Frame-and-panel construction has been used for centuries to build cabinet doors, case sides, and other assemblies. It is so attractive you might think it was designed that way just for looks. But it was actually devised as an elegant solution to the perennial problem of wood movement.

The problem is that a simple solid wood panel expands and contracts across its width in response to seasonal changes in humidity. So if such single-slab panel was used as a cabinet door, for example, it might swell shut during high summer humidity, and shrink enough to show unsightly gaps during winter’s low humidity. With frame-and-panel construction, the panel is fit unglued inside a frame, where it’s allowed to expand and contract while the frame maintains a consistent overall size. Brilliant.

Of course, panels can also be made from plywood, MDF, and other stable man-made boards. This approach offers the beauty of frame-and-panel construction without the wood movement problems. Whatever style you choose, it’s not hard to build frame-and-panel assemblies, especially with the rail and stile router bit sets available these days for the frame joinery. However, designing and making assemblies well requires some nuance and a basic understanding of wood movement. Here, I’ve compiled a handful of tips and techniques to help you finesse and perfect your frame-and-panel work.
Wood is hygroscopic; that is, it absorbs moisture from the air. And when it does, the moisture swells the cell walls, causing the wood to expand across its grain. Conversely, when moisture in the air decreases, the wood will shrink across its grain. This response to changing seasonal humidity must be factored into the design of a piece of furniture if it’s to last. Frame-and-panel construction is a solution that allows a wide solid wood panel to expand and contract freely within grooves in the frame.

The frame consists of stiles (the vertical members) and rails (the horizontals) that are relatively narrow, so they won’t substantially change dimension over the seasons. This dimensionally stable construction houses the panel within the frame grooves. A tongue at the panel perimeter tucks into the groove, maintaining a snug fit between the two even as the panel changes width.

When fitting a solid panel into its frame, leave a gap between the panel sides and the stile grooves to allow for wood movement. (Because the panel won’t change length, you can fit it fairly snugly between its rail grooves.) A proper fit is important to ensure that the fully expanded panel won’t muscle the frame joints apart. Likewise, you don’t want a fully contracted panel to pull entirely away from its grooves.

In the case of man-made boards (e.g. plywood and MDF), the frame serves to restrain the panel from warping and to hide any ugly edges—all the while benefiting from the aesthetics borrowed from traditional frame-and-panel design. And because a plywood panel is stable, it can be glued into the frame grooves, making for a virtually indestructible assembly.
Frame construction

Frame stiles and rails should be made from straight-grained stock for both stability and aesthetics. Straight-grained stock is less likely to cause a door to warp, and the straight graining visually accents a panel much better than wild grain.

As for the frame joinery, choose an approach that suits the application and your tooling. Keep in mind that a door with a floating solid-wood panel relies entirely on the frame joints for its strength, whereas a plywood panel can be glued in its grooves to increase the overall strength of the door.

The time-honored choice is the nearly unbreakable mortise-and-tenon joint, whether it incorporates a traditional integral tenon, or a “loose” tenon. A bridle-joint is as strong although less neat because the end-grain of the rail shows.

A simpler, but weaker, connection is the stub tenon joint, in which a short tongue on the end of the rail fits in the stile’s panel groove. I use this joint a lot for doors with plywood panels because the work goes quickly and I can glue the panel in its grooves for great strength. Of course if you have a router table, you can use a rail-and-stile router bit set to create the attractive coped stub tenon joints that are so ubiquitous in commercial cabinetry these days.

Panels and profiles

Although most panels can simply be categorized as either “raised” or “flat,” the way they’re profiled and fitted to their frame can make a world of difference in the look of a frame-and-panel assembly. Traditionally, a tablesawn or hand-planed bevel tapered all the way out to the edge, lacking a flat tongue at the edge to effectively mate with the frame grooves. That’s why most raised panels made in small shops today are cut on a router table. A wide variety of router bits are available that will shape an attractive profile that terminates in a flat tongue of consistent thickness.

Flat panels of either solid wood or plywood can be made in any thickness. The simplest approach is to make the panel as thick as the width of the frame groove. If you want something more substantial, you can either saw a centered tongue along the edge of a thicker panel to center it across the thickness of the frame, or create an offset tongue to recess the panel. I usually do the latter when making plywood panels.
Composing panels

Ideally, a solid-wood panel within a frame should be made from a single board with uninterrupted grain. However, wide boards can be hard to come by, requiring you to glue up large panels from narrower boards. Following a few simple design principles can yield panels with gracefully composed grain that makes your furniture stand proud.

When laying out, use long boards, sliding them against each other to create a good match at the edges. Rip, flip, and arrange the boards in whatever way is necessary to create the most uninterrupted, continuous grain pattern and consistent color. When working with boards that exhibit arched cathedral grain, it's a good idea to use a full-width board at the center of the panel, and then join narrower straight-grained pieces to its edges to create the wider panel. As a general rule, orient the arch of cathedral grain upward for a more uplifting feel. (When cutting panels from plywood sheets, select sections of the sheets that fit the criteria as closely as practically possible.)

Raising and rabbeting panels

Unless you own a shaper, raising panels is best done on a router table. You’ll want a strong (minimum 2hp; preferably variable speed) router to spin a typical panel raising bit. These hefty bits take a big bite, so make sure to remove stock by taking a series of shallow, sequentially deeper passes. For clean, accurate cuts, always use a featherboard to keep the panel pressed firmly against the table at the bit location. Also, use a guard to protect your hands from that big-ass bit.

When rabbeting the edges of a flat panel to fit the frame grooves, it’s important that the tongue be a consistent thickness. Otherwise, you invite gaps or problems fitting the panel into its grooves. For accuracy, I suggest creating the tongue by making two intersecting cuts on the tablesaw. Make the first cut with the panel flat on the table. Then make the second cut with the panel held vertically against the fence as shown in the photo below. Orienting the tongue between the blade and the fence like this ensures it will be a consistent thickness.
Fitting a solid-wood panel

Most seasoned woodworkers have learned by experience how much room to allow in stile grooves to accommodate wood movement of a solid wood panel, basing their decision on the type of wood and the relative humidity in the air. However, for this approach to work, it’s critical that you’re working with properly seasoned wood, and to be certain of that, you’ll need to read the moisture content with a moisture meter. Precise calculation of wood movement can get complicated, but as a ballpark reference, remember that most seasoned plainsawn domestic woods move between $\frac{1}{8}$" and $\frac{1}{4}$" per foot of width from the driest time of year to the wettest. Many exotic species move a bit less, and all quartersawn wood moves less than plainsawn. Overall, the exact amount of movement depends on the type of species and where you live.

With those parameters in mind, factor in the season and your locale. For example, if you’re building in the dead of a northeast winter, a 1'-wide panel has probably shrunk as much as it’s going to, so you’ll want to leave at least $\frac{1}{8}$" between each edge and its adjacent stile groove for the wood to expand during the humid summer. Conversely, in deep summertime, you can seat a panel almost fully in its stile grooves, leaving perhaps a $\frac{1}{16}$" clearance on each side as insurance.

### Tip Alert

Type “Wood movement charts” into your web browser for more information on the amount of movement to expect from a specific species.

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### Assembly Tips

- Pre-finish a solid-wood panel before assembly to prevent exposing non-finished edges later when the panel shrinks inward away from the stiles.
- To prevent buckling when gluing up a frame, use parallel jaw clamps. When using pipe clamps, flank the stiles with dowels whose diameter matches the frame thickness.
- Use a dowel or brad to pin a solid-wood panel in place through the back of the rails to ensure the panel stays centered as it expands and contracts.
- Because wood movement is not an issue with plywood panels, they can be glued into their frame grooves, which reinforces the overall construction.

### Tip Alert

If you don’t have parallel jaw clamps like the one in the foreground, use proper size dowels against pipe clamp jaws to prevent the assembly from buckling.
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