through the center of the first socket.



Adjusting Your Router and Jig

Every time you rout a new set of drawers, you'll make three adjustments to your router and jig. To test these adjustments, you'll need some scrap wood that is exactly the same thickness and width as the wood you'll be using for your drawer boxes.

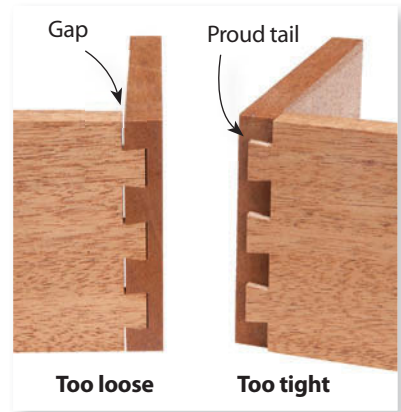
1 Fit

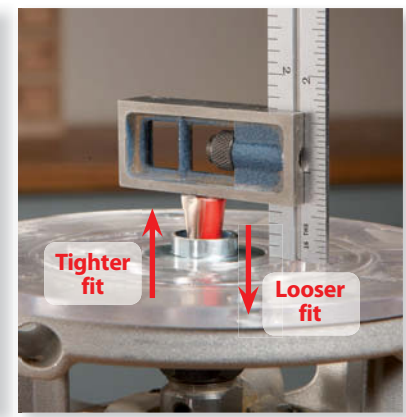
First, install the correct template guide in your router's base and adjust the bit's depth of cut as specified in your jig's manual. (Typically, it's 5/8".) The depth of cut determines the joint's fit.

Install the jig's comb as specified in the manual and rout a pair of test pieces. Try assembling them.

If the fit is too loose, you'll see gaps between the two boards. Adjust the bit to cut about 1/64" deeper and try again.

If the fit is too tight, the joint won't go home. Adjust the bit to cut about 1/64" less deep and try again.





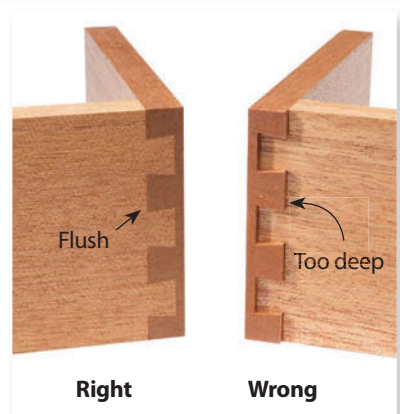
2 Depth

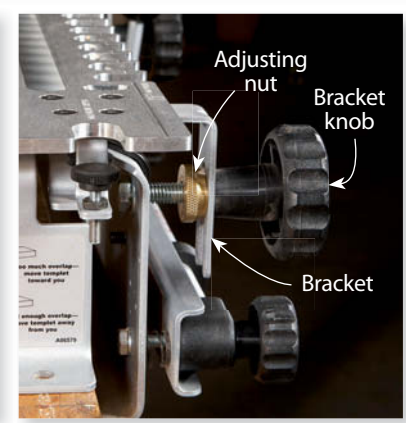
Next, adjust the position of the comb in or out. This affects how deep the sockets will be. Ideally, the sockets should be just deep enough so that the pins are flush when the joint is assembled.

In practice, it's best to position the comb so the sockets are about 1/64" too deep. This will compensate for any small error in your setup or minor variation in the thickness of the drawer's sides.

Adjusting nuts behind the comb's **brackets** determine the position of the comb. Both nuts must be the same distance from the front of the jig, so the comb remains parallel to the jig.

Examine the depth of the sockets on the test pieces you've made so far. If they're not deep enough (and this is easy to confuse with a joint that's too tight), turn each adjusting nut clockwise, closer to the jig, then tighten the **bracket knobs**. If the sockets are too deep—and this is the best place to start—loosen the knobs first, then turn the adjusting nuts counterclockwise, away from the jig. Re-tighten the knobs.





3 Spacing

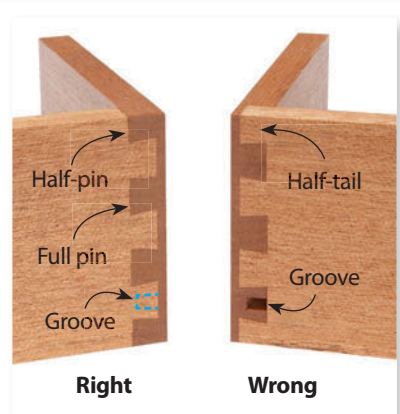
Last, adjust the position of the **stops** on the jig. Moving them left or right affects how the joint looks. Your goal is to make a joint that begins and ends with **half-pins** rather than **half-tails**.

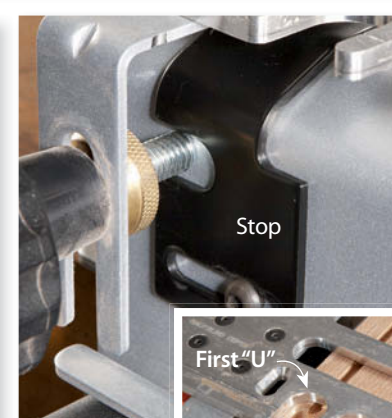
A half-pin doesn't have to be precisely half the width of a **full pin**, though. Close is good enough.

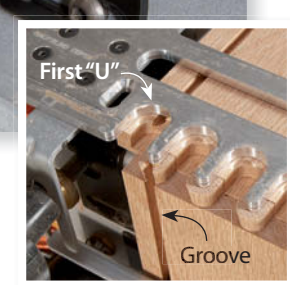
To set the stops, start with a new pair of test pieces. Determine where you want the groove for the drawer bottom to go, then draw "grooves" on the pieces. (Typically, grooves are located 3/8" to 1/2" above the bottom edge of a drawer.)

The **groove** should fall approximately in the middle of a socket, so a tail will cover it when the drawer is assembled.

To position each stop, loosen its adjusting screw and slide the stop all the way toward the end of the jig. Place one of the test pieces underneath the jig's comb and center the groove in the comb's **first "U."** Butt the stop up to the test piece and tighten it in place.







1

Cut all four drawer pieces to final size, then saw the drawer-bottom grooves. These grooves will help you position each piece in the dovetail jig.

2

Arrange the four parts of the drawer box and mark them. ("FB" indicates a Front/Back board.) The Left Corners are routed on the jig's left side; the Right Corners are routed on the jig's right side.

3

Place two pieces in the left side of the jig. The drawer grooves face the jig's outer edge. Front/Back boards go on top; Side boards go in front. To avoid error, draw "FB" and "Side" on the jig, too.

4

Rout the dovetails, then remove these boards from the jig. Place the other two boards in the jig and rout them. After routing both Left Corners, move on to the Right Corners.

5

Place two boards in the right side of the jig. Once again, the grooves face the jig's outer edge. Rout these boards, then place the remaining two boards in the jig and rout them.

Mill the wood

Some species are better than others for making drawers. You'll want a wood that's relatively stable; once it's been milled, it should stay flat. And you'll want a wood that doesn't chip out when you rout it.

Maple and red oak are two excellent choices. We used maple for our model cabinet (see "Cabinet-Building Essentials," page 32) because it contrasts nicely with cherry, the cabinet's primary wood.

If you have a tablesaw, jointer and planer, it's best to mill the wood yourself in order to ensure that it's flat. (If the drawer pieces are cupped, the dovetails won't go together properly; if they're twisted, the drawer box will be twisted, too.)

Drawer boxes are typically made from 1/2" thick material. Start with 4/4 (1") rough stock and saw it into individual drawer pieces (front, back and sides). Cut the pieces about 1/4" extra wide and 1" extra long. Be sure to mill some extra wood for testing the dovetail jig setups.

To ensure that your pieces stay flat, mill them down to 5/8" thick and let them sit for a few days. Joint the faces of the pieces and finish planing them down to 1/2". Joint the edges, rip the pieces to width and crosscut them to final length.

Saw grooves first

After all this work, the last thing you want to do is get confused about which board goes where on the jig. Here's an unorthodox marking system that's almost foolproof: Make the grooves for the drawer bottom before routing the dovetails. Once the grooves are cut, there's no mistaking which side of the board faces in and which side faces out on the jig—it's obvious.

Cut the grooves on the tablesaw using a standard blade (**Photo 1**). Raise the blade 1/4" high. You'll saw two overlapping cuts—start with the cut that's nearest the bottom edge. (If you're making the drawers for our model cabinet, the distance from the fence to the blade must be 1/2" to accommodate the undermount hardware.) Make this cut on all of your pieces. Adjust the saw's fence to make the second cut. Use a long piece of drawer-bottom plywood to test the groove's fit—you should be able to push the plywood along the groove with little effort.

Finally, mark each part of the drawer as a front, back or side (**Photo 2**). You're ready to rout.

Rout the dovetails

Use the test pieces to set up the jig (see page 51). It usually takes about a half-dozen tries to get everything right. Once you're set, you can rout many drawers without making any further

6

Assemble the drawer—without glue. Measure the distance between the bottoms of the grooves using pinch sticks. Cut the drawer bottom 1/16" smaller than this measurement.

7

Glue the drawer together. Assemble the front and sides first, then slide in the bottom. Add the back last. If the joints are nice and tight, you won't have to use clamps.

8

Square the drawer box by clamping large L-shaped blocks to opposite corners. These blocks are made from two layers of MDF.

9

Round over all the edges of the drawer box—except the front. Support the router with a thick board that's the same width as the box.

adjustments as long as all the wood is the exact same thickness.

Let's walk through how you'd make just one drawer. Place one of the drawer's front/back pieces and one of the side pieces in the left side of the jig (**Photo 3**). (These pieces are interchangeable, so it doesn't matter which two you use.) Make sure the boards are butted up to the stops and are flush with each other. It's a good idea to place a backer board in the jig, too. (For more on backer boards and other tips, see "10 Tips for Using A Dovetail Jig," page 55.)

Rout the dovetails (**Photo 4**). Place the router on the jig before you start it and turn it off before you remove it. Be careful not to tip the router. When you're done, inspect the joint before you remove the boards from the jig. If some portion is uncut, rout it again. Once the joint looks OK, remove the boards and place the other two Front/Back and Side boards in the jig. Rout them as well. Repeat this procedure on the right side of the jig (**Photo 5**).

Glue the drawer

Assemble the drawer—without glue—so you can figure out the exact size of the drawer bottom (**Photo 6**). While you could use a tape measure, there's no chance of making a math error if you use pinch sticks. (They're 1/8" thick and 3/4" wide.)

Here's how pinch sticks work: Insert one end of a stick in a groove, then extend the other stick until it bottoms out in the opposite groove. Clamp the sticks together, then rotate the assembly out of the grooves. Measure the length of the two sticks and subtract 1/16" . Measure the drawer in the opposite direction and cut the drawer bottom to size. Sand all of the inside surfaces of the drawer and the top side of the drawer bottom.

Glue the drawer together (**Photo 7**). You won't need a lot of glue—just apply it to the sockets with a small brush. Keep a damp rag handy for cleaning up the squeeze-out on the outside of the drawer. Make the joints as flush as you can.

After you add the last piece, make sure the drawer is square (**Photo 8**). Measure from corner to corner to see how close you are. The trick is bringing it in to square—L-shaped squaring blocks work well. After the glue dries, sand the joints flush.

Last, soften the edges of the drawer box with a 1/8" roundover bit (**Photo 9**). Before you start, put a big "X" on the front board—you don't want to round the front edges of this piece, where the applied front goes. Balance the router by using a board that's the same width as the drawer box. Use this piece to help rout both the inside and outside edges of each piece.

Learn how to make precise squaring blocks at **AmericanWoodworker.com/WebExtras**

10 Tips for Using a Dovetail Jig

A bunch of little tricks make the job go much easier!

by Tom Caspar

1 Paraffin Lube

When you rout a dovetail joint, your router should slide easily around the jig's fingers so you can feel when it's time to turn a corner. To eliminate drag, rub a piece of canning wax (paraffin) on top of the comb. You won't need much, but it sure helps!

2 Climb Cut First

To eliminate tearout inside a dovetail joint, make this your first step: Rout a shallow pass from right to left, all the way across the front board.

This scoring pass is a climb cut (routing in the direction of the bit's rotation). It goes in the opposite direction that you would normally move a router. Any climb cut presents a potential hazard, however: The bit can grab, suddenly pulling the router ahead. When you take a very shallow cut, though, that's usually not a problem.

When you've completed the scoring pass, rout the rest of the dovetail from left to right—in the opposite, and normal, direction.

How do you set up a dovetail jig to make lipped drawers? Find out at **AmericanWoodworker.com/WebExtras**

PHOTOGRAPHY: JASON ZENTNER | ILLUSTRATION: FRANK ROHRBACH

3 Make A Router Nest

When you're constantly picking up and putting down a router with an exposed dovetail bit, try parking it on a platform. This way, the bit is protected and won't catch anything. Of course, you should still turn off the router first!

This platform is just a 1-1/2" thick block, the same size as the router's base, with 1/4" x 1-3/4" sides nailed on all around. The hole is 1-3/8" dia. Once the router is perched, the block's lip makes sure it stays put.

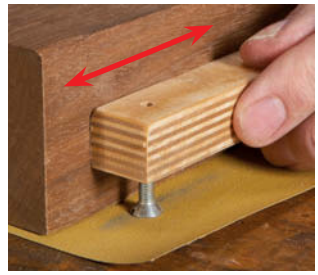
4 Add Bumpers

Accidentally routing into your dovetail jig will ruin your bit—and your day. On many jigs, the brackets that support the comb are directly in harm's way. If you're not sure of the router's position, you can chew right into them.

The solution is to add bumper blocks that prevent the router from getting too close to the brackets. On this jig, you can clamp the blocks directly to the comb; for models without extra-long combs, clamp tall blocks to the workbench.

5 Make A Height Block

One of the most frustrating parts of setting up a dovetail jig is adjusting the bit to the correct depth of cut. Using a ruler can be very awkward. It's much easier to use a height block.



To make the block, drill two 5/32" holes all the way through a piece of plywood using a drill press (the holes must be precisely vertical). Turn a machine screw into each hole, then carefully adjust the height of each screw to match the correct depth of cut (usually 5/8"). Check both screws with a combination square. To ensure that the block sits flat, sand the heads of the screws while butting the block up against a larger chunk of wood. This keeps the block square.

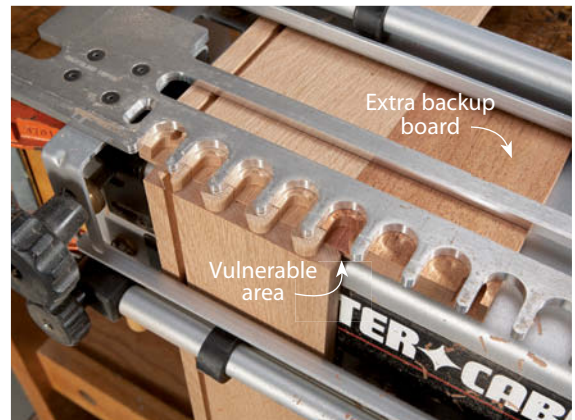
Once you've made the block, adjust its screws until you get a tight-fitting joint. Store it with your jig. Next time around, adjusting the bit will be a cinch.

6 Add An Extra Board

To prevent tearout, it's good practice to place an extra board on top of the jig next to the two boards you're routing.

Each time you rout a joint, rotate the backup board to a new corner. When you've used all four corners, cut off the ends of the board and start over.

Make a few backup boards when you mill the rest of the parts—they must be exactly the same thickness as your workpieces.



7 Cushion the Blow

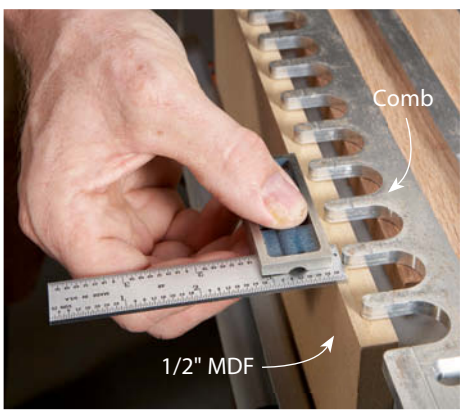
Here's a tip from the furniture-repair world. When you're knocking apart an unglued dovetail joint, place the pieces on material with some give, such as a towel, blanket or router mat.

You don't have to hold the parts up in the air—the material will compress when you strike the wood, allowing the joint to slowly come apart.

8 Register with a Wide Board

To control the depth of a dovetail joint, you move the comb in or out by adjusting the position of its brackets. When you're done adjusting each bracket, the comb must be perfectly parallel to the front of the jig. Here's an easy way to do that.

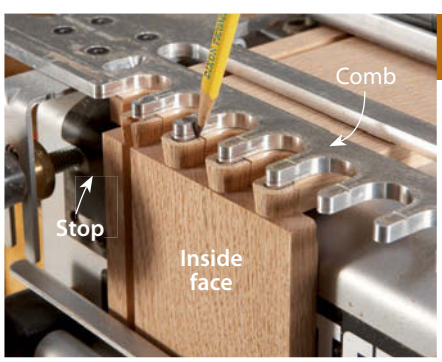
Clamp a 12" wide piece of 1/2" MDF in the jig, as shown at right. Position the comb so it's approximately in the correct position according to the jig's manual. Use a combination square to check both sides. Remove the MDF and clamp two boards in the left side of the jig. (They must be the same thickness as your final workpieces.) Make trial cuts and fine-tune the comb's position on the left side until the dovetails are exactly the correct depth. Put the MDF piece back in the jig, adjust the square to the comb's new setback on the left side, then slide the square to the right side of the comb. Adjust this side to match.



9 Same Spacing, Left and Right

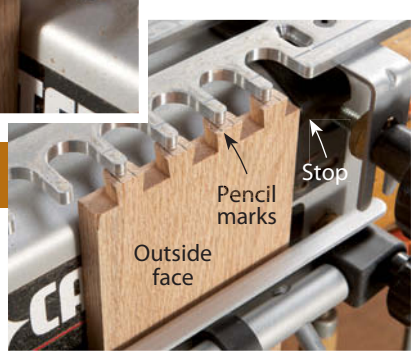
Every dovetail jig has adjustable stops that set the distance between the first tail and the bottom edge of a workpiece. One stop is on the left side of the jig; the other stop is on the right side. Both stops have to be in the same position, relative to the comb's fingers, for the first-tail spacing to match.

Here's how to set them. First, make a test joint on the left side of the jig and adjust the left stop where you want it. Trace around the fingers of the comb (Step 1). Remove the board from the jig and flip it around, so the opposite side faces out. Clamp the board in the right side of the jig so the tracings line up with the comb's fingers (Step 2). Butt the right stop up to the board. The spacing is now exactly the same on both sides of the jig.



Step 1, left side of jig

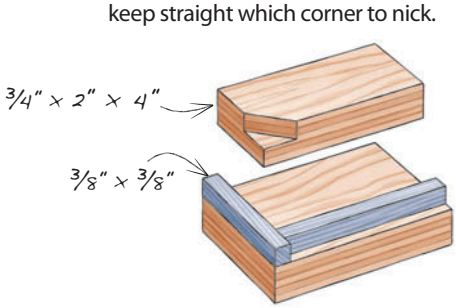
Step 2, right side of jig

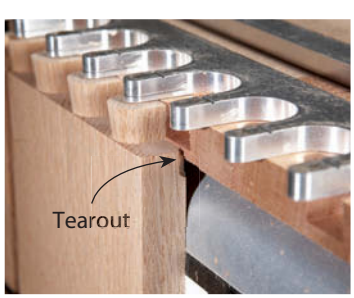


10 Score Vulnerable Corners

Tearout looks nasty on a well-made dovetail joint. Using a backer board can help reduce tearout (Tip 6), but it's not enough. An outside corner of the vertical piece may still chip out (see inset, below).

The best solution is to score this vulnerable area first, before routing. You could use a marking gauge, but if you don't have one, this little jig will do the trick. It works for boards mounted on either side of the jig—you just have to keep straight which corner to nick.





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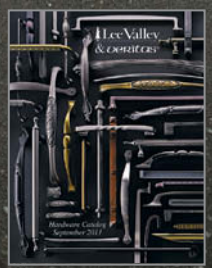


Lee Valley

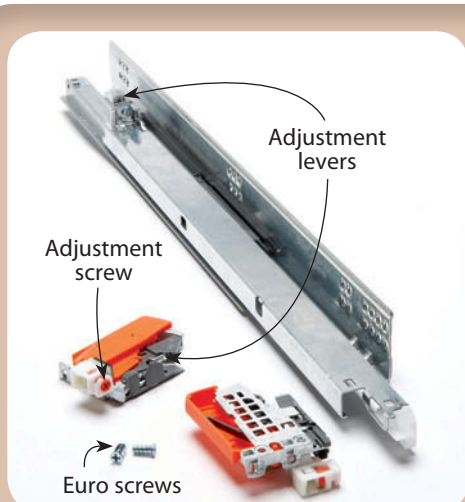
How to Install a Cabinet Drawer

Undermount slides show off the joinery.

by Greg Larson

WHEN YOU'VE TAKEN the time to build dovetailed drawers for your cabinets, it's a crime to cover them up with side-mount drawer slides. Undermount slides, a hallmark of high-end kitchens, show the beauty of this classic joinery because they're completely hidden underneath the drawer.

I'll show you how to install drawers using the undermount slides we use at the New England School of Architectural Woodworking (see "Drawer Slides with Euro Hinge Adjustability," below and Sources, page 61). These slides feature an integrated soft-close feature that kicks in during the final inch or two as the drawer is closing, which is great if you have family members who like to slam drawers.



Drawer Slides with Euro Hinge Adjustability

Blum Tandem undermount slides and inset locking devices make installing drawers easier than ever. The slides mount in the cabinet's 5mm dia. system holes; the locking devices mount on the bottom of the drawer. Each locking device has an adjustment lever for incrementally moving its side of the drawer up and down. Another lever at the back of each sliding rail raises and lowers the back of the drawer on each side, making it possible to adjust the drawer front so it's perfectly in plane with the face frame. Finally, each locking device has an adjustment screw that moves the drawer in and out so it can be aligned flush with the face frame.

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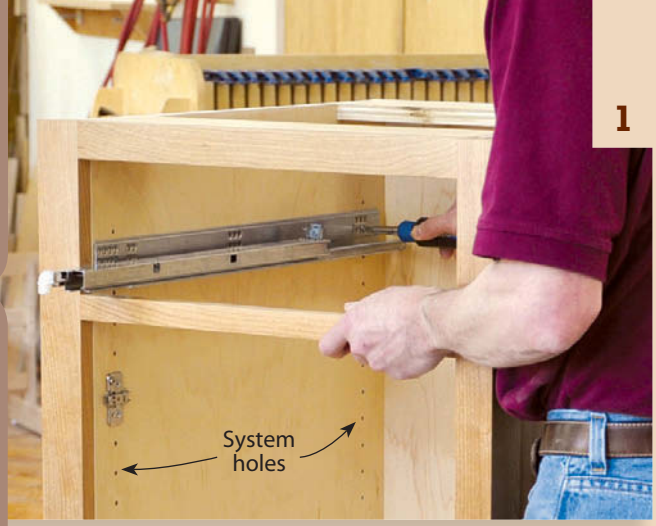


1 **Use the system holes** to install undermount drawer slides in the cabinet. Once the drawer is installed, these slides virtually disappear.

2 **Cut notches** for the drawer slides in the back of the drawer box, using a dado set. You'll have to reset the fence and make a second pass to complete each wide notch.

3 **Drill a hole** above each notch using a jig that's available from the slide manufacturer. These holes secure the slides to the back of the drawer.

4 **Install inset locking devices** on the bottom front corners of the drawer box. The same jig used in the last step makes it easy to locate and drill the pilot holes.

Mount the slides

Unlike side-mount slides, nearly all of the hardware for an undermount slide mounts inside the cabinet. The slides we use (and virtually all modern drawer slides) have mounting holes that are optimized for the 32mm system. So, if you follow the system rules to drill 5mm dia. holes in the sides of your cabinets (see "Cabinet-Building Essentials," page 32), you simply screw in the drawer slides, using 5mm x 13mm Euro screws (**Photo 1** and Sources). The beauty of using the 32mm system is that the installed slides will automatically be parallel and have the proper setback, making their installation much quicker and more accurate.

Install the drawer box

The drawer box must be slightly modified for use with undermount slides. First, cut 1-3/8" wide x 1/2" deep notches in the back corners, adjacent to the box sides (**Photo 2**). The notches should just graze the drawer bottom. When making the first pass, stop advancing the box as soon as the notch is cut. Then reset the fence and make a second stopped pass to complete the notch. To cut the notch in the other corner, move the fence to the opposite side of the blade and repeat the process.

Next, drill a stopped 6mm dia. x 10mm deep hole above each notch (**Photo 3**). For one or two drawers, it's easy enough to locate and drill the holes by hand, but for a larger quantity, it's more efficient to use the manufacturer's jig (see Sources).

Use the same jig to drill pilot holes for installing the inset locking devices that engage the drawer slides, which are installed on the underside front corners of the drawer box (**Photo 4**). The mounting screws install at a slight angle, so the jig is very handy to have. Install the locking devices using #6 x 1/2" truss-head screws (see Sources).

Installing the drawer box is easy (**Photo 5**). Just set the drawer onto the slides' rails and push it into the opening until the locking devices engage at the front and the pins engage at the back. To remove the drawer, simply reach under and squeeze the locking devices.

Mount the drawer front

Start by drilling two 5/16" holes through the front of the drawer box, 1" down from

the top and 1-1/2" from the inside face of each side. To avoid tear-out when drilling the holes, use a brad point bit and a piece of scrap wood as a backer. Trim the drawer front to fit the opening with 3/32" gaps all around. Use shims to center it in the opening and hold it in position (**Photo 6**). Then mark pilot hole locations on its back by pushing the same drill bit through each hole from inside the box and twisting it (**Photo 7**). Use these marks to drill stopped pilot holes for #8 screws in the back of the drawer front. This method ensures that when the drawer front is centered in the opening, its pilot holes are perfectly centered in relation to the holes in the drawer box.

Attach the drawer front to the drawer box using #8 x 1-1/8" washer-head drawer-front mounting screws (**Photo 8** and Sources). Because the drawer front's pilot holes are perfectly centered, the oversized holes in the drawer box still allow nearly 1/16" adjustment in any direction, so you can adjust the drawer front if any uneven gaps appear after the cabinet has been installed.

Installing the drawer pull pins the drawer front in position, so do not install the pull until the cabinet is installed and final centering adjustments are made to the drawer front.

To mount the pull, center it on the drawer front and then drill holes sized to match the shanks of the mounting screws through both the front and the drawer box. To better secure a tall drawer front, angle additional screws up from the bottom of the drawer box front into the applied front.

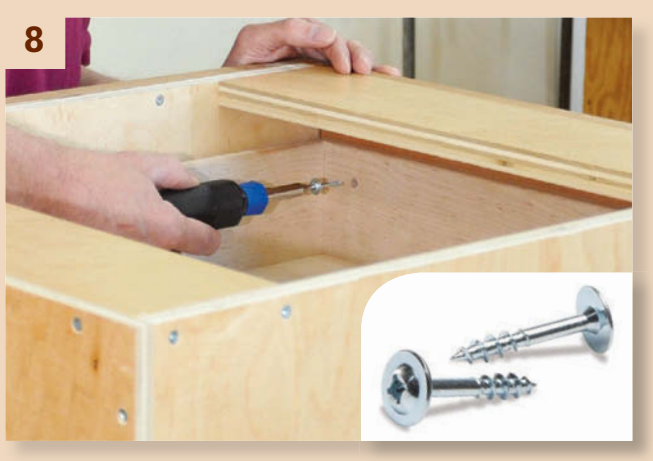
SOURCES

- McFeelys, mcfeelys.com, 800-871-8158, Euro Screws, 5mm x 13mm, #0513-ECS-C, $5.70 per box of 100 screws; Super Round Washer Head Screws, #8 x 1-1/8", 0811-SRZ-C, $7.35 per box of 100 screws.
- Woodworker's Hardware, wwhardware.com, 800-383-0130, Blum Tandem 562H Full-Extension Undermount Drawer Slide w/ Blumotion, 21", #B562H 5330B, $24.44 per pair; Blum Inset Locking Device, #BT51.1700PV, $8.08 per pair (one L and one R); Blum Tandem Boring Template, #BT65.1000.02, $53.34; Blum #2 Pozi Screw Driver, #B POZI, $8.33.
- Kitchen Cabinet Hardware, kitchen-cabinet-hardware.com, 800-530-8245, Delicate Pull, 96mm, #P84729-SN, $3.29.

5 **Use the notches** on the back to engage the slides when you install the drawer box. A pin on each sliding rail anchors the box at the back; the locking devices installed on the bottom secure it at the front.

6 **Use 3/32" shims** to center the drawer front after trimming it to fit the opening. The shims securely hold the drawer front in position for the next step.

7 **Mark pilot hole locations** on the drawer front after drilling oversize mounting holes through the drawer box. Use the same drill bit so the pilot holes will be perfectly centered.



8 **Fasten the drawer front** with washer-head screws. The oversize mounting holes and perfectly-centered pilot holes allow making minor adjustments, if necessary, after the cabinet is installed.

Installing Cabinets

Get the lay of the land before you start building.

by Greg Larson

YOU CAN BUILD the world's most beautiful cabinets, but if they're improperly installed, telltale gaps and misalignments will ruin their appearance. The cabinet-building method that I teach at the New England School of Architectural Woodworking (NESAW) is based in part on the understanding that proper installation is a critical part of the building process (see "Cabinet-Building Essentials," page 32).

Our method creates long runs of cabinets with integrated face frames, eliminating the need to align and level individual units, as is the case with stock, off-the-shelf cabinets. Our cabinets are designed to allow scribing wherever necessary to match an uneven wall or floor, eliminating the need for patched-in scribing boards. We also separate the toe base from the cabinet carcass. Built to match the length of each cabinet or run of cabinets, stand-alone toe bases are easy to level. And once they're installed, the carcass simply sits on top—automatically level. By using these construction methods and following the techniques demonstrated in this story, you can achieve a professional-looking installation first time, every time.

Level and plumb

It's nearly impossible to find a room with perfectly level floors and plumb walls with no undulations. This, of course, presents issues for the intrepid

EDITOR: TIM JOHNSON | PHOTOGRAPHY: NICK NOYES | ILLUSTRATION: FRANK ROHRBACH

installer, whose goal is cabinets with level countertops, plumb fronts and no gaps where they meet the walls. So where to start? The way to ensure a successful installation is to understand the characteristics of the room before you design the cabinets, so you can build in the necessary allowances.

A standard cabinet installation has a countertop height 36" from the finished floor (Fig. A, page 64). However, we call this the nominal height because floors are usually not level. That means there will be spots where the countertop is higher or lower than 36" from the floor. Since the cabinet carcass height is fixed, the variations in the floor have to be accommodated in the toe base, which is easy, because it's a separate unit that consists of a plywood frame with solid wood facing. The cabinet carcasses are 30-3/4" high, and assuming a countertop thickness of 1-1/4" (typical for granite), that leaves 4" for a nominal toe base height. However, the toe base's actual height will vary based on how much the floor is out of level (Fig. B).

Find high and low spots

The first step is to find the high and low spots in the floor. This can be done with a standard level, but if you are going to install many cabinets over a wide area, it's worthwhile to invest in a laser level, which is faster and more accurate (see Sources, page 66). Start by setting the laser level to a random height off the floor—4' or so works well. Get a straight stick about 1" square by 5' long. Working your way around the room, hold the stick straight up and down at the corners and various points along the perimeter where each base cabinet will be installed. At each point, mark the stick where the laser crosses it (**Photo 1**). Label each point with a letter and draw a floor plan showing where each point was measured. Keep the plan and this "story stick" for reference and to help eliminate mistakes.

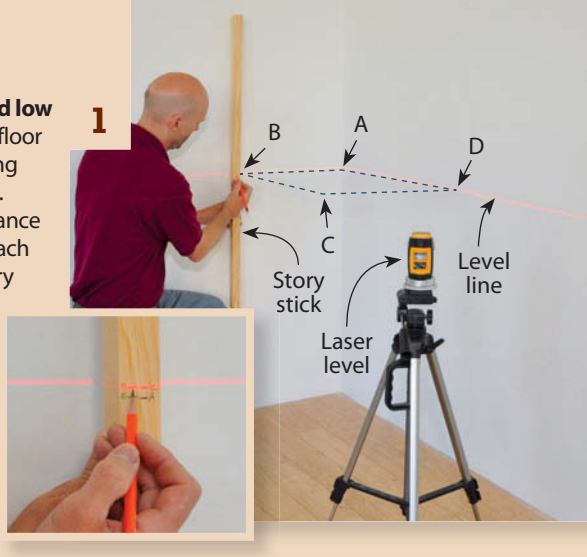
Mark the nominal height

The first decision is to determine where you want the countertop's nominal 36" height to be. This could be anywhere, but some common spots are midway along a run of cabinets, to divide in half a slope that runs from end to end, or at the sink or stove, because that's where you spend the most time standing. Once you determine the spot, mark it with a pencil line on the wall at 36" minus the countertop's height (34-3/4" in this case). This mark represents the top of all the base cabinet carcasses. Set the laser level to this point on the walls that the base cabinets will be installed on. (Or, use a long bubble level to mark level points on the walls.) Snap chalk lines at the laser lines, then measure down 30-3/4" and snap another line. This line represents the top of the toe base frames (**Photo 2**).

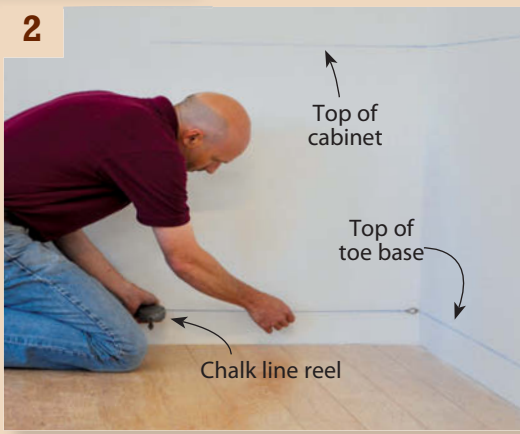
Level the toe base

One of the most critical parts of the installation process is setting the toe base frames, because this ultimately determines how level and plumb the cabinets are. So,

1 **Find high and low spots** on the floor before building your cabinets. Mark the variance in height at each corner of every cabinet. Use this info to determine the height of the cabinets' toe bases.



2 **Start the installation** process by marking level lines on the wall that indicate the cabinets' overall height (without the countertop) and the top of the toe base.



3 **Position the toe base frame** and level it with the lines on the wall. Insert shims to fill gaps, as necessary, to provide proper support at the fastening points. Then screw the frame to the wall and to the floor.

4 **Position the applied faces** for scribing to match the uneven floor. Clamp the faces level with the toe base frame and measure to make sure the amount you'll remove matches the scribe allowance that's built into each face.

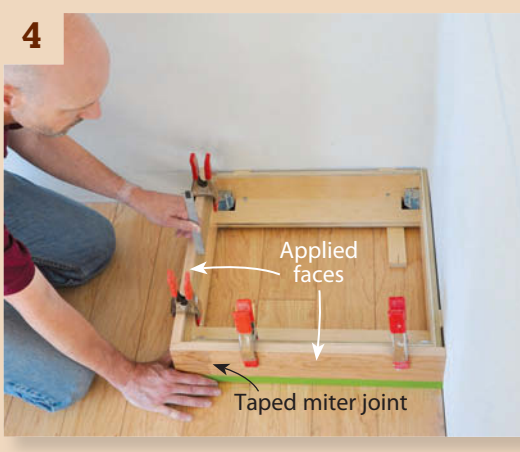
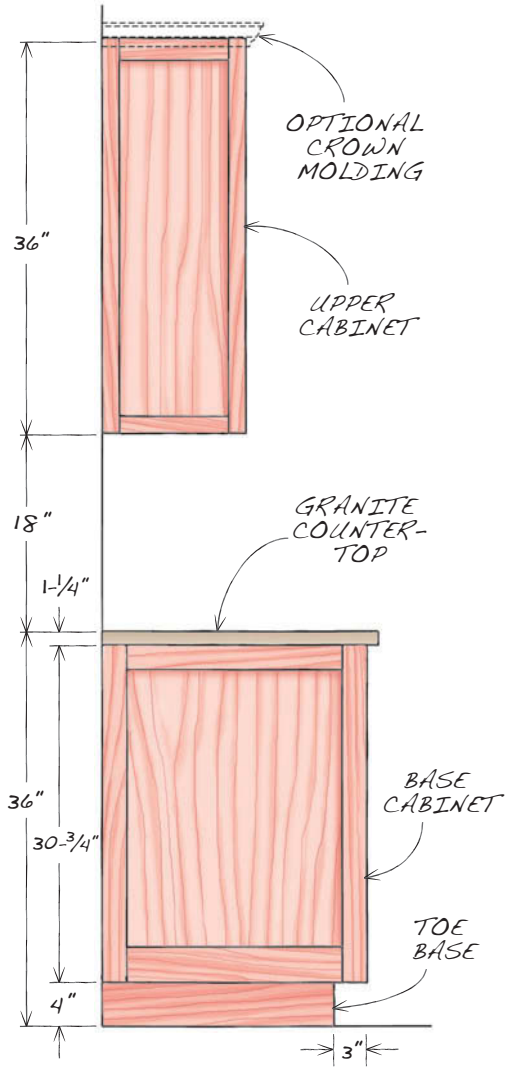


Fig. A Cabinet Installation Basics



take your time. The installation procedure is the same, whether for the short toe base shown here or a long toe base for a run of cabinets.

Typically, we construct the toe base frames less than 4" high so that we can shim up the low spots to hit the chalk line that indicates where the top should align. The actual height of each frame depends on how far out the floor is from the nominal 36" point you've chosen. If the floor drops 1/2" from one end of the cabinet to the other, and you want the nominal point to be in the middle of the cabinet, the frame has to be at least 1/2" shorter than 4". If you want the nominal point to be at the end of the cabinet where the floor is lowest, the frame has to be even shorter. For demonstration purposes, the frame shown here is 3-1/2" tall.

Place the toe base frame in position and adjust the levelers to align its back edge with the line on the wall (**Photo 3**). The frame shown here is being installed in a corner, so it must be aligned with both lines on the adjacent walls. Note: You can build toe base frames without levelers and use shims to level them, instead.

Once the back edge (or edges) of the toe base frame are aligned with the chalk lines, use a short level to level their front corners with the back. Check both diagonals to ensure the frame is truly level. Then anchor the back of the frame to the wall with screws. Support the screws by inserting shims to fill gaps between the back and the wall, as necessary. Next, install shims to support the frame's horizontal stretchers. Then screw through the stretchers into the floor in the front. Use the level again to verify that the frame is still level—and make the necessary adjustments if it isn't.

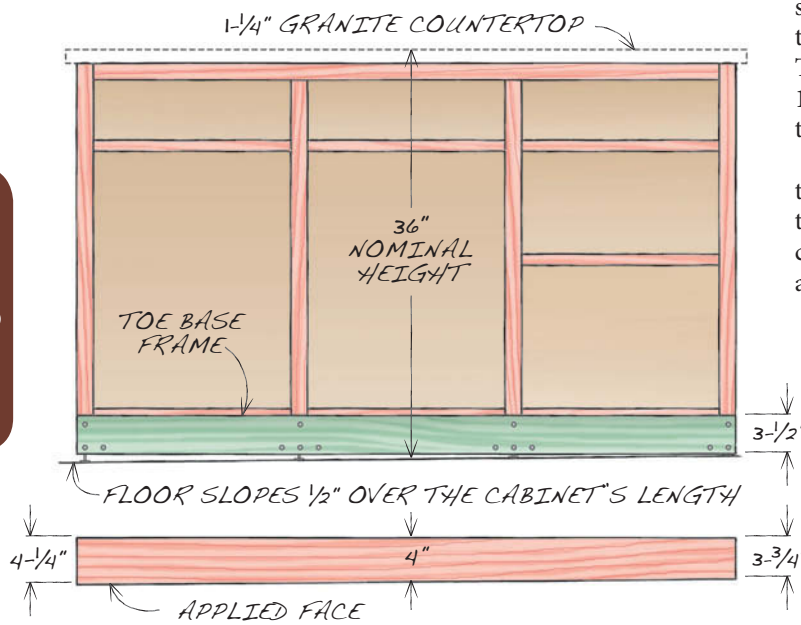
Install the facing

Cover the toe base frame by attaching a finished face that matches the rest of the cabinetry. This applied face is made of 3/4" thick solid wood, so it can be fastened with screws from inside the frame. While we typically build toe base frames less than 4" high, so they'll fit between the chalk lines on the wall and the floor's high spots, we typically build the applied faces wider than 4" to allow for scribing to an uneven floor. To make scribing easier, the applied faces have 1/2" deep x 3/4" wide rabbets on the back of their bottom edges.

The cabinet we're installing is finished on two sides, so its toe base requires installing two applied faces that are mitered to match the cabinet's joinery. (Toe bases for cabinets that are finished on only one side—the front, typically—require only one applied face. Installing a single applied face is similar to the procedure described below, but simpler, because there's no mitering.)

Start the installation by mitering both applied faces. Then cut them to length so that they'll both extend to the walls. Assemble the miter joint using clear packing tape (it holds better than masking tape). Then clamp the assembly to the toe base frame so both faces are parallel

Fig. B Establishing the Nominal Height



with the frame at the top while touching the floor's highest point at the bottom (**Photo 4**). Measure the distance from the top of the frame to the top of the applied face—it should be less than the width of the rabbet on the bottom of the applied face. If it's not, rip some material from the top of the applied face until it is.

Make a scribing block (about 3/4" thick x 3/4" wide) that's the same height as the distance you just measured. Use this block and a pencil to trace the floor's contours onto each applied face (**Photo 5**). Disassemble the applied faces and cut away the waste on each one, leaving the pencil line. Then use a block plane, rasp or sandpaper to true the cut to the pencil line (**Photo 6**). When both applied faces match the floor's contours, make sure their top edges are flush with top of the toe base frame or just slightly below it. (A small gap can't be seen under normal circumstances. This provides some leeway in case you mess up the scribe the first time.) Then glue the miter and fasten both faces from inside the frame, using #8 x 1-1/4" screws.

Fit the base cabinet

As with checking the floor for level, each wall must be checked for plumb before building the cabinets, so that the proper scribe allowance can be built in to the stile that will go against it. If the wall is out of plumb by 1/2", at least that much extra width (the scribe allowance) should be added to the stile, to allow scribing it to fit the wall.

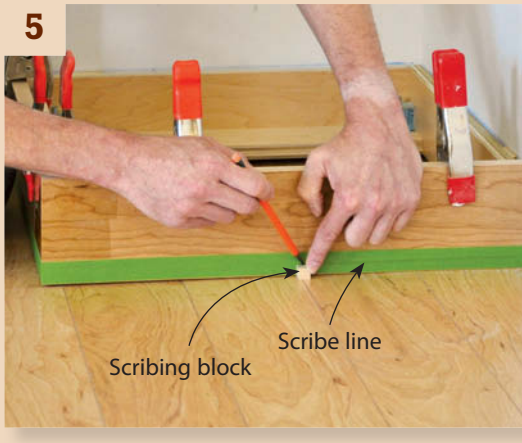
Set the cabinet on the toe base and push it against both walls to ensure that it's level and the right height (**Photo 7**). The face frame and side panel stiles should align with both upper chalk lines. If the walls aren't plumb, gaps will appear between the walls and the stiles.

The cabinet shown here was built with 1/2" scribe allowances, so that's exactly how much will be removed by scribing: Where the stile touches the wall, the full 1/2" will be removed; where there are gaps, less so. Use a 1/2" wide scribe block and a pencil to transfer the wall's contours onto the stiles (**Photo 8**). Scribe the stile with the largest gaps first. Saw the waste from this stile (**Photo 9**). Then test-fit it against the wall. When the fit is reasonably close, scribe and rough-cut the stile on the adjacent wall. Then check both stiles against the walls and fine-tune the scribes as necessary until both stiles fit perfectly. If scribing is new to you, it's a good idea to develop your skills by scribing a practice cabinet.

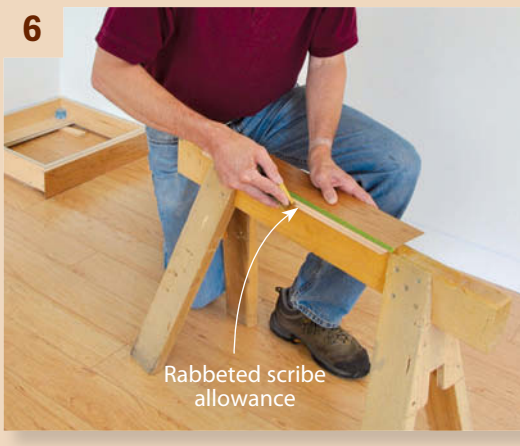
Fasten the base cabinet

Place shims in the gaps between the back of the cabinet and the wall. Then fasten the cabinet to the wall through the shims, using PowerHead screws, which are specifically designed for this purpose (**Photo 10** and Sources). These screws must penetrate at least 1-1/2" into the wall studs. I like to use 3" PowerHeads, so I can recess them and apply caps to match the interior plywood. I use the Micro Flush-Mount Power Drill Bit System to pre-drill the holes (see Sources). It's cool because you can preset the depth so that the screwhead sits just below the surface, so that when you install the decorative cap, it sits perfectly flush with the plywood. This makes the screw holes nearly invisible.

5 **Mark the scribe** on each face, using a scribing block that's the same height as the distance you just measured. Tape makes the scribe line easier to see during the next step.



6 **Plane, file or sand** each applied face to the scribe line after rough-sawing. The rabbeted scribe allowance makes this job easier, because there's less material to remove.



7 **Set the cabinet** on the toe base and push the face frame and side panel against the adjacent walls. Make sure the cabinet is level; then check for gaps. Rabbeted scribe allowances ease fitting the cabinet to the wall.

8 **Use a scribing block** to transfer the wall's uneven profile. Cut the block so its height matches the scribe allowance that you've built in (1/2" in this case).

9 **Rough-cut** each scribe at an angle—this makes fine-tuning easier. When a cabinet has two scribes, mark and rough-cut the one with the largest gap first. Then reposition the cabinet to mark the second scribe.

10 **Fasten the cabinet** to the wall using PowerHead screws, after installing shims as necessary, to eliminate gaps between the wall and the cabinet. PowerHead screws are specially designed for installing cabinets.

11 **Fasten the upper cabinet** to the wall after building a riser to hold it in position at the proper height and scribing it to fit the wall. Scrap plywood shims make it easy to remove the riser after the cabinet is installed.

12 **Create a finished** look by covering the exposed bottom of the upper cabinet's carcass with a pre-finished piece of 1/4" plywood that matches the exterior wood.

Industry standards require that each cabinet have at least four screws anchoring it to the wall and spaced apart no more than 16" on-center; this is particularly important for installing upper cabinets. Screws should be within 2" of the sides horizontally and within 2" of the top and bottom vertically. Note: Fastening the cabinets to the wall will be much easier if horizontal blocking is added between the studs when the walls are being constructed, at the top and bottom of both the base and upper cabinets.

Install the upper cabinet

The upper cabinet is easy to install once the base cabinet is in place, because it provides a level surface. Just build a riser to rest on this surface and support the upper cabinet at the correct mounting height (**Photo 11**). The standard distance from the installed countertop to the bottom of the upper cabinet's face frame is 18". Since the upper cabinet's face frames and side panels hang 1-1/8" below its plywood carcass, build the riser at least that much shorter and use shims of scrap plywood to build it up to the mounting height. This allows removing the riser without any fuss once the cabinet is installed.

Set the upper cabinet on the riser and scribe it to the wall as you did the base cabinet. Once both scribes fit, fasten the upper cabinet using the same rules as for the base cabinet. With upper cabinets, it's even more important to have blocking in the walls and follow the rules for screw placement to ensure the cabinet stays where you want it to stay—on the wall!

Lastly, cover the bottom of the upper cabinet's plywood carcass with a piece of pre-finished 1/4" plywood that matches the cabinet's exterior. Scribe the plywood to the wall, cut it to fit and fasten it with construction adhesive and pin nails (**Photo 12**).

This upper cabinet doesn't extend all the way to the ceiling, so adding crown molding is optional. The cabinet looks balanced without crown molding because its wider top rail adds visual weight. To create a balanced look with crown molding, install the molding so it covers 3/4" of the top rail, leaving 1-1/4" exposed.

SOURCES

- FastCap, fastcap.com, 888-443-3748, Laser Level, #AB2 LASER, $199; PowerHead Wood Screws, 3-1/2", #PHZ8.3.5, $10.20 per box of 100; Micro FlushMount Drill Bit System, #FC.DB.CB.9/16.MICRO, $50.

Greg Larson is the director of the New England School of Architectural Woodworking (NESAW), a career training school for cabinetmakers, and The Workbench, a woodworking and craft school for hobbyists. Both schools are located in Easthampton, in beautiful western Massachusetts. For more information, visit at www.nesaw.com and www.workbenchschool.com.

Pre-finishing Plywood

Hands down, the best way to finish cabinet interiors.

by Kevin Southwick

FACTORY-MADE pre-finished plywood makes cabinet building quicker, easier and cleaner, so it's unfortunate that most home centers and lumberyards don't stock it. Luckily, it's easy to apply a durable, good-looking, silky-smooth and fast-drying finish on the unfinished plywood sheets they do stock.

The trick is to use a combination of two modern finishes, Zinsser's SealCoat and Varathane's water-based floor finish. SealCoat, which is liquid dewaxed shellac, effectively seals the porous plywood. It's ready to use out of the can (at a "two-pound cut"), dries quickly and is compatible with virtually all other clear top coats. Used as the top coat, Varathane's water-based floor finish levels nicely and provides a smooth surface. Its formula contains aluminum oxide for extra abrasion resistance, which makes it perfect for this application.

Prepare the surface

Finishing plywood for cabinet interiors isn't nearly as fussy as finishing fine furniture, so every aspect, from preparing the surface to applying the top coat, can be relaxed a little.

Working with full sheets of plywood is easy if you have room to reach halfway across from both sides. If space is limited, cut the sheet into manageable sections.

Lay the sheet on sawhorses or a bench at a comfortable working height. Remove any splinters from the edges. Then sand the sheet with 100 grit paper, using a random-orbit sander (**Photo 1**). Use a tack cloth or vacuum to remove dust from the sanded surface. This step should take no more than 10 minutes.

Hand application

Applying the finish by hand is less messy than spraying and almost as fast. Solvent fumes will saturate the air in either case, due to the large surface area being finished, so be sure to wear a respirator and provide adequate ventilation.

Use a roller to rapidly apply the SealCoat (**Photo 2**). The best roller I've found for this is Purdy's "Parrot" 1/4" nap woven mohair roller, which is green (see Sources, page 69). This roller will hold a lot of finish and can be messy to use unless you roll it in the tray to press out the excess.

SealCoat dries fast, so distribute it quickly and evenly. Start in the middle of the panel and work toward the edges. The slight "orange peel" pattern the roller creates is of no concern, because it will disappear once the floor finish top coat is applied. Avoid overworking the SealCoat when it starts to get sticky. Wrap the roller in a plastic bag to save it for use on the next sheet.

Let the SealCoat dry 15 to 20 minutes. Then lightly sand smooth the raised grain and dust nibs by hand, using a block wrapped with 320 grit paper. Sanding should only take about five minutes. Use a dampened microfiber tack cloth to remove the dust (see Sources).

Apply one thick coat of the Varathane water-based floor finish (**Photo 3**). The best applicator for covering this large (32 sq. ft.) surface is specially designed for

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Sand the plywood with 100 grit to remove scuff marks and minor scratches. Pre-finishing plywood isn't nearly as fussy as finishing fine furniture, so you don't have to sweat the details.

Roll on the shellac. Start in the middle of the sheet and work toward the ends. Roll half of the sheet and then move to the other side to finish the job. This step takes about two minutes.

Use a floor-finish applicator to apply a generous, thick coat of water-based floor finish. Use sweeping strokes to distribute the finish evenly, followed by end-to-end strokes to level it.

Spraying on the finish is only slightly faster than applying it by hand. Spray from end to end, using an overlapping pattern. Work from one edge to the middle and then move to the other side.

floors (see Sources). Its removable pad comes attached to a wood block that's designed for use with a broom handle. Because the plywood sits on sawhorses, you won't need the handle.

Pour the floor finish into a roller tray. Dip the pad into the finish and distribute it quickly and evenly, starting in the middle of the sheet and working toward the edges. This material levels out very nicely if you flood it on and leave it alone, so avoid overworking it. Allow 20 to 30 minutes drying time before handling. Remove the pad from the block and wash it out with water, so it's ready for the next sheet.

Spray application

When you use an HVLP spray system (see Sources), covering the sheet with each finish takes about a minute. Fill the gun's cup with SealCoat. Then spray the plywood with a "half-lapping" pattern (overlapping one-half of the last pass) to ensure consistent coverage (**Photo 4**). As with the hand application, let the finish dry 15 to 20 minutes, then lightly sand the surface by hand.

Use denatured alcohol and absorbent rags to clean out the spray gun. Be sure to remove all shellac residue. Such thorough cleaning is very important when switching from shellac to a water-based finish, as leaving any small amount of shellac is guaranteed to gum up the works. Start by cleaning the cup itself. Then fill the cup with about 1/2" of clean alcohol and spray it through the gun to clean all parts of the fluid pathway to the spray tip. Rinse and repeat.

Fill the cup with the water-based finish and spray the surface. Lay on the finish nice and heavy, using a half-lapping pattern. Clean out the spray gun using water. The sheet should be dry to the touch and ready to move in 20–30 minutes.

SOURCES

- Menards, menards.com, Zinnser Sealcoat, #5555369, $39.47 per gal.; Varathane Interior Water Based Floor Finish, Satin, #5553219, $41.97 per gal.; Purdy Parrot Roller, 9", 1/4" nap, #140644091, $5.29; Varathane Floor Finish Applicator, #989751, $7.26.
- Rockler Woodworking and Hardware, rockler.com, 800-279-4441, HVLP Spray System, #61577, $150.

Kevin Southwick is a wood-finishing specialist and furniture restorer/conservator in Minneapolis, MN. To learn more, visit **southwickfurnitureconservation.com**

4-Tier Knife Block

Each layer *looks* like one solid piece of wood, but how do you make those deep slots? Here's the secret.

by Tom Caspar

A KNIFE BLOCK is one of the most convenient—and safest—ways to store kitchen knives. Most knife blocks are large chunks of wood composed of a dozen or more pieces laminated together. This one is much easier to make.

Before starting, take stock of your set of knives. Measure their width and length to make sure they'll fit in this block's slots without bottoming out. Adjust the widths of the slots or the lengths of the block's sections if necessary.

Matching grain

Each part of the knife block looks like it's made from one piece of wood, doesn't it? Well, it's not. Each layer is made from two pieces glued together—two pieces that are artfully arranged, that is. You can't achieve this effect by randomly taking pieces from a board and gluing them up, of course. So, what's the trick?

The secret is to "slip-match" each part (Fig. B, page 72). Basically, you take one long piece and crosscut it in half, then slip one piece on top of the other. This way, both the end grain and the side grain will match as closely as possible. If you start with a board that has very straight figure on its edges, the glue joints will be almost impossible to see.

Although you can make this knife block from various bits of scrap, the best way to achieve a uniform appearance is to make it from a single board about 6" wide and 8' long. The pieces you'll be working with are only 5/8" thick, so you can start with 4/4 (1") rough lumber or a board that's already been planed 3/4" thick.

Groove the pieces

Start by cutting your board into three pieces 24" long. If you're using 1" thick wood, plane all of the pieces down to 3/4" thick and set them aside for a week or so. (It's very important that your final stock be as flat as possible, so give the

PHOTOGRAPHY: JASON ZENTNER | ILLUSTRATION: FRANK ROHRBACH

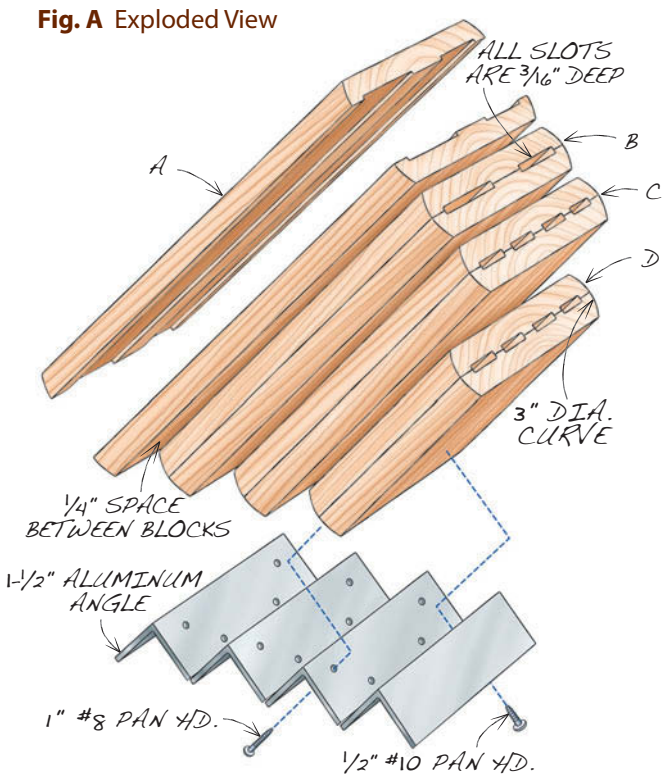
Each section of the knife block is made from two pieces of wood. Rout shallow grooves in each one.

Glue the pieces together. Note that the end grain should curve in the same direction on both pieces. This helps create the illusion that the glued-up pieces are a single block of wood.

Saw the sides of the blocks at two different angles to begin forming a curved edge.

Sand each side with a curved sanding block. Keep sanding until all the pencil marks are gone—this indicates that all the flat areas are now curved.

Fig. A Exploded View

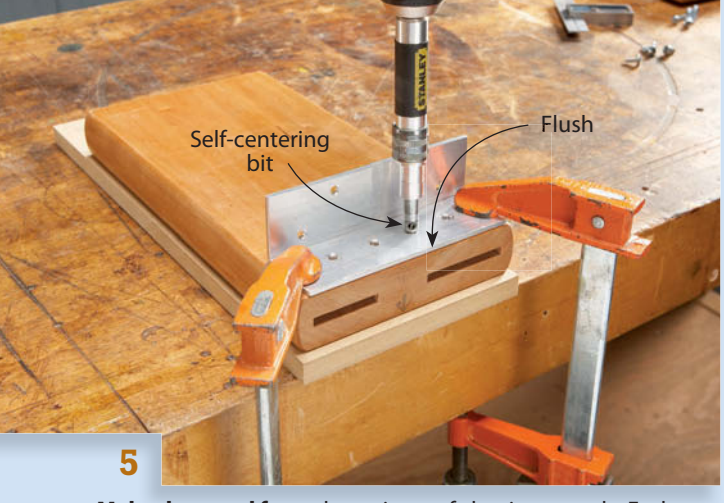


wood time to warp if it wants to.) Crosscut these pieces in half, making six pieces 12" long. Carefully mark the ends of these pieces so you'll be able to slip-match them in pairs later on. Joint and plane all pieces to 5/8" thick. (To avoid snipe, butt the boards end to end when you run them through the planer. Begin and end the "train" with scrap pieces.) Joint and rip the pieces 5-5/8" wide.

Reassemble the pieces into three pairs. Two pairs will be used to make the upper sections of the knife block (A & B). The remaining pair will be cut in half, later on, to make the two lower sections of the block (C & D). Mark the outside faces and adjoining sides of all these pairs, so you'll know exactly how to orient each piece on the router table in the next step.

Set up a 3/4" straight bit in your router table to make a groove that's 3/32" deep. Position the fence 7/16" away from the bit and cut grooves on both sides of the inside faces of all six pieces (Fig. C).

Select the two pairs of pieces that will become the upper sections of the knife block. Move the fence an additional 3/4" away from the bit and rout the grooves again, making them wider. This completes the narrow set of grooves in these blocks; to make the wider set, move the fence an additional 1/2" away from the bit (**Photo 1**). Pay close attention to how you orient these pieces when you rout them, so the grooves match when you reassemble the pieces into pairs.



5

Make the stand from short pieces of aluminum angle. Each angle must be precisely flush with the end of each block. Drill pilot holes with a self-centering bit to ensure that the angle doesn't shift when you run in the screws.

6

Fasten each angle to the end of a block. The spacers between the blocks must be exactly the right thickness in order for all the angles to align.

Finish routing grooves in the remaining pair of pieces (C & D, combined). Each groove is 7/8" wide, which will require two passes.

Glue and shape

Glue the pairs together (**Photo 2**). Place flat boards above and below the pieces to help distribute clamping pressure and avoid denting the wood. Clamp across the pieces first to force their edges flush, then use six clamps top and bottom.

The sides of the glued-up blocks must be straight, square and parallel before you round them. Set your jointer to take a 1/32" deep cut, then make two passes down one side of each block. Rip the pieces 5-1/2" wide.

Tilt the saw blade 10° and make two small bevel cuts along each side (Fig. D). (If you have a right-tilt saw, place the fence on the left side of the blade, so the blade tilts away from the fence.) Be sure that the center 1/4" of the piece remains uncut. Turn the piece around to cut the opposite side—there's no need to reset the fence. Next, tilt the saw blade 20° and repeat the operation (**Photo 3**). This time, be sure that the portion *taken away* is 1/4" wide. When you're done, each side will have five equal facets that are 1/4" wide.

Starting with 80 grit paper, sand the sides into a smooth curve (**Photo 4**). A curved-bottom cork block with a fairly large radius works best. Cut the pieces to final length. Sand their ends and faces, then apply a finish.

Add the base pieces

The base of the knife block is made from 1-1/2" aluminum angle, which is available at many home centers. Use a hacksaw with a 32 tpi blade to cut the angle into four pieces 5" long. File or sand their ends smooth.

Use a drill press and a fence to drill screw holes in each piece (Fig E). Note that three of these pieces are identical; the fourth piece, the one that goes in front, has no holes on the side that faces out.

Align each angle exactly even with the end of each block, then drill pilot holes and fasten the angles to the blocks (**Photo 5**). To fasten the blocks together, stack them one piece at a time, with spacers in between (**Photo 6**). The thickness of the spacers is critical. Plane them so the thickness of a block plus a spacer equals 1-1/2", the width of the angle.

Fig. B How to Match Grain

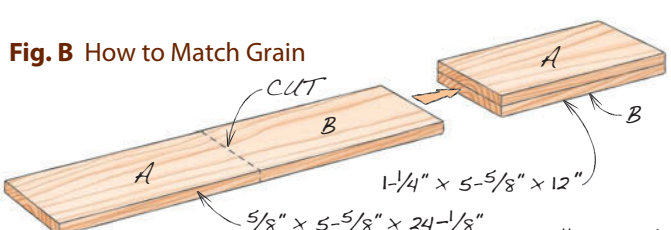


Fig. C Groove Layout

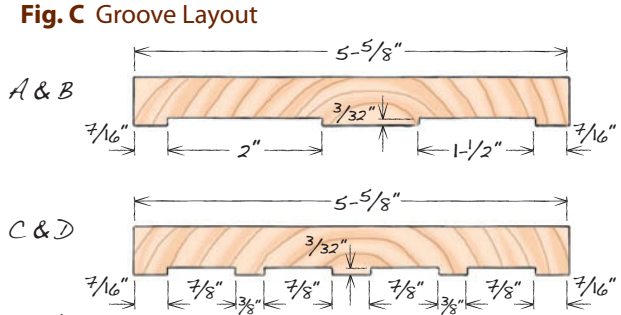
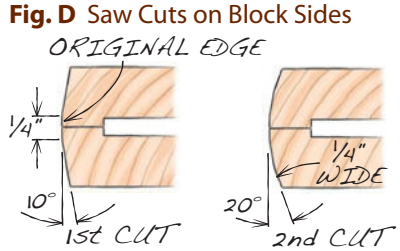


Fig. D Saw Cuts on Block Sides



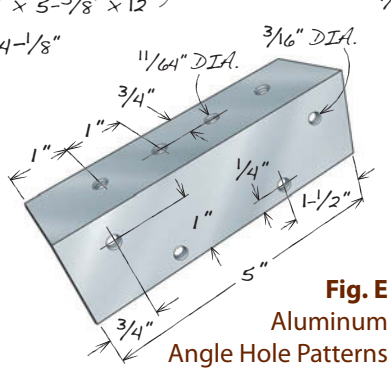


Fig. E Aluminum Angle Hole Patterns

Cutting List

Overall Dimensions: 8-1/2" H x 5-1/2" W x 10-1/2" D

Name	Qty.	Th x W x L
Block A	1	1-1/4" x 5-1/2" x 10-1/2"
Block B	1	1-1/4" x 5-1/2" x 9"
Block C	1	1-1/4" x 5-1/2" x 7-1/2"
Block D	1	1-1/4" x 5-1/2" x 4"
1/8" aluminum angle	4	1-1/2" x 1-1/2" x 5"

Notes: To make all the blocks, start with 3 pieces of 5/8" x 5-5/8" x 24-1/8" stock. Cut each piece in half to make the two sides of each block. Cut blocks C and D from one piece.

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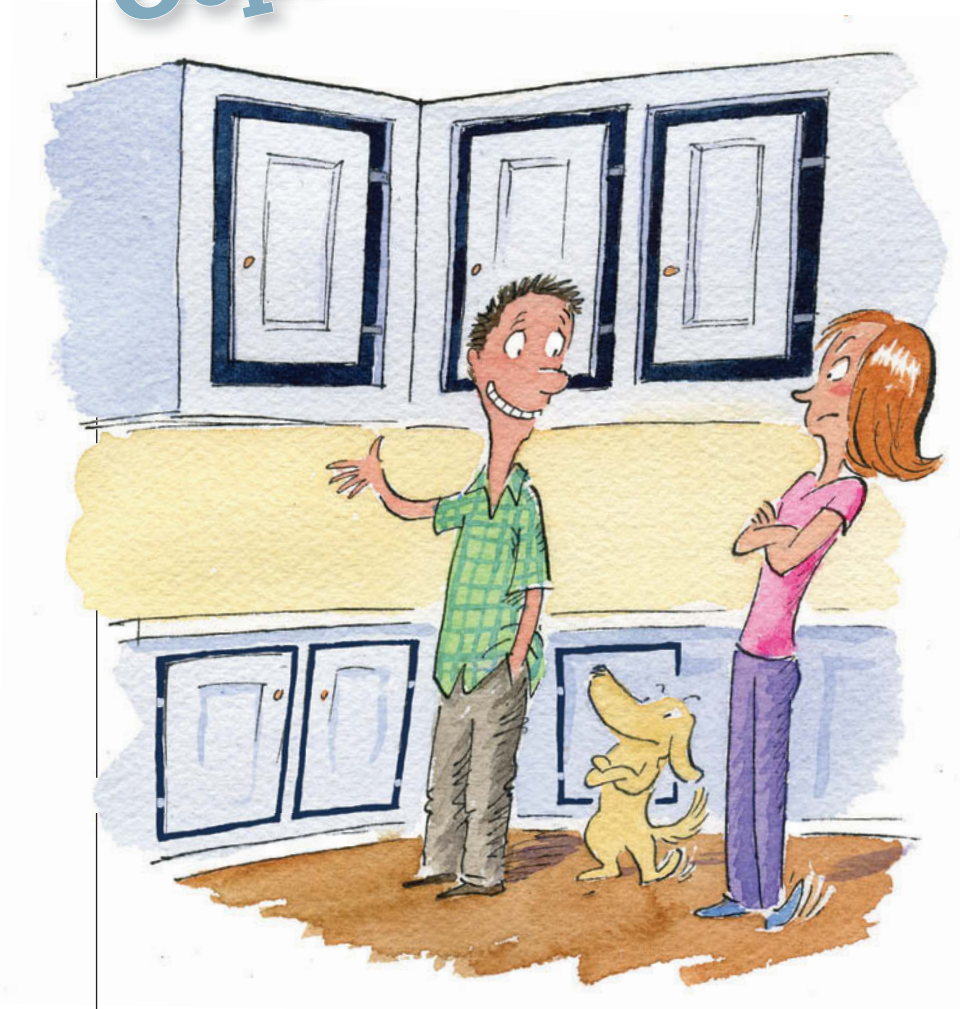

Inside Job

WHILE REMODELING MY KITCHEN, I decided to replace all the cabinet doors. Like the original inset doors, my new doors would mount flush with the cabinets' face frames. I measured each opening carefully, using a tape measure with a case that required adding 3" to each inside measurement.

I went to the lumberyard and bought straight-grained lumber for the doors' stiles and rails and highly figured boards for the panels. Dreaming of the beautiful doors I was about to create, I headed back to my shop and started building.

I sure had a sick feeling when I placed my first artfully-crafted door in its opening. Yes, I'd forgotten to add the 3", so the door was much too small. But my biggest mistake was that I built all of the doors before checking to make sure any of them would fit.

Bob Molloy

Door Jambed

SEVERAL YEARS AGO, I built a woodshop in my basement, which I closed off with a 36" door. When a family friend asked me to build a 39"-tall pub table, we agreed to make it 35" square, so it would easily fit through the door. To make the table extra-sturdy, I decided to glue the base to the plywood top.

I eased the completed table through the shop door and headed toward the basement door that led outside. I'd always assumed this door was 36" wide, because it was an exterior door. So you can imagine my surprise when the table wouldn't fit through, because the door was too narrow. In fact, I had to remove the door, the jamb and all the trim to get the table out of the basement.

I delivered the table, leaving it in the garage as my customer requested. A couple days later she called to thank me for doing such a good job. She also mentioned that a neighbor was coming over to remove her basement door, jamb and trim, so she could move the table inside!

Dennis Dorries

Make your woodworking mistakes pay! Send us your most memorable "What was I thinking?" blunders. You'll receive $100 for each one we print. E-mail to: **oops@AmericanWoodworker.com** or send to AW Oops!, American Woodworker, 1285 Corporate Center Drive, Suite180, Eagan, MN 55121. Submissions can't be returned and become our property upon acceptance and payment. We may edit submissions and use them in all print and electronic media.

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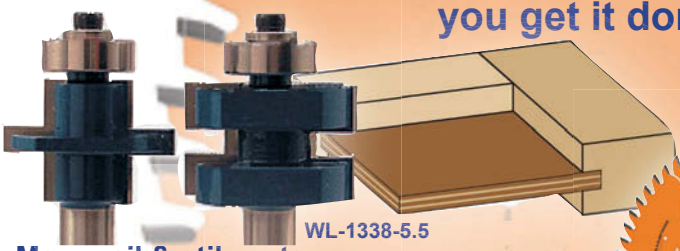

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