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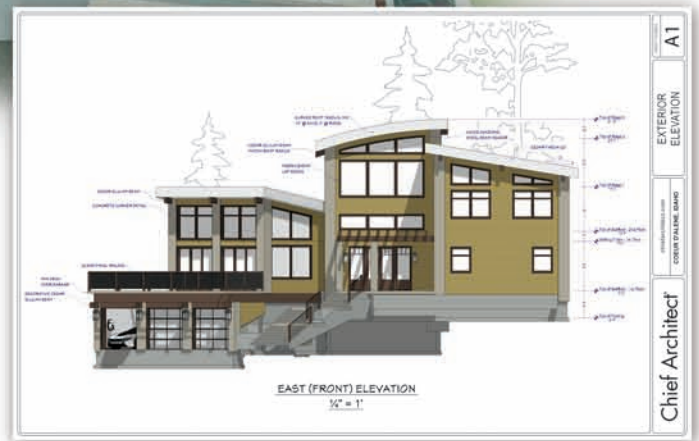


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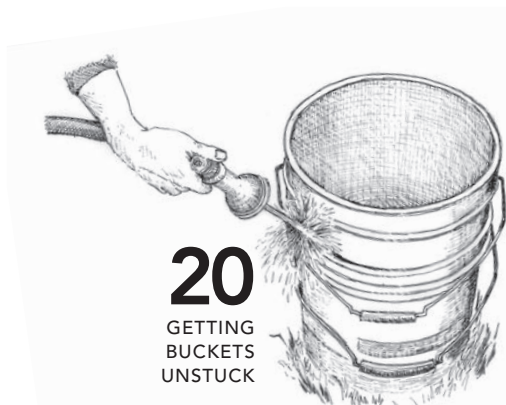
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The Taunton Press
Inspiration for hands-on living®

ON THE COVER FHB ambassador Jason Mollak, owner of JPM Construction in Elkhorn, Neb., secures the railing on this curved stairway. A deeper look at his process can be found on pp. 60-65. Photo by Justin Fink.



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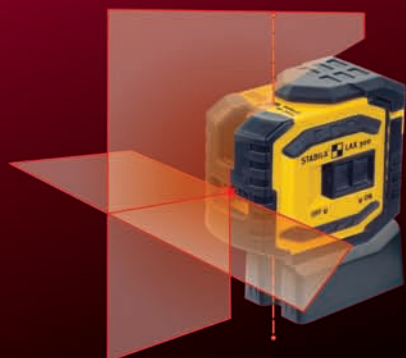
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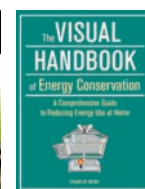
Fitting crown to a wavy ceiling

Do you bend the molding, feather the ceiling, or split the difference? Check out *FHB* ambassador Nick Schiffer's method.



From plans to reality

Drawings are a start, but as ambassador John Hourihan explains, often it's on the builder to make things come together.



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THE VOICES OF EXPERIENCE



PAUL BUUM, AIA ("Small Addition, Big Impact," pp. 52-57), has practiced residential architecture for over 25 years. He has been published extensively, including projects featured in the books *Farmhouse: New Inspiration for the Classic American Home*, *Not So Big Remodeling*, and *The Simple Home*, all from The Taunton Press. Paul is a graduate of the University of Minnesota and received the prestigious Young Architects Award from AIA Minnesota.

JORDAN GOLDMAN ("Right-sizing Mechanicals," pp. 66-69) is the engineering principal and a founder of ZeroEnergy Design in Boston. A certified Passive House consultant, a LEED accredited professional, and a HERS rater, he is fluent in building-envelope strategies, energy-efficient construction systems, and building-science design principles, as well as in the design, specification, and sizing of mechanical systems for enhanced energy performance.



JIM PETERSON has been a woodworker and home builder in Santa Barbara, Calif., for over 25 years. His company focuses on custom residential finish carpentry and fine woodworking while continually implementing new techniques and the latest technology. Jim also enjoys decorative marquetry, woodturning, wrapping fishing rods, and making furniture. In this issue, he writes about installing problem-free pocket doors (pp. 47-51).

In his senior year of high school, **JASON MOLLAK** ("Trimming Curved Stairs," pp. 60-65) began doing trim carpentry. His plan after graduating was to continue working while completing a program in building construction at a local community college, but he was offered a position as a supervisor and so left college after two semesters. He worked his way up to operations manager before leaving four years ago to start JPM Construction in Elkhorn, Neb.



write an article

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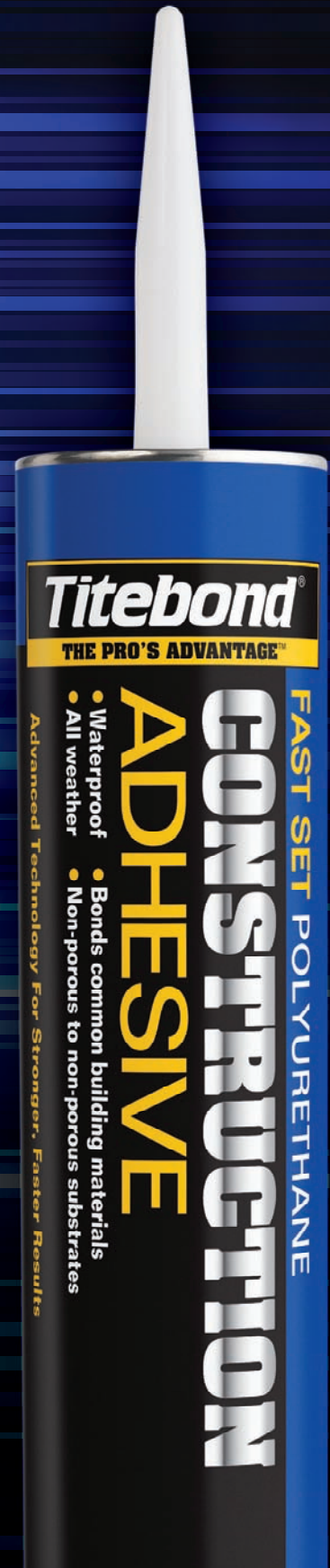


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Taping fiberglass batts to create an air barrier

In the ProHOME section of the October/November issue, Sean Groom goes into the details of how our Rhode Island project will be insulated. A combination of fiberglass insulation (in both blown and batt forms) and rigid mineral wool will help the home hit its energy goals. We received questions about the installation of the R-21 CertainTeed SmartBatts that will be used in the walls—specifically, if there is a benefit to taping the seams of the batts to the framing to improve airtightness and vapor control.

—ROB YAGID
editor in chief

ProHOME designer Michael Maines replies: Fiberglass batts are very open to air movement, so they perform best when they are fully sealed from air leaks. While taping the batts to the framing with flashing tape is certainly an involved process, CertainTeed has demonstrated the ability to reach an airtightness level of 1.6 ACH50 in a conventionally framed house by taking this extra step. That beats the latest energy codes, which mandate 3.0 ACH50 or less for new construction in climate zones 3 through 8. On the ProHOME, our primary air barrier is the taped Zip System sheathing on the walls and CertainTeed's MemBrain sheathing on the ceiling. The taped batts could serve as a secondary air barrier in the project. We'll be able to verify the degree to which the taped batts add to the airtightness of the wall when Mike Guertin runs blower-door testing at key intervals in the build. To see updates as this work proceeds, be sure to visit FineHomebuilding.com/prohome.

With regard to controlling vapor, code requires an interior vapor retarder, but the retarder does not have to be sealed perfectly to resist vapor movement by diffusion. So taping the batts is not critical if reducing vapor diffusion is the sole objective. The SmartBatt facing will work well enough to limit vapor drive when left untaped.



CertainTeed's SmartBatts have a coated facing that changes permeability based on the humidity level. When all of the facing seams are taped, the batts can create an interior air barrier.

An argument for passive solar

The message of Martin Holladay's piece on passive-solar design ("Musings of an Energy Nerd," *FHB* #262) was provocative. The takeaway was that affordable PV and good insulation values allow more-affordable high-performance homes, while passive solar has

become a distraction or even a fool's errand. I wish he would have made the case with a cost-benefit analysis between two specific homes to prove his point rather than making passive design seem outdated in and of itself. Economics change, but a home working with natural rhythms is poetry in motion. By emphasizing the aesthetic

freedom of ignoring passive elements, Holladay is ignoring the highest aesthetic achievement of all: a highly functional home that truly honors its site (including the sun's path).

My family's passive-solar home is the most comfortable home I've ever experienced, and it relies very little on mechanical systems for heating

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Dated design. One reader argues that the criticisms of passive-solar design shouldn't be anchored by examples of homes that are overly glazed.



and cooling. The overglazed monstrosity in the photograph (reprinted above) is a ridiculous example of what not to do. We've known better than that for decades. Some of the points made about thermal mass and imperfect overhangs seemed more like a witch hunt than constructive criticism. Well-designed overhangs, insulated slab foundations, and proper glass-to-mass ratios make for a comfortable and resilient home.

—DAN CLERE
Asheville, N.C.

November issue (*FHB* #262), Justin Fink mentions “substrates” again and again but never once mentions the traditional mud float. I’m a general contractor and have my tilework done by others, but I won’t accept bath jobs unless the walls are floated. Floating is the only method that allows correction for framing irregularities (out of plumb, out of square, not flat, etc.) and is the only jointless substrate.

—GEORGE A. HAMILTON JR.
via email

■ 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.

—ROB YAGID
editor in chief

Stone calculation correction

My wife and I always enjoy *Fine Homebuilding* articles, with their great graphics and pictures. I can’t help but comment, though, on a tiny error. On p. 55 of “Slab Foundation for Cold Climates” (*FHB* #262), there’s a sidebar on how to compute the quantity of gravel. It says that to convert cubic yards to tons, one should divide by 1.5. To make this conversion, you need to multiply, not divide, by 1.5.

—MICHAEL H.
Huntsville, Ala.

Floating walls for tile

In his article “How to Tile Everything” in the October/

that exposure to isocyanates is a particular concern. The worker in the photo is all suited up, but his ankles are clearly exposed, putting him at risk. I think it’s important for everyone to be diligent about their protective measures.

—NICK BORYC
Naperville, Ill.

The energy penalty of architectural adornment

We have our fake shutters, our fake corbels, and our fake beams, and now we have fake rafter tails (“Drawing Board,” *FHB* #261). With the plethora of articles you publish about energy-saving homes, it seems ironic that so many of these decorative elements are flying under the radar of energy consumption. It takes energy to produce them, to transport them, to install them, and to maintain them. Their so-called beauty is certainly in the eyes of the beholders, especially—in my opinion—the eyes of the manufacturers and builders who make money at the expense of the environment by providing them. If I were running LEED, I’d disqualify any home that has these energy-wasteful elements on it.

—BILL LEVINSON
Oakland, Calif.

Spray-foam protection

Paul Bennett’s well-written article “Spray-Foam Problems” (*FHB* #262) includes a photo of a person applying foam in a disposable suit for protection (below). On p. 47, Bennett states



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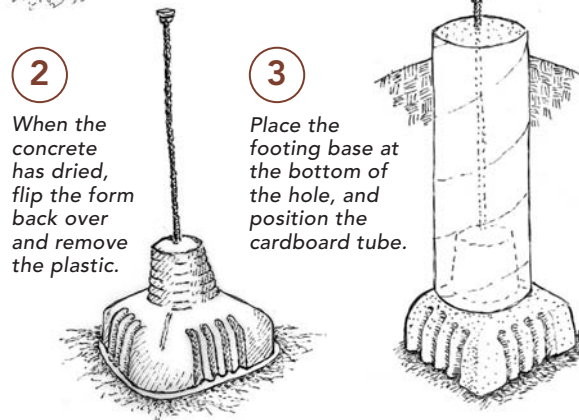
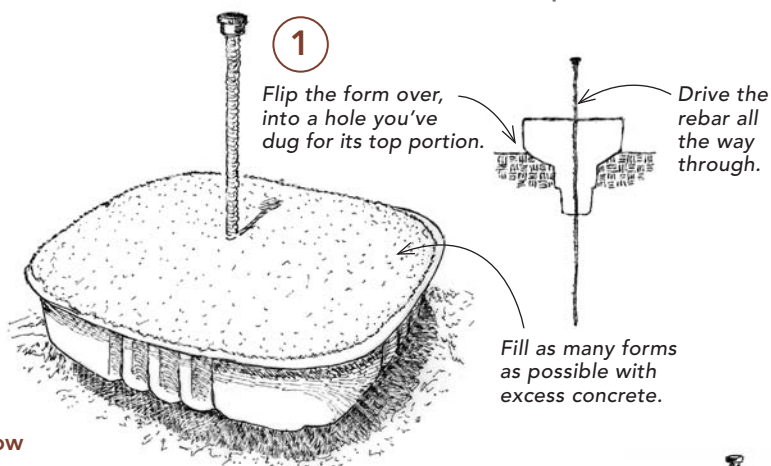
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Precast footings from leftover concrete

When placing concrete for a slab, sidewalk, footings, or a foundation, I order a little more to ensure that there is enough mix to complete the pour. Rather than sending any extra concrete back to the batch plant at the end of the job, I put it to use by casting deck footings that later can be set into place at the base of deck piers.

I use plastic footing forms as molds. After digging shallow holes in the ground, I flip the forms upside-down and place them in the holes, which will prevent the forms from tipping over when I fill them with concrete. I then drive 3-ft. lengths of rebar into the ground through the top of the footing forms. Once the concrete is set, I cut the ends on the bottom to about 6 in. and bend them over.

When building a deck, I dig the footing holes to frost depth and then drop a precast footing to the bottom of each one. I place a cardboard footing tube over the top of the footing and cut it off a few inches above the finish grade. Since the footing tube is only a couple of feet tall, I only have to mix a couple of sacks of concrete to fill it up.



—MIKE GUERTIN
East Greenwich, R.I.

Free lifetime supply of shims

In my business as a remodeling contractor, I am always using various shims for one thing or another. Instead of constantly buying new ones, I just repurpose scraps from tablesaw rips. Every time I rip anything and end up with waste that's $\frac{3}{8}$ in. and thinner, I gather it up and cut it to 4-in. lengths (the ideal length for shimming prehung door units). I gather up felt-paper scraps, too, and then cut them into uniform sizes and add them to the shim bucket. A strip of #30 or #15 paper is great when you need just a skosh more shim.

—R. TIMOTHY MADDOX
Lynchburg, Va.

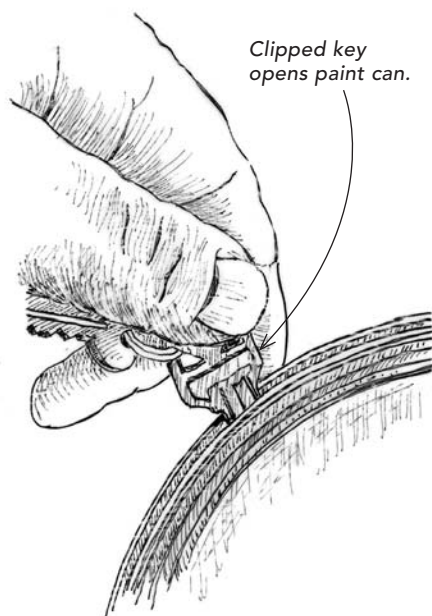
Paint-can key

I had a key on my keychain that I was no longer using, so I cut most of the long part off and made a paint-can opener out of it (drawing left). It's made of metal that is strong enough to get the job done, and it's always in my pocket. Now I don't have to look all over for a screwdriver or a dedicated paint-can opener.

—MIKE ALEXANDER
Monrovia, Md.

■ submit a tip

Tips & Techniques is a forum for readers to exchange information about methods, tools, and jigs they've devised. We'll pay for any we publish. Send details to Tips, *Fine Homebuilding*, P. O. Box 5506, Newtown, CT 06470-5506, email them to us at FH@Taunton.com, or upload them to FineHomebuilding.com/reader-tips.



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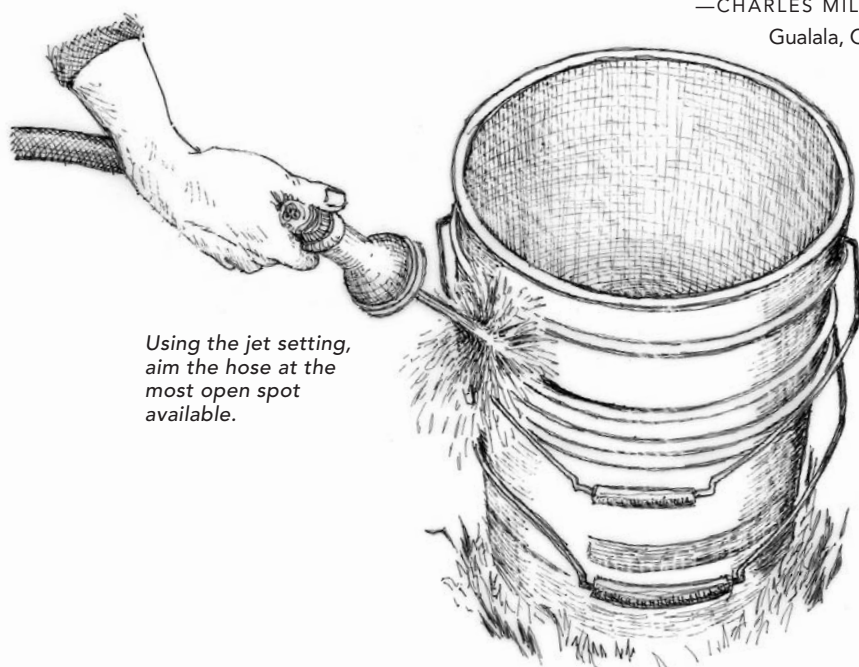
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Stuck-together mud buckets

My mud buckets occasionally get stuck together—I mean really stuck. Once when cleaning up after some painting, I decided to spray the stuck-together mud buckets with some water to see what would happen. As shown below, I put the hose attachment on the jet setting and pointed it at the crevice between the two buckets. In about 20 seconds, the buckets had separated. I've tried this repeatedly, and it always works.

—CHARLES MILLER
Gualala, Calif.

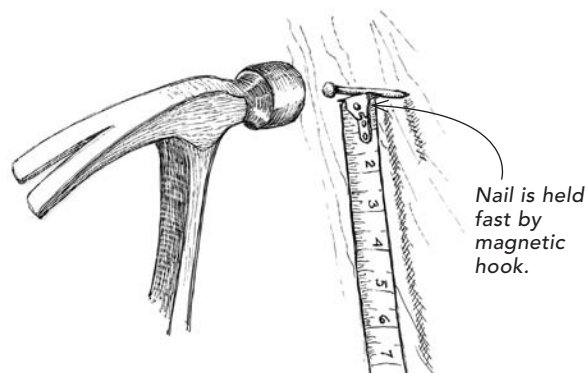


Using the jet setting, aim the hose at the most open spot available.

Keep the paint flowing

When using a paintbrush with latex/acrylic paint for an extended period, the paint in the brush can begin to dry out. One clue that this is happening is that the paint on the brush begins to feel gummy and doesn't lay on as well. Ignore this telltale sign, and not only does the quality of the work suffer, but hardening paint might ruin the brush. The solution is simple: When you start feeling the paint getting gummy, spritz the brush very lightly just below the ferrule with water from a spray bottle. How often you have to spritz depends on the temperature and humidity. The difference is immediately noticeable, and you'll really thank yourself when it comes time to clean the brush.

—ANDY ENGEL
Roxbury, Conn.



Nail is held fast by magnetic hook.

Magnetized tape holds nail

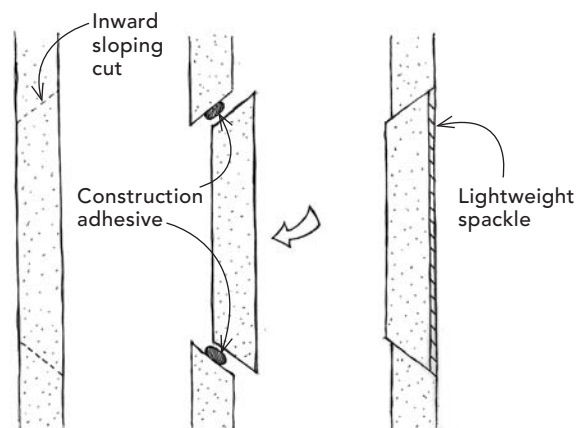
I'm a remodeler, so my work varies from day to day. On several occasions, I could have used one of those magnet nail starters on my hammer. Since I didn't have a hammer with this feature, I simply put the nail on the magnetized tip of my tape measure and extended the tape (drawing above). This also works great for starting small nails and nails going in joist hangers, where a traditional nail magnet won't work.

—RICHARD QUAGLIA
Fletcher, N.C.

Tapeless drywall patches

When cutting a hole in drywall, I use an oscillating multitool to make an inward sloping cut on each side so that the resulting cut-out piece can be reinserted into the hole (drawings below). When the time comes to replace the piece, I run a bead of construction adhesive around the sides to adhere it to the wall. Because the multitool created a small kerf, the patched piece sinks a little bit below the wall surface. So I fill in the depression and finish the edges with lightweight spackle. This takes a few coats with light sanding in between, but it creates much less mess than traditional taping and feathering with joint compound.

—DAVID MATZINGER
Menlo Park, Calif.



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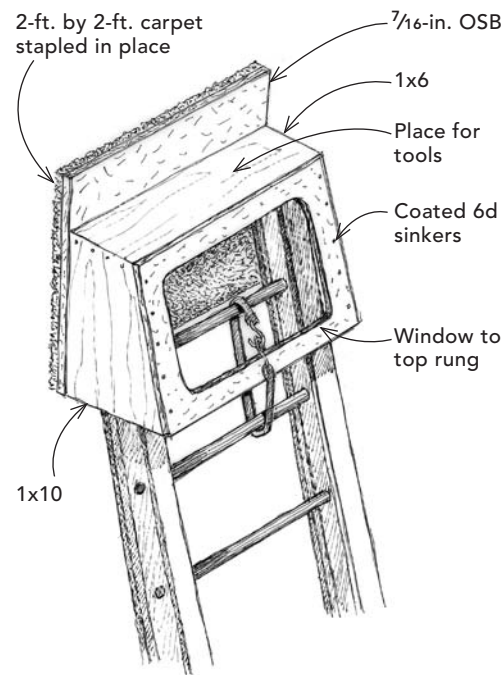
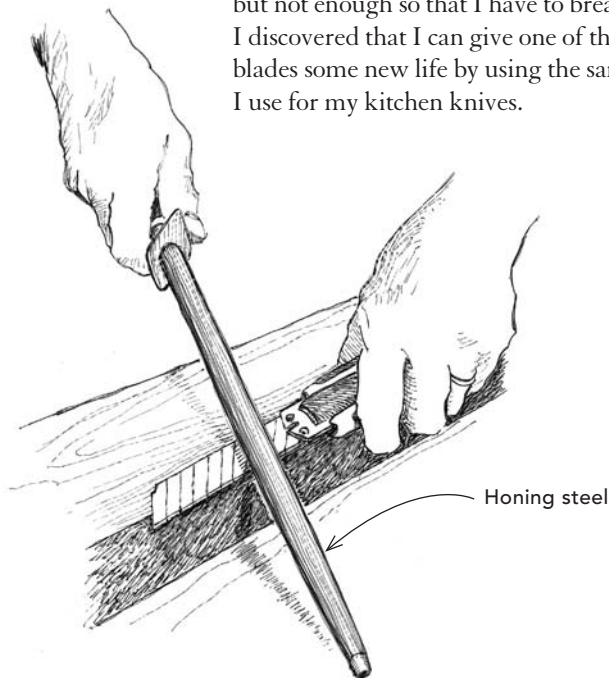
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Sharpening utility-knife blades

I've been using my utility knife to cut paper, thick fabric, Styrofoam, and other materials that dull the blade but not enough so that I have to break off a segment. I discovered that I can give one of these slightly dull blades some new life by using the same honing steel that I use for my kitchen knives.

—CHARLES CHANG
Calgary, Alta.



Ladder with a soft touch

The drawing above shows a site-built cap for my ladder that does two things really well: The 2-ft. by 2-ft. square of carpet protects the house surface, and the 7/16-in.-thick OSB backing distributes the ladder's weight. It has a 6-in.-wide shelf that accommodates paint, scrapers, and other tools. A bungee cord ties the cap to the ladder, and the window provides access to the top rung.

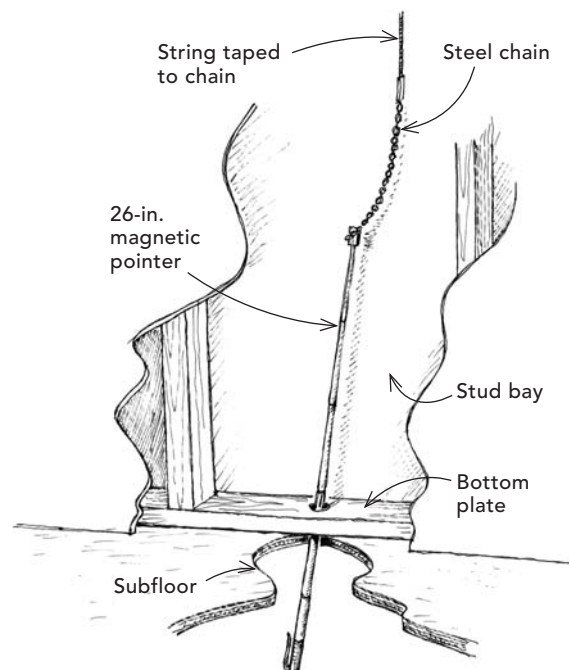
—GEORGE PAYNE
Middletown, Md.

TIP FROM THE ARCHIVES

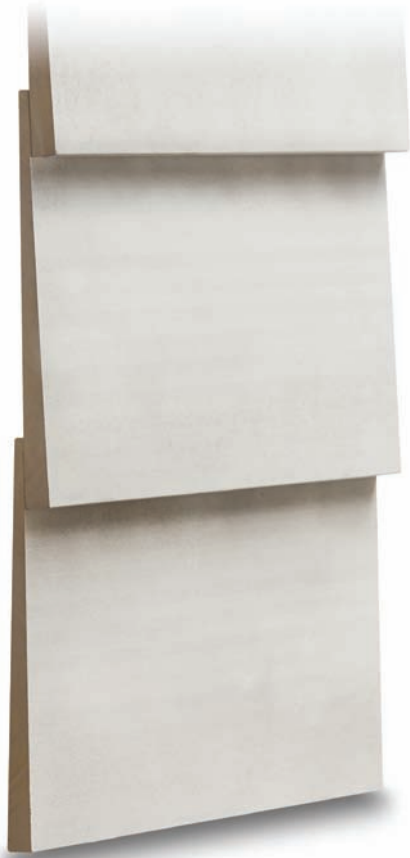
Another way to fish wires

I enjoyed your article "Running New Wires Through Old Walls" in *FHB* #176. Here's a variation on the weighted-line technique, which I find works well for running wire through an enclosed wall to a location one floor down. From below, I drill a 1/2-in.-dia. hole through the bottom plate into the stud bay. Through this hole, I insert a telescopic pointer that has a magnet on the end. When my partner lowers the weighted line into the wall cavity, I easily move the pointer around until it attaches to the chain on the end of the line. I then am able to pull the chain through the hole to attach the new wire so that my partner can pull it up.

—ROBERT CONDIE
Oakville, Ont.



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RIGHT-PRICED SPRAY RIG

Despite years of practice and the best-flowing finishes I could lay my hands on, my results with a paintbrush have plateaued somewhere around mediocre on the quality scale. I've dreamed of switching to an HVLP (high volume, low pressure) spray setup to avoid brush marks and to get a more professional cabinet-shop level of finish, but I assumed that anything affordable had to be junk. After reading some positive feedback on the Earlex 5500 (\$300), including a review from some trusted folks at *Fine Woodworking*, I decided to take the chance on it's being as good as people said.

This HVLP spray kit is close to ready right out of the box. The setup is simple: There's a turbine, a gun, and a hose that connects them together. The turbine unit provides a space for setting the gun down between uses, and it has a tall carry handle that will leave your other hand free for toting a gallon of paint, a roll of masking paper, or a cup of coffee. Unfortunately, the setup isn't perfect. First, the hose storage is a hassle, forcing you to disconnect the 13 ft. of hose from the gun and turbine for storage in a slot that's too narrow. Also, the rocker-style on/off switch is on the very bottom front of the unit and is recessed from the unit's plastic shroud, making it hard to find. There's also no on-board storage for the tip wrench, cleaning brush, and viscosity cup, which I consider must-haves on every spraying job.

The spray gun has just one point-of-flow adjustment: a metal knob at the back that increases flow when opened and restricts flow when tightened. It's simple and works well. At the business end, the air cap can be pushed in and rotated to three different positions: horizontal spray, vertical spray, and round (a tightly focused pattern for getting into tight spots). The rig includes a 2.0mm fluid tip, which is suitable for general-purpose paint spraying, but I bought a 1.5mm kit that offers an even finer spray. Kits with 2.5mm and 1.0mm tips are also available. These kits sell for \$30 to \$35 each.

For latex paint (you can also spray oil-based finishes), fill the spray cup with paint to the bottom of the angled shoulder, then add one viscosity cup's worth of clean water, which thins your mixture by about 10%. Stir the contents in the spray cup until the paint and water are mixed fully. Attach the cup to the gun, and do some test spraying to determine if the paint has been properly thinned. Some paint/primer combo products might need to be thinned up to around 15%, but I had fine results spraying Benjamin Moore Regal Select at about 10%.

Cleanup is a cinch, requiring a wrench for just one part. At the back of the gun, unscrew and remove the spray-control knob, and slide out the stainless-steel needle. At the front, unscrew the air-cap ring, then lift out the air-distributor assembly to expose the fluid

Earlex 5500

PRICE \$300

INCLUDED TIP 2.0 mm

OPTIONAL TIPS 1.0 mm,
1.5 mm, 2.5 mm

HOSE LENGTH 13 ft.

CUP SIZE 1 qt.

WEIGHT 12 lb.



tip, which is loosened with the included wrench for removal and cleaning. The quart-size, nonstick PTFE-coated container is wide enough to easily fit my whole hand. Finally, flush the feed tube with water or solvent.

BOTTOM LINE

This kit offers impressive results for \$300. I had no trouble achieving a smooth finish. Even the first trial runs—which were a bit too plagued by orange-peel texture for my liking (the result of a lack of paint filtration and an overly open spray-control knob)—produced a finish that looked better than one with brush marks. Although some aspects of the setup are awkward, and it lacks some of the features found on higher-end kits, this is a true bang-for-your-buck miracle.

Justin Fink, managing editor

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SMART TOOLS FOR SMARTPHONES

With ToolSmart—a collection of smart-phone-connected digital tools—General Tools aims to streamline measuring, estimating, and buying materials for projects. The ToolSmart iPhone and Android apps pair with digital devices using Bluetooth or Wi-Fi, enabling you to send measurements, photos, and videos to your smartphone and then organize the data by project. Within the app's project folders, you can create simple lists of measurements, and you can take photos in the app and annotate them to see the measurements in context. There's also a function that estimates materials (e.g., flooring, paint, crown molding) and then connects to the Lowe's online store so that you can order materials and have them shipped to your job. Of the seven tools, these three are the most useful for remodeling work.



Laser distance measurer

The TS01 Laser Distance Measurer (LDM; \$66) is an intuitive and practical tool, even without the Bluetooth smartphone app. With a few taps of the clearly labeled “measure/on” button, the backlit LCD wakes up, the laser pointer powers on, and your measurement shows up on the screen.

Several other buttons toggle between measurement modes, units of measure, and previously recorded measurements. The LDM can calculate area and volume and can triangulate the height of an object in the distance. Once paired with the ToolSmart app, the LDM requires just a click of the Bluetooth button to send your most recent measurement or calculation to your smartphone, where you can add it to a project list.



Angle finder

The TS02 Digital Angle Finder (DAV; \$50) is a 12-in. level mated to a rotating 10½-in. ruler. Hit the power and extend the measuring arm, and you're ready to measure any angle between zero and 228°.

The tool's large LCD screen is easy to read from an arm's length away, and the keypad has just three buttons: power, zeroing the angle finder, and quickly measuring angles—even in hard-to-reach locations. You can then send the measurements via Bluetooth to your smartphone for future reference or for creating cutlists.



Inspection camera

The TS03 Video Inspection Camera (VIC; \$200) connects to the ToolSmart app via Wi-Fi instead of Bluetooth. Once the connection is made, the image on the camera's screen is mirrored onto your smartphone. A tap of a button—either on the device or in the app on your phone—captures a still image or video clip and saves it in the app.

A flexible 3-ft.-long, 5/16-in.-dia. probe allows you to send the camera head deep into a wall, and the camera, with help from its adjustable-brightness LEDs, sends a clear image to the color LCD screen on the handset. The kit also includes a hook and magnet that you can attach to the end of the camera for retrieving small objects. There's also a tiny mirror that can be clipped to the camera head so you can see around tight corners.

Rob Wotzak, a remodeler in New Milford, Conn.



Stout screws

Whether it's for a more secure connection, reversibility, or precision placement, using screws instead of nails makes a lot of sense. For years on remodeling jobs, I've used drywall screws, but drywall screws aren't engineered for building and remodeling applications. They're brittle, aren't coated for exterior use, have bugle heads that can pull through, and often strip out. Sometimes I use structural screws, which are great for deck

ledgers and fastening beam plies together but are too large and expensive for light and medium fastening jobs.

Enter Simpson Strong-Tie's new SDWS Framing Screws (\$20 for 75). These screws have a broad flat head to distribute the load without pulling through. The aggressive tip starts easily, and the deep threads grab solidly. They come in 2½-in. and 3-in. lengths and are great for all kinds of framing connections as well as deck building and kitchen-cabinet installation. After bringing them to several job sites, I have found them easy to use and rock solid.

Mike Guertin, editorial adviser



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DURABLE DO-IT-ALL JACKET

With winter wind and cold rapidly approaching, I'm sure glad to have my new Milwaukee 3-in-1 Heated Jacket (251B-21), which pairs a heated hooded sweatshirt with a durable water-resistant shell. The flexible combination of layers helps me stay comfortable all day in any weather, no matter what I'm doing. Besides being comfortable, the jacket is job-site tough. Rivets and reinforced stitching strengthen all the high-wear, high-stress areas. The insulated shell, which can be worn with or without the hoodie, is made from thick rip-stop nylon and includes storm flaps and elastic cuffs to keep out wind and weather. Overall, it's durable, functional, and has an understated style that suits me fine.

The hooded sweatshirt is heavier than the average sweatshirt, and because it's

made from polyester, it's warmer, more water resistant, and tougher than a cotton hoodie. Embedded between the hoodie's inner and outer layers are flexible heating elements, creating front and rear heating zones. The carbon-fiber elements, which are powered by Milwaukee's M12 12v battery packs, have three settings (high, medium, and low), so you can match the heat output to the temperature and your activity level.

Milwaukee claims about eight hours of run-time with the heat on low and a 2.0-Ah pack, which matches my experience. Unlike other heated garments I've owned, the Milwaukee 3-in-1 can be machine washed and dried (on low), which sure beats trying to wipe away construction grime with a damp



rag—the method suggested for cleaning my old heated jacket.

Available in black and camo, and in sizes from small to 3X, the jacket sells for about \$300 without battery packs.

Patrick McCombe, associate editor

Photo: courtesy of Milwaukee

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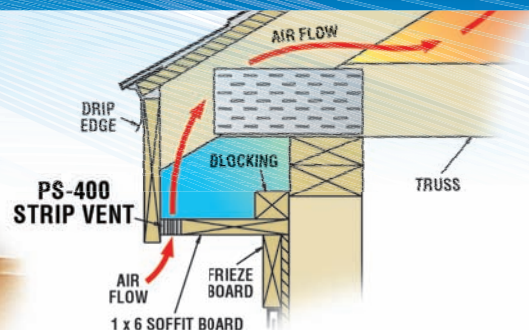
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Frustration-free safety glasses

I recently picked up a three-pack of 3M SecureFit safety glasses for \$20. I don't look good in them (I wouldn't look good wrapped in thousand-dollar bills), but unlike every other pair of goggles or safety glasses I've tried, these work well. They don't fall off my face or give me a headache from a poor fit. Of the three pairs included in the set that I purchased, the indoor/outdoor lightly tinted "mirror" pair is my favorite. While there's an air of Bono in how they look, I like them more for their utility in the sun. The reflective lenses knock down glare without being dark, which



is great when I'm making cuts outside and then bringing the pieces indoors.

This leads me to the second—and primary—reason why I like these glasses: I forget they're there. The lenses don't attract dust, and somehow they stay free of sweat and grease from my eyelashes. They're also amazingly scratch resistant. But most important, these glasses are so comfortable I forget I'm wearing them. Isn't that what you really want from safety glasses?

Mark Clement, contractor and tradeshow presenter from Ambler, Pa.

Photo: Dan Thornton

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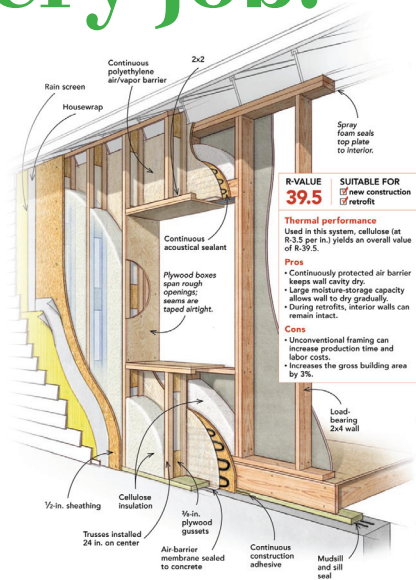
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The Right Header for Every Wall

Several code-approved options beyond the standard double 2x12 save material and energy

BY MIKE GUERTIN

When I started framing houses in the late 1970s, the standard header for almost any size window and door opening was a double 2x12 with a ½-in. plywood spacer to bring the header flush with the stud edges in a 2x4 wall. When the header is pushed hard to the double top plate of an 8-ft.-high wall, its bottom sets up window and door head jacks 6 ft. 10 in. off the floor, perfect for standard 6-ft. 8-in. doors.

When high-performance homes gained market share in the late 1980s, the building industry looked for options to reduce the amount of lumber used to build headers—or to eliminate conventional head-

ers altogether—in order to save resources, minimize thermal bridging, and provide more space for insulation. Double 2x12 headers are often oversize for the load, but they're still the standard. In most cases, there is no structural advantage to installing headers that are larger than required, and there are downsides. Not only do they cost more than right-size headers, but the deeper a lumber header is, the more likely it is to lead to drywall cracks as green lumber dries or dried lumber expands during seasonal humidity changes.

When I look at the prescriptive options available in the IRC, I'm surprised by how many builders still frame the way I did nearly 40



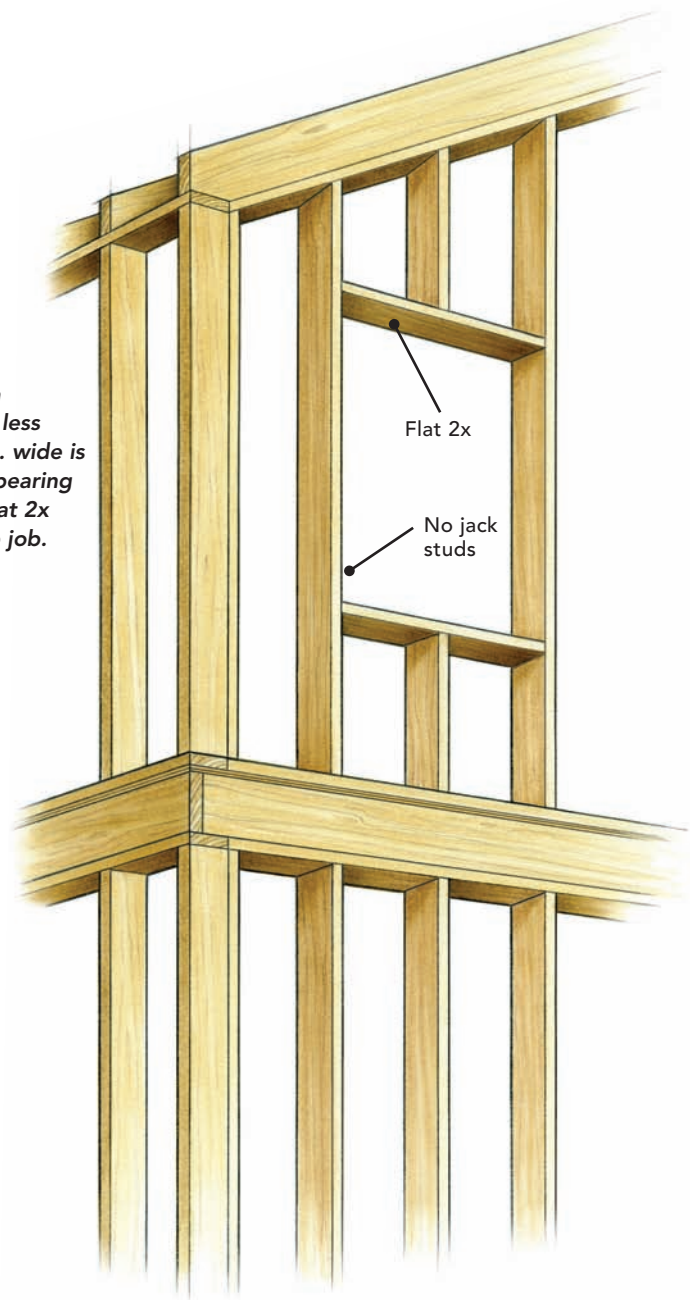
DO YOU EVEN NEED A HEADER?

The 2015 IRC says, "Load-bearing headers are not required in interior or exterior nonbearing walls. A single flat 2-inch by 4-inch member may be used ... for openings up to 8 feet in width" (R602.7.4).

In essence, the code doesn't require a header unless the end of a floor joist, roof rafter, or truss lands on that wall or there's a concentrated load bearing over the opening. You don't even need to install structural jack studs, since there is no load for them to bear.

A header also isn't required when a window or door is narrow enough to fit between studs on layout. This is more typical with framing on 24-in. centers. Then, when a window is less than 22 in. wide, you don't need a header; you just install 2x head and sill boards to box out the rough opening.

When an opening less than 8 ft. wide is in a nonbearing wall, a flat 2x does the job.



years ago. I guess bigger and beefier looks stronger and impresses clients, and I admit that it's easier to use the same-size headers throughout a house whether for a large patio door or a narrow window. Thoughtful header design takes planning and organization, but it's a better way to build. Shallower headers, single-ply headers, engineered lumber, innovative use of rim joists, and even no headers at all save material, money, and energy. □

Mike Guertin is a builder and remodeler in East Greenwich, R.I. Photos courtesy of the author, except where noted.

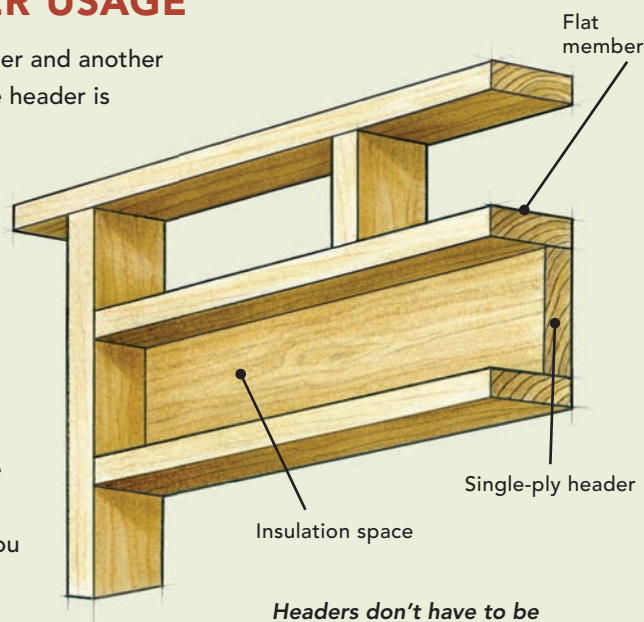
RIGHT-SIZE HEADERS OPTIMIZE LUMBER USAGE

Sizing a header for the load it will carry is pretty simple, can be done without an engineer, and usually results in headers that use less material. For conventionally framed houses, tables in the IRC help you determine the right-size header for the opening width and the load it supports. In the 2012 IRC and earlier versions, the header span table for exterior bearing walls (R502.6[1]) was published in chapter 5, “Floors”—hardly a logical spot—and the table only included two-ply, three-ply, and four-ply headers. The 2012 IRC added a table for single-ply headers in chapter 6. The 2015 IRC consolidated this information in a single exterior-wall-header table (R602.7[1]) in chapter 6. This section includes similar tables for headers in interior walls and porches.

In addition to their listing in the table, single-ply headers have a subsection requiring that one 2x flat board be installed

at the bottom of the header and another one on the top (unless the header is tight to the top plate).

The header options are listed by the number of plies (one to four) and the lumber size (2x4 to 2x12). While only three building widths (20 ft., 28 ft., and 36 ft.) are shown, the code permits you to interpolate for building widths between those listed. If you don’t want to interpolate, you can just use the spans listed for the next-larger building width. Also in the tables are columns labeled *NJ*, meaning “number of jack studs” required under each end of the header.



Headers don't have to be oversize. In many cases, a single ply of lumber works, leaving additional room for insulation.

EXAMPLE: Find a header for an opening in an exterior wall on the first floor of a two-story house with a center-bearing wall. The house is 28 ft. wide, the rough-opening width is 3 ft. 2 in., and the snow load is 30 lb. per sq. ft. or less (found in IRC chapter 3).

Girder spans and header spans for exterior walls																			
(Maximum spans for Douglas fir–larch, hem-fir, southern pine, and spruce-pine-fir, and required number of jack studs)																			
Girders and headers supporting	Size	Ground snow load (lb. per sq. ft.)																	
		30						50						70					
		Building width (ft.)																	
		20		28		36		20		28		36		20		28		36	
		Span	NJ	Span	NJ	Span	NJ	Span	NJ	Span	NJ	Span	NJ	Span	NJ	Span	NJ	Span	NJ
Roof, ceiling, and one center-bearing floor	1-2x8	3-11	1	3-5	1	3-0	1	3-7	1	3-0	2	2-8	2	-	-	-	-	-	-
	1-2x10	5-0	2	4-4	2	3-10	2	4-6	2	3-11	2	3-4	2	-	-	-	-	-	-
	1-2x12	5-10	2	4-9	2	4-2	2	5-5	2	4-2	2	3-4	2	-	-	-	-	-	-
	2-2x4	3-1	1	2-9	1	2-5	1	2-9	1	2-5	1	2-2	1	2-7	1	2-3	1	2-0	1
	2-2x6	4-6	1	4-0	1	3-7	2	4-1	1	3-7	2	3-3	2	3-9	2	3-3	2	2-11	2
	2-2x8	5-9	2	5-0	2	4-6	2	5-2	2	4-6	2	4-1	2	4-9	2	4-2	2	3-9	2
	2-2x10	7-0	2	6-2	2	5-6	2	6-4	2	5-6	2	5-0	2	5-9	2	5-1	2	4-7	3
	2-2x12	8-1	2	7-1	2	6-5	2	7-4	2	6-5	2	5-9	3	6-8	2	5-10	3	5-3	3
	3-2x8	7-2	1	6-3	2	5-8	2	6-5	2	5-8	2	5-1	2	5-11	2	5-2	2	4-8	2

1. Locate the group in the left column that matches the situation.

2. Find the applicable snow load in the upper row.

3. Below the snow load, choose the building width.

4. Below the building width, look in the span column and find at least one span that matches or exceeds your opening (3 ft. 2 in. or greater). The closest in this case is 3 ft. 5 in.

5. Move directly left from the chosen span to the size column to find a header configuration. Use any header design for openings equal to or greater than yours. For spans up to 3 ft. 5 in., you can use a single 2x8 or two 2x6s, which could span up to 4 ft.

INTERPOLATION

If the house width falls between the three provided in the IRC, header spans can be interpolated with some simple math. For example, let's use the same rough opening and house configuration as before, except that in this case the house is 26 ft. wide. We'll use a single 2x8 header.

Begin with the difference in span for a given header configuration between the building width on each side of the actual building width. At 20 ft., a single 2x8 can span 3 ft. 11 in. At 28 ft., it can span 3 ft. 5 in., so the header span difference is 6 in. over 8 ft. To find the difference per foot, divide 6 in. by 8 ft.:

$$6 \text{ in.} \div 8 \text{ ft.} = 0.75 \text{ in. per ft.}$$

Since the 26-ft.-wide building is 6 ft. wider than the 20-ft. width from the table, calculate the following:

$$0.75 \text{ in. per ft.} \times 6 \text{ ft.} = 4.5 \text{ in.}$$

Subtract the above number from the header span for a 20-ft.-wide building to find the allowable header span for a 26-ft.-wide building:

$$3 \text{ ft. } 11 \text{ in.} - 4.5 \text{ in.} = 3 \text{ ft. } 6.5 \text{ in.}$$

Why header spans change

Today's lumber isn't as strong as the old-growth material of years past, so lumber-rating authorities have been reducing the rated structural capacity of most species. One way that those reductions are manifest is in shorter header spans. If your code jurisdiction adopts a more recent version of the IRC, you may have to change your header sizes according to the revised table.



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LSL
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strand lumber



**Insulated
header**

ENGINEERED-LUMBER HEADERS

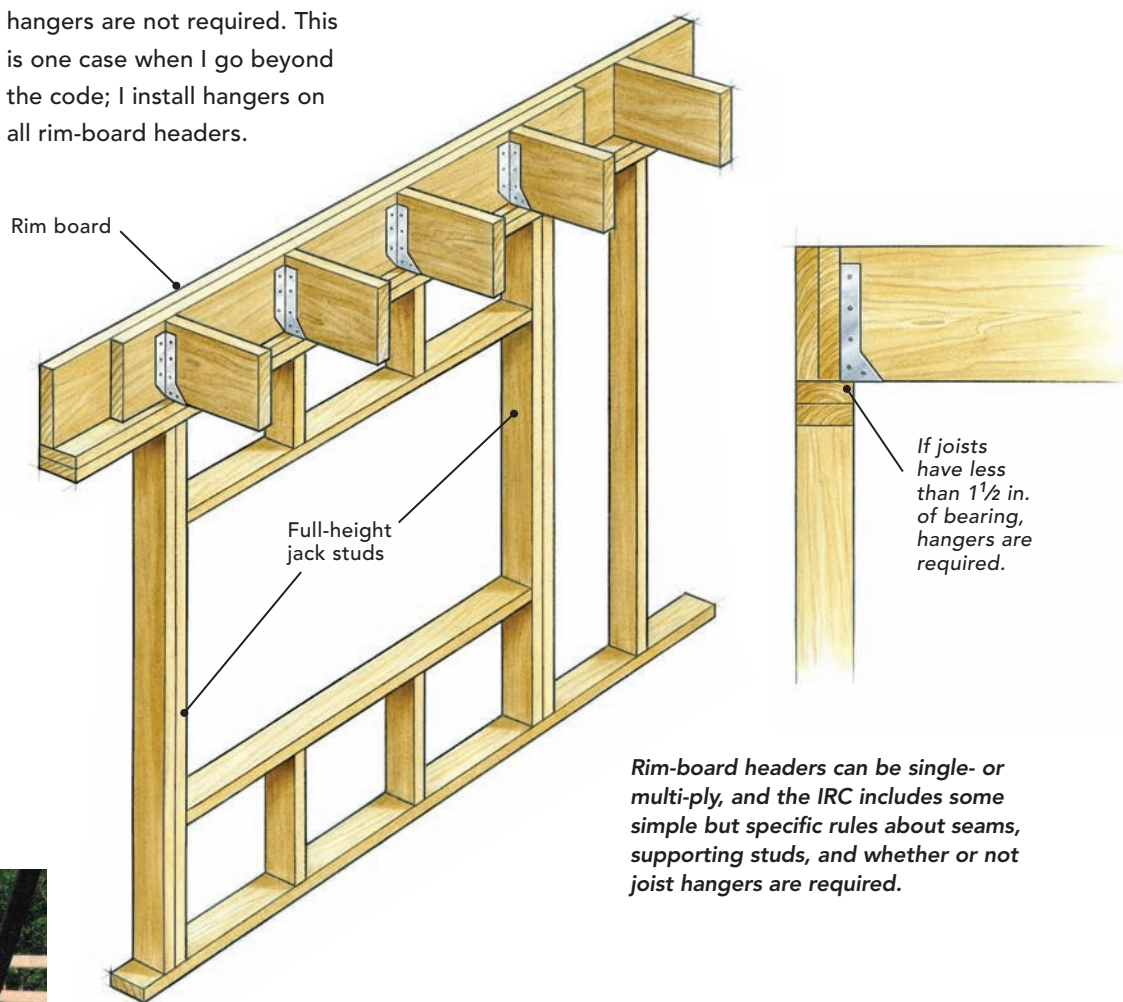
LVL, LSL, and insulated headers are usually more consistent in size and less prone to shrinking and swelling than sawn-lumber headers, which is one reason many builders have adopted them. Some companies make headers in a laminated sandwich with a rigid insulating-foam core or face. (The one shown here is from SJS Components.) Engineered-lumber manufacturers provide header-span tables similar to the ones listed in the IRC, making it easy to size them. I've used engineered lumber as single-ply headers, multi-ply headers, and rim-board headers. In many cases, the engineered-lumber members can span greater distances compared to sawn-lumber headers of similar sizes. It's important to check the manufacturer's instructions, as there may be special-use conditions not covered in the code.

RIM-BOARD HEADERS USE EXISTING FRAMING

Why does a header have to be framed into an exterior wall when there's already a rim board in the floor framing above the top plate? A rim board often can bridge a window or door opening, and as of the 2015 IRC, there is a subsection on them (R602.7.2). Rim-board headers are sized according to the same table used to size regular headers, and in many cases the single-ply rim board you're already installing may eliminate the need for a conventional header below. In situations where the loads are greater or the opening is larger, the rim board can be sistered with additional material (photo). In all cases, there can be no joints in a rim-board header over the opening and for 6 in. past the outer bearing studs. The number of outer studs framing each end of the rough opening must at least equal half the studs displaced by the opening, assuming you are using the maximum stud spacing permitted in table R602.3(5). This may sound

confusing, but it's easy in practice. If there would be two studs falling in the opening, then you would need one jack stud at the left side of the opening and another at the right side.

According to the IRC, as long as floor joists have at least 1½ in. of top plate to bear on (say, a single rim board on a 2x4 top plate), hangers are not required. This is one case when I go beyond the code; I install hangers on all rim-board headers.



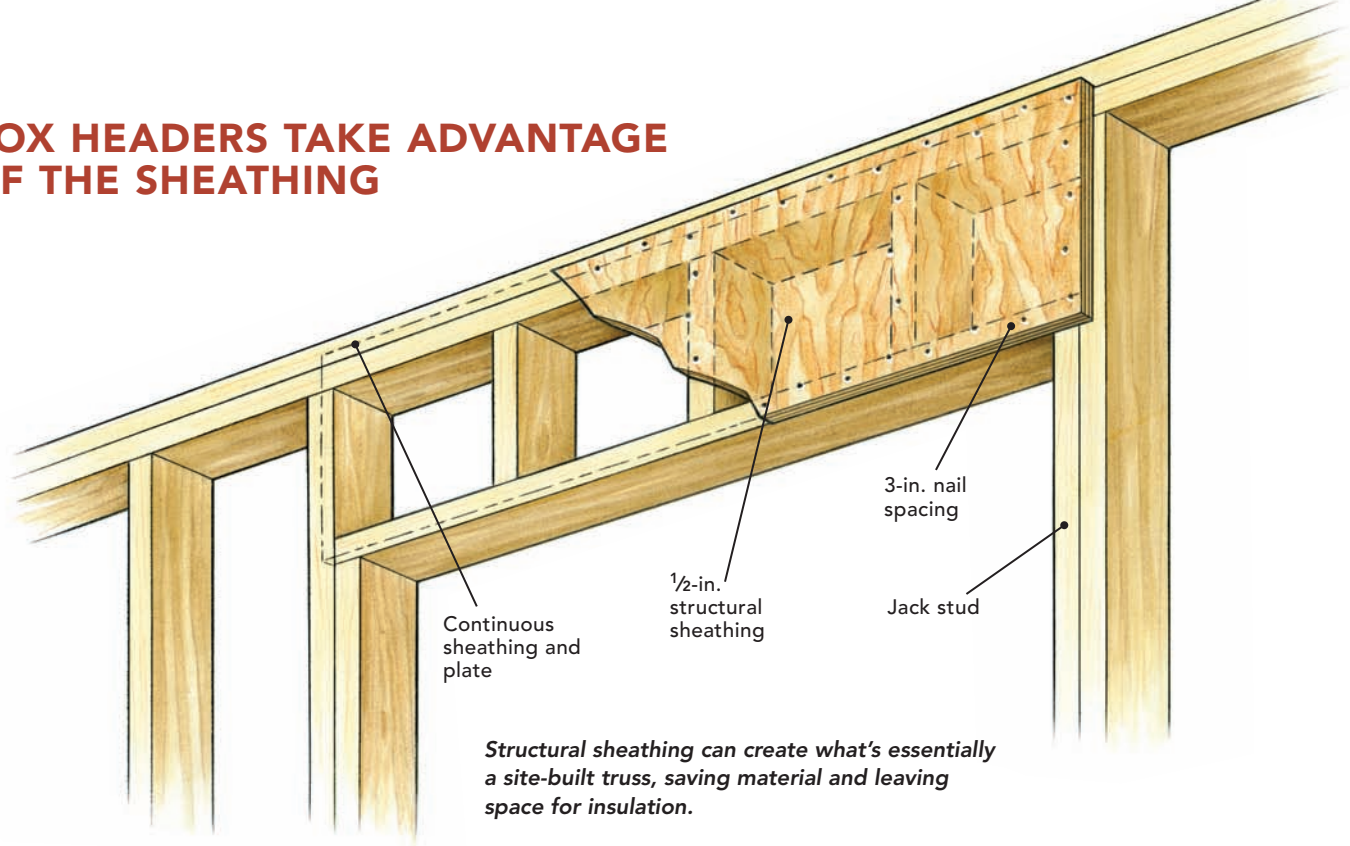
Building up headers

When building multi-ply headers, you should start with the IRC's fastening schedule (table R602.3[1]), which covers two-ply headers with a ½-in. plywood or OSB spacer, presumably for a 2x4 wall. (No fastening schedule is given for other headers.) The schedule calls for

16d common nails at 16 in. on center or 16d box nails at 12 in. on center. I run two rows of nails on 2x6 to 2x10 headers and add a third row in the middle of 2x12 headers.

In 2x6 walls, I usually frame double headers by sandwiching 2-in. rigid foam between

BOX HEADERS TAKE ADVANTAGE OF THE SHEATHING



Box headers are made by installing structural-sheathing panels to the outside face or to the inside and outside faces of the framing between the top plate and a flat 2x at the head of a rough opening. The sheathing and framing combine to act as a truss. Because they are built with a minimal amount of lumber, there is more space to fill with insulation. Box headers can be used only in walls supporting just a roof and a ceiling, and in walls supporting a roof, a ceiling, and one center-bearing floor with an interior center-bearing wall. The IRC lists spans for 9-in.-tall and 15-in.-tall box headers.

Two-sided box headers have greater spans than single-sided ones. All you have to do is follow a few conditions outlined in figure R602.7.3. Begin by framing in the cripple studs between the top plate and a flat 2x at the head of the rough opening, and support the flat 2x with the same number of jack studs the code requires for a conventional header of that length. Make sure the structural sheathing and top plate continue through the opening without any joints. Follow the fastening schedule: 8d common nails spaced every 3 in. and driven into the plates and the cripples. The sheathing must be a nominal

1/2 in. thick, and its strength axis must run parallel with the wall length. (The strength axis of most structural sheathing aligns with the sheets' long edges.) In many cases, the exterior wall sheathing alone can be used to create a one-sided box header. For instance, in a 28-ft.-deep house with two stories and a center-bearing wall, a one-sided 9-in.-tall box header can span up to 3 ft.

Two-sided box headers give greater spans, but the interior structural panel is applied to the face of the studs, requiring you to pad out all the studs to match the plane before installing drywall. Alternatively, if you're framing walls from 2x6s, you can rip 1/2 in. off the plate, the tops of the king studs, and the head board. This isn't allowed with a 2x4 wall.

If you're already framing with 1/2-in. structural sheathing, then one-sided box headers are easy to incorporate. Just keep joints in the sheathing and top plate from falling above the opening, and nail the perimeter of the header properly. If the house is being sheathed with 7/16-in. OSB, you can install pieces of 1/2-in. panels just for box headers. The slight difference in thickness won't cause any problems.

1 3/4-in. LVL stock or 2 1/2-in. rigid foam between 2x stock. Because nails aren't long enough to penetrate both plies and the foam, I use 5-in. or 5 1/2-in. Fasten Master FlatLok or HeadLok screws, or 5-in. Simpson Strong-Tie SDWS screws.

The low-profile heads on these screws sit flush with the surfaces of the lumber, so they don't interfere with sheathing or drywall. I space the screws roughly 16 in. apart about 2 in. down from the edges of the header.

I rarely frame walls with 2x4s, but when I do, I use 1/2-in. rigid foam between the plies of built-up headers rather than OSB or plywood. Even though the R-value of the foam is small, it breaks the thermal bridge somewhat.

A New Approach to Coffered

Foam-core beams and moldings make
for an attractive easy-to-install ceiling

BY BRIAN KITCHIN AND NICK AITCHISON



Ceilings

As drywallers, we're used to most of our work being the backdrop for other finishes. Increasingly, however, we're adding those details that make a home's interior stand out, such as the coffered ceiling shown here. Several manufacturers make EPS polystyrene moldings and trim for exterior and interior use. (We buy from Foamcore Architectural Mouldings in Toronto; foamcoremouldings.com.) These moldings are more commonly used for synthetic-stucco exteriors, sometimes called EIFS (exterior insulation and finish system). Recently, they have been adapted for interiors by applying a smooth coat of joint compound to the high-density EPS substrate. The visible surfaces are caulked and painted later.

We glue the moldings—which come in many profiles—to the ceiling and walls with polyurethane drywall adhesive, clamping them temporarily with coarse-thread drywall screws. Once the glue is dry, the bond is tenacious. We've had to scrape away misplaced moldings only a few hours later.

Once the pieces are hung, we fill any gaps that are larger than $\frac{3}{8}$ in. with a squirt of the

CUT, GLUE, AND SCREW

Installing EPS moldings is easy. Parts are cut on a 12-in. miter saw. (Thick profiles require rotating the stock and making multiple cuts.) After cutting, the top and sides in contact with walls are coated with spray polyurethane drywall adhesive and glued to primed drywall. The moldings are temporarily held in place with coarse-thread drywall screws while the glue dries, which takes between two and four hours. After that, the screws are removed and the holes are caulked or filled with lightweight all-purpose joint compound.





Fill in the grid. Once the perimeter and the long interior beams are installed, shorter pieces are cut and fit in between. A compact laser projects the layout marks across the entire ceiling so that the beams are placed straight.



What is this stuff?

Made from high-density expanded polystyrene (EPS), foam moldings like those used in this project have their origins in the architectural details found on synthetic-stucco exteriors. But instead of a fiberglass mesh that accepts acrylic stucco, the moldings made for interior use are coated at the factory with a thin layer of joint compound. Inside corners are mitered on-site rather than coped, and seams where the lengths of molding come together use butt joints rather than scarf joints. Corners are caulked, and gaps and seams are filled with compound and sanded with 220-grit paper when dry. Suppliers of foam moldings, who usually cater to the synthetic-stucco and drywall trades, have large catalogs of stock profiles and can make custom profiles subject to minimum order. Common profiles cost from \$3 to \$6 (U.S.) per ft.

adhesive to act as a backer for the lightweight joint compound we apply to the seams and gaps. The moldings come with all of the visible surfaces coated with compound, and they accept paint like drywall. The finished product is often mistaken for painted wood. Because the EPS is very stable, it doesn't move with changes in humidity and temperature, so the joints stay tight during our humid summers and cold winters.

Why would a homeowner or builder choose to install a coffered ceiling or crown molding made from EPS and joint compound instead of wood or MDF? The answer is simple: speed and cost. With a crew of three, we installed the coffered ceiling shown here in half a day. Caulking all the gaps and inside corners took another two hours. The material cost \$1400 (U.S.), a fraction of what it would cost a finish carpenter to install a

similar ceiling made from wood moldings. The only downside we see is that the moldings only come in 8-ft. lengths, so you end up making more cuts and filling more seams than you would with longer material. □

Brian Kitchin and Nick Aitchison are the owners of Drywall Nation in Sudbury, Ont., and are *Fine Homebuilding* ambassadors. Photos by Patrick McCombe.



Clamp with screws. The moldings are held in place with 1 $\frac{1}{4}$ -in. coarse-thread drywall screws while the glue dries.

CUT AND FIT THE CROWN MOLDING

Once the grid of intersecting beams is complete, crown molding with a triangular cross section is installed around the inside. Inside corners are mitered rather than coped because of the material's EPS core. Miters stay tight seasonally because the drywall substrate is dimensionally stable, as are the compound-coated foam moldings on top. Once all the crown is in place, the corners are caulked, and any butt joints are filled with compound (no tape) and sanded.

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What You Didn't Know About Alarms

Smoke alarms and CO alarms are more nuanced than most people realize

BY GLENN MATHEWSON

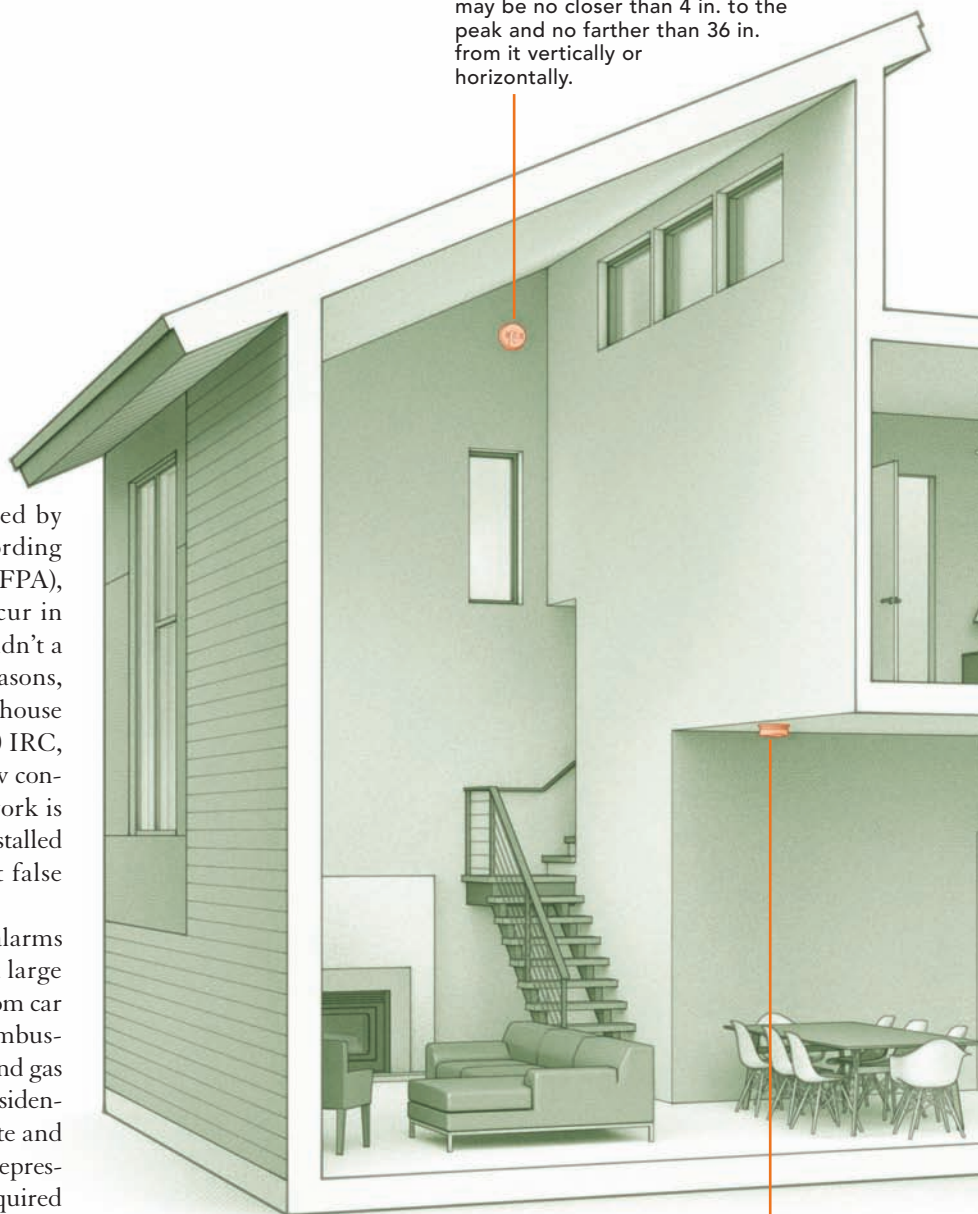
Residential smoke alarms have been required by national building codes for decades, yet according to the National Fire Protection Association (NFPA), approximately 60% of home fire deaths occur in houses without functioning smoke alarms. Why wouldn't a home have functioning alarms? There are several reasons, including the increasingly unlikely one that an older house hasn't undergone a remodeling project since the 2000 IRC, when interconnected alarms were required both in new construction and when virtually any permitted interior work is done. In other cases, it could be that the alarms were installed in poor locations, were disabled because of frequent false alarms, or were beyond their useful life span.

In the 2009 IRC, hardwired carbon monoxide (CO) alarms joined smoke alarms as a requirement. While CO is a large component of smoke in a house fire, it also can come from car exhaust in attached garages or from poorly vented combustion appliances such as boilers, furnaces, water heaters, and gas stoves. CO has no odor, color, or taste. Levels found in residential fires can render a person unconscious in one minute and dead in three. Low-level exposure can cause headache, depression, confusion, and memory loss. CO alarms are not required to connect with a house's smoke alarms, although they may.

Until the 2012 IRC, *interconnection* was understood to be a physical connection of all alarms in a building via wiring. Alarms that communicate wirelessly are now allowed. They are still required to be powered by house current, but wireless alarms can offer many more features.

Glenn Mathewson is a building inspector in Westminster, Colo.

Code Alarms on sloped ceilings may be no closer than 4 in. to the peak and no farther than 36 in. from it vertically or horizontally.



Best practice Combination ionization and photoelectric alarms to provide broad protection

Code Photoelectric smoke alarms must be at least 6 ft., and ionization alarms at least 20 ft. (10 ft. if they have a silencing button), from permanent cooking appliances.

LOCATING ALARMS

For alarms to function, they need to be where the smoke or CO goes. That's why codes specify certain locations, and the NFPA has even more best-practice recommendations. Because smoke distribution in buildings is uneven, some pockets, such as corners or areas near fans or supply ducts, remain clear longer than others. Therefore, alarms may not be mounted

in those spots. On the other hand, if smoke alarms frequently cry wolf, they will eventually be disregarded or disabled. Steam is a common cause of false alarms, so there are requirements about locating them around bathrooms and kitchens. CO is another matter. Its density is about equal to that of air, so it doesn't necessarily rise to the ceiling. That's why CO alarms are not required to be installed high up.

Code Alarms must be at least 36 in. from a supply register of a forced-air HVAC system or from the tip of a ceiling fan's blades.

Code Wall-mounted smoke alarms must be between 4 in. and 12 in. from the ceiling.

Code Smoke alarms must be mounted no closer than 3 ft. from bathroom doors.

Code There must be a smoke alarm on every level and inside and outside every bedroom.

Code There must be a CO alarm outside every bedroom and inside ones with fireplaces.

Best practice CO alarm on every level

Best practice CO alarm near garage entry

Best practice No CO alarm near combustion appliances due to potential false alarms

Code CO alarms don't have any height requirements but are otherwise subject to the same location restrictions as smoke alarms.

SMOKE-ALARM TYPES

Ionization alarms have a tiny amount of radioactive americium 241 that induces an electrical current between two plates. Smoke particles between those plates interrupt the current, triggering the alarm. Ionization alarms are very responsive to fires that produce little smoke.

Photoelectric alarms are best at detecting smoky fires. They aim an LED light across a chamber, away from an internal photo sensor. Smoke particles in the chamber reflect the light back to the photo sensor, activating the sensor and triggering the alarm.

Both ionization and photoelectric alarms satisfy the code, but combination ionization and photoelectric alarms offer the best of both worlds.

Wireless alarms can be powered from any nearby unswitched circuit and don't require a three-conductor cable to connect all the units. This can save installation costs in remodeling work.

Smart alarms, such as the Nest system, alert occupants to smoke or CO with a voice that says what's been detected and where. If CO is detected, the system signals a Nest thermostat and automatically shuts off the furnace, a likely source of CO. Smart alarms also can alert mobile devices.

NOTE

Replace your alarms. You know to test your alarms monthly and to replace the batteries every six months, right? But you might not know that alarms wear out. Replace smoke alarms themselves every decade and CO alarms every two to six years depending on the manufacturer's instructions.



Tool
Test

Compact Routers

Choose the best tool for
profiling, flush trimming, and
mortising one-handed

BY PAUL JOHNSON

The original compact routers were created for a singular purpose: trimming laminate for countertops, cabinetry, and shelves. More recently, compact routers have become the go-to tools for edge profiling, flush trimming, and hinge mortising. I use one nearly every day in my remodeling and cabinetmaking business, and I really appreciate how a compact router, which can be held with one hand, frees my other hand for holding stock or managing the cord. Since I was in the market for a new compact router, I welcomed the chance to review all of the currently available models in a head-to-head test.

How we tested

I routinely use my compact router for dadoes, grooves, and rabbets, so I began the process with a power test. I gathered half

a dozen species of hardwoods and some MDF and took successively deeper passes with a 3/4-in. mortising bit. I found that all but one of the routers could take 1/2-in.-deep passes with little problem. With power no longer a question, I concentrated on day-to-day shop and job-site tasks. I rounded over hundreds of feet of door edges and cabinet faces; routed profiles into cabinet tops and shelves; mortised hinges; and cut slots, rabbets, and dados.

Best overall and best value

After a few weeks of using these routers, I determined that the Bosch is the best overall, but the Makita and Ridgid are also in the running. The Bosch is available in several kits, which are differentiated by the last letters of their model name. The EVSPK has both plunge and fixed bases and is my top pick for general finish carpentry and cabinetmaking. The accessories in the EVSNK make it suitable primarily for laminate work. If you don't need the plunge base, the EVSK includes a router, case, and edge guide. The Ridgid is my best-value pick. □

Paul Johnson is a cabinetmaker and remodeler in Lake Oswego, Ore. Photos by Nina Johnson, except where noted.

BOSCH PR20

PRICE \$209 (EVSNK); \$163 (EVSPK); \$112 (EVSK) POWER 1 hp
SPEED 16,000 to 35,000 rpm WEIGHT 3.3 lb.

**BEST
OVERALL**



The Bosch is well made, comfortable, and the second-lightest router in the group. The textured finger holds on the base are a great way to stabilize the router when bearing on narrow workpieces. Its clear baseplate has a bigger hole for larger bits and provides the best line of sight of all the routers. I also appreciated the Bosch's 10-ft. cord, which is longer than that on all the other tools except the Festool. Both macro and micro depth adjustments are smooth and precise; undoing the quick clamp lever and turning the base counterclockwise allows the base to be set to any depth. Turn it clockwise again and you can fine-tune the setting with the micro-adjustment dial. My one complaint is that you have to push the base upward as it's locked or the depth setting will change slightly with hard pressure. Even with this small flaw, the router is a joy to use.

BOTTOM LINE This is the compact router to get.

RIDGID R2401

PRICE \$99 POWER 1 1/2 hp
SPEED 20,000 to 30,000 rpm WEIGHT 3.4 lb.

**BEST
VALUE**



The Ridgid is one of my favorite compact routers. It's the quietest and one of the lightest routers tested, which makes it comfortable to use. It has LED lights and easy-to-use macro and micro depth adjustments. Pressing down on a lever enables macro height adjustments, and a thumbwheel allows for fine-tuning. I don't like having to hold down the macro adjustment to remove the base, however. The process is awkward, especially when you're trying to put the base back on.

BOTTOM LINE This tool performs well and is comfortable to use.

FESTOOL MFK 700 EQ

PRICE \$525 POWER 1 hp
SPEED 10,000 to 26,000 rpm WEIGHT 4.2 lb.

The fit and finish of the Festool trim router is exceptional. The bases attach with absolutely no slop, and the depth adjustment is the most precise of all the routers tested. At 13 ft., the power cord is also the longest of the bunch, making an extension cord unnecessary in most cases. Nice and quiet, the MFK 700 router purrs pleasingly, is easy to hold one handed, and has a wide, stable base. Unfortunately, visibility is poor because the baseplate is big and covers the work area completely, which makes freehand routing nearly impossible.

BOTTOM LINE This precise and powerful tool suffers from poor visibility.



DeWALT DWP611PK

PRICE \$161 POWER 1¼ hp

SPEED 16,000 to 27,000 rpm WEIGHT 4.6 lb.



The DeWalt's best feature is its innovative depth adjustment. The base attaches to a ring that rides along threads in the router body. Turning the ring moves the base up and down, making it easy to dial in the correct depth. I also like how the baseplate is square on one side and round on the other, which offers stability when riding against a fence or jig and enhances access in tight spots. My primary objection is that I find the DeWalt uncomfortable to hold. It has a wide body, and the depth-adjustment ring makes it even wider at the spot where I typically grip. Those with larger hands might find it more comfortable.

BOTTOM LINE

A large housing hampers an otherwise excellent router.

PORTER-CABLE PC450PK

PRICE \$160 POWER 1¼ hp

SPEED 27,000 rpm WEIGHT 4.6 lb.



The Porter-Cable router appears to be identical to the DeWalt, and it shares the DeWalt's innovative depth-adjustment ring and quick release for changing bases—not surprising, since both brands are owned by the same company. Unfortunately, the Porter-Cable version doesn't have variable speed or the LED light, two useful features found on the DeWalt. I don't use variable speed often, but I find it helpful when using larger bits and to control burning. These omissions don't make much sense to me, especially when you consider that the Porter-Cable is priced about the same as the DeWalt.

BOTTOM LINE

A big body and no variable speed are significant drawbacks.

TWO PAIR

It's easy to see that the DeWalt and Porter-Cable and the Makita and Grizzly routers share common DNA, but the individual models vary in power and features.

MAKITA RT0701CX7

PRICE \$135 POWER 1¼ hp

SPEED 10,000 to 30,000 rpm WEIGHT 3.9 lb.



The Makita is nearly as comfortable as the Bosch, with a narrow, smooth body that's comfortable to grasp. This is also one of the few router kits that includes plastic shrouds (both fixed and plunge) for improved dust collection. The fixed base slides on and off very easily and can be adjusted up or down by hand for macro adjustments or with a thumbwheel for micro adjustments. The disappointment here is that the rack-and-pinion depth adjustment is finicky for micro changes, and I had to hold the base tightly when locking down the clamp to prevent it from moving.

BOTTOM LINE

This otherwise solid tool suffers from finicky micro adjustments.

GRIZZLY T27139

PRICE \$74 POWER 1 hp

SPEED 10,000 to 30,000 rpm WEIGHT 3.9 lb.



Although the plastic components are slightly different, the Grizzly's body and bases appear to be exactly the same as the Makita's. And like the Makita, the Grizzly's body is slim and easy to grip one-handed. The Grizzly's \$75 price tag makes it the least-expensive tool in the test. I found that it worked fine for ordinary edge profiling and dadoes, but when I tried deeper passes in dense material, I could feel the motor slow. I also found that the depth adjuster stuck both when I was adjusting the depth and when I was installing or removing the base.

BOTTOM LINE

This inexpensive, comfortable tool doesn't quite match the power of the other routers.



Problem-free Pocket Doors

Hang pocket doors so
they work for a lifetime

BY JIM PETERSON

Because they're a great space saver, pocket doors are often the only way to make small rooms accessible. A tiny half-bath carved from an existing floor plan is a perfect example. But pocket doors aren't just for tiny baths and town-house closets; they're also a classy way to separate larger living spaces, such as the pair of biparting doors separating the library or dining room in a large manor house. Unfortunately, pocket doors have a well-deserved reputation for being finicky. Sometimes pocket doors don't line up with their jambs, sometimes they rub on the floor or pocket, and sometimes they just fall off the track.

Some of the frustration builders have with pocket doors is caused by the setup they're using. Most builders either use a fully assembled prehung pocket door supplied by a door shop, or a pocket-door kit from a lumberyard or home center. Unfortunately, both types have flimsy stud walls made from cheap wood and sheet metal. This makes them susceptible to flexing and bending, which causes the door misalignment and rubbing that builders and homeowners

Photo: Brian Vanden Brink. Design:
Dominic Mercadante Architect.

ers complain about. Rather than deal with these problems, I build my own door pockets and use high-quality European hardware. In the more than 10 years that I've been installing pocket doors this way, I have yet to get one callback related to pocket-door problems.

Match the hardware to the door

My first step for a pocket-door installation is determining the size, weight, and thickness of the door planned for the pocket. This is important because the hardware I use is determined by the width and weight of the door. The size of the pocket is also determined by the door dimensions. Once I've matched the door to the hardware, I can get the rough-opening requirements from the hardware manufacturer. The hardware packaging and the manufacturer's website contain detailed installation instructions and measured drawings for sizing the rough opening and door pocket correctly.

My favorite pocket-door hardware comes from Häfele and is available in two versions. The lighter-duty version, the HAWA 40 (\$200), can handle doors up to about 80 lb. The HAWA 80 (\$400) is rated for doors up to 176 lb. If a door weighs 70 lb. or more, I get the HAWA 80, as maxing out the lighter-duty hardware eventually bends the track or wears out the rollers. The stronger version also makes it easy to hang really heavy doors. The secret is the hanging hardware, which allows the door to pivot during installation and removal and lets you connect the top of the door to the rollers and the track one set of rollers at a time.

Another big plus of this hardware is that both versions have only $\frac{1}{8}$ in. of space between the bottom of the track and the top of the pocket door. That's just enough room to fit a $\frac{1}{16}$ -in.-thick wrench for removing the door from the rollers and hanging hardware. These tight tolerances allow me to set a pocket door's head casing at the same height as the head casing on other bifold, sliding, and swinging doors, rather than setting it above. It's the only hardware I've found that can do this.

Prepare the opening and the pocket

Pocket doors require a rough-opening width that's at least twice the width of the door, plus at least one extra inch for jamb and shim space. When the HAWA 80 hardware is used (as on this job), the rough-opening height must be at least $2\frac{3}{4}$ in. taller than the door to allow for the track, the hanging hardware, and the floor guide. I always ask the general contractor and the framers to place structural headers above a

PREP THE OPENING AND



Fasten the strike jamb. Using opposing shims, plumb the strike-side jamb, and fasten it every 8 in. with pairs of trim-head screws. A 6-ft. level ensures that the jamb is straight throughout its length so that it will make full contact with the edge of the door.



Install the track. Fasten the track to two layers of $\frac{3}{4}$ -in. plywood attached to the bottom of the structural header. The plywood provides a straight, twist-resistant surface and bridges the gap that's in the center of a two-ply header, which is where the track-mounting screws go.

BUILD THE POCKET

ROCK-SOLID FRAMING

A straight header with a well-fastened, full-width plywood bottom is the best mounting surface for the pocket door's aluminum track. The $\frac{3}{4}$ -in. plywood sides on the pocket resist flexing better than the manufactured pockets provided by door suppliers and ready-to-assemble pocket-door kits. Pocket screws in the plywood connect the pocket to the subfloor and the framing.

Structural header

Two layers of $\frac{3}{4}$ -in. plywood for track mounting

Track

Backing for head jamb and casing

$\frac{3}{4}$ -in. plywood sides fastened with pocket screws



Close the pocket. With the track in place, fasten the second side of the pocket to the subfloor and surrounding framing with pocket screws. It's important to keep the plywood in the same plane as the surrounding framing. Any variation will prevent the drywall and casing from lying flat.

PREP AND HANG THE DOOR



Prep the door for hardware. The HAWA 80 has two aluminum U-channels for receiving the hanging hardware. A plywood template clamped to the door and a router with a top-guided pattern bit and guide bushing create a pair of accurate mortises.

Help with heavy doors.

Fastened with four screws, the 1-in.-wide by 1 $\frac{1}{4}$ -in.-deep U-channels receive the rollers and make it easier to hang the door.



Cut a groove. Using a fence and a $\frac{3}{8}$ -in. straight bit, cut a groove in the bottom of the door for the plastic floor guide that keeps the door centered in the pocket. Taking several passes ensures the right depth without overheating the bit.



Plan for repairs. Create an opening in the track with a $\frac{1}{2}$ -in.-dia. carbide-tipped router bit so that the rollers can be replaced if necessary. Since the roller doesn't reach the opening even when the door is fully closed, the door's operation is unaffected.



Hang time. Slide the pocket-side hanging hardware, which rotates for easier installation, into the aluminum U-channel on the top of the door before tightening the locking bolt with Häfele's $\frac{1}{16}$ -in.-thick wrench. With the door pushed partway into the pocket, slide the second roller into the second U-channel.



REMOVABLE STOPS

A properly installed pocket door is removable for finishing and repairs. The rough opening should be sized so that the width of the finished opening is $\frac{1}{8}$ in. wider than the door, not including the stops. This ensures that when the stops on the pocket side of the opening are removed, the door can be pulled from the opening without damage.

pocket door as high as they can. I want to fur it down myself using LVL or plywood, which won't shrink and twist as it dries, unlike ordinary framing lumber.

For a pocket in a 2x4 wall, I install the pocket-door track and bumper and then create the pocket sides with $\frac{3}{4}$ -in. plywood, using pocket screws for fastening. I'm careful to keep the plywood flush with the rest of the framing while I fasten it on three sides. When the door is on a concrete slab, I use concrete screws and Simpson Strong-Tie L90 L-brackets for fastening the plywood to the floor. I like using plywood because it goes up fast and results in a strong wall. The continuous layer of plywood also helps to deaden the sound of a rolling pocket door. For 2x6 and thicker walls, I prefer to build pockets from $1\frac{3}{8}$ -in. smooth-faced (flush) solid-core interior doors. I use the doors because they have the same attributes as plywood and don't twist like dimensional lumber.

Hang the door

Unlike swinging doors, pocket doors have unbeveled edges and aren't bored for a lockset, but I still have prep work to do before hanging them. With my door bench set up in another room, I begin prepping a pocket door by creating the recesses in the top of the door to accommodate the U-channels. I do this using a homemade router template and a router with a template collar. Then I put a groove in the bottom of the door with an edge guide and a slot cutter. The groove is for the bottom guide, which keeps the door centered in the pocket so that it opens and closes without hitting the sides.

I plumb the strike-side jamb, making sure that the door edge will contact it fully from top to bottom. I then hang the door from the hardware. Before installing the pocket-side jamb on the pocket side of the opening, I kerf both sides for brushed weatherstripping that I install on both sides of the pocket. The weatherstripping prevents seeing inside the pocket, where dust and pet hair tend to accumulate. I leave a $\frac{5}{16}$ -in. space between jamb and door to provide room for the brushes. After installing the jambs on the opening, I then install the casing. If the casing has mitered corners, I pocket screw and glue the head casing to the sides, forming an upside-down "U." After letting the glue set for about 30 minutes, I install the trim as a unit, which keeps the miters tight and coplaner. □

Jim Peterson is a finish carpenter in Santa Barbara, Calif. Photos by Patrick McCombe, except where noted.



Small Addition, **BIG IMPACT**

A 2-ft. bump-out brings a midcentury home into the next century

BY PAUL BUUM

first worked with Stacy and Eileen to remodel their Wisconsin vacation cabin, and we were in the process of drawing plans for the remodel of their existing house in Edina, Minn., when a good-looking house in a neighborhood they admired suddenly came on the market. Built in 1958 on a tree-lined street, the house is in a neighborhood known for its midcentury homes. These homes have low rooflines, large windows, and bright and airy rooms. When Stacy and Eileen's offer was accepted on the house, we quickly abandoned remodeling plans for their existing home and went to work on this new project. Our aim was to update the house without sacrificing its midcentury charm.

With any remodel, I first ask clients to list what they like and don't like about the house. For starters, Stacy and Eileen loved their new home's 1950s character, with its open plan, large windows, and light-filled living areas. They also liked the expansive yard, mature trees, and the neighborhood's welcoming feel.

Kitchen and bath drove the remodel

Neither of them liked their new kitchen, however. They thought it was too dark and too small, and they wanted a center island. They also wanted to update the hall bath and add a separate shower. A larger garage with storage and a real

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FROM DRAB TO FAB

When Stacy and Eileen bought their home in Edina, Minn., the drab exterior made it look like every other midcentury home in the neighborhood. A new color palette, better landscaping, and a new garage door transformed its appearance. The blue-gray exterior (Benjamin Moore Navy Masterpiece) is a combination of old and new materials. The original redwood siding was cleaned up and repainted, and new fiber-cement siding was installed on the garage and rear addition. The vertical siding on the house and the horizontal siding on the garage complement the scale and texture of the old redwood. The darker siding color helps to bring out the existing limestone veneer, which emphasizes the home's solid-looking base and reinforces the other horizontal elements. The translucent garage door provides balance for the front windows.

STEEL DOES THE HEAVY LIFTING

Due to the length of the span, we decided to use a steel beam to support the roof over the new addition. The advantage of steel is that it can have a smaller cross section than a wood beam of comparable strength, so it takes up less space. I told Stacy and Eileen and the interior designer early on that I wanted to expose the steel beam and column to help with the more-modern aesthetic they wanted. They



quickly agreed, and we continued the steel look with some of the cabinet doors and appliances. More conventionally, we would have buried the beam in a wood or drywall soffit, but the visible steel was a fun way to set off the new space and call more attention to an otherwise simple design feature.

To further distinguish the new space from the old, we decided to use a stone tile on the floor instead of the oak flooring in place elsewhere. This new floor provides the landing for the large sliding French doors and carries into the kitchen, where it serves as a base for the steel column and continues under the cabinets. It's also heated, creating a nice spot to take off your shoes on a cold day and making it really comfortable to work at the kitchen sink.

To make up for the cabinets lost to the wall of windows installed over the sink, we added floor-to-ceiling storage on the opposite wall.





Sophisticated mudroom. Carved from the inside of the garage, the new 6-ft. by 12-ft. mudroom offers plenty of storage and a bench for putting on shoes. The large window and maple cabinets give the small space a lightness that contrasts with the dark-gray tile floor and countertop. The counter includes a half-dozen outlets for charging electronics.



Revamped bath. Keeping fixtures in their original locations and converting what was a hall closet at the end of the tub into a shower kept costs down for the bath remodel. The ribbed-glass partition next to the vanity was inspired by a partition wall with a ribbed-glass window that was in the same spot in the original bathroom.

SPECS

Bedrooms: 3

Bathrooms: 2

Size: original, 1848 sq. ft.; renovated, 2003 sq. ft. (finished basement not included)

Location: Edina, Minn.

Architect: Paul Buom, AIA, SALA Architects, salaarc.com

Designer: Christine Frisk, InUnison Design, inunisondesign.com

General contractor: Choice Wood Company, choicecompanies.com



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mudroom connecting the garage and kitchen rounded out their wish list.

Making more room

There wasn't enough room in the kitchen's existing floor plan for a center island, so we designed a 2-ft. addition. This small bump-out was all we needed to make room for an island. To support the roof above the addition, we used an exposed steel beam to carry

the roof load and to define the new workspace. We also added a full-height pantry to make up for the cabinets lost to the new windows that frame the view onto the backyard.

With the addition, the family room also grew by 2 ft. We added a four-panel sliding French door that provides a view onto the stone terrace and backyard from the family room. We updated the hall bath with new finishes and fixtures, but we didn't move any of the plumbing, which simplified construc-

tion and saved money. We found the space for adding the new freestanding tile shower by taking over a neighboring closet.

The garage addition, which made the space about 250 sq. ft. bigger than it was before, allowed us to carve a section from the original garage footprint for a 6-ft. by 12-ft. mudroom with a bench, a closet, and built-in cabinetry. The new mudroom and a larger garage reduce clutter and make this everyday entry more welcoming.

BACKYARD OASIS

Vertical fiber-cement siding, which complements the home's original redwood siding, helps the 2-ft. addition blend seamlessly into the rear elevation. The addition is highlighted by large kitchen windows and a new sliding French door that provides wide views of the backyard from nearly everywhere in the main living area.

Compared to the small concrete slab that served as the original patio, the new bluestone terrace provides plenty of room to spread out. A single step along the perimeter provides easy backyard access and plenty of overflow seating. The outdoor dining area, accessed by the new sliding door, has table seating for six and enough space to comfortably walk around seated guests.

The fire pit is a natural gathering spot for guests and provides soft light for evening conversation and cocktails. A door off the mudroom provides additional access to the hot tub and the rest of the patio space.



Stacy and Eileen have lived in their new home for over a year now, and they tell me they love it. I like the house, too, and I think the whole team, including the owners, InUnison Design, and Choice Wood Company did a great job updating the house while showing it the respect it deserves. □

Paul Buom, AIA, is an architect at SALA Architects in Minneapolis. Photos by Troy Thies, except where noted.



A Faster, More Durable Floor Finish

Portable UV equipment yields a fully cured finish in seconds, not days

BY JORGE BOROR

When I decided to offer my customers UV-cured floor finishes, I knew little about the process. What I did know was that the finish was more durable than oil- or water-based polyurethane—more like the clear coat you get with prefinished flooring—and I liked the idea of standing out from the competition. I figured that this would be the next big thing in the residential flooring market and that other contractors would be close on my heels, so I ordered the equipment (jelight.com) and signed up for training. That decision paid off, because I've been seeing more and more flooring companies take on this new technology.

Now, for what amounts to about a \$6-per-sq.-ft. upcharge, my customers have the option of a floor finish that is more durable than any non-UV-cured product. That's a big selling point for me, because many of my jobs are in Providence and Boston, where a lot of homes open right onto dirty, high-traffic, and heavily salted sidewalks. Keeping hardwood floors in decent shape under those conditions isn't easy, and I'll take all the help I can get. Beyond durability, the UV cure also adds convenience.

The turnaround on a standard floor finish is three to four days, after which the finish is dry but not cured. That's an important, though often misunderstood, distinction. Until a finish has cured—which requires anywhere from a week to a month, depending on the product and conditions—it's very susceptible to scratches. You may be able to walk across the floor within a couple of hours, but the fumes can be intense, and it's out of the question to replace area rugs and furniture and to use the space normally. UV systems achieve the same cure in a matter of seconds.

Jorge "Tito" Boror is owner of Rende Hardwood Flooring in Providence, R.I. Photos by Justin Fink, except where noted.



Inset photo: courtesy of the author

THE PROCESS IS SIMPLE

All aspects of a site-cured UV floor finish are the same as with a traditional sand-and-finish scenario, except for two major differences: The final clear coat must be a special water-based UV-activated product, and once that UV coating is dry to the touch (typically in one to two hours), it must be exposed to high-powered UV lighting equipment in order for it to cure.

THE RIGHT FINISH

As the technology gains a stronger foothold, more manufacturers are getting on board with their versions of UV coatings. I've tried every brand I can get my hands on, and they vary. In general, the big tradeoff seems to be ease of workability vs. hardness of the cured coating. In short, the most durable finishes require a coating that's a bit harder to level out during application. For this job, we used the General Finishes product, which is high on the durability scale and therefore more challenging to apply. The company recommends that it be applied with a T-bar, but we've had better luck with a floor-finish roller and a careful touch.

THE RIGHT TOOLS

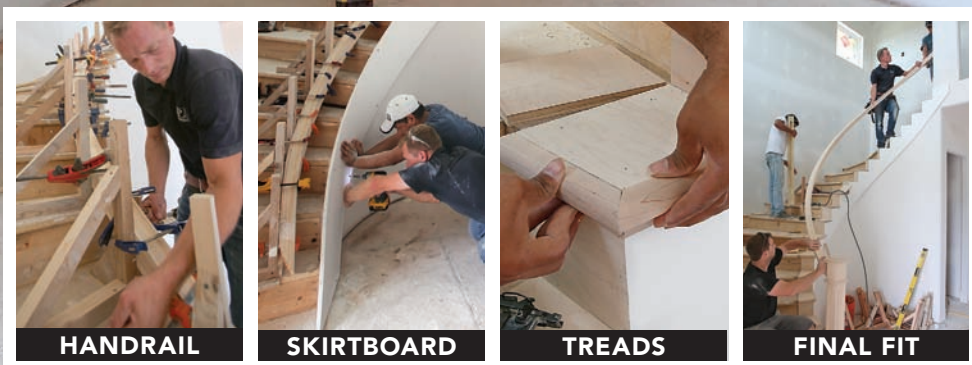
UV coatings dry by evaporation but cure only when exposed to intense UV light. The standard tools for flooring work are a handheld unit (right) and a rolling unit (left). The handheld unit is used for detail work, reaching close-quarters areas, and creating a cured spot so that the larger rolling unit can be set onto the floor. Most of the job depends on the rolling unit, which has a front-mounted UV light, so the unit creates its own cured path. The process is just like mowing a lawn, but with a stricter pace. If the unit is pushed too fast, the finish will not cure properly; if pushed too slowly, it's prone to bubbling and burn marks.



Trimming Curved Stairs

Site-laminated handrails, flexible skirtboards, and off-angle miters are standard on winding walkways

BY JASON MOLLAK



Most of the whole-house finish carpentry my crew tackles includes basic stair packages—skirtboards, false treads for the ends of the rough risers and treads, one or more newels, and a handrail with balusters. So it's a nice change of pace when we're thrown a curve.

While I don't recommend that your first set of stairs be curved—or even your fifth—the skills needed to do this work aren't new to finish carpenters, just slightly different than on a standard stair. Rather than treads with a consistent depth, you're faced with pie-shaped treads. The 45° miters on open-stringer nosings are replaced with off-angle cuts to bridge the curvature of the skirtboard, which must be bent to fit the ascending curve of the stairway rather than just following a simple rise and run on a standard stairway. The key to all of this curved work is to think of the framed stairway as your template. Following this method, and using materials suited for the job, your task is simply to bend, measure, and fit the pieces to the curved template provided by the framers.

It's common practice here in Nebraska for stairs to be fully carpeted, so the framers usually set the stage with particleboard treads that have a rounded front edge. But many jobs, including this one, are trimmed to accommodate false tread ends and a swath of carpet that mimics the classic look of a carpet runner. Our process starts with cutting off the radiused front edge on both sides of each tread to make way for false tread and riser caps.

On straight stairways, we normally use prefabricated false treads, which are squares of plywood with solid-wood molding attached to the edges. These caps are cut to fit along both sides of each rough tread, leaving space

BEND THE HANDRAIL FIRST



Prep the rough stairs. Radius-edged rough treads are cut flush to the rough risers to create an accurate reference point for measurements and to clear the way for the false tread caps that come later.



Bending brackets. Fastened 6 in. from the open end of each tread and parallel to the face of the risers, site-made brackets become the handrail bending form. The brackets at the upper and lower ends of the stairs are also braced laterally (inset) to resist the forces of the rail as it's pushed against the form.



Aim for a fair curve. After its laminations are coated with wood glue, the poplar handrail is sandwiched together, held with a few bands of shrink wrap, and pressed into place against the form. When the rail is properly positioned, it should be tight to the face of each bracket, set down against the angled stops on each bracket that match the slope of the stairs, and twisted so that the bottom face is flat to the top of the treads. Holding the rail tight to all these critical areas requires a lot of clamps, so have plenty on hand.

THE SKIRTBOARD FOLLOWS THE FRAMING

Flex and fasten. The flexible PVC skirtboard is cut level along the bottom, then pressed into place and temporarily fastened at each tread with screws. Most of the holes will be covered later by the tread returns.



Mark in place. With the skirtboard fastened tight, it's easy to scribe level and plumb cuts at the upper end (top) and then to mark the back side where the board will be notched for the treads and risers (bottom).



Easy notching. Laid out flat, the skirtboard can be notched using a sliding miter saw. The tread cuts are straight 90° chops, but the saw is beveled to make the riser cuts so that these edges can be mated tightly to the finished riser stock that comes later.



Shims for the win. To ensure a tight miter between the skirtboard and the riser stock, slide shims behind the skirt to square its face to the top of each rough tread.

for the carpet to be fastened between. The concept is the same on curved stairways, but those false treads have to be fabricated on-site to fit the off-angle joint between tread and curved skirtboard.

The stairs are the bending form

The best way to create a handrail that matches the curve of the stairway is to bend it using the stairs as your guide. To do this, you need bendable railing stock—a profiled handrail made up of strips of wood that are glued together on-site—and rigid brackets to form the rail against. (We sourced this and other stair parts from fitts.com.)

Some carpenters have metal brackets for this task, but I've done fine with site-made versions assembled with clear framing-

lumber offcuts. Whatever your bracket type, make sure they are built square, positioned the same distance from the end of each tread, and screwed down securely. When forming the rail, you can push it tight to the treads, but we like to add angled spacer blocks to the brackets to raise it up off the treads for easier clamp placement. Whichever method you use, I recommend reinforcing the uppermost and lowermost brackets with lateral bracing because these supports are susceptible to rolling as the handrail is pushed into place.

Some stairbuilders prefer glue with a long open time for this job, but I use conventional Titebond II wood glue and find that the open time is fine for getting things into place and clamped before the adhesive starts to set up. But a stress-free glue-up demands thought-

ful prep work, including having plenty of clamps on hand (more than you think you will need) and at least a few helpers to push, pull, twist, and clamp the rail into position. Remember that the railing must be clamped against the brackets so that its bottom edge is flat to the treads; otherwise, it will lead to problems during the installation of the balusters. While the glued handrail is setting up—a minimum of 24 hours is best—work can continue on the skirtboards.

Modern materials make for an easier skirt

Veneered plywood ripped into 1/4-in. strips can be laminated around the stair brackets to create stain-grade skirtboards. If the job calls for paint-grade skirts, I prefer to use a single

DRESS UP THE TREADS AND RISERS

Start with a scribe. With the riser stock mitered and joined to the skirtboard, the false tread can be aligned with the face of the skirt, then scribed along its back edge to trace the angle for a tight fit.



Mark the overhang. Once the fit between the back of the false tread and the riser is tight, the underside can be traced and cut off flush with the face of the riser before final fastening with construction adhesive and finish nails.

Off-angle miters. Hardwood nosing conceals the ends of the plywood false treads. The curvature of the stairway means that the angle where the front edge of the tread meets the skirtboard will be beyond 90°, and the small miter return at the rear will require a slight back bevel.



Set the newel. The last step before fitting the curved rail is to set the newel at the bottom (and top, if included in your design) to provide a reference point to use when marking the cuts at the top and bottom of the handrail.

piece of PVC trim because it saves time compared to doing another laminated glue-up.

The PVC board is tacked into position so that it can be marked on the back side at each riser and tread. Then it is unscrewed and laid flat for easy cutting on the miter saw, where each tread gets a straight cut and each riser gets an angled cut to marry up with the riser caps that come next.

For a tight fit at the mitered joint between riser caps and skirtboard, you'll likely have to do some shimming at each tread location to counteract the tendency of the skirt material to bend inward along its top edge.

The final fit

After 24 hours, the handrail can be removed from the clamping brackets, stripped of its temporary clamping pads, and sanded

smooth on the top and bottom with a belt sander and random-orbit sander.

It's best to tackle any minor repair work during the rougher belt-sanding stage. I look for voids in the lamination and stress splits that may have occurred while pushing the rail against the bending brackets. Both can be filled with wood glue and clamped for 30 to 60 minutes before being worked down with the belt sander.

Once the newel has been notched and set into place, we temporarily support the curved handrail at its planned height, but slightly offset from where it will be located so that it clears the newel at the bottom and the wall at the top. This lets us mark the cuts along the top and bottom of the rail, which we then sneak up on with several rounds of cutting and checking in place. It sounds like

guesswork, but this is where confidence in your finish-carpentry skills is a must. The tendency for a steep-curved handrail to twist out of alignment once it's unclamped makes it difficult to gauge the miter and bevel settings using levels or math, especially when the railing may need to be muscled back into place for final fastening, as on this job. Resigning yourself to a few trips back and forth to the saw is a fair compromise for a railing that fits tight between the top and bottom fastening points and that follows the stairs with a fair curve. When the fit is tight and the railing is fastened at the top and bottom, balusters can be installed just like on any other job. □

Jason Mollak is an *FHB* ambassador and owner of JPM Construction in Elkhorn, Neb. Photos by Justin Fink.

PREP AND FIT THE HANDRAIL



Sand in stages. The sanding process starts with a belt sander, using 80-grit paper perpendicular to the grain and then 120-grit paper with the grain. Final sanding is done with a random-orbit sander, working from 120 grit to 150 grit and finishing with a final pass of hand sanding.



Sneak up on the cuts. After the railing is held in position on the stairway and marked where it crosses the top and bottom connection points, it's brought to the saw and held in place as the angle is tweaked and checked until the fit is perfect.



A centered screw. The railing is secured to the wall at the top of the stairs using a single heavy-duty screw through a counterbored hole.



Twist, then fasten. A long clamp on the handrail offers leverage for twisting the rail into alignment for fastening to the newel.



RIGHT-SIZING MECHANICALS

An efficient home means a smaller, less expensive conditioning system

BY JORDAN GOLDMAN

Today's HVAC systems are increasingly complex. Manufacturers have designed them this way to improve energy performance and to provide better control over the indoor temperature throughout a house. But it's actually much easier to couple a simple HVAC system with a tight building envelope. Improving the envelope first and then designing an HVAC system to match leads to substantially smaller and simpler heating and cooling systems, while providing improved comfort and energy efficiency.

Clients are increasingly demanding energy-efficient homes and buildings. The threat of climate change has led to stricter energy codes as well as a desire from homeowners to reduce their impact on the environment, and for most of the country, heating represents the largest end use of home energy.



COMFORT CAN BE COMPLICATED

Tight building envelopes are intended primarily to reduce energy use, operating costs, and the environmental impacts of homes and buildings. They also have substantial benefits for comfort and for mechanical-system design.

Our thermal comfort is strongly correlated with the mean radiant temperature of a room. Simply put, the mean radiant temperature is a weighted average of the surface temperatures enclosing a room. An occupant of a room with an air temperature of 70°F but a low mean radiant temperature is likely to feel uncomfortably chilly. On the other hand, an occupant is likely to be more comfortable in a room with a lower air temperature and a higher mean radiant temperature.

Superinsulation specs

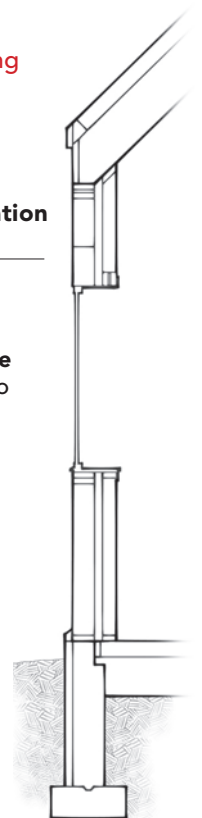
Roof:
R-65 to R-70

Above-grade walls: R-40 to R-45

Windows:
U-0.15 to U-0.20

Foundation:
R-25 to R-30

Slab:
R-15 to R-20



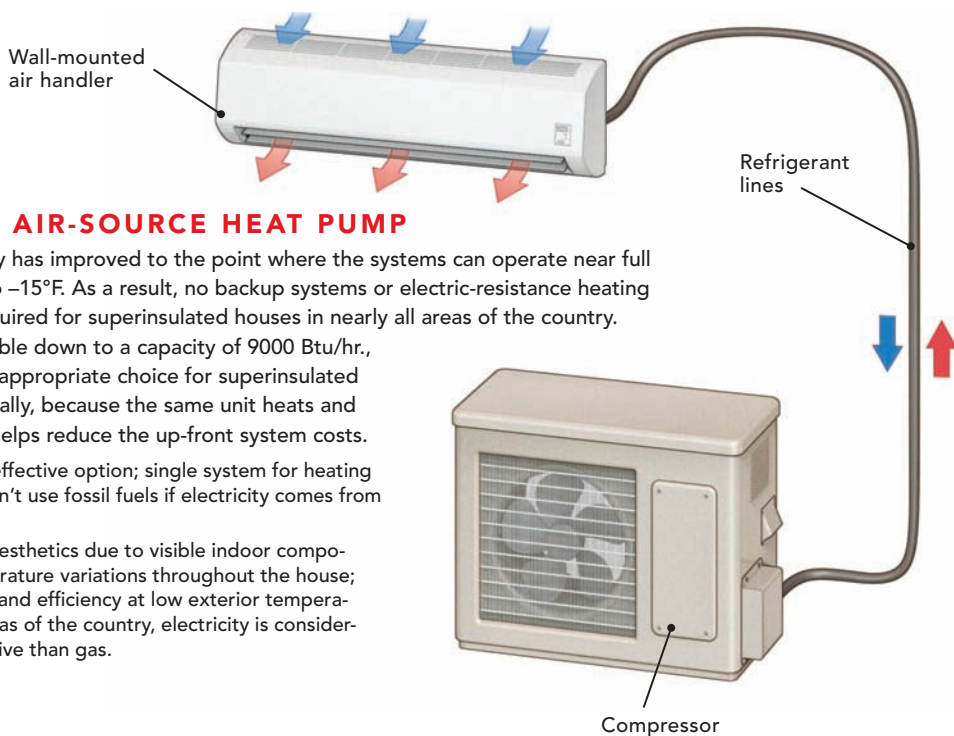
Energy efficiency is a relatively new concept

Insulation has been used for a couple of thousand years in an effort to make homes more comfortable. Insulation materials have evolved from wattle and daub to fibers and foam, but comfort always was and still is a primary objective. To satisfy that objective, we also have designed central heating systems that directly combat heat loss through the walls, floors, and roof by incorporating a tight building envelope in their design.

In the late 19th century, it became standard practice to install radiators in front of windows, and a large radiator in entry vestibules, to combat discomfort in these cold and drafty spots. Forced-air systems then came along in the mid-1930s. But the idea of decreasing the operating-energy costs and carbon footprints of our

FOUR PROVEN OPTIONS

Air-source heat pumps (ASHPs, also called minisplits) use a vapor-compression refrigerant cycle to exchange heat. ASHPs work just like air conditioners, moving heat from indoors to outdoors in the summer. Unlike with an air conditioner, though, the cycle can reverse in the winter to allow the ASHP to move heat from outdoors to indoors.



DUCTLESS AIR-SOURCE HEAT PUMP

ASHP technology has improved to the point where the systems can operate near full capacity down to -15°F . As a result, no backup systems or electric-resistance heating elements are required for superinsulated houses in nearly all areas of the country.

ASHPs are available down to a capacity of 9000 Btu/hr., making them an appropriate choice for superinsulated houses. Additionally, because the same unit heats and cools, an ASHP helps reduce the up-front system costs.

Pros: Most cost-effective option; single system for heating and cooling; doesn't use fossil fuels if electricity comes from another source.

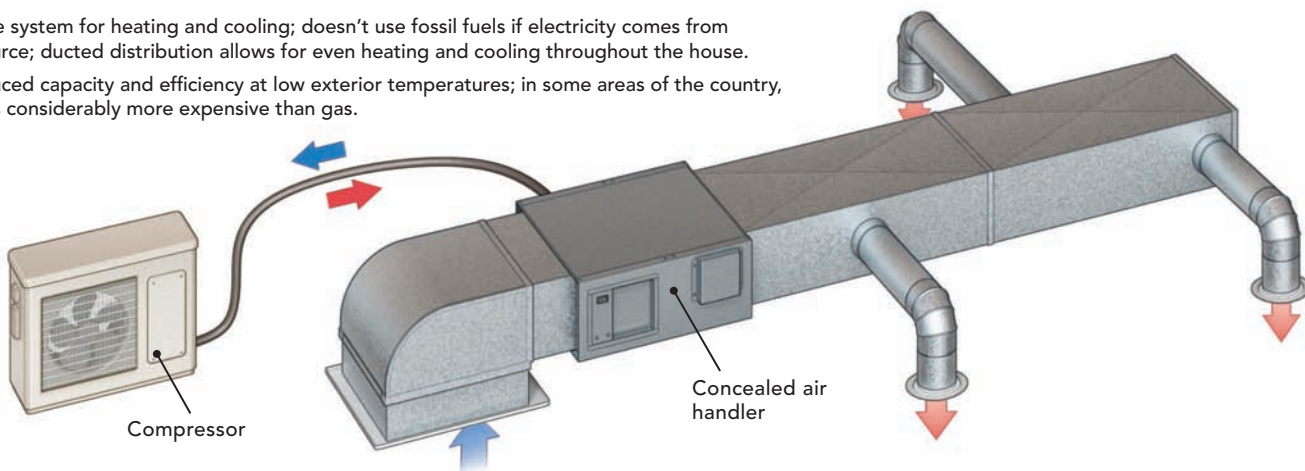
Cons: Negative aesthetics due to visible indoor component; small temperature variations throughout the house; reduced capacity and efficiency at low exterior temperatures; in some areas of the country, electricity is considerably more expensive than gas.

DUCTED AIR-SOURCE HEAT PUMP

For distribution, ASHPs can be mounted on the wall in one or more locations, recessed in a ceiling, or fully concealed and coupled with ductwork. While more expensive, a concealed ducted unit is better in terms of aesthetics and distribution.

Pros: Single system for heating and cooling; doesn't use fossil fuels if electricity comes from another source; ducted distribution allows for even heating and cooling throughout the house.

Cons: Reduced capacity and efficiency at low exterior temperatures; in some areas of the country, electricity is considerably more expensive than gas.



homes and buildings is relatively new. It's now common practice to insulate homes beyond the levels that are required to maintain a minimum acceptable level of comfort. That has created new opportunities for HVAC systems.

Treat the envelope as the primary heating and cooling system

While many in the home-building industry view efficient, high-performance mechanical systems as peripheral components to a house, they're actually integral to the building envelope.

In a superinsulated home, the envelope does most of the heavy lifting, keeping the house warm in the winter and cool in the summer. As a result, much less is required of the mechanical systems.

To start with, mechanical systems in a superinsulated house can be smaller and simpler than those for conventional houses. There is no longer a need to provide heat at the windows and exterior walls. Ducted distribution systems can be scaled back and confined to the interior core of the house, or eliminated altogether in favor of ductless

options. These changes not only mean lower up-front investments, fewer components to maintain, and lower ongoing maintenance costs, but they also require less square footage, leaving more area for living space.

In the event of a power outage or heating-system failure, a superinsulated house has passive survivability—that is, the ability to maintain an acceptable indoor temperature. A recent house of ours lost heat during the polar vortex of 2014, and it took three days for the homeowner to notice. In that time, the indoor temperature dropped only 8°F .

FOR A TIGHT HOUSE

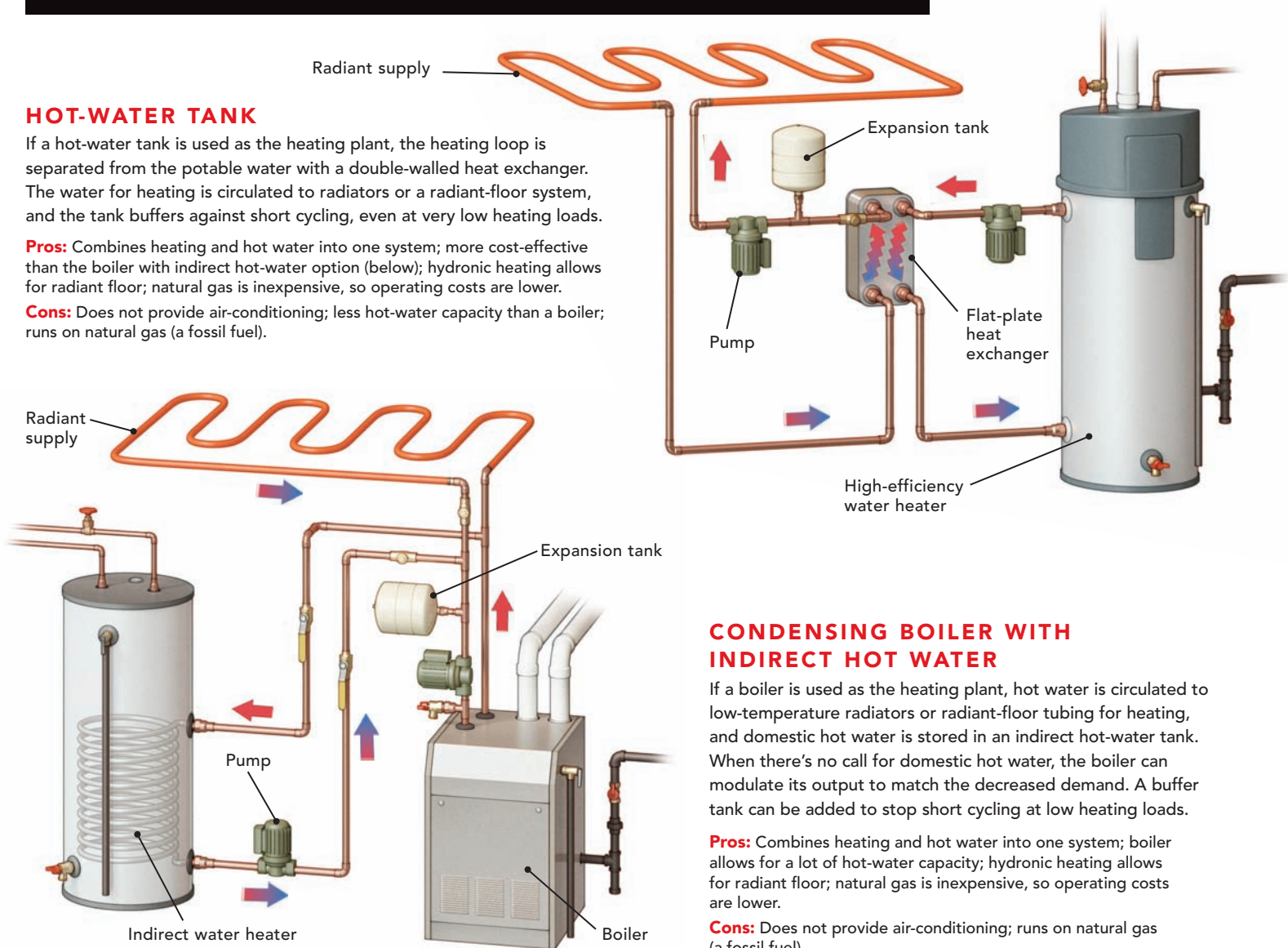
Heat-and-hot-water systems combine space heating and domestic-water heating into a single system. The heating can be done with a hydronic boiler or a hot-water tank, and because most of the heating plant's capacity is used for domestic hot water, oversizing is a nonissue.

HOT-WATER TANK

If a hot-water tank is used as the heating plant, the heating loop is separated from the potable water with a double-walled heat exchanger. The water for heating is circulated to radiators or a radiant-floor system, and the tank buffers against short cycling, even at very low heating loads.

Pros: Combines heating and hot water into one system; more cost-effective than the boiler with indirect hot-water option (below); hydronic heating allows for radiant floor; natural gas is inexpensive, so operating costs are lower.

Cons: Does not provide air-conditioning; less hot-water capacity than a boiler; runs on natural gas (a fossil fuel).



CONDENSING BOILER WITH INDIRECT HOT WATER

If a boiler is used as the heating plant, hot water is circulated to low-temperature radiators or radiant-floor tubing for heating, and domestic hot water is stored in an indirect hot-water tank. When there's no call for domestic hot water, the boiler can modulate its output to match the decreased demand. A buffer tank can be added to stop short cycling at low heating loads.

Pros: Combines heating and hot water into one system; boiler allows for a lot of hot-water capacity; hydronic heating allows for radiant floor; natural gas is inexpensive, so operating costs are lower.

Cons: Does not provide air-conditioning; runs on natural gas (a fossil fuel).

Why a bigger system isn't always a better system

An old rule of thumb for sizing heating systems in New England was 40 Btu/hr. per sq. ft. of living space. So, for example, a 2000-sq.-ft. house would have a peak load of 80,000 Btu/hr. A superinsulated house reduces that figure to 5 to 10 Btu/hr. per sq. ft. of living space, so that same 2000-sq.-ft. house would have a peak heating load of just 10,000 to 20,000 Btu/hr.

Most boilers and furnaces start at 40,000 to 60,000 Btu/hr., so even the smallest equip-

ment would be way too large for a super-insulated house on the coldest day, let alone a typical winter day. Oversize equipment is an issue because it's prone to short cycling, which might lead to reduced efficiency and shorter equipment life. In cooling climates where central air-conditioning is common, short cycling means that the system might satisfy the room's temperature requirement too quickly, before the air handler has had time to fully dehumidify all of the room's air.

In an effort to avoid oversize furnaces, adventurous builders and building-science

advocates have tried countless alternatives for heating their small, superinsulated houses (for descriptions of some of these, see "Heating Options for a Small Home," *FHB* #217), but there are a few more strategies that I've used on projects over the years that do the job well without either overcomplicating the assemblies or asking the HVAC contractors to step way outside of their comfort zone. □

Jordan Goldman is a founder of and engineering principal at ZeroEnergy Design in Boston.



PROHOME

Elevating the Standard of Building

Exterior claddings and durable interior finishes
create a resilient and attractive home

BY SEAN GROOM



FOLLOW THE BUILD

Beginning with *FHB* #260, we've been exploring the theory and logic behind our demonstration home. Be sure to visit FineHomebuilding.com/prohome regularly to watch the construction of the house unfold and to hear expert insights straight from the design-and-build team.

WATCH our multi-part video series highlighting every important step of the project.

GET UPDATES on the build and special events by following us, our project partners, and #proHOME on social media.



Building the ProHOME in the aesthetic of a traditional farmhouse dictated bevel siding and time-honored paint colors, but that didn't mean modern materials and methods were off the table. Engineered siding provides a durable, low-maintenance exterior, and the paint will last longer

thanks to a ventilated rain-screen assembly. Accent siding with mitered corners and a deck with cable railings are signs that the traditional aesthetic gives way to a modern design in the interior. The contemporary feel there announces that the house isn't stuck in the past, but the lack of ornamentation and the monochro-

matic color scheme simplify maintenance in a rental property. The appliances in the ProHOME confirm the modern bent and offer both efficiency and convenience.

Sean Groom is a contributing editor. Photos by Brian McAward, except where noted.

A TRADITIONAL LOOK WITH LOW-MAINTENANCE MATERIALS

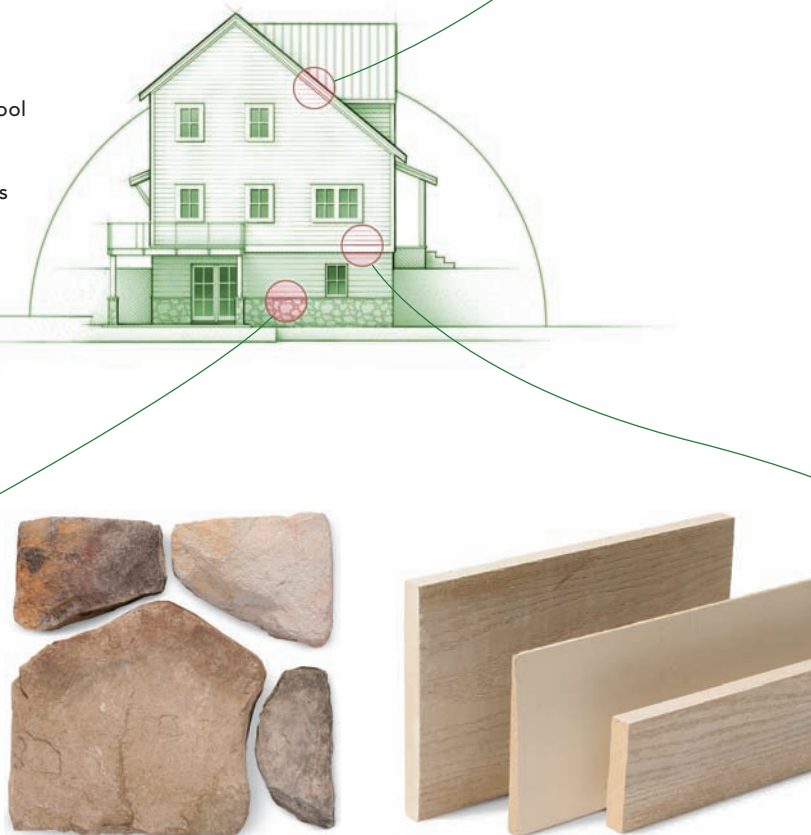
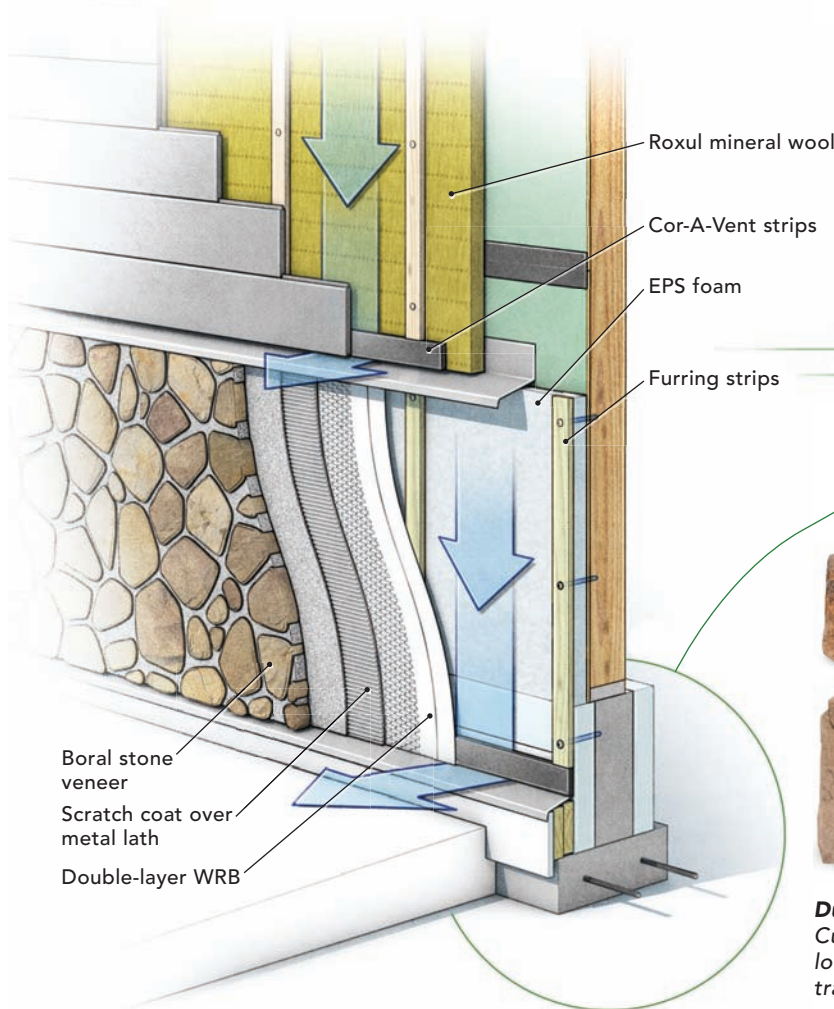
In keeping with the farmhouse design, most of the house is clad with a 4-in.-reveal clapboard siding painted a classic farmhouse white. This cladding and trim, Boral TruExterior, is a poly-ash exterior board made from a combination of refined coal fly ash, glass fibers, and polymers.

These poly-ash boards have several advantages over wood and PVC products. They aren't affected by moisture or heat, they're rated for ground contact, they can be painted dark colors, and their end cuts don't need to be primed or sealed. The material's performance is similar to fiber-cement siding, yet TruExterior is lighter—closer to the weight of wood—with a flexibility approaching that of PVC boards.

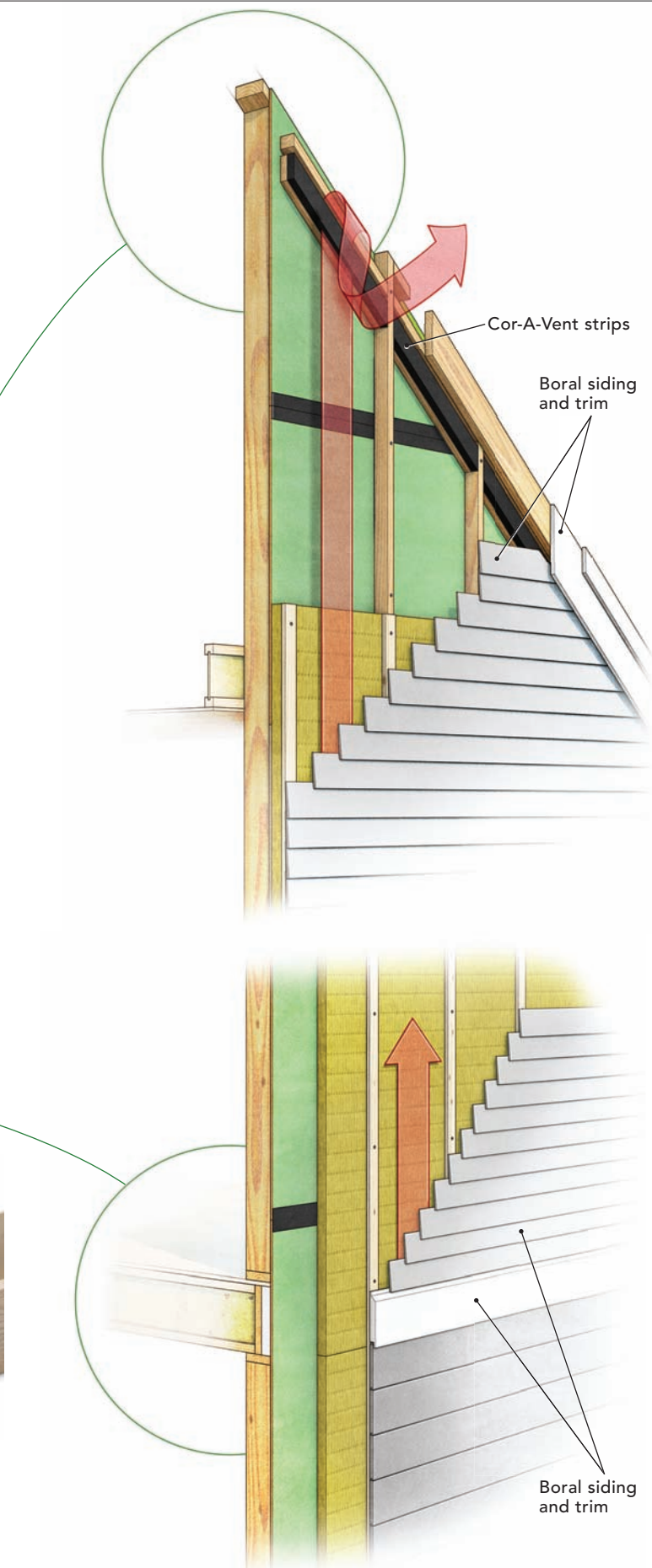
To add visual interest, designer Michael Maines chose a tongue-and-groove siding, TruExterior nickel gap, for the shed dormer. Run horizontally, detailed with mitered corners, and painted a warm gray, this accent siding not only provides an aesthetic break with the traditional clapboard on the rest of the house, but it also creates a fictional history that suggests both dormers were added at a later date. The same siding continues around the front door to help draw the eye to the entry.

The 1x3 strapping that holds the Roxul exterior insulation in place creates the ventilation space behind the siding (a best practice). At the top and bottom of the wall, Cor-A-Vent SV5 vents allow the passage of air and water. Furring creates a pocket at the corner boards and windows, much like a J-channel, so the bevel siding tucks behind the trim.

A facade of Boral Cultured Stone applied to the exposed foundation and as a wainscot around the walkout basement completes the farmhouse look. Maines selected a mix of three colors to blend with the local stone, which is used to create retaining walls around the site and to provide a traditional-looking foundation. To make the stone in plane with the siding above, builder Mike Guertin furred the stone out from the wall, creating an air gap between the exterior insulation and the water-resistive barrier (WRB) and metal lath that the scratch coat is applied to. (Areas where Cultured Stone is used require EPS rigid foam rather than the semicompressible Roxul mineral wool, which isn't an appropriate base for the heavy stone veneer.)



Durable cladding. Maines selected a mix of three colors of Boral's Cultured Stone—a manufactured stone veneer—to reinforce the look of an older farmhouse. Equally impervious to water is the traditional-looking bevel siding and trim—an engineered poly-ash product also made by Boral.



ELEVATING THE STANDARD

Cor-A-Vent ventilation products

Ventilation ensures that unconditioned attics and siding perform at their best. A ridge-and-soffit vent system are standard construction details, but the ventilated rain screen of the ProHOME that allows the sheathing and both sides of the siding to dry isn't standard practice. The $\frac{3}{4}$ -in.-thick Cor-A-Vent SV5 siding vent at the base and the top of the siding matches the thickness of the ventilation furring. The honeycomb structure allows water to drain and air to flow through, plus it keeps insects at bay. It's constructed of thermally stable, crush-resistant, extruded polypropylene sheets that can be screwed, nailed, or stapled in place.



A CLEAN, MODERN RAILING

Aesthetically, the deck will break up the tall walls above the walkout portions of the basement, adding some visual relief. At nearly 400 sq. ft., the deck will offer plenty of outdoor space for entertaining. The Feeney DesignRail aluminum posts and rails with stainless-steel cable infill create a clean, modern look with a relatively unobstructed view. An integrated LED rail lighting will reinforce the modern appearance. The decking will be either a hardwood or a composite product depending on cost and availability.

A HARDWORKING SPARE INTERIOR

When the framing and the installation of mechanical systems are complete in a new house and work turns to hanging drywall, it can seem as if there are acres of the paper-faced gypsum boards. This drywall is an essential finish in the crisp, clean, and minimalist interior planned for the ProHOME. There is no crown molding, and instead of casing, the windows have simple drywall returns, although the deep recesses have wood sills to enhance durability. In those places where there is trim, it's unassuming: The painted, three-panel Shaker-style interior doors are trimmed with the same painted 3/16-in. flat stock used for the baseboard.

There are six types of CertainTeed drywall used in the house. While there are the expected products such as Diamondback GlassRoc as tile underlayment, specialized drywall products were chosen to provide sound control, improve indoor-air quality, and add durability in high-traffic areas.

In a small house with open common spaces, it's important to manage noise in the private, away spaces when occupants want to retreat to a quiet refuge. In the second-floor bedrooms and the first-floor flex room (which shares common walls with the powder room and the living room), Guertin will install a noise-reducing drywall: Silent FX QuickCut. The

panels have a viscoelastic polymer in their center to limit sound transmission. Similar types of products frequently have two paper layers in the center surrounding the polymer, and cutting them requires either scoring deeply on each side (slow) or using a handsaw (slow and messy). The Silent FX QuickCut panels are cut by scoring and snapping them, the same as regular drywall.

Wall and ceiling drywall panels in much of the house, including the exterior walls and the ceilings in the rooms with noise-reducing drywall, are AirRenew. The light-blue gypsum core of this drywall product has a unique formulation that sequesters volatile organic compounds (VOCs) such as formaldehyde, which is emitted from the glue used in engineered wood products. In addition to AirRenew Essential, a drywall for "regular" duty, other versions of AirRenew that are mold and moisture resistant, abuse and impact resistant, and fire resistant (Type X) are used throughout the house.

In high-traffic areas, more-robust drywall panels provide additional resistance to bumps, knocks, and abrasions. The AirRenew drywall is available in an extreme-abuse version that will be used in the stairwells and in the entry foyer. CertainTeed's new Habito drywall, which is intended to replicate the density and strength of plaster with a drywall panel, will be used on the accent wall

Not a commodity product. After it's been taped, primed, and painted, drywall tends to look like, well, drywall. But bedrooms in the ProHOME have walls that reduce sound transmission and absorb VOCs, thanks to specialized drywall products. The simple drywall returns at the windows celebrate the common material.





Flooring with resale in mind. Reclaimed wood was considered for the flooring because of its character and ability to hide wear; however, the look may be off-putting to some. Carbonized bamboo flooring offers enough grain pattern and character to mask scuffs, and it has wider appeal.

between the living room and the flex room and on the pantry wall facing the dining room because flat-screen TVs and other items likely will be hung on these walls. Habito is able to hold a 30-lb. load with a single #10 screw. For items such as shelf brackets or TV brackets that use six #10 screws, the drywall is rated to hold 180 lb. without screwing into blocking or studs. It also will be used in the garage, so installing hooks or shelving wherever it's convenient will be easy.

In contrast to the clean, spare white walls, the floors will be covered with warm-toned wood. Guertin has chosen carbonized bamboo planks with uniform grain and enough character to hide wear and tear. For a rental/spec house, the wall and floor options make sense. With a single color throughout the house and little trim, it's easy to refresh the walls with a coat of paint, and the flooring gains more character with use and hides abuse well.

ProHOME SPONSORS

The following manufacturers are supporting the construction of the ProHOME's exterior and interior. Visit FineHomebuilding.com/prohome for a complete list of project partners and for more information on the products and materials used in ProHOME.



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APPLIANCES ARE THE DAILY TOUCH POINTS OF A HOUSE

The design of the ProHOME and the layout of each individual room will shape the experience of living in the house. In places such as the kitchen and the laundry room, however, the daily interactions with the appliances will have a profound impact on the success of those rooms. To limit the electric load of the house, the starting point for selecting kitchen and laundry-room appliances in the ProHOME was an Energy Star rating. From there, features were considered that would make daily life a little more convenient.

Creating space for a second-floor laundry room simplifies the laundry process by having the washer and dryer near the bedrooms and showers, where the dirty clothes accumulate and where the clothes will return when they're clean.

The washer (WFE92HEFC) and dryer (WED9290FC) are both from Whirlpool. Among the washer's time-saving features is an integrated detergent reservoir that takes care of a dozen loads with a single fill. The machine's FanFresh option allows you to start and change loads when it fits your schedule. Once the washer's spin cycle is complete, a fan blows air over the clothes and periodically tumbles them to prevent them from acquiring a damp smell. The postspin tumbling and fan also allow for a small load of two to four items made from synthetic fabrics (such as workout clothes) to be tossed in the washer on the way to bed so that they'll be clean and dry when the sun comes up.

The innovative Whirlpool heat-pump dryer is perfect for a tight house like this. A vented (traditional) dryer blows a good deal of air out of the house, and replacement air must come from somewhere. In older, leakier homes, the replacement air is pulled in through holes in the envelope, such as the unsealed space between a window and the rough opening. Tight homes require either planned makeup air or a ventless dryer. Ventless, or condensing, dryers have been around for a number of years and have generally gotten a bad reputation for long cycles that don't quite dry the clothes. Ventless dryers such as this one that replace the air-cooled or water-cooled condensing surface of the dryer with the cool coil of a heat pump and that heat the drying air with a hot coil reduce dryer energy consumption by 50% to 60%. Homeowner reviews claim that clothes, especially bath towels, are also much softer when dried in a heat-pump dryer.

One of the principles that Guertin wanted embodied in the house was flexibility. When situations arise allowing him to future-proof the house by accommodating potential

changes a homeowner might make, he tries to build in those accommodations. The laundry area presented two opportunities for this: The heat-pump dryer is a nice appliance with great energy performance, but it is more expensive than a traditional dryer. Guertin has ducted the walls for both venting and makeup air in the event that a future owner installs a conventional dryer. The second opportunity is in the walkout lower level that is a potential in-law apartment. To accommodate self-contained living on that level, Guertin has prepared a laundry area. The dryer is connected to a Dryerbox in-wall receptacle, which allows the dryer to be pushed tight to the wall. The duct runs upward and connects with an In-O-Vate low-friction elbow that exhausts out the sidewall. Keeping the duct run as straight and smooth-flowing as possible not only increases efficiency, which speeds up drying time, but it also discourages lint buildup. A makeup-air duct outfitted with Tamarack Technology's Cape Vent prevents unwanted air infiltration. Tamarack, a manufacturer



High-performance dryer for a tight house.
A heat-pump dryer drastically lowers energy consumption while eliminating the need to provide mechanical makeup air that a vented dryer would require in a house with an effective air-sealing strategy.



Efficient and convenient. Flexibility is a theme throughout the kitchen, which contains a microwave with convection-baking capability, a dishwasher with convertible racking and special scrub-jet zones, and a refrigerator with icemakers in the refrigerator door and freezer drawer as well as plenty of specialized storage for everything from frozen pizzas, to produce, to drinks.

of ventilation equipment and controls, is also supplying a Dragon 150 garage exhaust fan. This type of ventilation appliance is often overlooked, but it's an important safety feature in a home with living space over the garage. The fan exhausts fumes—whether CO from vehicle exhaust or from gas storage cans or fertilizer bags—so that they don't find their way into the house. The Dragon fan can be wired to a timer switch or wired to run for a set period each time the garage-door opener is activated.

The stainless-steel suite of Whirlpool kitchen appliances includes plenty of features that a family will appreciate when they're cooking and cleaning up after mealtimes. The five-burner ceramic glass cooktop electric range (WEE730H0DS) offers plenty of stovetop cooking options, including a warming area, and the oven's rapid preheat function reaches the target temperature quickly. The over-range microwave

(WMH76719CS) features convection-oven capability for additional baking flexibility and also houses an exterior-vented exhaust fan, which will have a Cape Vent in the duct to prevent drafts.

The 26-cu.-ft. French-door refrigerator (WRV986FDEM) has lots of handy features, including two pull-out drawers. One of these drawers has five selectable temperature settings, so it can be tuned for specific items such as meat and fish, or cheeses, or frozen food that needs to thaw. The other drawer is for produce.

The dishwasher's (WDT920SADM) convertible racking has tines that fold out of the way or slide into wider configurations to accommodate all sizes of bowls, pots, and casserole dishes. Forty targeted spray jets mounted on the rack scour all surfaces to make sure cookware is fully cleaned.

gallery

Everything under the sun for fun

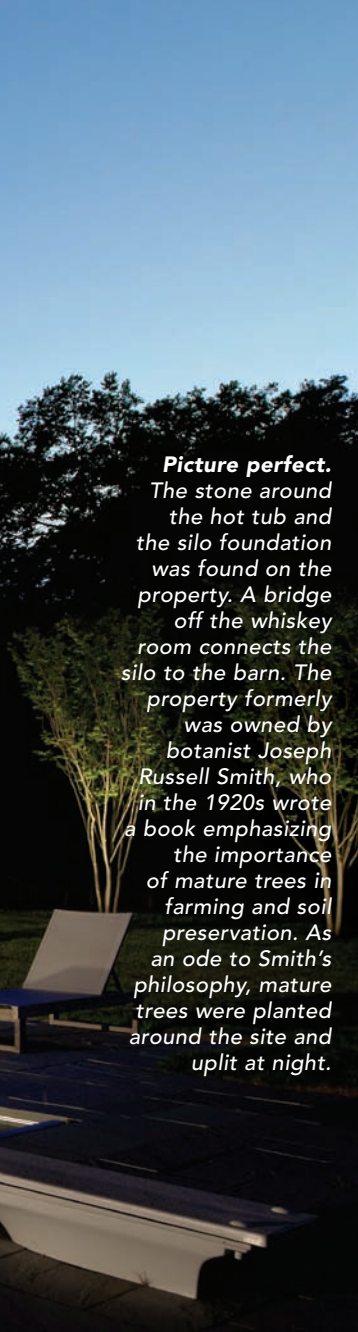
After beautifully renovating their clients' unique home ("Finishing Touch," p. 98), Zach Gasper and the team from GreenSpur were retained by the couple to create a multifaceted outdoor complex for entertaining. Inspiration for the complex came from the antique bank barn on the property and the history of the farm itself. After a timber expert assessed the early 1800s structure as being in excellent condition for its age, the 30x40 barn was converted to a dining and dance hall. Renovations included bringing electricity to the barn and creating new openings in the front and at one side of the barn. The lumber

from these cut-out sections, along with wood from a three-board fence found on the property, were used to construct the sliding barn doors. Included in the plan for the complex were a pool and a pool house. A grain silo once sat adjacent to the barn, and though it had been removed long ago, a new silo was built in its place. Erected in one day, the 24-ft.-dia. silo is insulated with closed-cell spray foam and is heated and cooled with a ductless minisplit. A whiskey bar on the first floor serves as the socializing center and hub for the outdoor space and as a connection to the barn.

—Maureen Friedman

Sweet retreat.

A slab was poured in the area below the barn so that the space could be used as a shaded hideaway to escape the summer sun.



Picture perfect. The stone around the hot tub and the silo foundation was found on the property. A bridge off the whiskey room connects the silo to the barn. The property formerly was owned by botanist Joseph Russell Smith, who in the 1920s wrote a book emphasizing the importance of mature trees in farming and soil preservation. As an ode to Smith's philosophy, mature trees were planted around the site and uplit at night.



Entertaining in the round. The whiskey room features a custom-built curved-steel and reclaimed-wood bookshelf. The bookshelf holds World War II memorabilia that had belonged to the father of one of the clients. The hardwood flooring is reclaimed lumber from a Virginia tobacco barn.



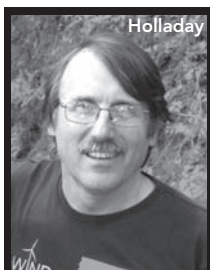
Great views, day or night. With the barn doors open, great views of the main house and pond, the pool, and the hot tub can be captured from the dining and dance hall.



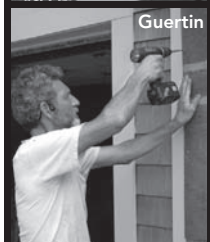
The many levels of silo living. For easy access to the pool and hot tub, the changing area and spa are located on the ground floor. The whiskey room and kitchen are on the first floor. A bedroom and bath are found on the second floor, and a studio is on the third floor.

askthe experts

YOUR QUESTIONS—PRO ANSWERS



Holladay



Guertin

experts

Martin Holladay is a senior editor at *Fine Homebuilding*. His weekly blog at GreenBuildingAdvisor.com focuses on energy-efficient residential construction.

Editorial adviser Mike Guertin is a builder and remodeler who has written over 100 articles for *Fine Homebuilding* and appeared in dozens of videos.

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Adding head flashing

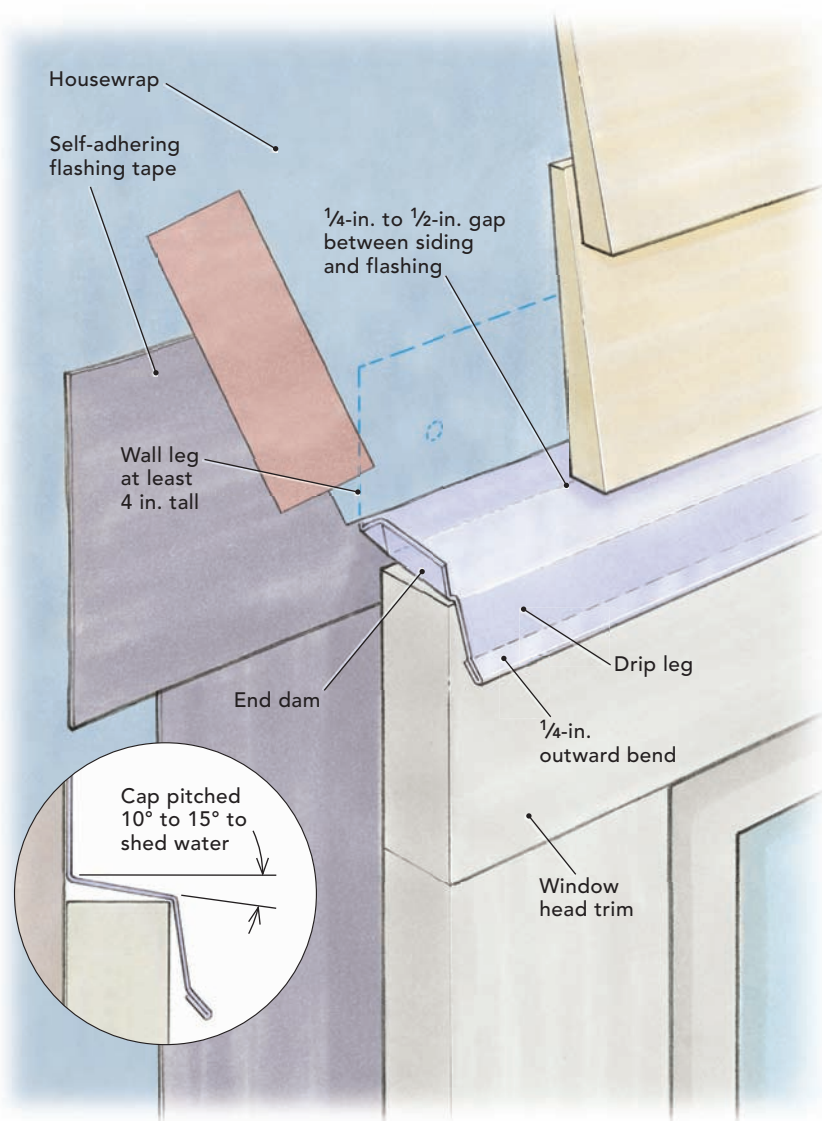
The doors and windows on my home do not have head flashing. Can I add this missing protection?

—DAVID WOLF
via email

Mike Guertin: Head flashing prevents water from leaking in at the joint between the bottom edge of siding and the top of the head trim. You won't necessarily find head flashing on windows and doors that have integral flanges because some manufacturers call for it and some don't. That might explain why you don't see any on your windows and doors. It's common practice to seal these units to the wall with self-adhering flashing tape and then to lap the housewrap over the top. You can't go wrong by adding head flashing, however.

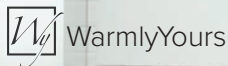
For flanged windows and doors that have separate trim surrounds but no head flashing over the trim, it would be a good idea to install some. You may be able to remove the trim without removing the siding above it, allowing you to slip a head flashing behind the water-resistant barrier before reinstalling the trim. Before doing that, though, be sure to cut the siding course up by 1/4 in. to 1/2 in. to leave a space between the bottom edge of the siding and the head flashing. This space will allow water to drain freely.

The metal or plastic head flashing should have a wall leg of at least 4 in., although a wall leg shorter than that can be extended by bonding a strip of flashing tape to it. The cap projection should be



sloped downward 10° to 15° to readily shed water. Bend the drip leg down at least 3/4 in., and give it a slight inward bend. Finish the drip leg with about a 1/4-in. outward bend at the bottom edge. You can form end dams to keep water from dripping off the ends of the flashing and getting behind the siding.

After fastening the cap flashing to the walls, lap the housewrap over the wall leg. You also can take the extra step of flashing the window and door heads with flashing tape before installing the head flashing. The tape backs up the head flashing in the event that wind-driven water gets behind this primary layer of defense.



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Repairing a vapor barrier. If a vapor barrier is damaged during a drywall installation or repair, it may be patched with housewrap tape, but small holes only marginally impact effectiveness.

Drywall repairs and vapor barriers

When patching drywall on an exterior wall, it's almost impossible not to damage the vapor barrier. What can be done to ensure that a vapor barrier stays uninterrupted?

—LEVI HYMES
via email

Martin Holladay: You don't mention what type of vapor barrier you're talking about, but I'm guessing that you are referring to a layer of polyethylene.

While air barriers need to be continuous and without holes to work effectively, vapor barriers don't have to be free of holes. A vapor barrier that is riddled with holes that make up 5% of the vapor barrier's area is

still 95% effective. Patch the polyethylene with housewrap tape if you can, but don't worry about it too much. U.S. building codes don't require an interior vapor barrier. In climate zones 5 through 8 and marine zone 4, most U.S. building codes require an interior vapor retarder (a more permeable layer than a vapor barrier). The requirement for an interior vapor retarder can be met with a layer of vapor-retarder paint. (For more on vapor barriers and vapor retarders, see "Musings of an Energy Nerd," pp. 84-87.)

Insulating an old cottage

Just like you described in your piece on insulating walls with no sheathing ("Energy-Smart Details," FHB #260), my 1929 cottage on Lake Huron (climate zone 5) has no exterior wall sheathing. It is used mostly between April and November and is unheated the rest of the year. Parts of the cottage are insulated with fiberglass, but some areas and a cathedral ceiling are uninsulated, which is causing problems with ice dams. There is also little in terms of a vapor barrier. My plan is to use the combination of air-permeable insulation and rigid foam you described on the interior, and a ½-in. layer of rigid foam with a ventilated rain-screen assembly under new vinyl siding. Since the building is only occasionally heated, should I be concerned about moisture control?

—ERIC SCHOETTLE
via email

M.H.: That article addressed solutions for remodelers only working from the inside. Since you plan exterior work, your approach can be different. Before proceeding, consult an engineer to determine whether the lack of wall sheathing on your house is structurally worrisome. If an engineer recommends OSB or plywood wall sheathing, now is the time to install it.

I recommend that you add a thicker layer of exterior rigid foam than the ½-in. layer you mentioned. In your climate zone, it's best for the exterior rigid-foam layer to have a minimum R-value of R-5 if your walls are

framed with 2x4s, or R-7.5 if your walls are framed with 2x6s. To achieve R-5, you need 1½ in. of EPS, 1 in. of XPS, or at least 1 in. of polyiso (the performance of which suffers as the temperature drops). To achieve R-7.5, you need 2 in. of EPS, 1½ in. of XPS, or at least 2 in. of polyiso.

If you want to open up your walls on the interior for other reasons, you can fill the empty stud bays with the insulation material of your choice. This could be either fiberglass batts, blown-in fiberglass, or dense-packed cellulose.

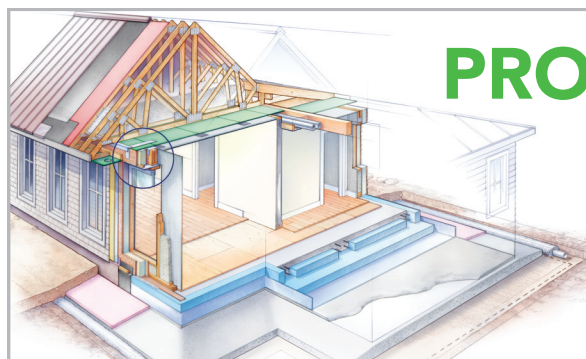
If your cathedral ceiling is uninsulated, adding insulation will certainly reduce the chance of ice dams. (For more information on this, see “Insulating a Cathedral Ceiling,” *FHB* #228.)

Humid basement

Even with an air-conditioning vent at one end and a dehumidifier at the other, my basement is excessively humid. There is an exterior door and a garage door at one end. Would covering the walls and floor with moisture-blocking paint help reduce the overall humidity?

—JEFF PAULEY
via email

M.G.: The problem may be due to warm, humid air entering the space from the outside rather than through the slab or walls. Doors, especially garage doors, are notoriously leaky. When warm air leaks into a basement, the air cools and the relative humidity increases. If the air temperature reaches the dew point, moisture can condense on surfaces such as the slab or walls. Eliminating the doors is usually not an option, so the best approach is to air-seal them well. If the garage door is old, a new insulated model with better weathersealing may help. If both doors have been air-sealed and there are none of the other air leaks common to a basement (see “Air-sealing Basics,” *FHB* #254) and still the problem persists, then I’d address the floor and walls, which can transfer moisture from the surrounding soil. Exterior site drainage or interior water management would alleviate that problem, but I don’t recommend moisture-blocking paint. It can work, but it’s not a long-term fix for this problem, and it can be hard to clean the concrete well enough to get a reliable bond.



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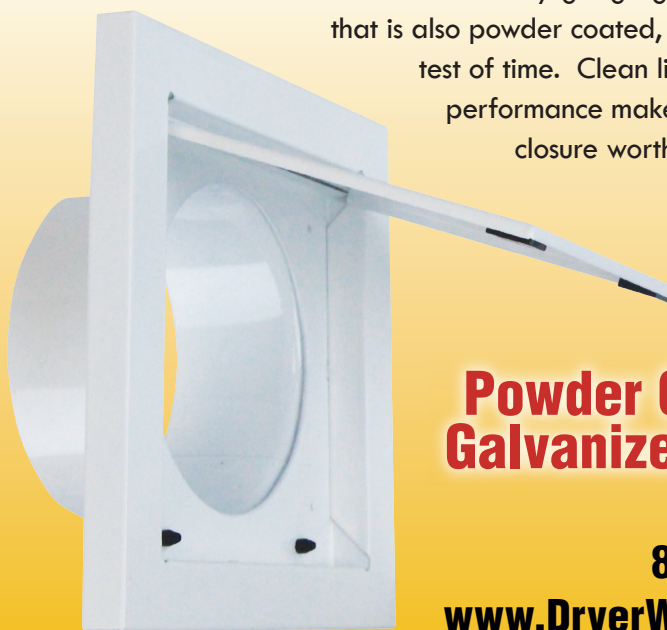


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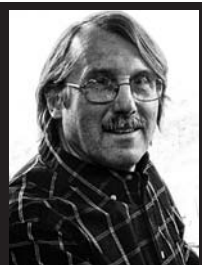
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"Musings of an Energy Nerd" showcases the best of Martin Holladay's weekly blog at GreenBuildingAdvisor.com, where he provides common-sense advice about energy issues to residential designers and builders. His conclusions usually fall between minimum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

Green Building Advisor
Green Building Advisor is for designers, engineers, builders, and homeowners who craft energy-efficient and environmentally responsible homes.

Do I need a vapor retarder?

Every couple of weeks, someone emails me a description of a proposed wall assembly and then asks, "Do I need a vapor retarder?" The short answer I give is that if the wall doesn't have a vapor retarder, then there probably is no need to worry. It's rare for a building to have a problem that's caused by water-vapor diffusion. (*Vapor retarders* slow vapor move-

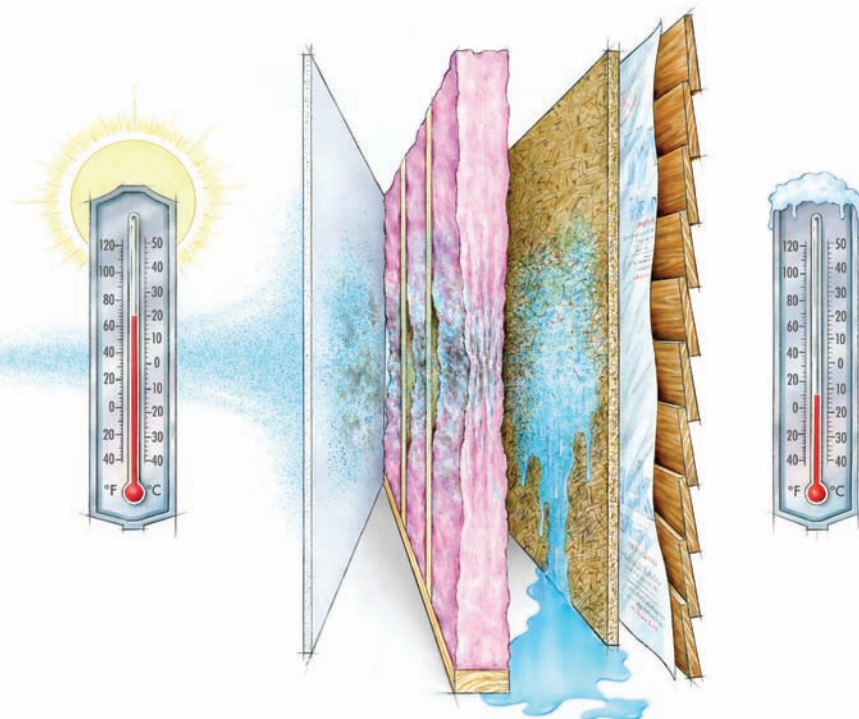
ment and have a permeance rating of between 0.01 and 1. With a permeance of less than 0.01, *vapor barriers* essentially halt vapor flow.)

Water vapor is water in a gaseous state—that is, water that has evaporated. The passing of water vapor through building materials is known as vapor diffusion.

From the 1970s through the early '80s, builders were taught that it

was important to install a vapor barrier (usually polyethylene sheeting) on the warm-in-winter side of wall insulation and ceiling insulation. Many textbooks and magazines explained that this step was necessary to keep the walls dry during the winter, and that any walls without vapor barriers would get wet because the vapor would condense when it hit

HOW VAPOR DRIVE WORKS During winter, moisture driven outward by interior warmth can enter walls and ceilings by diffusing as vapor through building materials (although it's far more likely to be carried by air leaks). This moisture can condense on the cold back of the exterior sheathing, causing problems such as mold and rot.



What's the short version?

- Most buildings don't need polyethylene anywhere, except directly under a concrete slab or on a crawlspace floor.
- The main reason to install an interior vapor retarder is to keep a building inspector happy.
- If a building inspector wants you to install polyethylene in a

wall or ceiling, try to convince him to accept a layer of vapor-retarder paint or a smart retarder instead.

- Although most walls and ceilings don't need a vapor barrier, it's always good to include an interior air barrier. Air leakage is far more likely to lead to problems than vapor diffusion.

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a cold surface (for example, the interior face of the sheathing).

This was bad advice for several reasons, although there are exceptions, which I'll get into later. Outward vapor diffusion during the winter almost never leads to wet walls or ceilings. In conventional walls or ceilings, the problem is almost always due to air leakage, not vapor diffusion. Far more moisture is transported by air leaks than by vapor diffusion. And since it prevents wall assemblies from drying inward during the summer, an interior polyethylene vapor barrier can actually make the wall wetter than it would be without the poly.

Air leakage and vapor diffusion create wet walls in different ways

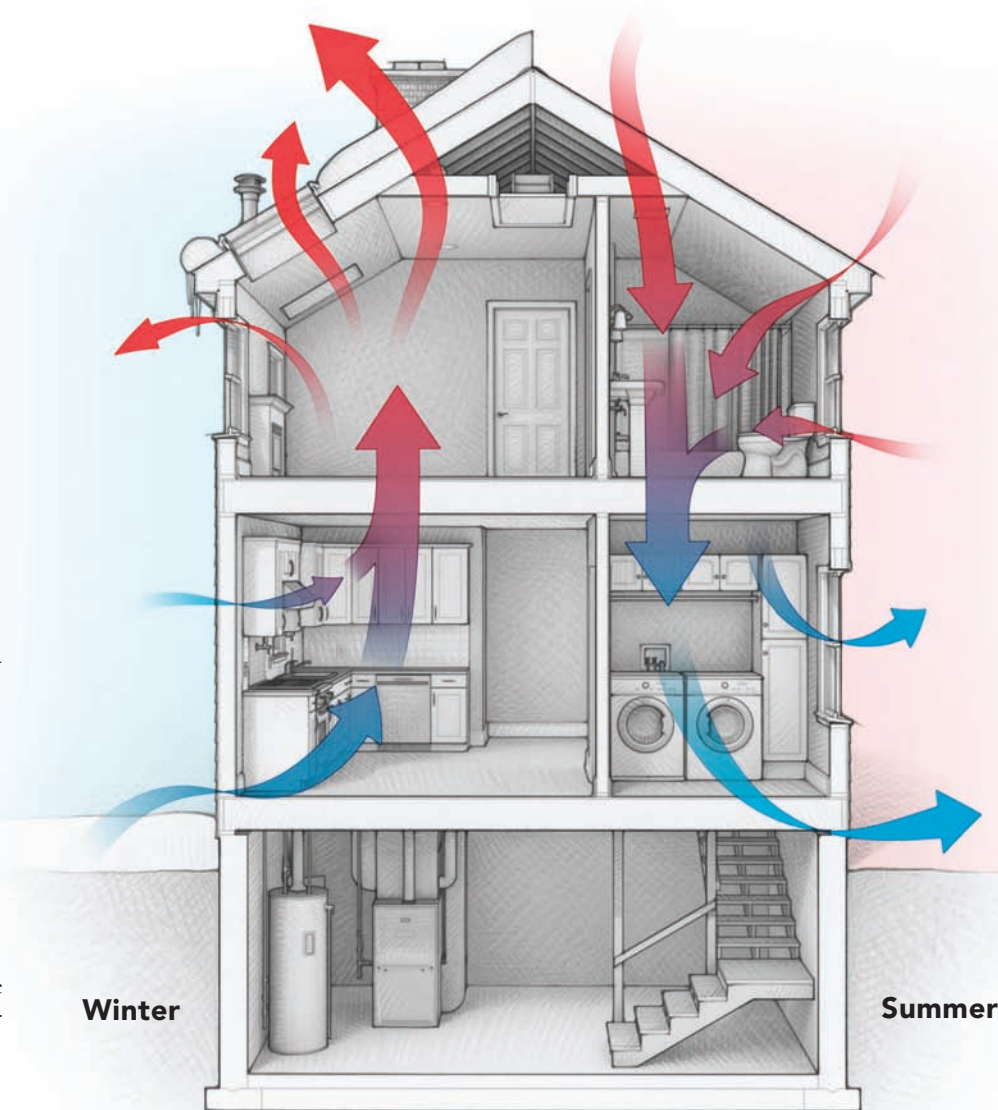
Water vapor can diffuse through vapor-permeable materials—for example, gypsum wallboard—even when the wall assembly is perfectly airtight. If the air on one side of the drywall is hot and humid, and the air on the other side of the drywall is dry and cold, the drywall absorbs moisture from the humid side. Once the drywall is damp, some of its moisture evaporates from the side facing dry air.

Air leakage is a different phenomenon. A hole in the drywall (at an electrical box, for example) allows warm interior air to enter the wall cavity and then escape through cracks in the sheathing. This is especially likely to occur if there is a strong driving force such as the stack effect or a fan that is pressurizing the house. If the wall sheathing is cold, some of the moisture in the air may condense on the sheathing or cause the sheathing to absorb moisture. If the sheathing gets sufficiently wet, rot and mold can result.

An air barrier is a material that stops air leakage. A vapor barrier is a material that stops vapor diffusion. Materials such as gypsum wallboard or plastic housewrap are vapor permeable but are still air barriers, while others, such as vapor-retarder paint on a leaky plaster wall or the kraft facing on fiberglass batts, meet the legal definition for a vapor retarder without being an air barrier. Finally, it's possible for some materials, such as polyethylene sheeting with

WORRY ABOUT AIR, NOT WATER VAPOR

Holes in the drywall (which usually serves as the interior air barrier)—such as around electrical switches and outlets, lights, and at the bottom of walls—can admit far more moisture than will diffuse through the drywall as vapor. Airflow can reverse seasonally.



taped seams, to act as both vapor barrier and air barrier.

When vapor diffusion does cause trouble

Still, you can't quite ignore vapor diffusion. Vapor diffusion can transport a significant amount of moisture in rooms with high humidity—for example, greenhouses,

rooms with indoor swimming pools, or rooms that are deliberately humidified—especially in a cold climate. If your building includes a greenhouse or indoor swimming pool, get expert advice from a specialty contractor on your wall and ceiling details before proceeding with the project.

In very cold climates (climate zone 8 as well as the colder parts of climate zone 7),

interior polyethylene vapor barriers are often beneficial. That said, interior polyethylene sometimes can cause problems even in these climates, especially in buildings that are air-conditioned during the summer. When in doubt, a “smart” vapor retarder is always safer than polyethylene. The permeance of smart retarders (for example, MemBrain or Intello Plus) increases as they become wetter, allowing inward drying to occur.

When open-cell spray foam is used on the underside of roof sheathing to create an unvented conditioned attic in a cold climate (zones 5 and colder), outward vapor diffusion during the winter can lead to damaging moisture accumulation in the roof sheathing. For this reason, closed-cell spray foam is a better choice for this application. If you do use open-cell spray foam, protect it on the interior with a layer of gypsum wall-board coated with vapor-retarder paint.

In double-stud walls, outward vapor diffusion during cold-climate winters can cause moisture accumulation in the exterior sheathing. Builders should include details that reduce the risks associated with this type of moisture accumulation. A ventilated rain screen with a vapor-permeable sheathing such as fiberboard or DensGlass Gold speeds drying to the exterior. Installing a layer of OSB or plywood sheathing in the center of the wall creates a vapor retarder where the wall is still warm. If you don’t want to include sheathing in the center of the wall, installing a smart vapor retarder on the interior side of the wall is a good idea. Smart vapor retarders limit outward diffusion while allowing drying to the interior in warm weather.

In homes sided with a material that holds water (for example, brick veneer) and sheathed with a vapor-permeable material such as fiberboard, water vapor can diffuse inward during summer. Sun heating wet brick can drive moisture inward, and the moisture can condense on polyethylene installed under the drywall if the house is air-conditioned. These problems can be avoided if the wall doesn’t have any interior poly and if OSB, plywood, or rigid-foam sheathing is specified instead of fiberboard.

Diffusion also can be a builder’s friend. During the summer, inward vapor diffusion through drywall can dry a damp wall assembly. That’s why the use of interior polyethylene or vinyl wallpaper often leads to problems.



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Installing a subfloor

STEP BY STEP



The subfloor is the layer of structural sheathing applied directly to the joists that provides a base for all the finish floors to come. Some types of flooring, such as carpet or traditional hardwood, can be installed directly on top of the subfloor. Others—such as tile, vinyl, and some engineered-wood products—require an additional layer called underlayment before they are installed.

The most important function of a subfloor is to create a structural diaphragm that helps to distribute wind and seismic loads through the house frame. That's the main reason subflooring has a code-specified nailing schedule (every 6 in. on edges parallel to joists, and 12-in. spacing in the field). But perhaps the most obvious reason that proper subfloor installation is important is to minimize floor squeaks down the road. If subflooring panels can move against the joists or abutting sheets, they will squeak. Gluing the panels down in addition to nailing them is considered best practice for eliminating squeaks, although it's



1 Start straight. Snap a chalkline across the joists 4 ft. from the outside of the rim joist.



2 Start spreading the glue. Apply a bead of adhesive on each joist up to the chalkline.



3 Lay the first sheet. Align the edge with the chalkline. Choose either the tongue or the edge of the sheet; just be consistent.



4 Start at one corner and work out. Keep the nails between $\frac{3}{8}$ in. and $\frac{1}{2}$ in. from the edges of the panel.

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Subfloor adhesives

Although not required by code, gluing down subflooring helps to prevent squeaks. That's so widely accepted that I've never seen a subfloor installed without adhesive.

The most common adhesives come in 28-oz. tubes and are applied using a large caulk gun. Keep these adhesives warm in the winter. When cold, they don't adhere as well, and they become extremely viscous. I've broken guns trying to get cold glue to come out. Also, pay attention to the expiration date. When the solvents in old glue evaporate, it thickens, is hard to apply, and doesn't adhere well.

More recently, polyurethane foam adhesives have hit the market, and they're applied with the same type of applicator gun used with pro-style cans of spray foam. With foam-based adhesives, the problem is more likely to be the glue hardening inside a gun that's unused for months. Unopened foam cans have a shelf life of 18 months.

Many adhesives have application temperature ranges, and some can be applied to wet or icy lumber, while others should not be. Never put down more than a sheet's worth of adhesive at one time, or it can skin over and lose adhesion. Also, walking on joists is dicey enough without adding slippery, wet adhesive to the equation.



STEP BY STEP



5 Space the nails correctly. Drive the nails no farther apart than 6 in. on the short edges and 12 in. in the middle of the sheet, completely nailing each sheet before moving to the next one.



6 Space the ends of subsequent sheets. Use a 10d common nail to create an expansion space between sheets. After a few sheets, you may need to cut one shorter to keep the edges on the joists.



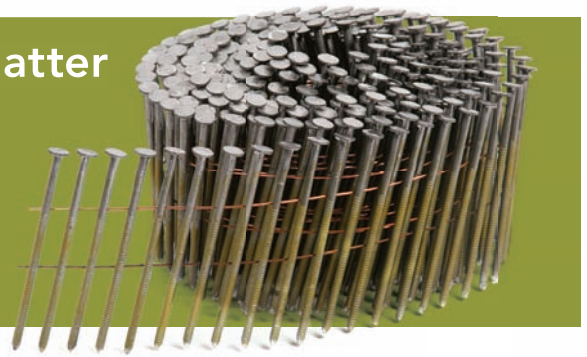
7 Repeat these steps on succeeding rows. Stagger the sheet ends, and slide their grooves over the tongues of the previous row.



8 Tap gently. If the tongues and grooves in succeeding rows of sheathing don't engage easily, a few taps with a hammer against a 2x block should be enough to persuade them together.

The right nails matter

Use ring-shank or screw-shank nails long enough to penetrate the joists at least 1 in. Smooth-shank nails can withdraw over time.



not included in the structural calculations, nor is it required by code. Some engineered floor specifications, however, may require the use of adhesive. Whenever working with engineered floor systems, be sure to follow the manufacturer's instructions to the letter.

New materials solve old problems

Most subflooring used these days is either 3/4-in. plywood or 3/4-in. OSB, one long edge of which has a tongue and the other long edge a matching groove. Tongue-and-groove subflooring was pretty new to the market when I started framing in the 1980s. Prior to that, the standard was regular old 5/8-in. or 3/4-in. CDX plywood. To support the edges of the sheets so that they didn't sag between the joists, carpenters installed blocking where the long edges of the sheets would meet. This required extra material for the blocking as well as a fair amount of extra work.

The introduction of tongue-and-groove subflooring eliminated the need for the extra work of installing the blocking because the sheets support each other when their edges interlock. Getting the sheets to go together could sometimes be challenging, however, particularly if they'd been exposed to much moisture prior to installation. The solution with the commodity sheets I saw in years past was to beat them together with a sledgehammer, using a length of 2x to cushion the blows.

Even after subflooring has been installed, extended exposure to the elements often can lead to trouble. Plywood subflooring can delaminate, and OSB is famous for its edges swelling (sometimes to the point where the joints must be sanded down prior to the finish flooring being installed). The market responded to these problems with premium grades of subflooring, such as the Huber AdvanTech used here. The company promises that AdvanTech can be exposed to the weather for 500 days with no edge swelling severe enough to require sanding, and says that carpenters should never need to use more than a few taps with a block and a framing hammer to drive the sheets home.

Andy Engel is a senior editor. Technical expertise provided by carpenters Robert Scott and Ken Whiting. Photos by the author, except where noted.



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Second-floor additions for a ranch house

During the 1940s and '50s, countless ranch houses were built throughout the country. Efficient and inexpensive to build, these houses generally were designed to accommodate folks looking to settle in the suburbs as quickly and as inexpensively as possible. The resulting single-story ranch-style homes had small kitchens, small bathrooms (often only one), and small bedrooms. Built before the television era, they had no family rooms or large gathering spaces. While these houses were perfect starter homes for many, they were

left wanting as families grew and lifestyles changed. The small and modest ranch just didn't work after the kitchen had become the primary gathering and entertaining room and now that couples wanted their master bedroom to become a retreat.

The good news is that ranches are adaptable and expandable. Over the years, many of them have been remodeled to accommodate the needs of a new generation. Basements have been finished, and first-floor additions have been used to create larger kitchens and great rooms as well

as first-floor master suites. Where the property is too small to allow for a first-floor expansion or where the homeowners just don't want to reduce their yard space, a ranch can be expanded upward with a new second floor.

While designing a first-floor addition that looks like it has always been there is often straightforward, designing a second-floor addition can present a host of design hurdles. This is especially true if the existing house will continue to be occupied while the new second floor is being built. Because



READY FOR A REMODEL

Most 1950s-era ranches were about 40 ft. long and 30 ft. wide. These houses typically had 8-ft.-high ceilings and a simple gable roof. A common exterior finish was brick, especially in the upper Midwest and the Mid-Atlantic states. In some areas, these houses had full basements, many of which were finished into recreation rooms that provided casual gathering areas that the houses lacked. To expand such houses, first-floor additions are possible. But for many of them, the only way to add space is to go up.



THE POTENTIAL FOR BLAND

Any time you make a house taller, it's important to consider how the additional height will affect the proportions of the exterior elevations. A ranch remodeled with a new flooring system built over the existing ceiling structure takes on the height of the new second floor and then some. Without a good design, the exterior can easily become disproportionate, bland, and unappealing.

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A PORCH ADDS INTEREST AND OUTDOOR SPACE

One way to avoid a bland exterior is to disguise the extra height created by the second-floor addition with a front porch. The roof of the porch can be designed to fill the space between the top of the first-floor windows and the sill of the second-floor windows. The addition of a porch also creates a place to transition siding types and possibly allow flexibility in window size and location. With an existing brick base, there isn't much likelihood of finding new brick that matches, so using a different siding material on the addition makes sense. In effect, the new porch gives order and rhythm to the overall exterior while also creating a nice outdoor space and a lot of curb appeal. Here, shutters and muntins are used to bring additional visual interest to the tall elevation.



A SIMPLE BAND OF TRIM BALANCES A TALL EXTERIOR



Another good option is to acknowledge the extra height of the exterior by turning it into an asset. This can be done by breaking the exterior design into two masses that are biased to create a taller base. A simple band of trim at the second-floor windowsills does the trick. Here, the entire exterior is re-sided with stucco, but this approach also can be done by switching siding types. The new roof has deep and extensive overhangs at the eaves and rakes to counterbalance the emphasis on height with a strong horizontal element. Lastly, adding a small front-entry porch is a useful design idea that makes sure that the front door doesn't get lost under all of the extra height and the big roof.

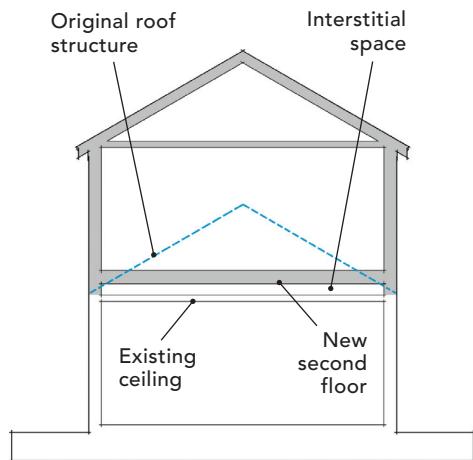
A FITTING STYLE THAT'S A BIT MORE MODERN

While the first two solutions take the overall design of the expanded ranch to a decidedly traditional aesthetic, here is an idea that brings the ranch house in a different direction. In a take on the prairie style, the new second floor is designed to stress the horizontal nature common to ranches. Just above the first-floor windows, the second-floor walls overhang the original footprint to create a shadow line that lightens the look of the tall addition and deemphasizes the extra height of the new house. To break up the field of stucco siding, a band of trim is used at the second-floor windowsills. Another band of trim is used to transition between the two siding types. A hip roof with deep overhangs is quintessential prairie style and grounds the design. Here, the windows on the first floor have also been replaced.



the existing ceiling joists are usually too small to be used as floor joists for the addition above, either they need to be removed or a new floor system needs to be installed above them. Moreover, ripping off the entire roof and ceiling system just can't be done without exposing the family and their belongings to weather, water, discomfort, and annoyance.

The result is that many second-floor additions are built above the existing ceiling structure, creating a larger interstitial space between the first and second floors. This space makes it simple for mechanical contractors to run wiring and piping headed to the addition. But this foot or more added to the overall height of the house can be



New floor over old ceiling

The floor framing for the new second story is often added above the existing ceiling joists, leaving the finished ceiling in place and creating a natural chase for running mechanicals. This means, however, that the designer must figure out how to proportionately detail the extratall exterior.

tricky for designers. While not evident on the inside, the extra height at the exterior can mean that there will be larger fields of siding, making for a bland elevation and awkward proportions.

Fortunately, there are design solutions for adding a second floor to a ranch without resulting in an awkward and less than appealing exterior. Most of them have to do with breaking up the exterior with architectural elements.

Bud Dietrich is an architect in New Port Richey, Fla. Drawings by the author.

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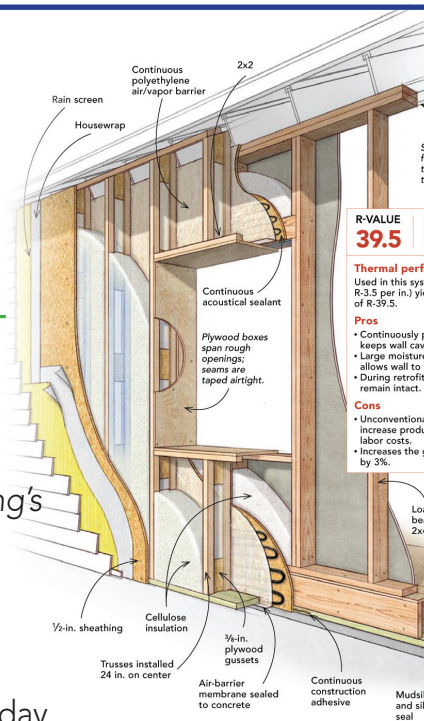
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ANDREW LEGGE, FOUNDER This principal at Havelock Wool uses wool from New Zealand to create natural, alternative insulation.

What inspired Havelock Wool?

I started Havelock Wool with another American who has a similar love for all things New Zealand. The farmers there were looking for new markets and uses for their wool, and the American market—which generates only 1% of the global annual yield of wool—is a great place to introduce this time-tested, high-quality natural product.

Is the insulation clothing-grade wool?

Our friends in New Zealand think we're using better wool than necessary to effectively insulate homes, but it carries a significantly higher fiber diameter than Merino wool and is more coarse. This means that it's comfortable to the touch but not as soft as Merino wool, which is prized for its comfort.

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wool, fiberglass, or cellulose. We are using 60-year-old repurposed carding machines with electric motors that were collecting dust in South Carolina after so many textile jobs moved offshore.

Is there a long history of wool being used as insulation?

There is. We know that using wool for insulating homes dates back hundreds

We will never replace mainstream insulation products, but we will address an increasing part of the market that chooses to make smarter and healthier decisions.

of years in the United Kingdom and has been common in Australia and New Zealand over the last 40 to 50 years. Wool has evolved over time to protect sheep from the elements, and it has been used for the same purpose by humans around the world for thousands of years.

What makes wool a so-called high-integrity fiber?

Wool inherently regulates temperature and moisture. Moisture works against most

other types of insulation; thus, wool's ability to absorb and desorb moisture relative to the ambient air is a major advantage to our product's longevity. Moreover, wool contains keratin, which means it will not support the growth of mold.

Is wool insulation expensive?

Prices vary by region and by buyer, but as you might expect, large installers buy at wholesale prices and smaller installers at retail prices. Speaking in averages, there is a general spectrum of insulation costs. Fiberglass and cellulose are the least expensive, while closed-cell foam is the most expensive. We aim to be a bit less expensive than closed-cell foam, whose cost is anywhere from two to three times that of fiberglass.

Does the insulation contain any additives or binders?

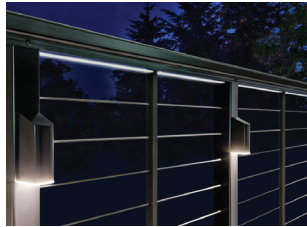
We have no synthetic additives, glues, or binders. For an insect repellent and flame retardant, we use a very small amount of boric acid. We have not had any issues with moths or vermin, nor have our friends in New Zealand who have been using the product for decades. Also, the amino acids in wool bond with formaldehyde, nitrogen dioxide, and sulphur dioxide, naturally abating these contaminants.

Is there a low demand for wool?

The global demand for wool has declined over the last half century, due largely to the proliferation of synthetic fibers. Our point of view can be summarized by a favorite hashtag: #naturedoesitbetter. We will never replace mainstream insulation products, but we will continue to address an increasing part of the market that chooses to make smarter, healthier decisions. And there is plenty of wool to keep those folks happy.



For the complete interview, visit [FineHomeBuilding.com/extras](https://finehomebuilding.com/extras).



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Dryer Wall Vent	www.dryerwallvent.com	p. 17	Warmly Yours	www.warmlyyours.com	p. 81
Duragroove	www.duragroove.com	p. 97	Whirlpool Corporation	maytag.com/warranty	p. 21
			Zip Wall	zipdoor.com	p. 28

Two cabins become one



Now one unique 1800-sq.-ft. home, this house was originally two cabins built side-by-side 10 ft. from each other. The right side was a log cabin built in the late 1700s and was the first building on the property. Sometime in the early 1800s, an identically sized stone cabin was built next to the log cabin. Years ago, previous owners added a central doorway and an exterior wall between the cabins to make the two structures one.

Wanting to update the interior and exterior of the home, the current owners contacted GreenSpur, a local design firm. The team from GreenSpur began by removing the patchwork infill connecting the two cabins. To emphasize the original form and material of each of the cabins, they replaced the infill with a modern glass atrium that serves as the new entry. To better insulate the leaky log cabin, all of the chinking was removed to expose the

bare wood. Rigid insulation was added to the cavities and sealed in place with spray foam, and new chinking was added inside and out. Radiant flooring now helps to heat the house in winter. The 7-ft. first-floor ceiling heights in both buildings were raised to a more comfortable 8 ft., except on the far end of the log-cabin side, where the floor above the living room was removed to create a 26-ft.-high ceiling. All of the cabinetry, built-

ins, and most of the furniture in the house were made with wood salvaged from a three-board fence found on the property. This mix of minimalism and historical textures balances both the old and the new. Delighted with the changes to the house, the homeowners then hired GreenSpur to refashion an antique barn on their property into an entertainment complex (see "Project Gallery," pp. 78-79).

—Maureen Friedman

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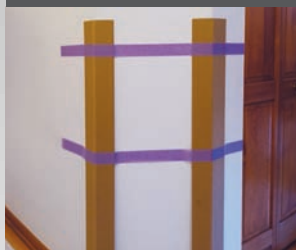
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