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Strategies for Finishing

Whether you're finishing new siding or restoring old and worn claddings, follow

When working for clients who love the look of natural wood siding, you have two options to present to them. You can suggest leaving the siding unfinished and letting it fade to gray as it weathers, or you can recommend applying a high-quality stain to enhance and preserve the natural character of the wood and extend its life. For many, the beauty and richness of wood siding is a motivating factor to pursue the stained approach.

As with any finishing project, proper preparation is essential. While the process varies slightly for each specific project, the procedure for applying the stain does not. Before you begin, create a sample board to ensure that the siding is compatible with the client's desired stain. Certain woods have excessive tannin levels that could impact the look of the final finish. Also, remind your clients that to keep a home looking its best, they should expect to maintain the siding with a fresh coat of finish every two to four years, depending upon the home's exposure.

CHOOSE YOUR APPLICATION TOOLS

Whichever application method you choose, apply stain only when outdoor temperatures are greater than 50°F and less than 90°F and the forecast is clear for 48 hours. Brushing with a natural bristle brush is the preferred method to ensure proper penetration of the stain and an even application. An airless sprayer or roller can be used to expedite coverage, but back-brushing immediately is still recommended. Always keep a wet edge when applying stain to ensure an even finish. Two coats is typical, with 24 hours of dry time between coats. Please refer to the Product Label, Technical Data Sheet (TDS), or Safety Data Sheet (SDS) for safety and detailed application instructions.

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PREPARATION IS CRITICAL

Aside from the need to first strip previously coated siding back to bare wood, the prep work for applying stain to any exterior siding—whether old or new—is the same. Scrub off any dirt, grime, and mildew with a solution of TSP (trisodium phosphate) and water, using a non-ferrous brush to eliminate the chance of dislodged bristles rusting and staining the siding. Remove the cleaning solution with a power washer, being careful to avoid damage by holding the nozzle no closer than 8 in. from the surface and never exceeding 800 psi. Allow the cleaned siding to dry for 48 hours before sanding. Sanding is critical even on freshly sawn siding, as mill glaze could prevent the stain from penetrating the siding evenly. Sand vertical wall surfaces to 120 grit and any horizontal surfaces to 80 grit, and then remove any dust. Ensure the siding has a moisture content of 18% or less before moving on.



Failure to clean or sand the siding properly before applying stain (above) can result in blotchiness or an uneven color tone across the facade of the home.

OPACITY MATTERS

Selecting the transparency of siding stain comes down to a balance of aesthetics and performance. Stain opacities are usually broken into four categories, each with a different percentage of pigment and additives worked into their mix. Pigment provides color to the stain, but it also helps protect wood from UV degradation. Here is what you need to know about each type.

Clear

Clear finish is the best at highlighting the natural character of the wood. Quality clear finishes have UV inhibitors added to them to offer some protection from exposure, but you should still expect to maintain them more often than other types. Clear finish is also used as a protective maintenance coat over other stains.

Transparent

This stain can be tinted to impart color to the siding, while highlighting the grain and figure of the wood. Because it has minimal pigment, though, it will still require a maintenance schedule similar to clear finish to prevent UV exposure from changing the tone of the wood beneath.

Semi-Transparent

Sometimes referred to as semi-solid stain, this is the best balance for those concerned with maintenance but not willing to lose the character of the wood. Because this stain has a higher ratio of pigment in its mix, it offers better protection than transparent or clear finishes.

Solid

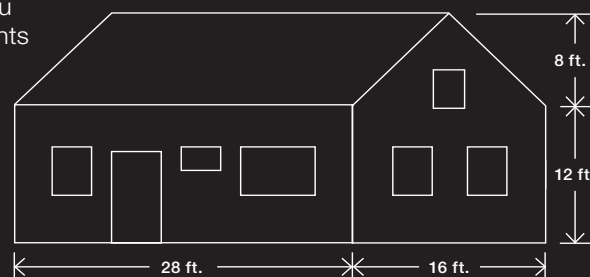
Though this stain offers the greatest protection, it masks nearly all of the character of the underlying wood. Of the opacity options, this stain is most comparable to a painted finish in terms of its final look and performance.



CALCULATING QUANTITY

To determine how much stain you need, take accurate measurements of each facade to be stained and reference the stain manufacturer's coverage specifications before using the formula below.

$$\begin{aligned} 28 \text{ ft.} \times 12 \text{ ft.} &= 336 \text{ sq. ft.} \\ 16 \text{ ft.} \times 12 \text{ ft.} &= 192 \text{ sq. ft.} \\ 8 \text{ ft.} \times 8 \text{ ft.} &= 64 \text{ sq. ft.} \\ \text{total: } &592 \text{ sq. ft.} \end{aligned}$$



$$592 \text{ sq. ft. divided by } 400 \text{ sq. ft. per gal.} = 1.48 \text{ gal.}$$



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CURVED DECKS

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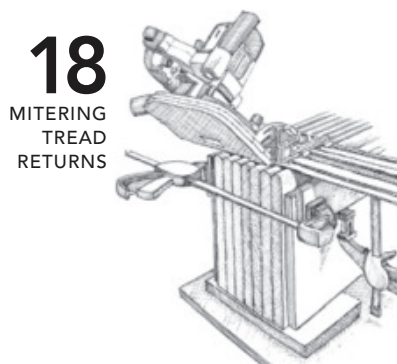
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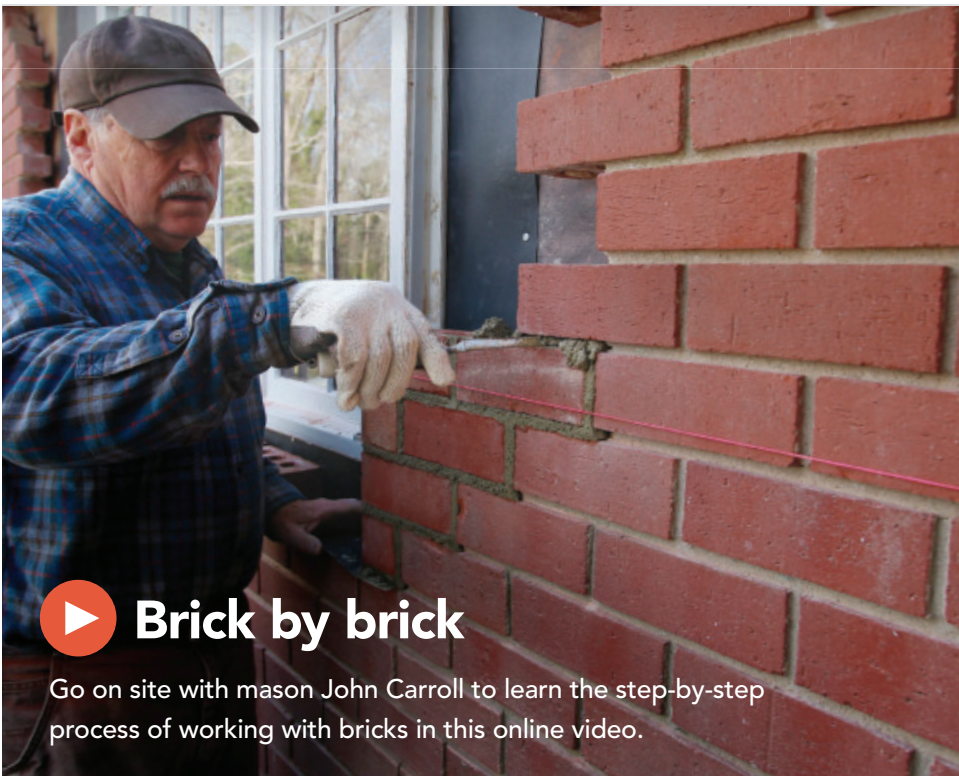


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Brick by brick

Go on site with mason John Carroll to learn the step-by-step process of working with bricks in this online video.



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A witchy window

Join the guys for episode 47 as they discuss both good and bad window placements, plus a host of other topics.

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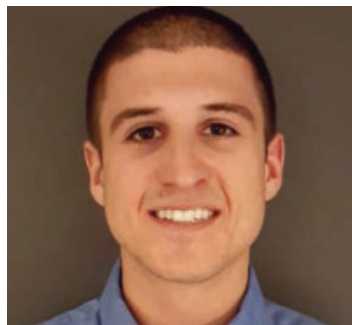
In 1996, senior editor **ANDY ENGEL** put aside building houses in favor of writing magazine articles about them. The author of *Building Stairs (For Pros by Pros)* and *Carpentry Complete*, both published by The Taunton Press, he still straps on his tool belt nearly every weekend to work on his very own version of the Winchester House. In this issue, he gives step-by-step instructions for joining stair rails and fittings ("Building Skills," pp. 88-92).

DAN HISEL, AIA, LEED AP, ("Make it Modern," pp. 48-53) has over 20 years of experience in contemporary residential design and work for nonprofit organizations. His designs have won numerous awards, including the Progressive Architecture Award, and have been published in *Dwell*, *Architecture*, and *Design New England* magazines. Dan has also taught design studios at several universities, most recently Wentworth Institute of Technology in Boston.



As a teenager, **JOHN CARROLL** ("Take the Fear out of Brick Veneer," pp. 66-73), worked as a roofer with his father's construction business. After earning a master's degree in history from East Carolina University, he became a general contractor. John has been writing about building since 1989. His latest book is *The Complete Visual Guide to Building a House*, published by The Taunton Press. John specializes in brick masonry in Durham, N.C.

A fifth-generation contractor, **JOE CIARALDI** ("Quick Curves With Steel," pp. 44-47) has been part of residential design and construction all his life. As a young boy, Joe would build anything he could get his hands on, and after graduating high school, he dove straight into the family business. Joe routinely takes advantage of manufacturer certification programs and professional development trainings, and has won several national awards for deck building.



write an article

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My door is always open

When I took over as editor of *Fine Homebuilding*, editorial director Rob Yagid told me I had to move out of my cubicle and into an office with a door. I was hoping his reasoning was that I could now bring my dog to the office and have a place to keep him contained. As it turns out, the reasons were managerial, which is far less fun. In any case, I'm writing this note from my desk in my office with a door—a door that's wide open. Truth be told, I never really close it. I like to be connected to the buzz of the *FHB* art and editorial staff.

The designers in our audience push each other to improve the flow of every floor plan and the proportions of every elevation. The builders push each other to better understand the ever-changing materials we use and the science that will make or break their success. While the conversations around here may be different than the ones happening around your design table or on your job sites, the energy is the same—and just as contagious. I leave my door open so I won't ever be far from the discussion about designing and building houses.

With the door open, I can still hear the arguments over semantics in the building code (see the question about roof membrane in "Ask the Experts," pp. 82), chime in on countless revisions before settling on the best way to explain the required dimensions of a bathroom under a sloped roof (see the contentious second paragraph in "Drawing Board," pp. 94-97), and encourage my



team to think about whether thinset can still be called thinset if it's applied in a thicker layer (See "Laying Large Tiles," pp. 40-43). Some might call this level of detail crazy, but I think it's crucial for all of us—here at *FHB* and out in the field.

This is why I'm starting off my role as editor by telling you my door is always open, and everything is up for discussion. If you like what we're doing, chime in so we'll know to keep it going. If you don't like what we're doing, chime in so we'll know if we need to adjust our perspective. Every editor and art director on this staff reads every bit of reader/viewer feedback that we get—good or bad—so your thoughts will not go unheard. Give us a shout: FH@taunton.com.

—JUSTIN FINK
editor



Prefab railing costs

In *FHB* #266, the article titled "A Field Guide for Prefab Railing" states that the cost of materials is about \$175 per linear foot. I disagree with that estimate, and feel it is misleading.

I live in a fairly remote area without a great deal of competition among suppliers—and I'm bidding on the materials myself without a contractor markup—but my materials bid for a railing with aluminum top and bottom rails (about 75 linear ft.) is about

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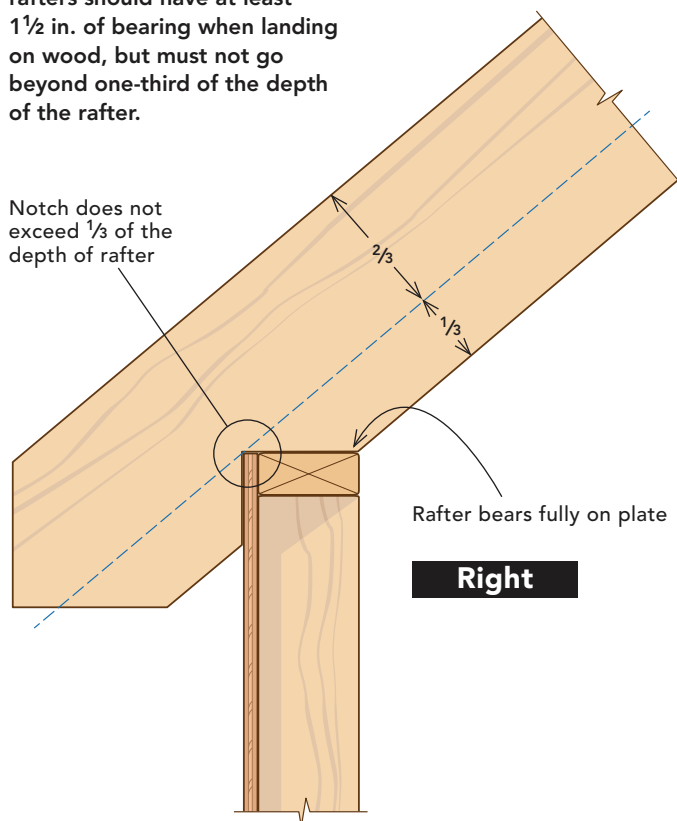
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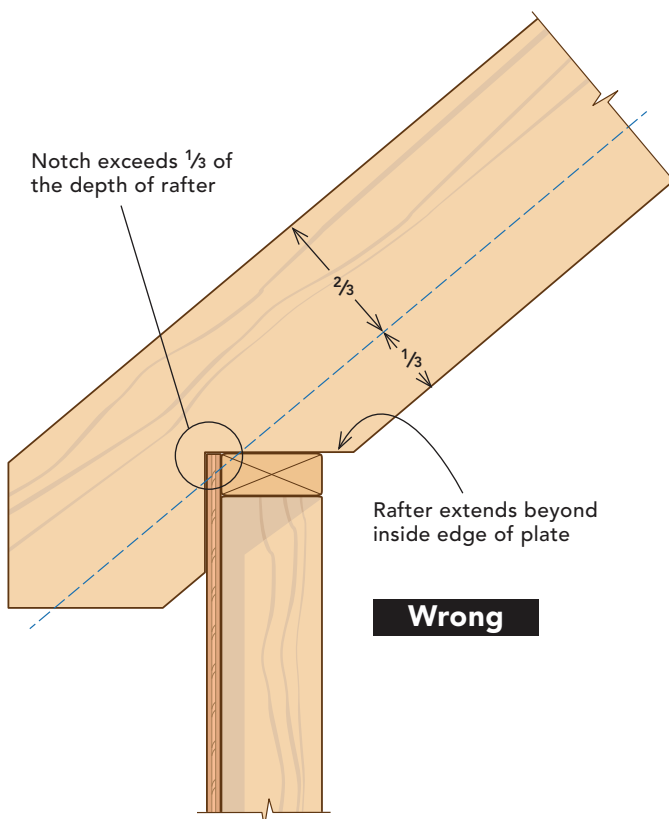
According to building codes, rafters should have at least 1½ in. of bearing when landing on wood, but must not go beyond one-third of the depth of the rafter.

Notch does not exceed 1/3 of the depth of rafter



Right

Notch exceeds 1/3 of the depth of rafter



Wrong

your safety

Home building is inherently dangerous. From accidents with power tools to falls from ladders, scaffolds, and roofs, builders risk serious injury and even death. We try to promote safe work habits through our articles. But what is safe for one person under certain circumstances may not be safe for you under different circumstances. So don't try anything you learn about here (or elsewhere) unless you're certain that it is safe for you. Please be careful.

—JUSTIN FINK
editor



Email your own letter to us at FH@taunton.com.

\$6,000. With the much more expensive option of glass panels, my materials bid goes up to about \$11,000. Using the article's \$175 as a guide, the cost would be about \$13,000 for materials alone. That, to me, seems extraordinarily high.

—PAUL DANIEL MARKS
Port Townsend, Wash.

Editor Justin Fink replies:

You're right, that would be one expensive run of deck railings, Paul. The language in that article should have said "about \$175 per section" of railing, not per foot. Since kits are sold in a variety of lengths, it probably does make sense to estimate based on linear footage. For the Trex Transcend line shown in that article, the cost per foot would be in the neighborhood of \$32. Sorry for the confusion.

Notching rafters

Thank you for an excellent article by Andy Engel on laying out and cutting rafters. I'm not a professional carpenter, so it explained things to me in a clear and concise way. I do have one question, though. What are the rules around cutting out the bird's mouth?

—DAVID MULHOLLAND
Washington, D.C.

Senior editor Andy Engel replies: Thanks for the kind words on the rafter piece, David. I've always made the level cut the same width as the top plate, but that's mainly in an effort to be neat. The IRC only requires that rafters bear a minimum of 1½ in. on wood (3 in. on masonry). This means that the level cut of the bird's mouth could be shorter than the top plate, but then you run into the realities of trying to toenail through both sides of such a small section of wood. On the flip side, the level cut shouldn't be longer than the plate width. First and foremost, it violates the building code that says the level cut can't extend beyond one-third of the rafter's overall depth, but also because the bottom of the rafter is in tension, there would be a tendency for the rafter to split starting at the inside upper corner of the wall plate.

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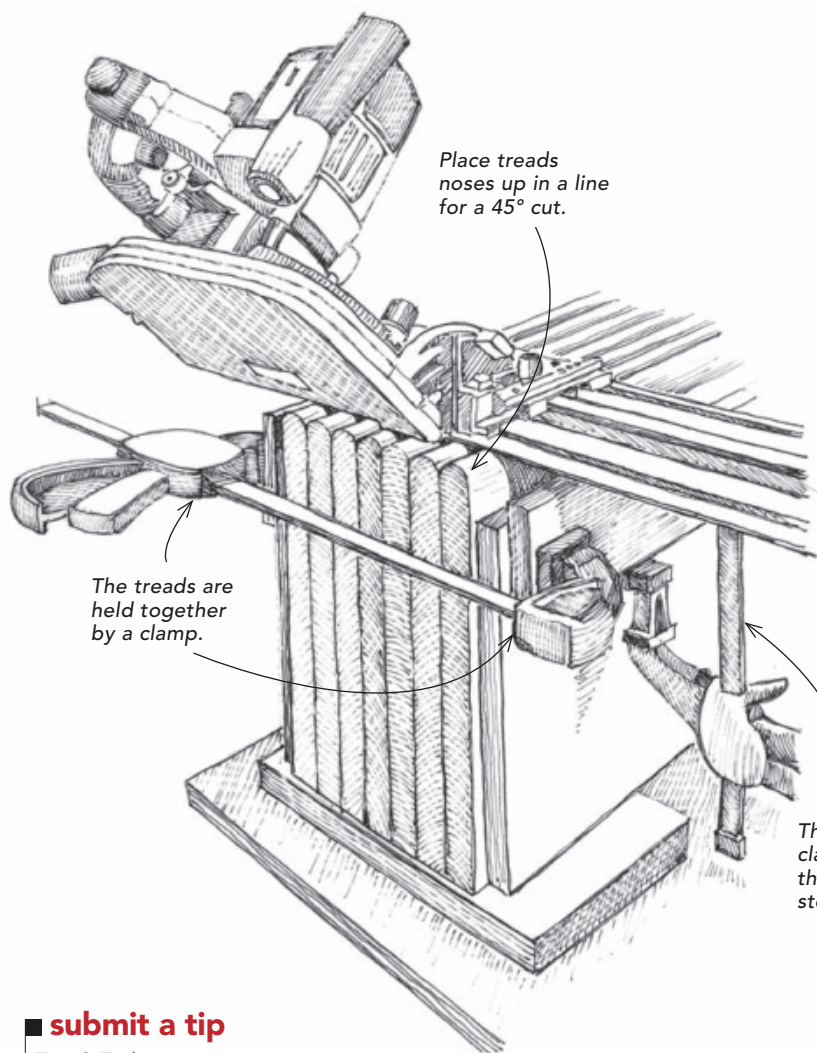


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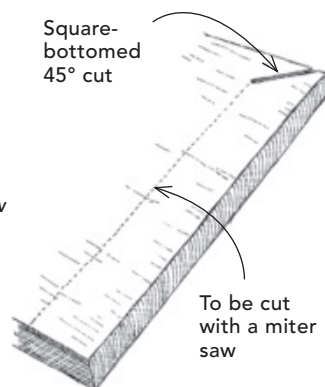


Track-saw mitered returns

Cutting stair treads for mitered returns is difficult. The round sawblade has to make a perfect square-bottomed 45° cut into a very expensive piece of roughly 12-in.-wide tread stock. I found my track saw did the job on all the treads at once without any tearout or splintering, and not much setup or worry.

First, I clamped all the treads together—noses up—and aligned the tops. Then I placed scrap wood on each side for the track-saw clamps to grab. I clamped the saw's track to the setup, set the depth of the cut, and made one pass with the saw set at 45°. To finish the treads, all I had to do was remove the waste with my 12-in. sliding miter saw.

—PETE DANIELSKI
Kodiak, Alaska



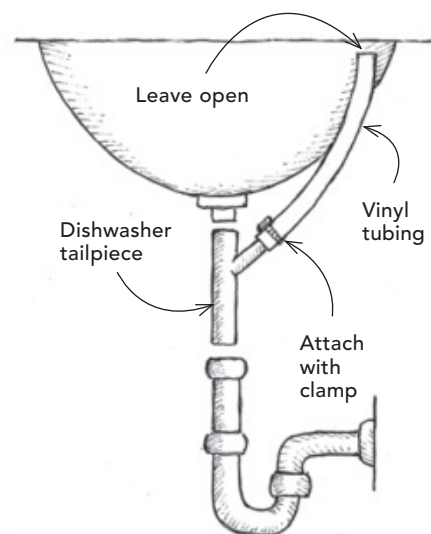
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Adding an overflow to a sink

Beautiful vessel sinks made of stone, copper, granite, and marble are very popular in bathroom remodels. Unfortunately, they often drain very slowly because they don't have built-in overflows. Though not its stated purpose, a secondary benefit of an overflow is to release trapped air when water flows down the drain. I've found a simple way to re-create the air-release feature in sinks without overflows. I use a dishwasher tailpiece (in place of the regular tailpiece) and clamp a piece of sturdy vinyl tubing to it. I leave the other end of the vinyl tubing open. It allows air to escape, and water flows rapidly down the drain. For pedestal sinks, you can run the vinyl tubing behind the sink so it's less obtrusive. And because the work is all done upstream of the trap, there's no danger of releasing sewer gasses.

—NICK FERA
Brielle, N.J.



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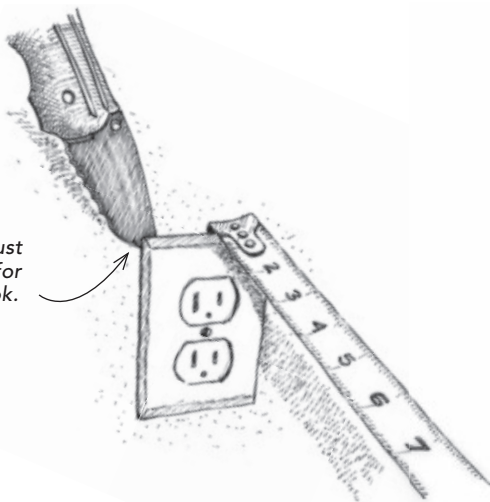
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A knife blade opens a gap just wide enough for the tape's hook.



Measuring a room by yourself

A good place to start measuring a room is at an electrical outlet. There are usually a couple of them on each wall, about 3 ft. from the corners. Stick the tip of a knife into the top edge of the outlet cover and the wall, creating a gap just big enough to insert the blade of the measuring tape. Carefully pull the tape to the opposite wall for your measurement. If you want the measurement to be accurate to within $\frac{1}{8}$ in. or less, use a combination square against the wall, measure to it, and add the 1-in. width of its blade to calculate the overall measurement.

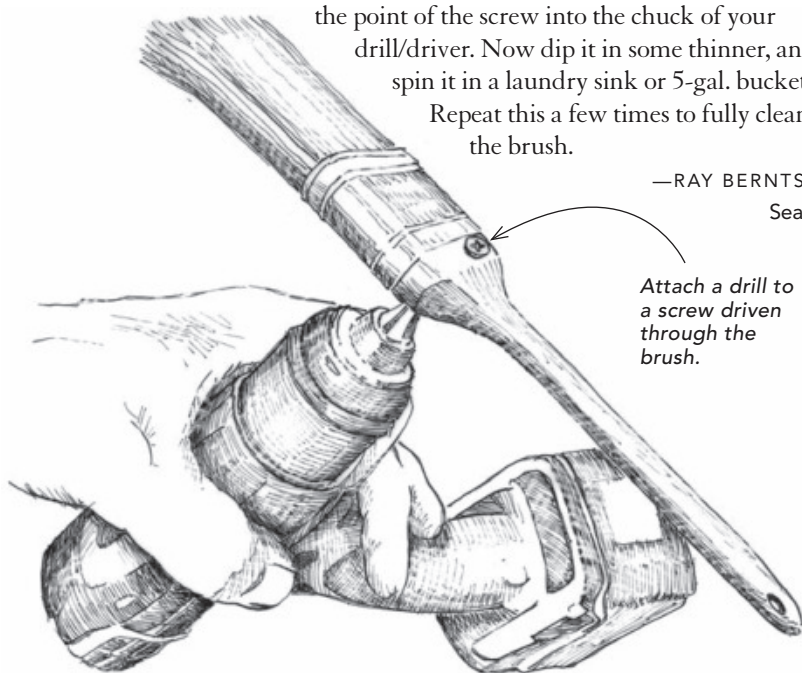
—MARCH COOVER
Dallas

Paintbrush cleanup

This tip works especially well for cleaning small brushes. Run an oversize screw into the paintbrush at approximately its center of gravity. Then tighten the point of the screw into the chuck of your drill/driver. Now dip it in some thinner, and spin it in a laundry sink or 5-gal. bucket.

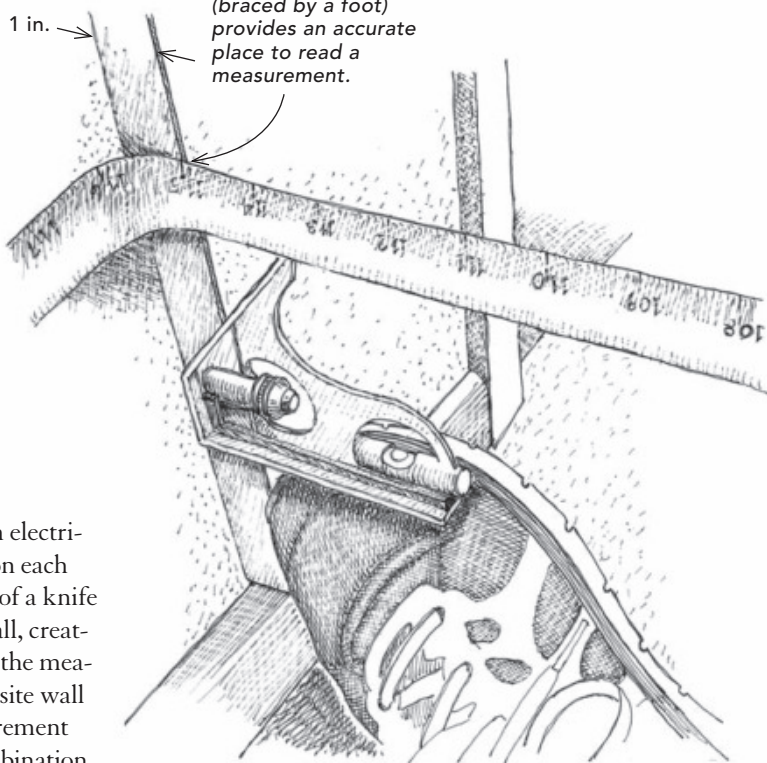
Repeat this a few times to fully clean the brush.

—RAY BERNTSEN
Seattle



Attach a drill to a screw driven through the brush.

A combination square (braced by a foot) provides an accurate place to read a measurement.



Front-door light location

The customary location for exterior entry lights is next to the door. But electricians and builders rarely think about the ramifications of this light location and what happens in summertime when nighttime insects swarm to bright beacons. Every time the door is opened, bugs attracted to the light rush into the house. My old-time electrician friend suggests positioning lights further from the door, at 6 ft. to 10 ft. away. The illumination still brightens up the entry area, but the light is far enough away that swarming bugs don't sneak inside.

—MIKE GUERTIN
East Greenwich, R.I.

Oil on your hands?

One time I was looking for a way to clean roofing tar off my hands. I poured a little vegetable oil on them, and it cleaned up the tar pretty well when wiped with paper towels. I've also found that vegetable oil works to remove other oily things. It's an excellent substitute for paint thinner when cleaning brushes used with oil-based paints and polyurethanes. It also works as well as any commercial cleaner on grease and grime that builds up on objects like range hoods or doorknobs. Just put a little oil on a rag and use some elbow grease. It's non-toxic and leaves your hands feeling soft and supple.

—BILL SHAW
Bar Harbor, Maine



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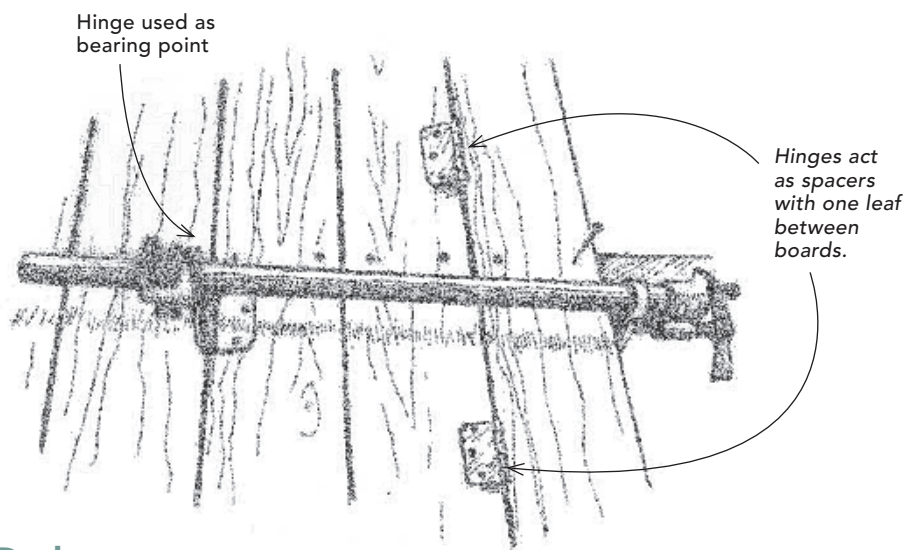
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FLOORING



Deck spacers

When installing new deck boards, we used 3½-in. door hinges as spacers. We inserted one leaf of the hinge between boards to gap them, and used the barrel of another hinge as a bearing point to pull things tight with a pipe clamp. If we needed wider spacing, we could have just inserted both leaves.

—PETER OQVIST
San Rafael, Calif.



ISSUE 186 // 2007

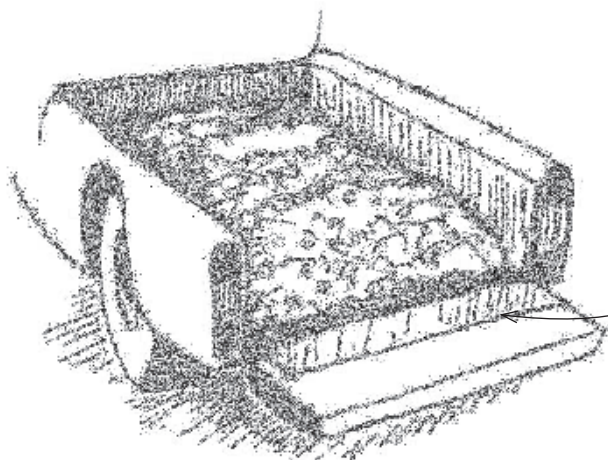
TIP FROM THE ARCHIVES

Tailgate gravel shield

I occasionally need to haul a load of gravel in my pickup, and when it's time to unload the stuff, some of it inevitably gets caught in the gap between the open tailgate and the truck bed. If I'm not careful to clean it out, the stuck bits of gravel eventually chip the paint and even dent the metal.

As shown in the drawing below, I minimize the trapped-gravel problem with a length of aluminum coil-stock flashing. I store the flashing under the bed liner until needed.

—CLYDE KENNEDY
Rushville, Ohio



Flashing tucks
under the bed liner
when not in use.

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Blade diameter: 8½ in.

Weight: 14 lb.

Max. depth of cut: 3½ in.

Max. bevel: 65°

Price: \$575

WORM-DRIVE REIMAGINED

The worm-drive circular saw has remained relatively unchanged during its decades of production, but now there's a new version of the venerable classic. Cuz-D's Straight Flush looks a bit like a Skil 77, but its olive-drab paint, heft (14 lb.), and assorted levers and buttons make it appear more like a tactical weapon. In addition to being an all-around workhorse, this 8½-in. saw is capable of cuts up to 3½ in. deep and bevels from -5° to 65°. The front of the saw folds up to allow for a plunge or nose cut, and makes it easy for you to cut flush to vertical surfaces with a removable guard that exposes the inset arbor blade, resulting in true zero-clearance cuts. With the guard removed and the front of the base tilted up for nose cutting, the Straight Flush looks dangerous, but it does its job very well. It's fast, efficient, and leaves a very clean cut.

The nose-cutting feature of the saw became incredibly useful when I had to cut existing floor joists to insert a new beam from

below. Instead of starting the cut with a circular saw and finishing with a reciprocating saw, the Straight Flush allowed me to cut all the way through the joists with one tool while leaving the sheathing intact over the beam pocket. Considering how interior walls have become unfashionable in homes these days, the Straight Flush may be worth having simply for these flush beam retrofits.

I had to rip down 18-ft. LVLs to match the height of some existing beams, and the saw plowed through the engineered lumber with ease, proving power is no issue. There's a thumb lever that retracts the blade guard, which is so useful it left me wondering why it's not a feature on every saw. You can also use the Straight Flush as a jamb saw—the handle rotates 90°—for trimming door jambs to accept flooring. The only downsides are that the saw is heavy for all-day cutting and it uses proprietary blades which sell for \$49 to \$59.

Andrew Grace is a remodeler in Ligonier, Pa.



No-Crack Caulking

I am too finicky about my projects to rely on someone else's prep and finish work, so I've tried every caulk under the sun. In my experience, they all crack eventually. But about a year ago, my painter friend recommended Sherwin Williams SherMax caulk.

Keep in mind that I am never caulking an area over ¼ in., and gen-

erally I am only caulking a paper-thin gap between two materials, so I can't say how well it holds up on large gaps. But in my experience, this caulk does not shrink and it does not crack.

SherMax is not quite as easy to work with as some other latex caulks that I've used. It can pull a bit if you're not careful. To prevent pull-

ing, I lick my finger before striking the caulk line. I also wear gloves or have a bucket of water for cleaning my hands before it dries because this caulk is super tough and does not come off easily.

Tyler Grace is an FHB ambassador and a remodeler in Hadden Heights, N.J.

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SMOOTH AND STEALTHY DRIVER

To deal with the noise and excessive vibration associated with impact drivers, tool companies are slowly introducing cordless drivers that use a hydraulic impacting mechanism instead of the hammer and anvil found on conventional impact drivers. The most recent entry to this category is the Milwaukee Surge (model 2760). I've been testing one for a month, using it for building cabinets and general remodeling. It looks just like a regular impact driver, but—according to its maker—it produces half the noise and one-third the vibration.

The 18v impact drivers I normally use produce about 1,500 in.-lb. of torque. The Surge is rated for 450 in.-lb., so I expected it to be far less capable—an assumption that turned out to be wrong. The hydraulic mechanism in the Surge produces more impacts per minute and a longer pulse of torque, which partially offsets its lower rating.

I noticed no difference in driving speed for fasteners up to ¼ in. dia. and 6 in. long (including both conventional lags and structural screws), but it struggled near the end and often stalled, which tells me it isn't as

powerful as some models. The Surge is definitely quieter than any other impact driver I've used. Milwaukee says it produces 76 db., but at 18 in. away I measured 93 db. while driving 3-in. screws. For comparison, my regular Milwaukee impact produced 100 db., and a DeWalt impact driver produced 96 db. The difference is greater than you might think because decibels are measured on a logarithmic scale, so an increase of 3 db. means the sound is doubled.

Features include an LED light, a reversible belt hook, and a bit holder. A selector switch allows you to set the tool to a maximum speed/power of 900, 2100, or 3000 rpm. It also has a mode for sheet-metal screws that's meant to drive them without stripping. I give the Surge a thumbs up because its low vibration and quiet operation make it more pleasant to use than a standard impact driver. It can't be my only driving tool because it lacks the power to drive large fasteners, but its low noise and smooth operation make it my choice for 90% of the fasteners I use.

David Frane is a remodeler in Alamo, Calif.

Milwaukee Surge 2760

Length: 5 in.

Weight: 3.3 lb.
with compact pack

Max. speed: 3,000 rpm

Max. impacts: 4,000 per
minute

Price: \$149 (tool only);
\$249 (kit with two compact
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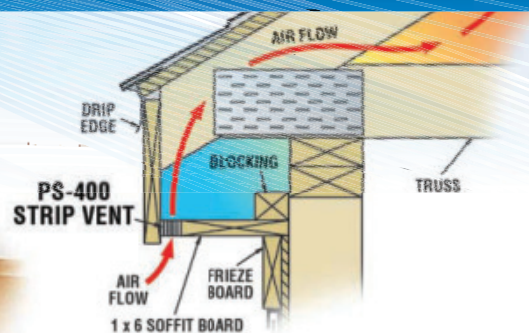


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Wheeled Tool Tote

I'll admit I'm a sucker for anything that makes it easier to carry my tools around, but I think you'd agree there's a lot to like about Milwaukee's new Hardtop Rolling Bag. The 24-in. rolling tool chest has a heavy-duty ballistic nylon cover with a rigid plastic inner lining that helps the box keep its shape. The rig navigates rough terrain and can even climb steps with the help of its 6-in. wheels. A variety of pockets organize tools from iPads to screwdrivers and a large open interior accommodates bigger tools and extension cords. It sells for about \$200 and comes with a lifetime warranty.

Patrick McCombe is associate editor.



Period Bulbs and Fixtures

There's something undeniably cool about vintage fixtures and their warm, glowing bulbs. The only downside is that they use a lot more electricity than modern LEDs. But now you can have that vintage look with long-lasting, energy-efficient bulbs. UltraLux makes pendants, chandeliers, and sconces for both indoor and outdoor use in period-appropriate styles inspired by the earliest days of electric lighting. Matching LED bulbs complete the look and achieve the warm glow of early, Edison-style bulbs. Clear bulbs sell for \$8, and amber bulbs sell for \$10.

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Spray Finish

Waterborne lacquer and a modest spray setup yield quick, quality painted work

BY TYLER GRACE

People often ask why I spray finish a lot of my own cabinetry, built-ins, and trim on site. The answer depends on why you're asking the question. If you're wondering why I spray finish instead of using prefinished options, it's because a spray finish means more leeway for caulking transitions, filling nail holes, plugging screws, and sanding joints that need a bit of extra touchup work. If you're questioning my choice of a spray finish over a brushed finish, the answer is that a spray finish is faster to apply and smoother to the touch. If you're wondering why anybody would bear the hassle of doing a spray finish on site instead of in a dedicated booth, I'd ask if you were offering me a bigger shop. And if you're asking why I spray finish on my own rather than pick up the phone and call a painter to do the spraying for me, well, that just

comes down to how much control I want over my work, and whether I'd rather pay a subcontractor or myself.

The truth is that spraying on site isn't always the best option—it takes time to set up and break down an on-site spray job, and time is money. But spraying on site has some definite perks for finish carpenters and remodelers who want to offer their customers one-stop shopping for their custom finish work. Besides, high-quality spray equipment is less expensive than ever, and modern waterborne finishes are safer, are easier to work with, and dry much faster than their solvent-based predecessors.

On a medium-size job like finishing the mantel, overmantel, bookcases, and console cabinet pictured here, I can easily spray two coats of shellac, two coats of primer, and two coats of waterborne lacquer in

PREP

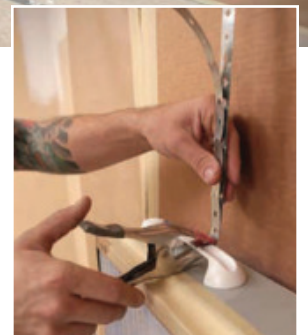
Before spraying on site, you need to thoroughly clean the room to eliminate the chance of swirling dust, protect surfaces in the line of fire, set up steady airflow to draw away overspray, and protect yourself with the right equipment. Because I mostly use waterborne primer and lacquer, which are fairly safe compared to solvent-based finishes, ordinary box fans suffice for air movement, and a particulate respirator is all I need to protect my lungs.

Isolate face frames.

If the cabinetry has a different finish or color on the inside, apply painter's tape just inside the edge of the face frame to ensure a crisp line, then slide slightly oversize cardboard into place over the tape.



Full-scope masking. I use a combination of cardboard, Ram Board, kraft paper, painter's plastic, and tape to protect all of the doors, windows, floors, walls, and—if they can't be removed—lights, hinges and hardware, and other finished surfaces. After masking off the area around the windows, I set a finish nail into the top edge of the casing to secure the metal strapping hanging in front of the window. I use the strapping to suspend the box fans, each of which also receives a furnace filter to catch overspray and protect the motor.



On Site



PRIME

Although often treated as nothing more than an obligatory step in the painting sequence, primer deserves as much care as the top coats that come after it. Aim for a smooth, consistent finish, sanding between each coat to get the surface completely level for the finish that comes later.



Seal with shellac. Waterborne primer will raise the grain on raw wood, so I start by applying two coats of thinned, dewaxed shellac to any stock that isn't factory primed, and to any spots where the factory primer was sanded through.



Open for airflow. Rather than spraying into closed cabinetry, which can cause blowback, leave the backs off and set the cabinetry in front of the exhaust fans so that airflow helps draw away the overspray.



Start upside down. Even though all of the surfaces will be sanded, I spray cabinetry upside down so that overspray will land on what will be the underside of the shelves, where a dead-smooth surface is less crucial.



Simple spray rack. For small parts that need to be coated on both sides, I suspend the pieces from coat hangers using small hooks spun to face opposing directions, all hung from an old rolling garment rack.



Sponge sanding. After priming, sand all surfaces to ensure a glass-smooth surface that's ready for top coats. I use a 150-grit sanding sponge, then I vacuum and use a tack cloth to pick up every bit of dust.

a single day, with results that are as good as you'd see in any cabinet shop.

Experience will guide your workflow

If I'm building cabinetry on site, I generally set up a shop in the room where the work will be installed. Since I'm already isolating and protecting the entire room when setting up my tools, it's easy to get it ready for spraying too. In addition to vacuuming thoroughly, set up includes masking the room and ensuring proper airflow.

Spraying on site also means deciding what should be installed before finishing and what should be left free to move around. Most of this decision comes down to the risk of overspray. When spraying quick-curing waterborne finishes into enclosed spaces, the overspray can blow back toward you and settle on surfaces that are already beginning to cure, leaving a gritty finish. Trimwork and relatively flat items aren't as problematic as boxes, which is why I chose to install this mantel and overmantel and then finish them in place. I also fit and fastened the console cabinet because I only needed to spray the outside of that piece (the interior was built using prefinished plywood).

The bookcases were scribed to fit, but then pulled out of position and placed in front of the windows and fans for better ventilation while spraying. Whenever possible in a situation like this one, I leave the backs off and spray them separately so there will be good airflow to pull away the overspray.

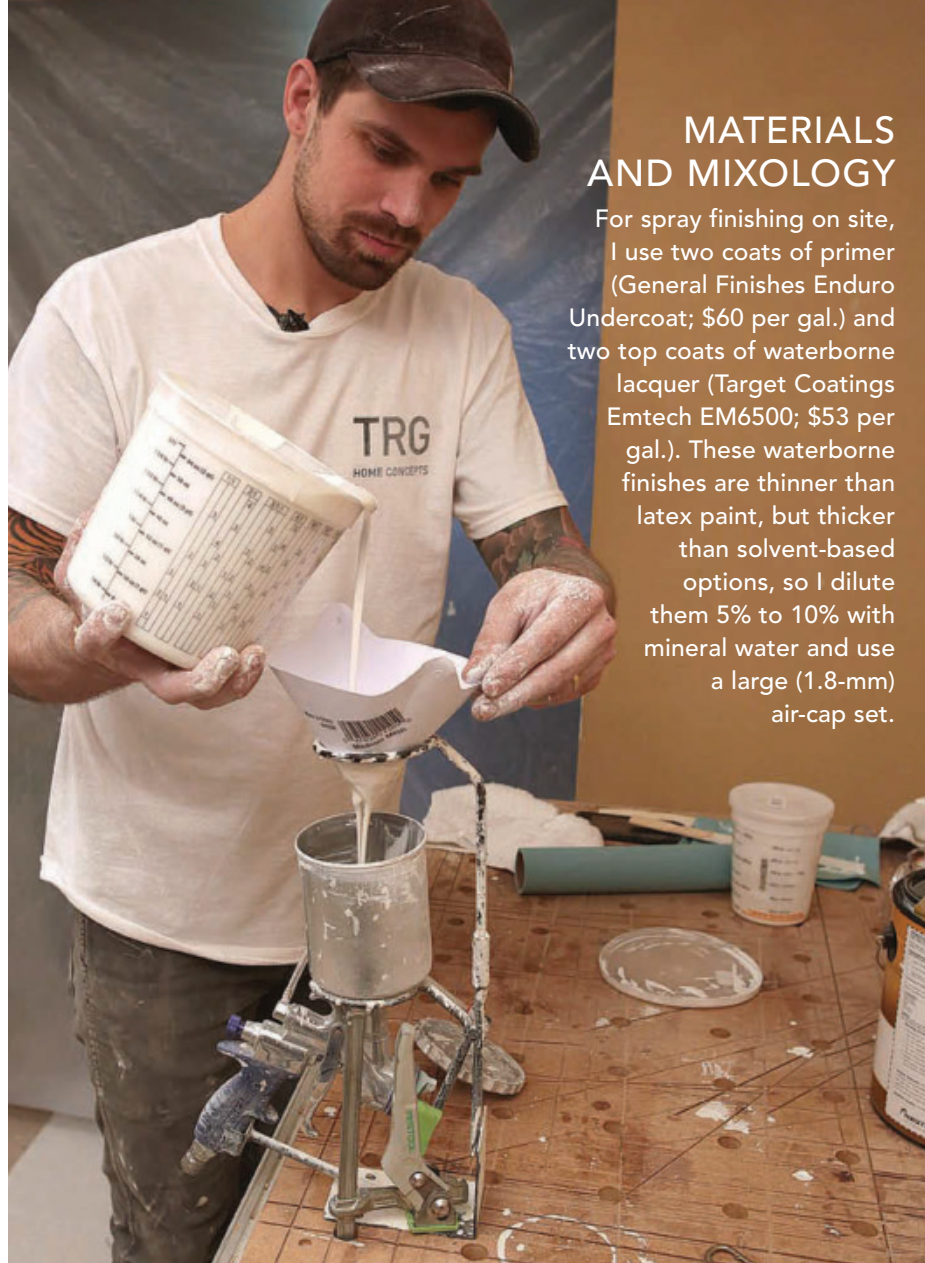
The right products used in the right sequence

After the cabinets are fabricated, I sand everything to 150 grit—first using a random orbital sander and then hand-sanding—being sure to ease any hard or sharp edges to aid with paint adhesion in these areas.

Waterborne coatings raise wood grain much more than solvent-based coatings. If you don't combat this reality early on, you'll fight it the entire finishing process. You could spray the primer on raw wood and then sand down the raised grain, but sanding off most of the primer you've just sprayed doesn't make much sense to me. Instead, I coat the unprimed wood and MDF with thinned dewaxed shellac. The shellac seals the wood without raising the grain, dries within minutes, and is compatible with just about anything you'd spray on top of it. The only hassle is that, because shellac is solvent-based, you

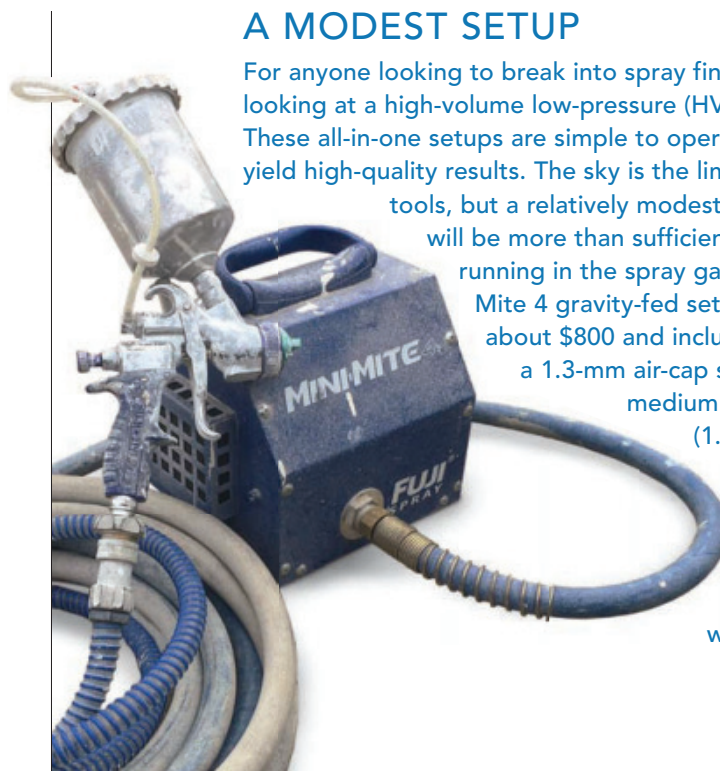
MATERIALS AND MIXOLOGY

For spray finishing on site, I use two coats of primer (General Finishes Enduro Undercoat; \$60 per gal.) and two top coats of waterborne lacquer (Target Coatings Emtech EM6500; \$53 per gal.). These waterborne finishes are thinner than latex paint, but thicker than solvent-based options, so I dilute them 5% to 10% with mineral water and use a large (1.8-mm) air-cap set.



A MODEST SETUP

For anyone looking to break into spray finishing, I recommend looking at a high-volume low-pressure (HVLP) turbine unit. These all-in-one setups are simple to operate, and generally yield high-quality results. The sky is the limit on prices for these tools, but a relatively modest investment of \$1,000 will be more than sufficient to get you up and running in the spray game. I use a Fuji Mini-Mite 4 gravity-fed setup, which sells for about \$800 and includes a 25-ft. hose and a 1.3-mm air-cap set. To that I added medium (1.5-mm) and large (1.8-mm) air-cap kits, a cleaning kit, extra parts, and a 6-ft. flexible whip hose, which allows for easier maneuvering when spraying.



PAINT

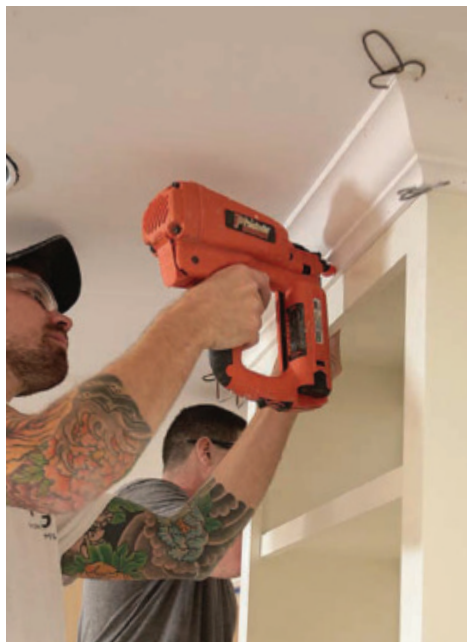
The top coats on any piece should only be for color. If you're looking to achieve build or correct any inconsistencies in the previous coats, you didn't do an adequate job with the prep or priming sequences. Most importantly, take the time to test-spray on scraps or masking and adjust your settings before spraying the actual work.

Finish flatwork in place.

Relatively flat or open surfaces are less prone to blowback, so they can be leaned against a wall, set on a table, or installed and painted in place.



To see a video of Tyler's spraying process, visit FineHomebuilding.com/magazine.



In with the trim. After repositioning and fastening the built-ins, apply the prefinished trim elements. Every fastener used at this stage must be spackled—I use Dap Crackshot—and spot finished, so be frugal with your fasteners.



Caulk the transitions. Seams between components look best when sealed with caulk. After taping both sides of each joint, I apply Sherwin Williams SherMax and smooth it with a wet finger, then peel off the tape for a perfect bead.



Spot finish. For blending and touch-up work, I set the air cap to the focused setting so I can limit my spray pattern to just the spot where I want it without creating a lot of overspray.

either need to break down and thoroughly clean your sprayer before moving on to the primer coats, or have a dedicated gun. After years of cleaning between finishes, I bought a second gun just for shellac—a basic AeroJet RS1 spray gun for about \$130.

After sealing all the raw wood, I apply two coats of a waterborne, high-build, sandable primer, knocking down the surface between coats to ensure I'm creating a glass-smooth base for the top coats. If site conditions are ideal—warm and dry—I'm usually ready to sand the primer within one hour of applying it. I use 150-grit sanding sponges, then vacuum the dust and wipe it with a tack cloth if needed; whatever it takes to remove any residual dust that could interfere with the adhesion of the finish. After the second round of primer, vacuuming, and tacking, the piece is ready for the top coats.

The top coats of waterborne lacquer are applied in the same sequence as the primer coats, but I switch from the 150-grit sanding sponges to either 220-grit or 320-grit between coats. At this point, the sandpaper is simply scuffing the surface so the finish has something to bite into.

When spraying all coats, I apply the finish in slow passes, holding the gun perpendicular to and 6 in. to 12 in. away from the surface being sprayed. To avoid buildup, it's important to start spraying before moving the gun over the surface, being sure to keep steady pressure on the trigger until each pass is finished. This method, when paired with passes that overlap by about 50%, ensures an even build and a perfect sheen.

Touch it up in place

After everything is coated, I re-install the cabinet backs, re-install the cabinets (which have already been scribed for a perfect fit), and trim out the remainder of the casework with stock that I've already primed and top-coated prior to cutting and fastening.

After installing the trim, I putty nail holes, caulk any transitions, and then touch up the trim right in place. This way, every part of the cabinetry and trim appears as if it is one cohesive piece with a consistent finish, reaffirming the wonderful results you can achieve by spraying on site. □

Tyler Grace is an *FHB* Ambassador and owner of TRG Home Concepts in Haddon Heights, N.J. (trghomeconcepts.com). Photos by Brian McAward.

GET YOUR SPRAYER DIALED IN

Knowing the quirks of your sprayer is crucial to maintaining a proper balance between spray pattern and film thickness, and this comes down to understanding three settings on the spray gun: airflow, material, and air-cap orientation. The key is to make practice passes on masking paper to ensure you have the right results.

1 Airflow to the gun will affect the amount of atomization and overspray. Ideally, use the least amount of air possible while still maintaining full atomization. You want the material to be fully atomized so the finish is completely broken apart without large particles or splatters appearing anywhere.



2 Adjusting the amount of material that comes through the needle allows you to match the volume of finish with the pattern. Spraying too thinly will leave a gritty finish that does not level out correctly. Spraying too heavily will lead to sags and runs and lengthen the cure time. But don't worry if it doesn't look perfect while wet. The goal, unlike with solvent-based finishes, is to get a heavy enough coat of waterborne finish on the surface that it will level out as intended. Generally, I aim for a 2-mil to 3-mil wet-film thickness, which can be checked with a gauge (photos below).

3 Most air caps allow you to spray in three patterns: a horizontal fan, a vertical fan, or an isolated point. Adjust the width of your spray pattern and volume of finish to correspond with the item you are spraying. If you're spraying a large flat area, use a wide fan pattern. If you're touching up a caulk line or nail holes, dial the spray pattern to a small point.



Laying Large Tile

Large-format tiles have their own set of rules—install them like standard tiles and watch the job fail

BY ISAAK MESTER

As a second-generation remodeling contractor, I've seen a lot of design trends. One that seems to have staying power is large-format tile—that is, any tile with at least one edge more than 15 in. long. Whether they're 16x16, 18x18, or plank style, open any home-design magazine and chances are you will see large-format tiles.

Most of the techniques used to install larger tile will be familiar to anyone who's ever set smaller tile. Laying out the tile is similar, cutting it is the same except that you need a bigger saw (which can be rented), and grouting it is no different. However, some normal procedures used for installing smaller tile take on heightened importance when working with large-format tile, and there are several differences that are crucial to both the final look and to the longevity of the floor.

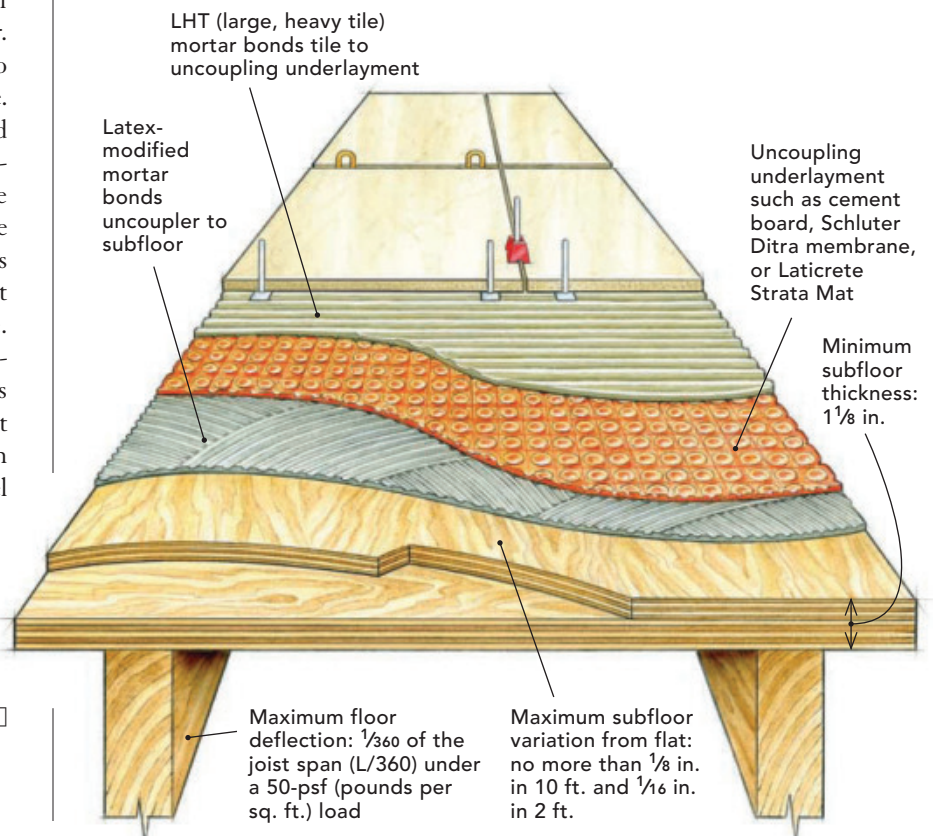
Flaws in the substrate can cause any tile floor to fail, but their effect is greater with large-format tile. Also, regular thinset mortar can't support the size and weight of large-format tile. Large tile exaggerates lippage (variations in the height of adjoining tiles). While inconsistent mortar application and setting pressure are the leading causes of lippage, tile warpage plays a role. Most tile will be warped to some degree, but the size of large-format tile exaggerates warpage. Especially when laying tile in a running bond pattern, where the end of one row aligns with the centers of neighboring rows, installers need to rely on grout joints wide enough to disguise the problem, and even then it can be impossible to achieve an acceptable level of lippage without using a clamping system.

The good news is that although large-format tiles have their own rulebook, manufacturers and the Tile Council of North America (tcnatile.com) offer helpful solutions. Address the above concerns, and you're well on your way to creating a durable and stylish floor.

Isaak Mester owns Mester & Son in Haskell, N.J. Photos by Andy Engel.

PREP THE SUBSTRATE

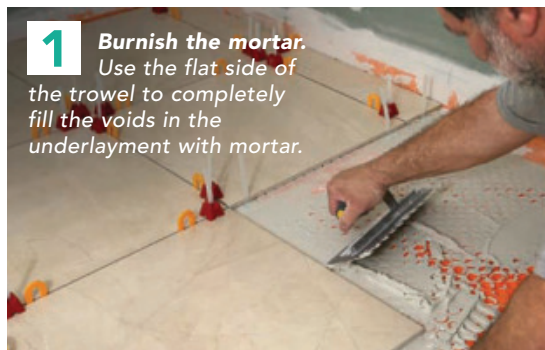
The substrate is the most important part of any tile floor, but according to the Tile Council of North America (TCNA), "As tile size increases, the effect of substrate irregularities is compounded." Larger tiles can be more prone to cracking from subfloor flex, and because of the length of their sides, a substrate that isn't flat makes it much harder to avoid lippage. Getting to flat may mean sanding high spots or using floor-leveling compound. Installing an uncoupling membrane or backerboard is also a good way to isolate the tile from movement in the framing, which helps prevent cracking. The National Tile Contractors Association and the TCNA each specify deflection, flatness, and subfloor thickness in their manuals, and also provide specifications for mortars and other details.





FOUR STEPS TO MORTAR APPLICATION

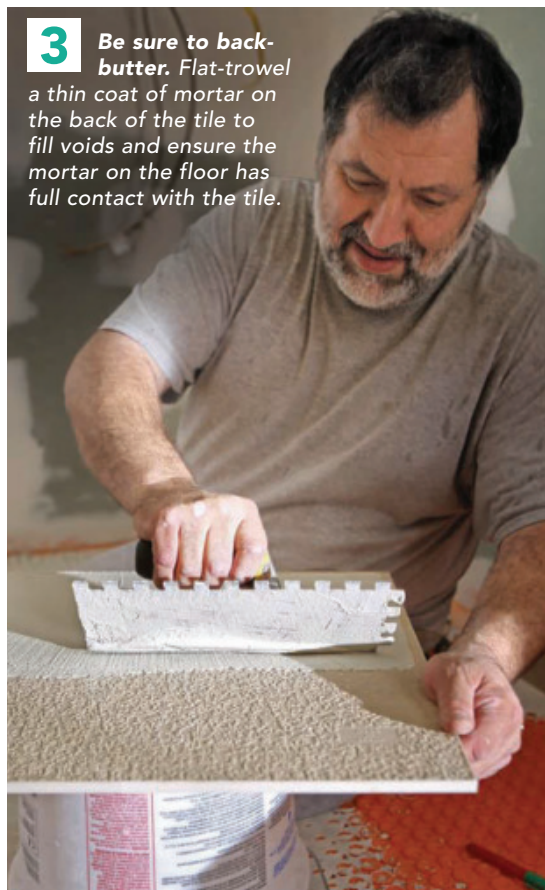
When setting large-format tile, correct mortar selection is extremely important. Use LHT (large, heavy tile) mortar, which is also called medium-bed mortar, because it will not sink down under the weight of the tile. Regular mortar will compress as it sets and cause lippage between the tile edges. With a cement-board underlayment, you must use a latex-modified LHT mortar, but setting tile over plastic underlayment usually calls for non-modified mortar. Here I used Mapei's Kerabond T mortar, but Laticrete, Custom Building Products, and TEC all manufacture non-modified mortars I've used successfully.



1 **Burnish the mortar.**
Use the flat side of the trowel to completely fill the voids in the underlayment with mortar.



2 **Comb it out.** After spreading the mortar in a uniform direction, set one end of the tile perpendicular to the furrows, then drop it in place so it pushes the air out and beds fully.



3 **Be sure to back-butter.** Flat-trowel a thin coat of mortar on the back of the tile to fill voids and ensure the mortar on the floor has full contact with the tile.



4 **Clean as you go.** After setting each tile, use a margin trowel to remove excess mortar from joints and edges that could interfere with grouting.

CLAMP THE TILE EDGES TO AVOID LIPPAGE

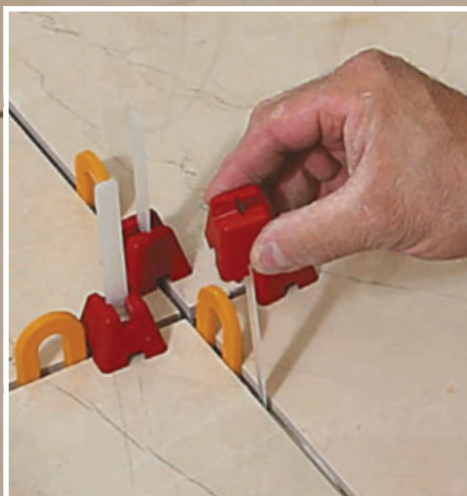
Any warpage in large-format tile is magnified by its size and made more apparent by narrow grout lines. (Plus, if you're using square-edged tile, there's no roundover that might disguise lippage.) Mortar shrinks as it dries, so a floor that may have been perfectly flat after installation at 4 p.m. won't be flat by 7 a.m. the next day. To help avoid lippage, various manufacturers make leveling systems that ensure your tile achieves a flat finish by holding it in plane as the mortar sets. All of the systems have some kind of base that is slipped below the tile into the fresh mortar, and some way of pulling against that base with a strap. I like the Tuscan Leveling System, which uses a clamping tool to pull the clamp tight, similar to how a nylon cable tie works. Other systems work by driving a wedge through the strap and against the tile or by threading a plastic nut down the strap, but I've found that those systems can scratch softer tile. All of the systems have some means of breaking the strap off below the tile after the mortar has dried, leaving the base in place to be hidden by grout.



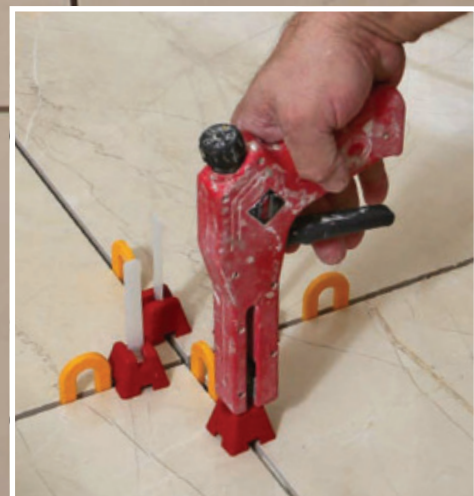
4 Break off the strap. After the mortar has set, use a second setting on the gun to pull hard enough on the strap to break it at its connection to the base.



1 Slip in the strap. Lift the tile slightly with a margin trowel to help keep from pushing mortar out with the strap.



2 Cap the strap. Place the special cap that allows the strap to be pulled up, but captures it so it can't move backward.



3 Tighten the clamp. Use a proprietary gun to pull up the strap while holding the cap down, creating clamping force to draw the tiles into plane.



Quick Curves With Steel

Light-gauge steel makes creative deck framing easier

BY JOE CIARALDI

We use curves a lot when we build our decks. Sometimes they can solve design problems, like by avoiding existing landscaping or providing extra deck space for a table and chairs. Other times, the curve is all about aesthetics.

Not surprisingly, curves add significant labor and expense to a deck project. We find the process is easiest when you start with a steel deck frame. A steel frame costs 30% to 40% more than treated lumber, but the ability to quickly adapt the components to form

a curve make it worth the expense. Plus, customers like the uniform dark brown of the Trex Transcend steel joists and beams that we use, and the rot and insect resistance are icing on the cake.

Our crew likes how the steel components are lightweight and dead straight. Although we can usually convince clients to go with the steel track and joists once we explain the advantages, Trex's matching metal support posts are expensive (\$150 each), so most clients opt for pressure-treated wood posts wrapped with PVC trim boards. The match-

ing guardrails start out as pressure-treated posts bolted to the framing with Thrulok fasteners (fastenmaster.com), which are then covered with PVC post sleeves (see "A Field Guide for Prefab Railing," *FHB* #266, pp. 68-73). The curved rail parts start out as straight rail parts made by Trex. We create the curve by heating up and bending the straight rails on site (pp. 71). □

Joe Ciaraldi is a remodeler and deck builder in Salem, N.H. Photos by Patrick McCombe, except where noted.



Why steel?

STRAIGHT AND STRONG

With consistent dimensions and no knots or other defects, steel can span longer distances than similarly sized beams and joists made from pressure-treated wood.

LESS WEIGHT, LESS WASTE

A light-gauge steel joist is about $\frac{1}{3}$ the weight of a pressure-treated wood joist. Because there are no knots or wane, waste is minimal and what is left over is recyclable.

ROT- AND INSECT-PROOF

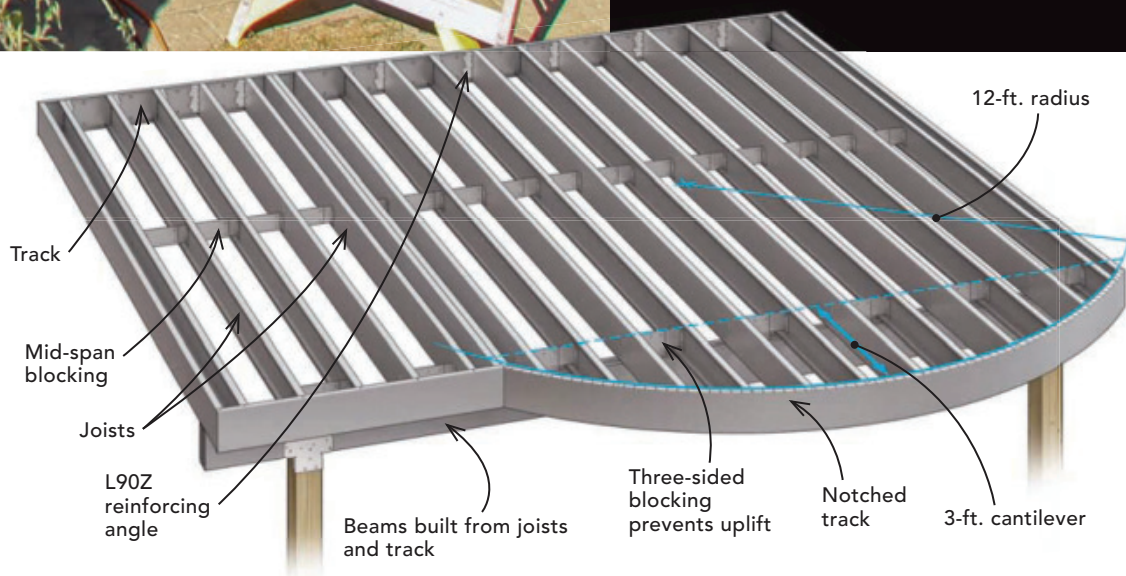
Steel framing is rot-proof and insect-proof, making it a good choice for outdoor projects. A zinc coating on the steel prevents rust.

MAKING THE SWITCH IS EASY

Steel framing is arranged much like wood, with ledgers, beams, joists, and blocking. You'll need a metal-cutting circular saw and a grinder for cuts, plus an impact driver for fastening.

SIZING THE STEEL

When framing a curve, joists must be long enough to reach the center of the curve. The curve is transferred to the joists using a 12-ft. string to reproduce the radius. We build our decks to 75 psf (pounds per sq. ft.) for the region's sometimes heavy snow, but Trex has span tables for loads from 50 psf to 200 psf as well as details for supporting beams, post connections, and cantilevers.



FRAMING A CURVE

To reduce mistakes and allow us to tweak the radius for the best look, we run the joists long and cut them in place. Field cuts are hit with color-matching spray paint to prevent corrosion.



Swing an arc. Starting at a point 12 ft. from the center of the overhanging curve, we swing an arc to transfer the radius to the other joists. Once the length is established, a plumb line is drawn on the side of the joists to guide the metal-cutting saw.



Cut the joists. A metal-cutting circular saw spins slower than a conventional circular saw and has a shrouded blade to contain the hot chips. A 4-in. or 5-in. grinder is good for odd-shaped cuts and notching the steel framing components.



Notch the rim joist. By cutting through the top and bottom flanges of the 8-in. track, the rigid metal gets spaghetti-soft and conforms easily to the curve.



Fasten the rim joist. Guided by the plumb vial of a magnetic torpedo level, the track is fastened with self-drilling screws through the top and bottom flanges into the joists.

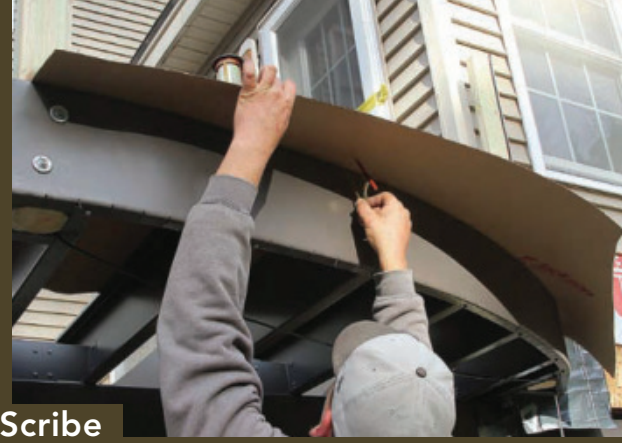
Finishes made to fit

The curved border and guardrail components are heat-formed with a propane-fired oven that can heat two 8-ft. parts at a time.



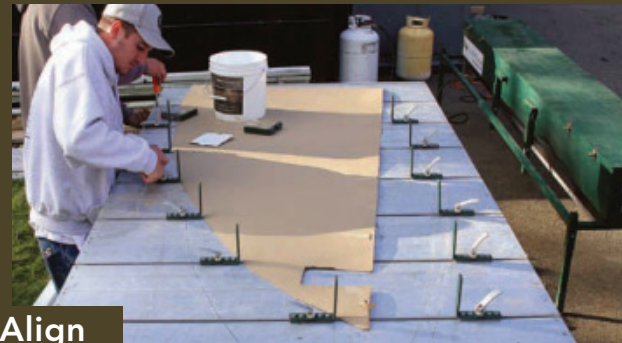
1 Scribe

The curve is scribed onto cardboard and cut to create a template for bending the border and railing. The compass is set to accommodate the fascia board, overhanging deck board, and PVC boards temporarily used in the bending process.



2 Align

The template is taped to the bending table and the form clamps lined up with its edge. The cam-style clamps ride in T-slots and exert pressure on both sides of the curving border and rail parts.



3 Bend

The deck board that creates the curving border is heated for about two hours in the oven before it is pliable enough to bend. Gloves are a must for handling the hot board.



4 Clamp

With PVC boards protecting the edges, the curved border and rail parts are clamped in place. Once clamped, the parts are cooled with water from a hose that's equipped with a watering nozzle.





Make it Modern



A sensitive path to updating a traditional home with modern design details

BY DAN HISEL

There are few design topics that spark more disagreement than the addition of modern details to older, traditional homes. And there are many legitimate reasons why. Some feel that modern renovations might hurt the resale value of a home. Others are concerned about the home fitting in with other houses in the neighborhood. Many homeowners in historic districts are indeed limited by guidelines that demand conformance to a historic style. Still, there are good reasons why my firm is not shy about taking a modern design approach when remodeling older homes.

For one, many of our clients are interested in modern architecture and are frustrated by the lack of modern homes in the New England neighborhoods where we work. Unable to find a house that suits their style, they purchase older homes and come to us to help bring them into the 21st century with modern details and technologies that improve the home's performance and express their personal sensibilities.

Another reason for taking a modern approach is that nearly all homeowners renovating today are interested in three related goals: an open floor plan where the social spaces in the house (especially the kitchen) flow into one another, additional daylight with more glass, and a stronger, more fluid connection with the outdoors. These ideas all originate in the modern movement, and it is our belief that they require a modern expression. When done well, old and new can coexist comfortably.

Here, I'll offer a systematic approach to modernizing an older home based on a project we completed at 9 Salem Ave. in Newburyport, Massachusetts, one of the oldest neighborhoods in the country. The home was originally built around 1800, probably by shipbuilders working on the docks nearby.

Identify the home's identity

Before we start a project on an older home, we research any legal constraints on the property, includ-

Continued on page 52



BEFORE

OPEN IS MODERN



Today's open floor plans are a modern idea, and they should be articulated with modern design. But this doesn't mean you can't keep some of the home's original character intact. Looking toward the front door in this remodel (photo far right), you can see the beams in the ceiling where walls were removed and catch a glimpse of the original stair details. The large window seat allows people to occupy a unique place that is simultaneously inside and outside. Framed in bamboo plywood, the window seat is intentionally different in style from the small double-hung windows that were kept elsewhere to maintain the home's original character. Large sliding glass doors open the previously dark interiors to sunlight and views of the yard. Outside, the doors are set apart from the original home with a sculptural wall and a roof overhang that also offer privacy and shelter (photo above).



A PLAN, DECONSTRUCTED

The "Before" plan shows the small rooms and limited views of the original house. The front hall is especially cramped and dark, as are the kitchen and dining rooms. Reinventing the first floor meant removing walls to open up the space. The most significant change on the second floor was making two baths out of one, which gave the homeowners a master suite and a separate bath for the second bedroom.

First floor





SPECS

Bedrooms: 3

Bathrooms: 2 full; 2 half

Size: 2,300 sq. ft.

Cost: \$130 per sq. ft.

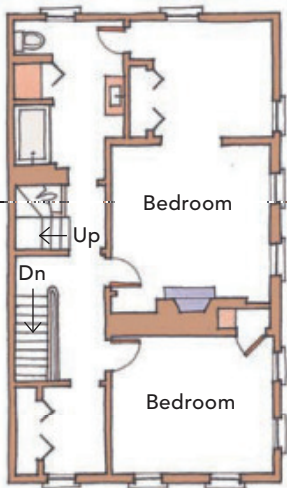
Completed: 2008

Location: Newburyport, Mass.

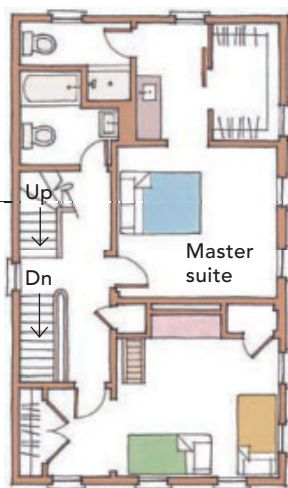
Architect: Dan Hisel, danhiselarchitect.com

Builder: Britton Construction, Inc., brittonconstructioninc.com

Second floor

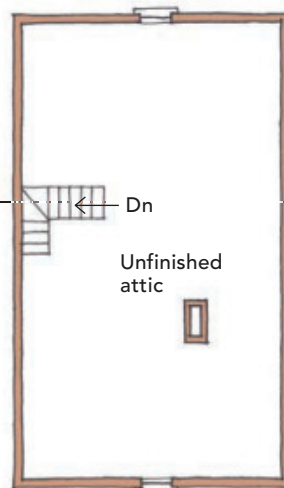


Before

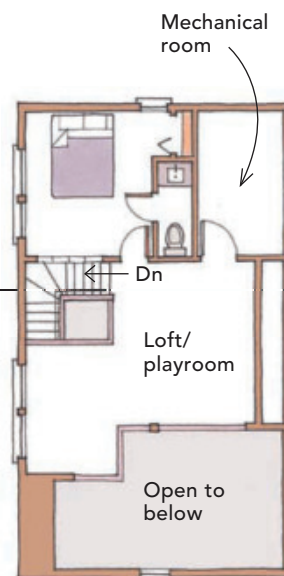


After

Attic



Before



After

Still charming. From the street, the house appears largely as it has for many years. The modern renovations are held back from the front of the house and are designed to help draw a clear distinction between what is original and what is new.



Continued from page 49

ing those imposed by planning and zoning regulations, historic districts or commissions, or neighborhood covenants. Then, after a complete debriefing with our client to gain a full understanding of their goals, the next order of business is to become familiar with the house itself. We learn what we can about its history and identify the primary attributes that give the house its character.

Newburyport is full of marvelous examples of historic architectural styles, from Federal to Georgian to Victorian. The house at 9 Salem is one of many Greek Revival homes built throughout Newburyport in the mid-18th century. The house is set close to the sidewalk and has a simple gable form with an asymmetrical front door. It is one room wide and three rooms deep, with double-hung windows arrayed more or less evenly around its elevations. The identity of this house is its essential simplicity; it's Monopoly-house iconography. We decided to save this traditional form, along with its entry and window placement, and it became our partner in the design process.

An important thing to note about this house is that, at the time of purchase, it had suffered many years of abuse and neglect as a rental property. The interiors were dark and dingy and almost completely devoid of historic character. The house's overall condition was only marginally salvageable. While the roof was in OK shape, the windows were old and leaky, the shingles were at the end of their lifespan, and the systems throughout the house were in a very poor state. There was also a very ugly and dilapidated shed-roofed addition off the back, useful only as storage, which we elected to demolish in order to get more light into the kitchen.

Restore significant details

Most projects we work on do not call for historic preservation, per se. That is the territory of restoration experts and professionals trained in the forensics of historic-building practices. Our projects—and most



of the houses available on the market today—are not historically significant. So, while we attempt to honor the character of the older structures, we do not treat them as precious objects.

We did elect to retain several historic details of the 9 Salem house, including the hallmark Greek Revival front entrance and corner boards on the exterior, and the stair railing and newel post inside. The entry trim was in keeping with details found around the neighborhood, and, while not terribly remarkable, the balustrade had some nice curves and traditional details.

We replaced the leaky old windows with new Andersen 2-over-2 double-hung windows with insulated low-e glass, which allowed us to keep the historic look while updating the performance of the windows. We have also done other projects in which we restored and reinstalled old windows along with new storm windows to increase performance. The pros and cons of these window strategies should be weighed for each specific home and budget.

We also did a lot of nonaesthetic work at 9 Salem. We installed new insulation and heating and cooling systems and replaced the electrical and plumbing systems in full.

Let the new look new

The owners of 9 Salem were interested in opening up the plan of the first floor to create spaces that flowed into each other and allowed the family to be together while doing homework, making dinner, work-

ing, and hanging out. They also wanted to brighten the dim interiors and open the interior spaces to a new deck and the backyard. This list of objectives was impossible to achieve within the small partitioned rooms of the old house, with their small openings and double-hung windows. As I mentioned, our philosophy is that these new details require contemporary forms.

The new interiors are now unabashedly modern, with clean white walls and simple rectangular trim. In order to get more light into the house, we added large sliding doors and a sizeable window seat to the interior living space. The lounge where the window seat is located is quite small, so the seat is a functional solution that provides space for family and friends to gather. It's large enough to accommodate two adults, and because it straddles the interior and exterior of the house, the bamboo plywood box allows its occupants to enjoy the warmth of the fire inside while feeling as if they're sitting in the garden.

Bring the plan outside

The blurring of interior and exterior space is one of the central tenets of modern architecture. The easy flow and communication with nature reflects a philosophy of the outdoors as healthy and therapeutic rather than dangerous and threatening.

At the 9 Salem house, the large sliding glass doors open onto an outdoor living space where the kids can play and the family can dine. These large sliders needed to be installed in walls alongside traditional double-hung windows, which presented certain design

"While we attempt to honor the character of the older structures, we do not treat them as precious objects."

challenges. Our solution was to frame the sliding glass doors with contemporary Ipe walls and overhangs that achieve several goals. The walls provide the deck with privacy from the street, while the roof overhang provides weather protection and passive-solar shading for the large sliding doors. The deck is quite low to the ground, which eliminates the need for railings and gives the new exterior details a sculptural quality.

Respect Scale

Our renovations at 9 Salem were modest, due in part to a limited budget and a shared desire to keep the modernity to a scale that could be described as subtle or quiet. This is not to say that there isn't room for bold gestures and dynamic forms, but it's a good rule in general to be aware of the scale of renovations as they relate to the original form. This, perhaps more than anything else, is how modern renovations come to exist in dialogue with, rather than opposition to, the neighborhood and community. □

Dan Hisel is an architect in Arlington, Mass. Photos by Eric Roth. "Before" photos courtesy of the author.



Clean is timeless. Cabinetry and trim with very clean lines provide a timeless style in the kitchen, where concrete countertops and a back-painted glass backsplash add a touch of modern style and sophistication.

Faster Drywall



14-in. Flat Box
For ceilings
with raking
light, \$340

3-in. Nail Spotter
Coats screw
heads with
compound, \$300

12-in. Flat Box
Applies second
and third coats
to seams, \$330

8-in. Angle Box
Works with angle
heads (\$350 ea.) to
coat corners, \$389

Angle Head
Smooths corners
after taping and
rolling, \$350

Corner Roller
Fully embeds
tape in
corners, \$200

Loading Pump
Fills taping tools with
compound, \$390

Automatic Taper
Applies compound
and tape to seams
and corners, \$1300

Finishing

Automatic tools produce better walls in less time

BY BRIAN KITCHIN AND NICK AITCHISON



Festool Planex
Dust-collecting
drywall sander, \$1150



15-in. to 23-in. Drywall Stilts
Brings high work
within reach, \$280



Festool CT 36
Tool-triggered
dust-collecting
vacuum, \$756



Whenever we see professional drywall finishers hand-taping a new home or addition, we wonder how the builder who hired them can afford to lose so much time on the job. With modern taping tools—most of ours are made by Columbia (columbiatools.com)—the two of us can tape and finish an entire 2,400-sq.-ft. house in about four-and-a-half days. The same work with hand-taping tools would easily take two or three times as long.

So why do some drywallers stubbornly refuse to use automatic tools? Our guess is they're intimidated by the learning curve—it takes a few jobs to become truly proficient—or they're scared off by the price of a setup.

If you're not willing to spend \$3,200 or more to buy the tools all at once, you can significantly boost your efficiency with a pair of flat boxes and a loading pump to fill them, which adds up to about \$1,300. In a second round of purchases, get an automatic taper (\$1,300) and an angle box with 3-in. and 3½-in. angle heads (\$750) for finishing corners. Another option is to rent equipment from drywall tool manufacturers. □

Brian Kitchen and Nick Aitchison are *FHB* ambassadors and the owners of Drywall Nation in Sudbury, Ont. Photos by Patrick McCombe, except where noted.

LOAD THE TAPE AND MIX THE MUD

Automatic taping tools all require thinned mud to work properly, so we use a sopping-wet grout sponge to add water to lightweight all-purpose joint compound. Then we mix the thinned mud for a few minutes with a heavy-duty drill and a mud paddle. Mud for the automatic taper gets 5 to 6 sponge squeezes, mud for angle boxes gets 4 to 5 squeezes, and mud for flat boxes gets 2 to 3 squeezes.



Better tape. Though it costs more than paper joint tape (\$5 vs. \$2 per 250-ft. roll), FibaFuse tape bonds tenaciously and doesn't bubble.



Just add water. Compound must be thinned and thoroughly mixed before you can use it in automatic taping tools.



Quicker corners. When taping inside corners, flip a lever on the tool's housing to deploy the creaser wheel, which folds the tape and pushes it into the corner.



Photos upper left: Rodney Diaz



Faster taping. Loaded with joint tape and thinned compound, an automatic taper can tape seams and corners quickly. As the tool advances, it rolls out the tape and dispenses the compound at the same time. Another finisher on the three-person crew follows behind with a taping knife to fully embed the tape and smooth the joint.



Go tall. Adjustable and available in multiple heights, stilts allow you to safely reach tall ceilings with the automatic taper without having to stop and move a stepladder or rolling scaffold.



Go long. Angle heads, flushers, rollers, and spotters can be equipped with extension handles to reach tall walls and ceilings. Most tools have universal mounts that make the handles and heads interchangeable between manufacturers.

FINISH COATS FEATHER OUT FASTER



Flat boxes fill seams. Equipped with a brake that holds the box parallel to the wall during positioning, flat boxes are used to coat and smooth seams. Once the box is in place, release the brake and the box will pivot on the handle.

Like with hand-taping, joints and corners get progressively wider with the second and third coats of compound. Most drywall contractors who rely on automatic tools have flat boxes and angle heads in two or three widths.



Adjust the flow. The eccentric cam adjusts the flow, so you can determine the amount of compound to dispense. The idea is to fully coat the seam without excess and leave a smooth finish free of voids as you go.



Spotters fill screws. Made in 2-in. and 3-in. widths, screw spotters are used to lay down a stripe of compound to cover drywall nails and screws.

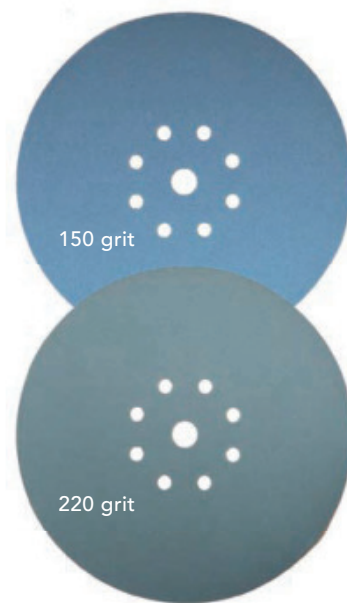


Angle box for corners. Adaptable to angle heads of various sizes, an angle box dispenses an even coat of compound to both sides of an inside corner.



Handwork is still required. Automatic tools can finish a large part of the job, but you still need to know how to use hand tools for corner beads, repairs, and tight spots, like this AV equipment built-in.

Faster, easier sanding. Attached to a tool-triggered vacuum, a drywall sander captures nearly all the dust. It's also less taxing because the orbital sanding disc is doing much of the work and the suction helps hold the sanding head to the drywall.



Blue grit

Before applying the final coat of compound, sand the joints and corners with 150-grit sandpaper. The final coat of compound is sanded with 220-grit paper. Festool's 8½-in. discs are color-coded for easy identification.

TOOLBOX



Hand-sand corners. Drywall sanders don't reach all the way into inside corners and tight spots, so these areas must be touched up by hand with a traditional pole sander.

CELLULOSE The



DENSE-PACK

In new construction, dense-pack cellulose is often blown behind an air-permeable polypropylene netting using a professional blowing machine. Achieving the proper density (at least 3½ lb. per cu. ft.) pushes the netting out beyond the face of the framing, so installers use an aluminum roller to flatten the material prior to hanging drywall. Properly installed, dense-pack cellulose is fully self-supporting, even if the netting is removed.

Cost-effective, versatile, and green, cellulose may be the hardest-working insulation available

BY MICHAEL MAINES

No other insulation takes less energy to produce, uses more recycled content, or is less toxic to humans than cellulose. It has respectable R-values, resists air movement, absorbs sound, and is highly resistant to fire, pests, and moisture. No insulation is perfect for every situation, but my first choice whenever it will do the job is cellulose.

A lot of older attics feature a thin layer of flaky, dusty cellulose, blown in sometime



LOOSE-FILL

Loose-fill cellulose is typically seen in attic floors. Densely packed bales of cellulose are broken apart and fed into the cellulose blower's hopper, where the material is agitated and blown onto the attic floor through a 2½-in.-dia. to 4-in.-dia. semicorrugated hose. To stop air leaks, installers

between the 1950s and 1970s, but cellulose didn't really take off until the 1990s, when high-powered blowers, insulation netting, borate treatment, and fiberizing combined to create an insulation product that was cost-effective and versatile with three common methods of installation: loose-fill, dense-pack, and damp-spray.

The installation cost of loose-fill, which is most common on attic floors, starts at \$1.30 to \$2 per sq. ft. of floor. This assumes you're

Perfect Insulation



must first air-seal any penetrations (can lights; holes around pipes, ducts, and cables; and the gap around chimneys) before blowing. Loose-fill settles about 10% after installation, so this must be accounted for when planning how deep to blow in the insulation.



DAMP-SPRAY

Damp-spray adds water and sometimes adhesive to the cellulose fiber at the end of the blowing hose so the cellulose sticks to the framing. Cavities are overfilled and then the excess removed with a rotating brush and vacuumed up for reuse. Although damp-spray involves less prep work and installs faster than dense-pack, it's tough to find installers who use this method, and it doesn't work for roofs or ceilings as it doesn't adhere well enough to support its own weight.

working with a reasonably accessible attic and an insulation layer from R-38 to R-60. Expect to pay several hundred dollars more for setup, breakdown, and air-sealing measures.

The cost of dense-pack installation, which is used in both new construction and remodeling, starts at about \$2 per sq. ft. of wall area. Projects with difficult access and those requiring scaffolding or extension ladders will cost more, as will air-sealing measures. Double-stud walls and extra-deep ceiling

cavities also cost more (in the \$3 to \$4 per sq. ft. range), and are best done by creating "cells" with scraps of netting, as large cavities don't allow for consistent packing.

I'm not aware of any damp-spray installers here in Maine where I work, but I'm told it works out to \$1.25 per sq. ft. for 2x4 walls and \$1.75 per sq. ft. for 2x6 walls.

In addition to the bagged product used in the three installation methods described above, one company, Cellulose Material

Solutions (cmsgreen.com), makes cellulose batts and blankets. The batts are meant to replace fiberglass or mineral-wool batts and the blankets give fans of cellulose a replacement for rigid foam and semirigid mineral-wool insulation. □

Michael Maines is a designer in Palermo, Maine and a frequent *Fine Homebuilding* contributor. Photos by Patrick McCombe, except where noted.

ONE MATERIAL MULTIPLE METHODS

Whether it's dense-pack, damp-spray, loose-fill, or made into batts or blankets, all cellulose insulation starts with the same raw material: recycled paper. Most manufacturers use recycled newspaper (80% to 85% by weight) to make cellulose insulation, although new start-up UltraCell (ultracellinsulation.com) is working on cellulose made primarily from recycled cardboard, which is less dusty than newspaper. The remaining 15% to 20% of the cellulose mix is boron compounds, which act as a fire retardant and pest deterrent. Some products substitute ammonium sulfate, sodium sulfate, or magnesium sulfate for some of the boron compounds. These sulfates are less expensive fire retardants, but there are some claims of an unpleasant odor and possible corrosion issues when exposed to moisture.



R-value

The R-value of cellulose is based mainly on its installed density, with denser installations generally delivering higher R-values. Loose-fill cellulose has an R-value of R-3.7 to R-3.8 per in., while damp-spray and dense-pack assemblies are rated at R-3.6 per in. or higher depending on its installed density. The difference in appearance between a proper dense-pack installation and one with a lower R-value that is prone to settling or air leaks is tough to spot in existing construction, so you should ask for empty bag counts from the insulation contractor. Knowing the weight and number of bags blown and then doing some quick math to determine the density of the installed insulation will ensure you're getting a quality job.



Fire control

Cellulose insulation is so fire-resistant you can melt a penny with a propane torch while it sits on a handful of cellulose and the material will be only slightly charred. Its performance during a fire is backed up by its Class 1/Class A fire rating (it has a flame-spread rating of 15 or less and a smoke-developed index of 5 or less). These properties mean that cellulose will smolder, but it won't burn without applying a high-temperature flame. Nu-Wool and other manufacturers offer over 50 UL-listed fire-rated assemblies, some providing up to three hours of fire resistance.



Air control

Cellulose is not technically an air barrier on its own, although at sufficient densities it can slow air movement enough to meet the envelope airtightness requirements of the 2012 IRC (3 ACH50 for most climate zones) without an additional air barrier. Cellulose's air-sealing qualities are especially useful in retrofit work where existing walls are left intact and the cellulose is installed through holes made in the home's exterior or interior. Cellulose is also less affected by wind-washing—a condition where air moving past the insulation reduces its insulating ability—than unprotected fiberglass batts or blown-in fiberglass. (See assembly details pp. 64.)





Sound control

Cellulose performs well in assemblies meant to minimize sound because its small fibers fill the voids that transmit high-frequency sound and its density helps dampen lower frequencies. One maker's testing shows that a cellulose-insulated 2x4 wall spaced 16 in. on-center with no exotic sound-control measures (only cellulose and air-sealing) could achieve an STC (sound transmission class) of 41, and a double-stud wall could reach STC-61, which is virtually soundproof. According to the same company, a typical wall insulated with fiberglass batts is STC-39.



Water resistance

Due to its unique makeup, cellulose has a helpful relationship with water. It can take on and release moisture seasonally as it pulls moisture away from framing and sheathing. Research done by Building Science Corp., a leader in building science and technology, found that although computer modeling predicted high moisture levels and data loggers confirmed this on a superinsulated project in Western Massachusetts, when they opened the walls they found no evidence of damage.

BALES



Environmental impact

According to the Cellulose Insulation Manufacturers' Association, cellulose production diverts almost one-million tons of paper waste from landfills annually in the United States, and insulating a single 1,500-sq.-ft. house with cellulose will recycle as much newspaper as an individual will consume in 40 years. As long as the recycled content is at least 10% (it usually is) and is manufactured within 500 miles (there are a lot of manufacturers spread throughout the country), cellulose insulation is worth LEED points and the NAHB's Green Building Program points.



Mold/fungus resistance

Testing conducted by Building Science Corp. found no evidence of mold or fungal growth in cellulose insulation, even when environmental conditions are conducive to growth (meaning 100% relative humidity and temperatures above 50°F.) A four-year study conducted at Truman State University found that even a 5% borate treatment was enough to effectively halt mold and fungal growth, and cellulose includes even higher percentages of borates (in the range of 15% by weight) in order to meet fire-resistance requirements.

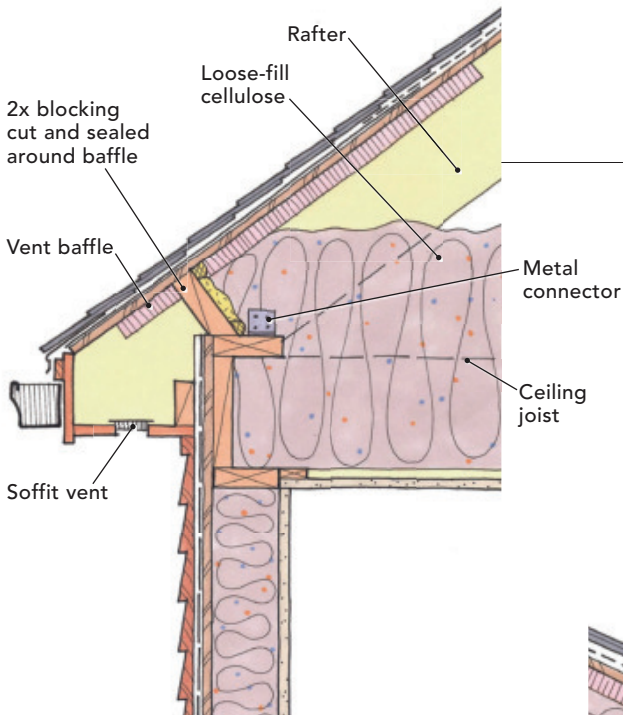
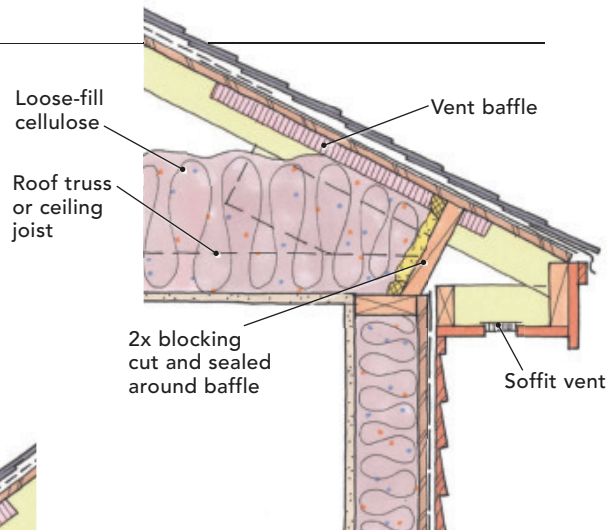
CELLULOSE The Perfect Insulation

COMMON ASSEMBLIES

Like any air-permeable insulation, cellulose will only perform to its highest potential if installed as part of a well-designed assembly that controls airflow.

Loose-fill attic

Inexpensive and effective, a loose-filled attic is the most common use of cellulose insulation. Before blowing, any penetrations and air leaks in the ceiling drywall should be sealed and vent baffles installed to provide ventilation and reduce wind-washing.

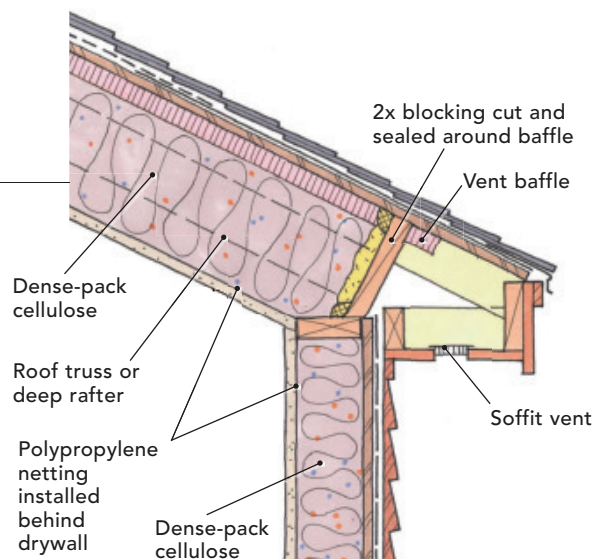


Deep loose-fill attic

Moving the top plate and rafters up to the top of the ceiling joists provides more room for a deep layer of cellulose. Complete any air-sealing before installing the insulation. Extra-deep fills (more than 12 in.) may require strapping or other reinforcement of the ceiling drywall, especially when framing is 24 in. o.c.

Dense-pack wall and ceiling

Contained with non-woven netting stapled to the framing, dense-packed walls and ceilings should be blown to a density of at least a 3½ lb. per cu. ft. to prevent settling and achieve the specified R-value. Cavities deeper than 12 in. should be divided into smaller sections with the netting so they can be filled enough to resist settling.





Dense-packing takes time

With dense-pack cellulose, installing the polypropylene netting (insulweb .com) often takes as long as filling the bays. Properly installed, the netting is tight and usually “lip stitched,” meaning it’s fastened to the corners of framing members and not just to the face that receives the drywall. Deep cavities also require that installers create smaller cells within the cavity, so the cellulose can be installed at a high enough density to resist settling. Installers use an upholstery stapler with an extended magazine to fasten the netting, and the spacing between staples should be so tight that the staples nearly touch.

COMING TO A JOB NEAR YOU

If you’re using cellulose for the first time, you’ll want to keep these things in mind.



You still have to air-seal

Like all fibrous insulation, cellulose requires proper air-sealing to work effectively. Gaps around windows and doors as well as any other penetrations in the air barrier should be fully sealed. Although some weatherization professionals prefer air-sealing tapes or non-hardening acoustical sealant, canned spray foam is generally the go-to choice for filling most small or narrow gaps. Larger holes and gaps are closed off with rigid insulation held in place with a perimeter bead of spray foam.



Make room

Cellulose insulation contractors generally have a box truck or medium-sized trailer to house their tools, blowing equipment, and bales of cellulose. Although some trucks have a generator on board, most plug in to the house’s power and require two 15-amp circuits—one for the blower and one for the agitator. The smallest setups take up two parking spaces and dense-packing an entire house or large addition will have the truck taking up this amount of space for several days.



Take the Fear out of Brick Veneer

Basic masonry skills are all a remodeler needs to move a door or window in a brick wall

BY JOHN CARROLL

The first step when remodeling an exterior wall is to remove the wall covering. This is simple enough when the cladding is siding, but more complicated when a house is clad in brick. One scary part of remodeling a brick opening is removing the existing steel lintel that supports the brick above. Because brick's bonded pattern makes a self-supporting corbelled arch, most lintels only support a triangle of brick directly above them. You can often remove the bricks in this triangular area and those above will stay put. Other times, there are so few courses above the

lintel that it makes sense to take them all out—in openings of 3 ft. or less, often a few courses above the lintel can be removed and the mortar will hold the bricks temporarily.

In some cases, relying on the mortar or the corbelled arch is not safe. If an opening interrupts the corbelled pattern, there is no self-supporting arch. With wide openings, it might be impractical to remove enough of the bricks above. In these cases, you need a structural engineer to design a shoring plan.

Replacing the brick veneer takes special skills as well. The object is to make the new work match the old. Bricks can be salvaged

from the demolition, but that often doesn't yield enough for the remodeling job and cleaning off the old mortar is time consuming. The best solution is often to take a few bricks to a masonry supply house and see if they can find a good match, but that wasn't necessary here. These bricks were discontinued decades ago, but when he built this house in 1958, the owner's grandfather stacked the leftover bricks at the back of the lot.

Mortar accounts for about 20% of the surface of a typical brick wall, and its color and joint profile affect how well new work matches the old. Older mortar tends to be



OUT WITH THE OLD

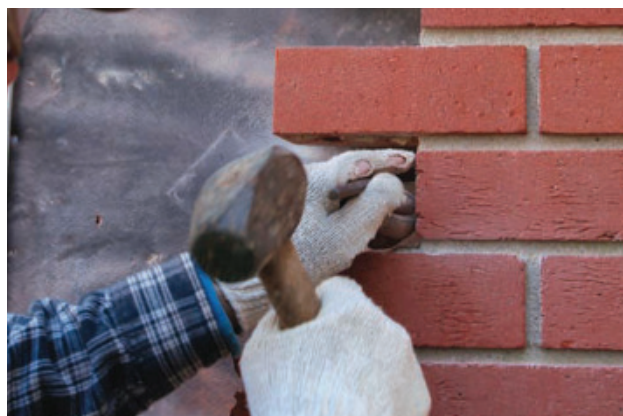
Before laying any new bricks, I had to tooth out the bricks on the sides, which were simply cut back far enough by the carpenter to leave room to install and flash the window. Tothing out bricks is challenging because half of every other brick is unsupported on the top and bottom, and these projecting halves break easily. The main tools I use are a rotary hammer with a 1/4-in. masonry drill bit, a masonry chisel, a 3-lb. hammer, and a grinder with a diamond blade. I don't try to take out whole bricks; instead, I break them into small pieces. As much as possible, I work inward from the ends of the bricks to place less stress on the surrounding brick and mortar.



Break the brick. To take pressure off the surrounding brick, first weaken the mortar by drilling a series of holes all the way through the joints, then break the brick by drilling holes from the outside in.



Grind away. A grinder removes mortar without shocking surrounding bricks, but this tool can only reach the outside edges because it doesn't fit between bricks.



Chisel where you must. Use a 3-lb. hammer and a 1/2-in. masonry chisel to clean up the remaining mortar. Tap lightly to avoid damaging the brick.

lighter and tanner in color than modern mortars, which are often gray. To match mortar, you'll need samples. Play around with different cements and dyes (*FHB* #258, pp. 60-65) and give your samples about three weeks to dry to ensure the closest match.

This process sounds intimidating, but many remodelers already have the majority of the tools to do the work, and just need to learn the right techniques for the job. □

John Carroll is a mason and remodeling contractor in Durham, N.C. Photos by Andy Engel, except where noted.

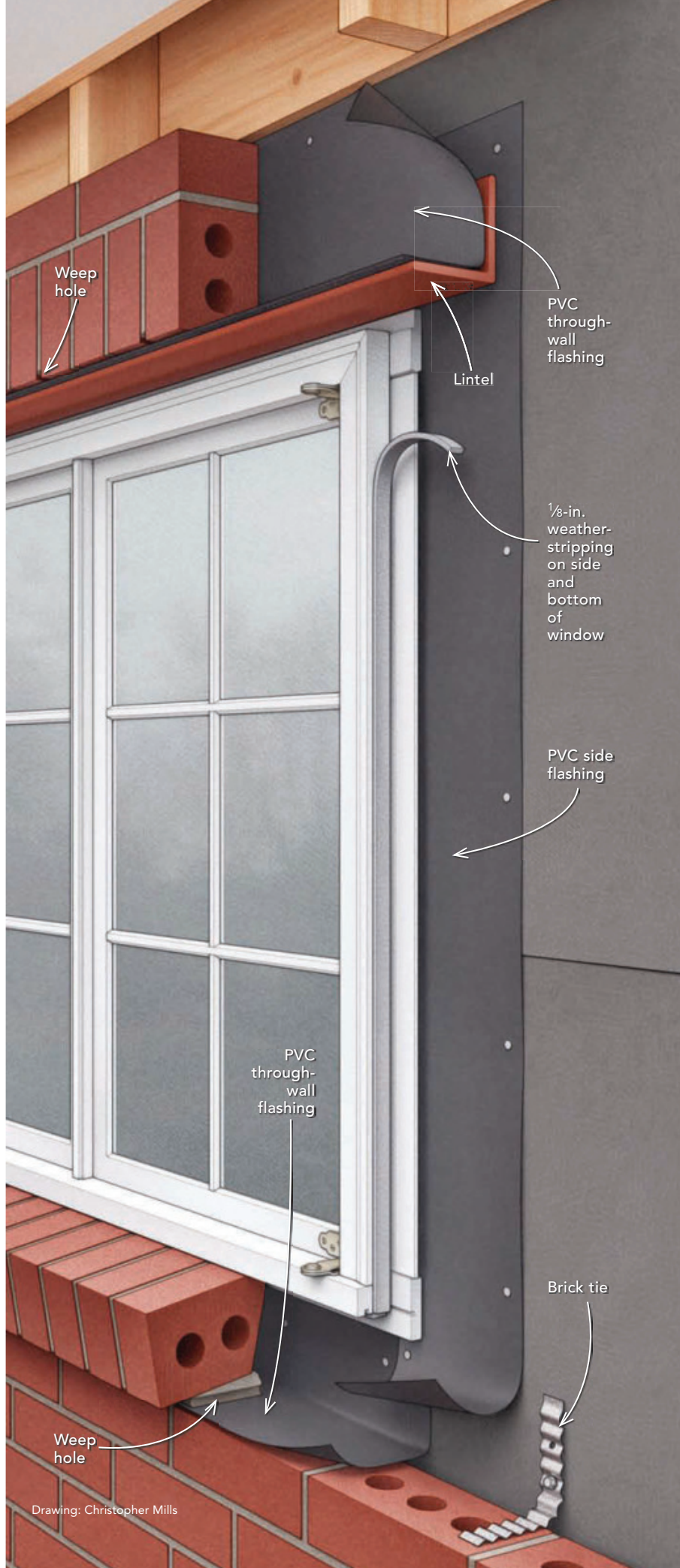
MANAGE WATER AND MOVEMENT

Like all types of siding, brick isn't waterproof. You have to plan for and manage water that gets behind it. A carpenter usually handles integrating the window flashing with the weather-resistive barrier (WRB) on the sheathing, but with brick you have to go a step beyond and lead water out to the face of the brick below the window. For this I use PVC through-wall flashing, available at masonry supply houses. And because the frame of the house and the brick veneer expand and contract at different rates and for different reasons (the wood frame due to changes in moisture content, the brick in response to temperature swings), it's important to keep the two from contacting each other to allow for movement differentials.

Get water out. PVC flashing runs from below the windowsill and is trimmed even with the brick face. Flashing that's run down the side of the window laps the sill flashing.



Foam for a gap. To hold the bricks a consistent 1/8 in. away from the window and provide a backer for sealant, apply foam weatherstripping along the window sides and beneath the sill, about 1/4 in. back from the face.



Drawing: Christopher Mills

LAY SOME BRICKS

I lay the bricks along a string stretched evenly across the top of the existing bricks, raising the string with each course. To tie brick veneer to the framing, galvanized straps are required every 16 in. horizontally and every sixth course (about 16 in.) vertically. I screw the straps to the studs with 1½-in. galvanized structural screws, which make a strong attachment but don't go so deep as to puncture a wire or pipe. A common question is whether the weight of additional courses of brick will squeeze out the freshly laid mortar below. Unless there's a point load—for example, from a lintel—this isn't a problem.



Butter the bed and head joints. Place enough mortar in the horizontal “bed” joint to fully support the brick. Any extra will squeeze out. Use a wiping motion with the trowel to “butter” the vertical head joint on the end of the brick.



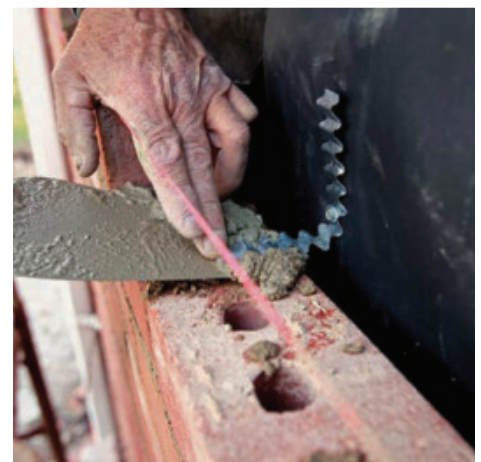
Mix the mortar right Mortar consistency makes all the difference. It needs enough body to support the bricks, but must be wet enough to stick when buttering the ends. I make 5 gal. at a time, measuring the ingredients in 1-gal. containers and mixing the dry ingredients with water equal to half the volume of the cement. This produces a stiff mixture, and I add more water to get to the consistency of cake batter. In this case, the total amount of water was about ¾ that of the cement.



Slip in the brick. Hold the weight of the brick in your hand as it's placed. Finish by tapping the end of the brick with the end of the trowel to compress the mortar in the head joint.



Pack in mortar. Fill bed joints between the new brick and the half of the brick above using a ¼-in. or ⅜-in. tuck pointer. Put a mound of mortar on the brick, and push it in until the joint is packed solid.



Bed the wall ties. Attaching wall ties just above where they bend takes the slack out of the tie. Embed the tie by lifting it up and pushing mortar under it as you spread mortar for the next bricks.

ADJUST THE PATTERN

I had to cut bricks on both sides of the window on each course. The pattern on the right side worked out so each course abuts the window with a substantially sized brick. On the left side, though, I had to adjust the pattern to avoid having a 1-in. piece at the end of every other course. Pieces of brick this small look like mistakes and are hard to cut and set. To allow a larger end piece, I shortened the second-to-last bricks in those courses. After reaching the top of the window, I stopped for the day to let the mortar set overnight so I could place the lintel.

Diamonds are a mason's best friend. Brick can be cut with many tools, from hammers to wet saws, but one of the simplest ways is with an angle grinder kitted out with a diamond blade.



Brick layout isn't cast in stone. To avoid having a 1-in. sliver of brick at the window, which would look like a mistake, the previous brick in every course was shortened by 1½ in.



Bigger bricks look better. Shortening the previous brick allows for a larger end brick that looks good and is easier to set. The change in the pattern blends into the wall almost unnoticeably.



TOOL THE JOINTS

Matching the profile of the existing mortar joints is key when blending new work to old. For this task, a variety of joint tools are available that shape the mortar into different profiles. If your local masonry supply house doesn't have a joint tool that matches your job, check online. Always wait until the mortar has firmed up before tooling the joints. The wait time depends on the temperature—mortar sets much



Cut off the excess. To properly bed bricks, you have to overfill the joints and let some mortar squeeze out. Remove the excess with a cutting motion so as not to smear it.

faster in hot, dry weather than on cool, damp days. The existing joints on this house were simply recessed about $\frac{5}{16}$ -in. deep. To match that joint profile, I used a wheeled joint raker (photo near right), setting the nail (a regular 10d common nail) to rake out the mortar to the same depth as the joints on the existing brick wall. After raking the joints, I used an old paintbrush to sweep away the crumbs.



Let the mortar set. Once the mortar has dried to a slightly crumbly texture, tool the joints to a consistent depth and shape. Work the head joints before the bed joints for a clean job.



Work in from the corner. A joint raker won't fit where the brick returns to the window, so a tuck point is used instead. To make a crisp, mortar-packed angle, work the mortar away from the corner.

SET AND FLASH THE LINTEL

By the next morning, the mortar had set and had plenty of compressive strength to support the lintel. Lintel size and required bearing area on the brick are governed by building codes and vary depending on the span. In this case, I used a 3½-in. by 3½-in. lintel bearing 4 in. on each end. Do not

fasten lintels to the house frame. The wood frame expands and contracts more than the masonry and tying the two together can crack the brickwork. To protect it from water that could cause rust, I covered the lintel with the same PVC flashing used at the sill and added weep holes in the joints.



Not much mortar for the lintel. The 5/16-in. thickness of the lintel is close to that of an ideal mortar joint. To keep the courses consistent, only a little mortar was placed under the lintel.



Butter the side. In the upright, soldier position, the brick surface that usually acts as the bottom becomes the side. For a consistent joint width, no mortar was used between the soldiers and the lintel.

Brick-spacing rules The total height of brickwork is adjusted via the thickness of the joints. Thicker joints make brickwork taller (or wider, in the case of bricks laid sideways like in sills or soldier courses), while thinner ones make brickwork shorter (or narrower). A brick-spacing rule

provides feet and inches on one side and several scales for laying out courses of varying joint thicknesses on the other. The brick spacing is marked A through K and represents 1/8-in. to 3/4-in. joint spaces. Each increment on a brick-spacing rule represents the thickness of one brick



FINISH WITH THE SILL

To shed water, sill bricks have to project about 1 in. past the brick below, and they have to slope. To keep the sill straight and at a consistent pitch, a brick is laid at each end and a string stretched across their top outside corners. To allow for a sloping placement, I cut the backs of the sill bricks at an angle. The exact angle isn't particularly important as long as it provides clearance to slide the brick under the windowsill.

Make a mud bed. Lay the angle-cut sill bricks with their long points hitting the weatherstripping applied under the window sill. The mortar will cover any layout marks, so check the spacing with a brick rule.



SOLDIER ON

The course of bricks above the window is dry-set on the flashing that covers the lintel. To match the rest of the house, I installed a soldier course here, which butts to the last two courses of running-bond bricks. These two courses stopped even with the courses abutting the window below, with the

first brick in the running bond resting partially on the lintel. I cut bricks for the soldier course to match the height of these two courses of running bond. I laid out the spacing for the soldier course with a brick-spacing rule, setting its end in $\frac{7}{16}$ in. to allow for the final joint.



Drain the brick. Water needs a way out. Soak $\frac{1}{4}$ -in. dowels in water overnight, and set one in a mortar joint every foot or so. In an hour or two, rotate and pull out the dowels.



Tie in the soldier course. Although a frieze board would have covered the top of the soldier course, a final course of running-bond brick was laid on top to lock the soldiers in place.

and one mortar joint. Keep in mind when planning courses between other brickwork (where a soldier course or a sill meets the brick to the sides, for example) that the rule doesn't account for the last mortar joint. Deduct about $\frac{7}{16}$ in. from the total to allow for the last joint.

Sometimes, shorter distances don't fall within the rule's increments. In those cases, you can use the increments as a starting point, and fudge the joints in the last several courses to make the layout work. Brick rules are available for standard-height bricks ($2\frac{1}{4}$ in.) and oversize bricks.



The final raking. To prevent blowing out the corners, rake the joints from the bottom halfway up, and then finish by raking down from above.



To see a video on how this wall was rebuilt, visit FineHomebuilding.com/magazine.

Building a Net-Zero Production Home

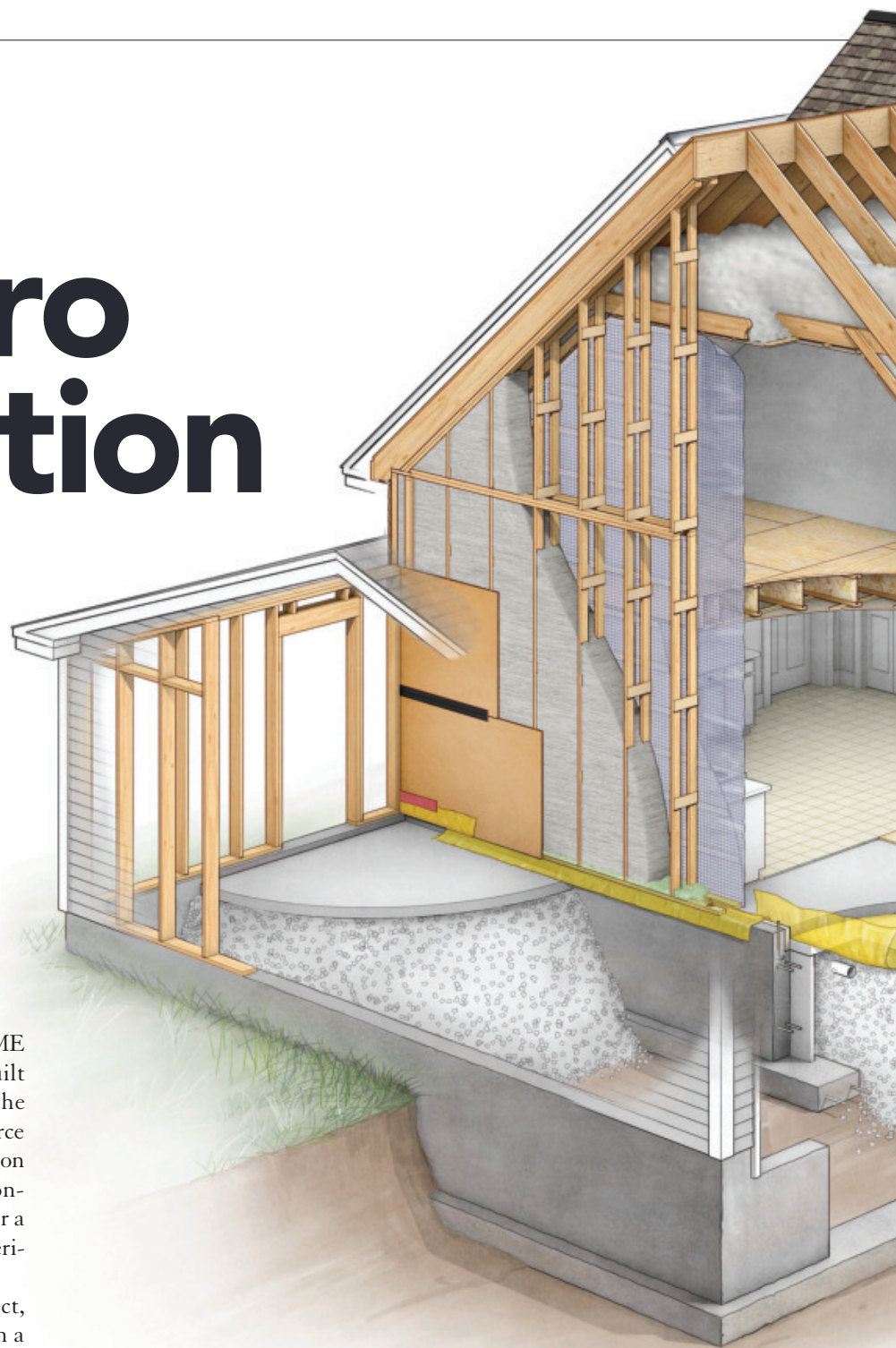
Low energy costs
don't have to come
at a high price

BY SEAN GROOM

Last year, *Fine Homebuilding* launched the ProHOME series with a custom-designed and custom-built demonstration house in Rhode Island. The ProHOME program was created as a resource for builders and designers. With an in-depth exploration of the different approaches builders take when constructing high-performance houses, we intend to foster a conversation about design, envelope assemblies, materials, and craftsmanship.

Building on the momentum from the 2016 project, this year's ProHOME is a production-built house in a small development of net-zero-ready houses in Wilder, Vermont, all with a focus on affordability and universal design principles. The design is intended to be quickly built and easily duplicated while meeting stringent air-sealing and performance standards and a strict budget. To remain competitive in their market, the houses in this area need to sell at approximately \$140 per sq. ft., even considering the lower heating and cooling costs of a net-zero house, so it is critical to drive construction costs as low as possible while maintaining performance. □

Sean Groom is a contributing editor.



PROVEN PERFORMANCE

Production building is about balancing curb appeal and energy performance with adaptable and repeatable assemblies. The 2017 ProHOME is the second house in an eight-home net-zero-ready development where double-stud walls and Passive House-worthy air-sealing result in lower utility costs without high construction costs.



THE DESIGN/BUILD TEAM

The 2017 ProHOME is an opportunity for *Fine Homebuilding* to showcase the construction of an affordable net-zero house. Last year, Paul Biebel worked with *FHB* on three articles related to high-performance building measures and costs. We feel his approach and the success of his homes is worth exploring and sharing in detail. As we cover the design, assemblies, and materials used in the ProHOME in the magazine, Tim Biebel will be covering the weekly progress and details of the building methods on the ProHOME blog.



Since starting Biebel Builders in Vermont in 1976, **PAUL BIEBEL** has grown his business from a two-man operation to a design/build firm specializing in energy-efficient

construction that utilizes solar panels to create net-zero housing. Even after 40 years in the business, Paul is still trying new things. In 2009, he launched the Prudent Living brand to focus on high-performance homes.



TIM BIEBEL has been vice president of Prudent Living since its founding in 2009. Prior to that, he worked in construction as a laborer and

foreman on a wide variety of projects. He holds certifications from building organizations such as the North American Board of Certified Energy Practitioners and the Building Performance Institute.

AN INFILL DEVELOPMENT COMES WITH CONSTRAINTS

Paul and Tim Biebel are building an eight-home community of net-zero houses. Their site is in an established neighborhood, tucked behind an existing house and enclosed by roads along the front and back property lines. They purchased the development from a builder who had roughed-in a road and permitted the eight lots. To avoid the time and cost of getting new zoning approvals and permits, Prudent Living decided to work from the original permits. That means the lot sizes, layouts, and house footprints are fixed and are relatively unchangeable.

The small adjustments made to the preexisting site plan were driven by Paul and Tim's goal that each home be capable of net zero if the homeowner is willing to invest in a PV array: The orientation of each house was adjusted to align the roof ridges east-west to maximize southern exposure, and the homes were pushed far enough apart on the 0.3-acre lots to prevent solar shading of the house next door.

All storm-water runoff—even during so-called "100-year" events—has to be contained on the property. To make this work, each house will include a rain garden and be graded so additional runoff is captured by swales and channeled to the large catchment basin at the north end of the property. To limit hardscapes, the turnaround at the end of the street and the emergency-access path at the northern end of the development are constructed with pervious grass pavers. To limit hardscapes, the turnaround at the end of the street and the emergency-access path at the northern end of the development are constructed with pervious grass pavers.



ProHOME SPONSORS

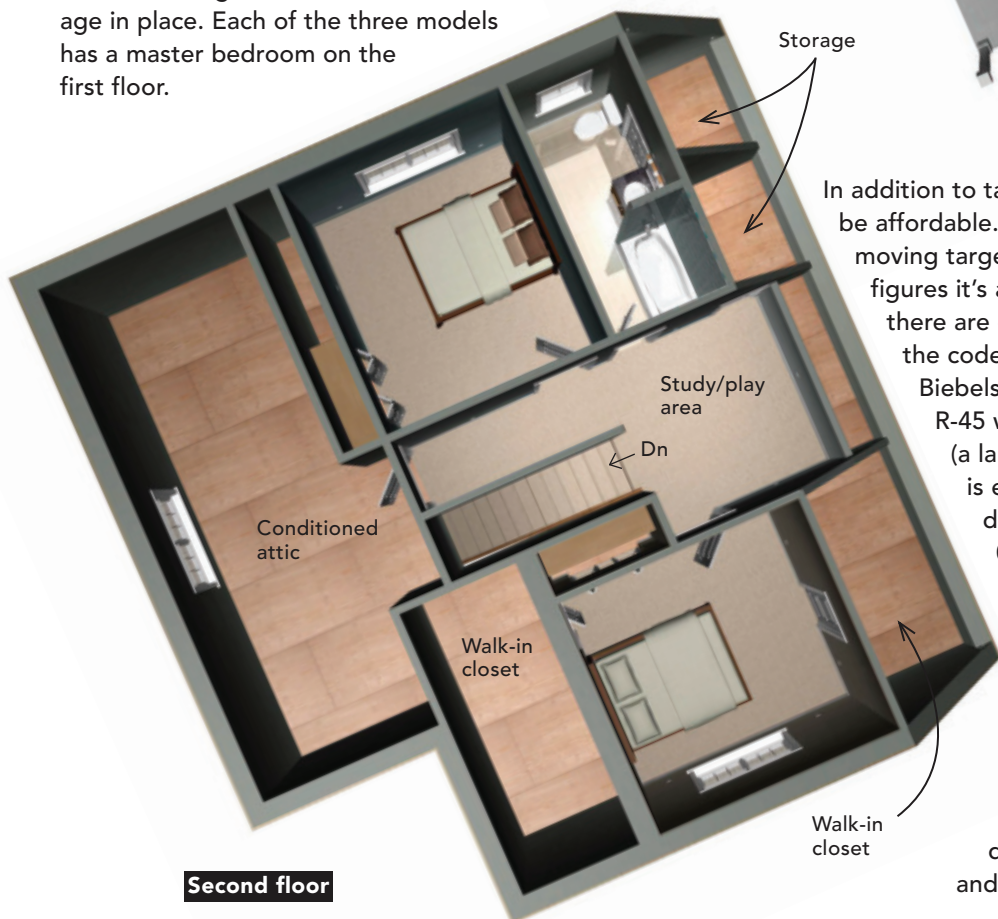
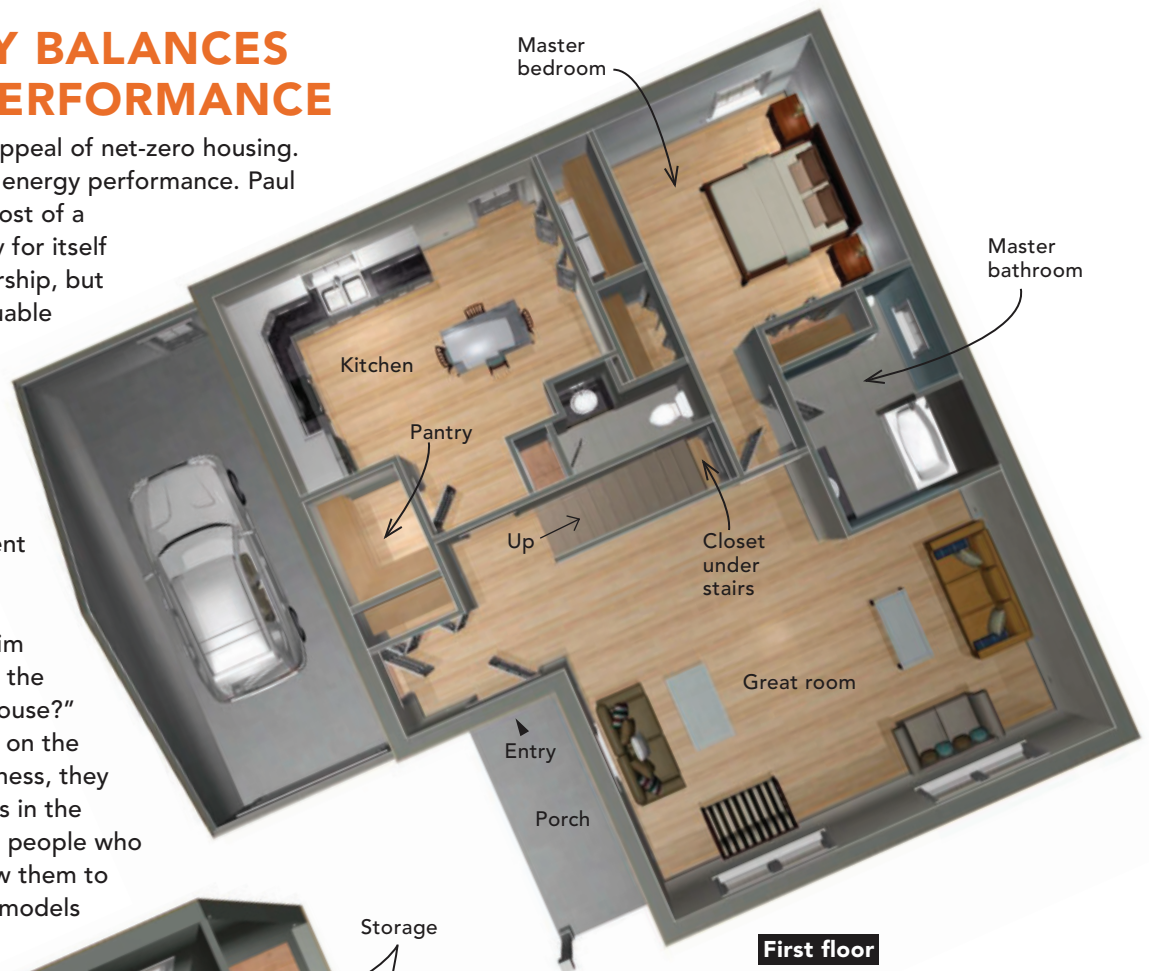
The 2017 ProHOME is supported by a host of industry sponsors. As a brand, we're not comfortable telling you to put products in your homes that we wouldn't put in ours. We've worked with our build team to identify appropriate products to include in this project. Our sponsorship model is built on an invitation-only, first-come, first-served basis. A variety of methods and products are available to construct a home of this caliber, but we chose based upon what works best to meet the goals for this home. For a complete list of project partners and more information on the products and materials used in the 2017 ProHOME, visit FineHomebuilding.com/prohome.



AFFORDABILITY BALANCES DESIGN AND PERFORMANCE

Prudent Living has bet on the appeal of net-zero housing. That means design is driven by energy performance. Paul is convinced that the up-front cost of a net-zero house will not only pay for itself inside the first decade of ownership, but that the home will be more valuable over time. He asks potential buyers to think about the value of a code-built home compared to a net-zero home 15 years from now when it's selling in a market where new homes are built to more stringent codes than they are today.

The 2017 ProHOME is a spec house, which means Paul and Tim had to ask themselves, "Who is the likely customer for a net-zero house?" Based on the inquiries they see on the custom-home side of their business, they decided that all the spec houses in the development have to appeal to people who are downsizing and should allow them to age in place. Each of the three models has a master bedroom on the first floor.



In addition to targeting empty nesters, the houses have to be affordable. "Affordable" is both a nebulous term and a moving target in the building world: In their market, Paul figures it's about \$300,000. With a net-zero-ready house, there are costs involved in raising performance above the code-mandated minimum. In the ProHOME, the Biebels have invested in R-15 subslab insulation, R-45 walls, and an R-60 roof. Plus, additional time (a labor cost) goes into air-sealing. This house is expected to match the performance of the development's model home, which tested at 0.55 ACH50. To control costs, the houses have slab-on-grade foundations and builder-grade finishes like engineered flooring, carpeting, and fiberglass tub surrounds. As with most production-built developments, the buyer has an allowance for finishes. In the ProHOME, the finishes will be higher quality (and therefore more costly) than the typical house in the development, but the floor plan, framing plan, and envelope details are all the same.

gallery

A bright, modern children's bedroom with built-in wooden bunk beds, a flat-screen TV, and a large orange armchair. The room features a large, woven, spherical ottoman on a patterned rug. The walls are light-colored wood paneling, and the ceiling has a white fan. The room is filled with toys and games, including a teddy bear on the orange chair and a large stuffed animal on the floor.

Who's ready for a sleepover?

Some of my favorite childhood memories are of sleepovers at grandma's house when my out-of-town cousins would visit for the summer. My grandmother didn't have a fancy bunk room, so we'd all pile on the pull-out couch and in sleeping bags on the floor of the family room. There was something so exciting about spending hours and hours talking with my cousins until way beyond our normal bedtime—and then the next morning we were all still together and ready to share in another day's adventures! A fancy bunk room is definitely not required for kids to have a great time together, but if my grandmother had a room in her house like any of these bunk rooms, I think my cousins and I would never have gone home. —*Maureen Friedman*

ORANGE YOU GLAD IT'S TIME FOR BED

From the bright orange notes in the furnishings to the Tootsie Pops-wrapper art above the flat-screen TV, everything about this room screams sleepover fun. With bunks for four plus two trundle beds, this finished attic room on Cape Cod can comfortably sleep six. Underbed storage drawers and built-in nooks provide plenty of spaces to stash toys and games.

Design Hutker Architects, Falmouth, Mass., hutkerarchitects.com

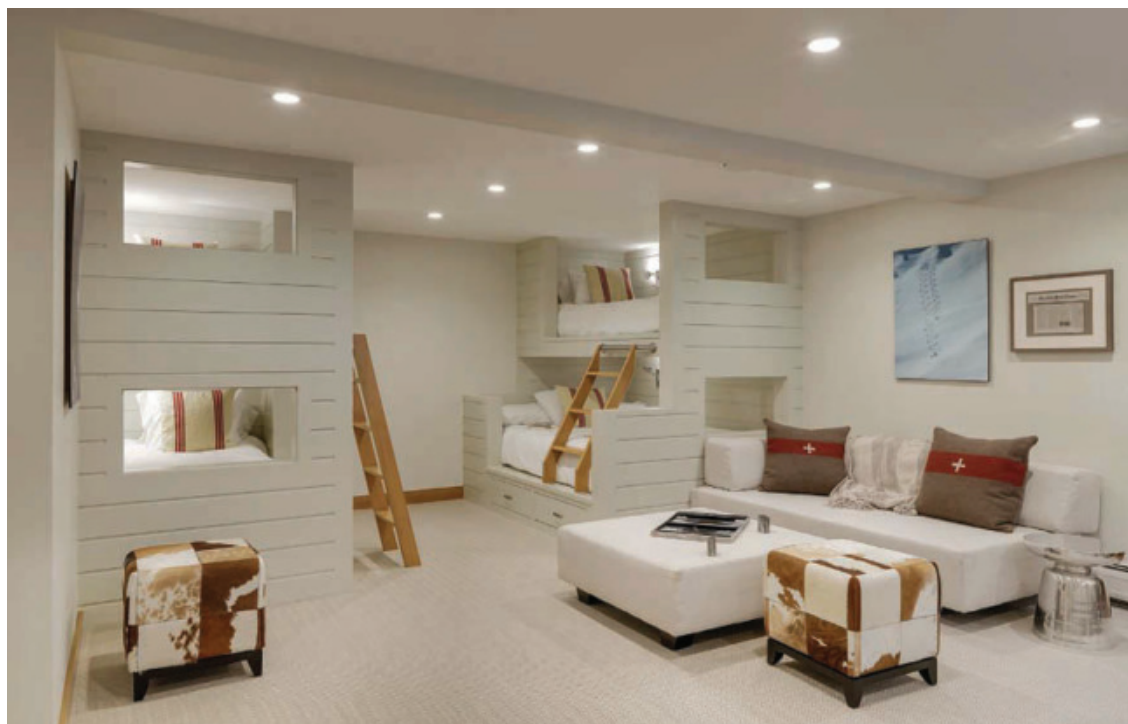
Construction C.H. Newton Builders, West Falmouth, Mass., chnewton.com

Photo Brian Vanden Brink, brianvandenbrink.com



LOWER-LEVEL LUXURY

The basement of this Stowe vacation home is the perfect space for the younger generation to have their own getaway. Openings in each bunk look into the room's play area, so the kids can get comfortable in bed but still socialize with friends and family. The double bed in one of the lower bunks breaks up the traditional twin-size bunk layout and is ideal for families or couples.



Design Milford Cushman and Chad Forcier, Cushman Design Group, Stowe, Vt., cushmandesign.com

Interior design Martha Wagner, Martha Wagner Interiors, Inc.

Interior millwork and built-ins Donald P. Blake Jr., Inc., Morrisville, Vt., stowebuilder.com

Photo Susan Teare, susanteare.com



LIKE SLEEPING IN THE TREETOPS

With its rustic stained-pine walls, 10-ft.-high ceilings, and large windows, this bunkroom in a vacation home in northern Vermont feels spacious yet cozy. With double beds on the bottom and single bunks up top, it's a great space for children and adults to settle in for an extended stay. Located over the two-car garage, the room is separated from the main part of the house and offers lots of privacy for quiet reading or an afternoon nap.

Design Milford Cushman and Kelley Osgood, Cushman Design Group, Stowe, Vt., cushmandesign.com

Interior design Carol Flanagan, Carol Flanagan Interior Design, Greenwich, Conn., carolflanagandesign.com

Interior millwork and built-ins Patterson and Smith Construction, Stowe, Vt., pattersonandsmith.com

Photo Susan Teare, susanteare.com

askthe experts

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experts



John Carroll
mason



Justin Fink
editor



Patrick McCombe
associate editor

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Saving a stone foundation

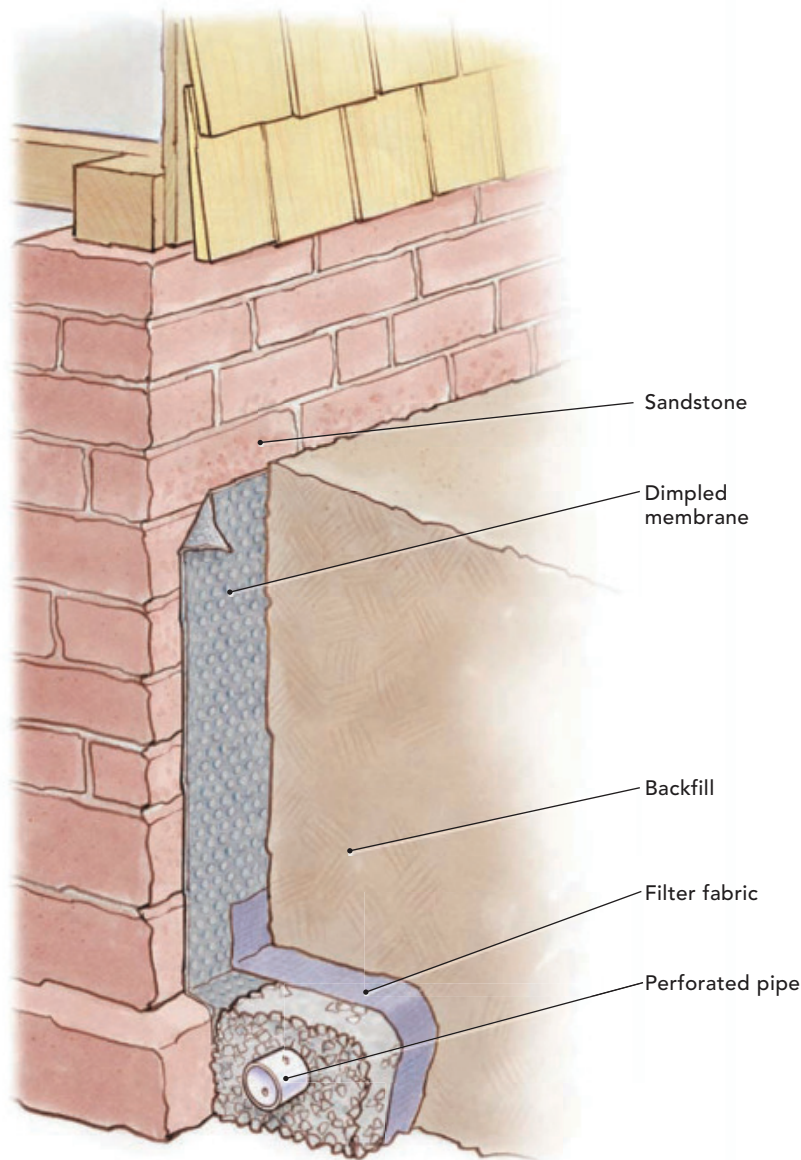
I just finished repointing a hundred-year-old sandstone foundation. The above-grade courses are in good shape, but the course at ground level is eroded away by an inch or more in some places, and is soft enough in other places that I can easily scrape away $\frac{1}{2}$ in. to $\frac{3}{4}$ in. of stone. The wall appears sound, and shows no large cracks, but I would like to prevent or slow further erosion. Can you recommend a coating or other solution?

—ED EVERSTINE
Fombell, Pa.

John Carroll: I suspect that the course of stone that's in contact with the ground is deteriorating because it gets saturated with water, and when that water freezes, it expands, rupturing the surface.

Because sandstone is soft and porous, it wicks up water readily. By the same token, its porosity allows it to dry fast, which is why you haven't had problems with the courses above grade. The same thing happens with soft brick and other soft stone. Masonry coatings can prevent the stone and soft brick from taking on water, but if water does get in, the coating prevents the masonry from drying out, doing more harm than good.

Instead of trying to seal moisture out of the stone, I would recommend that you concentrate on drying out the soil next to the foundation. For starters, make sure gutters and downspouts are directing the bulk of the water away from



the foundation. Best practice would be to excavate the soil next to the foundation and install a perforated drainage pipe near the footing that leads to a dry well or daylight. Backfill almost to grade with $\frac{3}{4}$ -in. gravel separated from the soil with filter fabric. You could also install a

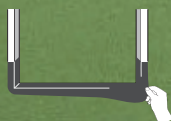
dimpled membrane such as Delta MS (cosella-dorken.com) on the foundation to keep the stone dry. Like the gravel, the mat should drain to a perforated pipe leading to daylight or a dry well. Finally, slope the finished grade so water runs away from the foundation.

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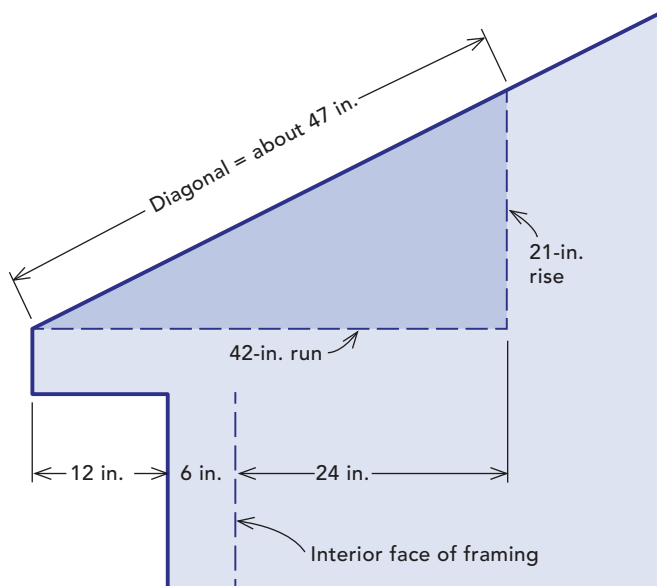
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$$\begin{aligned}\text{run}^2 + \text{rise}^2 &= \text{diagonal}^2 \\ 42^2 + 21^2 &= 2205 \\ \sqrt{2205} &= 46.96 \text{ (about 47 in.)}\end{aligned}$$

The right amount of roof membrane

I just bought an old house and I'm getting quotes to have the worn-out roof stripped and re-shingled. I don't know what problems the existing roof may have had in terms of leaks—if any—but thinking back on some heavy winters with ice dam problems, I want to be sure the new roof is protected. Is this just as simple as putting membrane on the eaves?

—DAVE PETERSON
via email

Justin Fink: You're on the right track, Dave. Ice-barrier membrane adhered along the roof eaves is not only good insurance, it's actually required by the building code for

houses located in the upper half of the United States (wherever the January average temperature is 25°F or lower or where there is a possibility of ice forming on the roof eaves).

One thing to be aware of that many people misunderstand—even some professional roofers—is how far up the roof the membrane is supposed to extend. Most of these products are sold in 36-in.-wide rolls, so a single row of 36 in. of protection is what roofers most often put down. But according to section R905 of the International Residential Code, ice barriers must “extend from the lowest edges of all roof surfaces to a point not less than 24 inches inside the exterior wall line of the building.”

This is an important distinction, because roof overhangs, wall thickness, and roof pitches will all be factors when determining how far up the roof deck the membrane is supposed to extend. For example, if you have a 9-pitch roof with 12 in. overhangs set atop sheathed 2x6 exterior walls, that means the membrane will need to extend just shy of 4 ft. up the slope of the roof deck (drawing left) to meet the letter of the code. Steeper roofs will require more membrane. For a 12-pitch roof with the same details, the membrane will need to extend almost 5 ft. up the roof.

To figure out how far the membrane must extend on your roof, go up to your attic and measure 24 in. horizontally inward from the point where the inside plane of your exterior wall meets the roof sheathing. Add to that your wall thickness and overhang and you have the run. Next, find the rise by measuring from the point you just established straight up to the underside of your roof deck. Then, use the Pythagorean theorem ($a^2 + b^2 = c^2$) to solve for the diagonal.

Buying a vermiculite-insulated house

I'm considering buying a house that has vermiculite insulation in the attic. I've heard conflicting opinions about this insulation, so I'm not sure whether it's dangerous and should be removed, or benign and should be left alone. What's the answer?

—LEE MARKOWITZ
via email

Patrick McCombe: Vermiculite—a shiny, mined mineral that looks like a cross between mica and clay cat litter—was a popular insulation from 1919 to 1990. Sold in bags under the Zonolite brand name, the material—which is fireproof and easy to retrofit—was used to insulate an estimated 940,000 American homes.

Virtually all of the vermiculite sold in the United States came from the Libby Mine in the northwest corner of Montana. Now a Superfund site, the Libby



Vermiculite is a mined mineral that was used as building insulation for decades. It frequently contains asbestos and is costly to remediate.

Mine was shut down in 1990 due to the presence of asbestos. The vermiculite in the Libby mine is particularly dangerous because it is laced with the tremolite form of asbestos, the most toxic form. Tremolite fibers are barbed, so they get stuck more easily in soft lung tissue and are tougher to expell.

Asbestos exposure from vermiculite insulation can lead to asbestosis, lung cancer, and mesothelioma, which can show up years or even decades after exposure.

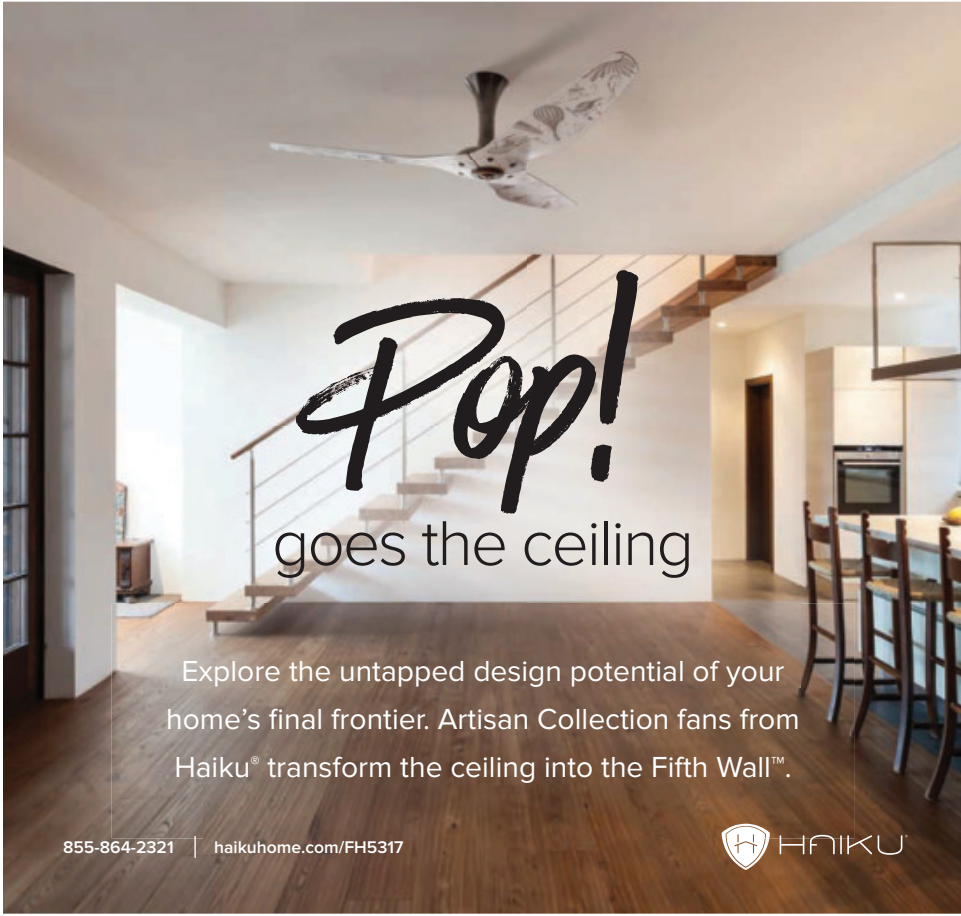
Asbestos within vermiculite is so common that all vermiculite insulation sold in the U.S. is assumed to contain the fibers. However, some doesn't, so it's worth having the material tested before committing to an expensive cleanup. Home centers and online retailers sell do-it-yourself kits that are sent away for analysis after you do the sampling. You can also contract local environmental testing companies to analyze possible asbestos-containing materials.

Asbestos fibers are most dangerous when they're airborne, so it's important to not disturb the insulation or attempt to clean it up yourself. Vermiculite-insulated attics should not be used for storage and the material should be abated by certified contractors before attempting any remodeling work.

Walls insulated with vermiculite are thought to be less likely to spread asbestos fibers than attic insulation, which can be blown around by wind moving through attic vents. However, I see evidence of air movement within wall cavities any time I'm remodeling, so I wouldn't assume vermiculite-insulated walls are safe.

Removing and cleaning up an attic's worth of vermiculite can be very expensive, because workers must be asbestos-certified and the area must be cordoned off from the rest of the house and placed under negative air pressure to prevent spreading the asbestos fibers throughout the home. The material must be bagged before it's disposed of in approved landfills. Any vermiculite cleanup should include post-cleanup dust sampling to ensure the job was done correctly.

Given the high cost of cleanup and the very real danger of breathing asbestos fibers, I would definitely consider the costs of abatement as part of any real-estate transaction.



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"Musings of an Energy Nerd" showcases the best of Martin Holladay's weekly blog at GreenBuildingAdvisor.com, where he provides common-sense advice about energy issues to residential designers and builders. His conclusions usually fall between minimum code compliance and the Passive House standard, which often makes them controversial to both building-science geeks and everyday builders.

Green Building Advisor

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When sunshine drives moisture into walls

Builders first started worrying about vapor diffusion in 1938, when Tyler Stewart Rogers published an influential article on condensation in the *Architectural Record*. The article, "Preventing Condensation in Insulated Structures," states, "A vapor barrier undoubtedly should be employed on the warm side of any insulation as the first step in minimizing condensation." Rogers assumed that the main source of condensation on sheathing was the result of the diffusion of water vapor through the wall and ceiling plaster in wintertime.

Rogers' recommendation to use interior vapor barriers, which was eventually incorporated into most model building codes, became established dogma for over 40 years. But eventually, building scientists discovered that interior vapor barriers were causing more problems than they were solving. Interior vapor barriers are rarely necessary, since wintertime vapor diffusion doesn't typically lead to problems in walls or ceilings. What Rogers didn't know back in 1938 is that the main way that sheathing gets damp in the winter is actually via air leakage, not vapor diffusion. But a different phenomenon—summertime vapor diffusion—has become the far more serious matter.

Zaring Homes goes bankrupt

During the 1990s, summertime vapor diffusion began to wreak



Nothing going on here. From the outside, this house looks perfectly normal. But inside, water vapor driven through the brick veneer has spiked the reading on a moisture meter and supercharged mold growth.



havoc on hundreds of North American homes. This epidemic of rotting walls was brought on by a combination of two factors that Rogers did not predict: The widespread adoption of air conditioning, and the use of interior polyethylene vapor barriers.

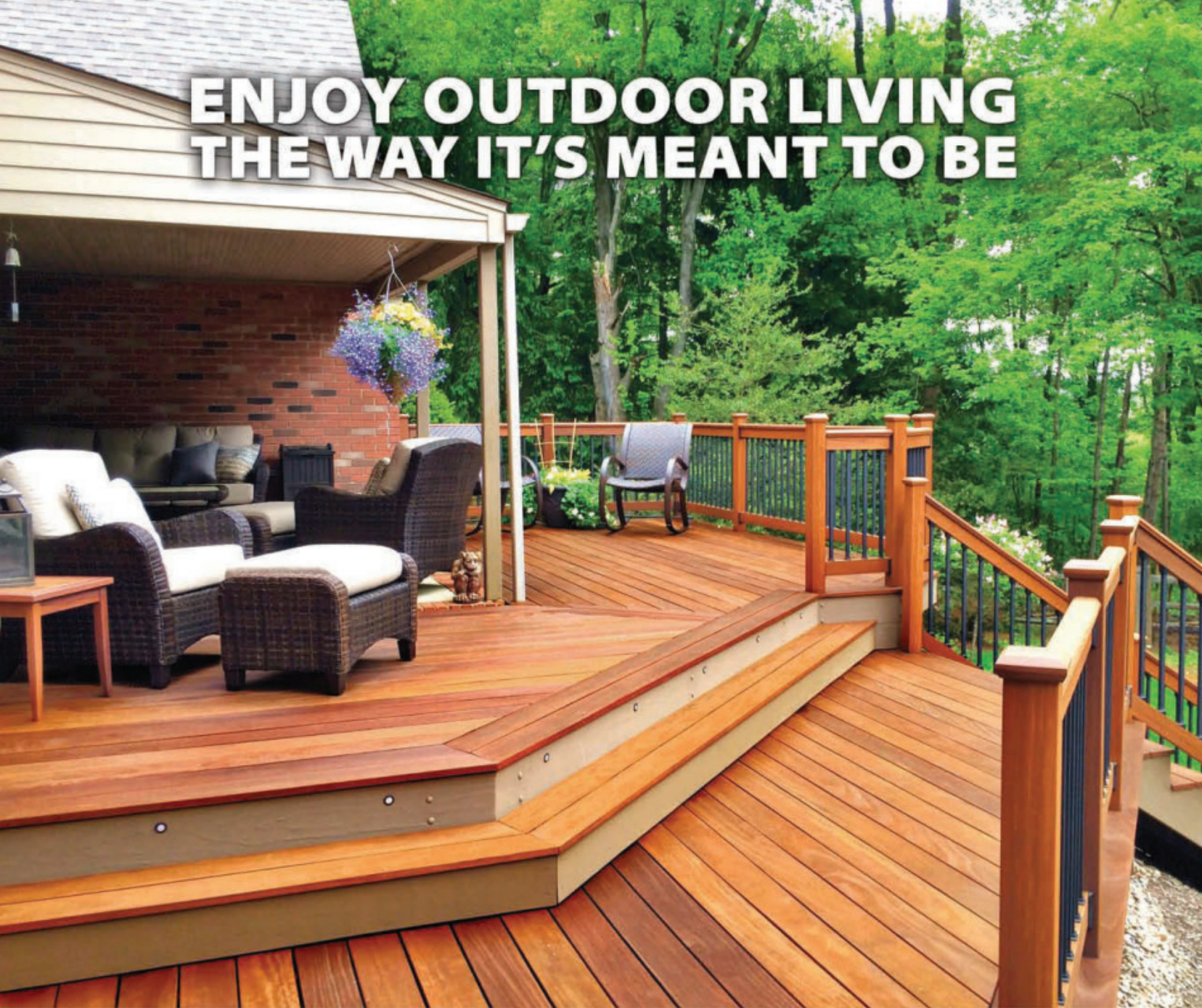
Rogers had conceived of interior vapor barriers as a defense against the diffusion of water vapor from the interior of a home into cold wall cavities. But he couldn't foresee that these vapor barriers would eventually be cooled by air conditioning, thereby turning them into condens-

ing surfaces that would drip water into walls during the summer.

Interior vapor barriers—such as polyethylene under the drywall or vinyl wallpaper over it—are unforgiving. They not only prevent outward diffusion during the winter; but also inward drying during the summer. These days, building scientists instead recommend the use of vapor retarders like MemBrain, kraft paper, or vapor-retarder paint.

It took a series of disasters to fully illuminate the phenomenon of summertime vapor diffusion. One early victim was Cincinnati builder

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Zaring Homes. In the mid-1990s, Zaring Homes was a thriving midsize builder that completed over 1,500 new homes a year. But the company's expansion plans came to a screeching halt when dozens of its new homes developed mold and extensive rot.

The first signs of a problem surfaced in July 1999, when homeowners at Zaring's Parkside development in Mason, Ohio, began complaining of wet carpets only 10 weeks after the first residents moved into the new neighborhood. When inspection holes were cut into the drywall, workers discovered ¼ in. of standing water in the bottom of the stud cavities. "We were able to wring water out of the fiberglass insulation," said Stephen Vamosi, a consulting architect at Intertech Design in Cincinnati.

Consultants concluded that water vapor was being driven inward from the damp brick veneer through permeable Celotex fiberboard wall sheathing. During the summer months, when the homes at Parkside were all air conditioned, moisture was condensing on the back of the polyethylene sheeting installed behind the drywall.

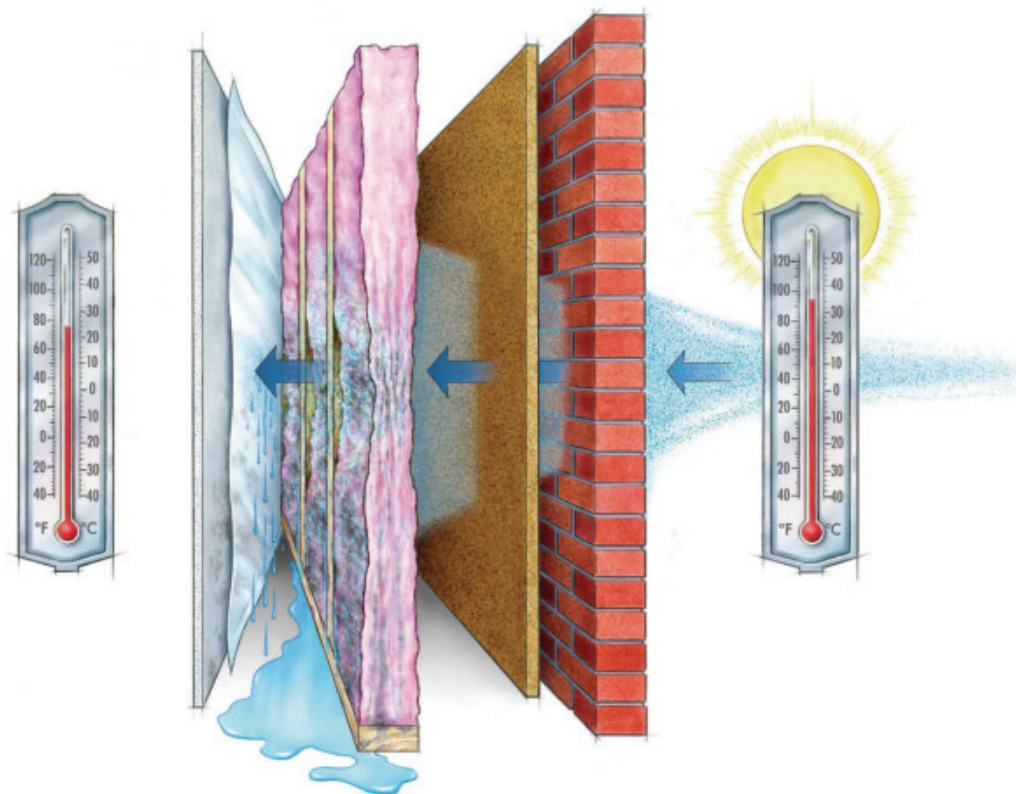
"Zaring Homes went out of business because they had a \$20 million to \$50 million liability," said building scientist Joseph Lstiburek. "Hundreds of homes were potentially involved. To fix the problems would probably cost \$60,000 to \$70,000 per home. It was a spectacular failure."

How inward solar vapor drive happens

The phenomenon that destroyed Zaring Homes' walls came to be known as inward solar vapor drive. It requires four elements: a reservoir cladding (siding that can hold significant amounts of water), permeable wall sheathing, a polyethylene vapor barrier on the interior of the wall, and an air-conditioned interior.

Reservoir claddings include brick veneer, stucco, manufactured stone, fiber-cement siding, and, to a lesser extent, wood siding. Though the failures are less spectacular, inward solar vapor drive can also cause problems in walls sheathed with less permeable types of sheathing, especially OSB.

Whenever a wall separates environments with different temperatures and moisture conditions, moisture vapor will be driven



VAPOR DRIVE WORKS BOTH WAYS

Historically, vapor drive was thought to be a winter problem, when warmth from inside a house drives moisture outward to condense on the back of the sheathing. This assumption led to code-required vapor barriers behind the interior wall coverings. But the advent of residential air conditioning introduced a new worry; inward moisture drive in the summer. Once sun hits the exterior, moisture is driven through vapor-permeable sheathing into the wall, where it condenses on plastic vapor barriers or behind vinyl wallpaper.

across the wall from the hot, moist side toward the cool, dry side. In the case of solar vapor drive, after a soaking rainstorm, the sun eventually comes out to bake the damp siding, driving moisture inward. Problems with inward solar vapor drive show up first on elevations that get the most sun exposure, so north walls are usually immune.

The heat of the sun easily drives the moisture in damp siding through housewrap and permeable wall sheathing. The fact that housewrap is vapor-permeable allows damp sheathing to dry outward, which is good, but housewrap does little to prevent inward solar vapor drive. The first cold surface that sun-driven vapor encounters is usually the polyethylene behind the drywall. That's where the moisture condenses, then it runs down the poly to pool at the bottom of the wall cavity. It doesn't take long before mold begins to grow and the walls begin to rot.

Data from a 2003 to 2004 study by building scientists John Straube, Eric Burnett, and Randy Van Straaten confirmed the

phenomenon of inward solar vapor drive. "Inward vapor drive redistributes moisture quite dramatically," said Straube. "Solar-driven vapor is much more important" than winter diffusion.

Once inward solar vapor drive was well understood, it was identified as one of the main causes of a cluster of wall rot in EIFS-clad homes in North Carolina. Inward solar vapor drive through a variety of stucco types is also blamed for many of the "leaky condo" problems in stucco-clad multifamily buildings in Vancouver, British Columbia.

Avoiding problems from solar vapor drive

If the components of a wall assembly are poorly chosen, as they clearly were at the Parkside development built by Zaring Homes, there may be no faster mechanism for destroying a house than inward solar vapor drive. After only 10 weeks of occupancy, some of the Zaring homes were so wet that most of the brick veneer,

sheathing, insulation, and drywall had to be removed.

But once you understand inward solar vapor drive, it's relatively easy to choose building details to avoid moisture problems. You'll probably only need to adopt one or two of them at most.

- Never include interior polyethylene or vinyl wallpaper in an air-conditioned home. If your building inspector insists on an interior vapor retarder that comes in a roll, choose a smart retarder like MemBrain that allows drying to the interior.

- Avoid high-permeance sheathings like fiberboard behind reservoir claddings. Instead, specify a less permeable sheathing (OSB, CDX, or foam), especially behind brick veneer, stucco, or manufactured stone.

- Use an asphalt-felt water-resistive barrier (WRB). Homes built with this type of WRB experience fewer problems with inward solar vapor drive than homes with plastic housewrap.

- Consider using a vapor-impermeable WRB. The best-known example is Delta-Dry, a stiff, high-density polyethylene formed into a 5/16-in.-thick egg-carton configuration. This three-dimensional WRB creates two air spaces—one between the siding and the WRB and the other between the WRB and the sheathing. Unlike typical housewraps, Delta-Dry depends on air movement to keep the sheathing dry.

- Build rain-screen walls. Walls with a rainscreen gap between the siding and the sheathing experience much less inward moisture transfer than walls without a gap. Ventilated rainscreen gaps are more effective at limiting inward moisture transfer than unventilated rainscreen gaps.

- Use light colors. Because darker colors absorb heat more efficiently, more vapor drive problems occur in homes with dark-colored siding than light-colored siding.

- Choose a traditional stucco formulation without modern polymeric admixtures, since stuccos with these admixtures dry much more slowly than traditional stucco.

- Choose a siding such as vinyl that is not a moisture reservoir.

Special thanks to architect Steve Bostwick, one of the consultants who investigated the Zaring Homes disaster, and to William Rose, whose research highlighted Tyler Stewart Rogers' role in establishing the idea that the warm-in-winter side of wall insulation should be protected by a vapor barrier. Rose is a building researcher at the University of Illinois in Urbana-Champaign.

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STEP BY STEP



Thirty years ago, in a fit consisting of equal parts hubris and innocence, I let a builder convince me to install his stair rails. I was newly self-employed and saw installing railings as an opportunity to expand my offerings, even though I knew next to nothing about them. While I lost my shirt on that job, these step-by-step instructions will help you keep yours on.

For me, one of the more intimidating parts of the installation was cutting and attaching easings, volutes, and goosenecks to straight rails. These parts are expensive, which makes cutting the correct angle even more stressful—and then you still have to fasten the fittings and rails together both invisibly and stoutly. The fittings come with instructions, but they don't tell the whole story.

The key thing to remember is that fittings have to be cut at the

Continued on page 92



1 Locate the cut. Set the pitch block with the run side on a flat surface, place the fitting on the same surface, and mark the point where the two intersect. (To mark an up-easing or gooseneck, rest the pitch block on its rise side.)



2 Mark the cut. Keep the fitting on the flat surface, then flip the pitch block to its rise side and use it to mark a cutline. (To mark an up-easing or gooseneck, rest the pitch block on its run side.)



3 Make the cut. Make an auxiliary fence by clamping a piece of plywood or MDF to a miter saw, and make the initial cut through it. Then, hold the fitting so its bottom fully contacts the auxiliary fence, line up the mark with the kerf in the fence, and cut to the line.



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4 Make a template. To locate the bolt holes, slice a thin piece from the rail you're using. Drill a $\frac{1}{8}$ -in. hole in its center, $1\frac{5}{16}$ in. up from the bottom.

5 Locate the holes. Use opposite sides of the template to mark the fitting and the rail. This way, if the hole in the template is off-center, the holes in each piece will still align.

6 Drill pilot holes. Drill $\frac{1}{8}$ -in.-dia. pilot holes in both the fitting and the rail, eyeballed square to the ends. The pilot hole will minimize the chance of the grain throwing off the larger bits to follow.

7 Enlarge the holes. Drill a $\frac{1}{4}$ -in. hole in each piece, square to the ends. This creates the hole for the lag end of the hanger bolt in the fitting. For the rail, enlarge the hole with a $\frac{3}{8}$ -in. bit, providing a little wiggle room for the machine-threaded end.

8 Drill the access hole. Use a sharp spade bit to drill a 1-in. access hole about $1\frac{1}{2}$ in. deep, centered side to side and $1\frac{3}{8}$ in. from the end of the rail. Mark the bit with tape so as not to drill through the top of the rail.



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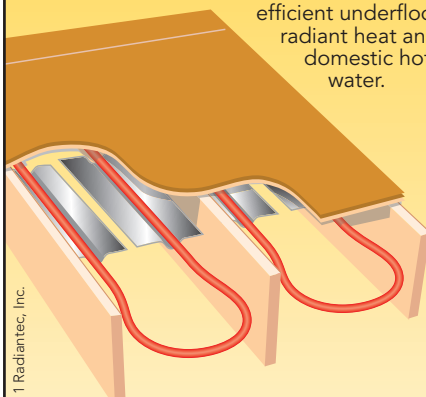
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Continued from page 88

point where their curves are tangent to the line of the rail, and each cut has to be square to the rail. A pitch block—a right triangle with one leg the height of the stair's rise and one leg the length of its run—is used to lay out the cut. Pitch blocks are similar to the cutout resulting from notching the stair stringers, but don't be tempted to use those cutouts because they'll be smaller than the stair's actual dimensions by the thickness of the saw's kerf. Once the parts are cut, they can be joined with a hidden $\frac{5}{16}$ -in. rail bolt, also called a hanger bolt and usually included with the fitting.

There are two main types of rail fittings. Starting volutes and easings are fittings used to transition from the bottom newel post to the stair rail. Up-easings and goose-necks are the second type, used to transition from a stair rail to a vertical section of rail at a landing. Shown here is a starting volute. The installation steps are the same for both types of fittings, except the orientation of the pitch block used to mark the pieces is reversed between the two.

Senior editor Andy Engel is the author of *Building Stairs (For Pros, by Pros)* from The Taunton Press. Photos by Rodney Diaz.

STEP BY STEP



9 Make way for the washer and nut. Chisel a flat spot inside the access hole that's large enough to accommodate a $\frac{5}{16}$ -in. flat washer, being careful not to damage the rim of the hole. A sharp $\frac{3}{8}$ -in. chisel works well.



10 Insert the bolt. Eye the edge of a pair of locking pliers so they're even with the end of the rail. Align the bolt to leave room in the access hole to slip a wrench past, then clamp it tightly. Lube the threads with wax and turn the lag end into the volute. When the edge of the pliers hits the endgrain of the volute, the bolt will be at the right depth.



11 Connect the parts. Coat the ends of the rail and the fitting with glue, put the bolt into the rail, and place a washer and nut on the end. Keeping the beads on the rail and fitting aligned, tighten the nut with a $\frac{1}{2}$ -in. wrench.



12 Plug the hole. Glue in the 1-in. plug included with the rail bolt, being sure to line up the grain direction. Leaving the plug a little proud makes it easier to flush the two up in the next step.



13 Fair the joint. Rails and fittings are made on separate machines and rarely match perfectly. If you're lucky, sanding will be enough to fair the joint, but most cases require a combination of chisels and files, with sanding as the final step.

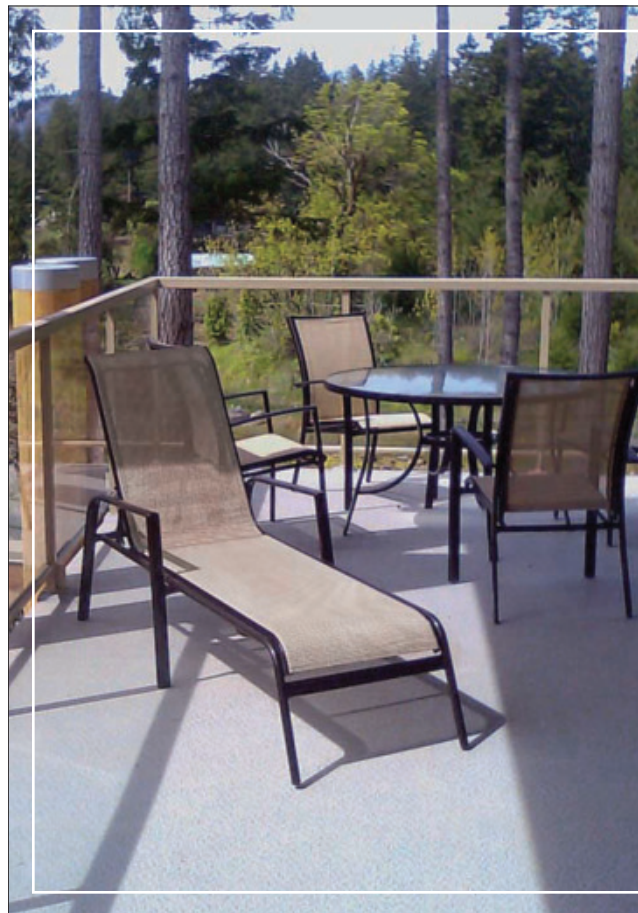
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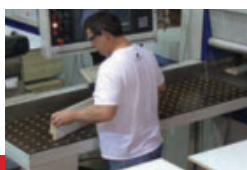


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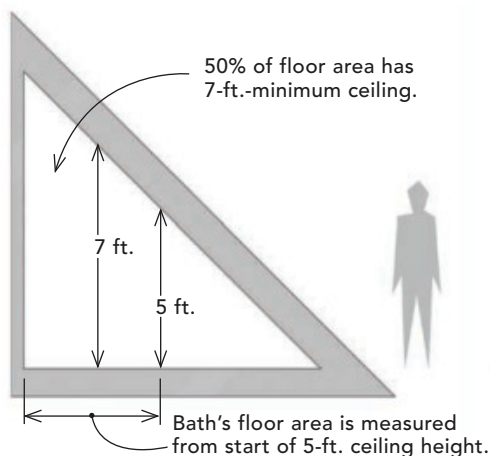


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Bathrooms with sloped ceilings

Adding a bathroom to an existing home is a common remodeling project, and often the only place available is under a sloped ceiling. Not only will that space likely have a small footprint, but unless you are able to add a dormer to gain headroom, this project means building the bath with some serious limitations. Still, it's possible to design a bathroom that is not only safe and comfortable to use, but also attractive enough to want in your home.

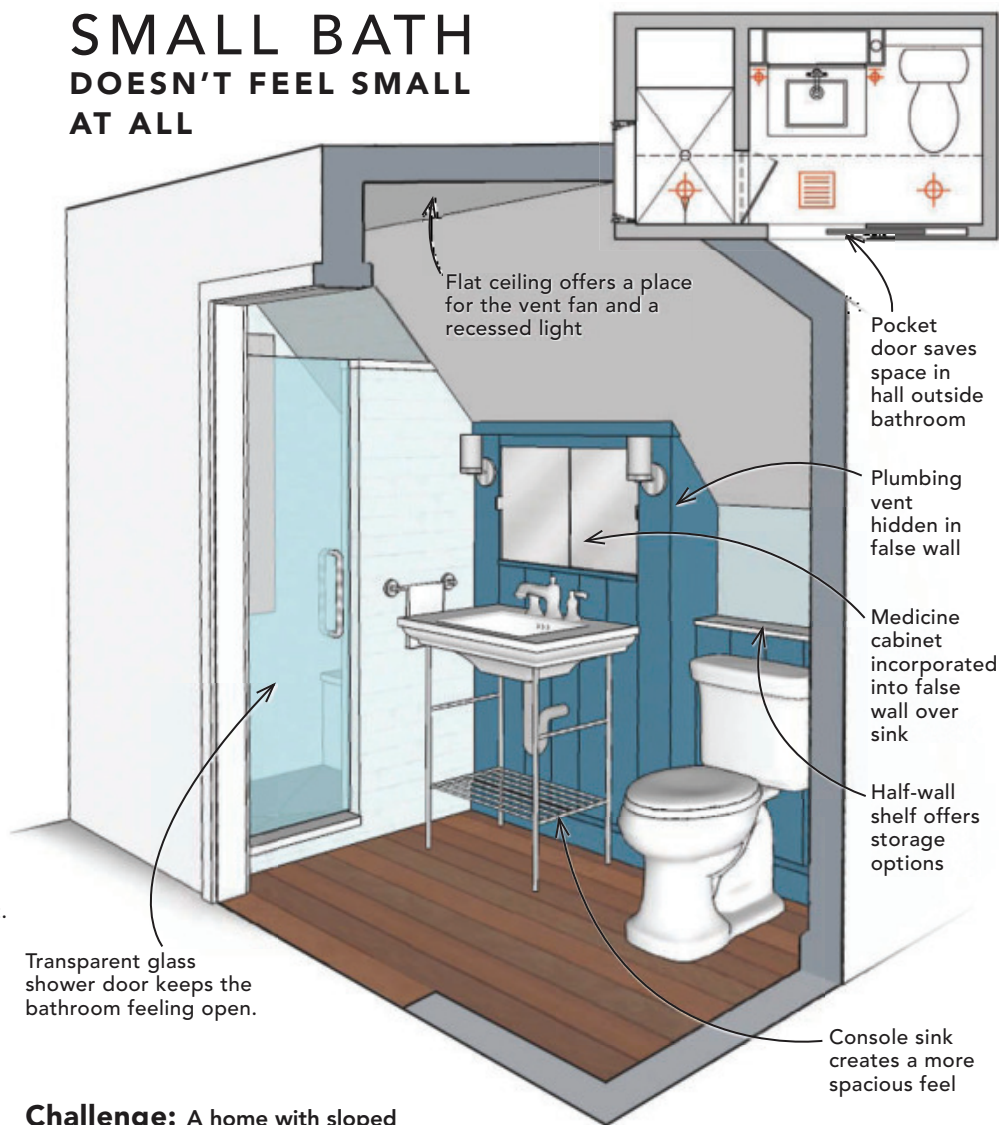
By code, habitable spaces, hallways, basements, and bathrooms are required to have ceilings at least 7 ft. high. In rooms with



sloped ceilings, up to half of the ceiling may be between 5 ft. and 7 ft. high, with the other half at least 7 ft. high. Bathrooms don't have a minimum required size, but any portion of the room with ceilings lower than 5 ft. are not counted in the size of the room. This will determine if you can fit a bathroom in the space, and where the bathroom's inside wall must be located.

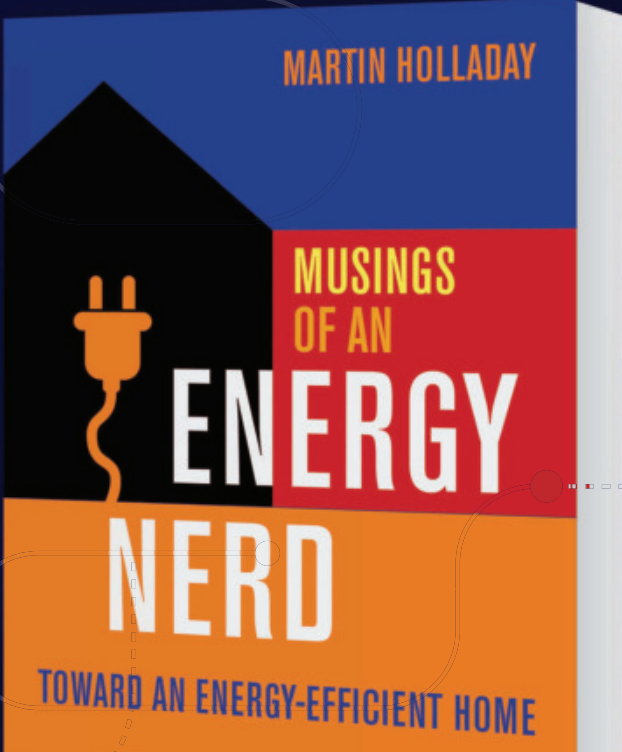
Headroom at the front edge of fixtures must be at least 6 ft. 8 in., while the ceiling height at the back side must be enough that the fixture can be used for its intended purpose. Therefore, if a bathroom is accessed from the side where the sloped ceiling is taller, the fixtures are best placed along the

SMALL BATH DOESN'T FEEL SMALL AT ALL



Challenge: A home with sloped ceilings on the second floor needs a bathroom, and this is the only available location. Floor area and headroom are limited, as are storage options, and there is an existing window at one end. It's a tight space to work with.

Solutions: The eye gauges the size of a room by the corners it can see, so we kept this space from feeling closed in by pushing the visible corners farther away with the tiled shower wall and the paneled half-wall. The half-wall also brings the sink and toilet out from the back wall, providing the required headroom at each fixture. We made the small space feel bigger by choosing a console sink, fully tiling the shower partition wall, and using a limited color palette; disengaging the top of the wall from the ceiling and using a frameless glass door; and contrasting colors and textures for the cabinetry behind the sink and toilet.



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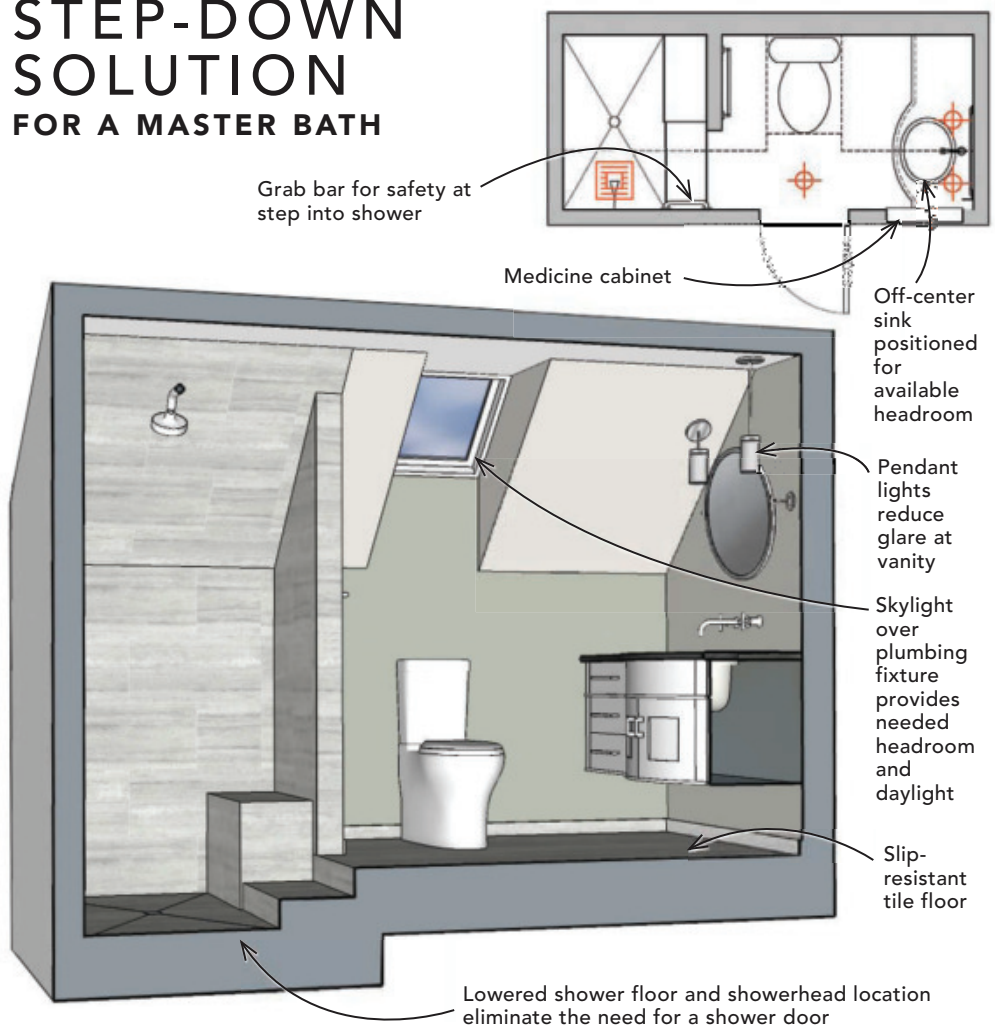
wall opposite the door. As you'll see in the first example shown on pp. 94, I like to put the sink in the middle, with the toilet on one side and the tub and/or shower on the other side. There is usually more space in front of the sink than in front of the toilet, so it becomes the best transition zone for entering the bath or drying off after getting out of the shower, and it puts the toilet in the least visible area. When the door is on the narrow end of a tight bathroom, I prefer a sink-toilet-shower arrangement. But as you'll see in the second example (drawing right), there are reasons to break these rules.

When not restricted by height, I put the top of a bathroom mirror or medicine cabinet at least 6 ft. 2 in. above the floor, but in the case of a bath under a low, sloped ceiling, that's rarely possible. In these cases, I either compromise and lower the mirror height, or use a mirror mounted on an articulating arm on an adjacent wall that can be adjusted to serve whomever is using it. When there is enough floor space, one technique I've used is to build a false wall with storage behind the vanity, pulling it forward away from the low point of the ceiling. This allows me to mount the mirror at an appropriate height. I've used a similar approach in bathrooms with pedestal sinks or other sinks with little counter space, in which I then build a half-wall to create a ledge that functions as extra counter space.

Code calls for a distance of 15 in. from the center of the toilet to any fixtures or walls flanking it. A span of 15 in. between a toilet and a wall will still feel tight, so I stick with 18 in. if possible. In front of the toilet, you need at least 21 in. of space, but toilets come in different lengths—from about 25 in. to 30 in. or more. So you can choose a shorter-length toilet to meet this clearance if needed.

To satisfy the code, the interior of a shower needs to be at least 30 in. by 30 in. The exception is that one dimension can be a minimum of 25 in. if the interior area is at least 1,300 sq. in. in total. Shower access (by door, doorway, or curtain) needs to have a clearance of at least 22 in. in width. The ceiling at the showerhead must have at least 30 in. by 30 in. of space at a minimum height of 6 ft. 8 in. This means that you'll likely be putting the showerhead on the tall-ceiling side of the shower. A ceiling-

STEP-DOWN SOLUTION FOR A MASTER BATH



Challenge: A new second-floor master suite needs a bathroom, but there's no way to shoehorn a sink, toilet, and shower into the space while meeting minimum height and comfort requirements. The windowless space is dark and the clients want the convenience and storage of a full vanity. Time to think outside the box.

Solutions: We realized that if we dropped the ceiling over the first-floor pantry space below, we could lower the shower floor to create the necessary height for the shower fixture. A skylight provides light and ventilation, as well as additional headroom over the toilet. The floating vanity helps the room feel larger and its curves soften an otherwise angular room. We kept the colors light and quiet for a sense of space and openness and located the medicine cabinet adjacent to the sink instead of on the rear wall.

mounted showerhead may help in some situations, as will putting the control valve on a different wall than the showerhead if it's more convenient for use. When a shower is tucked under a slope, plan to tile the sloped ceiling to protect the surface from water.

Shower rods don't work when the roof slopes down over a tub, so my solution is to install a fixed, frameless glass panel on the

low-ceiling side of the shower and a swinging panel on the high side. An alternative is to install a fixed panel on the tall, showerhead side and leave the other end open.

Usually a small bathroom has only a shower or a combination tub and shower, but not always. Bathtubs without showerheads are not subject to the height requirement, and can be tucked into lower areas.

These days, lots of tubs smaller than the standard 60-in. length are available.

Ventilation, light, and heat

No matter how small, bathrooms need ventilation fans, preferably as close as possible to the shower. Squeezing them into a tight space can be tricky. I often flatten the ceiling, where I then install the fan unit. Ducting through a sidewall is preferable to going through the roof. Through-wall fans and remote fans can help you duct through a sidewall in a tricky location.

Although vanity lights are best located at about 60 in. to 66 in. high, it's often necessary to place them above the mirror. To reduce glare, I sometimes install pendant lights in front of the mirror instead of wall-mounted sconces. There are even some medicine cabinets and mirrors available with integrated LED lighting.

A strategy to create additional headroom with the added benefit of daylighting is to use skylights. I've placed them over toilets and sinks to gain the depth of the rafters. Use the lowest U-value units you can find to reduce condensation, which is a problem with skylights in cold climates.

If you need to bring heat to the bathroom, you'll want to find the most unobtrusive way possible to do so. Radiant electric mats are becoming pretty standard on higher-end projects and don't require any space, but most don't put out enough heat to make the bathroom comfortable. A small toe-kick heater, a wall-hung electric heater, or heated towel bars (my favorite) can all work.

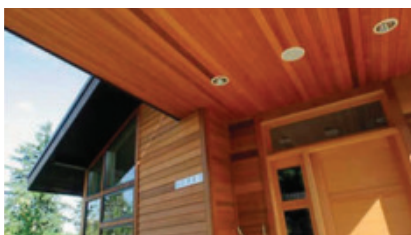
Spaciousness

Your choice of fixtures and materials can make the room feel more spacious. Wall-hung, pedestal, and furniture-style vanities have less visual mass, making the bathroom appear to have more open space. Glass or open shower doors make the room feel bigger than a curtain does. A continuous horizontal band of trim run around the room will stretch space visually, and running the tile vertically adds to the visual height. Keep the palette simple; less contrast between tiles and other surfaces expands space. And the ceiling doesn't have to be white—matching the walls with a half-tone is classy and more integrated.

Michael Maines is a residential designer in Palermo, Maine. Drawings by the author.

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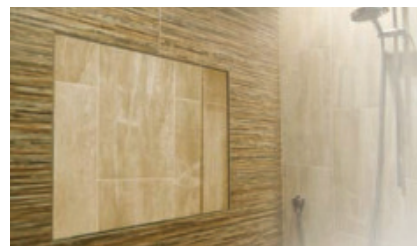
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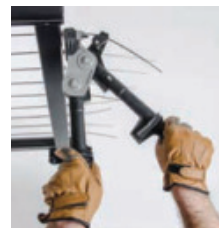


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Most woodworkers hate to apply finishes, just as most carpenters hate to paint. But Peter Gedrys is wired differently. He doesn't build anything—all he does is apply finishes. To appreciate what Gedrys does for a living, most of us can't rely on direct experience, because not many operate at his level.

"There are cooks, and there are chefs," Gedrys says. By any measure, Gedrys is the latter, bringing museum-quality furniture finishes to architectural woodwork. A typical stain-grade finish might include one coat of a pigment stain followed by two or three coats of polyurethane. Gedrys' process typically involves multiple layers of wood dye, shellac, and glazing before he even gets to the topcoat, which, on an exterior door, will include a minimum of five coats of varnish. The resulting finish has color, clarity, and depth that cannot be achieved any other way. "Do it right," he says, "and you'll have something that changes color in different light and just ... glows."

Thirty years ago, Gedrys started out stripping furniture for a man who would turn his back whenever he refinished a piece so Gedrys couldn't watch. As a result, Gedrys is largely self-taught, but he has a very different attitude about sharing what he knows. In addition to running his business, Architectural Finishes, in East Haddam, Connecticut, Gedrys also teaches all over the country—at schools, at conferences, and even in private lessons. Teaching, he says, helps him learn and improve. "That's what drives me. I want to be the best. But there's always somebody better. Always." And then he adds, without a hint of irony, "I feel like I'm just scratching the surface."

— Kevin Ireton, editor at large



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