

Carcase Construction

Choosing and making the right joints

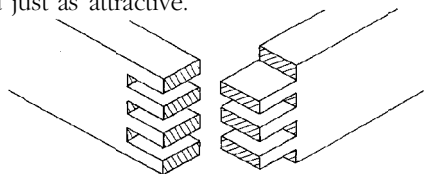
by Tage Frid

Furniture construction is broken down into two main categories: frame and carcase. In frame construction, relatively narrow boards are joined—usually with a mortise and tenon joint—as in a chair or table base, or in a frame and panel door. (See *Fine Woodworking*, Summer 1976.) In carcase construction, boards are joined end to end using dovetails, tongue-and-groove joints and the like, as in a drawer or hutch. When designing a carcase, the beginner may find it difficult to know which joint to choose. Some joints are excellent in plywood but weak in solid wood, and vice-versa. Many beginners are so concerned with the "craft" aspect that they design in the most complicated techniques. They use a complex joint where a joint easier to make would work just as well. I always choose the strongest but easiest joint to construct. I cannot see spending time over-constructing a piece. And I expect my furniture to last long after I do.

Most carcase joints can be made by hand, but are usually more easily and precisely made on a circular saw. I would advise people who don't own a circular saw to buy a table saw and not a radial arm saw. The latter is limited in function and not as accurate or flexible. It was designed for cross-cutting rough lumber to lengths, and even then is limited to a certain width. Many of the joints described here would be dangerous and impractical to make on a radial arm saw. I prefer at least a ten-inch table saw, and it does not cost that much more than an eight-inch. Buy one with at least a 1-hp motor, as an underpowered machine is much more dangerous to work with.

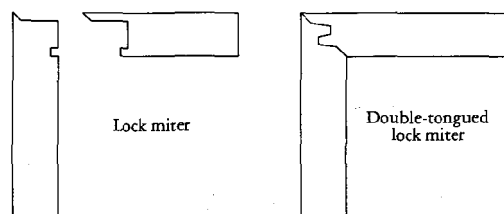
Joints at corners

In the article on dovetails, (*Fine Woodworking*, Spring 1976), it is stated that dovetailing is one of the strongest and most attractive methods of joining the ends of boards together. This is true if you are going to make joints by hand. But most carcase joints lend themselves to machine fabrication. The closest machine joint to a dovetail is a finger or box joint. Because of the greater number of pins and the resulting total glue surface, it is stronger than a dovetail, far easier to make, and just as attractive.



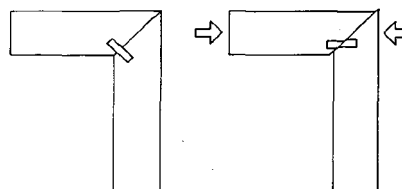
Tage Frid teaches furniture design and construction at the Rhode Island School of Design, and has been a professional woodworker for close to 50 years.

The lock miter is used for either solid wood or plywood. Its advantages are that it is hidden to the outside, and that it requires clamping in only one direction, because of the built-in locking action. The "double-tongued" lock miter is the best and fastest production joint for plywood but it requires a shaper with special knives, (available from Woodworkers Tool Works in Chicago; see page 62). Only one shaper setting is required—the first piece is run through vertically, the second horizontally. The same clamping benefit holds true here. I use this joint only in plywood. In production work, the time saved pays for the relatively high cost of the cutter.



The spline miter really lends itself to plywood, but can be used in solid wood on smaller pieces such as boxes. The grain direction of the spline must follow that of the pieces being joined. The spline should be placed 1/5 to 1/6 of the way in from the inside corner so as not to weaken the corner. Because of the 45-degree angle, all pieces must be glued up simultaneously, a real disadvantage in a piece with many parts. Also, a lot of clamps (in all directions) are required to ensure tight glue lines.

A lesser-used spline miter with a parallel spline has several advantages but can be used only in plywood. This spline is just as strong as the diagonal one. The spline slots are minutely offset (about 1/32 in.). Clamps are needed only parallel to the spline, and the offset pulls the pieces tightly together. The ease of clamping this joint is a real advantage. You can glue the inside members and sides first, and when they dry, glue on the top and bottom.

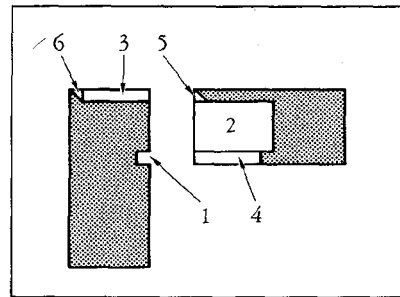
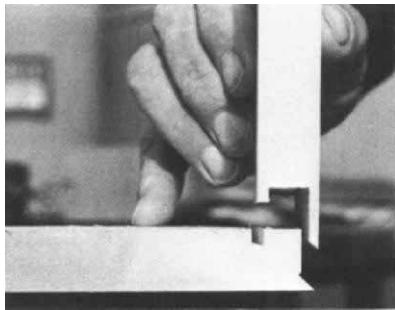
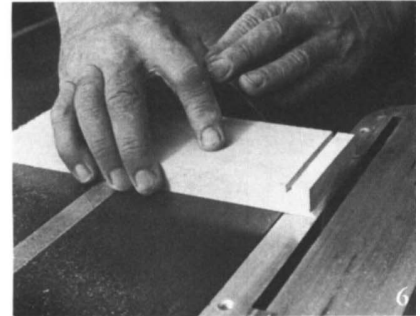
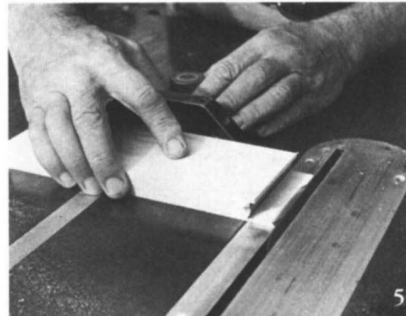
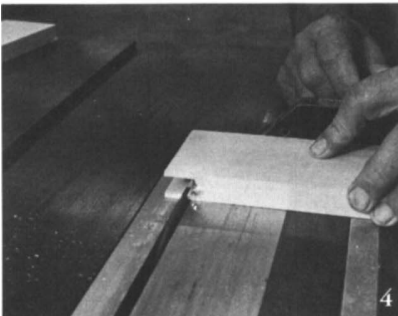
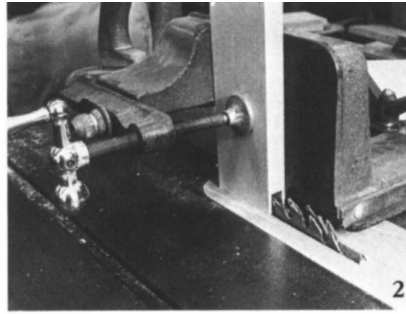
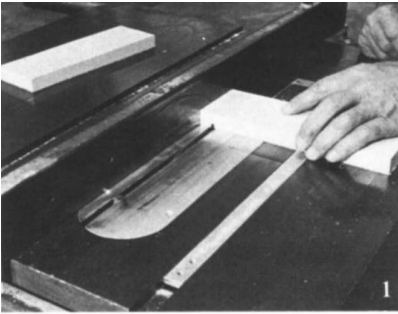


A corner tongue and groove, rounded or square, is good for either type of wood. In plywood the grain of the corner piece must run lengthwise along the edging. However, in solid woods, the grain must run in the same direction as the grain

Making a Lock Miter

Set the table saw fence to just inside the board thickness. Set a single blade to a height $1/5$ to $1/6$ of the thickness. Make the first cut using a miter gauge (1). Set the dado blades to the desired width (about $2/3$ the thickness). Mark off the blade height from the other board and cut the dado. A tenoning jig is much safer here than using the fence (2). Scribe the other dado side to

the first piece. Set a single blade to the height of the top edge of the dado. Saw to make the second tongue (3). Cut off the tongue on the dadoed piece to the right length (4). Tilt the blade to 45 degrees and miter the mating tongues (5 & 6). Keep checking back and forth between pieces as you make each cut to test for a good fit, or make a scrap set as you go along.



Making a Spline Miter

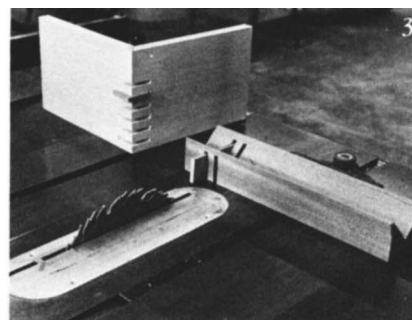
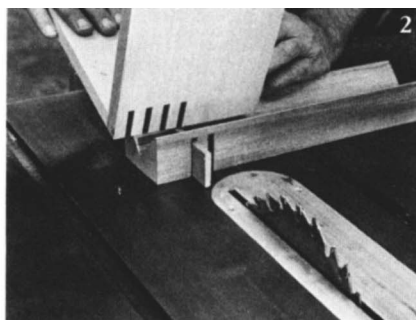
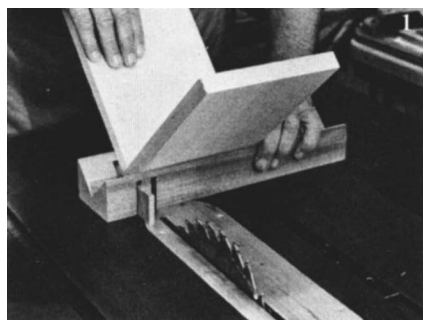
To make a spline miter set the blade at 45 degrees and cut the pieces using the miter gauge (1). Lower the blades, move the fence to the opposite side of the blade and cut the two spline slots (2). This method keeps the cuts parallel to the edge and prevents the pieces from skewing.



Making Multiple-Spline Joints

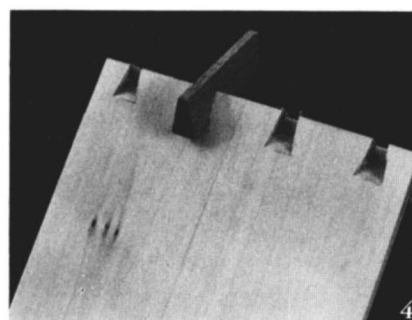
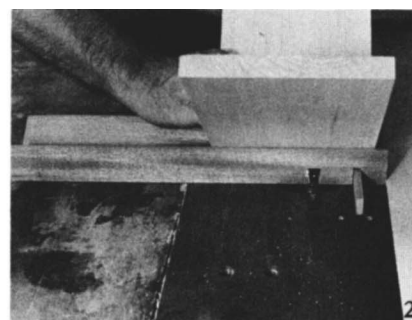
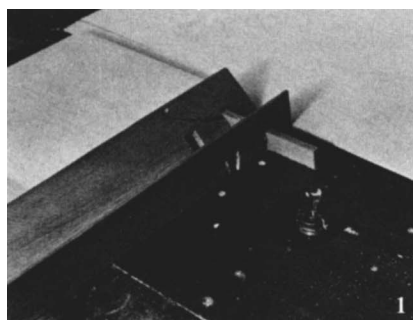
Mock Finger Joints

The mock finger joint is made using a simple jig on the table saw. The carcass pieces are first mitered and glued. A jig with a 45-degree vee cut out of it is made and a dado cut is sawed into the jig. A spline is fitted into the cut. The jig is screwed to the miter gauge. A cut is made at the desired arbitrary distance from the spline (1). The pieces are set in up against the spline and the first cut is made. The first cut slips onto the spline and the next slot is made (2). The process is continued down the length (3).



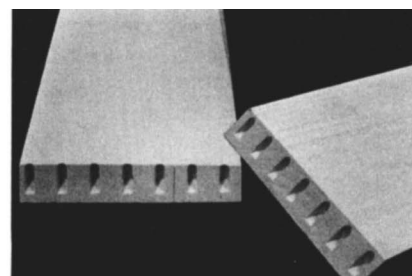
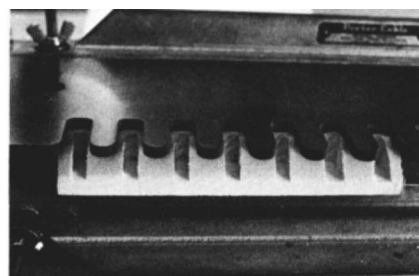
Mock Dovetails

For a mock dovetail the jig is exactly the same as in the mock finger joint. A fence is set up on the router table that is no higher than the bottom of the vee on the jig. A board is attached to the back of the jig to provide a greater surface running against the fence (1). The process is exactly the same as the mock finger joint (2,3). The length of spline is angled on both sides to fit into the dovetail slots (4).

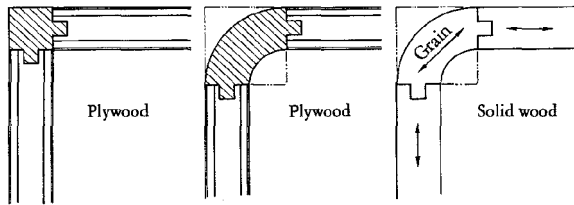


Full-Blind Splines

The first piece is lined up with the left side of the jig and the second with the right so that the two align properly. Or a piece of plywood can be made to serve as a guide. If the joint is made with a dovetail jig the splines will have to be rounded on two edges. Or the splines can be made smaller and left square since there is plenty of glue surface. The joint can also be made on a mortiser, using a jig just as in the mock spline joints.

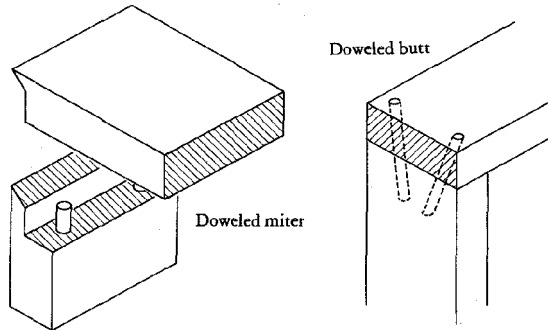


of the sides so that expansion is constant. The grain should run diagonally from tongue to tongue. Any shaped corner molding can be used. The inside is shaped first, the pieces are glued together, and then the outside is shaped.

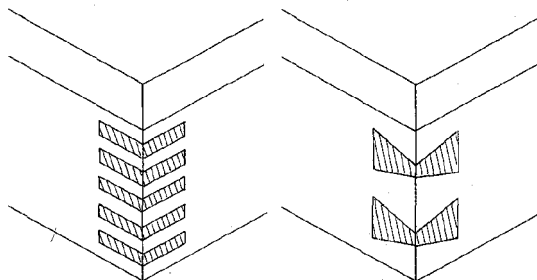


The doweled miter is used where structure is not crucial—in small boxes, knickknack cabinets, spice racks, etc. It is easy to make, and aligns itself correctly for gluing because of the dowels. A dowel center is useful for transferring the position of one hole to its corresponding hole. This joint works in solid wood or plywood.

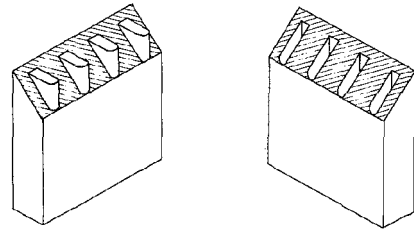
I generally do not use a butt joint with dowels, but when I do, I find it advantageous to angle the dowels. This adds needed strength to the joint.



Several joints are made by cutting a miter, gluing the corners together, and then cutting slots to receive splines. Water-based animal glue in an electric glue pot is perfect for gluing the miters since the glue is strong and dries in just a few minutes so you can then finish cutting the joint. These joints have great strength and pleasing decorative qualities. With jigs, they can be made extremely fast. The first is a mock finger joint—it resembles a finger joint without the alternating fingers. For the same effect in a small piece, thin, handsaw kerfs are spaced down the joint. Pieces of veneer are hammered to make them thinner, and glue is squeezed into the saw cut. When the veneer splines go into the slots they swell from the moisture of the glue. (A loose through dovetail can be repaired in the same way, by evening out the gap with a saw cut and diagonally inserting a veneer strip.) A mock dovetail is made similarly, but using a router mounted in a table. If desired, a contrasting wood can be used for splines as a decorative detail.

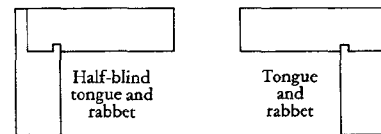


If the splines are to be hidden, the spline slots can be cut using a router with a machine dovetail jig. This joint is considerably stronger than a full-blind dovetail because of the greater glue surface.



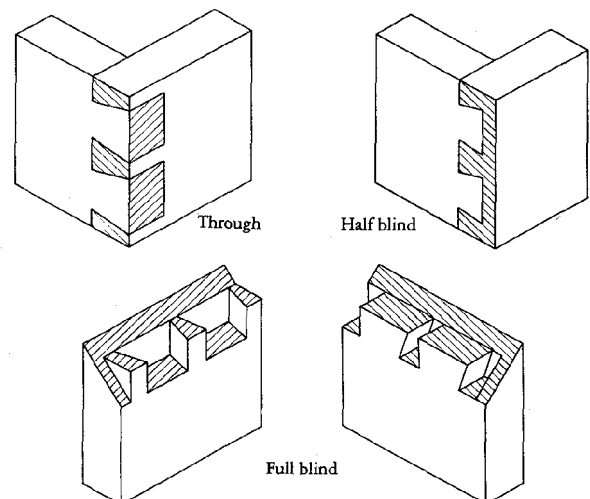
The tongue and rabbet is not the strongest joint but is good enough for the back of a drawer (although not as strong as a dovetail). It is very easy to make. The proportions must be strictly adhered to, as they are determined by factors of strength. The groove should be no deeper than 1/4 to 1/5 of the board's thickness.

The half-blind tongue and rabbet is made like a lock miter but without the miter. It is particularly good for drawer fronts, but in that case be sure to put the drawer stop somewhere other than in the front because of the limited joint strength. This joint can also be made with a router.



Machine-cut dovetails made with a router and dovetail jig are useful where great quantities must be cut, or where the extra strength of a hand-cut dovetail is not needed. I use them when I have stacks of drawers to do for kitchens. Otherwise, I prefer hand-cut dovetails for their strength and looks. Besides, when you've made them for many years you'll find them easier to do than setting up the router.

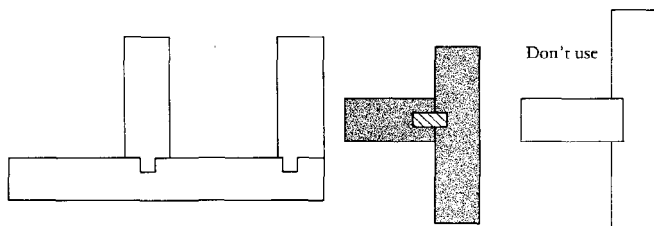
The through and half-blind hand dovetails are explained in the dovetail article in the Spring 1976 issue of *Fine Woodworking*. The full-blind dovetail (and similarly the machine-made, full-blind spline joint) is not used to be "crafty," but is used where strength is important, as in a freestanding cabinet without a back, or in a cabinet with glass doors.



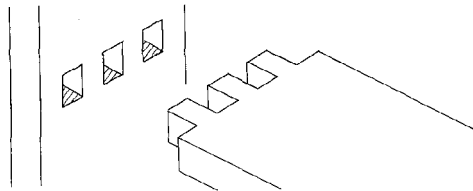
Joints not at corners

A simple tongue and groove can be used for any type of wood except composition boards. At the ends of boards the tongue is set off center so that the outside shoulder isn't too weak. Fiberboard and particle board are made of waste materials and so there is no grain strength. Since a tongue would break, a spline must be used with these materials. The spline should go into the carcass side about 1/4 of the side's thickness, and twice that amount into the perpendicular piece. Setting the spline further into the side will weaken it, and keeping it shorter in the perpendicular piece will not add enough strength.

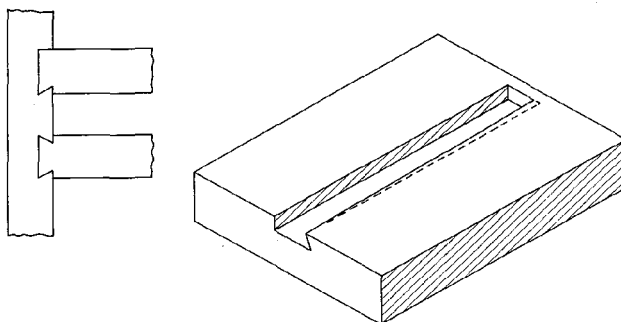
I would never use a fully-housed dado joint. There are no shoulders to lock the wood and help resist sideways stresses. Also, if the wood is sanded after the joint is cut, the piece becomes too loose. If there are imperfections in the wood, the piece will not fit tightly.



Another strong joint is a series of small mortise and tenons. For extra strength, the tenons should run through the sides and be wedged from the outside at assembly.

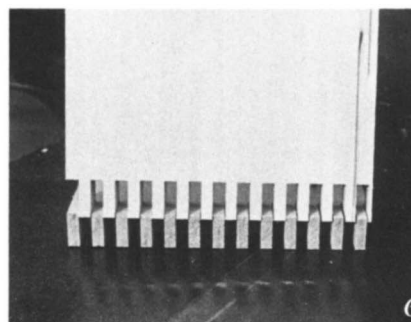
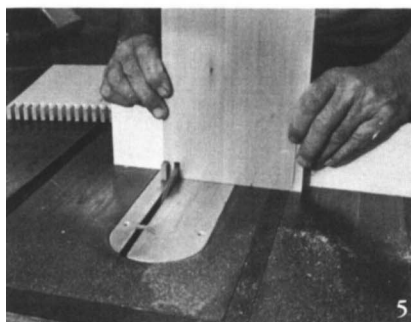
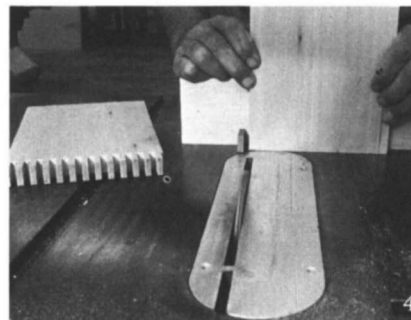
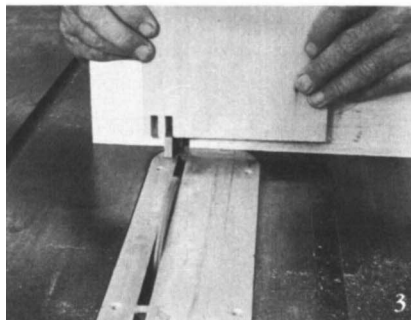
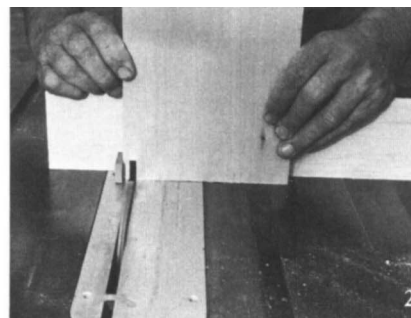
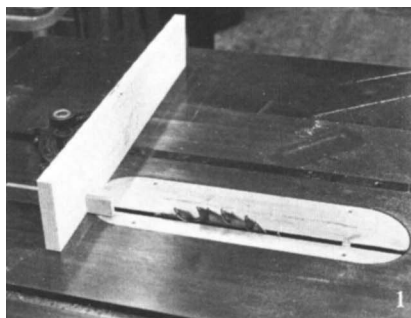


The sliding dovetail is an excellent joint for perpendiculars. The double-shoulder version is machine cut with a router and a dovetail bit. The single-shoulder joint is cut by hand with a dovetail plane and its corresponding saw, and with a router plane. The machine version is excellent for production. If



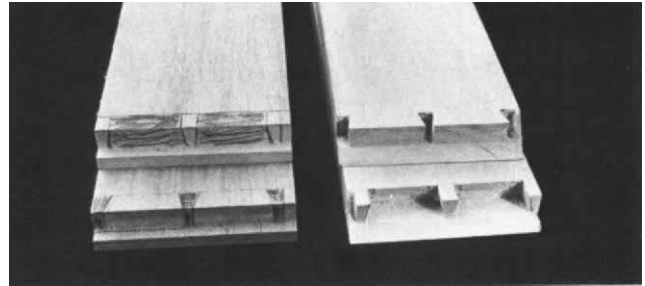
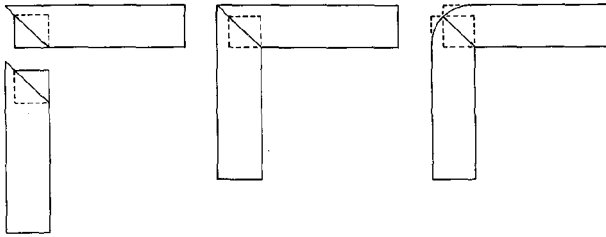
Making a Finger Joint

A simple jig on a miter gauge makes cutting this joint very simple. A correct fit is solely dependent on how accurate the jig is. Raise the blade a hair higher than the thickness of the boards: It is easier to sand a little off the ends of the joint than to plane the whole side. Make a cut in the board with the dado blades. Then make a spline that is exactly the same size as the slot and fits into it snugly (7). Line up the blade to a position precisely one spline thickness over from the first cut. Screw the jig to the miter gauge. With the spline in the slot, cut the first finger with the board edge up against the spline (2). Slip the finger slot onto the spline and continue down the board, moving over one each time (3). Start the second piece lined up to the open sawcut so the first cut makes a slot (4). Continue down the board (5) and the two should fit together perfectly (6). I recommend you do a small test to check the accuracy of your jig before cutting the final pieces.



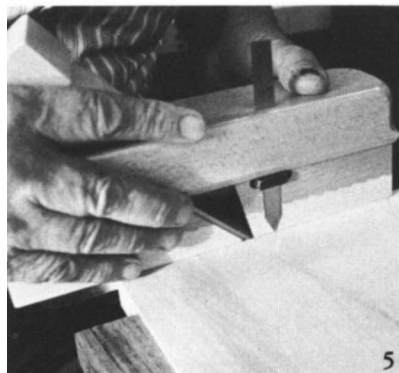
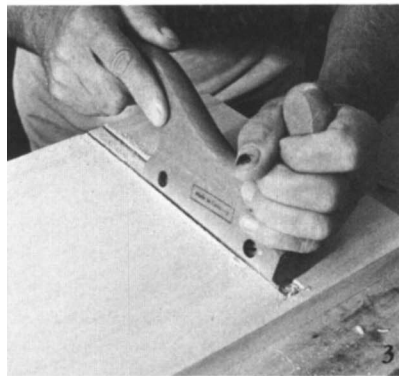
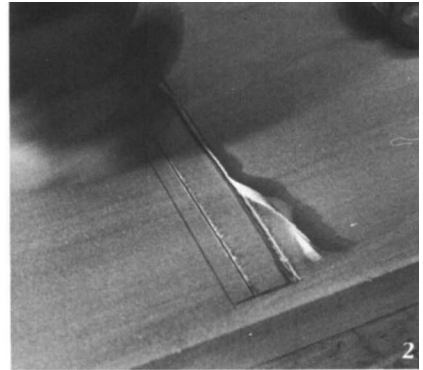
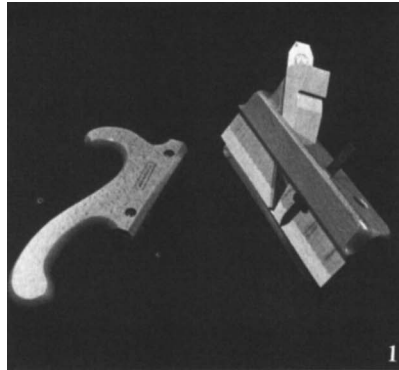
Making a Full-Blind Dovetail

The pieces are marked and the excess above the pins and tails is removed. The remainder that will form the top miter must be a square. A 45-degree angle is cut at the edge (or at both edges). The pins are marked, cut and chiseled out. The tails are marked from the pins, sawed and chiseled out. With a little luck, they might fit. If for some reason the corner is slightly open, hit it lightly with a hammer when the piece is being glued. This will bend the fibers over and close the imperfection. For a round corner the dovetail is made exactly the same but without the upper miter.



Making Hand-Cut Sliding Dovetails

Hand-cut sliding dovetails require the special dovetail plane and saw (7). The position for the groove is marked with a framing square and scribed. The angle of the taper is drawn in. For lumber $\frac{3}{4}$ in. or thicker I use about a $\frac{1}{8}$ -in. taper. If the groove is to be stopped in the front I mark off where the joint ends. All lines are scribed and scored deeper with a chisel. This is important since the cutting is across the grain. A slight vee is pared off of each line the whole way down (2). If the joint is to be hidden the end is chiseled out. This stops the groove and provides an opening to start the saw in. The straight side is sawed at 90 degrees and the tapered side is sawed at an angle using the saw shoulder as the guide (3). The router plane cuts out the mass of material and the groove is finished (4). The depth of the dovetail is marked onto the edge of the other board with the arrow-shaped blade in the dovetail plane which is available from Woodcraft Supply (5). I make the dovetail $\frac{1}{32}$ in. shorter than the depth of the groove. The planing is continued until the piece appears to be the right size (6). It should slide in easily at first and become very tight in the last fifth of the groove. One or two more passes with the plane with testing in between should result in the desired fit. If the joint is hidden, the front of the dovetail is pared off.



only a few sliding dovetails are required, the hand method is preferred. It is extremely simple and much faster than one would expect. In the hand version the track is tapered so that the dovetail slides in easily at first and locks at the end as it is hammered into place. Consequently, as the dovetail is forced in tight, a small shoulder is pressed into the straight side and increases at the narrow end. In the machine version, the pieces should mate exactly and thus will require a lot of force to assemble. This is especially true if glue is used on a long dovetail, because the glue will swell the grain, making the piece increasingly difficult to slide in.

With both types of sliding dovetails, glue is not necessary, although a spot can be put at the front to fix it in position, or the whole length can be glued. If two different materials are used (e.g., plywood shelves into solid sides), only the front should be glued so that as movement occurs, the front will remain flush.

In a chest of drawers or similar carcass higher or wider than two feet, some sort of strengthening brace will be required. I use a sliding dovetail in the center brace, and if additional bracing is needed, a tongue and groove out to the sides. The sliding dovetail holds the center in tight.

If you wish to keep joints from showing through in front, you can stop the joints before the front or else cover them. In solid wood I sometimes cut a half-inch strip off the cabinet, run the joints through, and reglue the strip. In plywood I run the joints through and add a facing for the same result.

Backs for carcasses

The back of a carcass is an important strength-determining factor. Various methods for inserting backs will require differing assembly sequences, which must correspond to that of the particular carcass joint used. This is an important relationship that must be decided at the design stage.

The easiest and most common way to insert a back is to make a rabbet around the four sides and screw on a piece of plywood after the carcass is glued. This method gives you a second chance to square a cabinet that has been glued slightly out of square. The plywood can be made square or slightly out-of-square the opposite way and this will counteract the mistake. This type of back is fine if the cabinet is designed to go against a wall. Most antique furniture was designed to be placed against a wall, and so the backs were usually crudely made and left rough. Today furniture is used much more flexibly, e.g., as room dividers, so it is advisable to design a piece with the back as nice as the rest of the cabinet. The cost and effort of sanding and finishing the back are minimal in light of the time spent designing and executing the piece. Of course, if the piece is designed to be fastened to the wall, the back must still be finished, but not to the same perfection.

A good method for a freestanding piece is to make a groove for a piece of plywood or solid wood which is inserted at the same time the cabinet is glued up. If solid wood is used, be sure the back is free-floating to allow for movement. You may pin or glue the back just at the center points, which will allow the wood to expand equally out to both sides. Leave a little space in the groove on each side to allow for expansion.

If the sides of the cabinet are frame and panels, a set-in flat back would look out of place. To keep your design consistent you can make a frame and panel back that is inserted using either of the assembly sequences described for a plywood back.