Gluing Up

How to get a strong, square assembly

by Ian J. Kirby

Gluing up is unique among woodworking operations. It's an irreversible, one-shot deal and has to be got right. You may have done accurate work up to this point, only to find that a small error in assembling or clamping has produced all sorts of inaccuracies that will be difficult, perhaps impossible, to fix. A common lament in woodworking is that "everything went perfectly until glue-up, then everything went wrong." When you think about it, this is not surprising. How often do we systematically consider gluing up, and how much time do we give to dry clamping? Usually very little, and then halfheartedly.

To get the best results, we should bring a studied method to this operation and practice it more. We ought to have a table especially prepared for this purpose, its top surface flat, clear of debris and well waxed to resist glue penetration. A piece of varnished plywood over your benchtop will do, but a sturdy table, 36 in. high with a Formica surface, is better.

Before gluing up, you should dry-clamp each assembly exactly as you would clamp a glued assembly. This means positioning and tightening all the clamps, with correct glue blocks, and checking the whole assembly for accuracy. Gluing should proceed calmly, in an atmosphere of preparedness, with the glue and necessary applicators ready, clamps standing by, and you and your assistant decided on the order of events. The time of day you glue up is important. Most woodworkers like to glue up in the evening and let the glue set overnight. To meet this goal, a lot of work often gets rushed, dry clamping gets short-circuited and we have all the necessary ingredients for a disastrous glue-up—fatigue, unpreparedness and anxiety. The only reason to proceed under such conditions lies in the spurious notion that glue cures only while the moon is out.

Consider the alternative. Leave the work dry-clamped overnight. The next morning, check the clamping to see if everything is still properly aligned. Then collect all the tools and materials you need and begin to glue up. The light is better, your mind is fresh, the pressure to complete the job is gone. If you can't leave the work dry-clamped overnight, at least let it sit for an hour while you attend to other things.

Gluing up actually begins with a decision about what to glue together and in what order. The more subassemblies you can get together, the easier the total operation will be, especially the final glue-up. But before gluing any parts, always clean and prefinish surfaces that cannot be reached later with a plane. It's much easier to work on a piece of wood while its entire surface is exposed and accessible than to try to remove mill marks and other blemishes once other parts are permanently in the way.

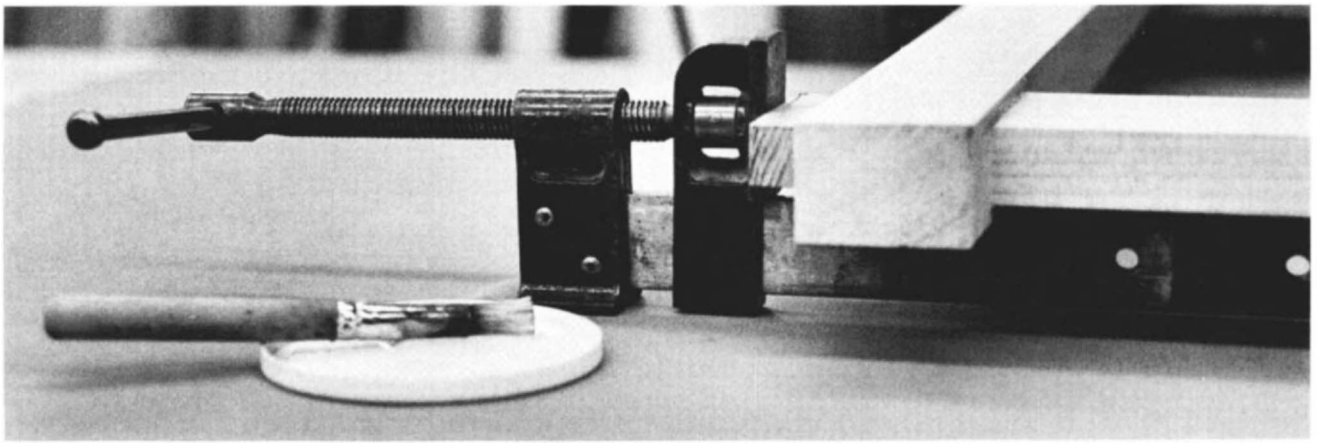
You must also weigh the inconvenience of having three or four finishing sessions as the job proceeds against one grand and difficult cleanup after final assembly. Prefinished surfaces will resist glue penetration from squeeze-out. When the excess glue is dry, simply lift it off with a sharp chisel. When finishing prior to gluing up, take care to keep the finishing material off joint interfaces.

Bar clamps—The type of bar clamp you use has considerable bearing on the ease and accuracy of the glue-up. For general cabinetmaking applications, quick-action bar clamps with a circular pad at the screw end are no substitute for a standard bar clamp. A good clamp should sit on a glue table without falling over at the slightest touch. The bars should be identical in section, and the heads should move easily, but not flop around. When pressure is applied, the face of the head should be at 90° to the bar—this way we know exactly where pressure is transferred. A collection of clamps is an investment no matter which you choose, but it is a long-term investment you can make by purchasing one or two clamps at a time. The combined value in the end may equal that of two major machines. The best choice in the main is between Jorgenson, Wetzler and Record clamps. I prefer the last.

Applying the glue—The amount of glue squeeze-out is an important signal. Since it is waste, it is best to have as little as possible, but we still want assurance that there is sufficient glue in the joint. The smallest bit of squeeze-out is enough. This results from getting the glue in the right place in the right amount. For different jobs you will need different applicators. White glue (polyvinyl acetate) and yellow glue (aliphatic resin) can be stored in and dispensed from a squeeze bottle. But a squeeze bottle is not a good applicator, and won't guarantee that the surfaces being joined are completely wetted by the glue. There is no reliable adhesion if joining surfaces don't get completely wetted.

Since the future of the piece depends on the quality of its joints, we need to take a close look at the business of applying the glue. Manufacturers try to lower the surface tension of the glue so it will spread easily. Nevertheless, the glue should be rubbed or rolled on, not merely squeezed out onto the surface. A set of stiff-bristle brushes of different sizes (I use plumber's flux brushes) will suffice in most instances. If you use white or yellow glue, brushes can be stored in a jar of water, but it is just as easy to wash them out and begin next time with a dry brush. If you use urea-formaldehyde glue or resorcinol, you must clean the brush after each use, for these will set hard even in water.

When edge joining boards, white or yellow glue can be squeezed from a plastic bottle onto one surface. If the boards are clamped or rubbed together and the clamps are removed immediately and the joint broken, chances are you will find that the glue has covered both surfaces uniformly. That this happens in edge joining does not mean that it will happen in other joining situations. In fact, it's not a good method for edge joining either. A better way would be to run a very light



The size and position of the clamping block can make the difference between success and failure when gluing up. The block should be the same dimensions as the section of the rail, and placed directly opposite the shoulder area, centering the clamping pressure on the joint.

bead on each surface, and then with a 1-in. wide paint roller, spread the glue thinly. Now we know that the surfaces are evenly wetted and that when the joint is clamped we won't have gobs of the stuff dripping on the floor, the table and the clamps. Spreading glue with your fingers is a bad practice. You need fingers for other things, and the grease and dirt you add to the glue won't help adhesion. If you insist on using your fingers, wash your hands first.

Edge gluing—When gluing up several narrow boards to make a case side, tabletop or framed panel, there are four important considerations: the position of each board in the composite piece, the grain direction of each, the number of clamps to be used and the means for aligning and registering the boards to keep them from swimming about when pressure is applied. Assuming that all of the boards are dimensionally stable and free of defects, the first thing to decide is how to arrange them to get the best appearance. This involves shuffling the pieces around to achieve visual harmony and continuity in the figure. Remember that after gluing up you will have to clean up the surfaces with a smoothing plane, so try to decide on an arrangement that permits the grain of all the boards to run in the same direction. If this is not possible, then you will have to plane in both directions and carefully avoid tearing the grain on an adjacent board.

Having decided on their arrangement, mark the boards so their order can be recalled when they are put in the clamps. Dry clamping will determine the number of clamps you need and where to put them. As shown in figure 1 on the next page, clamping pressure is diffused in a fan of about 90° from the clamp head. You will need enough clamps to ensure that the lines of diffusion overlap at the first edge joint. The number of clamps then is a function of the length of the boards and of the widths of the two outer boards. Since the boards themselves transmit and spread the pressure, clamping blocks are unnecessary in edge gluing. Plan to joint and rip the composite piece to width after glue-up. This will remove any depressions the clamps leave.

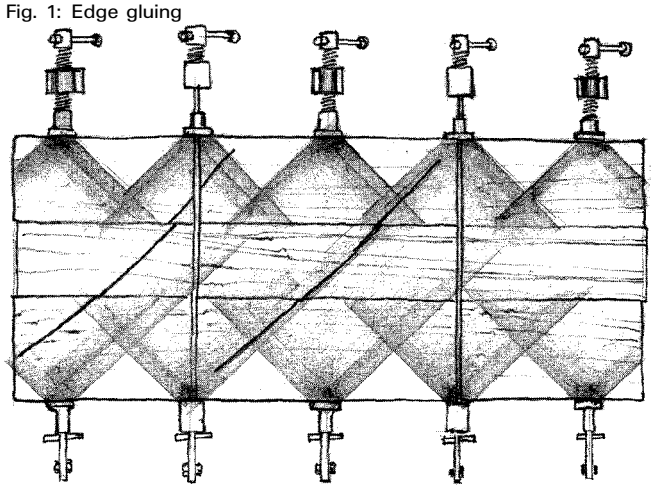
When you know how many clamps the job calls for, put half the number (half plus one if the total number is odd) on the table, evenly spaced. If the bars are not bent or damaged, they will register the boards in the horizontal plane. Coat each edge to be joined with glue, wetting all the surfaces thoroughly and uniformly. When the boards have been put into the clamps and slight pressure applied, place the remaining clamps over the top of the panel and begin to tighten all the clamps. Having an equal number of clamps top and bottom prevents the panel from bowing under pressure.

Ideally you should be able to edge-glue boards without having to rely on any mechanical means of holding them flush. But when the boards are even slightly warped this isn't possible. It is common to use dowels for aligning and registering boards; if you're going to do this, use a doweling jig to align the holes. Another method for registering edge-glued boards is the Lamello joining plate *(FWW* #29, July '81, pp. 79-80); the machine that cuts the slots is expensive, but worth the investment for the professional woodworker. The quickest solution is to lightly clamp battens across the width of the panel. Don't overtighten the bar clamps. This can squeeze out most of the glue and starve the joint. Moderate pressure is all that is needed when edge gluing.

Gluing up mortise-and-tenon joints—Mortise-and-tenon joints usually get little attention when gluing—most woodworkers want to assemble them as fast as they can. But the pace ought to be less hurried; ideally there should be two people at a glue-up, one to direct the order of events and to tighten the clamps, the other to manage the shoe end of the clamps. Both apply the glue. One coats the tenons thoroughly while the other puts glue in the mortises. Because the mortise and tenon goes together in a sliding fit you can't expect to apply glue to the tenon alone and still have enough in the joint. You will have to spread glue in the mortise as well. Don't just squirt in some glue and push it around with a stick or pencil, because the excess glue can impede fitting the joint. Visualize the glue as a fluid pad of considerable thickness. The pressure exerted by an excess on one side of a tenon can misalign the members. So apply glue thinly and evenly to all surfaces. Better than squeezing lots of glue into the mortise and stirring it with a stick is using a stiff-bristle brush.

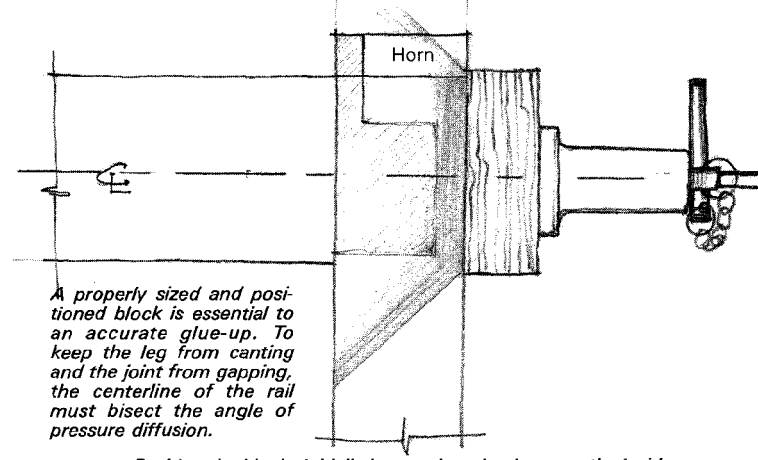
During dry clamping pay close attention to dimensioning and positioning the clamping blocks. Their purpose is not so much to protect the stock as to transfer the pressure from the clamp to the workpiece in exactly the area required. The fact that the clamp heads can lean away from a right angle under pressure, that they may have been put onto the work slightly askew and that the workpiece may not have edges perpendicular to its face, are all things you must consider when direct-

Fig. 1: Edge gluing



Shaded areas show diffusion of clamping pressure. Use enough clamps to ensure that lines of pressure overlap at the two outer joints. An equal number of clamps above and below the panel prevents bowing.

Fig. 2a: Gluing leg/rail assemblies—Plan view



A properly sized and positioned block is essential to an accurate glue-up. To keep the leg from canting and the joint from gapping, the centerline of the rail must bisect the angle of pressure diffusion.

Position the blocks initially by eye, but check across the inside surface of both legs with a straightedge to make fine adjustments in their final placement.

Fig. 2b: Side elevation

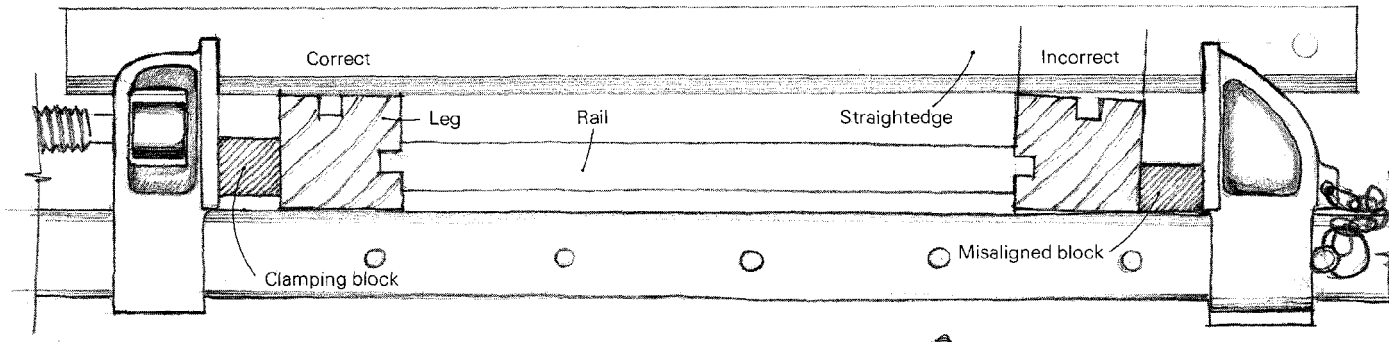
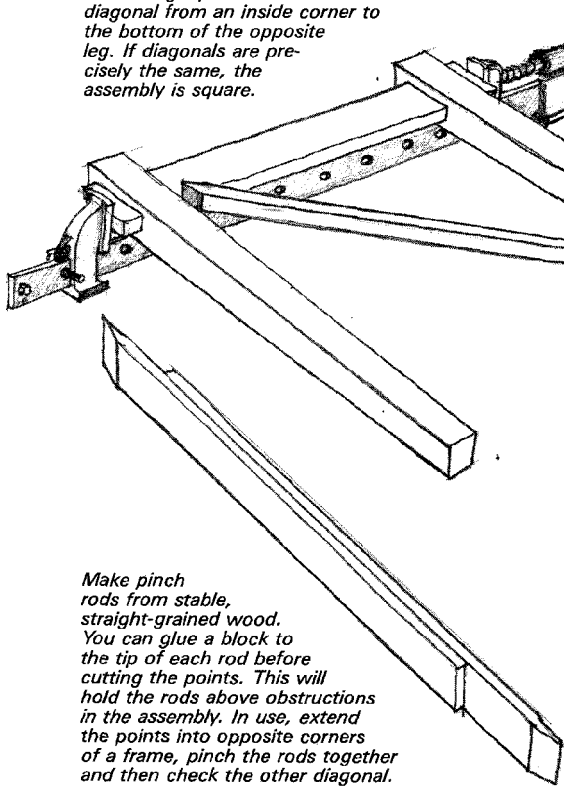


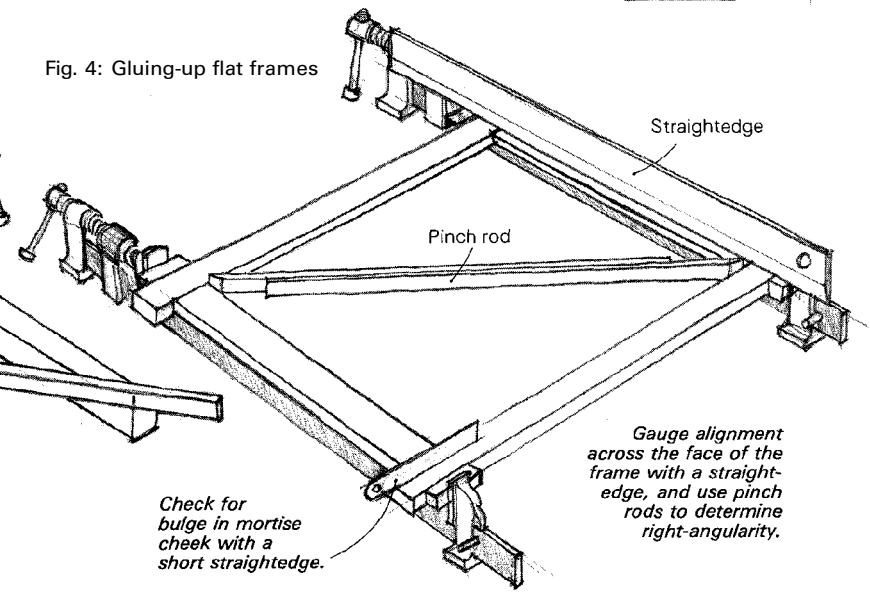
Fig. 3: Checking for alignment

Use a single pinch rod to measure the diagonal from an inside corner to the bottom of the opposite leg. If diagonals are precisely the same, the assembly is square.



Make pinch rods from stable, straight-grained wood. You can glue a block to the tip of each rod before cutting the points. This will hold the rods above obstructions in the assembly. In use, extend the points into opposite corners of a frame, pinch the rods together and then check the other diagonal.

Fig. 4: Gluing-up flat frames

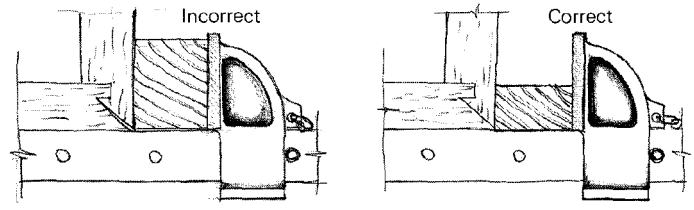


Gauge alignment across the face of the frame with a straightedge, and use pinch rods to determine right-angularity.

Check for bulge in mortise cheek with a short straightedge.

Fig. 5: Clamping blocks in carcase glue-ups

An improperly sized or positioned block can bow a carcase side and cause the joint to open, below left. The example below right is correct.



ing clamping pressure. Putting a piece of plywood between the workpiece and the clamp shoe or head isn't enough.

In gluing up leg/rail or rail/stile assemblies, the size of the glue block that distributes the pressure to the shoulder line of the joint is important. Providing that the grain of the block runs lengthwise and it is thick enough not to distort under pressure, the block should be about as long as the rail is wide, and about as wide as the rail is thick, as shown in figures 2a and 2b. With the right clamping block, pressure can be placed where you need it by moving the block slightly to one side or another or up or down the legs. If you attempt to glue up without clamping blocks, there's little chance of directing pressure where it is required.

The parts of a correctly glued-up assembly or subassembly should not twist or wind in relation to one another. They should be aligned and at right angles to one another. Joint lines should close up tightly. When assembling two legs and a rail, as in a table frame, cut the legs % in. longer than the finished length. This excess, called the horn, is left at the top of the leg, where it can reinforce the mortise and help keep the end grain from splitting during dry clamping and gluing up. The horns are cut off later when the glue has cured. On rail/stile assemblies, where you have mortises at both ends of the vertical members, add 1½ in. to the length of the stile, making a ¾-in. horn at each end. When laying out the joints on legs, measure from the bottom to the top, not from top to bottom. This way you won't have to cut the legs to final length after assembly. When laying out the joints on stiles, clamp the two members side by side and lay out the final cut to length at the top (striking across both at once); then measure down from these to lay out the finished length at the bottom. Use a try square and a layout knife for the best results. Then you can accurately check the work when gluing up.

Checking for alignment—The legs should be sighted with winding strips to make sure they are in the same plane. Don't try to sight tapered legs on the tapered side. To correct twist or wind in the assembly, one person holds it down tightly on the clamp bed and slackens off the clamping pressure. The second person, holding one leg in each hand, moves the legs into proper alignment. Then the clamps are retightened.

Right-angularity between legs and rail is frequently overlooked. This is best checked by laying a straightedge across both legs as shown in figure 2b. To correct misalignment, the clamping block must be raised or lowered to redirect clamping pressure. If this isn't done, the rails will go off at odd angles at the next glue-up when the subassemblies are joined by two more rails. Then the finished piece will be under constant tension and the rails may bow. Using the straightedge as a reference, shift the clamping blocks in the appropriate direction. Here dry clamping will tell you, ahead of time where to position each block. Remember to dimension each block carefully, as improperly sized blocks are difficult to position and can misalign an accurate joint by putting pressure in the wrong place.

Next check for overall squareness in plan. A try square is hardly adequate for checking this sort of right-angularity. On assemblies with long legs and rails, it can gauge only a fraction of the lengths involved, and if the legs are curved or tapered, or if the rails aren't straight across their bottom edges, a try square won't work at all.

Squareness is best determined by taking diagonal measurements from the top inside corners to the inside bottom corners of the legs. If the diagonals are equal, the assembly is square. You can make these measurements with a long rule, though take care to place the rule at the same depth in the two corners. A flexible metal tape can also be used, but this requires two people for accurate results. One holds the one-inch mark in precise alignment with the corner, while the other pulls the tape taut to measure the distance to the bottom inside of the leg.

Traditionally, diagonal measurements are taken with pinch rods. Shown in figures 3 and 4, these are similar to the two sticks described in *FWW* #6, Spring '77, p. 46, only their ends are pointed to fit into corners, and stepped so they can span obstructions like center stiles and stretchers. Considering their high degree of accuracy and the small amount of effort needed to make them, there's little reason to use anything else to measure internal diagonal distances. We should find the diagonals equal if the clamp holding the assembly together is in line with the rail member. If they are not equal, reorient the clamp and the blocks in such a way that the members will creep into square with one another.

Assembling frames—When gluing up a flat frame, as for a door, employ the same checking procedures and assembly methods as you would for a leg/rail assembly. But because a frame is closed on four sides and relatively thin in section, it calls for some special attentions. The flatness of the gluing table is particularly important. If we are using identical clamps and we press the frame down onto the clamp bars, we will get a twisted frame if the table we are working on has a twisted top. Usually the cheeks of a mortise in a frame are fairly thin, and the glue in the joint migrates to the center where it can cause them to bulge outward. Avoid this by clamping across the cheeks with a C-clamp and properly sized blocks.

Gluing up carcases—A situation where improperly dimensioned clamping blocks can be dramatically counterproductive is in gluing up carcases. Too large a block, as shown in figure 5, can misapply the pressure, cause the sides to bow like crazy and open the joint on its outer edge. For clamping case sides tightly against an internal shelf or other member, we have little choice other than to use cambered cauls *(FWW* #23, July '80, p. 12).

Gluing dovetails is totally different from gluing mortises and tenons. If the dovetail has been made so that the end grain of the pins and tails is below the surface on the adjacent boards *(FWW* #21, March '80, p. 75), then all that is required to glue a large carcase together is one clamp and two people. After the glue has been applied and the joint put together, the dovetails are clamped home individually. They will not spring back if correctly made, because there is considerable friction in the glue interfaces between the pins and tails. When the glue has been uniformly brushed on the long grain of the pins and tails, each part swells, making the close fit even tighter. Don't delay assembly after applying the glue, and don't try to hammer the parts home, as you quite properly did during the dry test assembly. Clamping is the proper means once the glue is applied, and it is sweet and easy to clamp each tail one after the other and see the glue come squeezing out at the bed of each pin. □

Ian Kirby writes frequently for this magazine.