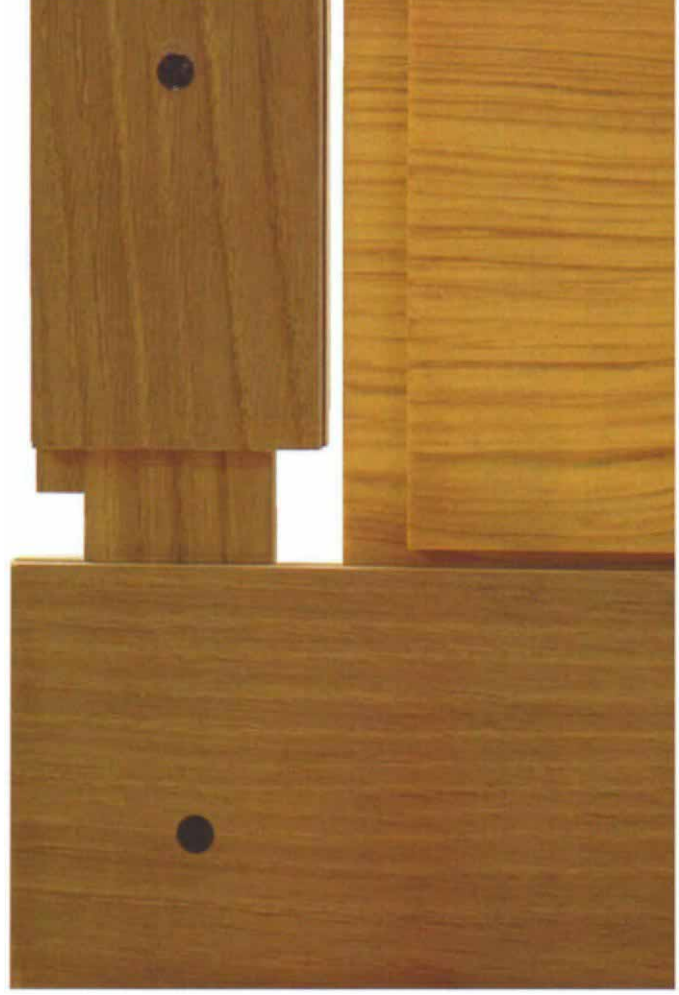
Frame-and-panel Carcases

A classic solution for sound construction

by David Savage



The haunch on the side of the tenon plugs the panel groove, and it stiffens the whole joint. Colored stick-on dots placed on the parts as they are machined make it easier to maintain the correct relationship of the pieces during assembly.

As long as we are daft enough to work in solid wood, we must contend with the fact that wood is constantly altering its width, Since wood moves only across its width, and not along its length, you can easily set up cross-grain constructions that restrict movement. This inevitably leads to disaster because the forces involved are immense. Just remember how ancient stoneworkers split marble slabs from a mountainside. They would drill a hole, insert one dry wooden peg and add water; the expanding peg would do the rest,

An unknown worker in medieval Europe solved this problem when he discovered the frame-and-panel construction. His goal had been to build a coffer that wouldn't self-destruct. The sides and tops of these coffers usually split because traditional slab construction techniques called for rigidly fastening wide boards together with metal or wood cleats. I've always imagined that after experimenting with heavier and stronger slabs, our medieval friend realized that no panel was strong enough to resist splitting. Eventually he found he could build a strong frame from relatively narrow components and fill the spaces between the frame members with separate panels. The key to the system was fitting the panels loosely in grooves cut into the frame; this left the panels free to expand during wetter seasons and to contract when the humidity dropped.

This medieval discovery dramatically changed the history of furniture design, and the frame-and-panel system is as valuable today as it was 500 years ago. In fact, the technique has been called a hallmark of British furnituremakers. Our furniture design, at its best, tends toward quiet confidence. Our oaks, elms and other native timbers are the envy of the world, and we like to use them with restraint and in the solid. Our weather is so changeable—damp and foggy one day, bright and dry the next—that if we didn't use special techniques, such as frame and panel, most of our best carcase work would likely split right down the middle. Although contemporary woodworkers might make panels from plywood, particleboard, medium-density fiberboard or plastics (man-made, dimensionally stable materials which can fulfill the designer's dreams more cheaply and more efficiently than solid wood), I still favor solid wood for my work, such as the piece shown in the top photo on the next page. So I will concentrate on solid techniques in this article.

Once you master the frame and panel, you might like to build a cabinet like mine. The basic dimensions are shown in figure 1 on p. 89. As you can see, the piece is basically two boxes with doors. The two boxes are connected with a simple frame-like middle section, just like the one that forms the base.

Pros and cons of frame and panel- In addition to accommodating wood movement, frame-and-panel constructions, such as the one in figure 2 on p. 89, enable the woodworker to control the graphics of the timber better than is possible with slab constructions. Frequently, the most exciting figure in a walnut board, for example, is next to a natural defect. With frame-and-panel systems, you can cut around the defects and produce small clear panels to fit within the frames. Highly figured but structurally weak timber can also be supported by a strong frame. If the frame is designed by someone with a sensitive eye for rhythm and proportion, light and dark color, and tone, the frame will create lines that enhance the beauty of the individual panels and draw the components into a cohesive whole. The detailing on the frames and the surface variations of the fielded panels also create patterns of light and shadows that are infinitely more complex and interesting to the eye than any flat surface could be.

The design possibilities of frame-and-panel construction are virtually infinite, especially when you consider that you are not limited to vertical components, such as doors, cabinet backs and sides. The frame-and-panel unit can be tipped horizontally, as shown in the bottom photo on the next page, to form a surface that can be

Photo above: John Gollop

The author's double cabinet of quartersawn English oak is a simple piece that relies heavily on sensitively judged proportions. Note how the bottom stiles in both doors are wider than the rails and how they relate visually to the dark midsection and base. The piece was designed by Savage and built in his shop by Malcolm Vaughan.

This blanket chest by Luke Hughes has both horizontal and vertical framed units that support decorative veneered plywood panels. Reeded molding on the mitered corners hides the legjoint on the chest, which is 42½ in. wide, 21½ in. deep and 20 in. high.

built upon and divided at will. Since the strength of the furniture is in the frame, the panels are usually thinner than comparable slabs; so the piece has strength without excess weight.

Of course, frame-and-panel assemblies do have certain disadvantages. They are slow and quite expensive to build. Producing a frame and panel demands considerable skill and precise machine work, if you hope to assemble the unit without a great deal of costly, time-consuming fitting and fiddling. The problems seem even greater when you progress from simple doors and backs to frame-and-panel carcases, which involve joining frames, rails or panels at the corner of a leg. These projects can be a real muddle of tenons, grooves and dovetails, but they're actually quite manageable, as shown in the drawing on the facing page, if you follow the correct sequence for laying out and cutting the joints.

Building frames and panels—I recommend that you build a pair of frame-and-panel doors rather than attempt a carcase as your first project. Building doors is a good exercise for developing skills, and once you can build good doors, frame-and-panel carcases will be a lot more manageable. Since I'm running a business, I favor machine techniques, such as hollow-chisel mortisers for cutting mortises and tablesaw jigs for tenons. I groove frames with a dado blade on the tablesaw, and raise panels and cut moldings on a shaper. You could, of course, do all the work with hand tools or any combination of hand tool and machine techniques, depending upon how your shop is equipped. In any case, there is no room for sloppy, inaccurate work. The key is to produce quality work, efficiently and quickly, because quality divorced from speed is meaningless in almost any situation.

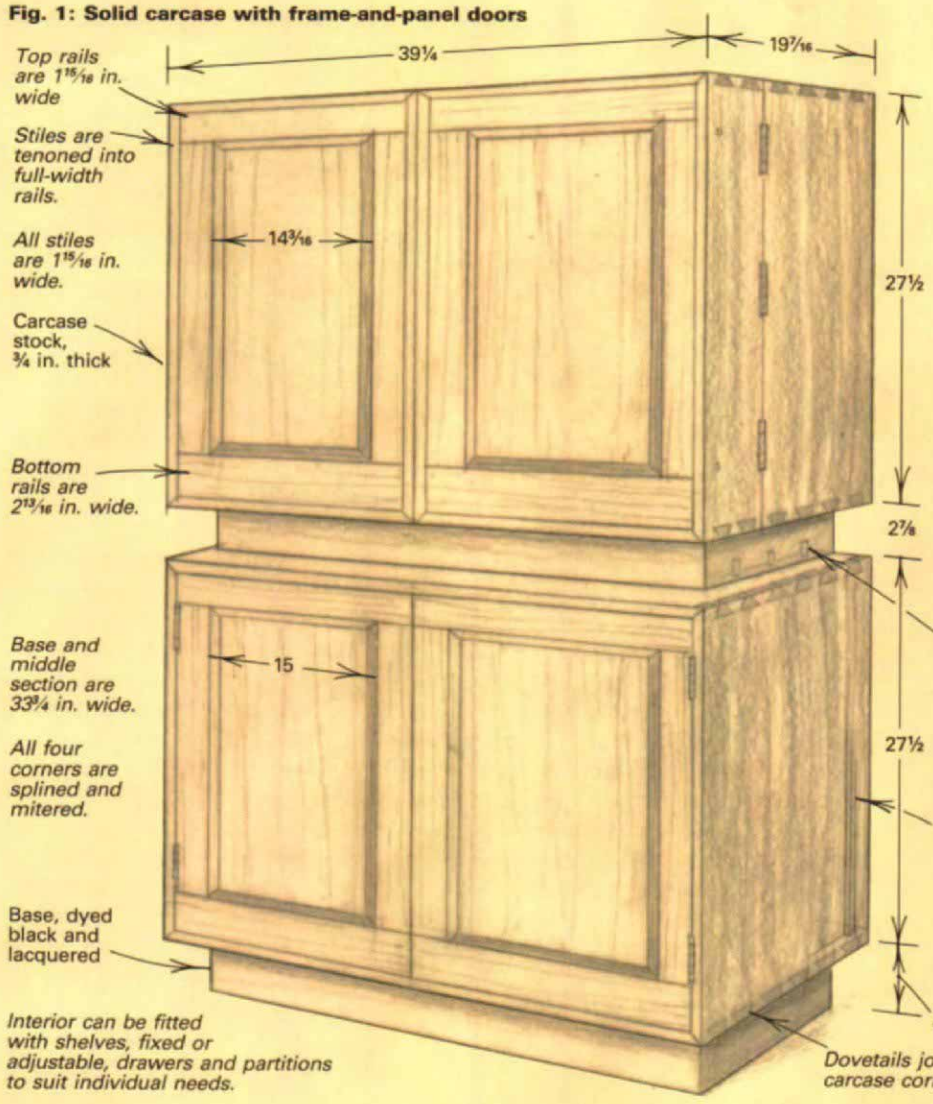
With large doors and architectural fittings, you generally mortise the stiles and fit the rails to them. This keeps the endgrain of the rails out of sight and lets you clamp across the narrowest part of the structure. With smaller cabinet doors, you could run the rails across both doors to maintain a continuous figure in the timber, and that brings us to the delicate business of design, wood selection and joinery layout.

Design considerations—Design can be an intimidating word, but it's just the first part of any job. In my shop we always work from drawings. The more complicated the piece, the more detailed the plans. Experienced craftsmen can build from scale drawings, but others are far better off to make large-scale or full-size versions. We always make our sketches on thin sheets of plywood, which can be dusted off when needed and propped behind the bench when not. A paper drawing is just a nuisance.

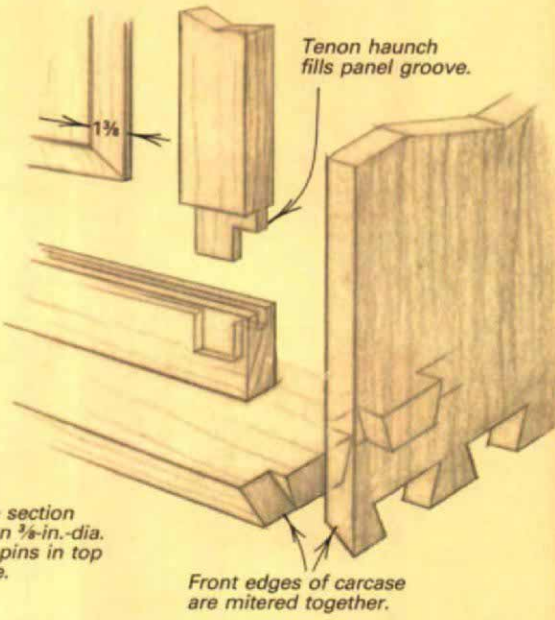
Now comes the fun. Design drawing is the process of resolving unknowns: the width of stiles and rails, the length of tenons and other joinery, the look of the completed structure, and other details. First, work out the proportions. Decide on the width of the stiles, bearing in mind that visually they will have a double width where the doors meet. The top rail is usually the same width as the stiles, but the bottom rail can be a little bit wider. So why make the bottom rail wider? Pure aesthetics—it prevents the visual illusion of the panel dropping out of the frame. I cannot tell you to make your stiles 2 in. wide and the bottom rail 2½ in. wide, because you must determine these measurements to suit each individual project. But proportioning the frame is a delicate job: 1/16 in. can make the difference between a very special piece and something rather ordinary.

Make the drawing with two different sides: use the left to resolve visual problems and the right to resolve technical problems. On the left you'll play with light and shade, rhythm and movement. Here you control the pace and manner in which the eye moves across the surface of your furniture. Think of the relationship between the different

Fig. 1: Solid carcase with frame-and-panel doors



Detail: Carcase corner



Detail: Section view of base

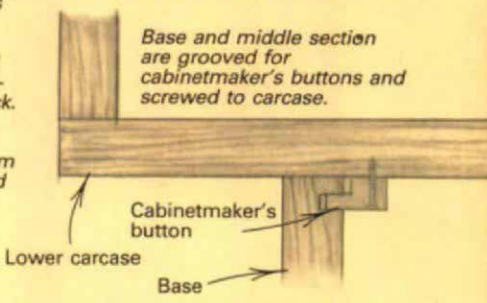
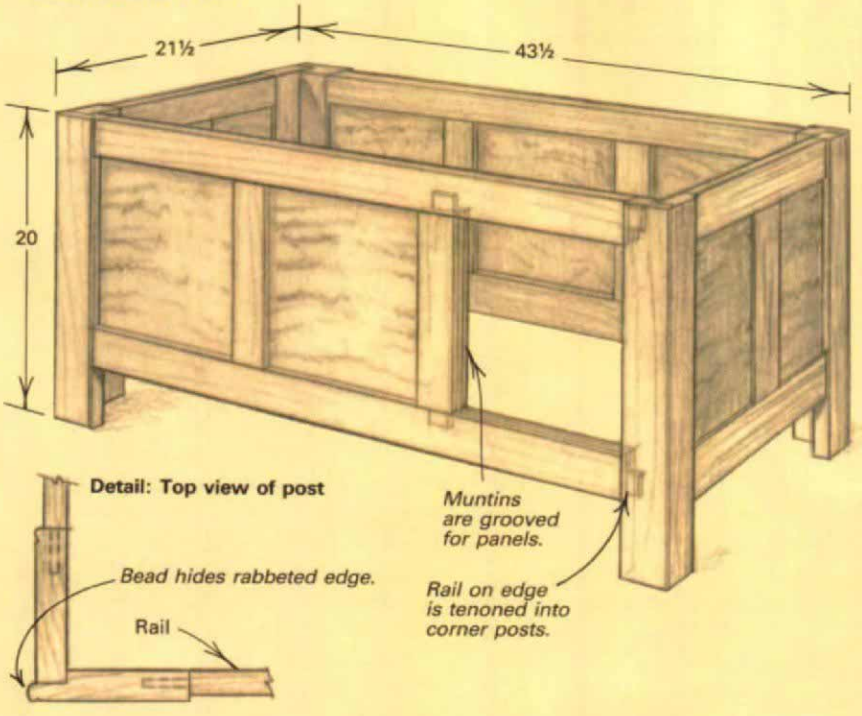
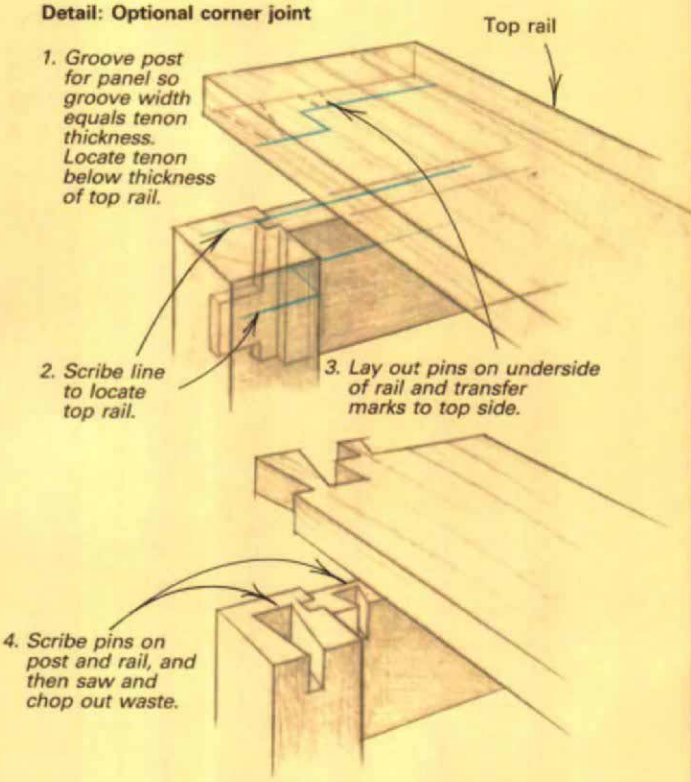


Fig. 2: Blanket chest



Detail: Top view of post

Detail: Optional corner joint



Drawing: Kathleen Rushton

Photo: James Jackson

The hyedua (ogea) and pearwood in Martin Grierson's collector's cabinet create contrasting frames and panels. The case's mitered corners are tapered to lead the eye into the panel The cabinet back is a frame with wide pear panels for an uninterrupted surface.

Alan Peters built this chest of drawers in solid English walnut with ebony details. The horizontal frame-and-panel units supporting the drawers allow flexibility for deciding where to divide compartments. The dividers and uprights are doweled into the horizontal units.

accents as musical notes in a score. Decide on the width of the fields for the individual panels. Experiment with the visual rhythm of differently spaced verticals. Examine the effects of various moldings on light and shade. Literally play around. Creative thought has many of the same features as children's play, so relax and enjoy the process. What feels right will probably look right and be right.

The right side of the drawing should resolve the technical questions of joinery. The object is to think through the building process so you can comprehend how things will be done. Design with a tooling catalog at your elbow, and do not design a groove of 5/16 in. if you don't have a cutter that size. Make the groove match the 1/4-in. or 3/8-in. cutter you own. Assess, for example, the position of the panel in relation to the joints. For expansion, allow the groove to be 1/8 in. or so deeper than the panel held within it. You should also locate the panels slightly below the surface of the frame, so you can clean up the assembled frame without marring the face of the panel. It helps to draw a full-scale cross section of this area since the groove, panel width and molding are so closely interrelated.

Some general technical points may be of assistance. Make grooves and mortises and tenons one-third of the frame thickness, and place them exactly in the center of the thickness. Draw your tenons 1/8 in. less in length than the depth of their mortises. Do not be tempted to make deeper mortises in the wider bottom rail-it only complicates the job. The most important thing to grasp is the function of the haunch, shown in the photo on p. 87. This little so-and-so is only there to plug a hole where the groove in the frame carries through to the end. Making stopped grooves is a real bore-these haunches fill the gap and stiffen the tenon joint at the same time.

When sketching out the panels, be sure to allow for expansion or contraction after they leave your shop. Near my home in Devon, which is on the English channel and very damp, I can be fairly certain that panels will not expand after leaving my shop, but you must make an assessment of the relative humidity in your area. The panels must fit in the frame loosely so the wood can expand and contract with the seasons. The amount of space between the panel and the bottom of the frame groove varies, but generally you should leave at least 1/16 in. all around in a damp environment and 1/8 in. to 1/4 in. in a dry season. Once you've worked out all the details on your drawing, you can use it to make up a cutting list.

Roughing out stock—Spend some time selecting the timber, and keep in mind that straight-grained timber is the safest choice for frames. When you've sorted through the stock, machine the frames before final-dimensioning the panels. At this time you should also cut several test pieces. These are not just scraps, but are short pieces that should be grooved and dimensioned just like the furniture components, so they can be used to set up the machines and mark out all the joints, thereby saving time and minimizing waste. You must be very accurate when crosscutting, ripping and thicknessing stock. Cleaning up and fitting operations will remove only a shaving; so trust your drawing and set the machines accordingly. The frames can be laid over the timber for the panels so you can choose the visual graphics of the panels more accurately.

Rather than cut the rails to length at the beginning, I make both doors as one large piece and cut them apart later. This saves time and ensures that the figure and color of timber is unified. I clamp the two rails together and mark out the mortises, scribing across both top and bottom rails with a sharp marking knife. To minimize errors when machining, I pencil over the waste sections. In measuring out the stock, remember to leave about 1 in. at each end of the rails for horns and 3/16 in. for the sawkerf separating the two doors. The horns protect the mortise and minimize the chance of breaking the joint when clamps are applied.

Now set up your mortising gauge and lay out the joint in the exact center of the rail. This makes it easier to locate the tenons and the grooves in the frame. As added insurance, always gauge from the same face of each piece, usually the face that will end up not showing. To simplify this operation, 1 arrange the stock so all the non-visible sides are facing down. After laying out the mortises with a marking gauge, 1 chop all the joints in the top rail with my hollow-chisel mortiser, readjust the depth stop to account for added width of the bottom rails and chop the mortises in those pieces.

It's essential that the stiles are crosscut exactly, and I mean exactly, the same length because the shoulders are gauged from the ends when tenons are cut on a tablesaw. For safety, attach a high auxiliary fence to the regular rip fence, as well as to a sliding carriage so you can move the pieces on end past the blade. You can make your own sliding carriage, as discussed in *FWW* #60, p. 12, or buy a standard tenoning jig. Resist the temptation to cut the tenons freehand; otherwise you risk a dangerous throwback. You can also rout the tenons or cut them by making multiple passes with the piece laid flat and supported by the miter gauge. Cut a tenon on a test piece and check its fit in your mortise. Adjust your setup until the tenon makes a friction fit into its mortise. The fit should not be too tight because the glue will swell it slightly.

Before cutting the tenon shoulders, use the test pieces to set the blade so it just kisses the tenon. Then set the rip fence to the length of the tenon and guide the work past the blade with the miter gauge or sliding table. It is important not to cut off all the waste material in a single pass. Instead, remove half the waste with the first pass, and then butt the end of the tenon stock against the miter gauge, as shown in the bottom photo at right, to remove the rest of the waste to the shoulder. If you cut at the shoulder line on the first pass, the waste will jam between the blade and fence and come whistling back at you.

When using the rip fence as a dimension stop, it is important to run all pieces from the same point on the fence. Again, the secret of clean-cut shoulders is checking the cut on a test piece until it is exactly right, using a very sharp blade and backing up the cut with a scrap piece against the miter gauge to prevent "spelching" or tearout. Now cut the haunches on the tablesaw using the two-step sequence you used for the tenon shoulders: cut the cheek with the piece on end in a sliding carriage, and then eliminate the waste by rotating the piece 90° and crosscutting to the haunch shoulder using the saw's regular miter gauge to support the piece. Check your drawing carefully before you cut; it is very easy to cut haunches in the wrong place.

Most woodworkers cut the panel grooves on a tablesaw fitted with a dado blade, which can be adjusted to make various width cuts with and across the grain. The width of cut and its position should be adjusted to exactly coincide with the width and location of a tenon. Make sure you groove the correct side of the rails and stiles or it will spoil your whole day.

Raising the panels can be done with a tablesaw, but the operation leaves a poor finish that must be cleaned up with a shoulder plane. I've obtained the best results by raising the panels on a shaper, using specially designed high-speed steel tooling honed to a mirror shine. These cutters leave a cloud of chips and a beautifully polished field with one pass.

Finish the panels to 180-grit with a hand-held pad sander and test fit the panels with a scrap piece. If everything fits, knock up the frame with the panels inside. During assembly, you'll be glad that you left the horns on the end of the rails; they protect the piece from accidental damage and are useful when knocking apart a tight mortise-and-tenon joint. If the joint is too tight, shave the tenon cheeks with a shoulder plane. If all is well, you can remove

Tenons are sawn with stock held against a high auxiliary fence and supported by a miter gauge. Because of the danger of kickback, never attempt this cut freehand.

Tenon shoulders are cut on the tablesaw in two stages. The first cut removes about half the waste, and the second cut, as shown below, removes the rest and establishes the shoulder line. Cutting all the waste in a single pass could result in the scrap being trapped between the blade and fence and getting thrown out from the saw.

the horns with a fine handsaw and true the surface with a handplane after gluing the pieces together for final assembly. Apply your finish to the panels; I generally use oil or lacquer for exterior surfaces and wax for the interior. The finish will help keep the panels free, should any glue seep into the grooves accidentally.

Before assembly, make a pass with a finely tuned handplane on the grooved sides of the stiles and rails to remove any remaining machine marks. I recommend a PVA glue for mortise-and-tenon joints, as this allows for some flexibility as the rails expand and contract. Finally, fine-tune the face of the frame with a series of quick cuts with a finishing plane. As you move the plane across the joint, you will see the value of locating the panel below the level of the frame. You can true the face of the frame without damaging the panel and can bring the plane in from any angle or side that produces a clean cut. After sanding lightly with 220-grit paper, apply finish to the entire piece.

David Savage is a furnituremaker, designer and teacher in Devon, England. For more information about instructional programs at David Savage Furnituremakers, write him at 21 Westcombe, Bideford, Devon, England EX39 3JQ.

Photos this page: John Gollop