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Contents

On the cover: Mike Whalen of DBS Remodel in Poughkeepsie, N.Y., planes out an existing studwall in preparation for a tiled, barrier-free shower in Rhinebeck, N.Y. See the story on page 7. Photo by Tim Healey.

FEATURE

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BY MIKE WHALEN

Prepping Floor and Wall Framing for Tile

Floor systems need to be strong and stiff enough to support tile, but often in an existing home, they are underdesigned, out-of-level, and structurally compromised (as shown here) and need to be evaluated by a design professional **(1)**. When pouring liquid-applied self-leveling compound, the author first sets screws to a level elevation using a laser, paints the screws fluorescent orange to stand out **(2)**, then works the compound flush to the tops of the screws **(3)**, feathering it out to level **(4)**.

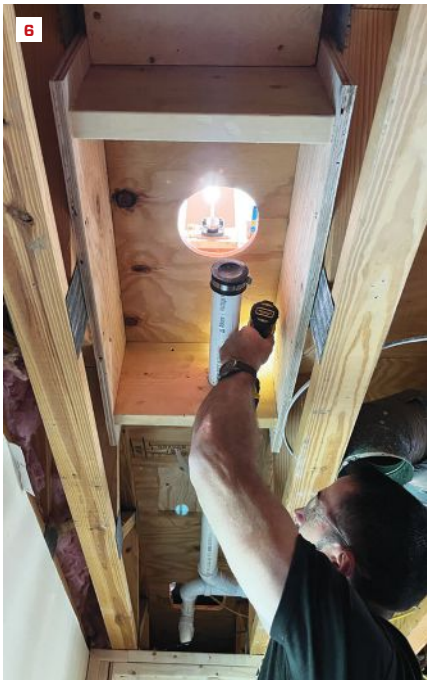
Photos by Mike Whalen and Tim Healey; illustrations by Tim Healey

I'm a lead carpenter for a company that specializes in kitchen and bath remodeling projects. We do all our own tile work, for the most part, but on the rare occasions we do sub it out, we'll do all the necessary prep work for the tile installation. Over the years, we've honed our skills installing tile over wood framing and have learned that a long-lasting installation depends on a sturdy and stable base—you can't just wade into a tile job without checking the existing framing and fixing any underlying problems, and then expect great results. With floors, we evaluate the strength of the existing floor system and its anticipated deflection and check it for level; with walls, we have to check whether they are plumb and square and whether the individual studs are in plane with one another. The following is a primer on how we approach prepping for tile in wood structures, focusing mainly on bathrooms.

Floor framing. The housing stock we work on varies in age. Older homes often have sawn joists and shiplapped or plank subflooring that can be underdesigned, out of level, and structurally compromised **(1)**. Newer homes tend to be framed with engineered lumber, such as wood I-joists or trusses, with OSB subflooring. More often than not, though, we're dealing with floor systems framed with 2x10s at 16 inches on-center and 3/4-inch T&G plywood subflooring.

Regardless of age and framing method, we have to verify that the home's floor system can support the tile specced for the project. We're concerned with the strength and stiffness of the floor as well as its deflection (expressed by values such as L/360, L/480, and L/720—see "Tiling Over Plywood Subfloors," Mar/11, for information about uniform vs. concentrated deflection).

Deflection. Ceramic tile smaller than 10 by 10 inches can withstand a moderate amount of deflection, or L/360, where "L" represents the span of the floor joists in inches and a 360-inch span can safely deflect 1 inch (360/360 = 1). Larger format tile, say 12x24, may require L/480, while natural stone tile has even more stringent deflection requirements of L/720 or greater. We consult with both the tile manufacturer for its installation requirements and our in-house design professionals to determine if the existing floor framing can support the tile. On older homes, we often have to sister



Floors out of level by 1 inch or more typically need to be reframed. Here, a new kitchen floor is being framed in an older home; the original floor was 3 inches out of level **(5)**. The author installs blocking between existing floor trusses under a barrier-free shower to prevent flexing of the subfloor **(6, 7)**. He checks the subfloor for level prior to installing a pre-pitched shower pan **(8)**.

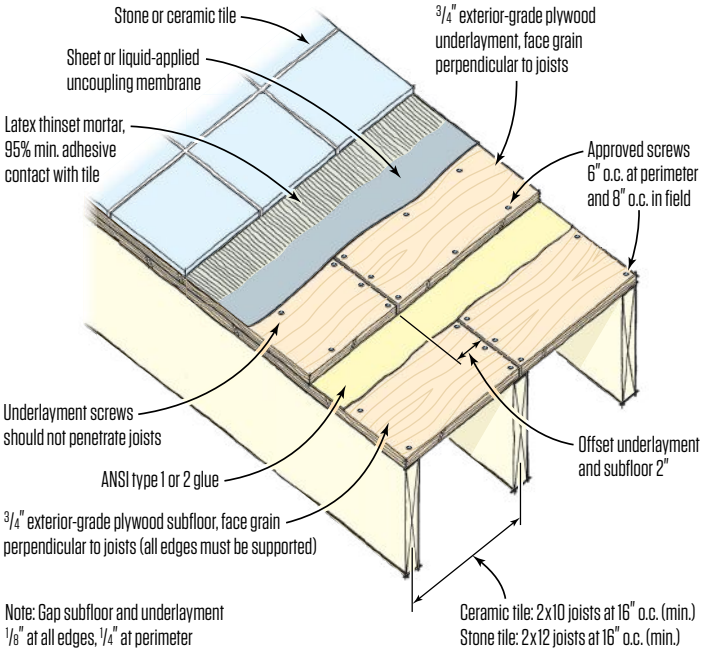
new joists onto existing ones and add midspan blocking to stiffen the floors and meet the deflection requirements.

Leveling. For floors 3/4 inch or less out of level, we apply a liquid-applied self-leveling compound (laticrete.com) to level out the floor **(2–4)**. If a floor is greater than 3/4 inch out of level, we talk to the client about methods to level the floor framing, including reframing the entire floor if it's too far out of whack (it's not unheard of for floors to be as much as 3 inches out of level) **(5)**.

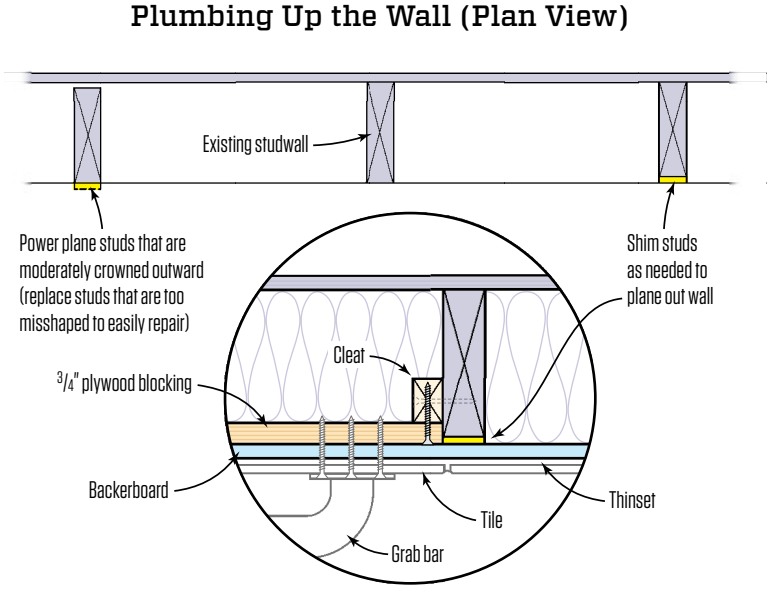
Subfloor. We inspect the existing subflooring to see if it's strong enough to support tile and if there is any water damage; we replace any undersized or rotted subflooring. Typically, we encounter existing 3/4-inch T&G plywood subflooring that has been fastened off with nails. Nails tend to pop over time and cause squeaking, so we enhance the subfloor's fasteners with 1 1/2-inch screws to suck it down to the framing.

We also check the gapping of the existing subfloor sheathing, which should have a 1/8-inch gap at all edges and a 1/4-inch gap around the perimeter to allow for seasonal expansion and contraction. If a seam between two sheets of subflooring was not properly gapped and it's squeaking, we have—as a quasi-last resort—run a circular saw down the problematic seams to create a gap. This has to

Laminated Plywood Setting Bed



The author checks for plane by spanning a 6-foot-long level across an existing studwall, revealing a gap between a stud and the level **(9)**; the stud will be shimmed later. Here, a stud crowned outward is power-planed **(10)**. The author rechecks the wall for plane after installing grab-bar blocking **(11, 12)**. Note: The unfaced batts are in a party wall between town-house units.



Plywood blocking helps lessen compressing of batts in exterior wall cavities and provides a greater area and more flexibility for mounting accessories. Blocking is screwed to cleats ripped from 2-by stock.

be done somewhat surgically, though, to avoid cutting the tongues off the panel edges and compromising the stiffness of the subfloor.

Underlayment. We're typically striving for a 1 1/2-inch-thick wood base—along with an uncoupling membrane—for floor tile. So, we install a second layer of 3/4-inch T&G CDX plywood, or underlayment. We glue the underlayment down with construction adhesive (loctiteproducts.com), gap it, and fasten it off with 1 1/2-inch screws (see illustration, page 8). In addition, we shoot 1 1/4-inch crown staples in a tight spacing in the field to help prevent any squeaks from occurring.

One caveat with regard to installing this second underlayment layer is that in bath remodels, we're frequently asked to install barrier-free showers—they seem to be the norm today as opposed to curbed ones. To accomplish this, we thinset a 3/4-inch-thick pre-pitched shower pan (wedi.net) to the existing subfloor in lieu of 3/4-inch underlayment, then block between the joists under the shower pan to prevent flexing of the subfloor **(6–8)**.

Wall framing. With the underlayment installed, we begin tweaking the existing studwalls. Using a long straightedge, typically a 6-foot level, we span across as

To help with jobsite communication, the design plans are posted on the walls, and the locations of critical items are marked on blocking and studs **(13)**. On a wet wall, a metal protection plate (below the controls) was recessed flush with the face of the framing **(14)**. The floor surface is vacuumed **(15)**, then the uncoupling membrane is thinset to the underlayment **(16)**.

many of the studs as possible to see how they're planing out **(9–11)**. We power-plane individual studs that are crowned outward, shim ones that are sunk back with a strip of lauan or ripped-down 2-by stock, and replace any gnarly 2-bys that are too difficult to repair (see illustration, page 9). If a studwall is significantly out of plumb (some walls can be out of plumb 3/4 inch or more), we'll sister new studs to the existing ones to bring the entire wall to plumb.

For walls that are out of square, we shim out one of the walls to be at a right angle to the other one. It's important that the walls are square, particularly in the shower area where underlying backer-board and shower-pan systems have to join together perfectly. Tile layout and installation can be infinitely more difficult if the walls are not 90 degrees from one another.

Communication. After the initial demolition, we post the plans on the walls for reference not only for us but for our trade partners and clients. We tack up the interior elevation and details specific to each wall and begin to mark the layout on the framing. We mark the fixture layout and blocking locations for grab bars, hand-held shower devices, benches, niches, shelves, and glass shower doors, if applicable. We note items such as what style of vanity we're installing, and if it has a decorative bottom. Again, we're doing this not only for us but to help communicate with trade partners and the homeowners. Some clients have trouble envisioning their project and it helps them to, say, physically stand in the shower and mark where and how high the shower controls and head should be, how high grab bars should be, and so on.

Blocking. Prior to installing blocking, we insulate the wall cavities as necessary for thermal comfort or for sound attenuation. We install a mix of solid and plywood blocking (3/4-inch plywood blocking screwed to cleats ripped down from scrap 2-by stock) **(12, 13)**. The plywood blocking helps lessen compressing of batt insulation in exterior wall cavities, while also providing a greater area for mounting accessories. For example, if a client wants to change the height of a grab bar at the last minute, we've got it covered.

Finishing the rough-in. We flush up any protection plating to the face of framing by chiseling out the framing and resetting the plates **(14)**, then check the floor for fastener heads that are proud of the surface and vacuum the floor area **(15)**. We thinset the uncoupling membrane (schluter.com) to the underlayment per the manufacturer's recommendations **(16)**. If we're not going to tile right away, we protect the floor surface with sheet stock until we're ready to proceed. Finally, we take photographs to document the blocking locations prior to closing up the walls (after the rough-in inspection by our local building official).

Mike Whalen is a project manager at DBS Remodel, a design-build residential remodeling company based in Poughkeepsie, N.Y. Check out Mike's new residential-construction-themed podcast, "Beyond the Belt," on Spotify.

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Q I have heard that 5/4 PVC trim can be bent with "heat blankets," but I do not know the best kind to use. Are there other heat sources that would work, and how do you form the curve once the material is heated?

A *Nathan Nebbia, owner of Built Better by Nate, based in Berwick, Maine, responds:* I do all of my PVC bending with Heatcon heat blankets (heatcon.com). I use the deck forming kit, which works for PVC trim stock and includes blankets wide enough (8 inches) and with enough heat output to also bend solid PVC decking. (Note: They do not work for composite or cap-stock materials.) The blankets are 10 feet long. A kit comes with two blankets, which will work for one 10-foot length, or four blankets that can do up to 20-foot lengths. They are not cheap (currently $2,700 for the 10-foot kit), but I think they are worth the investment.

For the best and quickest results, you should use two blankets—one under the stock and one on top of it. To make an "oven" that fits the blankets and the stock, I build a box with a hinged lid out of solid 2-by stock and screw cement backerboard to the inside surfaces. I have also used two insulation batts, sandwiching the blankets and trim between them, but that method takes longer, as it doesn't hold the heat as well as the box does.

The cheap way to do it—without blankets—is to make a box, put a propane torpedo heater at one end, and blow heat through. This, too, can be made to work, but the heat doesn't disperse as evenly as you want it to for bending an entire length of trim. Also, it's almost guaranteed that you will overheat the end of the trim near the heater, which will make it floppy and can distort the material, while the far end will be stiff. As a result, the trim will be very difficult to handle.

BENDING FORM

When bending trim, you want to slowly heat up the material. Don't crank the controller right to the maximum, especially on more delicate molding. With flat PVC trim stock, I shoot for a temperature of 250°F to 280°F. The tighter the bend, the more tempted I am to max out the temperature, but I never go over 300°F; higher temperatures will result in rippling and distortion. If that does happen to your trim, tugging on the ends of the boards can help straighten some of it out. One way to help prevent distortion is by slowly heating up to around 200°F, then cranking the heat to 280°F for just a short time—no more than five minutes. With a deck board, I always max out the temperature because the "skin" on the board is much more durable than trim stock, but you still don't want to heat it up too fast.

If you are using 5/4 trim stock, you can expect to wait 25 minutes or more for the board to come up to temperature.

I do all the temperature readings with an infrared

For bending PVC trim, the author builds a box from 2-by stock, sized to fit the heat blankets and lined with cement backerboard. It's good to have many hands on deck once the heated trim comes out of the "oven" to transfer the heated trim to the form, which the author screws to the subfloor. Blocks define the curve, but it's important that the form have continuous support front and back to ensure a smooth curve, as the heated trim will conform to the exact contour of the form.

Photos: Nathan Nebbiat

temperature gun. I even drill a hole into the middle of my oven to get accurate readings while the material is heating up inside.

I make a bending form on a convenient area of subfloor on the job that we can keep clean while we're doing the bending. The warm plastic is almost like a liquid, and it will conform to whatever you put it against, so it's important that the form have a continuous edge that follows an even curve. To achieve this, I build a form with two stops, one on the inside and one on the outside. I begin by tracing out my radius and screwing a ripped piece of PVC stock to the subfloor following that radius. Then I measure the width of the trim board I'm bending and add a strong 1/16 inch to it because the trim board will be slightly expanded once it's out of the oven. I then screw another stop along this outer line.

When bending a molding that's nested, like a crown molding, I make sure the back (inside line) of my form is tall enough to support the molding while it's in the nested position. An easy way to do this is to rip 1/2-inch PVC sheet stock down to the height needed and screw it to a bunch of mounting blocks following the curve. It's kind of like one of those wooden snakes you can move around, except you secure the blocks to your work surface.

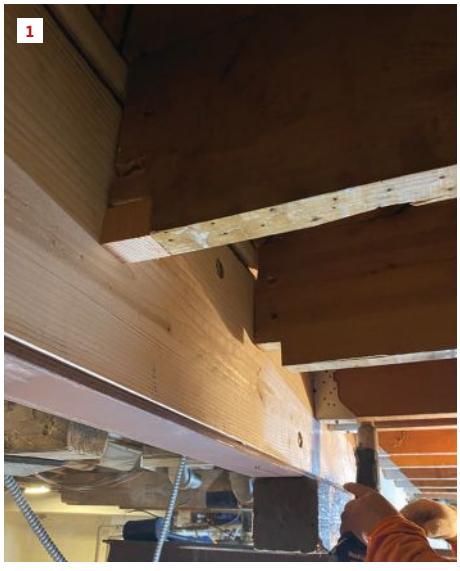
HANDLING HOT TRIM

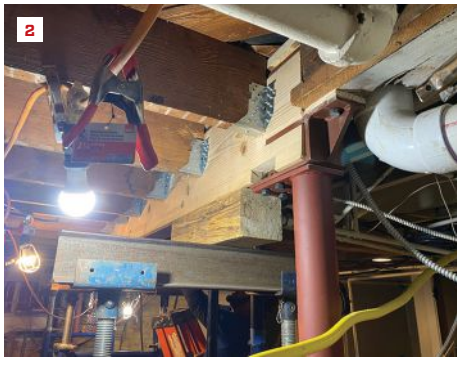
Taking the heated PVC out of the oven is tricky. I've done this many times by myself, but at first, it's best to have helpers. Make sure everything you need for bending is set up so you can pull the PVC out of the oven and set it into the form as quickly as possible. Waste a minute, and it will cool and stiffen up, and you will need to try again. Also make sure to wear gloves, as your hands will be on the hot material for a couple of minutes.

For flat stock, the process is pretty cut and dry once you place it between the form boards. A good tip is to drag the stock into the form instead of trying to pick it up in its wet-noodle state. The same is true for a nested profile, but make sure to hand press the top edges of the profile against the tall back of the form to prevent the trim from rippling.

After two to five minutes in the form, the trim should be good to go. I usually wait the full five minutes so I know I won't get any springback. A good way to be sure is to check that the temperature has fallen below 140°F.

After cooling, the trim retains its curved form (left). For this project, crown molding was used to provide the flared edge common on many homes designed in Dutch Colonial and Tudor Revival styles (right).





The author's crew has installed fitted blocks in joist notches **(1)**. In this case, the joist width allowed for HTU hangers with an elongated heel **(2)**. Plywood can be used to pack out the width of a joist to allow double 2-by hangers **(3)**.

Photos: Jake Lewandowski

Q We are replacing a beam in an old ceiling/floor assembly. Some of the rough-sawn joists are a full 2 inches thick, others 3 inches, and these thicknesses vary plus or minus up to 1/4 inch. In one area, the joist ends are also notched for a ledger board. What would you recommend for hardware, since regular joist hangers won't work?

A *Jake Lewandowski of Great Lakes Builders, a Chicago-based structural repair contractor, responds:* Good question. We have encountered this type of scenario on numerous projects, and there are a number of ways to deal with it. Keep in mind that any solution we come up with, we always run by an engineer first.

A common problem we see is a large, heavy timber girder beam (we refer to this as a "beam line" in our area) with a small, continuous 2x2 board nailed along the side of the beam at the bottom. The joists were notched to sit on top of the 2x2 and the joist ends were toenailed into the timber beam. Regularly, we see the 2x2 missing (torn out somewhere along the way) or rotating and, typically, a horizontal crack right at the notch on the joist.

To correct for this when you are replacing the existing beam, you might consider increasing the width of the new beam. For example, if the plans show a three-ply LVL beam, you could make it four or five plies. Doing this often allows you to reduce the beam depth (explore options with an engineer), and I would consider that if a shallower beam is a benefit. Hopefully, then you would be able to cut the notches out of the joists, which would be ideal.

The easiest (though not my favorite) solution is to add solid blocking between the joists, fastening it to the beam with some sort of structural fasteners. Then you would install joist hangers, using 2 1/2-inch SDS screws for the hangers. You want the fasteners to go through your blocking and into the timber.

My preferred repair is to infill the notch with a fitted block and then install Simpson HTU hangers (made for trusses), which have an elongated heel. Unfortunately, this solution is not always possible due to the increased thickness of the joists.

In cases where I have a full 2-inch joist, I will install the fitted block to infill the notch. Then I will fasten a 1/2-inch plywood block full joist height on each side of the joist to make it a full 3 inches. We can then use a double 2-by hanger. Or we can make it 3 1/2 inches to accept a double LVL hanger. The width of the plywood can vary to accommodate variations in joist width.

If no notch is present, or you're looking to install a flush-mount beam, or you have a ledger connection and your joists are irregular in width, the ideal solution is to have Simpson Strong-Tie bend a hanger to your width specifications. The downside is there are only a handful of hangers that you can select from, and it can take weeks or more to get them. As an alternative, I would look for rough-lumber hangers, which have an "R" at the end of the SCU number for "rough lumber" and are a true 2 inches wide. There's always the single-ply LVL hanger option, as well, which is just over 1 3/4 inches wide. If the available hanger options don't fit exactly, choose one that's wider and pack it out with plywood running the full height of the joist. For example, for a 2 1/4-inch-thick joist, we would use an LUS28-2 (which is 3 inches wide and made for carrying double members at nominal 2-by dimensions) and add a full-joist-height piece of 3/8-inch plywood on both sides of the joist.

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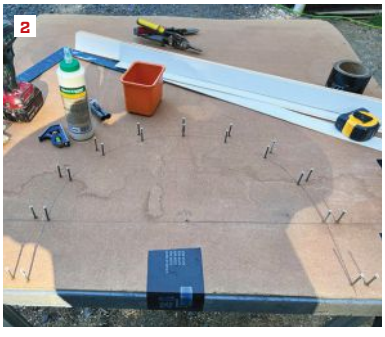
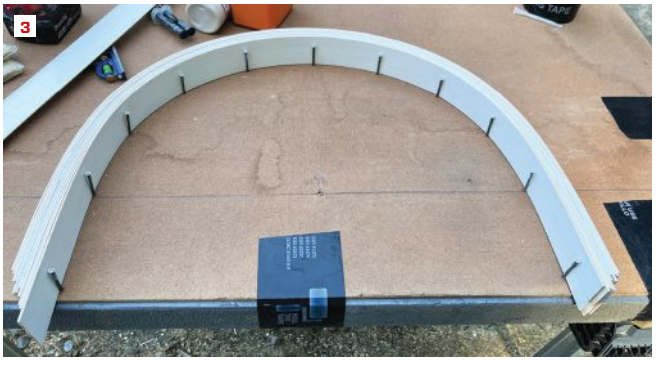
Trimless Return for an Arch-Top Window

BY NATHAN TUTTLE

The homeowners requested a plaster-look interior finish for a pair of small, arch-top windows in their bath remodel **(1)**.





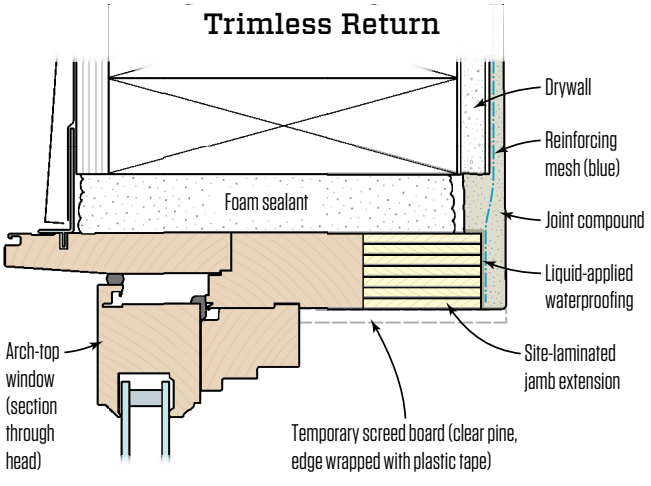
The arched portions of the jamb extensions were made from thin strips of pine bent and glued up in a site-built form **(2, 3)**. The finished assemblies were glued and screwed flush to the window frames **(4)**.

Photos by New Dimension Construction and Tim Healey; illustration by Tim Healey

Last summer, the homeowners of a project we were trying to wrap up made a request for a "simple, plaster look" on a pair of small, arch-top windows in their newly renovated second-story bathroom **(1)**. We had built a number of arch-top windows (and interior doors) on their remodel and finished them off with either wood trim or tile returns. But the request for plaster returns proved to be a bit of a head scratcher—how were we going to make the transition from the drywall to the window without trim?

We briefly considered installing corner bead, but the windows had a tight radius that would have entailed making many cuts with snips to form the bead to the arch. Also, there would be some buildup of metal along the edge that could affect the bonding of the mud. Instead, we decided to install fiberglass reinforcing mesh around the window opening and key the joint compound into the mesh, similar to old-school lath-and-plaster work (see illustration, below).

Site-built jamb extensions, comprising three straight runs (for the jambs and sill) and a site-laminated arched top, were needed bridge the gap between the window frames and the face of the drywall. To fabricate the arch tops, we marked the inside and outside radii of the new extensions on a piece of sheet stock, then set a series of finish screws along the lines **(2)**. We cut pieces of clear pine stock to the jamb depths, then ripped them into thin strips on a table saw. (When we demoed the walls, we found one of the exterior



walls was framed with 2x6s and the other with 2x4s, which necessitated two different jamb depths.) We glued up the ripped strips and bent them along the radius lines; the finish screws held the laminations in place. We ran the strips long **(3)** and later cut them along the arch's spring line. After gluing and screwing the four pieces of the extension jamb together, we glued and screwed the final assemblies through the front edge of the extension jams and into the window frames **(4)**.

A "lath-and-plaster" solution. Prior to mudding the windows, we installed temporary screed boards made from ripped-down clear pine run about a 1/4 inch proud of the extension jambs. We wrapped the outer edge of the screed boards with plastic tape to act for easy release after the drywall mud cured **(5)**. We then brushed on Hydro Ban waterproofing membrane (laticrete.com) to the face of the extension jambs to prevent moisture from the joint compound from being sucked into the wood, possibly cracking the compound. Next, we tacked a large piece of fiberglass reinforcing mesh over the openings with stainless steel T-50 staples and cut out the window opening **(6)**.

For the first coat, we used Durabond-90 joint compound (usg.com). We pushed the mud through the mesh about 1/2 inch thick at the gap between the jamb and the drywall, and ran it up to the screed board about 1/8 inch. Durabond is a setting-type mud, and we used the 90 version to give us more time to work the material **(7)**. Next, we applied USG Plus 3 pre-mixed joint compound—in three coats—using an oversized, 14-inch drywall knife (marshalltown.com) to float the material from the screed boards out to the edges about 2 feet. Blending and floating the edges is easier with USG Plus 3.

After the joint compound cured, we removed the temporary screed and used a fine, 220-grit sanding mesh to break the edge of our "plaster" corner. The painters primed and painted the window return, and it blended in nicely **(8)**.

I recently ran into the homeowner, and she said the trimless returns have held up, and she's happy with the look.

Nathan Tuttle is a project completion specialist at New Dimension Construction in Millbrook, N.Y.

A temporary screed board (its edges wrapped with plastic tape for easier release) was run 1/4 inch proud of the jamb extensions **(5)**. To avoid overlapping seams and the potential for cracking, a single piece of mesh was installed, cut to the opening, and set in liquid-applied Hydro Ban waterproofing **(6)**.

The first coat was done with Durabond-90 joint compound. At the gap between the jamb and the drywall, the author pushed Durabond through the mesh about 1/2 inch to key it in **(7)**. Three coats of USG Plus 3 joint compound were used to blend and float the edges out. The completed trimless return **(8)**.

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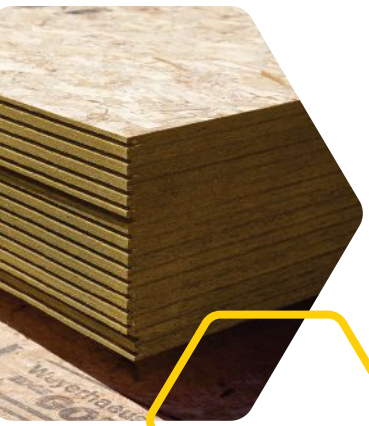

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Indexing Jigs for Repetitious Carpentry Tasks

BY BRIAN CAMPBELL

A number of carpentry jobs require repeating a series of precision moves. Building anything with louvers and making a wooden grid for a screen or floor register are examples that I have run into frequently in my carpentry career. These tasks can be quite painstaking in part because of all the repetitious steps, and in part because those steps require great precision. If you're off by just a small fraction of an inch, you're sunk; anyone's eye can easily pick out off-parallel louvers or a slight variation in a closely spaced wooden grid.

With this type of work, I avoid doing a separate layout before making my cuts and instead build a jig that allows me to accurately position a router or saw at precise, repeatable increments. This not only saves the time of laying out each cut but also reduces the chances for introducing and compounding errors.

Louvered gable-end vent. In my first example, I'll describe the process I use for making louvered gable-end vents **(1–5)**. In this case, we were matching an existing vent on the main house with one on a new addition, so an off-the-shelf vent product wasn't going to work. For the triangular vent frame, we used 5/4 Windsor One Protected boards—the same material we were using for fascia and corner boards on the addition. A gable-end vent is usually fairly well protected by the rake overhang and doesn't see a lot of weather. In addition, it ventilates (obviously), so it will dry if it does get wet. But I still want to use a durable material for long-term performance.

To make the vent, I started by setting up a worktable made of standard pegboard, which has a grid of holes on 1-inch centers. Two layers of pegboard with the holes aligned provide enough support for accurately and securely positioning 1/4-inch or 6mm shelf pins. I made a jig out of the same Windsor One material that would bridge across the triangular vent. I aligned this frame for the first mortise location, and carefully squared it to the pegboard and pinned it down with an 18-gauge nailer. With two shelf pins on the bottom surface of the jig, I could position it on the pegboard and advance it at even increments for each mortise I needed to cut in the frame to hold the louvers.

The top surface of the jig was constructed of two layers of beveled siding (the same material we were using to side the addition). The thick part of the beveled material faced toward the bottom of the vent, which angled the router so that the mortises would slant down from back to front, letting the louvers drain to the outside. Only the top layer of the beveled surface needs to be continuous;

Photos by Brian Campbell

The author builds a jig that bridges across the top of a frame for a gable-end vent. Shelf pins in the jig register in the holes on the pegboard work surface **(1)**. The top of the jig is made from two layers of beveled siding that position a plunge router at an angle **(2)**. By running the router along a slot in the jig, he cuts angled mortises across all three members of the frame **(3)**.

on the bottom, I used short scraps. (If you want a steeper angle, you could cut wedges to insert beneath the top layer, but be aware that the length of the mortising bit is a limiting factor on how deep the mortise can be.)

I cut a slot in the top surface of the siding near the short point of the bevel, and by running a plunge router with a straight mortising bit down the slot, I was able to cut angled mortises in each of the three pieces of the vent frame—in a single run across the frame for each louver.

I made tick marks along the slot to indicate the beginning and end of each mortise run, which got shorter in length as I advanced up the triangular frame. I could have also drawn a line on the angled sides of the vent to indicate the stop and start points for each mortise line. The ends of the mortises don't have to be super-precise because they are on the back of the frame and will never be visible. What is critical are the depth and width of the mortises, which need to hold the louvers securely at the same angle and at the same distance from each other so they are parallel and evenly spaced.

I cut my mortises about 7/8 inch deep, which left a full 1/4 inch from the bottom of the mortise to the front face of the 1 1/16-inch-thick frame (the mortise is angled, so the remainder is a little thicker than it would be for a straight mortise). I ripped the louvers to width afterward, so they were flush with the back of the frame. This allowed us to staple bug screen over the back before installing the vent, to reduce the number of hornets and other insects taking up residency in the attic.

One important point when using pegboard: I mark an "X" next to each hole I use to keep track of where I am on the pegboard surface as I move the jig across it. It's easy to get cross-eyed looking at all those holes and be unsure of which ones you've used. By being methodical and making those tick marks to map my progress after each pass, I saved myself from mis-cutting a mortise at an uneven distance—the sort of mistake that typically happens near the end of a job to make the heartbreak even greater.

Once the frame and jig were made, cutting the mortises took only about 15 minutes. So the actual work was incredibly fast, but the set-up time is relatively long. That sort of job pacing is something you need to get used to with jobs like this.

Rectangular units. We did a similar job—making reproduction fixed-louver shutters—that was also covered in *JLC* (see "Replacement Shutters Made Simpler," May/11). As with the vent

After routing the mortises, the author ripped louvers so they are flush to the back **(4)**, providing a flat surface to which bug screen can be attached. A steeper mortise angle and wider louvers would provide more weather protection, but in this case the finished vent **(5)** would be installed under a wide rake overhang, which offered enough protection from the elements.

The author uses a table-saw sled **(6)** with a cleat fixed to the plywood that's the same width as the dado. The cleat is placed at the distance between successive dado cuts (in this case about 4 inches for an adjustable shelf system). He used a similar sled to cut the cross laps for a wooden HVAC floor register **(7)** and for a Craftsman-style wall screen **(8)**.

described above, we used an indexing jig. This one, however, took about three hours to set up and calibrate. And the shutter job was different in that all the mortises—all 500 of them, which we were able to complete in one afternoon once we finished building the jig—were identical, because we were building rectangular units with louvers that were all the same length.

In that case, we set the shelf pins at the ends of each shutter stile and moved the workpieces (the shutter stiles) while keeping the router at a fixed angle, and we used blocks to stop the router at each end of the short mortises. In contrast, for the gable-end vent, moving the router over a fixed workpiece and using a full pegboard surface was better suited to adjusting the length of each mortise run.

Self-indexing jigs. A variation on the process of using indexing pins that register to a pegboard surface (like we used for the gable-end vent) or to a series of reference holes (like we did with the replacement shutters) makes use of "self-indexing"—a method that indexes each new cut off one of the cuts you made previously. A simple version is a table-saw sled with a self-indexing cleat **(6)**. Using a dado blade on the saw, you can cut one shelf mortise across a side panel, then lift the workpiece up, slide it over, lock it down onto the cleat, and make your next pass. I used this sled for cutting tool storage units that had dadoes in the side panels spaced every 4 inches. This allowed me to adjust the position of the shelves to fit a wide variety of toolboxes.

I used a similar sled with a self-indexing cleat for cutting the many cross laps in both the "joists" (long members) and "purlins" (shorter cross members) of a heat register that sat flush in a hardwood floor **(7)**. I would use a similar process to make the grid for a Craftsman-style screen like the one shown at left **(8)**. For this type of work, I line up the members and cut each row of cross laps in one pass. It takes a little longer to align the pieces and shim them to fit tightly in the sled, but it ensures that each run is cut in a perfectly straight line.

Brian Campbell is a finish carpenter in the Twin Cities of Minn.

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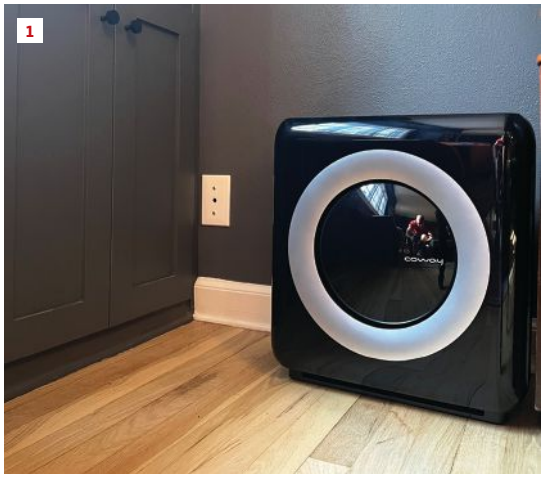

Photos by Travis Brundgardt

Whole-House HEPA Filtration

Awareness of how important air quality is to human health has grown in our industry, as well as in society at large. The COVID-19 virus invigorated sales of household air cleaners, and the abbreviation IAQ became as ubiquitous in conversations as NFL, ROI, and, for builders, CYA. Innovations like the Comparetto Cube (five filters and a box fan) and the Corsi-Rosenthal box (just four filters) were offset in the marketplace by opportunists putting a computer fan behind a filter media in a sleek housing and offering it for sale online. While some of those devices did offer some benefit, many of the air cleaners dropped off on front porches by masked Amazon drivers were boxes of "snake oil" with little hope of providing improved health outcomes for their owners, as referenced in articles by Allison Bailes and others trying to save consumers from a bad purchase.

In terms of function, air cleaners are simple machines and typically have just two key elements: a fan and a filter. Like a miniature forced-air furnace without any heating (or cooling), they simply pull air into a housing and push it back out through a filter to capture some level of particulate—nothing more. The level of filtration varies by unit but like any range hood or bath fan, these small units can filter the air in a localized area only. The limitation on the volume they clean or "scrub" is a function of their size (filter surface area with fan strength) and location (the air they can access).

The typical interior of a home allows for communication of air from one room to the next through hallways and under and around closed doors, and from one floor to another. But despite these pathways, most existing homes have relatively little air circulation without the use of central air handlers and distribution ductwork. As a result, these tiny, localized air scrubbers have limited reach, and unlike with a Corsi-Rosenthal Box, which has a larger filter surface area and decent airflow, you need multiple units to handle multiple rooms.

In theory, you could set the fan in an existing, centrally ducted air handler to run continuously to circulate air to these individual filtered locations. But in recent years, we've shifted away from recommending continuous operation of the air handler, as this can lead to high humidity, especially in tighter, better insulated homes, which call for less cooling and therefore less dehumidification of the constantly circulated air. Also, hoping that the air circulated to these spaces will efficiently find its way to these air scrubbers for cleaning and redistribution throughout the house is too optimistic. Eventually, the air should in theory find the filter, but the volume of air flowing through the filter devices is fixed, and many units don't separate their supply and return by more than a few inches, so they may scrub the same air over and over without cleaning the dirtier air that can't get in the mix.

A wide variety of small filter fans **(1–3)** have inundated the consumer market. Most of these have too small a filter area and too little airflow to effectively clean indoor air except in small, localized areas of a home.

The Fantech Hero HS300 **(4, 5)** offers "3 stage filtration," which includes a carbon prefilter that reportedly captures 90% of particles between 3 to 10 microns, as well as a HEPA filter to capture 99.97% of particles .3 microns and larger. As an alternative to being integrated with an existing air handler (see images on facing page), the unit can be installed as a stand-alone unit in an attic or basement with 8-inch supply and return ducts to serve the main living space.

Rather than rely on small, room-by-room, plug-in units, we favor installing a whole-house HEPA filtration system, specifically the Fantech Hero HS300 appliance. Fantech boasts "3 stage filtration," citing a prefilter with carbon capturing 90% of particles between 3 and 10 microns and a HEPA filter to capture 99.97% of particles .3 microns and larger. This unit has two speed settings—220 and 300 cfm—and though it operates independently from the air handler, it uses the existing ductwork system to access the entire volume of the household air for constant filtration. It's an insulated box with an inlet at the top, a prefilter with carbon, then the fan, the HEPA filter, and outlet at the bottom. For us, the insulation is primarily for sound control since the unit isn't heating or cooling the air, though it also would allow for installation in an unconditioned space.

The Hero requires a 120-volt receptacle but draws only 1.23 amps under constant 300-cfm operation, so it doesn't need a dedicated circuit. In conversations with Fantech, I was told it can effectively treat spaces up to 3,000 square feet in a matter of hours, but that obviously would depend on the ductwork design and other factors in the home.

INSTALLATION OPTIONS

There are two methods for installing a Hero with forced-air duct systems, and we've used them both, for different mechanical room sizes. The fast and simple way involves cutting two rectangular openings on the side of the vertical return duct before it turns and enters the air handler. The back of the Hero has two corresponding ports, the top inlet and the bottom outlet, which have heavy-gauge-metal tabs that fold out and wrap into the rectangular openings you cut—pretty elementary metal work that requires only a pair of good snips, gloves, and, if you're fancy, a nice set of hand seamers to dress up and reinforce the openings. Gasket material is provided for sealing the back of the unit to the ductwork, and the folded metal is backed up with screws to secure the installation. Fantech recommends this installation method along with having the fan on the air handler set to run continuously to maximize filtration and to eliminate the possibility of the air short cycling. We find this approach works great for small mechanical rooms that can't accommodate the additional ductwork required for our preferred installation method, which provides more separation between intake and discharge.

When an existing air handler is used, the simplest way to mount the Fantech HS300 is on the side of the vertical return duct before it turns and enters the air handler **(6)**. Alternatively, knockouts in the filter's housing allow the unit to be mounted farther from the air handler using 8-inch flexible ducts **(7)**. This not only gets it out of the way but also helps limit sound transfer.

This second, preferred method makes use of a couple of 8-inch round knockouts—one at the top and one at the bottom of the unit—to connect the Hero to the return via collars and ductwork. This gives us flexibility to locate the unit farther from the air handler and potentially more out of the way, as well as limiting sound transfer from the already very quiet fan. By pulling the 8-inch inlet farther up the return trunk and discharging the filtered air through a separate 8-inch line into the return just before it enters the air handler, we believe we are eliminating any potential for short cycling even if the occupant turns off the continuous operation setting on the air-handler fan. There's little discernible noise from the Hero's fan thanks to the robust gaskets and heavy rubber insulation on the filter and fan access door, but the inside of the unit obviously is open to the air duct, so the low-level sound from the fan does travel into the ducts and communicate throughout the house. Locating the appliance remotely rather than hanging it from the return duct prevents the sound vibration from transferring into the duct, and installing flex duct from the Hero further reduces the sound.

In addition to the methods above that use the existing ductwork and air handler, a "stand alone system" option in the Fantech instructions allows the unit to be mounted in a basement or attic with dedicated 8-inch supply and return ducts to serve localized areas.

If mounted in an attic, the unit must run continuously to prevent condensation in the ductwork at temperatures below freezing. Reportedly maintenance free and "permanently lubricated," the motors are guaranteed for seven years, and the remaining components for five years. Recommendations are to change the prefilter every three to six months and the HEPA filter every two to five years. We typically leave homeowners with a replacement prefilter on install and suggest they order new replacements for both filters when they need to install the prefilter we supplied. Available for about $450 online, these Fantech HS300 Hero whole-house HEPA filtration units are more expensive than a Corsi-Rosenthal box but much quieter and far more aesthetically pleasing. I believe that with the integration with the ductwork in our clients' homes, they are an extremely effective solution to filtration, and we're making them as standard in our homes as ERVs and dedicated dehumidifiers.

Travis Brungardt, co-owner of Catalyst Construction, builds high-performance homes in and around Kansas City, Mo.

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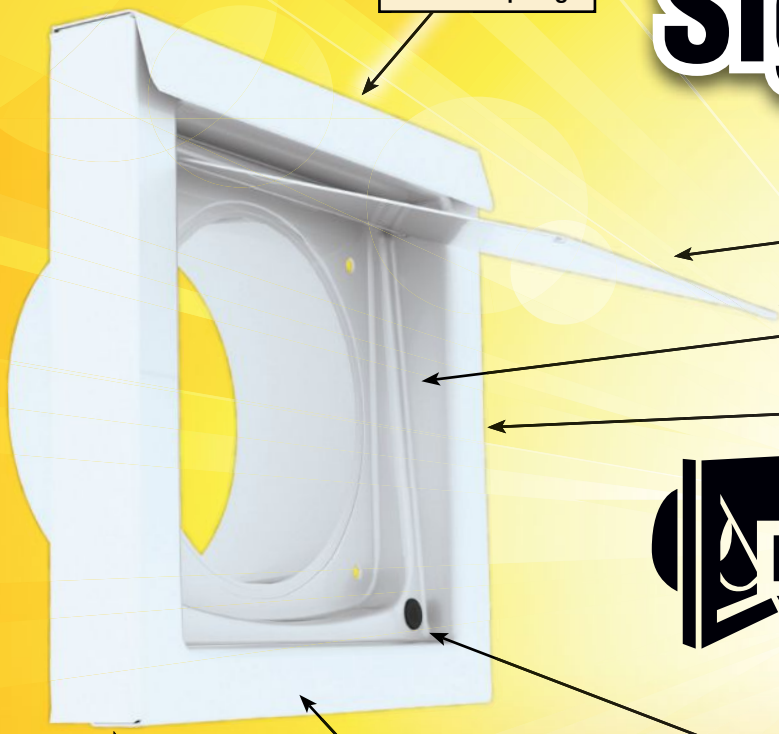
Sight To See



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Photos by Doug Cameron

Outsmarting Air From the Outside

A prescriptive path to simplifying a building's control layers

BY DOUG CAMERON

Over the last eight years, I have gradually changed my approach to detailing the control layers of building enclosures. I'm using Building Science Corp.'s terminology for the essential layers in a wall assembly that control, or limit, the movement of air, water, vapor, and thermal energy through a building enclosure. All are needed in the order given, with air being the first in order of importance and where I typically focus my attention. While the four different layers are helpful for understanding how an effective building enclosure performs, they are somewhat abstract ideas when it comes to putting the enclosure together. You don't have four separate layers that stack up neatly in a building assembly. Often, the air barrier functions as the water barrier. The air barrier and the thermal control layer—insulation—have to align (be installed adjacent to each other). Vapor control is its own animal; latex paint (a Class III vapor retarder) is usually enough in most climate zones provided that all the impermeable and permeable insulations used in a wall are installed in the right proportion.

There's a lot of "fine print" that gets confusing fast and that makes it hard to train crew members and subcontractors. In my experience, it's always better when the people doing the work understand why they are doing it. When they don't, the risk for errors increases. The approach I have come up with is all about simplifying how we build our wall and roof assemblies to address air, water,

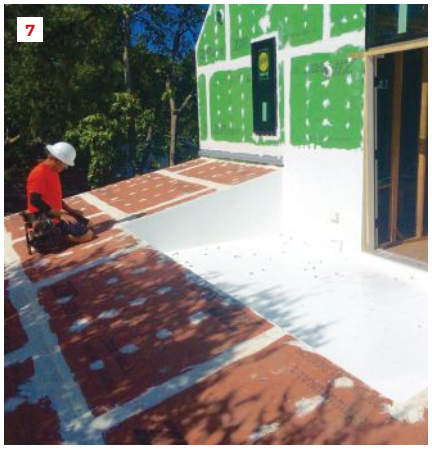
Exterior restoration. The author's first experience with using a fluid-applied barrier was the restoration of a 1950s home in central Austin **(1–5)**. The building's diagonal sheathing had minimal isolated water damage, so restoring it rather than replacing it was prudent. The experience opened the author's awareness of the versatility of a fluid-applied barrier.

and thermal control in one "layer," with the vast majority of the detailing done from the outside. My goal, of course, is outstanding building performance. But I also want to educate people about how to build a very efficient home in a simple fashion. Successful building, I think, is not just about great building performance; it also must done in a way that can be easily taught and reproduced.

EVOLUTION OF OUR ENCLOSURE

My journey started in late 2010 when I moved to the Onion Creek neighborhood in Austin, Texas. We moved there right after one flash flood, and about a year later, a second one hit the area. Our home was not in the flood zone, but many of our neighbors were devastated by water that rose up 4 to 5 feet on the first-story walls. I helped repair some of these homes and quickly became interested in finding a more flood-resilient wall system. We focused on the lower part of the wall, and this meant doing things like raising electrical boxes and flipping exterior doors to swing outward so water pressure wouldn't force the door open. And to address the resiliency of the walls, I started to look closely at fluid-applied membranes.

At that time, the only place you could find people doing fluid-applied barriers was on commercial work. I found information online about Prosoco's hurricane tests, which helped me work out some of the flood repair details, and I reached out to the local rep. And shortly afterward, I started going to meetings of the local American Institute of Architects chapter and met a DuPont rep, who trained our team on DuPont's commercial applications for fluid-applied barriers. Our first complete exterior job using the DuPont product was on the remodel of a 1950s home in central Austin. This house had diagonal shiplap sheathing, some of which had rotted near the porches where there had been a lot of splash back, but for the most part, it was in excellent condition. I brought fluid-applied to the



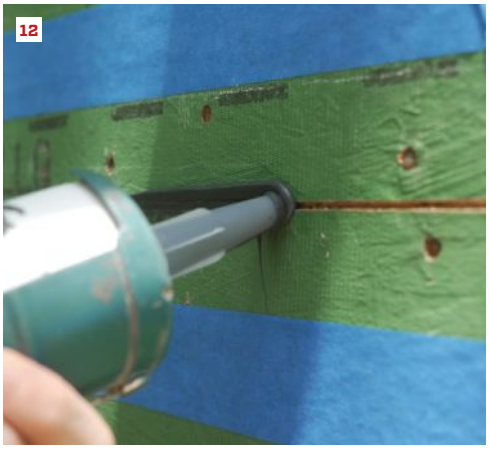
Block and caulk. On a new build, the author used DuPont's fluid-applied barrier in concert with Zip System sheathing **(6–8)**. Zip System was new to the author at the time, and he had more confidence in "finger painting" with fluid-applied than sealing panel seams with tape. It was on this and another, simultaneous new home that "block and caulk" was born **(9, 10)**.

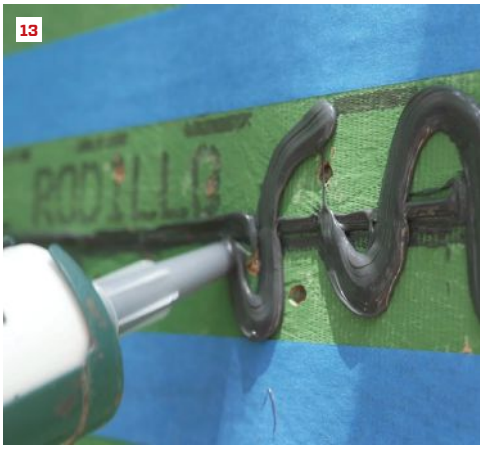
table during the planning phase because it allowed us to restore rather than replace the existing sheeting. The result, shown in the photos on the opposite page, was encouraging, and we felt fluid-applied membranes were an option we could use for exterior weatherproofing on other projects.

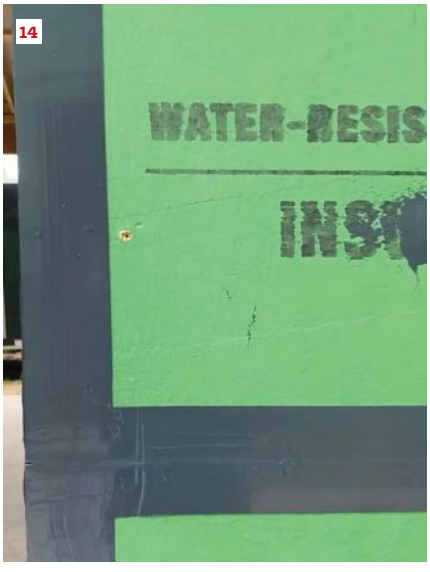
Shortly after this, we had two new builds in downtown Austin on which we were going to use Zip System sheathing for the first time. I liked the idea of a panel that combined the sheathing and water-resistive barrier (WRB), but I was skeptical about the tape. This was early on, and we didn't yet understand how well the acrylic-adhesive tape would work. Because fluid-applied was so new and so few retailers stocked it, we went through a wholesaler and with its discount, we could use fluid-applied to seal the Zip System seams for about the same price as the tape. I also felt we had better control with "finger painting" with fluid-applied than with an unknown tape. By this time, Huber had come out with its own fluid-applied product but only in sausage tubes, not in 5-gallon buckets. The company seemed to be marketing it mostly as a solution for door and window rough openings and framing transitions but wasn't geared up for the heavy applications that we wanted to do.

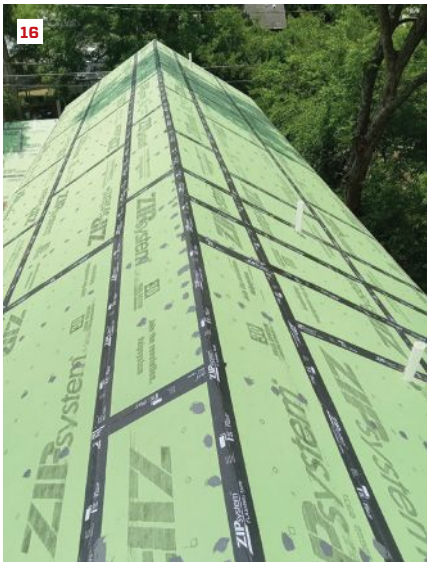
BLOCK AND CAULK

One of those first builds, shown in the photos above, was a job with some young architects. I had misgivings about some of the details, such as an enclosed outside roof deck. But if anything was going to work in this area, it would be a fluid-applied membrane. We included fluid-applied on all the seams and also hit all the nail holes. On walls, there is no driving force to push water through the holes from overdriven nails. But we started sealing all the nails because we could—we were right there with a material that we could dab on, the scaffolding was in place, and we felt maybe it would ensure an even tighter enclosure.





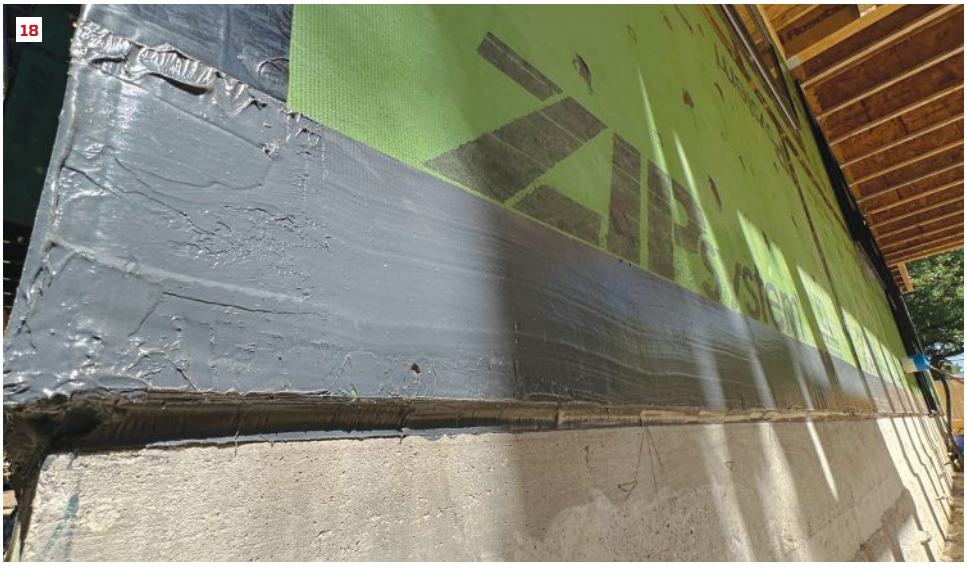




Panel seams. To seal the seams between sheathing panels, the author's crew starts by outlining them with 2-inch-wide painter's tape **(11)**. A first pass **(12)** fills in the joint, and the next zig-zag pass **(13)** applies enough sealant to lay down a thick bed when it's smoothed out **(14)**. To help take the cost out of the system, the author does now use Zip System tape on the wide expanse of the walls **(15)** and roof **(16)**. For these seams, rolling is critical to activate the pressure-sensitive tape adhesive.

The concept we employed goes way beyond just sealing seams and nail holes, though. We referred to our process as "block and caulk." To stop air, we focused on blocking all the air pathways through framing materials with the fluid-applied barrier. This included sealing not only the sheathing but also all the connections at the perimeter of the sheathed areas and making sure the sheathing plane extended up between rafters or cantilevers or behind any porch roofs or bump-outs. When we're working with our crews, we use a balloon analogy: We say the outside of the house is like a big balloon. We don't want any holes in it. If the crew thinks that way, we have a much higher chance of success. The analogy concentrates on air, but if we solve for that from the outside, we are solving for water, too.

And it worked incredibly well. When we tested those first couple of projects with a blower door, they both came in at .7 and .8 ACH50 at framing. We had all the mechanicals in place and the windows installed, but it was essentially just the frame—no insulation, roofing, or finishes. This convinced us that the process was well worth doing, and it had a simple elegance that made it easily understood by all involved.



Foundation-to-wall seal. At the base of the wall, the author's crew uses painter's tape to establish a clean line at the top and the bottom **(17)**. The tape makes it look nice, but it also allows the installer to apply a thick bed of sealant that is free of pinholes—a detail that trying to feather the edge to a chalk line won't effectively achieve **(18)**.

KEY DETAILS

Here are some of the key details that have we have developed over the last 10 years that give us confidence in making everything work from the outside:

Panel seams. In our initial ventures into sealing panels with fluid-applied, we used a fiberglass mesh tape, as specified by DuPont. Many manufacturers, Huber included, are reportedly adding microfibers to their formulations, so this is no longer necessary, but mesh was integral to our seam detail on our first projects (see photo, page 29). As with any product, but especially with chemical adhesives, it's important to follow each manufacturer's specifications to understand not only the sequencing but also the compatibility with the chemicals in other materials, such as the WRB facing on the panels, any flashing tape, or membranes that are part of the enclosure.

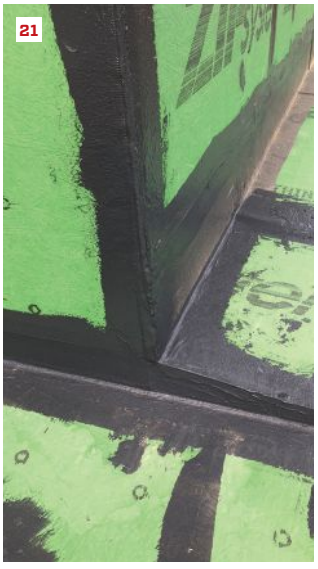
In our current process, we apply wide painter's tape to both sides of the panel seam, as shown in the photos on the opposite page. We take a first pass pumping the fluid into the joint followed by a zigzag pass between the two pieces of tape and then smooth it all out with a plastic paddle. Using the tape, of course, gives us a nice, clean line, but it also allows us to lay down a consistent bed of material that we feel confident is free of holes.

Foundation-to-wall seal. One place we especially liked the fluid-applied was at the intersection of the wall and the foundation. All the silyl-terminated polyether fluid-applied products bond well to a wide variety of materials, and because they are moisture curing, they aren't bothered by any moisture in the concrete.

I still have people telling me you shouldn't seal the bottom of the wall sheathing, but just seal under the sill, so water can drain out. A lot of people think the entire wall assembly is like a window, and you have to let water that might get into the wall escape. This is an example of how people get confused with concepts like "drainable assemblies." To set the record straight: Operable windows with moving parts have lots of pathways for water to get into the window assembly. The frames are designed so this water drains down to the bottom, and it needs a path out. That's why we need some sort of drainable sill (though maybe not a pan; more on that soon) and we don't seal the bottom flange.

Walls are not the same. Water will get behind the cladding, so you want some sort of drainable cladding assembly, preferably a vented rainscreen. And some water may get in the wall, typically condensation, but hopefully it's not a lot and the enclosure is dryable so this moisture can dissipate. You don't need to make the structure behind the sheathing drainable. But you do need to make it airtight. We felt that sealing the bottom of the sheathing to the edge of the slab with a fluid-applied flashing material was the most robust and long-lasting approach. An awesome painter who had worked with me for quite a while worked out a nice way to detail for this using painter's tape.

The advantage of using painter's tape is that we can load the joint with enough fluid that we are getting a good seal. If you use a chalk line, you are apt to brush it on lightly to make it look good but not necessarily to get a great air seal. The answer for some folks is to add a couple of beads of caulk under (and sometimes also over) the sill seal, in "belt-and-suspenders" fashion. We realize a little savings using painter's tape instead of the framers' applying another type of sealant before lifting their walls (plus eliminate the agony



Roof-to-wall seal. For an effective air seal around rafters, the crew cuts the sheathing to fit around the rafters, and the joint between the sheathing and the rafter tails is carefully filled with fluid-applied **(19)**. Similarly, the spaces between outlookers on the rake ends **(20)** and any roof transitions **(21)** are filled with a bed of fluid-applied sealant.

of stepping in it when they do so). Sometimes "belt and suspenders" is just not worth it. The durability of a thick layer of fluid-applied is suitably forgiving.

Roof-to-wall seal. Before we started doing block-and-caulk, the junction of the wall to the roof was our weakest link. We were mostly solving this with spray foam, but I felt terrible using it. My company name at the time was EcoSafe Spaces, and we were leaning on this product with a high GWP (global warming potential) that off-gassed terribly during the installation. It didn't look good to have guys wearing moon suits during the build. And when we added the fire-resistant coating in an enclosed attic, the noxious fumes lingered for years. None of this was helpful for marketing to sensitive clients. I'm not saying that spray foam doesn't have its place, but I felt there must be a better way to detail the air barrier at the roofline.

At the rake, we use outlookers that tie back to rafters or trusses so we have a strong uplift connection. Similarly at the eaves, we project rafters past the sheathing plane. Many of the houses we work on have cantilevers, too. We need a system that can accommodate these sorts of structural details. Just hanging fake rafter tails and bump-outs on the exterior skin is not going to do it, especially with the frequent wind loads we get in Texas.

Using the block-and-caulk method at the roofline certainly takes extra time and close attention to detail. But we feel we have dialed it in to the point that our framers now feel comfortable doing it. That's a major victory for us.

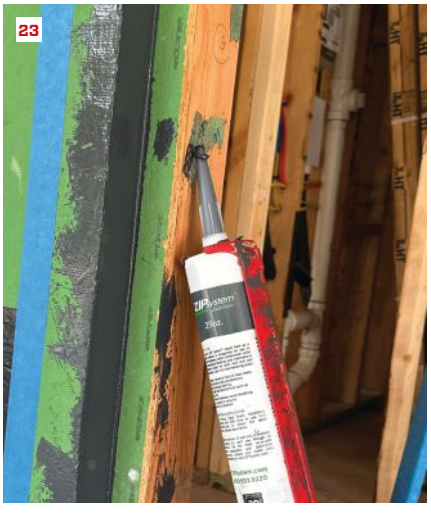
Windows and doors. On our projects, the windows are often one of the most expensive materials we use. A $150,000 window and door package is not atypical, so we don't mess around and don't take chances. We lean heavily on the distributor, starting with having a rep come out to verify every single window rough opening before delivery. We want the rough opening to be 3/4 inch greater than the window unit in both directions, leaving a 3/8-inch gap on all sides. We also make sure that all the framing sills are sloped about 1/2 inch from back to front to help with drainage. Then we coat the entire sill and jambs on all sides with the fluid-applied barrier and lap it onto the face of the sheathing 2 inches on all sides. This creates a gasket that seems to suck the flange on. We need to add 1/16-inch shims to push the bottom flange out slightly to make sure water can drain out the bottom. Once the unit is fastened in place, we apply another layer of fluid-applied over the face of the flange.

Most of the window manufacturers insist on bedding the flange at the head and the two sides (but never the bottom flange) in sealant, as well. I don't think this is needed with our fluid-applied gasket, but to satisfy this requirement, we will just use a bead of the same fluid-applied under the flanges, too. This makes it easy.

As Christine Williamson has said, "The metal sill pan is dead." I, too, see no reason to have a piece of metal to conduct heat through the enclosure just to collect water at the base of windows and doors when a fluid-applied sill will do the same thing. Some folks have balked at the possibility of tearing the rubbery, cured fluid-applied layer, but I have not had that trouble. We set our doors on plastic horseshoe shims, which helps to hold them off. We have also applied a layer of play sand into the wet fluid when we feel that site traffic across the opening might jeopardize the water-holding integrity of the installed material.


22

Windows. Sealing window openings starts with a sloped sill on the rough opening **(22)**. A first pass with fluid-applied fills in nail holes and the joint between the sheathing and framing **(23)**. This is followed by a zig-zag pass, which is smoothed into a continuous bed **(24)** covering all the surfaces of the rough opening **(25)**. The fluid-applied laps onto the face of the wall to create a "gasket" into which the window flanges are fastened. The author installs horseshoe shims to create a drainage gap along the bottom flange **(26)**. Once the flanges are screwed on, a layer of fluid-applied is applied on top of them **(27)**.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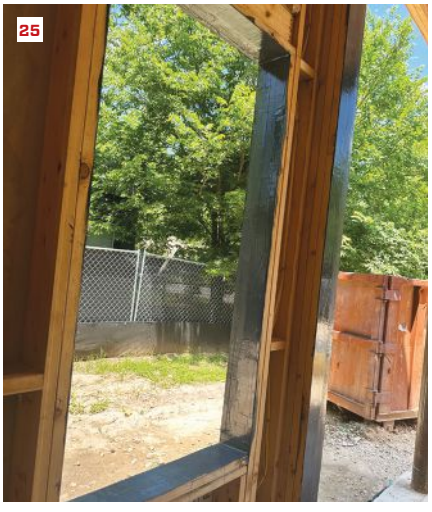
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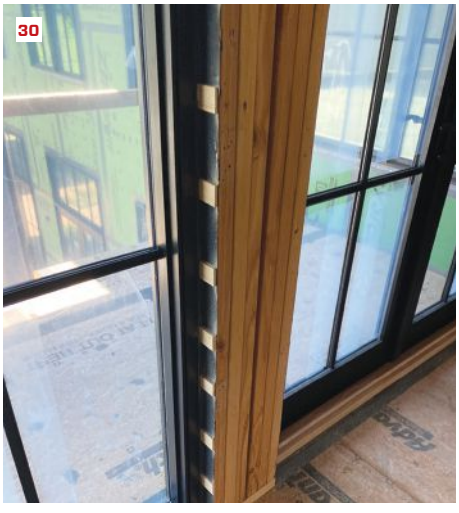


Doors. Instead of using metal pans, the author creates sill pans using fluid-applied **(28)**. Note: Seams in the porch deck are also sealed with fluid-applied. Doors are installed on horseshoe shims in a bed created by lines of fluid-applied that are spaced wide enough apart so there are channels between the smushed-out beads to allow water to drain **(29)**. The spaces between shims **(30)** are filled with backer rod **(31, 32)**. After the shims are cut back, the window is protected by painter's tape **(33)**, and a bead of fluid-applied completes the inside air seal **(34)**.

Penetrations. For any penetration through the exterior, the author's goal is to limit its size. When the author was off site, electricians installed the wrong type of exterior outlet **(35)**. The author corrected this by removing the box, patching in the sheathing **(36)** and using a surface-mounted metal box so only the wire, not the entire box, needed to be sealed **(37)**.

The last step at the openings is to air-seal them from the inside. We push foam backer rod all the way to the back of the cavity and fill the spaces between the shims with more backer rod. This is an inexpensive material, and I feel it not only adds a little insulation but also provides some stability to the last layer of backer rod at the inside surface that holds the sealant. This inside seal we do with more fluid-applied, so we preserve the consistency of materials and we don't have to worry about compatibility or shrinkage. Best of all, we avoid the mess of canned foam.

THERMAL CONTROL

While our block-and-caulk method solves for air and water control, we have not yet solved for thermal.

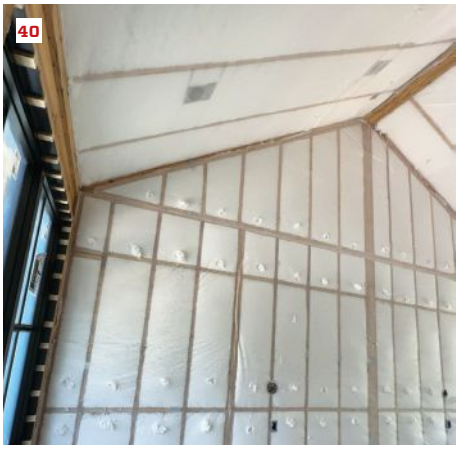
The roof and wall cavities are easy. To get away from spray foam, we prefer using HempWool, Rockwool, or a formaldehyde-free fiberglass blown-in-batt system. When it's a budget-driven decision, fiberglass usually wins. I like being able to blow this in before drywall, so we know we have thermal continuity. If we need more R-value in attic areas than we would normally get by filling the framing cavities, we have had good luck drooping the netting and filling up the resulting "bag" at each rafter bay, as shown in photo 41 on the next page.

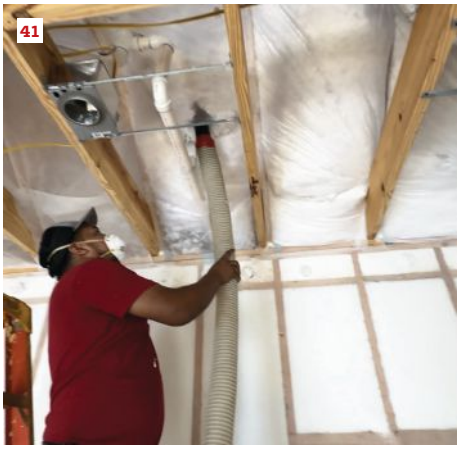
To address thermal bridging, we typically use 1-inch Zip-R panels, which have 1/2-inch (R-3) polyisocyanurate foam adhered to an OSB sheathing panel. At first, I was concerned with vapor control in our roof assembly. My concern was put to rest when I had the good fortune to talk with Joe Lstiburek at a conference, asking him if he felt we should be using vapor diffusion ports. (For more on these, see "Avoiding Wet Roofs," by Peter Yost; Jun/18 and Jul/18). He told me that 1/2 inch of foam is enough in our climate zone (3A); the 1-inch Zip-R panels with 1/2-inch rigid foam would provide enough thermal resistance to mitigate any temperature differential great enough to create a dew point on the underside of the sheathing inside the roof assembly.

Vapor control. If we were in a colder climate, it would be critical for us to use more than 1/2 inch of an impermeable foam when the cavities in the walls and roof are insulated with a permeable insulation like cellulose or fiberglass. To get the proportion right, follow the guidance in Chapter 7 of the IRC, which specifies the proportion of continuous insulation to cavity insulation required to limit condensation when only a Class III vapor retarder such as latex paint will be used on the interior. If you don't follow this guidance, there is a chance that the surface temperature on the back of the wall sheathing can drop below the dew point and condensation can form inside the framing cavities. (For more on following the IRC Chapter 7 guidance on condensation control, see "Avoiding Wet Walls," May/17.)

While 1/2 inch of foam was enough for our hot, humid climate, Lstiburek told me that one would ideally seal the seams from below. In theory, you could have some moisture vapor migrate up between the panels and condense on cooler OSB surfaces near the exterior. But while that's possible in theory, he said there was a very low risk if the seams are well sealed from the top so there is no air movement. Without air movement, the only driver of water vapor through those seams would be diffusion (evaporation). Diffusion is a function of area, so we'd be concerned only with the vapor at the surface directly below the seams. That wouldn't be a concern unless there was a pool or greenhouse in the enclosure; an ordinary house is unlikely to have enough indoor moisture to create sufficient condensation at the panel seams.

Compressive strength. Huber has yet to market Zip-R for roof applications, so it's not a manufacturer-warranted installation. I went through my engineer, who did his own compression testing with Zip-R on the roof. He was satisfied with what we needed for





Thermal control is achieved using 1-inch (R-3) Zip-R sheathing on the walls **(38)** and roof **(39)** to limit thermal bridging. (Note: In colder climates, thicker foam would be needed for continuous insulation.) The author fills the cavities with blown-in fiberglass **(40)**. In attic areas, he drapes the netting to create a "bag" that can be filled with more insulation than the depth of the framing would otherwise allow **(41)**.

roof loads. Please keep in mind this will also vary by region. We don't have significant snow loads, and in locations where you do have these loads, you are going to need more foam to satisfy the Chapter 7 requirements of the IRC. You would have to evaluate for yourself if the compressive strength of the Zip-R is sufficient.

AN ONGOING EVOLUTION

I love that we have simplified the process of building an airtight, watertight building enclosure that can all be done from the outside. The only part we must do inside is the air seal around the windows and doors. But here we are using the same fluid-applied barrier we use on the outside, so there's very little complexity to this step.

The key to making this work is keeping the material choices simple and getting buy-in from all the installers. They know how it works and can apply themselves with attention to detail without getting lost in the concepts and the origami and the sequencing of a wide variety of materials.

I'm not saying this is an inexpensive process. But we have worked at taking some of the cost out of it. We have gotten comfortable with the performance of Zip System tape, which is more cost-effective to use in the large expanse of roofs and walls than a fluid-applied barrier. The tape has an incredibly tenacious bond provided it gets rolled. The rolling activates the pressure-sensitive acrylic adhesive; without that, the tape can bubble and peel. It's also important to apply the tape straight and without folds or fish-mouths at the edges. This is especially true on a roof, where little folds can create funnels in the surface of the tape that can become leaks.

Another detail we have to address: We run the tape about an inch long where it intersects with the fluid-applied at the wall base and openings and at the roofline, and here we need to wipe the tape down with acetone, alcohol, or vinegar to remove the residue from the backing tape. Every added material adds its own complexity but as long as our team knows these details, it's manageable. It's when you get a lot of different materials, each with its own set of rules, and many diverging sequences moving from outside to inside the enclosure that things get too complicated and you run the risk of losing control.

Doug Cameron owns Render ATX, a design-build firm in Austin, Texas.

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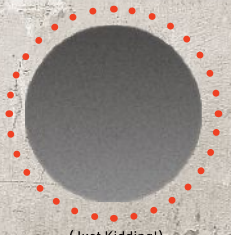

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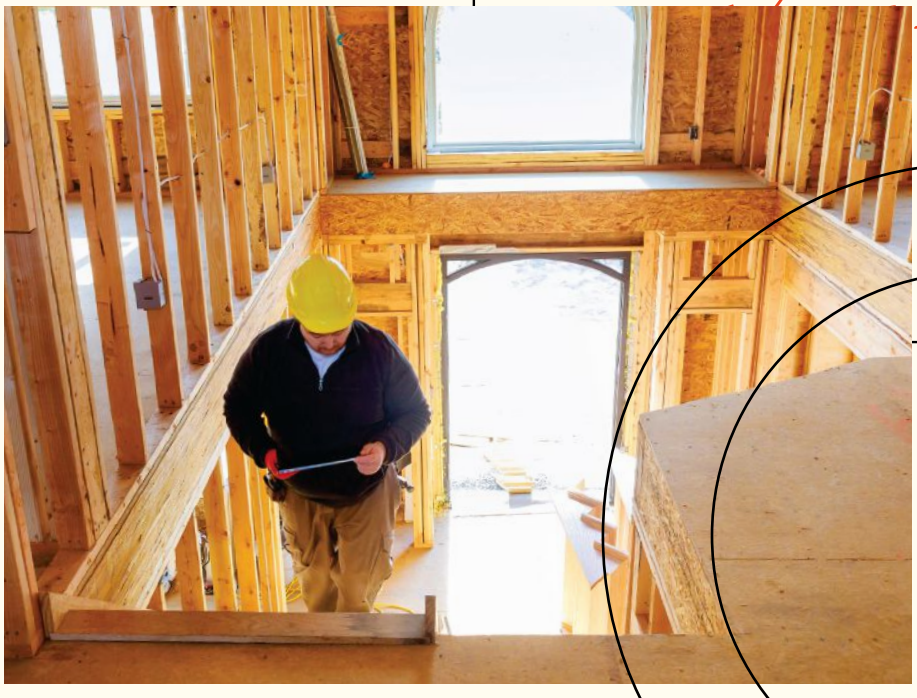

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Deck Ledgers and Cantilevered Floor Trusses

by Adam Barthel and Frank Woeste

The International Residential Code, the American Wood Council's DCA-6 *Prescriptive Residential Wood Deck Construction Guide*, and other standard industry publications all do not permit or recommend the attachment of a deck ledger to any cantilevered floor system, be it solid-sawn, I-joist, or floor trusses. But we still see examples of just this practice, sometimes following guidance from I-joist and floor-truss manufacturers. In this article, we will explain some of the technical obstacles facing a homeowner and deck contractor when considering the addition of a deck to a new or existing home with a floor system built with open-web floor trusses, with a particular focus on the structural problems that arise when attempting to fasten a deck ledger to cantilevered trusses.

Background

To ensure that decks are positively anchored to the primary structure for vertical loads, the IRC spells out how these loads are to be transferred to the primary structure by use of a band board, or rim joist. Section R507.9.1.2 in the 2021 IRC clarifies the point by stating that the band joist shall bear fully on the primary structure, as in providing wood-to-wood bearing, capable of supporting all the required loads.

However, when floor trusses are installed, a band joist is not present; instead, a nonstructural ribbon board is typically attached to the top of the floor trusses. This presents a problem for deck builders because the 2x4 ribbon board is not structurally adequate for a deck ledger attachment. Both the Structural Building Components Association and the AWC (in DCA-6, Figure 13B) specifically indicate that the 2x4 ribbon board is not intended for deck attachment (**Figure 1**).

Cantilevered Trusses

The SBCA's research report SRR-1408-01, "Attachment of Residential Deck Ledger to Metal Plate Connected Wood Truss Systems," provides solutions for deck ledger connections to floor trusses (see editor's sidebar, "Truss Industry Ledger Details," page 4). The fastener schedules in SRR-1408-01 are based on the essential assumption that the floor trusses are supported by "wood-to-wood bearing" at the location of the deck ledger attachment. SRR-1408-01 does not provide recommendations for cantilevers.

Of course, one pathway for a homebuilder to accomplish a safe deck ledger connection to a cantilevered floor system is to pursue an engineered solution based on the IRC's "Alternative materials, design, and methods of construction" provisions. Recently, we explored options for connecting a deck ledger to cantilevered floor trusses by reviewing related wood truss design resources, and proprietary fastener and connector literature.

Structural considerations. In a typical cantilever truss detail, 2x4 ribbon boards are nailed across the ends of the trusses at the top and bottom, with short verticals called "ribbon blocks" sometimes attached to the ends of the trusses and ribbon boards with 1x3 or $1^1/2$x3 plates (**Figure 2**, "Floor Truss Cantilever," page 6). To help visualize a plated cantilever floor truss,

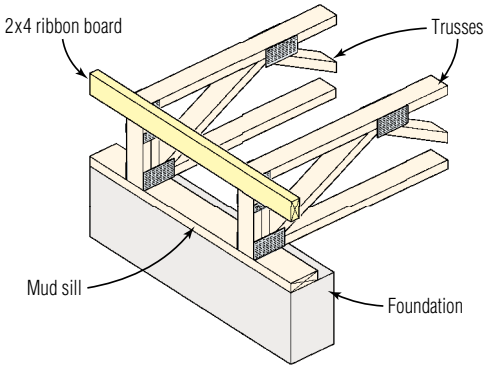
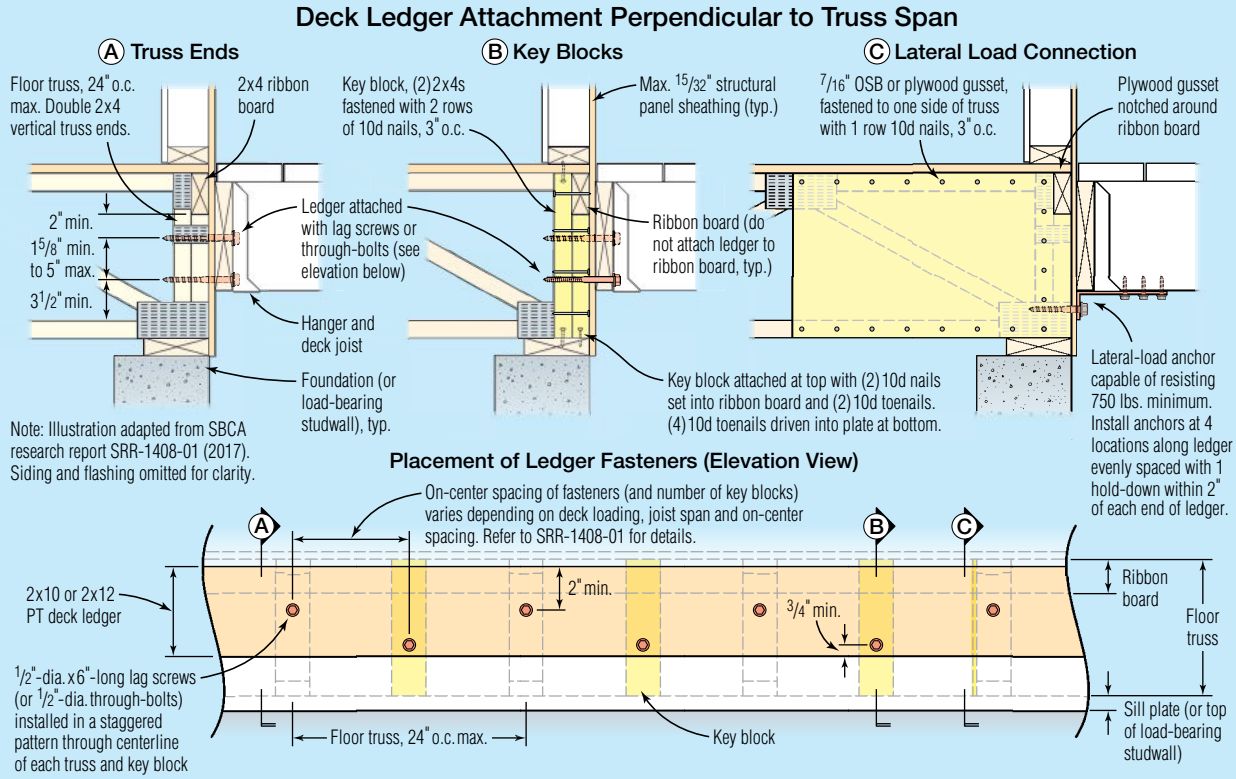


Figure 1. In a typical floor system framed with truss joists, a nonstructural ribbon board is attached to the top of the floor trusses. This 2x4 ribbon board is not intended for a deck ledger attachment.



Truss Industry Ledger Details

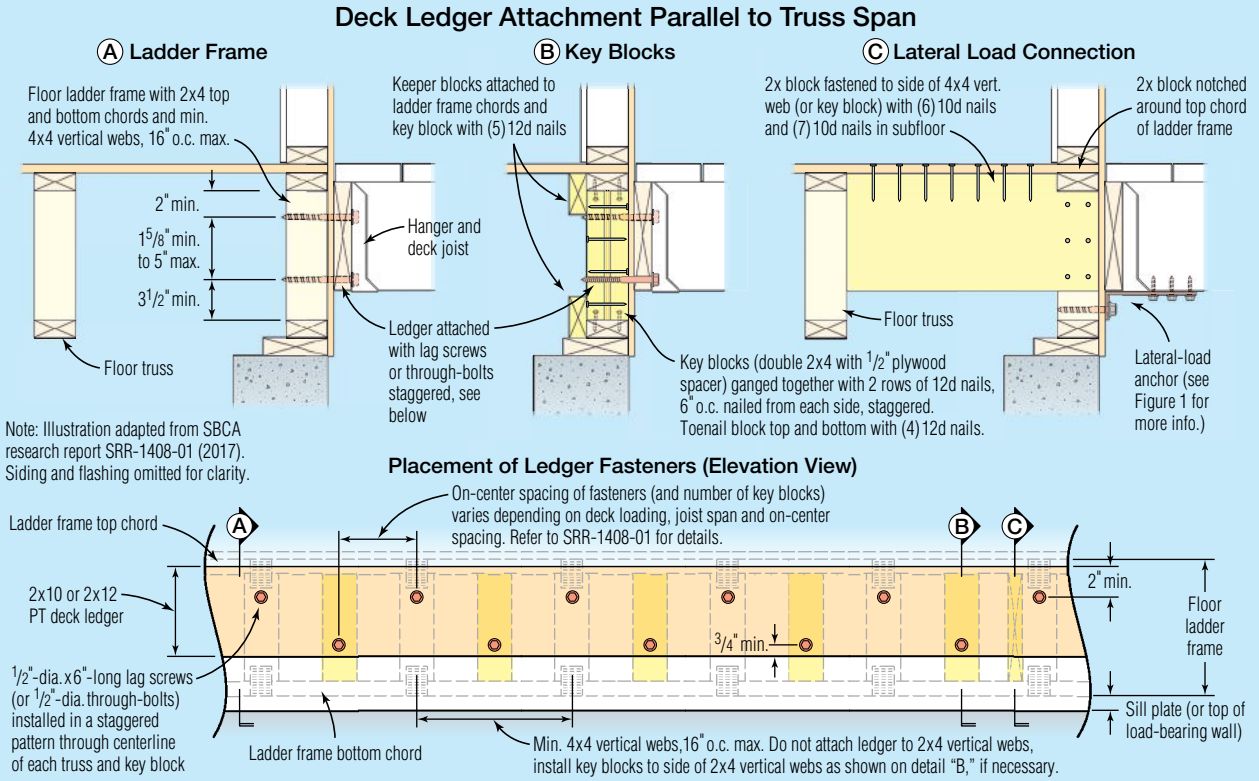
Solutions for deck ledger connections to floor trusses using several blocking details that provide a wood-to-wood-bearing load path for deck design loads to a wall or sill plate can be found in the Structural Building Components Association research report SRR-1408-01, "Attachment of Residential Deck Ledger to Metal Plate Connected Wood Truss Systems" (sbcindustry.com/deck-ledger-attachment). Included in this report are details for fastening the deck ledger when the floor trusses are both parallel to and perpendicular to the deck joists, as shown here.

Important additions to the report (but not included here) are tables based on different loads and ledger-to-truss connection details that provide the required spacing of 1/2-inch-diameter lag screws or bolts based on deck span. The fastener schedules given in SRR-1408-01 are based on the essential assumption that the floor trusses are supported by "wood-to-wood bearing" at the location of deck ledger attachment.

we referred to a detail published by Mitek in 2011 that shows the cantilever supporting a load-bearing wall. Note, however, that the detail does not indicate the vertical 2x4 ribbon block is a suitable connection point for supporting a deck ledger.

Assuming a deck contractor attached a deck ledger to 2x4 ribbon blocks, the vertical load capacity of the deck ledger connection would be limited by the strength of a structural connection composed of four elements—deck ledger, sheathing, ribbon block, and plated end vertical. Connecting a deck and ledger to this detail creates a unique design challenge. When a deck ledger is spaced 2 inches from a truss end vertical that is connected to both the top and bottom chords, what are the allowable design values for 1/2-inch bolts, 1/2-inch lag screws, or 1/4-inch structural screws?

Mind the gap. Fastener schedules and spacing requirements for connecting deck ledgers to fully supported solid-sawn band joists have been available in the IRC since Table R502.2.2.1 was included in the 2009 version. The tabulated values were based on laboratory load tests of deck ledger–band joist connections made with a 1/2-inch-diameter bolt or 1/2-inch-by-



A free-standing deck design—which eliminates the need for a deck ledger—is always a viable option that can be used with all types of floor systems. Free-standing decks must also be able to resist lateral loads, either by diagonal bracing provided between the support posts and the deck frame both side to side and front to back, or by specially engineered hardware used at the post-to-beam connections (or both). Another option is to anchor the deck frame to the primary structure with lateral load connectors; SRR-1408-01 includes lateral load connection details for deck ledgers fastened to open-web truss floor systems.

Note that these are not prescriptive details approved by any building code. When a builder uses the SBCA deck connection document, the construction comes under the code as an IRC R301.1.3 "Alternative materials, design, and methods of construction provisions" subject to the approval of the building official, who could say, "Yes, the detail looks like it's OK, but you still need a P.E. to sign off on it." —*Andrew Wormer,* PDB *editor*

4-inch lag screws (see "Load-Tested Deck Ledger Connections," Mar/04). In this study, researchers tested only two simulated connection configurations for the space between a deck ledger and house band that was fully supported on steel. In one, the space between the ledger and house band was occupied by a piece of 15/32-inch OSB and it did not bear on the steel test bed. For the other case, the space between the ledger and house band was occupied by a 1/2-inch-thick stack of washers and 15/32-inch OSB. These details matter, as testing showed that the amount of space between connected members impacts both the strength and deflection behavior of the assembly.

For connection analysis purposes, the short vertical, or "ribbon block," and wood sheathing would act as a spacer in the connection of a deck ledger to the top chord and bottom chord metal-plated end vertical. As this would be the critical link in the load path to wood-to-wood bearing on a wall and ultimately to the foundation, we reviewed the 2021 IRC Table R507.9.1.3 (1) "Deck Ledger Connection to Band Joist" under the 40-psf-live-load column to determine if the tabulated maximum spacing of bolts or lag screws would apply to connecting a deck

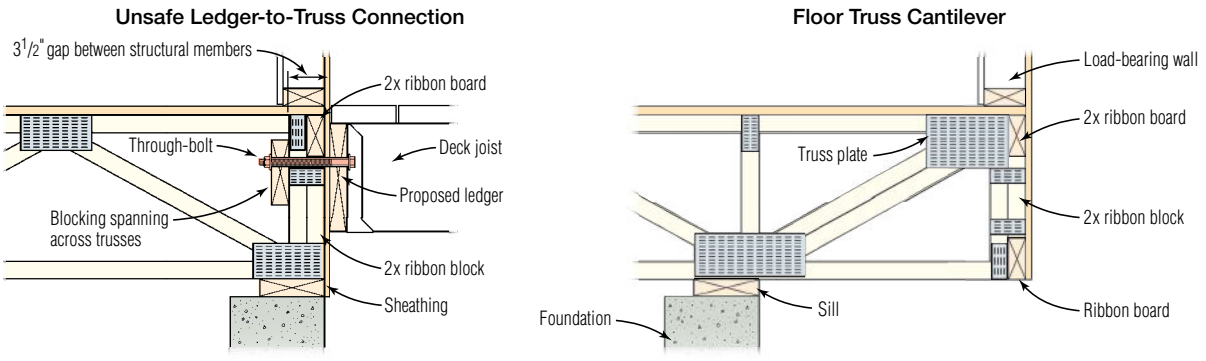


Figure 2. Above at left is a problematic bolted deck-ledger-to-floor-truss connection. Note that the bolts anchoring the proposed deck ledger to the floor system must span a 3 1/2-inch-wide gap between the blocking spanning the truss ends and the inside face of the wall sheathing, a precarious and improper connection detail with unknown capacity to support occupant live loads. Above right is a cantilevered truss designed to support a load-bearing wall but not a deck ledger. The vertical 2x4 ribbon block is not a suitable connection point, with the vertical load capacity limited by the strength of a structural connection between the deck ledger, sheathing, ribbon block, and plated end vertical. Engineering is required for a proper structural connection between a deck ledger and truss floor system.

ledger to the end verticals of the trusses through the 2x4 ribbon blocks. This table contains values only for connections that are separated by no more than 1/2 inch or 1 inch, while the members are spaced 2 inches apart in the ledger connection detail described above, and, therefore, the tabulated data do not apply. We are not aware of published test data for a 1/2-inch-diameter bolt or lag-screw connection between a horizontal member (ledger) and 2x4 member (end vertical) separated by 2 inches.

High-strength 1/4-inch-diameter structural screws that have been tested and rated for a 2-inch spacer between the ledger and plated truss end vertical could be a design option to transfer ledger loads to the plated end verticals. For the ledger connection depicted in "Floor Truss Cantilever," above right, the minimum screw size would be 1/4-inch diameter by 5 inches. Simpson Strong-Tie publishes lateral design values for a deck ledger connection that has solid bearing on a wall and the space between members is limited to 1/2 inch, not the 3 1/2-inch space for the connection shown in "Unsafe Ledger to Truss Connection," above left, or for a cantilever truss detail, as shown on the right.

FastenMaster also publishes lateral design values for its LedgerLok 1/4-inch-diameter structural screws, limiting the spacing members to 1 inch. Again, we are not aware of any manufacturers of 1/4-inch-diameter high-strength screws that have published lateral (shear) design values for deck ledger applications wherein the members are separated by 2 inches.

Recommendations. Absent published fastener design values for a "deck ledger to sheathing to ribbon block to end vertical" connection, our recommendation is that builders and deck contractors should not pursue an engineered ledger connection for a truss cantilever with ribbon block. Alternatively, a fastener or connector manufacturer may be able to develop a tested ledger-to-truss-cantilever connection system with installation instructions for use by builders, deck contractors, and building code officials.

In addition, since the cantilevered-truss-to-ledger connection deflects in service based on deck, floor, wall loads, and potentially roof loads, special consideration would need to be given to water or moisture details that will accommodate the likely cantilever deflection and rotation of the truss end vertical.

Since the integrity of the deck ledger connection is a life-safety issue, we recommend that any requisite engineering design work for consideration by the jurisdiction (under IRC R301.1.3) include:

· Specification of the proper deck-related live, dead, and lateral loads to the end vertical of the cantilevered trusses.

· Connection designs.

· Flashing design details.

· Copies of truss design drawings of the affected trusses for documentation by the jurisdiction, homebuilder, and homeowner.

At least for floor-truss cantilevers, coordination between the professional engineer and the truss manufacturer would be critically important. Differences in truss details are subtle, and some truss end details will better accommodate an engineered deck ledger connection than others. ❖

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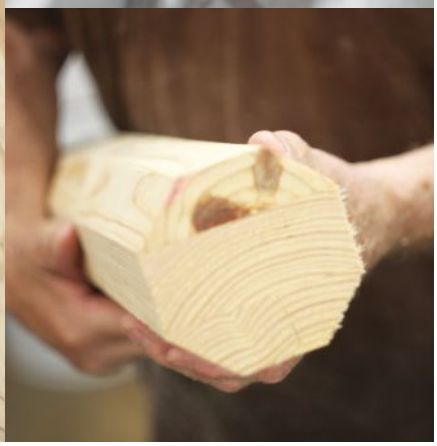

Framing an Octagonal Roof

A gazebo needs a roof. Here's a step-by-step guide for building it.

by John Carroll

With its long tradition as a garden structure, a free-standing gazebo makes a fine addition to an outdoor living space. There's no rule that says that a gazebo has to have eight sides, but octagons are eye-pleasing shapes that are relatively straightforward to frame.

In a previous article ("Framing Square Basics: Octagon Layout," Nov/Dec/22), I demonstrated how to use a framing square and dividers to lay out octagons measuring less than 67 inches wide. For larger octagons—a gazebo or a turret, for example—knowing that the length of one-half of one of the sides can be determined by multiplying the octagon's width by .2071 and that all of the angles are 45° or its complement simplifies the layout. Following the example in that article, the sides of a 12-foot-wide octagon will measure (.2071 x 12 feet) x 2 = 59 5/8 inches.

Framing the roof for an octagonal structure is a little more complex. If you ever have to build an octagonal roof, I recommend that you start by fabricating an octagonal ridge block or, perhaps, an eight-sided king post that extends down to the floor or to a beam at ceiling height. The first eight rafters, which are common rafters, will bear on the eight flat sides on the ridge block or king post. To avoid an awkward cut on the next eight rafters, which will be hip rafters, it's imperative to make the flat sides the same width as the rafter material.

Ridge Block

If you're using 2-by material for the rafters, you'll need to make the octagonal ridge 3 5/8 inches wide. I arrived at that dimension for the width of the octagon by drawing a full-sized octagon 10 inches wide using my framing square. Next, I drew in the eight converging rafters, making them the full thickness of the rafter stock and centering them on each side. By connecting the points where the rafters in the drawing converge, I could see the size of the ridge I'd need, which is 3 5/8 inches (**Figure 1**).

PHOTOS BY MATTHEW NAVEY; ILLUSTRATIONS BY TIM HEALEY

As noted above, the length of one of the sides of a 1-inch-wide octagon is .4142 inch (that's double the .2071-inch dimension used to lay out octagons). So, the math would look like this:

$$\frac{1}{.4142} = \frac{x}{1.5}$$

$$.4142x = \frac{1.5}{1}$$

$$x = \frac{1.5}{.4142} = 3.621, \text{ or } 3\,5/8$$

If you're using 2-by lumber for rafters, then, make the octagonal ridge block 3 5/8 inches wide. If you're using thicker timbers, make a drawing or use algebra to determine the proper size of the ridge block.

Laying Out the Frame

If you have the space, making a full-sized drawing of the frame in plan view is the simplest way to find the key dimensions for laying out the ridge and rafters of an octagonal roof. The floor of the gazebo, for example, might be used for this purpose. If you don't have that space, you can also calculate the dimensions needed using simple math and a bit of geometry. In this section, I'll show both approaches as I explain how to lay out the roof frame for a 12-foot-wide gazebo.

The material for the rafters of this hypothetical gazebo will be 2x8s, all bearing on a 3 5/8-inch-wide ridge block. The plan is to have the bottoms of the rafters meet the inside edge of the beams (or top plates). The desired roof pitch is 6-in-12.

Step one: Determine the height of the ridge block and the measuring length of the eight common rafters. With the exception of the thickness of the ridge, the technique described here is exactly like the one I described in the second article in my *JLC* "Framing Square Basics" series ("Rafter Layout," May/22).

The eight common rafters extend from the layout marked at the center of each beam to the flats on the octagonal ridge. If you've drawn the beams, the rafters, and the ridge full-sized on the floor, you can simply measure the distance from the inside of a beam to the flat face of the ridge along one of the rafters to find the critical dimension you'll need.

If you don't have a full-sized drawing, you can calculate that distance. After measuring the distance between the inside faces of the beams, subtract the thickness of the ridge, then divide the remainder by 2 (**Figure 2**). The result in this case, 66 11/16 (66.6875) inches, is the dimension needed to calculate the height of the ridge block and the distance between

Determine Size of Ridge Block

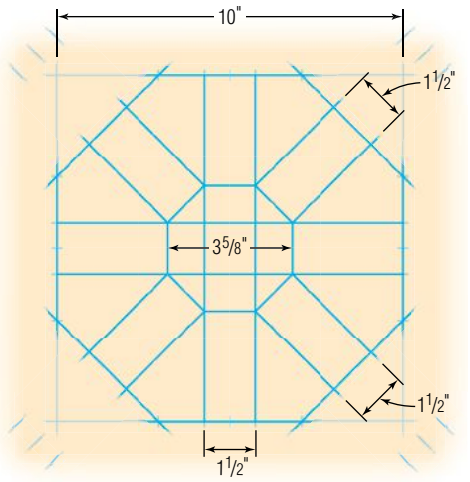

Figure 1. Start by drawing a full-sized octagon 10 inches wide using a framing square. Then draw eight converging rafters sized to match the thickness of the rafter stock and centered on each side. Connecting the points where the rafters in the drawing converge determines the size of the ridge block, which in this example is 3 5/8 inches wide.

Find Base of Measuring Triangle for the Commons

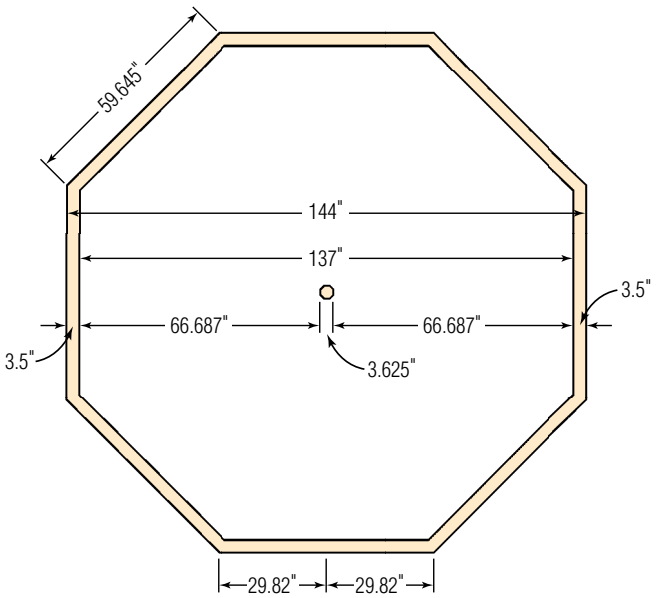

Figure 2. Find the base of the measuring triangle for the common rafters by measuring the distance between the inside faces of the beams (137 inches). Then, subtract the thickness of the 3 5/8-inch-wide ridge block, and divide the remainder (133 3/8 inches) by 2, which comes to 66 11/16, or 66.6875, inches.

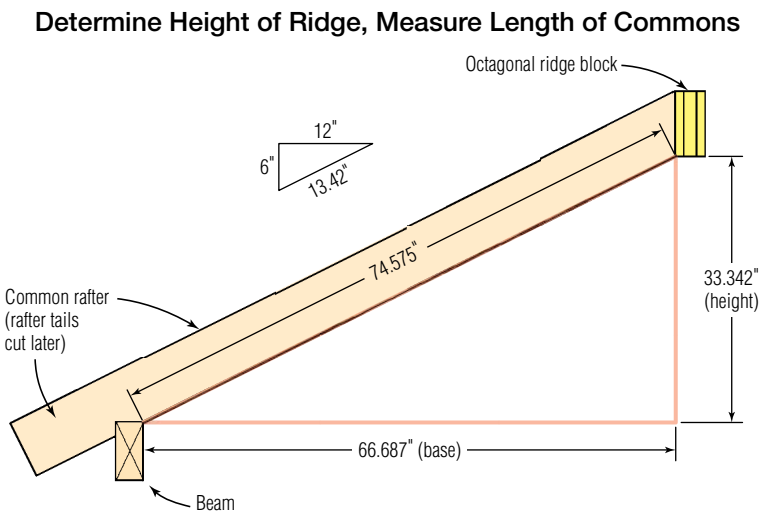

Figure 3. Use the length of the base ($66^{11}/_{16}$ inches) and the roof pitch (6-in-12) to determine the height of the ridge and the length of the common rafters. In the rafter table on a framing square, a right triangle with a base of 12 and height of 6 has a 13.42 hypotenuse. Divide $66^{11}/_{16}$ by 12 to find the common increment (5.557). Multiplying each of the sides by 5.557 results in a triangle with 66.6875-inch base, a 33.342-inch height, and a 74.575-inch hypotenuse, as shown above.

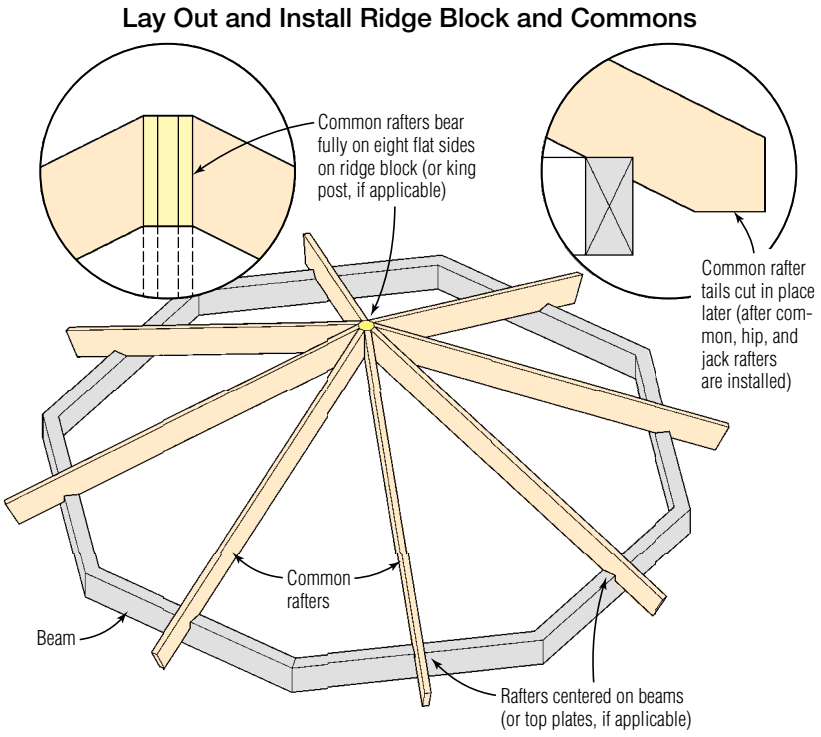

Figure 4. Common rafter measurements are taken from the bottom of the plumb cut and inside edge of the seat cut, or birdsmouth. These rafters are centered on the beams (or top plates) and should bear fully on the ridge block or king post, as shown.

the plumb cut and the birdsmouth cut on the rafter.

As shown in Figure 3, the 66.6875-inch dimension is the base of the measuring triangle needed to find critical dimensions for the ridge and the rafters. As noted previously, the desired pitch is 6-in-12. The hypotenuse of a triangle with an altitude of 6 inches and a base of 12 inches is 13.42 inches. This number is etched directly under the number 6 on the rafter table on most framing squares. The objective now is to expand this little 6-12-13.42 right triangle into a larger triangle with a base of 66.6875 inches.

To create this larger triangle, start by dividing the base dimension, 66.6875, by 12. The result, 5.557, is the number of 12-inch increments in the base. Next, multiply 6 by 5.557 to determine the altitude of the large triangle, 33.342. And, finally, multiply the hypotenuse of the little triangle, 13.42, by 5.557 to find the hypotenuse of the large measuring triangle. This comes to 74.575. In essence, you've expanded the smaller pitch triangle by a factor of 5.557 into the larger measuring triangle. And, because you've multiplied all three sides by the same number, you've preserved the same angles and the same pitch of the smaller triangle.

Step two: Lay out and install the ridge block and the common rafters. If there are provisions to keep the walls of the gazebo from spreading, an octagonal ridge block that's at least the height of the plumb cut ($8^1/_8$ inches on this roof) on the rafters may be used. In other cases, an octagonal king post that rests on the floor or on a structural beam at ceiling height may be called for. Either way, the bottoms of the joists should meet the ridge block or king post at a point that's 33.342 ($33^5/_{16}$) inches above the top of the beams.

The short points of the plumb cuts and the birdsmouth cuts should be 75.575 ($75^9/_{16}$) inches apart. I discussed how to lay out these cuts in my "Rafter Layout" article, so I won't go into those

techniques here. The rafter tails can be cut in place later, after all the rafters are installed (**Figure 4**). For more on that process, see my article "Framing Eaves and Rakes" (Aug/16).

Step three: Find the length of the base of the measuring triangle for the eight hip rafters. As with the common rafters, the length of the base of the measuring triangle provides the key to laying out the hip rafters. If you have a full-sized drawing, you simply can measure the distance from the point of the octagonal ridge to the inside corner where the beams meet. If you don't have a full-sized drawing, use the basic proportions of an octagon as shown here (**Figure 5**).

So, for every inch going straight out from the flat side of the octagon, there will be 1.0824 inches going diagonally out (at a 22 1/2° angle). This ratio applies to any size octagon. To calculate the length of the base for the measuring triangle, then, all you have to do is multiply 66.6875 by 1.0824, which comes to 72.1825 (**Figure 6**).

Step four: Determine the pitch of the hip rafters. Because the base of the measuring triangle for the hip rafters is longer than the base of the measuring triangle for the common rafters, the pitch of the hip rafters is milder than the pitch of the common rafters. This difference affects the angles of the cuts used to fit the rafters to the ridge at the top and the beam at the bottom.

Fortunately, there's a simple method for finding the pitch of the hip rafter. As we found in the section above, there are 5.557 12-inch increments in the 66.6875-inch-long base of the measuring triangle for the common rafters. The base of the measuring triangle for the hip rafter is 1.0824 times longer, or 72.1825 inches. If we divide that dimension by 5.557, we find that the increments are 12.989 inches long, which can be safely rounded up to 13. (12.989 inches is 1/64 inch shy of 13 inches.) So, the pitch of the hip on this roof is 6-in-13. In fact, changing the base number in the pitch from 12 to 13 for the hip rafters works with all octagonal roofs, regardless of pitch.

Step five: Prepare the lumber for the hip. In addition to changing the angles of the plumb and level cuts needed at the top and bottom of the hip rafter, the milder pitch of the hip also affects the dimension of the lumber needed. If you lay out a plumb cut for a 6-in-12 common rafter on a 2x8, the line measures 8 1/8 inches. If you lay out a plumb cut for a 6-in-13 hip rafter on the same board, the line measures 7 15/16 inches.

If left in place, this 3/16-inch difference in the height of the plumb line detracts from the appearance of the frame (which on a gazebo is open to view) because the cuts on jack rafters will hang down 3/16 inch below the hip rafters. For me, though, a more important issue is that this difference makes a layout that's

Basic Proportions of an Octagon

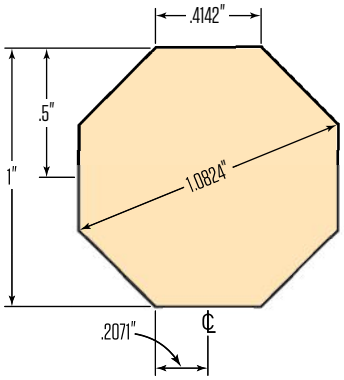

Figure 5. The side of an octagon that is exactly 1 inch wide measures .4142 inch, and the distance across the octagon from point to point through the center is 1.0824 inches.

Find Base of Measuring Triangle for the Hips

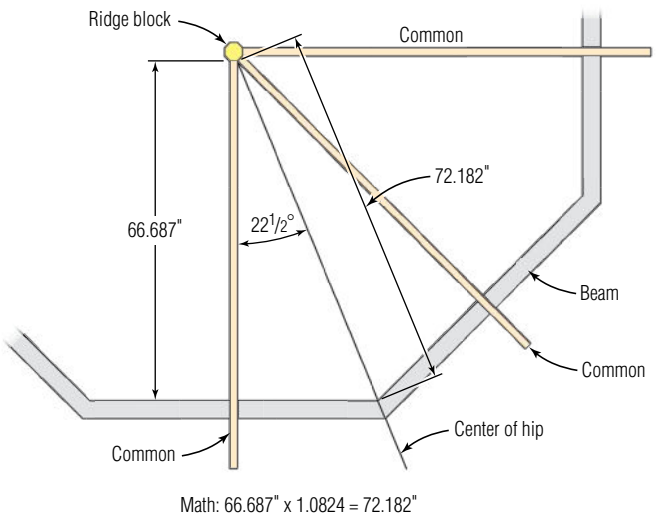

Figure 6. Multiply the length of a common rafter (66.6875) by 1.0824 to find the base of the measuring triangle for the hip rafters, or 72.1825. Dividing this number by the 5.557 increment determined in step one yields a new increment of 12.989 inches for the hip-rafter measuring triangle, which can be rounded up to 13. The pitch of the hip rafter is 6-in-13.

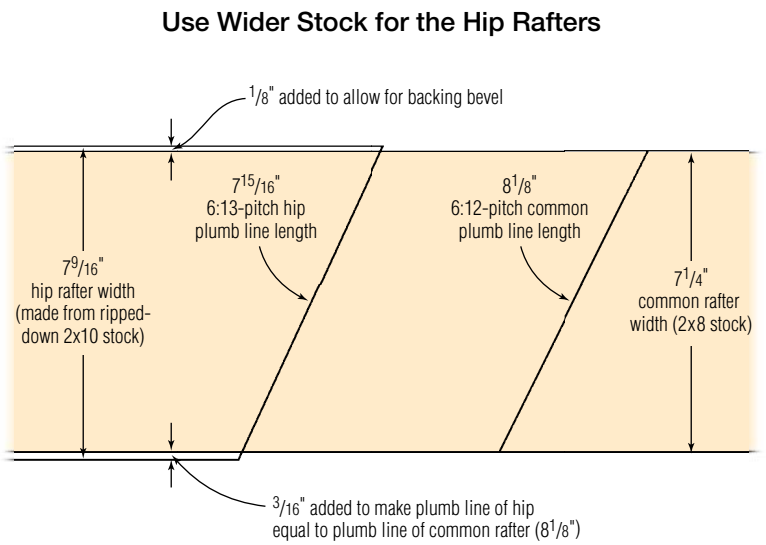

Figure 8. Wider stock for the hip rafters is needed to match the lengths of the plumb cuts of the hip and common rafters. As shown above, the amount marked above the bottom edge of the pitch block (about 1/8 inch) is the amount that you'd need to drop the hip if you opted not to cut the backing angle on the hip rafters.

already complicated more complex. The solution is to use wider material for the hip rafter.

For the plumb lines of the hip rafter to match those of the common rafter, the lumber has to be 7 7/16 inches wide. However, you can simplify the layout by adding another 1/8 inch and making the hip material 7 9/16 inches wide. To get material this wide, of course, you'd have to rip it out of 2x10 stock (**Figure 8**).

Here's why 7 9/16-inch-wide material would work best on this roof. One of the trickiest parts of laying out hip rafters is getting their top surface precisely even with the top surface of the common rafters. If the center of the hip is precisely in plane with the tops of the common rafters, the corners will protrude above that plane. Carpenters often calculate the layout along the centerline, then adjust the birdsmouth cut so that the entire hip drops, leaving the top corners in plane with the tops of the common rafters. This process is called "dropping the hip."

Another way to get the top of the hip in plane with the common rafters is to rip a double bevel on the top of the hip. Instead of dropping the hip, you cut away the part that protrudes above the plane of the common rafters. I prefer this second approach, both because it provides a better nailing surface for the roof deck and because I find it simplifies the layout.

Backing angle. The angle of this bevel cut is called the "backing angle." To find the backing angle, mark and cut a 6/13 pitch block on a scrap of 2-by material. (If you have a sliding compound miter saw, you can get the correct angle by setting the saw to 24 1/2°.) Place the pitch block on a drawing of an octagon in which the layout for the hip rafters is marked. Mark both sides where the layout lines intersect the pitch block, extend these marks with lines parallel to the inclined edge of the pitch block all the way to the square end, then bring the lines around the end and draw the bevel, as shown (**Figure 9**).

To measure the angle drawn on the end of the pitch block, set a bevel square to the angle on the end of the block and transfer that angle to a board. Then measure the angle using a layout square. In this case, the angle is 8°. Ripping 8° bevels along both edges of the pitch block puts the center in plane with the sides.

Step six: Find the distance between the short points of the plumb cut and the birdsmouth cut for the hip rafters. In step three, we established the base of the measuring triangle for the hip to be 72.182 inches. In step four, we used that dimension to demonstrate the pitch of the hip to be 6-in-13. You could use these numbers to calculate the altitude and hypotenuse of a measuring triangle for the hip rafter. But that triangle would be in the center of the thickness of the hip. So, you'd have to transfer the dimensions to the outside of the board in order to lay out the cuts at the top and bottom of the rafter. This transfer can be difficult to visualize and mark accurately.

I've found it's easier to use a measuring triangle that runs along the outside edge of the rafter material. This will have a base that is significantly shorter than the one in the center. It starts at the short point of the 67 1/2° bevel where the hip rafters meet the common rafters at the ridge block and ends 5/16 inch short of the point where the beams forming the octagon converge. All told, it's 2 1/8 inches shorter than the base at the center of the rafter. If you have a full-scale drawing, of course, you could just measure this dimension directly off the drawing. Otherwise, you need to subtract 2 1/8 (or 2.125) inches from 72.1825 to find this base, which is 70.057 (**Figure 10**).

The altitude (or height) of this new measuring triangle is slightly shorter, too, because it begins slightly downhill from the altitude of the center triangle. Because we are dealing with a 6-in-13 pitch, we know that the altitude will rise 6 inches for every 13 inches along the base. Dividing the 70.057 base by 13 shows that there are 5.389 13-inch increments. So, multiply 5.389 by 6 to find the altitude. This comes to 32.334.

The hypotenuse of a right triangle with a base of 70.057 inches and an altitude

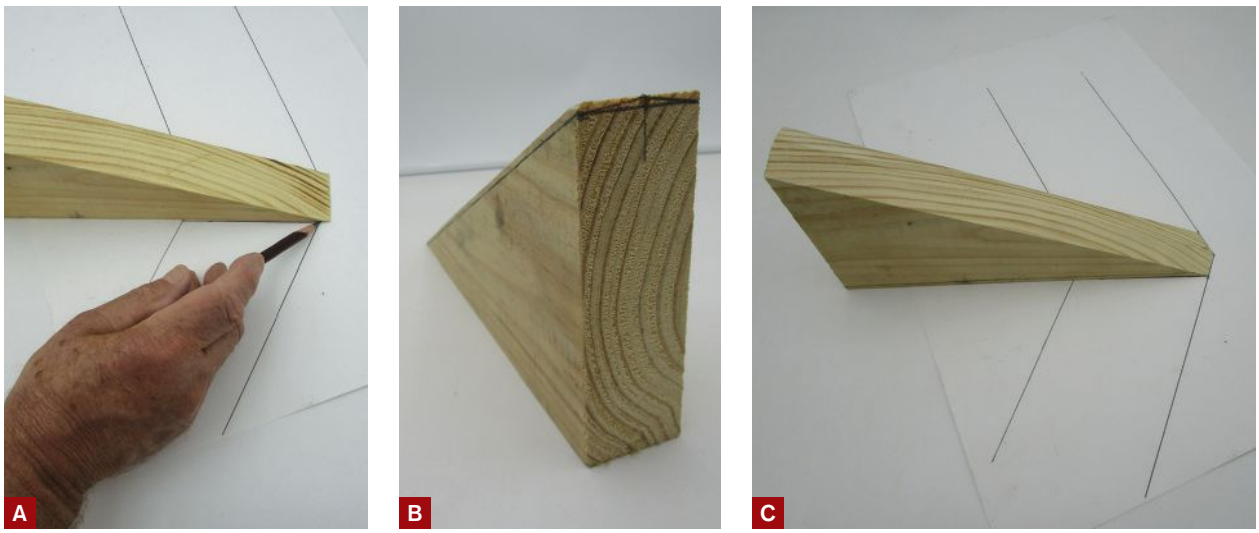

Figure 9. Set the pitch block so that the point is even with the outside corner of the octagon and mark both sides where the layout lines intersect the pitch block (A). Extend these marks with lines parallel to the inclined edge of the pitch block all the way to the square end. Then bring the lines around the end and draw the bevel, as shown (B). Measure the angle drawn on the end of the pitch block with a bevel square, and transfer that angle to a board and measure it with a layout square; in this case, the angle is 8°. Ripping 8° bevels along both edges of the pitch block puts the center in plane with the sides (C).

of 32.334 inches is the dimension needed for the hip rafter layout. If you don't mind doing a little geometry, you can find that dimension using the Pythagorean Theorem and a basic calculator, as shown in Figure 11.

You can also plug these numbers into a construction calculator, or you can simply measure and mark 32 5/16 inches up the side of a sheet of plywood and 70 3/16 inches along the bottom. Measuring diagonally across from mark to mark should give you the hypotenuse within 1/8 inch.

Step seven: Lay out and cut the plumb cut at the top of the hip. The plumb cut on the top of the hip rafter is a compound miter. To lay out the miter, use a framing square or a rafter jig to lay out the plumb cut for a 6-in-13 roof. Techniques for doing this are described in detail in my "Rafter Layout" article.

After marking this line on both sides of the rafter material, you have to cut a double bevel along the lines. This bevel should run at 22 1/2° from the face of the rafter and meet in the middle of the thickness.

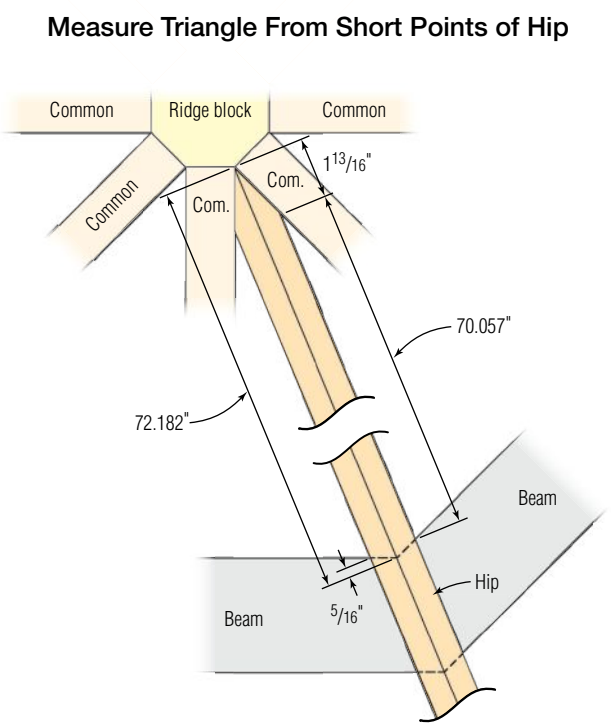

Figure 10. Because the hip rafters must fit between the commons, use a measuring triangle that runs along the outside of the rafter material rather than the center, as shown. The base of the triangle then starts where the hip rafters meet the commons, and ends short of the point where the beams (or top plates) of the octagon converge.

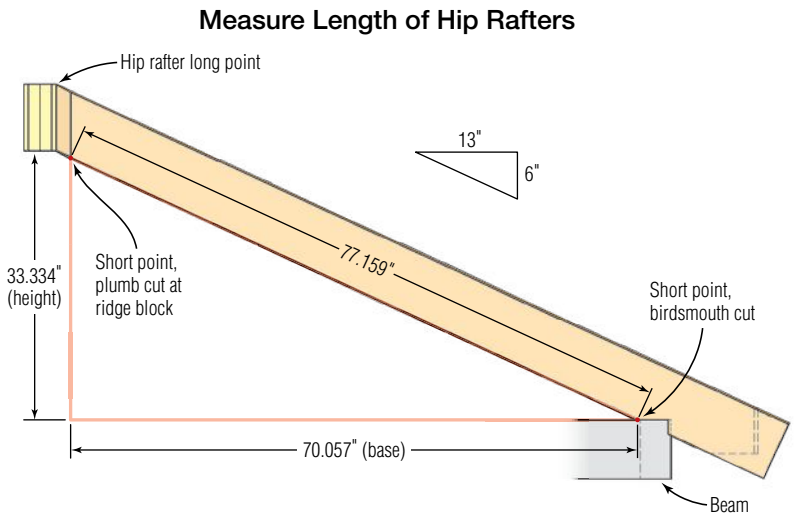

Figure 11. Divide the base of the measuring triangle (70.057) by 13 to determine the number of 13-inch increments (5.389), then multiply that number by 6 to find the height (32.334). To find the length of the hip rafters, use the Pythagorean Theorem as shown above. The hip rafter length is 77.159 inches.

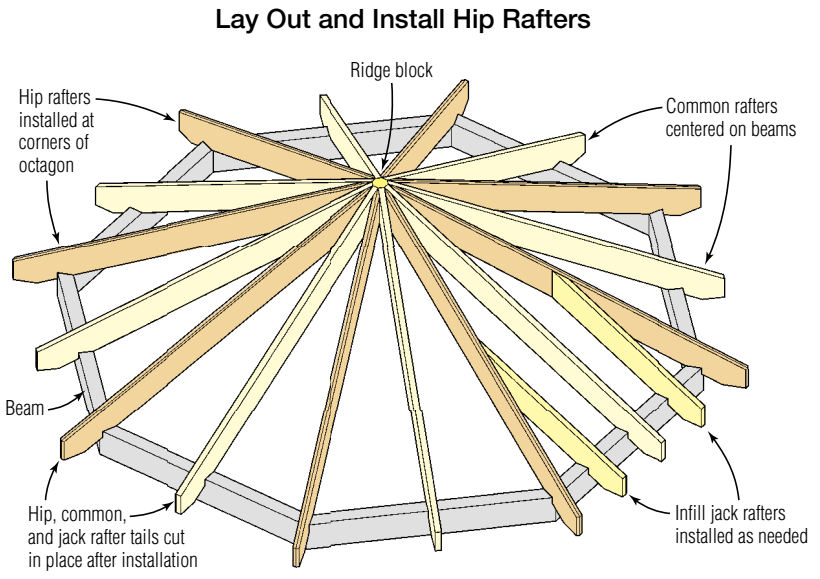

Figure 12. The hip rafters fit in the 45° space between the common rafters at the ridge block and require a plumb cut for a 6-in-13 pitch roof that is beveled 22½° on both sides. Use a 6-in-13 pitch block or rafter square to lay out the birdsmouth, which starts 77.159 inches from the short point of the plumb cut along the bottom edge of the hip rafter. Finally, install the jack rafters, which have the same birdsmouth cut and plumb cut as the common rafters, except with a 67½° bevel.

This cut, which permits the hip rafter to fit snugly in the 45° space between the common rafters, is difficult to make. The problem is that most circular saws cannot be set to the 67 1/2° angle required when running the saw along the face of the rafter material. The only exception I know of is the 10 1/4-inch Big Foot Saw with the 75° Swing Table.

Another tool that might make this compound miter is a radial arm saw. Its modern successor, a sliding compound miter saw, can't be set for this severe of a bevel, however.

A completely different approach would be to make a 90° cut along the plumb layout line, then mark the face of the miter cut with a centerline. Using a sharp handsaw, reciprocating saw, multi-tool, or circular saw set to 22 1/2°, cut along the centerline to create the bevel.

Step eight: Lay out and cut the birdsmouth at the bottom of the hip. The next step is to measure and mark 77 3/16 inches along the bottom of the rafter. Start at the short point of the bevel cut at the top. After making the mark at the bottom, use a framing square or a 6-in-13 rafter jig to draw a level line out from it. The birdsmouth will need to be about 4 1/4 inches deep to clear the point of the octagon at the outside of the beam. Because you've beveled the top, there's no need to drop the hip (**Figure 12**).

Step nine: Lay out the jack rafters. A single jack rafter between the common rafter and the hip rafter would probably be necessary on this roof. The jack rafters should be the same pitch as the common rafters, which is 6-in-12. The birdsmouth cut at the bottom is the same as that for the common rafters. The layout for the top is the same plumb line as on the common rafters. However, the cut must be beveled at a 67 1/2° angle to fit the hip. ❖

John Carroll, author of Working Alone *and* Measuring, Marking, and Layout, *is a builder who lives and works in Durham, N.C.*

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Pictured deck by NADRA member, Dave Fraser of Fraser Decks and Patio Covers

PHOTOS BY MARK CLEMENT

Resurfacing a Deck

Replacing decking on existing framing requires a confluence of building code, craft, and common sense

by Mark Clement

In my experience, deck builders have one of two approaches to resurfacing decks. For Group 1, it's a hard "No," and for plenty of sound reasons. For Group 2, the response is the opposite: "No permits. Ready-made revenue." Neither group is wrong, of course. Much like the dump truck/dump trailer/dumpster debate, the choice depends on what works best for your business and what you're set up for (I'm in the dump-truck camp, by the way).

While I prefer new construction—and a number of the decks that I've resurfaced have left me wondering why on earth I'm not in Group 1—the majority of the frames I inspect have decades of life left in them. I can't see below grade, of course, but 99% of the framing I've seen looks lumberyard new, even joists and other framing that is in ground contact. Other than some staining and maybe some rust at the hangers and some unfortunate 19.2-inch-on-center joist spacing, I can read the tags and lumber stamps like the lumber just slid off the truck. At times, the wood fiber is still so tenacious that removing fasteners is impossible.

For the most part, belt-and-suspenders structural repairs on decks like these are straightforward. But deck resurfacing projects call for a confluence and overlap of building code, craft, and common sense, especially when it comes to guard rails and unique features such as privacy screens or built-in benches.

Client Base

My resurface customers tend to have a lot in common with one another, again landing in two main groups. Clients in the first group are older and want minimal disruption and expense. I can see in their eyes that they want their old deck back. Those in the second group have kids in college or thereabouts and are justifiably trying to maximize their budgets.

When we meet to discuss resurface options, I can also see in their eyes—whether they're trying to save a buck or repair what they've got—that unless I can demonstrate that there are structural flaws, they're finding somebody to resurface the deck. The way I see it, that can be me—a deck builder set up for it—or not me.

Client meeting. All the decks I have resurfaced—and by resurface, I mean remove and replace the decking, guard rail system, or both—have been built with pressure-treated lumber or western red cedar and are around 25 years old. Some

age out. Others incur storm damage. Either way, the decking is cooked.

Paint. Sometimes, a deck has been "rescued" with deck rescue paint. These paints cake up the old, checked wood grain and deliver a robust new look … until they don't. It seems to me that once water gets into these systems, it can't get out, and decay accelerates. I've seen recoated decking on old decks on houses that needed to be sold without a pricey ping on the home inspection.

Materials. Despite being on a budget, everyone asks for composite decking. Upon my sharing the additional materials cost compared with treated southern pine, the lights start to dim. Upon clients' learning the additional labor and material costs for the extra blocking needed for picture-framing composites, and the similar cost trajectory of the rails, the lights flicker. And when I explain that composite decking gets hotter in the sun than wood decking, the flicker is just about out—especially for pet owners. But they still want low maintenance. Who wouldn't?

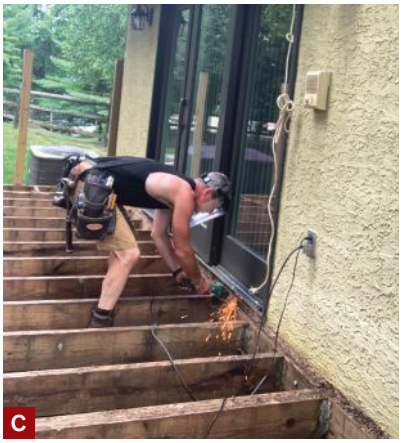

Figure 1. While this home's existing low-level deck was structurally sound, the western red cedar decking and guard rails needed replacement (A). After removing the rails, the author began prying up the decking from the center, using a NestorBar demolition tool for leverage (B). When the author can't break off a fastener with a hammer, he cuts it off flush with the framing with an angle grinder (C).

Selections

The real headache for deck maintenance is surfaces that need it least: the verticals. Assuming 2x2 PT balusters (or similar), each one requires coating on all four sides—none of which the coating applier is ever optimally positioned to coat. Instead, it becomes a slatherfest.

Railing. The stuff that's easiest to prep and coat—the wood decking—is more affordable than composite material, even after factoring the time spent coating it, especially if you can eliminate all the persnickety vertical work. To that end, I recommend a wood-metal-hybrid rail system: DekPro powder-coated aluminum balusters and rail brackets with wood rails and a wood top cap. My supplier can get the balusters and brackets quickly, the combination looks terrific and short-circuits the vertical maintenance tedium, and it's in line with a budget project. It's also in line with my business model of leaving customers happy for the long haul.

Decking. Most of my clients select PT decking, but lately, I've been using a middle-ground composite that has the qualities of wood without the maintenance issues: Acre by Modern Mill. It's not all plastic—or plastic-y. It's low maintenance, but it also accepts coatings. There's a natural component to it, too: 53% upcycled rice husks, combined with 47% PVC. It is more versatile than typical composite deck boards (it comes in 1-by profiles, shiplap, V-joint tongue-and-groove, and more), and it's mercifully cool on the feet. It also works beautifully when cut, ripped, and routed—think dust, not statically charged, snowy fibers.

Demo

Put a bunch of deck building carpenters in a room, and you'll get 10 sets of preferred methods, tools, and levers for quickly dismantling a deck. I've tried approaches such as cutting up the existing decking with a circ saw or chain saw (definite "no thank you" to the chain saw; I prefer not to be feathered in the rooster tail of chips shooting out everywhere).

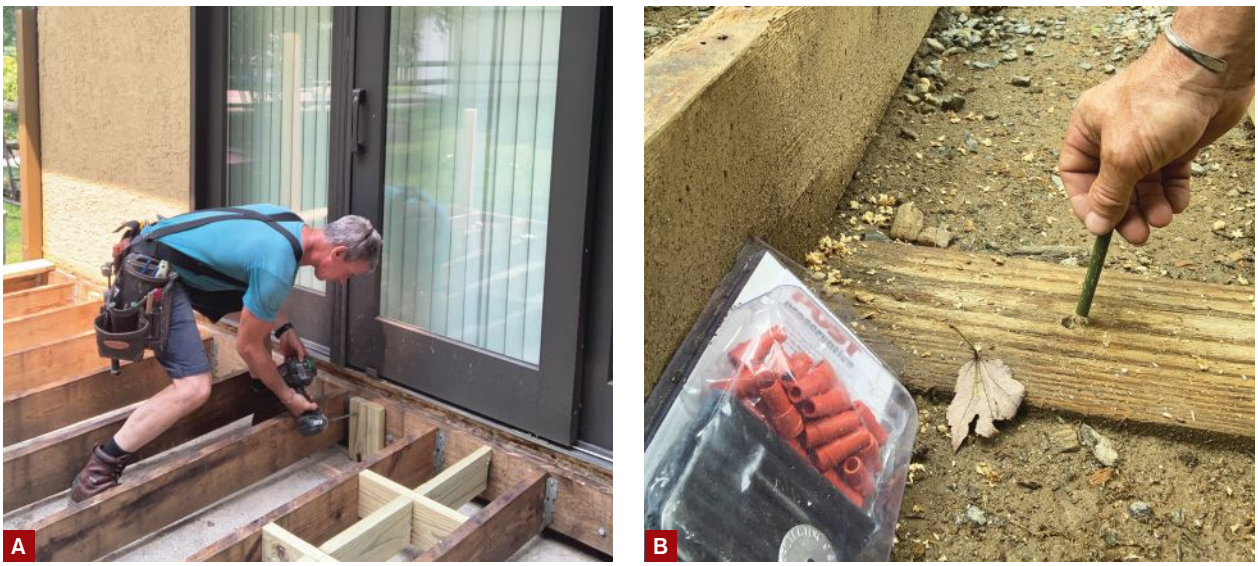

Figure 2. Once the existing framing is exposed, the author reinforces it with structural screws driven through the ledger into the rim joist and blocking as needed (A). To extend the life of the PT framing, the author inserts Post Proservative rods containing a fungicide and wood preservative into holes bored into the wood (B).

I've also tried various levers, none of which I find better than the uber-useful and effective, carpenter-designed NestorBar wrecking bar I prefer. It works both as a breaker bar and a lever (**Figure 1**).

First, though, I try to back out any fasteners I can, especially with PT decking. Some screws come out. Others … well, the second the bit skids out, that's it, and I've found there's no payback in trying to get after it. For cedar, like the deck shown in this article, it's almost moot. The NestorBar's perfect fetch pulls boards right through the screws and I break them off later.

On diagonal decking, I like to start on a long board in the field. Using a NestorBar and a set screw, I can lift a board, get some levers under it, and pop it off. Then, with the NestorBar's front and back claws, I can work from the center in either direction.

Some guard rails can be pulled apart by hand; those that can't, I unbolt and unscrew. Bashing stuff might save time upfront, but I lose it in the end picking up splinters and shards and fixing what I moved or broke.

Debris. I have three categories of debris: bucket, trash can, pile. I carry a bucket to fill with fasteners and little things. The trash can (with liner) gets whatever is in the 3-foot range. The rest goes in the pile. The debris all has to find its way out of the yard, and it's easier to manage it on the front end than to pick it out of the grass on the back end.

Exposed Frame

With the frame exposed, I inspect whatever connections I can and make an assessment. That typically means driving a pair of structural screws per joist bay into the ledger. I use 5/16-inch-diameter, 6-inch-long Spax PowerLags with a washer head; they invariably suck the ledger tightly back to the house.

On a deck with post-to-beam connections, I drive the same screws into those connections to reinforce them. On the project shown here, a patio deck over a concrete slab, I dropped a few 2x6 blocks to the slab to help support some longer spans and stiffen things up (**Figure 2**).

A lot of organic debris had built up in the quarter-century this deck had been in place. Disrupting it made me cough up a lung, so I spent a couple of hours blowing off the debris and rinsing off the slab. I'm the only person who knows those couple of hours were spent doing that, but I sleep better at night when a jobsite is clean and tidy.

Fasteners and joists. What fasteners don't break off with a hammer—hello, eye protection—I beat back into the framing. Fasteners I can't reach with my Estwing I cut flush with the framing using an angle grinder.

After the fasteners are gone, I apply joist tape to the tops of the joists and beams. I've used brands that have writing on them or that peel like duct tape, but I prefer Spax peel-and-stick, pressure-sensitive tape. It's easier to use and doesn't have lettering that shows through the gaps between decking boards. Whatever tape I use, I've found that a sharp, 25mm, snap-off knife is by far the best tool to cut it.

Last thing, I make sure to roll flashing tape along the top of the ledger and up the side of the house a little ways. Most of the time, the ledger is unflashed; 25 years ago, nobody gave a second thought to flashing.

Added preservative. The chemical treatment in deck and fence posts degrades just at and below grade over time. I visually inspect posts and poke them with an awl, and they are almost always intact. However, that condition can't last forever, so I've started using Post Proservative, a product new to the consumer market but one that utility companies have used for decades to re-treat utility poles. It's a dehydrated stick of fungicide and wood preservative in the form of a fused glass rod that inserts into a drilled hole. Here, I used it in the grade beam, but I've also used it on PT support posts that extend below grade. Once the wood reaches the right moisture level, the chemical liquefies and is drawn into the wood fibers via capillary action. It's a simple add-on and upsell.

Figure 3. After covering the tops of the joists with self-adhering flashing tape, the author installs the new decking. On this project, he used Modern Mill's Acre decking, a composite material made from upcycled rice hulls and PVC that can be cut like wood and can be stained or painted.

New Decking

Using Acre on this deck allowed me to get the tight looks composite installation techniques deliver—namely, parting boards and nicely divided sections of decking rather than just an ocean of deck space (**Figure 3**).

And I can skip most of the difficult, time-consuming elements associated with composites—blocks galore, fighting picture-frame miters closed—with no sacrifice in overall look. Acre is uniform all the way through, so there's no need to hide the ends or cut edges.

While many deck builders insist that decking should start at the outside band and work inward, leaving a ripped board at the house, I prefer to start with a full board at the house. Getting as parallel as I can to the front band is my main layout concern when I snap the chalk line for the starter board.

Another thing I like about Acre is that it is not shiny. If there is a low joist or the deck frame is lumpy, there is no penalty to me. When there are low spots, like at a parting board, I keep some 30-pound felt paper handy like flooring installers do and pack it up as needed.

Camo. On this project, I used Camo hidden fasteners (I always tell customers they're harder to see; they're not invisible). With easily 1,500 screws on a deck like this, I try to root out any wasted motion mercilessly. The number of moves required to position your body, the tool, the clips, and the fasteners is not nothing. Finding a way to move all those things in four moves instead of eight (times 1,500) puts money in my pocket.

Posts and Rails

As a member of Group 2 (repair/no permits), I'm left to my own devices to weave safe, effective—and profitable—guard rails into frames I didn't design or build while meeting a tight budget. And it is here that I take the spirit of the building code—a guard post and, by extension, rail system that can resist 200 pounds of lateral force without failure—into account.

More often than not, I'm replacing notched, saddled 4x4s. If they're cedar, they're like toothpicks after 25 years of service. PT posts can be too. Sometimes, a post is notched around a single-ply band joist. In other cases, a band joist consists of 2x8 framing with a 2x10 "fascia."

Should I add blocking and hold-downs to a modest, suburban deck because that's what is drawn in the local code book? Or should I use a career's worth of common sense and experience to replace what was there with something I know would cause catastrophic failure to the frame before it would fail—but is not drawn in the IRC or DCA-6?

On the low-level deck in this project, the point is moot, because the railing is effectively decorative, but in a detail the internet loves to hate, I've landed a post-setting process and connection I'm certain works the day I install it, two weeks later, and two years later. It is the simplest, fastest, most accurate way to set a deck post by myself I've found yet.

I start by screwing an L-block made with scrap 2-by stock 9 inches up from the bottom of the 4x4 post. Then I drive three $^{5}/_{16}$-inch-diameter, 6-inch-long

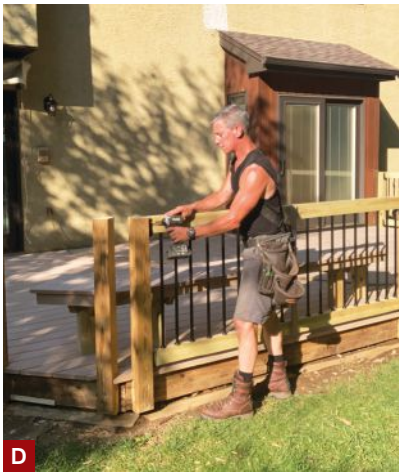

Figure 4. The author temporarily fastens an L-block to a post to hold it in position (A) while he drives structural screws through the post and into the framing (B). On the top rail, the author uses the stepped transition shown here (C) at corners and when joining two top rail sections together mid-span. DekPro aluminum balusters are a low-maintenance alternative to wood balusters and come in both round and square profiles (D).

Spax structural screws with washer heads into the post. After setting the post tight to the band joist, I drive a single 3-inch screw in through the L-block into the band, which holds the post in place while I check it for plumb. Then I just snug one structural screw, replumb the post in both directions, and set the second screw, shimming as needed. This second one I drive home, crushing the 4x4's wood fibers. I recheck for plumb, adjust and shim as necessary, then drive in the third screw. The top and bottom screws I set on the left side of the post; I set the center screw on the right. Using structural screws instead of drilling holes for through-bolts gives me 100% wood-fiber engagement, such that when the wood shrinks, and even if the shims fall out, the post remains slammed in (**Figure 4**).

Is this detail drawn in the code? No. Will hobbling this connection cause catastrophic damage to the deck frame? 100%. Do I spend money and time on hardware that's arguably not necessary? Nope.

Balusters. The DekPro aluminum baluster and bracket system is fast and easy to install. Layout is a snap. It's tough as nails and just as easy to maintain after the fact. I use it on new construction as often as I do on re-skins.

Top cap. For those of you proud of your miters in PT the day you finish building your decks, you should be. You dialed them in. Two weeks later, however, as the lumber dries, the toes of each miter shrink toward each other while the heels retreat, resulting in a miter that opens about 3/8 inch.

I've landed on an alternative I call a "stepped" transition. I use it to transition mid-span rail caps and to get around corners. The basic idea is that all the opposing grain moves together. If it all shrinks, the opening is even along the step. If it all swells, same thing. Basically, however, it stays where I put it.

To hold it in place, I screw it down to the post. I also predrill two 1-inch pilot holes with a 3/8-inch paddle bit in each ear and drive #10 x 3-inch screws into the pilot holes.

Clean Up

The last step is getting all the detritus out of the yard. I use a dump truck rather than a dumpster. I can back it up where I need it and load it easily, and it is a revenue stream as a hauler for other clients.

I get that some deck builders don't want to tangle with existing frames—especially those that were "weekend warriored" together—and I get there is a "but that's not code" conversation about connection strategies that make common sense but stretch the spirit of the code. And I get that deck builders like me see that the customer is going to pay for the deck to be surfaced no matter if I do it or not. But for the way my business is set up, I stand to make a profit and do high-quality work I enjoy. ❖

Mark Clement is a deck builder and remodeler in Ambler, Pa. He's the author of The Carpenter's Notebook. *Follow him at @myfixituplife.*


A


B


C


D


E

Backyard Pavilion

by Bayn Wood

In our area, most newly built homes include some sort of covered deck, covered patio, or lanai. We get calls almost every day to add these types of projects, either to complete a new build or as a retrofit to an existing home. Prefabricated aluminum louvered pergolas are another option, but the cost of those is prohibitive for most of our clients; stick-built patio covers—we call them pavilions—like the one shown here are less expensive and, in my opinion, add better value to a home **(A)**.

Our clients were already living in their recently completed home **(B)** when they called looking for a grade-level deck covered by a pavilion. After discussing the project, we recommended that they build an elevated patio instead—which costs less than a deck in our area—and put the money saved toward landscaping.

We framed the pavilion with triple 16-inch-wide LVL beams, which bear on 6x6 PT posts at the outside corners. The side beams carry into the house wall framing, which we beefed up to carry loads down to the foundation **(C)**.

The ridge beam is a double 2x10 that fits into a ridge beam pocket that we framed in the second-floor house wall. The outside of the ridge load path is brought down to the LVL beam with a doubled 2x4 post. The only tricky part of the roof is the cricket layover roof that creates the valley to push the water away from the house wall.

We clad the beams with 1-by rough sawn spruce painted to match the house. The two support posts, which bear on 28-inch-by-28-inch-by-42-inch-deep concrete piers, were clad with a stone veneer to match that used on the home's front elevation **(D, E)**. The ceiling is unfinished 1x6 tongue-and-groove pine with Trex low-voltage lights, which are used in the soffit, as well.

The real beauty of this project is that it cost our clients less to build the pavilion than the patio, which cost less than it would have to build a deck. This allowed for good profit margins for us and our subcontractors at a reasonable price for the owners, while adding great resale value to the house. ❖

Bayn Wood is president of Autumnwood Construction located in Macomb, Mich.

PHOTOS BY BAYN WOOD

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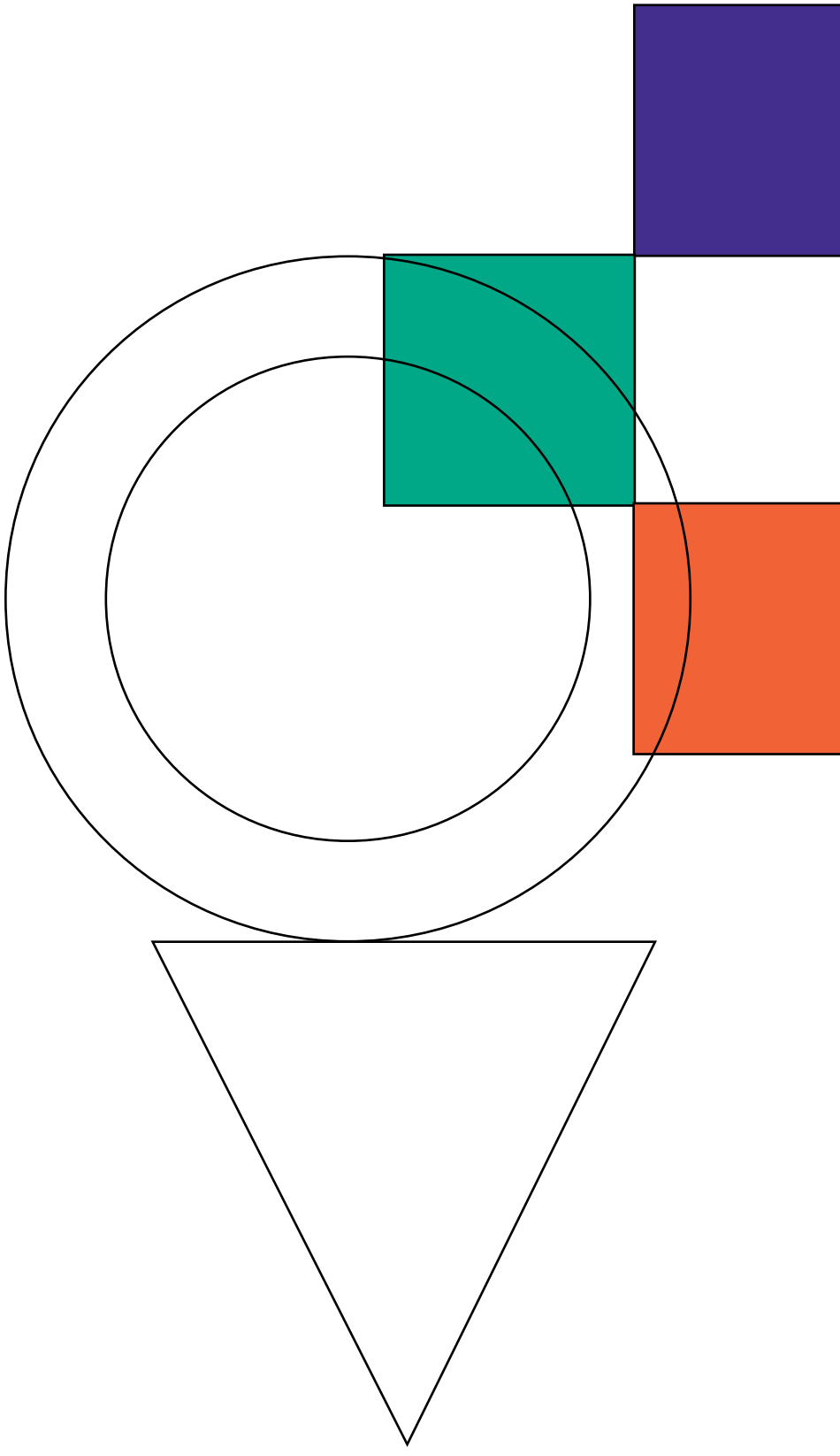

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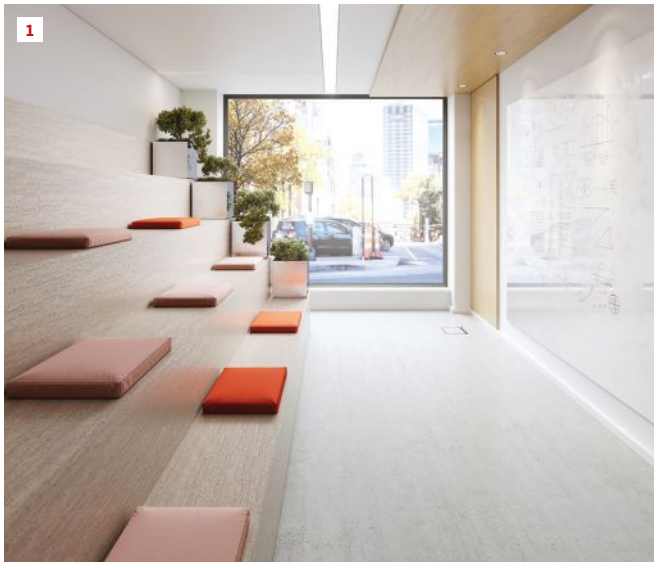
BY VINCENT SALANDRO



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Stiletto says its new Trimbone Titanium Hammer weighs 45% less than a standard steel hammer and reduces recoil shock vibrations. Equipped with a compact D-face and trim claw, the hammer fits in tight spaces. The trim claw pulls 2D to 16D nails, while a 180-degree side nail puller is ideal for 2D to 10D nails but can pull nails up to 16D. Replaceable colored grips and steel faces help extend the life of the hammer. It retails for $240, with accessories starting at $25. stiletto.com

5. Engineered Hardwood Flooring
In June, AHF Products introduced two Hartco-branded engineered-hardwood flooring collections with wire-brushed surfaces: Woodland Traditionalist and Dutton Pass. Woodland Traditionalist flooring sports a matte finish with scratch and stain resistance and an antimicrobial component that inhibits the growth of bacteria, according to the company. The Dutton Pass planks are made with white oak and have a low-gloss finish with nano aluminum oxide to resist scratches and stains. Both styles are offered in 6 1/2-inch-wide planks and varying lengths from 10 to 60 inches. hartco.com/en-us

6. Extruded-Aluminum Cabana Kit
Fabricated with powder-coated extruded aluminum, StruXure's Cabana X is a four-post, four-beam, 17-louver structure that the manufacturer says assembles quickly and withstands most weather conditions. The pivoting louvers can be adjusted using a hand-held remote. Prefabricated decorative wall panels, curtain rods, and fold-out couches as well as precut architectural corbels can be added to multiple sides. struxure.com

7. Multipurpose Ceramic Wall Tile
The Snippet collection of ceramic wall tiles from Crossville is offered with two faces, a left and right mirrored image of a geometric pattern, allowing for an array of installation designs. Offered in five tone-on-tone colorways—cotton, stone, coal, warm silver, and lipstick—in a large, 3-inch-by-12-inch format, the tiles can be installed in vertical indoor applications, including kitchen backsplashes and showers. crossvilleinc.com

8. Shou Sugi Ban Siding
Shou sugi ban siding from Nakamoto Forestry is made from Japanese cypress that is intensely burned as a preservative treatment. Instead of kiln-drying the wood for several days at low heat, Nakamoto air-dries its siding planks slowly and uses a flash-burning heat treatment. The siding will weather and change color over time, though oil can be applied to maintain color. Shou sugi ban siding is available in three finishes: suyaki (pictured), gendai, and pika-pika. Sukayi features a thick layer of soot that remains intact and provides an alligator-like skin texture. nakamotoforestry.com

9. Modern Aluminum Rail
Available in 6- and 8-foot lengths and 36- and 42-inch heights in both level and stair-rail versions, Deckorators Aluminum Rapid Rail kits have a matte black, powder-coated finish that resists scratches and corrosion, according to the manufacturer. Each kit includes drop-through square balusters, two-piece base and cap rails, brackets, hardware, and installation templates. Post kits—2 1/2 inches and 4 inches—matching gates, and continuous top rail brackets are sold separately. We found a kit for a 6-foot-by-36-inch rail section for $150 online. deckorators.com

10. Metal Roofing Tile
ProVia Barrel Tile 26-gauge metal roofing is galvanized on both sides and fortified with a GalvaTec coating that protects against mold, mildew, and UV rays. The manufacturer says that the roofing tiles are engineered to withstand 130-mile-per-hour winds and have a Class 4 impact rating and Class A fire rating. A Kynar 500 ceramic pigmented finish provides a low-sheen, matte appearance, while a resin-based topcoat protects the roofing tiles from dirt, mildew, and algae stains. The profile is offered in four colors. provia.com

11. Luxury Glass Wall
With panel sizes as large as 10 feet tall and 5 feet wide, Milgard AX550 Moving Glass Walls can cover an expansive area to let in ample natural light and blur the line between where the indoor space ends and outdoor living begins. Narrow frame profiles allow for even sightlines. Available in stacking, pocket, and bi-fold configurations in four colors, the doors operate with ease, according to the manufacturer. milgard.com

12. Durable, Multiuse Exterior Stain
The UV- and water-damage resistance provided by Solid-Color Exterior Deck, Fence, and Siding Stain promotes longer durability than traditional stains, according to its manufacturer, Dunn-Edwards. The water-based, matte-sheen stain is tintable in 50 colors and covers 325 to 375 square feet per gallon. The stain dries in one to two hours and can be recoated after four to six hours, according to the manufacturer. One gallon can be purchased from the Dunn-Edwards e-commerce site for $61 plus shipping. dunnedwards.com

A Worthy Pair of Cordless Belt Sanders

BY GARY STRIEGLER

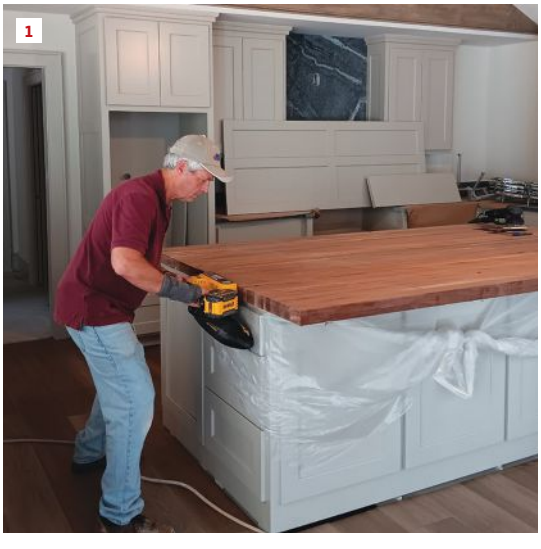
Anyone who uses a corded belt sander knows one of its major pitfalls: the power cord, which seems to get either hung up or stepped on while you are sanding, resulting in a gouged work surface. I've even managed to ruin a couple of cords by sanding over them. That's why I was excited to try out Metabo HPT's 36V MultiVolt (model SB3608DAQ4) and DeWalt's 20V Max XR (model DCW220B) 3-inch-by-21-inch cordless belt sanders. We often use belt sanders on our jobsites for tasks such as sanding cabinets and door edges, flattening joints in large glue-ups, and even rough-sanding floors on remodels. All of these jobs would be easier without the power cord if the battery life and power of cordless sanders could deliver results close to corded models, in the same way that cordless multi-tools, random orbit sanders, and trim routers now perform just as well as their corded counterparts.

Over the past few months, my team and I used these new Metabo HPT and DeWalt sanders on several projects to see how they compared to my corded models. Power is important, of course, but I also wanted to test dust collection, belt tracking, and the weight and balance of the tools.

Dust collection. I don't expect 100% dust collection from a belt sander, but I don't want the sander to throw a cloud of dust in the air or leave a pile of sawdust on the sanded surface. Both sanders have swiveling ports that allow them to be hooked up to a vacuum (the DeWalt also has a wireless tool control to trigger the vac), and this approach worked well for capturing sawdust on both machines. For me, though, the vacuum hose is often more trouble than a cord, and I was pleased to find that the dust bags that come with both sanders worked almost as effectively as a vacuum system at controlling sawdust.

Belt tracking. Tracking means that the belt stays centered without adjustments no matter what is being sanded. We put this feature to the test on a 5-by-8-foot walnut butcher-block countertop that we had glued up and needed to sand the edges and ends of to get rid of saw kerfs and clamp marks. Any time you sand something less than the width of the belt (the slab measured about 2 inches thick), it can make the belt wander and tear up the belt edge. I used both sanders for this task, pushing hard on the walnut edges, and experienced no tracking problems at all.

Balance. The walnut butcher-block top was way too wide to run through my planer in one piece, so I had to build it in three



Photos by Gary Striegler

Edge-sanding material that's thinner than the belt sanders' 3-inch-wide belts tests their tracking ability; the author found that the belts on both machines stayed centered without adjustments **(1)**. Cordless belt sanders are heavier than corded models, but the author found that both sanders were well-balanced and benefited from the extra weight on certain tasks **(2)**.

sections and glue and clamp them together. That left me with two 8-foot-long joints to sand on a very expensive project. A well-balanced sander is the fastest way to evenly remove material for a task like this, but poor balance can ruin a project by leaving grooves (we call it digging a hole) that show up when the painter or finisher starts to work.

To sand these long joints, I start by flattening the joint with the belt sander held at an angle, then go back and remove the cross-grain scratches by sanding parallel with the joint. As I do this, I feather out 4 to 5 inches from the joint on both sides, which leaves very little sawdust on the surface. In my testing, both machines did a good job of smoothing out the joints enough that they needed only a few quick passes with a random orbit sander afterward.

Both sanders proved to be well-balanced, and while the weight of the sanders (due to their batteries) was a little challenging for edge sanding, the extra weight was actually helpful for a job like this countertop. I would rather deal with the weight than a cord, and it was especially nice not having to worry about running over a power cord when working with this expensive material.

Power. One of the most demanding tasks we worked on with these two tools was sanding high spots out of a floor on a remodel job. I outfitted both sanders with new, 50-grit belts and started my guys sanding with fully charged batteries. I equipped the DeWalt with the company's Flexvolt 20V/60V Max 9.0-Ah battery, and the Metabo HPT with an 18-volt 8.0-Ah LiHD battery, and asked my crew to keep track of how long they could sand using heavy pressure on the sanders to remove maximum material. This wasn't a perfect test, as they had to stop to check their work with a straightedge occasionally, but they found that both sanders would run at full power for 15 to 20 minutes of heavy sanding on a battery charge, not quite enough time for a spare battery to totally charge up. The dust bags on both units filled up without leaving excessive dust on the floor.

I also used the sanders on several small cabinet projects, sanding face frames and end panels. For this type of work, the power and battery runtime were more than adequate, and I had no problem sanding smooth and flat, with no tracking problems.

Overall, I was pleased with both belt sanders. For all but the most intense sanding operations, the battery life was fine, and these cordless models sanded just as well as my corded ones. If I had to choose one, it would be the DeWalt, which seemed to sand a little faster, but it probably is going to come down to which battery platform you are using already. With either sander, you could safely put your older belt sander on the shelf and stop hassling with the cord.

Gary Striegler, a JLC contributing editor, owns Craftsman Builders (craftsmanbuildersnwa.com), in Fayetteville, Ark., and teaches workshops at the Marc Adams School of Woodworking. You can follow him on Instagram at @craftsmanbuilders.


3

DeWalt DCW220B
Surface feet/min. = 650 to 1,050
Belt size: 3 inches by 21 inches
Weight (tool only): 7.7 pounds
Price (tool only): $300
dewalt.com

Metabo HPT SB3608DAQ4
Surface feet/min. = 400 to 1,475
Belt size: 3 inches by 21 inches
Weight (tool only): 7.7 pounds
Price (tool only): $170
metabo-hpt.com

Both sanders had plenty of power and runtime to tackle tough tasks such as sanding down high spots on hardwood flooring **(3)**.

Reekon M1 Caliber Digital Measurer

BY TOMMIE MULLANEY

When I'm cutting material to length on a miter saw, accuracy and production are equally important to me. A tape measure is accurate, of course, but pulling a measurement for every cut isn't very productive. Stop blocks—either clamped to the workbench or integrated into the saw stand's extension arms—are both accurate and productive … as long as all of the cuts are the same length. Reekon's M1 Caliber digital measuring device promises increased productivity while eliminating the need for an old-school tape measure. This device attaches to your miter saw auxiliary fence and is designed to read with precision the measurement of any flat material. I've been using one for several months to see how well it lives up to its promise.

Setup. Attaching the tool is simple. The M1 comes with a strong, spring-loaded clamp in the back with a locking mechanism. The clamping force and rubber material made a secure bond when I affixed the M1 to the fence.

The M1 has a lot of buttons and features, which—even as a "techie"—I found to be a little confusing at first. It has the capability to read flat material not only at 90 degrees but also at 45 degrees from both the long and short points of the material. Because I found switching and calibrating the M1 when changing angles on the saw to be complicated, I didn't test this feature, but I think it would make sense if the saw was kept at a single angle—such as 45 degrees—over a period of time to make multiple cuts. For my testing, I kept the M1 calibrated to the saw at a 90-degree angle.

To calibrate the saw, you slide material under the wheel of the M1 and place it against the side of the saw blade. Then, with a few pushes on the buttons, you finalize the calibration. For example, the M1 allows you to set the kerf thickness of your blade so you can measure from both the left and right sides of the blade.

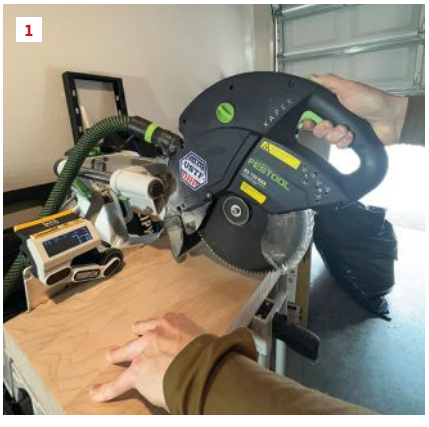
Display. The display on this machine is great. Numbers and units are easy to read, and the backlight helps in both low light and bright conditions. Outside, the maximum operating temperature is 105°F. I didn't exceed that temperature during my testing, but since I work in Florida, I can see how that could occasionally become an issue.

Battery life. The unit came with two AA batteries, which provide an estimated 15-hour life with the backlight on. For added convenience, I would love to see a rechargeable lithium-ion battery pack.

Accuracy. According to the M1's technical specifications, measurements should be accurate within +/- 0.029 inch—more than adequate for typical woodworking projects. But this specification comes with a caveat, which is that material that is warped, crooked, or bowed might result in variances that exceed this specification. The problem, of course, is that wood is rarely perfectly straight, and I had to move material around extremely carefully and slowly and frequently recalibrate the device to ensure that it all worked correctly. Even then, while working with 1x4 finger-jointed pine (which is about as straight a stock as you can find), I found that tolerances ranged from 1/16 inch to as much as 1/8 inch. For example, when I was making multiple cuts on a long piece of stock, the first several 6-inch-long pieces were dead accurate, but then as I spanned the stock up past 8 feet, the device lost a little accuracy over those longer lengths. This would probably be fine for rough framing but not for the trim carpentry work that I do. I almost think the M1 needs a larger wheel and more markings for the machine to read.

Fence compatibility. I've been using the M1 with a Festool Kapex 120; however, each saw and its fence may differ slightly in size and shape. To check the compatibility of this device with your saw, you can click on the "Adapter fence" link on the company's website. For miter saws that don't accept this device, Reekon offers an adapter fence to create an auxiliary fence with a surface tall enough for the M1 to clamp to. Price is $150. reekon.tools

Tommie Mullaney owns Black Label Carpentry in central Florida. You can visit his web page at blacklabelcarpentry.com or follow him on Instagram at @BlackLabelCarpentryCo.



The Reekon M1 is designed to clamp to a miter saw's fence and accurately measure the material being cut **(1)**. The display is large and clear **(2)**, and the spring-loaded clamp provides a strong connection to the fence **(3)**.

Photos: Tommie Mullaney

WaveCel T2+ Max Hard Hat

BY TIM UHLER

I don't know anyone who enjoys wearing hard hats, but they are an OSHA requirement for some of the overhead work we do and, eventually, most of us manage to get used to them. Until recently, I thought that not much has changed when it comes to hard hats. Sure, the new ones seem more comfortable, functional, and—dare I say it?—cooler looking. But the internals—the suspension that protects the noggin—are largely the same as they've been for a long time.

Last winter, at the World of Concrete trade show, I noticed that many booths had hard hats, but I was working at the show and didn't have a chance to look closely into them. When I got home, though, I did some research and found WaveCel's T2+ Max, which had the features I was looking for, including a full brim to block the sun, a vented design, and a light weight. This is an ANSI-rated Type II hard hat, which means that it is designed to offer protection from lateral blows and objects hitting the head from the front, back, and sides, as well as the top (Type 1 hard hats protect only from blows to the top of the head). It has an adjustable fit and accessory rails for options such as a four-point chin strap, a head lamp, earmuffs, and a face shield. I also liked that it is made in the U.S.

After speaking with a rep at the company, I realized I knew next to nothing about hard hats. He explained that most head injuries we are trying to prevent with hard hats come from glancing blows, which cause the brain to move inside the skull (I knew that) and to rotate (I didn't know that). According to the inventors, the WaveCel, which was first used for sports and bicycle helmets, can absorb up to 73% more rotational force than other hard hats and has up to 98% lower predicted risk of concussion than a standard helmet lining. Now, I take that all with a grain of salt since the authors of the study cited by the company rep are also co-inventors and patent holders. But I'm convinced this is a better design; watch the videos on the company's website to see for yourself.

With all of that as prelude, is this hard hat comfortable? I received three samples, and my crew and I wore them for several weeks as we lifted exterior walls with our telescoping forklift (when local safety rules require hard hats in the presence of an overhead hazard) and when we framed interior walls (even when they weren't required). We didn't have to wear them every day, but we did anyway.

I can say I have never worn a hard hat as comfortable as this one. It has a slightly lower profile than others I've worn, has good air circulation because of the vents (unvented models for cold-weather work are available), and has a built-in sweatband that works well. The hat didn't wobble or fall off when we were bent over framing walls, and we didn't have to crank it super-tight to keep it in place. And I think it made me look cool. At $150, it isn't cheap, but I think that the safety factor, comfort, and style that it offers make it well worth the cost. wavecel.com

Tim Uhler is a lead carpenter for Pioneer Builders in Port Orchard, Wash. He is a contributing editor to JLC *and* Tools of the Trade. *Follow him on Instagram at @awesomeframers, subscribe to his YouTube channel, or visit his website at awesomeframers.com.*

The WaveCel T2+ Max is a Type II hard hat with a wide brim, and top and rear vents for better air circulation **(1)**. Rails for ear muffs and other accessories are incorporated in the design **(2)**. Fit can be adjusted with the oversized dial **(3)**.

Photos: Tim Uhler

BY MARK LUZIO

True Divided Lights

I partially restored a historical tavern in the 1990s, and I recently had the opportunity to complete the project for new owners. The original structure was built circa 1750 on the Plainfield Pike—Rhode Island's first western road—and in 1798, it was purchased by Elihu Fish, a joiner and cabinetmaker from Newport. He added three large rooms, including a 16-by-30-foot ballroom on the top floor. The first floor was a dining room, which he trimmed in the new Federal style. Below this was a walk-in summer kitchen built into a sloping grade with stone foundation walls on two sides.

Earlier in Elihu's life, in the spring of 1776, he had signed an apprentice agreement with Edmond Townsend of the famous Goddard Townsend Quaker furniture makers of Newport, widely considered by historians, antique dealers, and collectors as some of the finest furniture makers ever to work in America. Elihu worked with them for 20 years, though his tenure was interrupted for several years after the British occupied Newport. Choosing to side with the Colonists, Elihu had signed on to a ship, the "Providence," that had a letter of marque—a license issued by the Colonial government—to attack British merchant ships. His ship was captured and the crew imprisoned. When he was eventually let go, he walked back to Rhode Island to complete his apprentice contract and worked as a journeyman until 1798, when he purchased the tavern.

Back in 1998, one final hurdle in my work on the tavern was to make new sash for the entire house. I had found eight of the original 12-light sash in the attic. Still dead-square after 200 years, these served as a template. There were 50 windows and almost 100 sash with 882 lights, or panes of glass. I finished all the 12-over-12 units, but the tavern was sold before I could make eight remaining sash for the summer kitchen. These were four small, 8-over-8 sash that fit openings in the stone walls, plus four extra-wide sash that were an unusual 15-over-10 **(1)**.

This year, the present owner contacted me and with his help, we restored the entire kitchen to its original condition. This included making new reproduction doors, paneling, and flooring, as well as the eight remaining windows.

To make reproduction 18th century sash, I now use machines to speed up the process, and the only handwork is at the very end. If Elihu walked into my shop, I would have loved to show him my 16-inch joiner, planer, shaper, and square-chisel mortise machines. I think he would have smiled when I flipped on the three-phase, though he might have been surprised that the half-laps and miters can be done on a sliding table saw. These repetitive and very precise cuts took about four hours for each group of inner mullions **(2)**. If you do the math on the eight sash for the summer kitchen, there are 82 lights, which required 176 miters, 142 copes, and 108 through-tenons. The pencil layout of all the joinery had to be precise. I cut exact spacer blocks for the inner grid and used them in the glue up, which took over an hour for each sash. The important cross-corner check with the tape measure was always dead on because the sash squared itself with all the half-laps and through-tenons. Elihu could not trust his glue to last and pinned the tenons, so I pinned all 108 tenons with 3/16-inch dowels to match his work.

With the summer kitchen done, the tavern is now exactly as it was 220 years ago in 1803 after Elihu planed the last sash. I was glad to take up the project again to give my final namaste to this master joiner and veteran who died in 1840 at the age of 84.

Mark Luzio owns Post Pattern Woodworking in Brooklyn, Conn.

Photos: Mark Luzio

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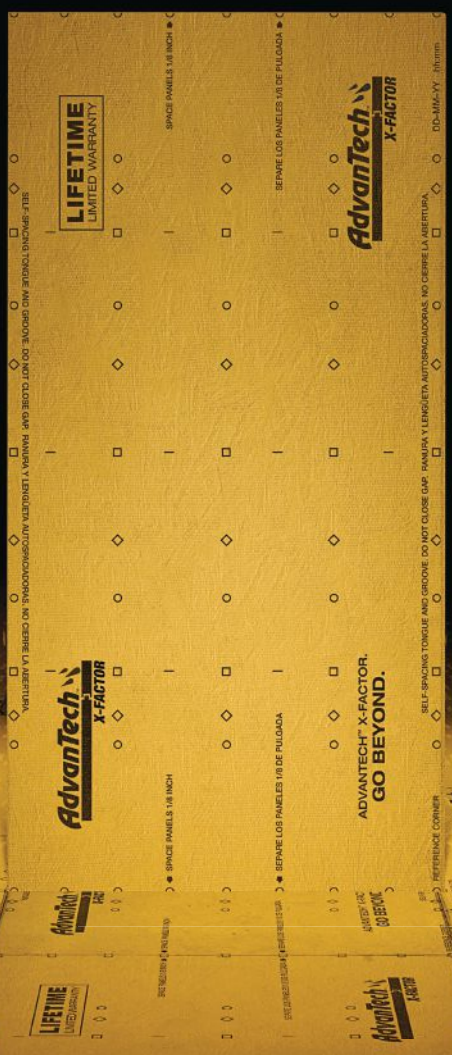

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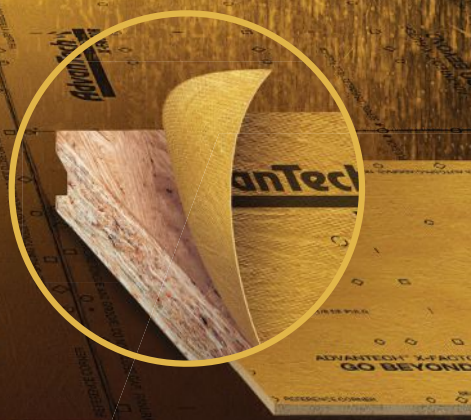

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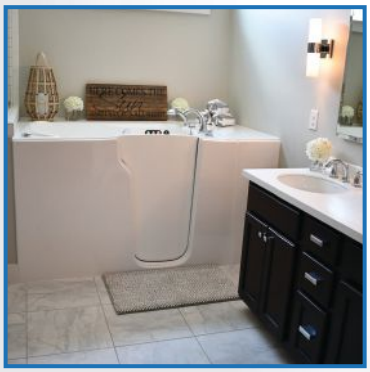

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