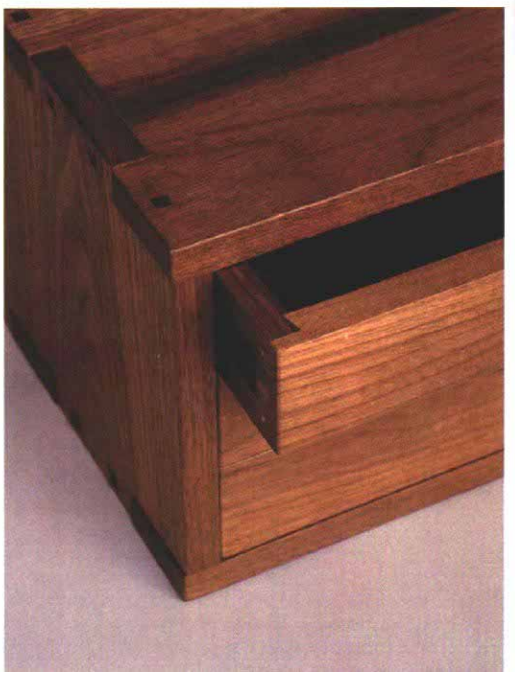
Twenty years of furnituremaking experience *separate the author's nailed, butt-joined carpenter's toolbox from his pegged, finger-joined walnut jewelry box. Drawer fronts are joined to drawer sides with pinned, half-blind, half dovetails.*



A Dozen Ways to Build a Box

Let function, economy and style guide your choice of joinery

by Gary Rogowski

The first box I ever built I put together with enough nails to build a small house. "Can't be too strong," was my motto. That toolbox is still together, too. But in building furniture for the last 20 years, I have learned a few more ways of putting boxes together, from plain and simple to elaborate and complex—all without those nails (see the photos above).

Box construction is a basic building block of furnituremaking. Whether you want to build a desk or a kitchen cabinet, an entertainment center or a jewelry box, knowing how to build a box that is both functional and stylistically appropriate is crucial. The more joinery options you're familiar (and comfortable) with, the greater your furnituremaking vocabulary and the greater the chances that you will consider your furniture projects successful.

There are three essential considerations when deciding on the joinery for a box: function, economy and style. Ask yourself what the box is for. A box's function will usually help determine appropriate types of joinery for the project based on how much work is involved (economy) and on the look you're trying to achieve (style). A carpenter's toolbox or a birdhouse doesn't really require anything more sophisticated than butt joints. Kitchen cabinets, because you generally need quite a few of them, are well-suited to simple joinery techniques, but they also must be strong. There's

Photos: Vincent Laurence

no point in dovetailing these cabinets; it would take forever and not serve any but a decorative purpose. A splined or biscuit-joined miter, however, is a very good compromise.

Other boxes, whether they house your fine silver or your prized handplane collection, may justify the time and effort required to dovetail a carcase precisely. The attention you pay to detail and the emphasis placed on the joinery as a design feature, are in keeping with the valued contents of those boxes.

There are many ways to put together a box. I discuss a dozen in this article, but there are at least another dozen besides. The methods I've presented here, though, collectively form a good initial "Vocabulary" of woodworking joinery. I've also provided some basic guidelines on choosing and cutting joinery, both for solid wood and for plywood and other sheet goods. No magazine article can cover such a vast topic in depth, however, so I've also listed a few books on joinery that treat the subject in much greater depth (see the further reading box on p. 79).

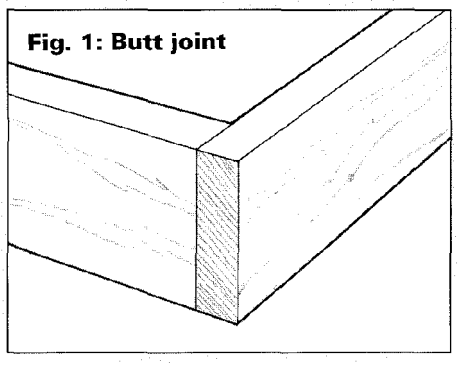
Knowing your alternatives just gets you started. Choosing the right joint for the job and acquiring the requisite skills is still up to you. Fortunately, as with most aspects of woodworking, there will be no one right answer (see the photo on p. 79), and every foray into unfamiliar territory will add to your repertoire.

Butt joints

Butt joints are the simplest and quickest way of putting a box together. Boards are simply cut to length at 90° both to the board's edge and to its face (a square cut) and then glued at the ends and fastened with nails or screws (see figure 1).

The problem with butt joints in solid stock is that you're joining long grain to end grain. That is an inherently weak connection because glue doesn't bind well to the open-ended wood fibers of the end grain. A box that's joined with butt joints won't last forever, especially if it's subject to a lot of abuse, but for applications such as garden frames or birdhouses, it's fine. Often, too, these kinds of utilitarian projects are made of plywood, which provides a better glue surface than solid stock for this joint.

FIGURE 1: ***The butt joint*** *is the simplest of woodworking joints, but in solid stock, it is also the weakest because of the long-grain to end-grain glue surface.*



Rabbet joints

The advantage of a simple rabbet joint over a butt joint is that the glue surface area is larger. It's still a long-grain to end-grain joint, but the greater surface area helps somewhat. Another advantage of the rabbet joint is that by cutting the rabbet at the end of one board to precisely the thickness of the mating board, your boards are automatically flush (see figure 2 below). Window frames are often made this way.

Rabbets can be planed by hand, cut on the tablesaw or routed. If the box is small and will not be put under a lot of stress, the glue joint should hold up fine by itself without mechanical fasteners. For larger pieces, however, and where greater strength will obviously be necessary, it's a good idea to nail or screw the joint, or pin it with dowels. Even with plywood, which is often joined with rabbet joints to make cabinets, the addition of fasteners is probably a good idea, providing a measure of insurance.

A double rabbet joint has a still greater glue surface area and, when cut on the tablesaw or routed on a router table, is easily set up. By setting bit or blade height and depth precisely the same, the boards will mate perfectly (see figure 3 below).

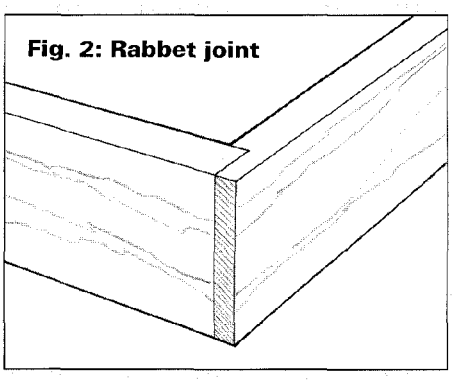
Another variation on the rabbet joint is the dado rabbet. This joint's greatest asset, besides its being relatively easy to create, is that it possesses some mechanical strength by virtue of its captured dado (see figure 4 below). This joint is best used with plywood, however, because in solid stock, the end of the board extending past the dado is susceptible to breaking, especially when you're fitting the joint. The grain is just so short there that a little too much pressure can cause the end to pop right off. Still, if fitted carefully, using a thin dado and keeping it as far from the corner as possible, the joint can be assembled without a great deal of trepidation.

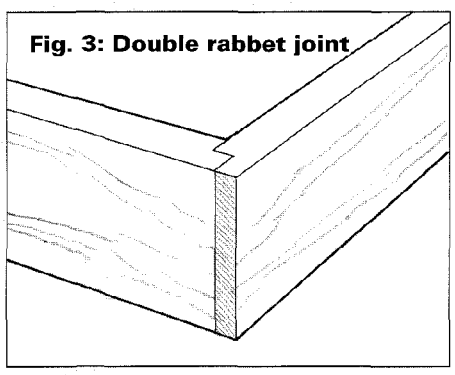
If you want the ends of the dadoed boards to be flush with the sides of the mating boards, it's crucial that you lay out the joint accurately. That's because the placement of the dado locates the rabbeted box side. If the dado is not set in far enough from the corner, the rabbeted side will remain proud of the corner; if the dado is set in too far, you have some short end grain to remove after glue-up.

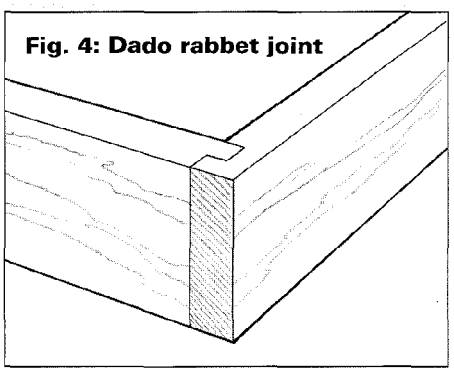
FIGURE 2: ***A rabbet joint*** *has a greater glue surface area than a butt joint and, therefore, is stronger. Additionally, with an accurately cut rabbet, the mating board will automatically set flush to the end of the rabbeted board.*

FIGURE 3: ***The double rabbet joint*** *has an even greater glue surface area than a rabbet joint and is easy to set up on the tablesaw or router table.*

FIGURE 4: ***The dado rabbet joint*** *possesses mechanical strength in one direction because of the captured dado.*







Drawings: Maria Meleschnig

Miter joints

Both butt and rabbet joints show end grain from one side of the corner. To avoid this or to carry a decorative edge around a box, mitered corners can be used (see figure 5 below). Depending on their size, miters can be cut on a miter saw, a sliding compound-miter saw or on a tablesaw.

On the tablesaw, I set the blade at 45° (for a four-sided box) and cut the miters with the box sides lying flat in a standard sliding crosscut jig. To ensure that the resulting joint is really 90°, I cut mating ends of a joint on opposing faces of the blade. This way, if the blade is a half of a degree over or under 45°, it's made up for with the cut on the second board.

Because miter cuts land somewhere between end grain and long grain, strengthening them makes sense. There are many ways of doing this, but two of the strongest and most attractive ways are the use of splines and of keys (see figures 6 and 7 below).

For a splined miter, a groove needs to be cut before gluing up the joint. To do this, I flip the box sides over in the crosscut jig so that the miter is facing down. The blade is still set at 45°, which is 90° to the miter. I locate the groove as far toward the inside corner of the miter as I safely can (thus allowing for a wider spline) and clamp a stop block in place so that both pieces will be grooved in the same spot. Then I just pass the box sides over the blade (see the photo at left below).

I cut splines either from plywood or solid stock. I use plywood splines for smaller or plywood boxes only because the plywood will not move with changes in humidity. When using solid splines, I always orient the grain in the same direction as the grain of the box sides. This way, the spline moves with the box. It's also a stronger construction. Even though a spline is fragile before it's installed (because it's a length of perpendicularly oriented, short-grained wood), once it's in the carcase, the spline's grain bridges the miter. I always test-fit the splines before gluing, checking especially to see that they aren't too deep for the grooves.

Another way of strengthening a miter joint is to glue in splines or keys across the joint after the miter has been glued together (see figure 7 below). The grooves for these joints can be cut on the tablesaw with a router or by hand.

For smaller boxes, I use a simple jig that clamps to my tablesaw's crosscut jig and that holds the box sides up at 45° to the table (see the photo at right below). I set blade height at about two-thirds the thickness of the joint, so I only have to clean up the keys on the outside of the box. Then, ei-

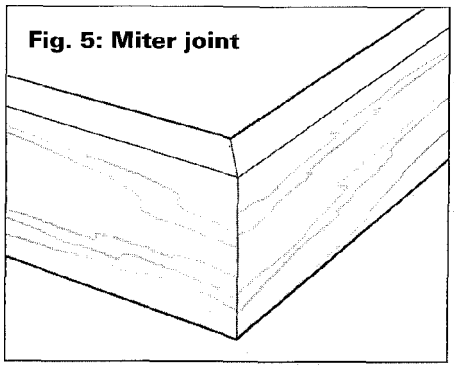
Cutting the groove for a spline *in a miter joint is simple using a clamped stop block in a sliding crosscut jig. The stop block ensures that the groove for the spline is positioned in the same place in both boards being glued together.*

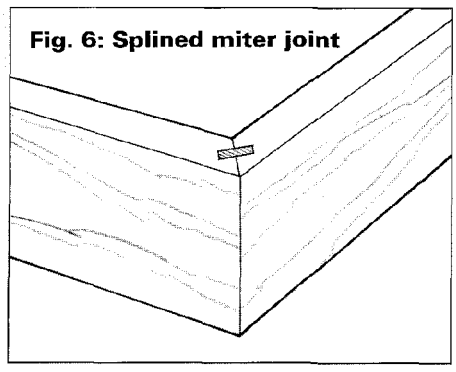
The author's jig for cutting grooves for keys *clamps right into his crosscut box. For boxes that fit safely into this jig, three keys provide plenty of strength.*

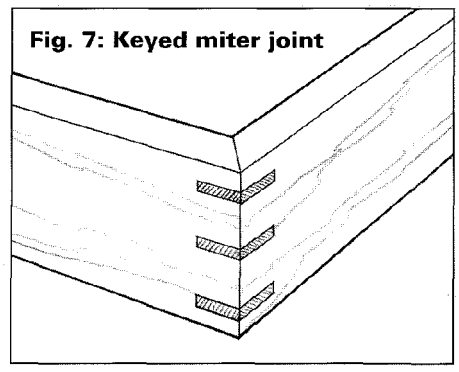
FIGURE 5: ***Mitered joints*** *look more "finished" generally than corners with exposed end grain, but miters are also trickier to cut precisely, which is critical if the joint is to close up nicely.*

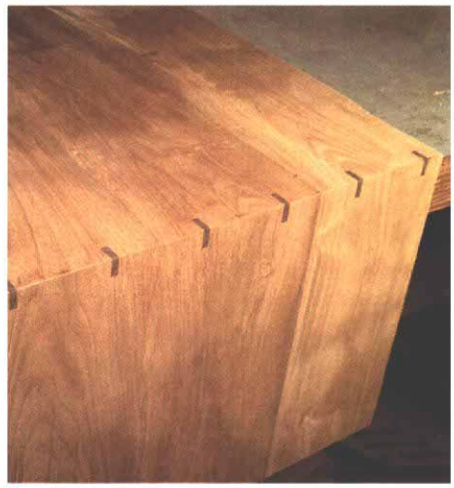
FIGURE 6: ***A splined miter joint*** *is considerably stronger than a simple miter joint. Whether plywood or solid wood is used for the spline, long grain bridges the miter and a long-grain to long-grain glue surface area results.*

FIGURE 7: ***Keyed miter joints,*** *like splined miters, are stronger than simple miter joints because of the long-grain to long-grain glue surface. The keyed miter joint is glued up as a simple miter joint, and then grooves for the keys are either cut or routed. The keys are cut oversized and then trimmed flush after they've been installed and the glue has set up.*









***Keyed miters**—Two sides of an alder toy box (above) show how attractive a keyed miterjoint can be. **To rout key grooves in big mitered carcases** (left), it's safer with a simple jig.*

ther holding the box firmly in the jig or clamping it in, I pass the entire setup over the blade. Because I only use this setup for relatively narrow boxes (drawers and such), I cut three key grooves, which make positioning of the jig straightforward: one groove equidistant from either edge of the board and one in the center.

Larger boxes require more support for a safe cut, and even though larger jigs can be made for the tablesaw, it's safer and much more accurate to keep the workpiece still and move the tool—in this case, a router—over the workpiece.

I made the fixture in the photo at left above so that I could rout grooves in a chest of drawers with mitered corners. The jig is centered on the corner of the carcase, at 45° to it, and is supported by angled blocks underneath it. The whole fixture is clamped together and to the carcase. The slots in the face of the jig are sized to fit my plunge router that's outfitted with a template guide. Using a straight bit, I rout grooves across the corners.

I plane the keys, so they're just proud of the corner of the box and then glue them into place, long grain across the corner. Once the glue has set, I cut the key nearly flush with the carcase and plane and sand the keys perfectly flush. By using a contrasting wood, this joint can be made attractive as well as strong (see the photo at right above).

Solid-wood corners for sheet goods

When building a carcase of plywood or some other sheet stock, it's possible to use a solid-wood corner and a tongue-and-groove joint. Grooves are generally cut into the solid corners with a tablesaw or router, and then the corresponding tongues are cut into the plywood or particleboard sides. It's also possible to tenon the sheet stock into the solid corners at full thickness. The joint is glued over the full length of the corner piece, which is oriented with its grain running along its length (see figure 8 below).

This type of joint is not suitable for solid stock, however, because the corner must be oriented lengthwise if it's to have any strength. What you'd end up with if you glued in solid panels for the full length of the corner would be a cross-grain construction resulting in either a failed joint or a cracked solid panel.

By using an oversized corner block, you can add a decorative element to the box, shaping a bead, bevel or roundover into the corner. Also, you can choose to leave the corner block proud of the carcase sides or sand it flush to them.

If you prefer to keep the corner block inconspicuous (flush with the carcase sides), it's better to cut the grooves into the plywood sides and cut tongues in the corner piece to keep the joint strong. That way, the corner block is not weakened by the opposing grooves coming too closely to one another.

Biscuits could also be used to join the corner to the carcase sides. This not only would help align the joint but also would provide a long-grain to long-grain gluing situation.

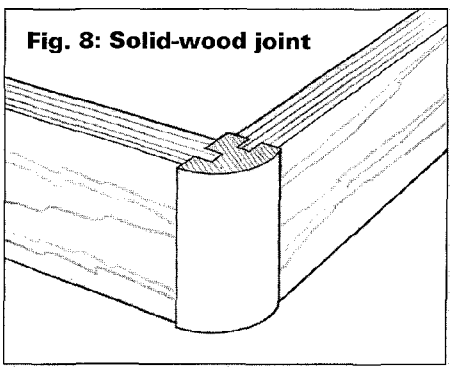


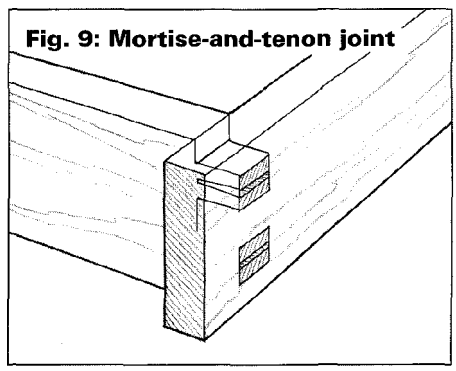
FIGURE 8: ***Solid-wood joints** can be used with panels of plywood or some other sheet stock to create strong, attractive boxes of almost any size. The corner block can be oversized and rounded over (as it is here) or shaped in some other way. Or it can be the same thickness as the carcase sides so that it's less noticeable.*

Mortise and tenon

Mortise-and-tenon joints can be used for carcase construction when the carcase sides are not flush at the corners. An example of this would be a chest of drawers in which the sides are tenoned into mortises in the top.

Mortises can be cut in a variety of ways. Chopping them by hand worked well for a

FIGURE 9: ***Mortise-and-tenon joints** can be used to join carcases whenever the sides aren't going to meet flush at a corner. The joint can be hidden or exposed, wedged or not. The joint here, with its hidden wedged-tenon, is a good joint in a situation where strength is needed but the joinery isn't the emphasis.*



few centuries until someone tried drilling them out first. With a fence on a drill-press table, accurate mortises can be drilled out quickly using a brad-point bit. The corners can then be squared or the tenons pared round to match the mortise.

Plunge routers, however, do a better job with this joint. With an accurate template, you can rout all the mortises at exactly the right spots to a precisely uniform depth.

An improvement on the mortise and tenon is the addition of a wedge (or wedges) in the tenon. The wedge creates pressure on the walls of the mortise, giving the joint some mechanical strength in addition to the strength of its long-grain glue surface (see figure 9 on the facing page).

If a wedged-tenon is also a through-tenon, as they often are, the wedges add visual interest to the piece as well. It's important, though, that you don't position a wedged-tenon too closely to the end of a board because the short grain on the outboard side of the mortise could easily break.

Further reading

Tage Frid Teaches Woodworking: Two Volumes in One, Unabridged (Joinery and *Shaping, Veneering, Finishing* combined), The Taunton Press, 1993.

Fine Woodworking on Joinery, The Taunton Press, 1985.

Fine Woodworking on Boxes, Carcases, and Drawers, The Taunton Press, 1985.

Finger joints and dovetails

Finger joints and dovetails, because of their large long-grain to long-grain glue surface areas, are the strongest joints in a woodworker's carcase-building repertoire. They are also nice-looking. In terms of appearance, both are best cut in solid stock, though they'd work equally well in plywood.

A tablesaw or router jig is the most efficient means of accurately cutting and spacing finger joints (see figure 10). I use a dado set on my tablesaw with a shop-built jig (for information on a similar setup, see *FWW* #89, p. 74). A router table also works.

In addition to having a large glue surface area, dovetails also possess a great degree of mechanical strength in one direction. Through- and half-blind (lapped) dovetails are the most commonly used types of dovetails for building carcases.

Through-dovetails can be cut in a variety of ways. Laying them out by hand and using a dovetail saw and chisel is the time-honored approach, but the dovetail-fixture makers are quick to tell you of the ease and speed with which you can achieve perfect results using their products. It's a matter of preference, really, and of how many you'll be cutting. Furnituremakers who cut dovetails daily can cut dovetails for an entire drawer in less time than it takes to read the manual for one of the fixtures. But once you're over the learning curve, it doesn't really take that long to set up one of the fixtures, especially if you have dozens of drawers to dovetail. In either case, make sure the dovetails are well-spaced, ending "with half pins at the corners for greatest strength (see figure 11 below).

Half-blind dovetails are good when you want to hide the joinery from one side, but you still want the strength of dovetails (see figure 12). Drawer fronts are the most obvious example. Done by hand, they require one more marking gauge setup and a bit more chisel work. Regularly spaced half-blind dovetails can also be router cut (for more information, see *FWW* #99, p. 58). □

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Choosing an appropriate joint *for a box is as much a matter of personal taste as it is an engineering decision. Boxes in the author's shop include a drawer featuring, through- and half-blind dovetails, a simple rabbeted plywood box and three finger-jointed boxes.*

FIGURE 10: ***Finger joints*** *are a strong and attractive way to join a box. The large glue surface area provides a great deal of strength, and the play of light on alternating edge and endgrain makes them enticing to look at as well.*

FIGURE 11: ***Dovetails*** *are the strongest carcase joint and through-dovetails are the simplest dovetails to cut, whether by hand or with a fixture and router. The joint's mechanical strength, large glue surface area and its reputation as being the hallmark of a craftsman make it a perennial favorite even in situations where its strength may not be necessary.*

FIGURE 12: ***Half-blind, or lapped, dovetails*** *are a good solution when you need a strong joint but don't want the joinery to steal the show. They're also the classic drawerfront-to-side joint, and in contrasting woods, they are very attractive.*