



Glued-up panels are essential for many woodworking jobs. The process seems straightforward, but care must be taken to ensure that the panel has an attractive grain pattern, is flat and free of excess glue. Above, the author removes glue squeeze-out with one

of the small plastic tabs used to seal plastic bags in grocery stores. The narrow strips along the edges of the assembly are scraps that prevent the clamps from damaging the panel. Clamps are mounted both above and below the panel to keep it flat.

Edge Gluing Boards

Making flat panels with nearly invisible joints

by Christian Becksvoort

Many woodworking projects involve gluing together several narrow boards to make a large panel for a tabletop, carcass side or other large surface. The process seems fairly straightforward, but there are many factors to consider. Selecting the stock, matching and orienting the grain, jointing the edges, gluing and clamping all affect the outcome of the finished panel.

The process begins with proper stock selection. It is highly unlikely that you can get a finished $\frac{3}{4}$ -in.-thick panel out of $\frac{3}{4}$ -in. stock. Even if the glue-up was perfect and the surfaces were planed to perfection, some scraping, sanding or planing would be necessary. Rough $\frac{1}{4}$ lumber is a full inch, which gives ample thickness for machining out a $\frac{3}{4}$ -in.-thick panel. Unfortunately, the surface of rough-sawn lumber is so uneven that it is difficult to match grain and color

or detect minor imperfections, such as surface checks. Thus, when I purchase $\frac{1}{4}$ stock, I have it milled on two sides to $\frac{7}{8}$ in., hit or miss. This means that most of the faces will be planed (hit), although there will be an occasional patch missed by the planer. To me that's a good compromise; about 95% to 98% of the surface is visible, yet there is still $\frac{1}{8}$ in. of stock for sanding or planing after the panel is glued. The result is a clean panel that is a full $\frac{3}{4}$ in. thick.

In general, avoid cupped or twisted stock. Bows and crooks are salvageable. The more careful you are in selecting stock, the easier the glue-up and the flatter the panel. When possible, cut all the pieces out of a single board to ensure similar grain and color throughout. Remember, it is virtually impossible to get three 4-ft. pieces out of a 12-ft. board. Most boards must be trimmed from 1 in.



In gluing up narrow boards, the goal is to produce a panel of uniform color, with a fairly continuous grain pattern across its width, as shown in the photo above, left. A poorly matched panel, shown in the photo above, right, looks more like an assemblage of separate boards.

to 6 in. on each end to remove checked sections. Individual panel pieces should be 1 in. to 2 in. longer than the finished panel to allow for gluing, clamp "sliding" and final trimming. Also, allow ample width for jointing, especially if the pieces are crooked or have rough edges.

Matching grain and color—When all the panel pieces are cut, match the grain and color. The goal is to produce a panel that looks as if it has continuous grain across its width, as opposed to separate boards glued together. Parallel grain along the edges of boards is fairly easy to match to parallel grain of the next board. Wide-face grain is a bit more difficult, while grain that runs out at an acute angle is extremely difficult to match up. The photos above show good and poor matching in a panel. With a little time, effort and practice, matching grain becomes almost second nature. The result of a well-matched panel is quite subtle. On the other hand, a mismatch is glaringly obvious. Experiment with different patterns: Remember that even with only two boards there are 16 different combinations of matching them!

Another aspect of matching is growth ring orientation. Here there are two schools of thought. The first holds that every other board in a panel should have its growth rings reversed. Thus, as each board cups, a slightly wavy panel results. The other theory is to have all the growth rings face the same direction. Then, if the boards should warp, they form one large curve. Generally, I hold with the second theory; I use cherry almost exclusively and it is a relatively stable wood. But I would follow the first method if I was working with wood that was prone to cupping or to excessive movement throughout the year (such as oaks or hickory). A second factor would be the amount of bracing or support attached to the panel. A tabletop with little overhang and rails under its full width will usually stay flat. So will a chest side that has locked corners and divider supports. On the other hand, large free-floating or unsupported panels, such as pedestal tabletops or slab doors, should have their growth rings reversed.

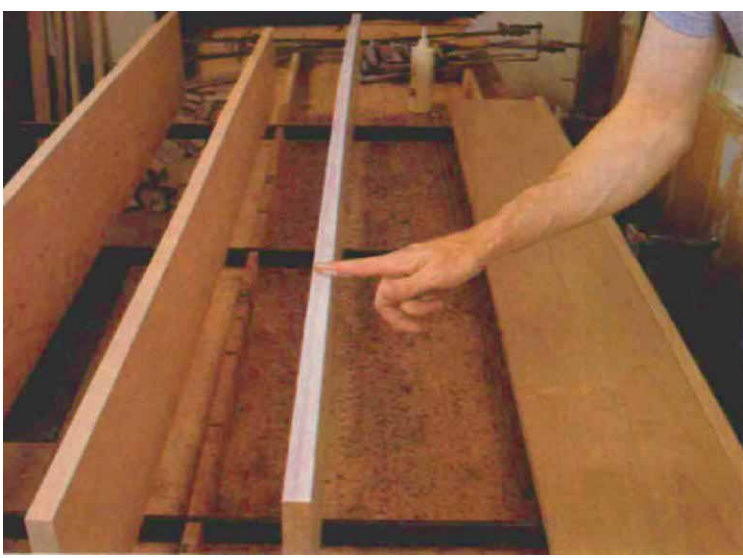
Finally, don't let rules stand in the way of common sense. If you have only three boards, and each has one good face and a minor defect (knot, worm hole, sap or chipped grain) on the other face, then obviously the defects all go on the underside. Nobody wants them on a tabletop or the outside of a cabinet, no matter what the

rules say. Once the boards are selected and their positions in the panel are determined, I mark the panel with a triangle, like the one shown in the above, left photo. The triangle makes it easy to instantly reconstruct all the careful matching you've just completed.

Next, true up the edges with a jointer or a long handplane. Either way, the edges of all boards must be absolutely perpendicular to the faces, otherwise the panel will be cupped. Some older texts recommend leaving a $\frac{1}{64}$ -in. gap in the center of each joint. This works only if the wood has recently come out of the kiln and has picked up some moisture at the ends. The theory is that eventually the rest of the board will pick up moisture, thereby relieving the stress caused by the gap. When I join boards, I aim for a tight joint along the full length. Undoubtedly there will be slight gaps now and then. If hand pressure can close the gap, I don't worry about it. However, if full clamping pressure is required to close the joint, there will be too much stress on the panel and the pieces must be rejoined. I always dry-fit my panels before gluing, so I can check if all the joints are tight, and identify potential problems, such as misalignment. For instance, two adjacent bowed boards may align properly, but result in a bowed panel. In this case, it's necessary to flip one board over so the bows counteract each other. Even though misalignment makes aligning the joint more difficult, it results in a straighter panel.

There are several ways to make aligning boards easier. In furniture factories, a "glue joint" is used. This is usually a modified tongue-and-groove joint along the edges. I should stress that this joint is merely for alignment, not for extra strength. A fresh, well-fitting butt joint with good glue is more than adequate. Old timers used dowels on their glue joints, but I don't care for them. In fact, if they are too long, they can actually work to weaken the joint, since the grain of the dowels runs across the grain of the boards. I find these devices unnecessary. If an unexpected misalignment occurs during glue-up, lay a piece of scrapwood on the high area and persuade it down with a mallet before the clamps are fully tightened.

Glues are a matter of preference. There are specific glues for special circumstances: resorcinol and epoxy for exterior use, plastic resin for water resistance and hide glue for possible future disassembly. I use an aliphatic resin glue, Titebond, almost exclusively. It is relatively inexpensive, has a reasonable assembly time, requires no premixing, possesses a long shelf life, sets fast, has very little creep and makes an exceptionally strong joint. It's ideal



Fingers make fine glue applicators. Here the author runs a bead of glue along the length of the joint and spreads it over the entire edge. A brush or narrow paint roller could also be used.



Rather than rely on dowels or other devices to align boards during glue-up, Becksvoort simply uses a mallet and a piece of scrap to hammer on the joint until the boards lie flat.

for panel work. Clamp time is 20 minutes under ideal conditions (over 75 degrees F, low humidity) to two hours if the panel will be subjected to stress (planing or sanding).

Clamps are another item to take into account. Bar clamps come in standard lengths, from 1 ft. to 10 ft., while pipe clamps, can be made from any length pipe. Although pipe clamps are cheaper, they bend easier. The steel I-clamps or flat bar clamps last several lifetimes. My favorites are Hartford clamps, no. 5, available from the Hartford Clamp Co., Box 8131, E. Hartford, Conn. 06108; (203) 528-1708. These have a 1/4-in. by 1 1/2-in. steel bar, and a sliding L-vise handle, which is a joy to use in close quarters.

If you glue panels on a regular basis, a glue table or rack is indispensable. Pipe clamps have "feet" or flat bases that allow them to be set directly on the floor or workbench. Bar clamps are more likely to tip over, so they should be supported by a rack or glue table. The table consists of a sturdy base, a top at a convenient height and two 3/4-in. by 2-in. rails about 24 in. apart to accept clamps. After you clamp the rails together, cut slots about 6 in. apart with a dado blade. The size and shape of the slots depend on the style of clamps you have. Then, attach the rails opposite each other. When setting up the table, place clamps in the end slots and sight along the length of the table to be sure the clamps are parallel, that is, in the same flat plane. The table may need to be shimmed, otherwise you might introduce twist into the panels being glued. A glue rack is a little simpler—merely two rails on a frame or, better yet, on a braced plywood sheet to catch glue drops. The rack can be put on sawhorses and stored upright if space is at a premium, but it will have to be leveled each time you use it.

Tightening clamps—On most panels, I space the clamps about 2 ft. apart on the glue rack. As the glue-up proceeds, other clamps will be put on the top of the panel between the bottom clamps to equalize the pressure and keep the panel flat. Spacer sticks inserted on each edge keep the clamp heads from compressing the grain. Now it's time for a dry run. Does everything line up? Are there any major gaps? Can you align the joints? If all checks out, it's glue time.

I prefer a thin glue film on each surface of the joint, but one thick film per joint works too. Run a bead of glue the length of the joint and spread it over the entire surface of the edge. Fingers work fine as applicators, as shown in the above, left photo. Then, lay the boards back down in order and proceed clamping. I usually start at the area of worst alignment and force the boards up or down as needed by pushing, prying ends up or down or persuad-

ing high spots with scrapwood and a mallet, as shown in the above, right photo. After the first bottom clamp is tight, set a clamp on top, midway between the bottom clamps. Never tighten all the bottom clamps first, as this causes the panel to buckle and explode. Finally, go back and tighten up the clamps as much as possible. If necessary, clamp the ends, as shown in the photo on p. 68. Having "glue-starved joints" is nothing but an excuse for dirty (oily), ill-fitting joints or inappropriate glue. The clamp pressures recommended by glue manufacturers for automatic clamp presses far exceed any pressure you can apply by hand. The key is to keep the pressure even on the top and bottom so the joints are tight and the panel flat. A certain percentage of glue is forced into the grain; only the excess squeezes out. Have you ever noticed that when using very thin glue films there is little, if any squeeze-out? Even so, the joint holds.

Excess glue should be removed since it introduces moisture into the panel, causes swelling and slows drying. It also clogs sandpaper and gums and dulls planer knives when dry. A cloth or scraper will do, although recently I've started using the little flat plastic tabs used to seal plastic bags in grocery stores. They do an excellent job and can be reused by flexing them and popping off the dried glue. Be sure to remove glue from both sides of the panel. When doing a run of several panels, scribble the time on the panel so you'll know when you can free up the clamps for the next round.

Cleaning up squeeze-out—As a general rule of thumb, I never glue up wide panels in one piece, but in two halves. A 48-in.-wide tabletop made up of many narrow boards can provide a real wrestling match. Four or five boards is all I usually do at a time, unless they are very well behaved.

When the panels are dry, the clamps can be removed. Again, alternate between the top and bottom clamps so that the pressure can be released evenly. Planing or sanding is the next step, which you can do in your shop if you have a wide planer or belt sander. I find it is more cost-effective to take several panels to a large cabinet or mill shop and use the wide belt machine. Five or six panels can be sanded, all the same thickness, flat and smooth to 120-, 150- or even 180-grit, in about one-half hour at a cost of \$20 to \$30. These machines can handle 24-in.-, 36-in.-, 48-in.- or 56-in.-wide panels. Look in the yellow pages and call for an appointment. □

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