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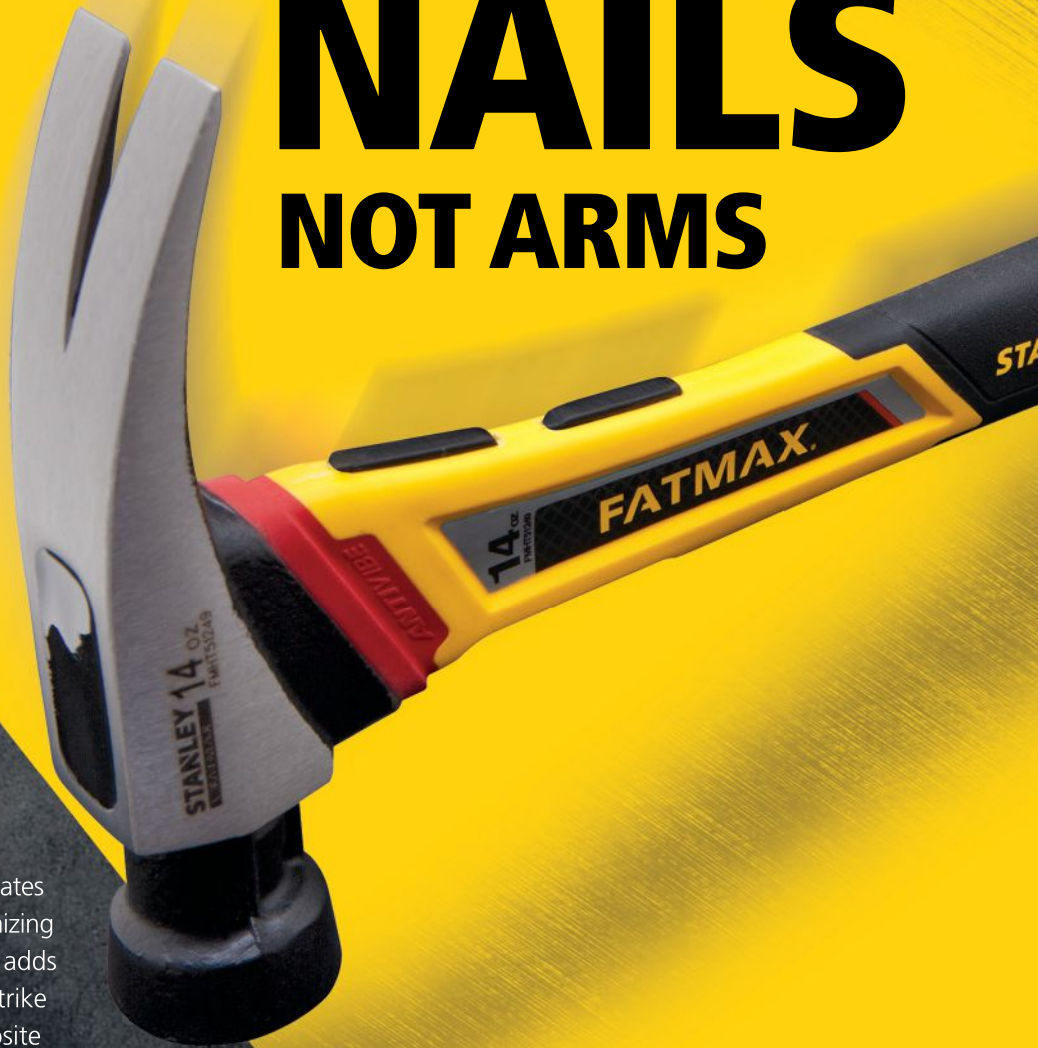
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On the cover: Todd Pudvar, operations manager for Topcoat Finishes, in Jericho, Vt., fastens PVC window trim with a stainless steel siding nail. Photo by Tim Healey.

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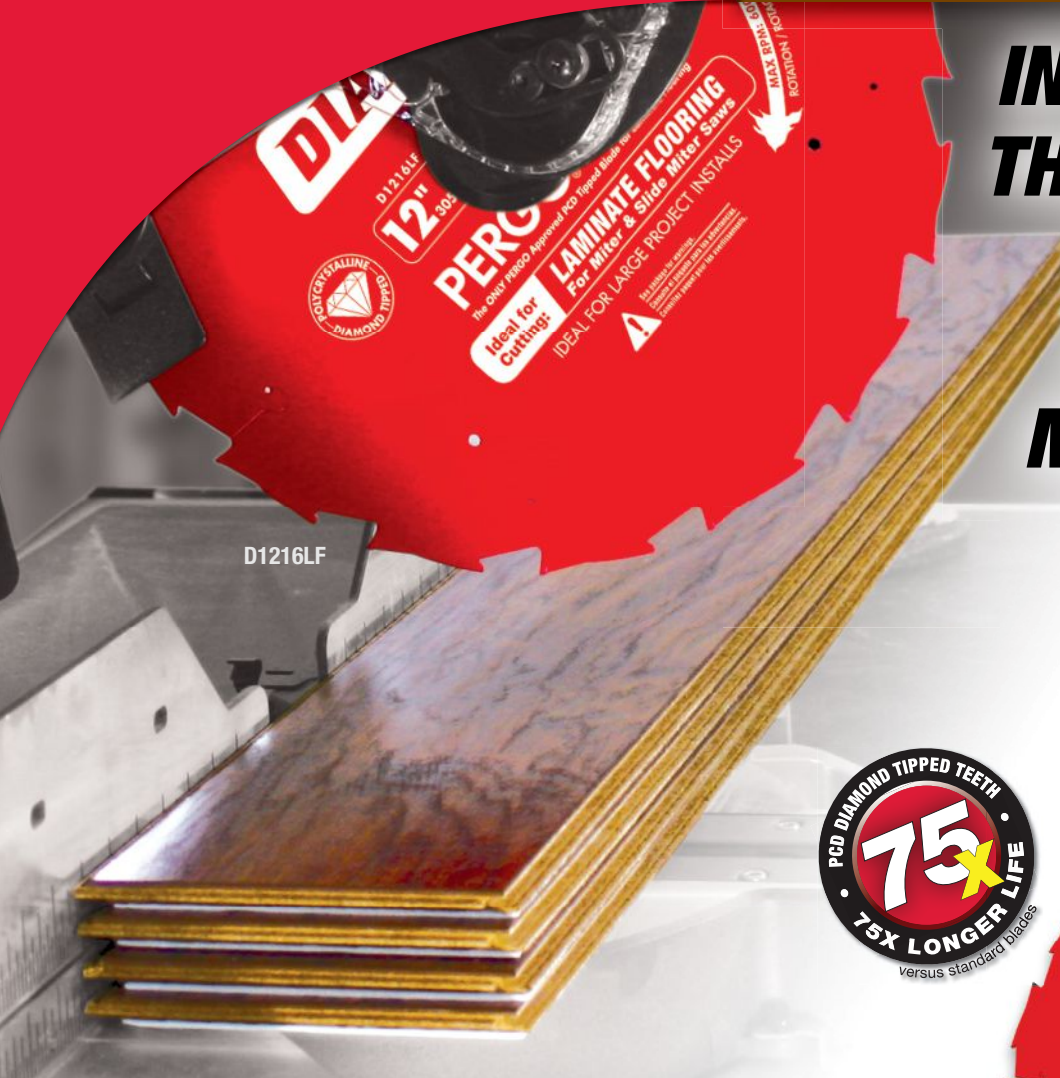
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Matt drives the bolts into the concrete using heavy-duty square washers between the bolt head and the sill. Hope this helps.

**“WHY ‘ENERGY-SAVING’ TIPS SUCK,” BY NATE ADAMS (JUL/14)**

Does anyone know of any information about the return on investment from replacing windows in a place like Saskatchewan or Manitoba, Canada?

Where I live, in Sask., temps can and do hit -50° C with a wind chill, turning old windows into what seems like the inside of a frosted up deep-freeze. When temps go from that to a balmy -10° C in a day, you know what happens to any amount of window condensation? Yep ... it melts. People often place towels under windows or on the jamb to sop up the water.

This isn't just a matter of window R-value, it's a matter of whole-wall performance as well as air quality. When the window freeze/thaw occurs all winter, that “drainage” goes either inside (behind the drywall between the vapor barrier and gypsum in our climate, and soaks the drywall, causing potential mold growth), or down the front of the drywall, wrecking paint, trim, and flooring, too.

Not replacing a few \$900 windows can add up to many thousands in replacement of drywall, millwork, paint, or possibly even mold abatement or time off work due to mold spores. Of course, when condensation gets into the building envelope (behind the gypsum and vapor barrier in our climate) from said window drainage ... oh boy. When the insulation becomes wet (and frozen), R-value decreases and a “snowball” effect ensues. When spring comes, guess what melts inside the wall? Problems follow.

All that said, it would simply be a shame to see information from one climate zone causing a ripple of doubt in homeowners wanting to make smart upgrade decisions for their biggest investments. Then again, I haven't seen good data on the return on new windows in my area, but I've certainly charged the replacement costs for my work, and those can be significant!

**Adams responds:** Mike, the best way to tell ROI is with a good energy model, tried to consumption. ROI is going to be crappy for any upgrade if you have a cheap fuel source. If you

are using propane or fuel oil, the numbers make a lot more sense, but still are unlikely to “pay back” in less than 10 years. Still, if anyone is making upgrades for money savings alone, it's a lousy motivation and they will be disappointed. Comfort and health/safety are better motivators, and it sounds like they are underlyng your comment, am I correct?

Food for thought: If walls aren't insulated or well-sealed, is it possible that similar things are happening behind the plaster/drywall?

**Glenn Gilbert:** Your article points out the main idea that I talk to all of my clients about—the fact is that there is no “silver bullet.” No matter what we choose to do, there isn't and never will be any one thing (device or habit) that will solve energy or any other type of complicated problem.

You point out that simply by changing perfectly good light bulbs (what self-conscious service provider would suggest such a ridiculous thing as more wasteful actions?) will only save \$5 here or \$10 there, and that's precisely the point. All of the little things do make a huge difference. If more small things are done to a house, then the annual combined savings become significant. Besides, I tell my clients that, “Yes it may be only \$5 to begin with, but would you rather keep that \$5 or give it to the utility conglomerates?”

Thank you for proving my point that if we all make small changes then larger effects result.

**Tom Zerull:** You can't look at the small amount of savings on a per-house basis, but must look at it on a countrywide basis. If you drive a car that gets 25 miles per gallon and someone else drives a Suburban, your price at the pump per fill-up may only be \$30. But if you multiply the gas use and cost savings nationwide, it's huge. Whoever wrote this article should know better. I am very disappointed in this magazine for even printing something like this.

**JLC editors respond:** Mr. Gilbert and Mr. Zerull are missing a key point in Nate Adams' argument. What we're talking about is a client who wants to save energy. One contractor comes and says he can replace the windows and that will result in lots of energy saved. Another comes and

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says, no, just weatherstrip the windows; you'll save a little less, but you will save some and it won't cost so much. (That's maybe you, advocating the easy out.) A third comes along and says that all the work on the window is nothing compared with all the air leaks in your attic that have turned your house into a complete energy hog. Adams is most like that third contractor.

If you want the car analogy to work, it's like some snake-oil salesman selling the driver of the Suburban a little device to install on his fuel line that will turn his vehicle into a Prius ... only it won't. And it takes real global energy to produce the new windows and the weather-stripping or the thermostats and the tubes of caulk. Real energy that's wasted because it's not solving the real problems. Focusing on little energy saving tips is a ruse—just feel-good pabulum that lulls people into thinking that they're saving real energy when they are actually ignoring substantial energy problems. When people are lulled into thinking they are doing good, they quit striving for making a real difference. So the tips actually hurt. That's what this article is about.

**“SPRINKLER MANDATE DEBATED” (JLC ONLINE, 8/7/14)**

**Michael McGee:** Good ... put them in. Just don't force it down our throats. Give the buyer a choice. Here in northern Illinois, the cost for a sprinkler system hasn't been under \$10,000. Most have been around \$15,000 for a 3,000-square-foot home. Homeowners insurance goes up, not down, because of the extra piping added to the cost of the house. There is the monthly monitoring fee; the cost for when the fire department responds to a false alarm every time the water pressure drops; and on and on. Give the home buyer a choice. Municipalities here are starting to do that.

**Whoever:** This should *not* be a one-fits-all: We built a log home in '09 and were forced to install interior sprinkler systems ... so the “light-weight” material argument does not apply in our case. As we are in a wildland area, I would rather have spent the money on exterior sprinklers.

**Robert Jordan:** When airbags were mandated, the car companies said they

would never sell another car because of the cost. Now, carmakers boast about how many airbags they have. Seat belts were the same.

The National Association of Home Builders fights *everything* that is mandated and increases the cost of a house. With any proposed increase in insulation or energy upgrades, NAHB fights tooth and nail. They “prove” it isn't cost-effective, doesn't save lives, yada, yada, yada. I would like to see what NAHB's position was on insulation circa 1950 when insulation was starting to be installed. Imagine telling a consumer today that you could save them \$5,000 by leaving out the insulation because it isn't really needed. That is what a builder told my father in 1950.

Sprinklers are here and will be mandated soon. With sprinklers, most fires will be put out quickly, causing little damage. I am renovating a duplex for rental. I will put in sprinklers. I will have lower insurance premiums. I won't lose my building if there is a fire. I will be protecting both of my tenants. Uponor is saying it increases the cost of the house by less than 2.5%. If the construction cost of a \$500,000 house is \$250,000, the sprinkler upgrade is \$6,250.

**JLC editor's note:** Uponor, a manufacturer of a residential sprinkler system that uses PEX piping and ties into the domestic cold-water supply, claims the system adds “as little as 1.5%” to the cost of construction.

**Von Salmi:** I recently read an article by the NAHB in which they stated that for every \$1,000 increase in mandated code requirements, the home buying market loses some 260,000 potential buyers by disqualification. [See “State and Metro Area House Prices: The Priced-Out Effect,” NAHB.org, 8/1/14.] In lieu of reacting in a knee-jerk fashion, maybe all parties should convene to address ways to develop safer, more value-oriented solutions to all of these issues. Protecting lives and providing more opportunities for home ownership should be the goal.

**Keep 'Em Coming**

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**Q** I want to tile the ceiling of my client's bathroom, including the shower. How should I detail the setting bed, and how do I keep it from all falling down?

**A** Michael Byrne, veteran tile installer and consultant, and moderator of *JLC's* ceramic tile online forum, responds: A tiled ceiling can literally be the crowning glory of a shower stall, but there are a few things you should do to ensure a durable, attractive, practical, and safe installation.

One of the most overlooked aspects of tiling a ceiling in a wet environment such as a bathroom or shower is that the ceiling should be sloped or crowned. The unsightly brown spots that you often see on flat tiled ceilings are actually the beginning of stalactites forming as water vapor condenses on the ceiling tiles and leaches minerals out of them. This problem can be eliminated by drying off the tiles each time the shower is used, which is inconvenient at best. But if the ceiling tiles are sloped, most of the surface moisture simply drains to the walls.

The Tile Council of North America (TCNA) says that the ceiling on a fully enclosed steam shower must be sloped a minimum of 2 inches per foot, and I use this as a good rule of thumb for any tiled ceiling in a wet area. The slope can be angled like a shed roof, peaked, reverse-peaked (so moisture flows toward the center of the shower, which is a common configuration in large steam showers that have benches on opposing walls), or—my favorite—arched.

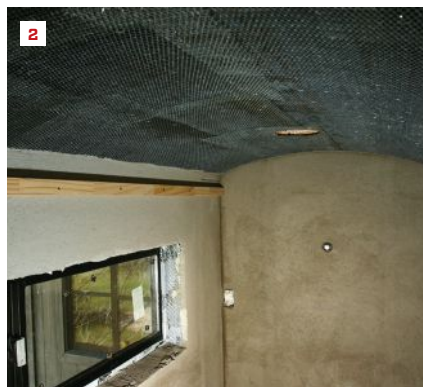
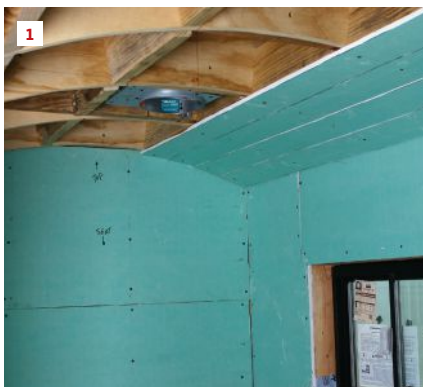
Another important part of tiling a ceiling is providing solid support for the tile. For any of these designs, I begin with framing members spaced 12 inches apart. For an

arched ceiling, I make curved joists out of ¾-inch plywood. Then I block between the arches to create a very strong framing grid. I never recommend applying tile directly to greenboard, but I use strips of greenboard attached to the arched framing as a support base for the mortar setting bed (1). I spread a layer of cold-patch roofing tar over the greenboard strips and then staple a layer of 30-pound felt paper over that.

An alternative to greenboard is two layers of ¾-inch cement backerboard screwed into the joists. Attach the backerboard one layer at a time, applying thinset mortar between the layers for added strength and stiffness.

When I did the ceiling in the photos, I let the roofing tar create my moisture barrier; for extra protection, sheet-style waterproofing membrane such as Noble Seal TS can be installed between the mortar bed and the support base, or between the framing and the first layer of backerboard.

I then attach wire mesh to the ceiling (2) and trowel on a layer of mortar for the setting bed, smoothing the curve with a flat trowel as I go (3). Finally, I use regular latex-modified thinset and back-butter all ceiling tiles as they go in. Surface tension holds the tiles in place until the mortar cures. When tiling a sloped or curved ceiling, begin at the lowest points and tile toward the highest point. Use spacers as needed to keep the tiles from sliding, which can break the surface tension and cause the tiles to fall.



I've seen electricians cram an amazing number of wires and switches into wall boxes—especially for gangs of three or four switches. What are the guidelines for determining box size, and how can you prevent overcrowding in a box?

David Herres, a licensed electrician in Clarksville, N.H., responds: When a box is overfilled to a point where excessive force is needed to push the devices (switches or receptacles) into place, you're asking for trouble. Wires can loosen or spring free of wire nuts, causing the circuit to fail, or the insulation on the wires may become damaged. In the latter case, if you're lucky, the breaker trips; if not, a partial arc fault can occur, creating a fire hazard. Also, an overcrowded box may be unable to properly dissipate heat, which will shorten the lives of the devices.

Most electricians know by experience what size box to choose for each application, but with larger devices with lots of wiring or in borderline cases, it may be necessary to

perform box-fill calculations. These are covered in 2014 National Electrical Code (NEC) sections 314.16(A) and 314.16(B). It is a two-stage process in which the volume of the box is determined first, followed by the volume of the contents, or the fill calculation. (These sections also address required volume for conduit.) The code states that in no case is the volume of the box to be less than the fill calculation. The box volume is often stamped on the box; if not, it can be determined by measuring the inside of the box. The process for determining the required volume involves adding up the conductors and devices in the box and consulting the box-size table.

Here are several ways to avoid overcrowding electrical boxes. Use deep wall boxes

where appropriate. Use grounding crimp connector sleeves instead of wire nuts—which occupy more space—for grounding splices. Choose the right size wire nut in critical situations—for example, a yellow or a red wire nut can accommodate two 12-AWG conductors or three 14-AWG conductors, but a yellow one takes up less space. Ground-fault circuit interrupters are bulkier than standard receptacles, so mount them in deep wall boxes if possible. Instead of octagonal junction boxes, use deep 4x4 square boxes, which have more space. "Pack" the box wisely. For example, if there are two or more wire nuts in the same box along with a wiring device, such as a switch, carefully lay the wire nuts side by side in the box—if stacked, they can interfere with placing the device.

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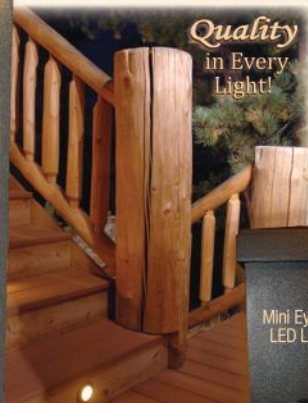
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**I'm building a house with a loft accessed by a code-approved stair. The client also wants a ship's ladder to the loft for the kids. Does code allow unorthodox stairs if a legal one is in place to access the same area?**

**A** Glenn Mathewson, a building official in Westminster, Colo., replies: Unorthodox stair designs, such as ship's ladder stairs, aren't specifically addressed by the IRC. So acceptance would be up to the individual authority—and some

authorities may trump any kind of justification with a simple "not in my town" response. But let's see how I might approach approving this secondary means of ascent.

The IRC regulates "stairs" and defines them as a change in elevation from one level

to the next, and it generally follows a philosophy of "if you build it, they will come"—meaning no matter how many stairs you provide, people will use them all and they must all provide the safety we have come to expect. This means that if you build a stairway and it looks and feels like a stairway, folks will use that stairway. If a home has two stairways to the second floor, both must comply, as both have equal opportunity to be used. Both are considered "means of egress."

However, the IRC does provide for some variety in stairways, such as for winder treads or spiral stairs. The geometry on spiral stairs is more forgiving than standard stairs, but the stair user is also well aware that they are not on normal stairs; thus, their attention is heightened to the stair's more claustrophobic design. That would be my philosophical approach to a ship's ladder stair—you know when you're on a ladder, and you won't expect it to work like a stairway.

To the potential user of a ship's ladder stair to a loft, it's clear that extra consideration needs to be taken that is quite different from the innocent choice to use one stairway rather than another only to find it's not what you expected. There is always some occupant responsibility to be assumed.

While the IRC doesn't regulate ship's ladder stairs, the IBC does for commercial applications (IBC 2012 1009.14). Minimum tread depth is 5 inches, with each tread extending out at least 3 ½ inches from the step above. The maximum riser height is 9½ inches, with handrails required on each side. As a reality check, this ladder is safer and less steep than the maximum ladder slope permitted by OSHA (1 foot in 4 feet), and certainly not as steep as the bunk bed ladder your little superhero climbs up every night.

No matter what kind of ladder is installed, there's still a very real fall hazard at the top of the ladder. But perhaps an in-swinging gate in the railing at the top of the ladder would take care of that issue.

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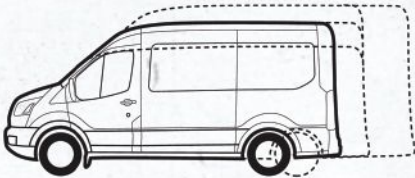
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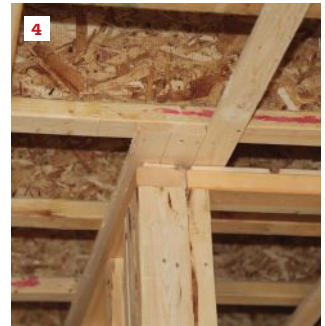
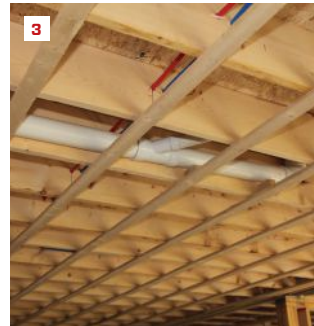
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BY MATTHEW ANDERSON



## Strapping Ceilings

**When carpenters from other parts** of the country come by one of our jobsites, one of the first questions they ask is, “What’s that nailed to the ceiling joists?” When I answer, “Strapping,” they then ask, “What is *that* for?”

The first few times I got these questions, I figured that these guys must not be real carpenters: How could they not know what strapping is? What I now know is that the Northeast is one of the few areas in the country where we strap our ceilings as a matter of course for every house we frame, regardless of the floor framing material. Strapping serves many purposes both for us as framers, as well as for many of the subs who follow.

### ATTACHING THE DRYWALL

My understanding is that installing strapping originated from the need to create a flat surface for attaching the ceiling to the uneven hand-hewn timbers once used as structural framing members (1). Carpenters shimmed the strapping down to the lowest point in

the room and then attached the finish material. While we no longer need to shim the strapping to achieve a relatively flat ceiling, the board hangers that follow behind us appreciate a full 2 ½ inches to attach the board to rather than the 1 ½ inches provided by dimensional lumber. We can also easily add nailing along walls that run parallel to our strapping.

### MAKING THE SUBS HAPPY

The trades that work in this area always appreciate strapping. Electricians can use the ¾-inch space to make long runs perpendicular to the floor joists without having to drill holes (2). Strapping in existing ceilings also makes snaking wires much easier. Plumbers can also save labor by running their ½-inch PEX tubing below the joists; and they can use the strapping to support waste and vent pipes at the required pitch (3).

If a room is being trimmed out with crown molding, we often add multiple rows of strapping along the

walls for the finish carpenters. Strapping can also provide extra nailing for coffered ceiling details.

Strapping makes it easier for us to install interior partitions (4), too. Rather than adding attachment blocks between the joists above the walls, we just add a few lengths of strapping, running them one bay longer than the wall. This gives the framer and the board hanger plenty of nailing to which they can attach the walls and dry-wall. Instead of an upper wall plate, we use a length of strapping to make up the final  $\frac{3}{4}$  inch of wall height. The thinner “top plate” also makes it easier to raise the partitions into place.

### ADDING RIGIDITY TO THE FLOORS

Strapping can also add measurable strength to floor and ceiling systems. In two recent situations, engineers took our strapping into consideration to make a framing situation acceptable.

In the first, we used 11 $\frac{7}{8}$ -inch I-joists to frame a large 20-by-28-foot living room. The room had very little actual floor weight, a situation that often leads to unacceptable levels of floor vibration. With no finished ceiling in the basement below the living room, the long spans of joists can twist when loaded. The torsional flutter that is created increases a certain amount of perceived vibration in the floor. Strapping attached to the basement ceiling eliminated joist deflection and brought vibration to an acceptable level.

The second situation we experienced was a hip roof over an unfinished attic space. The builder didn't want to sheath the attic floor area, which raised concerns about racking for the engineer. When I told him we would be strapping the ceiling, he said that the strapping would perform the same function as the sheathing would have.

### INSTALLING STRAPPING

We strap the ceilings after all ceiling and bearing-wall framing is finished. Working in teams of two, each carpenter begins by laying out an end of the room at 16 inches on-center. When the entire room is laid out, we snap chalk lines on the ceiling to ensure a straight and clean installation (5).



After snapping all of our lines, we lean lengths of strapping against the top plate at one end of the room. One carpenter then picks up a piece, places it on the line, and tacks it to a joist roughly in the middle of the length of strapping (6). He moves across the room tacking all the strips in place, then nails the starting end of each piece (7).

At the same time, his workmate saws the pieces to length in place, staggering the lengths between joists. For us, this method is faster than measuring and pre-cutting the pieces. After the cut ends are nailed up, the carpenters move across the room adding full lengths of strapping. Once all of the full-length pieces are tacked in place, one carpenter cuts finish pieces to length (8), while

his partner nails off the entire room with the nail gun (9).

After the room is strapped, we nail in any additional pieces as needed at parallel walls or beams. We lay out partitions on the floor and shoot those locations on the ceiling with a laser. Then we add additional strapping at those locations.

Once you've mastered the installation process, strapping ceilings goes very quickly and easily. Because strapping is included in every framing job we do, it's tough to put an exact price on the additional material and labor, but the cost is not significant.

*Matthew Anderson owns Anderson Framing & Remodeling Co., in East Sandwich, Mass.*



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## Building a Wooden Storm Door

BY GREG BURNET

**My company installs aluminum** storm doors, but we also offer a more traditional alternative: fabricating and installing custom storm doors out of rot-resistant wood such as white oak or mahogany. A wooden storm door can add character to a newer home or restore character to a home that may originally have had a wooden door. Doors can be simple frames with rectangular screen panels, or they can have decorative grilles, as in the photo above, left.

### BUILD THE DOOR FLAT

I made this door out of rift-sawn and quarter-sawn white oak, a strong, stable, and decay-resistant wood that's perfect for a door exposed to the weather. It also takes a finish well. I rough-cut the lengths I needed for the stiles and rails from rough-sawn stock and milled the stock down to a full inch thick. As I milled the lumber, I chose the best-looking faces for the exterior.

I cut the rails exactly to length using a miter saw set to 90°, but left the stiles long for the time being. I

ripped a 15° bevel along the top edge of the bottom rail to help the rail shed water and to keep water from pooling in the joints between the stiles and the rails.

Doors must be constructed dead flat if they are going to fit and operate properly. This is particularly true for storm doors, which are usually made from thinner material than an exterior door and often have a simple rectangular frame that holds either a screen panel or a glazing panel. Without the structural elements of a typical door, careful joinery and assembly on a flat surface are essential for keeping everything in one plane.

My company does a lot of door work, so we designed a large, flat workbench specifically for building doors. If you don't have a flat assembly table that's big enough, you can make a torsion box for assembling the door. Many designs for one can be found online—it's basically a large, flat box with an internal wooden grid that keeps the box perfectly flat. It can be placed on a table or on sawhorses to help ensure a flat glue-up.

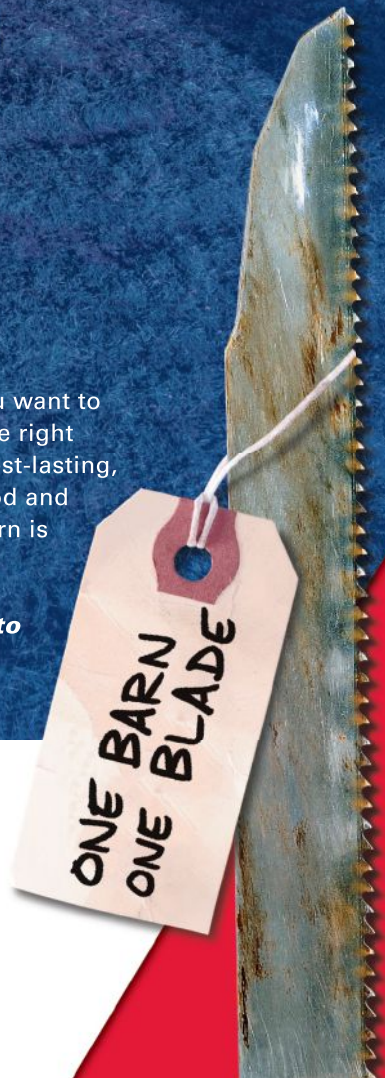
Photos by Sue Burnet



**FOR BREAKFAST WE HAD A BIG SLICE OF BARN.**

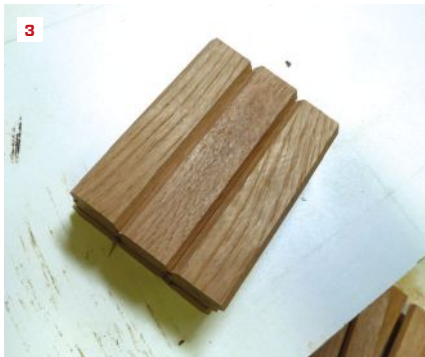
When you're about to cut off the front of an enormous 1930's tobacco barn, you want to stand way back. We had just one blade to make the cut, but boy did we have the right blade. The LENOX® T2 Demolition recip blade is engineered to deliver the longest-lasting, fastest cutting performance in the industry even when ripping through old wood and rusted nails. The result? Well, the blade got a nice wood-grain finish and the barn is getting much more natural light.

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### MORTISE-&-TENON JOINTS

To reinforce the corners of the door where the stiles and rails joined, we used loose tenons that slipped into machined mortises. Mortises can be cut with a drill and chisel, a router, or a hollow-chisel mortiser, but we've found that using a Festool Domino Joiner is the fastest method. It's easy to set up, is portable, and it's simple to operate—perfect for this application.

The general rule of thumb for this type of joint is to make the tenon approximately one-third the thickness of the stock being joined. The 10mm Domino bit that I chose was slightly larger than that.

We laid the door parts flat on our bench and struck marks for the centerline of each tenon on the face of each intersecting stile and rail (1). The marks also registered the Domino's fence to cut the mortise (2).

In the past we've had good success with Festool's rot-resistant SIPO Domino tenons for exterior work, but it's easy and less expensive to make our own. For this door, we used left-over white-oak scraps to make

tenons 10mm thick by 100mm long (3). We used two tenons at each joint, which we've found to be strong enough for an average door. Machining the mortises using the Domino Joiner just took a few minutes, and then we quickly dry-fit the joints to make sure everything aligned properly.

### THE GLUE-UP

Because storm doors are exterior doors, always use a waterproof glue, such as Gorilla Glue or Titebond III. We spread glue on all mating surfaces, including the tenons (4), and placed the assembly on bar clamps at each end of the door. We tightened the clamps and added a second set of clamps on top of the door. Once those clamps were tight, we sighted down the length of the door to be sure that the top pair of clamps were dead parallel, which meant that the door was perfectly flat (5).

We kept pressure on the joints for at least two to three hours. When we removed the clamps, we scraped off the glue squeeze-out using a stiff putty knife, and followed that

with a light sanding. (Avoid wiping off the excess glue when it's still wet, which drives the glue into the wood pores and prevents that area from taking stain).

### FINISHING THE DOOR

After removing the clamps, we sanded all surfaces of the door, starting with 100 grit and working up to 180.

Then we routed a ½-inch-wide rabbet around the inside of the frame (6). This rabbet would receive the interchangeable screen and glazed panels, so its depth was dictated by the thickness of the aluminum channel that held the panels—about ⅜ inch in this case. To minimize chip-out along the rabbet's edges, we made the cut in several passes, taking away a small amount of stock at a time until the rabbet was complete. At that point we squared the corners with a sharp chisel (7).

After a slight touch-up sanding, the frame was ready for finish. We stained the door and applied three coats of exterior varnish in the controlled environment of the



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shop. We made certain to seal all surfaces of the door, knowing that we still needed to cut the door to fit after we get to the jobsite.

#### SCREEN & GLAZING PANELS

To facilitate easy installation and removal of the screen and storm panels, we used solid brass thumb screws and tabs to secure the panels in the rabbet (8, 9). These thumb screws attached with a machined thread, so we first embedded solid brass threaded inserts in the door to accept the thumb screws.

Holes for the inserts were laid out and drilled, using tape on the drill bit to gauge a hole that would be slightly deeper than the length of the insert (10). Threading the inserts into the hard white oak took a bit of patience and care, but we used a headless bolt chucked into a drill. The inserts were then threaded onto the bolt and held in place with hex nuts. With the drill on a low-speed setting, we carefully spun each insert into its hole (11), taking care to drive them in perpendicular to the face of the door.

While this “combination” door was intended to mimic a traditional wood screen door, the screen and storm panels were interchangeable. The panels were made with extruded aluminum frames that hold either glass or screen. These extrusions are available from commercial glazing suppliers, as well as from some lumberyards and home centers (we used profiles from C.R. Laurence), and are easily cut using a hacksaw or miter saw fitted with a fine-tooth carbide blade. Friction-fit plastic corners from the manufacturer join the extrusions at a right angle to create the frame.

We measured and cut the lengths, then assembled the frame. The face of the screen extrusion has a groove that captures the screen with a spline that is pressed into the groove (12). Because the owners of this house had a large dog, we fitted the frame with a heavier than normal fiberglass screen sold as “pet screen.” The glazing extrusion is similar, except that a stepped rubber gasket inside the extrusion holds standard tempered glass securely (13).

#### FITTING & HANGING THE DOOR

Storm door installation is generally straightforward if the door opening is fairly true and square. We measured the opening and made sure that both the width and height were uniform, then we trimmed the door to size using a track saw (14). For an opening that is off, we would scribe the door to the opening and trim it to fit.

We hung the door on three butt hinges mortised into the edge of the slab and into the brick-mold door trim (15); extra hinges can be added for larger doors. Because of the oak’s density, we pre-drilled all screw holes. We drilled for and installed a traditional storm-door latch in the strike side of the door (16), along with a heavy-duty pneumatic closer mounted on the bottom rail. Finally, we stained and varnished any bare wood that was exposed during the fitting process and inserted the screen panel to complete the installation.

*Greg Burnet owns Chicago Window and Door Solutions and is a presenter at JLC Live.*

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BY MELANIE HODGDON

## The Pitfalls of Hybrid Estimating

I recently had a conversation with a client who had noticed that he usually failed to sell jobs that were labor-heavy, but had no idea why this was happening. When I asked him how he put his estimates together, he described three main steps:

- Multiply hours of labor by charge-out rate
- Price materials and add a 25% markup
- Add a 10% markup to subcontractor costs

There are two problems with this method. First, it's a "hybrid": Some components of the sale price are based on costs (materials and subs); some are not (labor). Second, the markup varies, and the labor charge-out rate was a black box.

To figure out what was causing his problem, we first determined what markup was underlying his charge-out rate. After working through my Labor Burden Calculator, we found that an employee being paid \$25 per hour was costing the company \$37.50 per hour. The

charge-out rate was \$60, so the markup on labor was 60% ( $\$22.50 \div \$37.50$ ).

### THREE SCENARIOS

Let's look at three estimates with varying proportions of labor, materials, and subcontractors. Remember, in all three the cost to the company is identical (\$54,000).

**Job A: Equal costs.** The company will spend equal amounts on labor, materials, and subs. After a 60% markup is applied to labor, 25% to materials, and 10% to subs, the job would be sold at \$71,100, for an overall markup of almost 32% and a margin of about 24% (see tables, left).

**Job B: Labor heavy.** Here, most costs are for labor. With the same markups as Job A, the selling price would be \$84,169. Overall markup is almost 60%—nearly twice that of Job A—and margin is also higher—almost 36%.

**Job C: Sub heavy.** Job C relies heavily on subs, with only 200 hours of labor. If I again apply the same markups, Job C would be sold at \$64,875, making the overall markup just over 20% and the margin just under 17%.

### Job A - Equal Costs

	Hrs	Cost/Hr	Cost	Markup*	Sale Price			
Labor	480	37.5	\$18,000	60%	\$28,800			
Mat'l			\$18,000	25%	\$22,500			
Subs			\$18,000	10%	\$19,800			
<b>Totals</b>			<b>\$54,000</b>		<b>\$71,100</b>	<b>Gross Profit</b>	<b>Overall Markup</b>	<b>Margin</b>
						\$17,100	31.7%	24.1%

### Job B - Labor Heavy

	Hrs	Cost/Hr	Cost	Markup*	Sale Price			
Labor	1300	37.5	\$48,750	60%	\$78,000			
Mat'l			\$2,625	25%	\$3,281			
Subs			\$2,625	10%	\$2,888			
<b>Totals</b>			<b>\$54,000</b>		<b>\$84,169</b>	<b>Gross Profit</b>	<b>Overall Markup</b>	<b>Margin</b>
						\$30,169	55.9%	35.8%

### Job C - Sub Heavy

	Hrs	Cost/Hr	Cost	Markup*	Sale Price			
Labor	200	37.5	\$7,500	60%	\$12,000			
Mat'l			\$11,500	25%	\$14,375			
Subs			\$35,000	10%	\$38,500			
<b>Totals</b>			<b>\$54,000</b>		<b>\$64,875</b>	<b>Gross Profit</b>	<b>Overall Markup</b>	<b>Margin</b>
						\$10,875	20.1%	16.8%

\*Markup is a percentage of cost.

### ONE MARKUP FOR ALL COSTS

When you look at the numbers, it's easy to see why my client was having a hard time selling labor-heavy work. His high markup on labor inflated his sales price well above that of his competitors. Our exercise also taught him something else: He was underpricing jobs on which most of the work was done by subs.

It is certainly possible to apply multiple markups, but the overall markup must meet your company's requirements. The lesson here is that once you've determined the markup your company requires to cover annual overhead and achieve your target profit, applying that markup across all costs will produce the same selling price no matter what the mix of cost categories. This is the simplest way to arrive at a price you can trust to meet your targets.

*Melanie Hodgdon is the owner of Business Systems Management (melaniehodgdon.com) and a co-author (with Leslie Shiner) of the book A Simple Guide to Turning a Profit as a Contractor. Download her Labor Burden Calculator spreadsheet from the online version of this article.*

/HR/

## Probationary Period for New Hires

BY DOUGLAS DELP

### WHAT HAPPENED

Good Guys Construction Co. wants to make sure it hires the right person for any open position with the company. After making a hire, Good Guys explains to the new employee that the first 90 days is a probationary period during which the company and the employee can determine whether the employee is the right fit for the job and the company.

### WHY IT'S A PROBLEM

Probationary or introductory periods may jeopardize Good Guys' at-will employment policy. At-will employment means that the employer and the employee can terminate the employment relationship for any reason or no reason, except for certain exceptions prohibited by law. In a number of court decisions, probationary or introductory periods were ruled to have created an implied employment contract that gave the employee extra job security once the initial period was completed. In other words, these cases suggest that once a new

employee successfully completes the initial 90-day probationary period, the burden is on the employer to show a valid reason to terminate that employee.

### WHAT YOU SHOULD DO

There are no advantages to having a defined probationary or introductory period. A better practice for employers is to develop a formal performance review process in which all employees are evaluated 90 days after their hire date, and at least annually thereafter. This performance review program should include a statement that an employee's performance can also be informally evaluated at any time throughout the year. This practice achieves the same outcome for the employer as a probationary period, without implying extra job security for the employee after the initial employment period is completed.

*Douglas Delp is founder of The Delp Group (delpgroup.com), which provides human resources services to small businesses.*



/LEGAL/

## No Written Change Order?

BY ALEXANDER BARTHET

**Throughout the course** of a project, your client requests and pays for several change orders, although you never get around to putting anything in writing. In one final request, you're asked to build a tiki hut in the backyard. On the basis of the client's agreement to your price, also undocumented, you do the work. But when you present the client with your final invoice, you find out that he didn't clear construction of the tiki hut with his wife and she's refusing to pay anything extra. Worse, she's a lawyer and has read your contract, which clearly states that all change orders must be in writing to be valid. Can you still get paid?

Depending on the jurisdiction you're in, the answer may be yes. Courts have found that, even where contracts specifically state the written-change-order requirement could not be waived, parties can waive the provision by prior course of conduct such as these cli-

ents displayed—requesting and then paying for several undocumented change orders during the project.

Additionally, some courts have found that written change orders are not needed when change-order work on a private project is required for proper functioning of the project. (When the owner is a public entity, however, the law is not as forgiving and the court generally finds undocumented change orders invalid.)

Best practice is to put change orders in writing and to get them signed by the owner. But if for some reason you don't, the waiver agreement may apply.

*Alexander Barthet (alex@barthet.com) is a principal of The Barthet Firm, a 12-lawyer commercial law practice focusing on construction-related matters. This article is for informational purposes only. It is not intended as legal advice. Consult an attorney before taking any action.*



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BY DOUG HORGAN

## Monitoring Home Performance

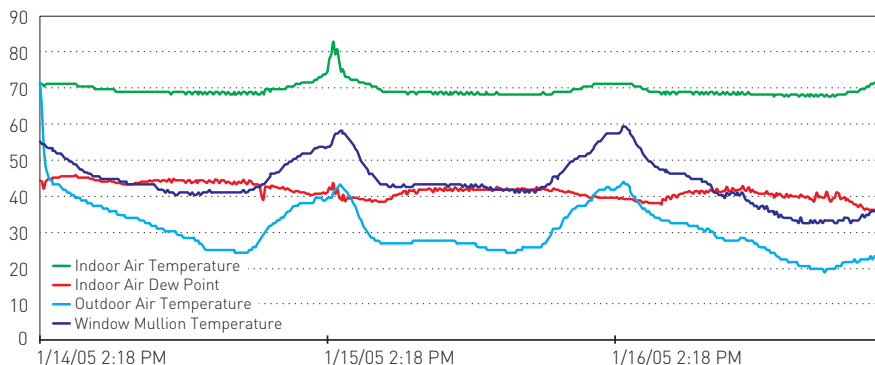
**It started with a call** from the homeowner saying the child's bedroom had been "freezing cold" that morning. But Bill, our heating subcontractor, said the bedroom was "fine"—within three degrees of the thermostat setting. The problem was that, by the time we drove out to the renovated house, it was 9:30 in the morning, 10 de-

grees warmer outside, and the bedroom door had been open for hours. The next day, we got the same call: The bedroom was too cold at 7 a.m. with the door closed. Our heating company was stuck in the rush of repairs that accompanies the first cold weather in fall, and once again couldn't get to the house first thing in the morning.

That's when we decided to buy some data loggers so we could see exactly what was happening. There are certain problems that are hard to catch because you may not be at the house when they happen. We've found data loggers to be invaluable for evaluating HVAC performance, condensation, and other temperature problems, especially when they are complicated or occur intermittently.

### Window Mullion Temperature Below Dew Point

Whenever the purple line (window mullion surface temperature) dipped below the red line (indoor dew point), condensation would form on the windows. Reducing indoor humidity lowered the dew point and solved the problem.



### MONITORING EQUIPMENT

I first bought my data loggers in 2001 from MicroDAQ ([microdaq.com](http://microdaq.com)), which has provided great support. Besides the four original Onset HOBO H8 units, I bought a remote temperature sensor on a 20-foot wire that can measure air or surface temperatures. We also needed a compatible USB cable and software to launch and download the data. We've since bought another eight recorders directly from Onset ([onsetcomp.com](http://onsetcomp.com)), so we can monitor several houses at a time or dissect complicated zoning problems that need multiple recorders.

The models we bought record temperature and humidity over an adjustable time

### CASE STUDY: COLD WINDOWS

We had some beautiful steel casement windows installed by a factory crew on a large remodel. However, even during construction, we noticed condensation forming on them. The clients called us in a panic during the first cold snap of the winter. They woke to find the window frames coated with ice melting onto the wood floor.

The architect had specified these units for other houses without mishap, so he reasonably

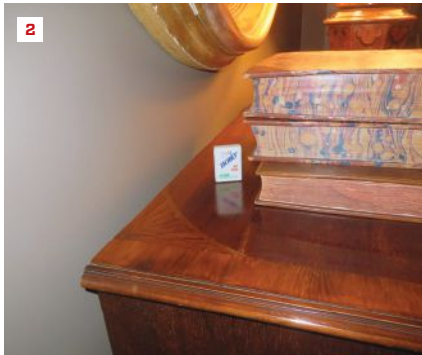
thought that the installation might be at fault. Our HVAC contractor didn't think the humidification equipment was unusual either.

We set up recorders to measure indoor temperature, indoor humidity, outdoor temperature, and using the remote temperature sensor (1), the temperature of the window frame. When the next cold snap hit, we were able to show that the inside surface of the window frames was below freezing

when the outdoor temperature dropped below 20° F. Using the built-in features of the Onset software, we could show that the window frames dropped below dew point, even when outdoor temps were above freezing (see graph, above).

With this information, the conversation changed from an installation question to a humidity management question. Our HVAC contractor installed outdoor temperature sensors to turn off the humidifiers below

an adjustable point. We used the recorders to home-in on the proper set-point and to show the anxious homeowners that the dip in indoor humidity was brief and not too severe. A third-party engineer was brought in to consult. After seeing a graph of the frame temperature dropping below dew point, and even below freezing, he wrote a letter to all parties explaining that the recordings conclusively identified the problem and our solution was probably the best one.



**1.** A remote temperature sensor on the inside of a casement window records surface temperatures. **2.** This data recorder with a blinking LED has been placed in an inconspicuous location.

interval. At the 10-minute interval I most often use, our loggers will store 27 days of readings. This is almost always enough time for a cold snap or heat wave to reveal problem behavior in the house. The updated H12 model can record even longer.

Most recently we invested in a water flow meter and HOBO ZW loggers, which communicate wirelessly and can be read live over the Internet. The ZW system is more expensive and took a lot more setup than the standalone loggers, so we continue to use both types, depending on the situation.

**PLACING SENSORS**

A typical scenario is one room that overheats on a hot day but is fine most of the time. In a case like this, with one problem area, I would normally put one temperature/humidity recorder in the problem room, another near the thermostat, one outdoors to record the ambient temperature, and typically at least one more somewhere in the house—perhaps in another room that isn’t having problems.

Keeping the recorders out of the sun is important. The recorders also have a blinking LED that can be annoying. For both reasons, I typically hide them behind pictures or books on shelves or tables (2). We also put one near the thermostat (but not on the thermo-

stat; some high-end communicating models can produce heat).

Onset makes special outdoor sensors with built-in shades to keep direct sun off, but I haven’t bought any of these; I just put a recorder in a Ziploc bag and tape it somewhere on the north side of a tree or perhaps on a shady screened porch.

I’m always careful to make a list of which recorder is placed where. (I numbered ours with a marker when they first arrived.) When I use more than a few recorders, I take photos of where I’ve placed them. After two or three weeks managing 12 recorders, it can be difficult to find them all.

**LOGGING DATA**

Typically, I’ll wait for the weather we need to get good information—in our typical scenario, a hot few days—before returning to collect the recorders. I connect them to a laptop on site and download the data. I use the Onset software to graph the data, which I find more digestible than the tens of thousands of data points. Sometimes I export the recordings into Excel if I want more graphing options.

The graph will show when (if ever) the room overheats—what time of day, what outdoor temperature, and what temperature the rest of the house is. Sometimes we find that the

**CASE STUDY: HVAC ZONE WITH A MIND OF ITS OWN**

In one house we renovated, there were eight zones on one air handler—leaving aside the other three air handlers—and it behaved oddly at times. The clients reported that the kitchen was often above set-point. This happened even in relatively mild, 80° F weather.

Using the data recorders set to measure every two minutes, we were able to see that the system would run all afternoon, trying to cool off the kitchen. The rangehood fan was broken and the clients preferred to leave all 23 recessed lights on

most days, creating a constant demand for air conditioning. Unable to satisfy demand, the system eventually would overcool other rooms (zone systems typically permit a bit of “blow-by”—air that passes the dampers), triggering the automatic thermostats to call for heat in those zones.

The zone-control board has a 3-minute purge cycle and a 20-minute changeover lockout, so once a zone calls for heat, it takes a minimum of almost half an hour before the system starts back to cooling. On 80° days, the kitchen would stay near the set-point until other

rooms started calling for heat, then would suddenly push several degrees hotter as the heat-cool-heat-cool cycle began.

When we showed the clients the graph demonstrating this pattern, they agreed to let us change the heat set-point in the other rooms during the afternoons so they wouldn’t call for heat as often. This helped, but it didn’t solve everything.

Follow-up recordings soon showed that on the hottest days, the kitchen still failed to cool. By watching kitchen humidity, we could see times when cooking without the

rangehood fan was the issue; but the problem happened even when humidity didn’t spike from cooking. The rest of the house was staying cool, leaving inadequate air supply to the kitchen as the most likely explanation, so we added more ductwork.

In this particular house, the data recorders helped us find more than one problem and eliminate some theories about what was causing them. Certainly, the conversations with the homeowners and the HVAC contractors went much more smoothly with all the information we had.



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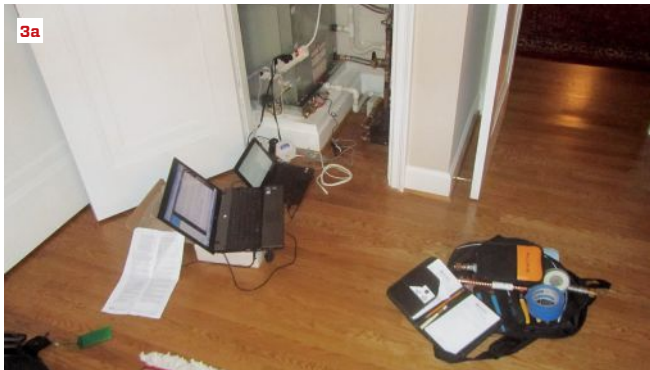


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**3a.** The HOBO ZW system setup is complex and requires an on-site computer, but the system can be monitored live over the Internet.

**3b.** To evaluate the performance of a condominium AC unit, the author secured temperature sensors to the inlet and outlet pipes, and a flow-rate meter in the HVAC system feed line.



### CASE STUDY: CONDO AC FLOW RATE

In a high-end condo we renovated, the water-to-air HVAC unit had shut down on several hot afternoons, leaving our clients without AC. But two similar air handlers in the same apartment—and units in apartments above and below—didn't have issues.

After several troubleshooting visits, our HVAC techs were pretty sure the problem was inadequate water flow provided by the building's common system. Rather than point fingers at the building staff and have our clients experience another failure without knowing for certain what the issue was, we set up a monitoring system that would allow us to monitor the building water-flow rate and temperatures live over the Internet (**3a, 3b**). With this setup, we could definitively see what the issue was. The HOBO ZW software even allowed us to set "alarms." When the temperatures or flow went out of user-selected ranges, the system would email a warning.

Whether spurred on by pride in their work (they are good guys), or by the impending arrival of our flow-rate monitoring system, the building staff thoroughly checked and cleaned the pipes and valves running to our client's unit. Afterward, we had good flow and temperature almost all summer and never had a problem with the AC again.

This was not a case where the data helped us find a specific issue. But it is a case where everyone involved was glad to have conclusive evidence that all was well. Clients were happy (in fact, they seemed to enjoy checking the live flow rate and temperature "dashboard"), and if there had been an issue, we would have been able to find and fix it.

entire zone isn't holding temperature, indicating we might need more insulation or more air conditioning. Other times it's just the one room, in which case we might need more supply air or a high return in that room to fix the problem. In the case of the cold bedroom, the data allowed our HVAC guys to see that there could be a problem. We first tried adjusting the existing system, but in the end had to install a zone damper to finally resolve the issue.

It can be helpful to monitor humidity as well as temperature. We have found a couple of times that the humidity sharply rises in the problem time-frame. In our climate, that indicates either a lot of humid, outside air entering the space (kids leaving doors or windows open have been the "problem" a few times), or cooking or bathing without adequate ventilation. In these cases, we will usually have clear, hard data showing that the room can stay cool enough on hot days when the windows aren't opened (that is, when the humidity tracks normally), and, with the unbiased information in front of us,

we can have a productive, unemotional discussion with the homeowners.

In fact, this turns out to be the most useful role for the recorders. Like many contractors, I take a "just the facts" approach. However, not everyone on the project team may be on the same page. The people living in an uncomfortable space will typically have strong emotions about the problem, and in my experience, they often seize on a theory that has little basis in fact, due to their lack of experience. Similarly, a salesperson for a heating company, or a window distributor, or a talented architect, may have strongly held ideas about what a problem is, or at least may want to be quite certain what it is before they pay to remedy it. The information provided by data recorders can be invaluable in these situations because they provide excellent long-term data about the actual issues.

*Doug Horgan is vice president of best practices at BOWA, a design/build remodeling company serving the Washington, D.C., metro area.*



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BY INDIGO RUTH-DAVIS

## A Passive House Consultant's Toolkit

**I'm a carpenter first** and a Passive House Consultant second. My builder's approach extends to my consulting work, where my goal is to simplify the design process of Passive House construction. I'm one of a growing group of professionals with the designation of Certified Passive House Consultant, or CPHC, who are refining their methods for achieving the Passive House standard in the U.S.

The perceived complexity and additional cost of Passive House construction has come under much scrutiny since it arrived in the U.S., with little understanding of what it actually takes to design and build a Passive House. The tools that a CPHC uses aren't terribly difficult to master and were designed, in fact, to simplify energy-efficient construction.

At the heart of Passive House design is the building's projected energy use, which is determined early in the design phase by the CPHC. My approach to this is bare-bones, and my toolkit consists of just these four items:

1. Passive House Planning Package, or PHPP, an energy-modeling spreadsheet developed by the Passivhaus Institute (\$215)

2. Solar Pathfinder shading analysis tool (\$260)
3. WUFI-ORNL hygrothermal analysis program (free)
4. THERM thermal bridge analysis program (free)

This inexpensive toolkit and the proper CPHC training are all one needs to design a Passive House. I'll use our most recent Passive House project in Vermont to demonstrate how they are used. This design/build project was a collaboration of myself (the CPHC) and Chris Miksic, both of Montpelier Construction (Passive House Institute US-Certified Passive House Builders), and the homeowner and designer, Greg Whitchurch.

### ENERGY MODELING

The first step for the consultant is to do a feasibility energy model. I use the PHPP because it's the cheapest energy-modeling tool available that is approved for Passive House certification. It was developed to simplify the energy balance calculations that are necessary to accurately predict energy performance for buildings with low heating demands. Building areas, R-values, window specifications, shading conditions, and information about the mechanical systems are entered into the program. The PHPP combines that data with local climate data and calculates the energy use.

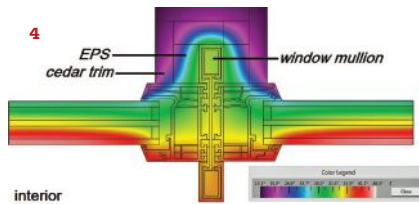
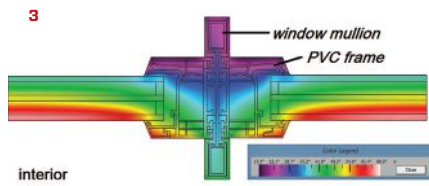
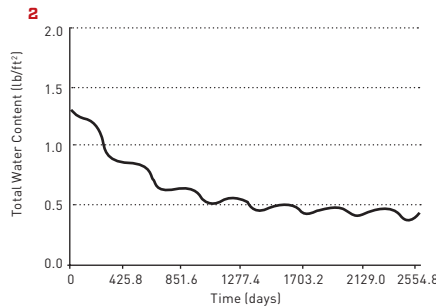
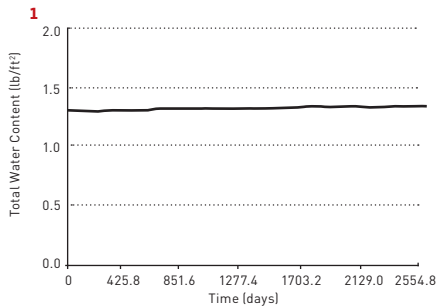
In our case, the Passive House energy demand criteria of 4.75 kBtu per square foot per year required that we use R-56 walls and an R-77 roof. For a Passive House this size (1,400 square feet), the heating load is equivalent to fifteen 100-watt light bulbs. After seeing the feasibility PHPP, our client was 100% committed to building a Passive House and in fact showed a distinct interest in exceeding the standard.

### SHADING ANALYSIS

The next step is to analyze the site's shading conditions. Harvesting heat from the sun is serious business in a Passive House, so accuracy in the shading analysis is key. Passive Houses in northern climates are often forced to rely heavily on solar gain through south-facing windows. For complex shading conditions, such as in mountainous or forested locations, I use a Solar Pathfinder—a clear plastic dome that projects shading objects from the site onto a sun path



Harvesting heat from the sun is serious business in a Passive House, so the shading analysis must be accurate. The author relies on a Solar Pathfinder to determine shading conditions for the building site.



- 1.** This WUFI-ORNL graph suggests that the total water content of an unvented roof assembly could rise if indoor conditions are similar to the base condition that WUFI-ORNL uses in its analysis.
- 2.** Adding 1 ACH in a back-venting plane would give the roof assembly excellent drying potential. Actual venting will vary widely based on roof slope and wind speeds, so this analysis is used only to demonstrate basic hygrothermal principles, not to predict exactly how the roof will perform.
- 3.** A THERM simulation shows that the window's connection mullion is a condensation risk.
- 4.** Wrapping the connection mullion in 1 inch of EPS insulation and cedar trim eliminates the thermal bridge.

chart (see photo, page 45). Shading percentages are tallied and entered into the PHPP.

Our building site was forested with a large hill to the southeast. After a fair number of trees were cleared, the pathfinder showed good solar-gain potential.

### MOISTURE ANALYSIS

Before building assemblies are finalized, they must be analyzed for moisture and mold risk. Potential for moisture issues in high-performance building assemblies can be greater than in conventional buildings. I use the program WUFI-ORNL/IBP for this analysis because it's free and is suitable for most non-commercial construction.

In our project, the roof design required special attention for possible moisture risk. When I modeled the proposed unvented dense-pack-cellulose roof with a variety of vapor retarders, WUFI-ORNL predicted in each case that the assembly would not be able to dry. As a result, the moisture content would slowly rise over the seven-year period that I analyzed **(1)**. When I compared this assembly to a back-vented assembly **(2)**, the results were dramatic. With 1 ACH in the venting plane, the roof assembly showed a significant, 66% drop in moisture content

over the seven-year period. Based on these results, I recommended a ventilation plane.

### THERMAL BRIDGE ANALYSIS

The final step in the design is to look for potential thermal bridges and to either eliminate them or account for them in the PHPP.

Thermal bridges that can't be eliminated need to be modeled separately in two-dimensional heat transfer programs such as THERM, which is a computer program developed by the Lawrence Berkley National Lab to help window manufacturers to accurately determine window performance for NFRC ratings. The PHPP can calculate heat transfer only from point A (inside surface of assembly) to point B (outside surface of assembly), while a program like THERM can calculate the additional thermal transfer that occurs when materials with significantly different R-value interact with each other within the assembly. Areas that typically could benefit from a THERM analysis are window installation details, foundation footing details, and band-joint details.

Our biggest thermal bridge concern was the window connection mullions. To determine if they were a thermal bridge, I first drew them in THERM. (THERM runs a

heat-transfer simulation with a mullion and then without one; the difference represents the contribution of the mullion. My THERM analysis of the mullion showed that it was a condensation risk and impacted our heat demand **(3)**. I used THERM again to determine that wrapping the outside of the mullion with a strip of 1 1/4-inch EPS insulation would eliminate this thermal bridge **(4)**.

Although these tools are not the most advanced ones available (compared with BIM software, for instance), their proper use insures a great leap forward in building design and construction. Passive House is at the center of a convergence of energy-efficient technologies. A CPHC's job is simply to promote knowledge about how this technology can be used to improve the way that we build.

*Indigo Ruth-Davis is a Passive House Institute U.S. Certified Passive House Consultant based in Calais, Vt. He is a partner at Montpelier Construction, a Certified Passive House Builder and building performance company. To learn more about the project mentioned in this article, see [montpelierconstruction.com/passive-house-construction.php](http://montpelierconstruction.com/passive-house-construction.php).*

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## Rake Wall Framing

### Frame, sheathe, and side before lifting the walls

BY TIM UHLER

One of our goals as a framing crew is to minimize the amount of work we do while on ladders, and we aim for this particularly when framing rake walls. We've found that the more framing we can do while a wall is on the deck, the safer and more efficient we are. But this is not just a production argument, it's a quality issue, too. It's just common sense that you can fit things together more precisely when you aren't dangling from a ladder.

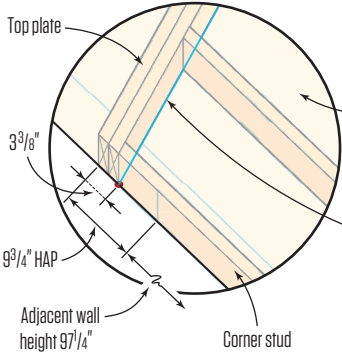
I've written on this topic before ("Framing Rake Walls," Sep/06), detailing the same basic methods for framing rake walls. However, since then we've changed the way we do a number of things, particularly with our layout process:

- We no longer snap out the entire wall. Here in the Pacific Northwest, the deck is often wet, and snapping out every stud and king stud in a wall like we used to do would ruin our chalk lines and make a mess. Instead, we define the perimeter framing (bottom plate, corner studs, and angled top plates), then calculate the on-center spacing along the angled top plate.
- We no longer cut studs in place over snapped lines. Instead, we pull measurements for the studs from the plate layout, and with a cut list in hand, cut the studs on the lumber pile.
- We no longer install rafters on top of the rake walls. Instead, we frame our walls to the top of the rafters. This keeps the wall much

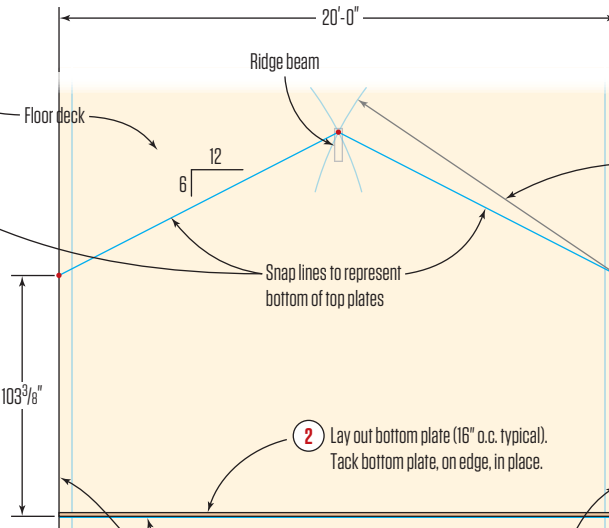
## Rake Wall Framing Layout

### A. Locate the Roof Peak

- 3 Determine rake wall height (to locate stud long points):  
 $97\frac{1}{4}"$  (adjacent wall height) +  $9\frac{3}{4}"$  (HAP) =  $107"$



- 4 Adjust corner stud height (short point):  
 $107"$  (rake wall height) -  $3\frac{3}{8}"$  (double top plate plumb cut) -  $\frac{1}{4}"$  (adjustment) =  $103\frac{3}{8}"$



- 2 Lay out bottom plate (16" o.c. typical).  
 Tack bottom plate, on edge, in place.

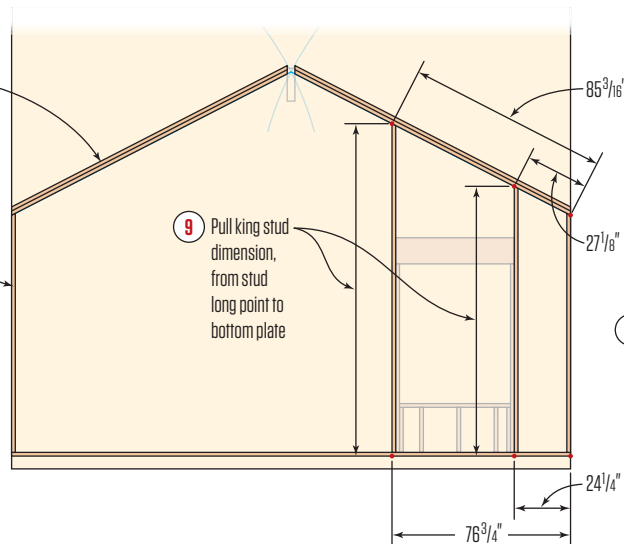
- 1 Square outside edges of wall to snapped line on floor (represents bottom plate of wall)

- 5 Calculate the theoretical rafter length (rafter line length):  
 $10$  Feet **Run**  $6$  Inch **Pitch** **Diag** =  $11'-2\frac{3}{16}"$  rafter length

- 6 Swing  $11'-2\frac{3}{16}"$ -long arcs from top of corner studs. Intersection of arcs defines roof peak.

### B. Corner and King Stud Layout

- 7 Cut double top plates and corner studs in place. Tack to deck and make sure framing is square and straight.



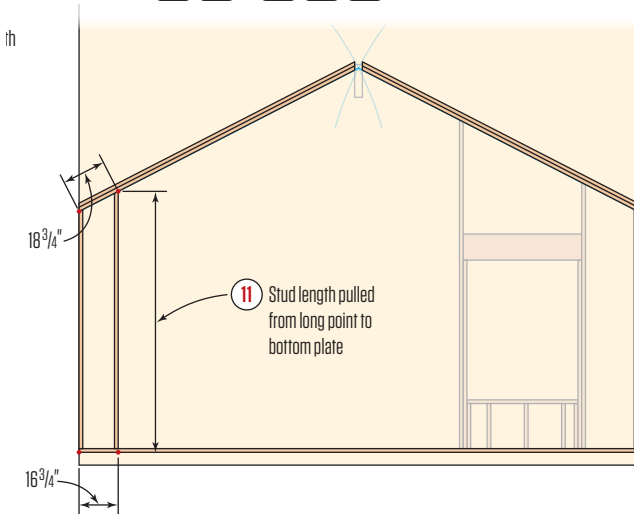
- 9 Pull king stud dimension, from stud long point to bottom plate

- 8 Calculate king stud locations along bottom of top plate:  
 $24\frac{1}{4}"$  Inch **Run**  $6$  Inch **Pitch** **Diag** =  $27\frac{1}{8}"$   
 $76\frac{3}{4}"$  Inch **Run**  $6$  Inch **Pitch** **Diag** =  $85\frac{3}{16}"$

### C. First Stud Layout

10 Calculate first stud location at 16<sup>3</sup>/<sub>4</sub>" o.c. (to locate long point):

$$16\frac{3}{4} \text{ Inch Run } 6 \text{ Inch Pitch Diag} = 18\frac{3}{4}"$$

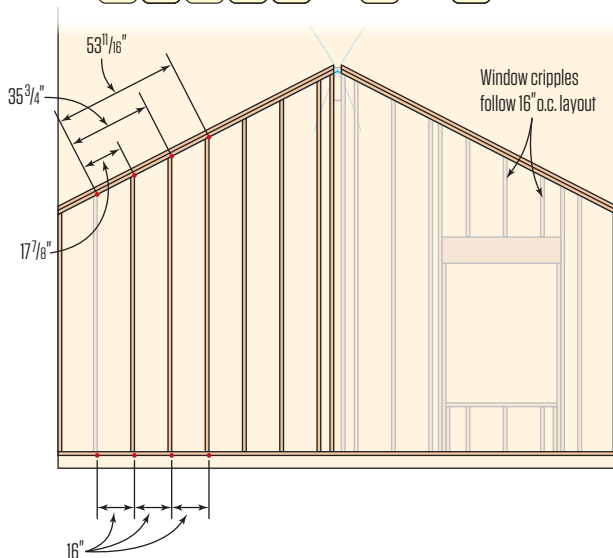


### D. Layout of Remaining Studs

12 Step off remaining stud locations at 16" o.c.:

$$16 \text{ Inch Run } 6 \text{ Inch Pitch Diag} = 17\frac{7}{8}"$$

$$\text{M+ } + \text{ Rcl M+ } = 35\frac{3}{4}" = 53\frac{11}{16}" = 71\frac{9}{16}" \dots$$



stiffer when we lift it.

■ We now install the soffit board instead of just framing out the overhang. This speeds production and helps to keep the wall stiff while being lifted.

What follows is our current method for framing any rake wall, including walls where the slopes differ or the slopes start at different heights.

### LAYOUT

There are just a few pieces of information needed to begin layout—the span of the roof section, the roof slope (more than one if they are different), the “heel stand” (“height above plate” or HAP) of the rafters, and the plate heights where the roof starts from.

1. To begin, we snap a line that represents the bottom plate and two lines that are square to the bottom for the corner studs at each end.

2. We cut the bottom plate, lay it out for studs at 16 inches on-center, and tack it on edge to the floor deck.

3. Next, we lay out the point where the slope of the roof starts at the outside of the wall (see illustration, left). This is done by making a story pole on a long 2x6 that shows every component of the wall elevation—the bottom plate thickness, the stud and top plates for the adjacent wall, and the height above plate (HAP) for the rafters. The top of the rafters is the top of the rake wall.

4. To find the height of the corner studs, we subtract the plumb distance of the double top plate for the rake wall, then subtract an additional 1/4 inch. We’ve found that rake walls always end up a hair taller than the precise calculated wall height. But subtracting that 1/4 inch works well. This is a critical step because if we get the wall height wrong, the whole wall will be slightly above the roof plane, whereas if it’s slightly lower than the roof plane, it’s easier to fix.

5. Next, we use the roof rise and run to calculate the rafter length using a Construction Master calculator.

6. As shown in the illustration, we tack a nail to the deck where the top of each corner stud will be and swing arcs with a radius equal to the rafter length. From the point where they intersect to the top of each corner stud represents the underside of the top plates. We don’t always snap this line, but we will if it’s longer than the plate stock we have on hand.

7. We can now cut the corner studs and top plates (see illustration). We tack the studs and first top plate on edge to the floor. Before tacking the studs down, we pull diagonals to check for square, then double-check the length of the wall at the top of those studs. When we’re setting the ridge, the top plates will be cut back half the ridge thickness on each side, but for now we keep the plate together to help stiffen the wall for lifting (1).

8. Typically, we lay out and install the king studs for any window and door openings first. We always lay out the uphill (long-point) side of the stud so that we’re cutting to the “sharp” point of the bevel. Using the Construction Master calculator, we enter that number as the RUN in the calculator and then find the DIAG. We measure the distance along the underside of the top plate (2).

9. As shown in the illustration, we measure along the bottom plate to get to the long side of each king stud.



10. Now we can lay out the studs along the rake wall. Pulling from the left, the first stud is  $16\frac{3}{4}$  inches to the long side of the stud. Again, using the Construction Master calculator, we calculate the distance along the top plate, this time using  $16\frac{3}{4}$  inches as the RUN.

11. Next, we mark the uphill side of the first stud.

12. Finally, we use the Construction Master to step-off the remaining studs, this time using a 16-inch RUN. The calculator keeps track, so hitting the equal sign for each successive stud yields the next number in the sequence. A framer tacks a nail at the first layout mark and just marks each of these numbers as I call them out.

Once the layout is complete, we can just pull the lengths from the studs off our layout marks to create a cut list (3).

## ASSEMBLING THE WALL

Using two guys—one cutting and one framing—is most efficient on these walls (4). With a cut list in hand, the sawyer can work at the lumber pile. To simplify things, we have just one lumber length for studs. When I do the materials take-off, I always calculate the height of the wall at the peak and order all the studs at that height. For example, if the peak is at 15 feet, 6 inches, I order 16-foot material. The

scrap is used up in window packages, cripple studs, blocking, and overhang framing.

While the sawyer is cutting out all the studs, the framer starts installing the king studs and frames-in all the window openings. This typically gives the sawyer time to get ahead cutting studs, and the framer can fill in the rest of the skeleton after the windows are roughed in.

When we block the wall for fire blocking and sheathing breaks, we cut standard-length blocks at  $14\frac{5}{8}$  inches for normal stud bays. For irregular blocking near windows or double studs, the cut man eyeballs rough lengths and we custom-cut these over the wall frame to keep it all straight. As we block, we check to make sure that our on-center studs at 4 feet, 8 feet, and so on, are correctly located so that our sheathing won't need to be cut to center on studs.

## OVERHANG & TRIM

Once the frame is complete, we sheathe and tape the wall (or install housewrap, if we aren't using Zip Wall), so we are ready to apply an overhang (5). We frame out a closed gable soffit using 2x6s with cripples every 4 feet on-center (6). We do all the cutting in place, sizing



the overhangs to fit LP SmartSide Soffit, which comes in 12-, 16- and 24-inch-wide panels. To accommodate expansion, we frame the overhang  $\frac{1}{4}$  inch wider than the soffit material.

LP SmartSide Soffit panels come in 16-foot lengths, and once nailed in place, they stiffen the wall and keep the fly rafters dead straight. For overhangs longer than 16 feet, we like to keep a full 16-footer centered along the length of the rake to help keep the wall stiff, and infill at each end as needed.

We install fly rafters and any trim, cutting in place and scribing the miters for a perfect fit (7). At the peak, where the fly rafters meet at a plumb cut, we add an RBC or an A35 clip to keep the overhang from opening as we lift (8). This keeps the plumb cuts on the trim nice and tight during lifting, too.

For lifting, we temporarily brace the overhang with 2-bys cut with 45° bevels to hold it square to the wall.

### ODD-SHAPED GABLES

Double gables, walls with two slopes, or other odd-shaped gables can be framed using the same process. The most important step is to accurately locate the wall line where the rafters land and to be sure

that the heel stand (height-above-plate) for the rafters is exactly correct. With these well defined, it's a matter of snapping out the rafter line length, or cutting top plates, equal to the rafter line length. If the length of the rafter is less than 20 feet, we just cut it out of 20-foot material and nail the skeleton of the wall (the bottom plate, end studs, and top plates) together, making sure it's square. From there, the rake-wall framing is standard.

**Double gable.** A house we recently framed had a double gable on the front that we decided to build as one wall. We located each end of each gable, then swung arcs with radii equal to the rafter line length. This located where each gable crossed. After that, the framing was like that of any other rake wall.

**Gable with a hole.** We often frame a gable in which a section of the floor plan extends through the plane of the main gable. If the ceiling in the smaller room is vaulted, we frame the smaller wall first and lift it into place, then we snap out and frame the larger wall with a hole in it that matches the profile of the smaller wall (4, 9).

Layout on the larger wall is only slightly more difficult. After snapping out the perimeter, we locate and snap out the position of the smaller wall's plates and heel stand. Where the top of the lower



rafter line touches the bottom of the larger rafter line forms the edge of the “hole.”

**Unequally sloped gable.** Sometimes we’ll have a gable end that has a different slope on each side. Usually the side with the shallower slope has a full-height wall. Again, we begin layout by locating the height of the walls where the rafters will sit, and the heel stand of the rafters. From there we snap out the slopes, but instead of swinging the arcs, we snap out each pitch.

While we could calculate the length of the rakes, it’s faster to snap out the slopes. For example, if one side is a 12:12 slope, we simply snap out a right triangle with equal sides, running the hypotenuse long. We do this with the shallow-pitch side, too, which locates the peak for us without our doing any math. I used to draw this out and use the exact lengths, but have found it’s just as fast to snap it out “longhand.”

## SIDING

We often install the lap siding—at least inside the gable, where the siding ends must be cut to fit the rake. This is so much easier to do when you aren’t on ladders or scaffolding. We have done this

with fiber cement, LP SmartSide, and cedar shingle siding (10). We recently sided a large gable with SmartSide in about 30 minutes, including installing the belly band, z-metal, siding, and “shadow” fascia (trim that hides the cut ends of the siding) (11). This easily would have taken us 2 to 6 labor hours working from scaffolding, depending on the setup.

## LIFTING RAKE WALLS

We try to frame as many walls as we can before lifting them because once the bracing is in place, it can make it difficult to work. We brace the wall plumb using our DeWalt DW0822 laser level, so that we don’t have to come back later and brace it again.

In round numbers, framing and sheathing the wall and attaching overhangs while it is on the ground is easily twice as fast (or even faster) as standing a sheathed frame and installing the overhang, trim, and siding from ladders or scaffolding. I also believe that it’s much safer and that the end-product is far better. With experience, the process becomes much easier as well.

*Tim Uhler is lead framer for Pioneer Builders, in Port Orchard, Wash.*

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# PVC TRIM



## Fastening & Finishing PVC Trim

The best ways to get the most out of this popular material

BY JLC STAFF

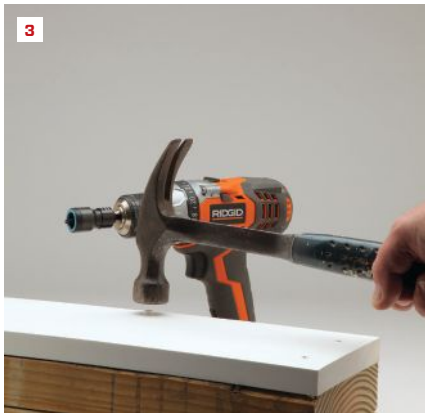
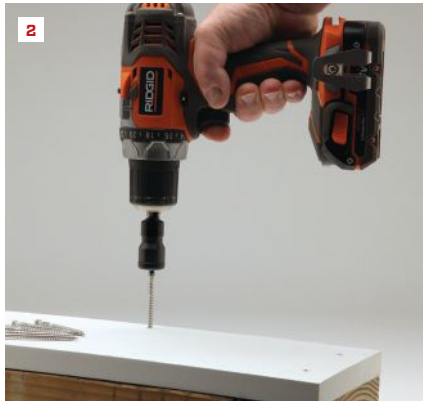
Ask five different carpenters from around the country how to frame a wall and chances are you'll get five different answers, each one with a good logical explanation behind it. In talking with our authors over the years, we noticed the same thing when they described how they install and finish PVC trim. We have taken their varied opinions on the subject and put them into this article, but we would welcome additional input from other readers who work with PVC trim.

While PVC trim is available in most parts of the country, its use is most widespread in the cold and wet Northeast. It has become the trim material of choice with many contractors who build homes in

places that are subject to harsh weather such as coastal areas. But because of its durability, low maintenance, and easy installation, use of PVC trim is bound to increase, especially as builders and subcontractors get used to working with it. Cutting and milling PVC is as easy as working with wood—maybe easier, given that PVC trim has no grain or imperfections.

### FASTENING PVC TRIM LEFT UNFINISHED

Every PVC trim manufacturer states that its products do not require paint for protection—one of the major advantages that PVC has over wood. And most of the builders and remodelers we spoke



with have installed PVC trim that was left unfinished. Josh Buesking, owner of Louisville Exteriors, in Crestwood, Ky., says that he often leaves the PVC trim he installs unfinished and has had no complaints. He even left it unfinished on his own home **(1)**. John Spier of Spier Construction, in Block Island, R.I., installs PVC trim in the harsh marine environment of the island and often leaves it unfinished. He reports that most of the failures he sees are a result of installation faults, not material defects.

Many builders fasten unfinished PVC trim using stainless steel or exterior-grade screws, driving the screwhead flush with the surface of the board. Frank Caputo, a general contractor in Cool, Calif., often uses GRK RT Composite Trim Head Screws. These screws have a reverse thread below the head that keeps the material from mushrooming out as the screw is driven. GRK offers its composite trim head screws in white to make them less visible.

But drive the screw flush and you still see the screwhead, even if it's white. Concealed fastener systems solve that problem by using self-countersinking screws and special bits that drive the screws to a specific depth **(2)**. As you drive the screw, it cuts a hole in the PVC that is concealed with a small cylindrical plug of the trim material that

slides into the hole and is tapped flush to the board surface with a hammer **(3)**. These systems have been around for a while for fastening composite deck material, but they also work well for PVC trim.

One widely available system is Cortex, made by FastenMaster, and every builder we talked to has used Cortex for attaching PVC trim. Tom Struble of Struble Siding, in West Milford, N.J., says that Cortex is his fastener of choice, although he has also used other systems with success. ProPlug, introduced this spring by Starborn Industries, is another concealed fastener system. It works in a similar way to Cortex, but one notable difference between the two systems is that ProPlug warns against using an impact driver, instead requiring a standard drill to drive and set its screws to the proper depth; Cortex, on the other hand, says that either tool can be used. Most carpenters we know use impact drivers to drive screws, something to be mindful of if you opt for the ProPlug system.

One key to success when using either of these systems is driving the screws perpendicular to the surface of the trim **(4)**. This may not be an issue when fastening door trim with both feet on solid ground, but it may take more focus to drive a screw straight into a rake board when you're up on a ladder with your arms fully extended.



## NAILING UNFINISHED PVC TRIM

Concealed fastener systems make the fasteners almost invisible, but driving the screws and plugging the holes may take more time and effort than you're willing to spend. Some contractors use nails as well as screws to fasten PVC trim. Azek, one of the best-known manufacturers of PVC trim, recommends using the same nails—either stainless or galvanized—that you use to fasten wood trim or siding. These nails should have a thin shank, a blunt point, and large head.

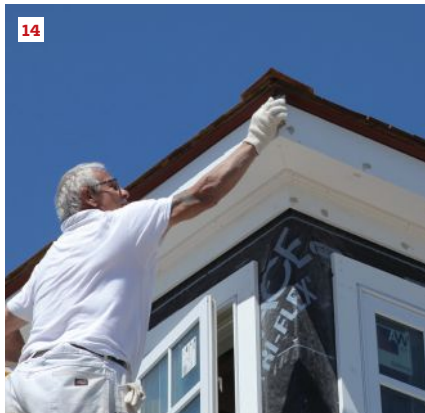
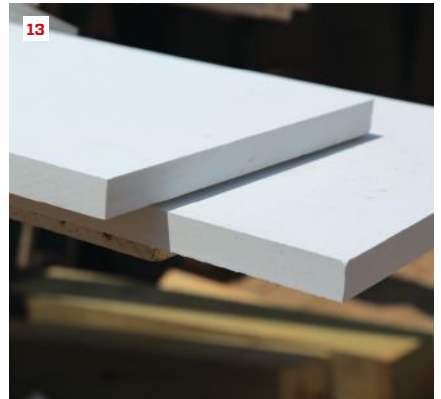
Nails can be driven by hand (5), but if using pneumatic tools (6), Azek specifies that you should use fasteners with a full round head (instead of clipped-head or finish nails), and that you should set the pressure so that the nails are set just below the surface of the board. Because of the consistency of PVC trim, it should be easier to dial in the gun pressure than when nailing into wood. John Goodrich, a project manager for Rick Roy Construction, in Harwich, Mass., cautions to always use pneumatic nails that are plastic collated. Wire collation doesn't always break off cleanly and any remaining pieces of wire can rust and discolor the trim, especially if you are leaving it unfinished (7).

But we're still talking about not painting the PVC trim, so nail

heads are as visible as the screwheads mentioned earlier. Spier says that he just tries to maintain a neat nailing pattern as he drives the nails (8). He sometimes uses nails with white heads that are less visible than nails with stainless heads. The problem with white nails is that your hammer can chip the paint off when it hits them. To get around this, John's crew uses plastic hammer caps from Maze Nails. These caps only cost a couple of bucks and each of his carpenters can run through a dozen or so on a typical house. Ironically, the better you are with a hammer, the faster you go through the caps because you always hit the nail near the center of the hammer head.

## GLUE, FASTENERS, OR BOTH FOR JOINTS?

Another plus in working with PVC trim is that the PVC adhesive chemically welds the pieces together, creating a very strong bond. In contrast, most glues that join two pieces of wood together depend on a mechanical bond. But if the PVC adhesive creates such a strong bond, do you even need to use fasteners at joints? Buesking, of Louisville Exteriors, says that he usually uses one or the other, rarely both. Even with miters, if he can get a screw into the framing near the joint, he finds that the joint stays pretty tight without glue.



The biggest drawback to PVC trim is that it expands and contracts with temperature changes, and allowing for this movement can have a bearing on how joints are assembled. Rick Roy Construction's Goodrich says that for long lengths of fascia, he and his crew always use a scarf joint or "weather cut," but that they leave the joint unglued (9). This angled cut allows the board to expand and contract without visually opening up. Also, on north-facing sides of the building that don't get prolonged sun exposure, Goodrich's crews fasten PVC fascia directly to the rafter tails, but on southern exposures, they install a wood subfascia or blocks between the rafter tails to keep the fascia more stable (10).

Spier uses both fasteners and glue on most joints. He doesn't glue butt joints in soffits and he also leaves the lap joints in long lengths unglued. He says that he sometimes uses plastic biscuits to help align the pieces on some joints.

Every PVC trim manufacturer sells its own PVC adhesive, but there are also many professional-grade PVC adhesives available. Most trim manufacturers have a list of adhesives that they recommend for gluing their trim, so make sure that the glue you're using has been approved for the trim you're installing. Adhesives such as

Bond & Fill's Quick+Easy are thick and can fill gaps as well. These adhesives are also sandable and paintable.

When gluing PVC trim, you should apply adhesive to only one surface and then hold the pieces together for the recommended setting time. Trim manufacturer Versatex says that using glue on both surfaces prevents the cells from fusing in a molecular bond.

### TREATING UNFINISHED EDGES

Goodrich showed us houses with unfinished PVC trim that his company had built more than 10 years ago (11). The trim looked great, with the exception of some cut edges, which showed a bit of discoloration (12). He said that the reason the discoloration occurs is because when you rip PVC trim, you expose the open interior cells (13). Moisture then gets into the open cells, which allows mold and mildew to develop over time.

In a 2012 article in *ThisIsCarpentry*, John Pace, the president of Versatex, says to take care not to damage the surface of the board. "To seal cut edges or clean a cut edge that has gotten dirty, sand them with 320-grit sandpaper, then wipe the edges with acetone—this will help to re-seal the cells." But the jury seems still to be out

Photos: 11-14, Roe Osborn; 15, Carter Silva



on sanding PVC trim. Spier says that a better alternative is using a sharp hand plane to smooth cut edges. Either way, wiping the cut edge with acetone will reseal the cells. Also, installing any type of trim, such as around windows, requires using sealants. With PVC trim, always use a polymer-based sealant; every PVC trim manufacturer cautions against using silicone-based products.

### PAINTING PVC TRIM

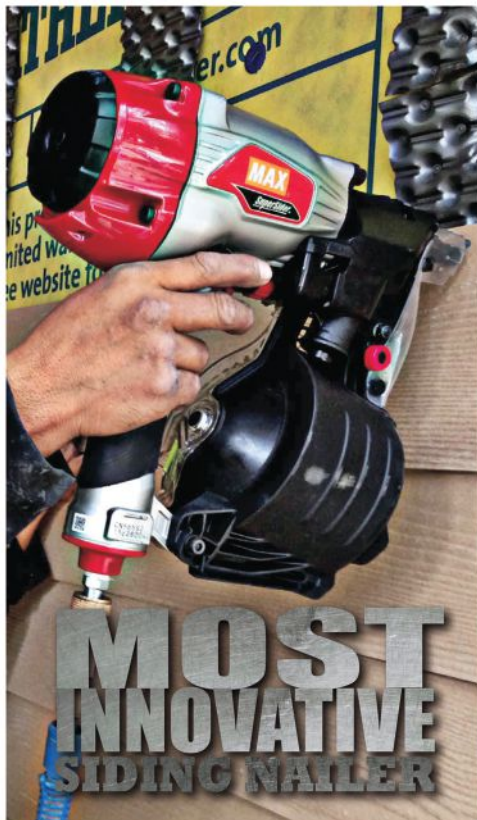
Although it's fine to leave PVC unfinished, many contractors like the added protection of paint. And if you want a color other than white, painting is your only alternative. Struble, of Struble Siding, says that more than half of the PVC trim he installs gets painted.

Painting PVC also helps to hide the fasteners. A concealed fastener system such as Cortex works fine, but if the surface will be painted, there are other ways to fill the fastener holes that are quicker and easier. The painters on Goodrich's crew use automotive Bondo to fill both screw and nail holes, applying it to each hole, then sanding it flush after it cures (14). Struble uses an exterior spackle to fill holes before painting, but Caputo in California says that in his experience, the spackle tends to crack and break down more quickly.

Manny Silva of Silva Lightning Builders, in Andover, Mass., always paints the PVC trim he installs because most of his clients want colored trim. Silva has a unique way of dealing with the fasteners. He drills countersunk screw holes for all of his screws using a W.L. Fuller countersink bit. After driving stainless screws, he fills the holes with PVC plugs that he makes himself during downtime (15). He adds a dab of PVC adhesive to each plug before tapping it into place (16). When all the plugs are in, he saws them flush with a Japanese saw (17), and sands everything before painting.

Scott Burt who owns Topcoat Finishes, a painting company in northern Vermont, uses exterior grade vinyl spackle to fill fastener holes (18). Before the spackle sets, Burt wipes around each filled hole with a damp rag to remove residue that can be visible when painted (19). After sanding, he paints the trim with a high-quality self-priming 100% acrylic paint (20).

When painting PVC trim, always choose a color with a high light reflective value (LRV). The lighter the color, the higher the LRV number and the less light (and heat) it absorbs. Because PVC trim can expand and distort as it absorbs heat, manufacturers all recommend using paint with an LRV of 55 or greater.



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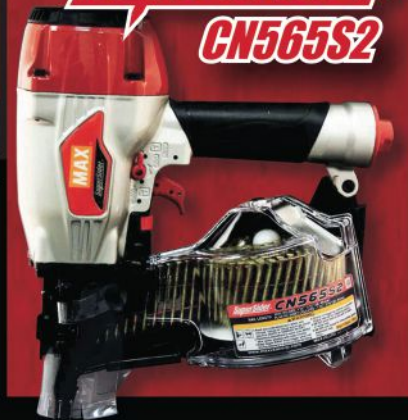
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# PASSIVE HOUSE



## Adding an Insulated Envelope An air-tight “puff jacket” achieves near Passive House levels

BY CHRIS CORSON

I've been working on superinsulated houses since the mid-1990s. I designed and built my first Passive House in Knox, Maine, in 2010 and 2011 (see “An Affordable Passive House,” May/12 and Jun/12), and since then, I've built six new Passive Houses, designed several more to be built by others, and completed a deep energy retrofit on my own home in Maine that meets the Passive House EnerPHit standard for retrofits.

In recent years I've been approached by a handful of potential clients who have asked me to do EnerPHit retrofits on their existing houses. But in almost all cases, I've declined the work. The sad truth is, it's so expensive to turn a leaky, poorly insulated old house into a

Passive House that it's rarely worth the investment. I referred all those clients to a weatherizing contractor who I knew could improve the houses to a moderate degree for a reasonable cost.

But in 2013, I accepted a deep energy retrofit job that, if it doesn't reach EnerPHit levels, will certainly come close. The job won't pay for itself by energy savings, but I decided that it still made sense. By the time the owner, Deb Poor, called me, she was already planning a gut-rehab of the house (to be carried out by another contractor, Tim Andrews of Nobleboro, Maine). Deb had her own reasons to have an energy retrofit done. In particular, she wanted the project to serve as an example to others of what was possible in this community.

# ADDING AN INSULATED ENVELOPE



**1.** The general contractor's crew stripped the existing clapboards off the building **(a)**, revealing a mix of building papers installed at various times throughout the building's life **(b)**.

**2.** The crew pulled the Pro Clima DA membrane tight over the existing sheathing **(a)**, drew layout lines on the fabric at stud locations **(b)**, and stapled the fabric to the wall **(c)**. Air-sealing tape would be applied over the staple lines before wood I-joists were screwed on at the stud locations.

**3.** Because the existing openings were so out of square, the crew built the window bucks in place using AdvanTech OSB and structural screws **(a)**. Each piece had to be carefully shimmed, plumbed, and leveled to make up for the irregular wall framing **(b)**, and corners were screwed together to make for a strong box **(c)**. After I-joists were installed against the walls, the crew added blocking around the bucks to complete the rough window frame **(d)**.

I think she's making a wise investment, even though a deep energy retrofit is not the most economical way to pursue the goals of Passive House. Her house is in a drop-dead gorgeous waterfront location in Damariscotta, Maine, a popular vacation spot. She's choosing top quality throughout, from frame to finish—it's going to be a showcase project even without the Passive House package. In this case, giving the house the comfort and independence of near Passive House performance is icing on the cake.

Retrofits are a labor of love—it will always be cheaper to start from scratch. There are also practical concerns. The better the bones of the home, the higher the likelihood that it's a good candidate for a deep energy retrofit. If the bones are sound and the basement is sound and dry, then a roof that needs replacing, or siding that's in shambles is something we can work with. In this case, the basics were all in place.

## EXISTING CONDITIONS

The original house was a typical Maine hodgepodge. The oldest part of the house was built in 1906, with good solid framing, horizontal sawn-board sheathing, and a sound rubble-stone foundation. A garage addition, which has plywood sheathing, was probably framed in the 1970s.

When Tim Andrews' crew ripped the existing clapboard siding off the house, we found an odd mix of paper underneath **(1)**. The oldest section had asphalt paper as the weather resistive barrier, and the work had been carefully done. The workers had even cut out little squares of paper to back-flash all the clapboard joints. It was nice work for its day.

Other parts of the house had Tyvek and Typar housewrap, which had been carelessly applied in the 1980s or 1990s. There wasn't any air space for a drainage plane behind the clapboards, and by this time, the housewrap had badly deteriorated and was rumpled and torn. But whether it was felt paper or housewrap, none of it could make the house anywhere near airtight, so it all went into the Dumpster. We removed the existing windows and started over at the level of the sheathing.

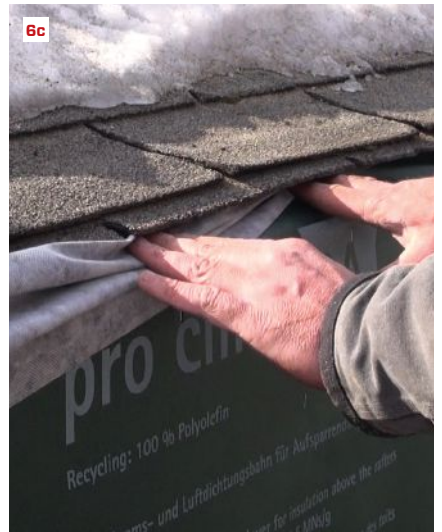
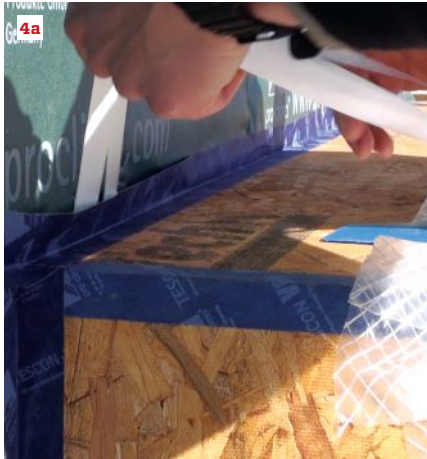
## NEW AIR BARRIER

The EnerPHit standard calls for an airtight envelope. In new construction, our high-performance wall system consists of a 2x4 or 2x6 frame sheathed with OSB and taped at the joints so that the layer of OSB forms the airtight control layer for the whole house. Then we apply an outer frame of wood I-joists outboard of this sheathing layer to form a cavity for 12 inches of cellulose insulation. That outer frame is enclosed with vapor-open fabric so that when the cavities are filled with dense-blown cellulose, the assembly can dry to the outside of the building. Everything inboard of the OSB layer is able to dry to the inside.

Our plan was to apply the same I-joist assembly to the outside of the Damariscotta house walls and have it function the same way. Essentially, we'd be wrapping the whole building in a thick jacket of insulation. But we needed something besides the sheathing to form the air barrier under the I-joists. We'd never be able to make the existing board sheathing—or even the existing plywood sheathing on the addition—airtight by using tape. So we chose an airtight vapor barrier fabric from Pro Clima called DA. We applied the fabric over the existing sheathing and taped the fabric joints with Pro Clima Tescon Vana tape **(2)**.

DA is heavier and tougher than typical housewraps. Although it's waterproof, it doesn't form the drainage plane for this job—it's just an air-control layer within the wall. But in retrofits, DA does offer the advantage of temporarily protecting interior framing, insulation, and finishes from rain and wind while

# ADDING AN INSULATED ENVELOPE



**4.** To preserve the air barrier at the windows, the crew applied Tescon Vana tape to the corners of the window bucks **(a)**. While taping the staple lines in the membrane, they also taped the joints where the window bucks meet the membrane on the wall **(b)**. Pressing the tape down with a plastic tool activated the adhesive in the vapor-open tape **(c)**.

**5.** The crew cut the existing roof eaves back flush to the wall, using a circular saw to cut through the roofing and sheathing **(a)** and a recip saw to cut the rafters flush with the wall sheathing **(b)**.

**6.** To connect the roof and wall air control layers, the open rafter bays were sheathed over and the DA membrane was extended up past the roof edge **(a)**. At the newly defined roof edge, the shingles were lifted **(b)**, and the DA fabric tucked underneath **(c)**. Later, the roofing crew would seal the DA membrane to the roof while applying Grace Ice & Water Shield self-adhering membrane to the roof.

work on the building exterior is in progress. (In this case, temporary protection didn't matter too much—the whole house was being gutted anyway.)

We rolled the DA out nice and flat and stapled it along the studs with pneumatic staples. We carefully laid out the stud locations before stapling and then taped over the staples with Tescon Vana tape to maintain a perfect air seal. Later, we would attach the I-joists at the same locations, driving structural screws through the flange, through the self-healing tape, and into the studs, so that the air barrier would remain intact. We were shooting for the Passive House airtightness spec of 1.0 ACH50 for retrofits, so we had to be meticulous about avoiding incidental punctures in the air barrier.

## WINDOW BUCKS

Our outer I-joint frame was going to add 12 inches to the wall thickness, so we needed to frame openings for the windows that would extend out just as far. Our solution was to build window bucks into the existing openings using Huber Engineered Woods' AdvanTech OSB sheathing **(3)**. Because we were installing new windows into an old wall that was badly out of plumb in some spots, our first day on the job I had a carpenter measure each existing opening and check it for plumb and square. I'm glad I did, because when we found out how out of whack some of the openings were, I immediately canceled my lumberyard order for ¾-inch AdvanTech for the window bucks, and changed it to ⅝ inch material. The inch we saved overall gave us just a little more leeway when the windows arrived.

Because the window openings varied so much, the easiest way to sequence this part of the work was to cut the DA membrane out of the window openings and build the window bucks in place. Each one had to be carefully measured, shimmed, plumbed, and squared as the pieces were assembled and attached to the studs using structural screws.

To ensure that the window bucks didn't interrupt the air barrier for the building, we carefully taped the corner joints on the window bucks themselves, then taped all the joints where the window bucks met the membrane on the walls **(4)**. The continuous tape seal perfects the air barrier in the wall center, and brings the air barrier to the outer wall plane around the window openings.

## WALL-TO-ROOF JOINT

To meet the EnerPHit standard, the whole house has to be airtight. That means the wall and roof systems can't just be airtight on their own; any joints where the wall and roof meet must also be air-sealed. That's impossibly complicated if you have to work around existing eaves details, so we cut the eaves off the building using a circular saw and a Sawzall **(5)**. (I like to use a chain saw, but my crew prefers to stick with carpentry tools.)

Once the eaves were cut flush to the wall edge, we installed sheathing over the openings between the rafters, then ran the DA membrane up to the level of the roof sheathing **(6)**. We loosened the existing asphalt shingles and removed enough nails so that we could tuck the DA up underneath and tack it in place. Later, the roofing crew would strip the shingles and apply peel-and-stick membrane over the whole roof, lapping it over the DA membrane at the eaves. At that point, the wall air barrier and the roof air barrier became connected into one continuous airtight control layer.

## INSTALLING WOOD I-JOISTS

With the air barrier complete, we built a framework of I-joists run vertically over the entire wall. One man on the ground cut the roof angle into the top end of each I-joint, then passed the piece up to the crew on the scaffolding **(7)**. The

# ADDING AN INSULATED ENVELOPE



**7.** The crew used a radial arm saw to cut wood I-joists to match the roof angle **(a)**, then screwed the I-joists to the wall at stud locations **(b, c)**.

**8.** After rolling out Pro Clima Solitex Mento membrane directly over the I-joists, the crew stretched the fabric tight **(a)** and stapled it to the I-joists **(b)**. Laps and staple lines were sealed with Pro Clima Tescon Vana tape **(c)**.

**9.** The crew applied horizontal strapping over the Solitex Mento fabric **(a)**, then applied vertical strapping over that **(b)** to provide nailing for clapboard siding. The strapping secured the fabric to the wall, enabling the crew to blow the I-joist cavities with dense-blown cellulose insulation **(c)**.

I-joists were screwed through the Pro Clima tape into the main wall framing using structural screws.

### VAPOR-OPEN MEMBRANE

Once the I-joists were attached, the crew ran an outer membrane layer of Pro Clima Solitex Mento Plus, which serves as a drainage plane, or weather-resistant barrier, under the wood siding (there is no OSB or other wood sheathing on the outboard edge of the I-joists). We rolled the membrane out, pulled it as tight as possible, and attached it with pneumatic staples **(8)**.

As we have learned, it's best to use a lot of staples when fastening the Solitex. When we started to insulate the building, the crew sometimes found that where we had not used enough staples, the air pressure from the powerful insulation blower would blow the membrane off the joists and let insulation leak into the next bay.

Although Solitex is non-porous and is completely watertight and airtight, it has a very high perm rating of 38, which enables the insulated cavity to dry freely to the outdoors.

We taped the Solitex seams using Tescon Vana tape, which is vapor-open and uses a VOC-free adhesive. The adhesive is pressure-sensitive and time-sensitive: You must apply pressure to it to activate the bond. Once activated, the bond grows stronger over time.

As we applied the tape, we pressed down on it with a plastic tool called a Pressfix, supplied by Pro Clima. Over the years, we've used everything from \$250 rollers to cheap plastic knives from The Home Depot for pressing down tape, but the Pressfix is our favorite tool for taping. It slides easily, and it's firm enough to stick the tape down but flexible enough not to hurt your fingers. You can tape all day long without getting fatigued.

### STRAPPING & INSULATING

The Solitex Mento formed the drainage plane behind the building's wood siding. We created an air space for the rainscreen wall by attaching strapping through the fabric into the I-joists **(9)**. For horizontal siding such as the wood

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## Do Fabric Membranes & Tapes Work?

I've water-tested Solitex Mento by blasting it from short range with a pressure-washer after blowing the cavities with insulation. When we cut the fabric open and inspected the insulation, the cellulose behind the fabric was bone dry. I also have instruments in place on the OSB air-barrier layer of some of the houses we've built this way, and that sheathing has stayed around 8% moisture content through two Maine winters. So I know that the vapor-control strategy and the bulk-water management strategy both work well.

I've also tested the Tescon Vana tape, albeit in an unscientific way: I've used it to mend a down parka. Tescon Vana is designed to adhere to fabric, and it sticks well to clothing. People sometimes use ordinary duct tape to repair their ski jackets, and later you'll see them walking around in their down jackets with a little strip of gray adhesive where the duct tape got brittle and peeled away, and the feathers are coming out again. But I used Tescon Vana to repair the ripped armpit on my parka two winters ago, and I've

worn that thing every day, all winter long—skiing, snowboarding, back-country—and the tape is still holding. I have also used Tescon Vana to mend ripped blue jeans, a pair of cycling shoes, the crotch of my snowboarding pants, and the knee of my son's jeans (abrasion testing), and to tape a license plate to one of my job trailers (two years ago!). All are still holding up fine, with the exception of my son's jeans. He just wore another hole through the tape. If you put that tape on clothing, it will never come off.

## ADDING AN INSULATED ENVELOPE

clapboards on this house, we apply horizontal strapping first, then a layer of vertical strapping; for vertical board siding, we attach the vertical strapping before the horizontal cross-strapping.

Finally, we blew insulation into the cavities, cutting a hole in the Solitex for the blower hose, then repairing the hole again with Tescon Vana tape when the cavity was filled. It's a lot of insulation, and it can literally take days to blow it all.

### INSTALLING WINDOWS

The final step in building the envelope was to install the windows, which were supplied by Intus Windows. The units were set in the opening using Intus' system of mounting brackets. I always recommend installing the windows in the center of the wall depth because that minimizes heat flow through the window opening framing. But in this case, the owner insisted on setting the windows all the way to the outside to create a deep bench windowsill on the inside.

To integrate these "outie" windows into the home's drainage plane, we started by placing a ½-inch by 3-inch sill dam on the rough sill. We flashed the dam with 3M All Weather Flashing Tape 8067, then installed the windows, setting the face of each window flush with the Solitex Mento Plus fabric that forms the wall's drainage plane (10). Next we created a dual seal between the windows and the walls: First, we sealed each window to the sill dam with Tescon Vana tape; then we applied a second layer of tape to seal the drainage-plane fabric to the window.

The idea is that if for some reason the window itself springs a leak, the incidental water will puddle on the protected sill inboard of the window, where it can dry to the inside by evaporation. But if water penetrates the exterior trim surround at the base of the window, the water will be directed into the drainage plane air space behind the siding and make its way down and out of the drain-and-dry exterior rainscreen.

### WHAT'S NEXT?

Early in the project, the owner had decided to leave the basement out of the conditioned envelope, restricting the deep energy retrofit work to the occupied floors above the cellar. But near the end of the project—after the house was wrapped, the windows were in, and the general contractor's crew was working on exterior and interior finishes—she changed her mind and asked us to dry out and insulate the basement space as well.

I would have done some things differently if this decision had been made in advance. For example, we would not have insulated and air-sealed the floor above the basement as we did.

However, the change in plans has an upside: When it comes to Passive House certification under the EnerPHit protocol, this will change the math because we can now include the basement volume in the calculations. Improving the basement as part of this project puts EnerPHit certification within reach, at least potentially. So after we carry out the basement phase of the job, I'm considering submitting this house for official EnerPHit certification. If we pass, that can only help the house serve as an example, the way the owner intended. But even if we miss the threshold by a little bit, I'm sure that we will have drastically lowered this home's energy consumption and its carbon footprint. And that's a big step in the right direction.

*Designer, builder, and certified Passive House consultant Chris Corson owns and manages EcoCor, based in Belfast, Maine.*



**10.** A sill dam nailed to the front edge of the windowsill was flashed with 3M All Weather Flashing Tape 8067 (a). After the Intus window was set into place (b), its edge was sealed to the taped sill dam using Pro Clima Tescon Vana tape to form an inner airtight and watertight seal (c). Finally, the Pro Clima Solitex Mento Plus drainage plane membrane was sealed to the window with Vana tape (d).



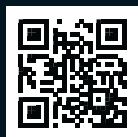
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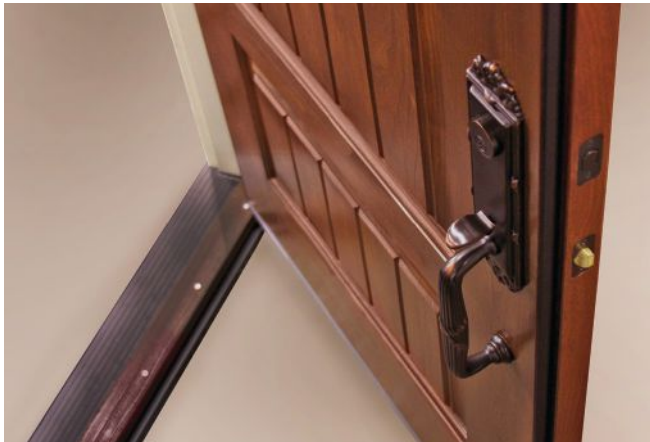
### Digital Lock

The low-profile August Smart Lock installs in minutes on the interior side of an existing deadbolt and locks or unlocks the door using Bluetooth technology. The unit is powered by four AA batteries and doesn't require an Internet connection. Log records and access controls may be accessed via smartphone or computer. Introductory price: \$200. [august.com](http://august.com)



### Hip Vent

The new Cobra Hip Vent provides 9 square inches of net-free ventilating area per linear foot, and its low 5/8-inch profile is perfect for hard-to-vent hips. The vent's Dual Weather Fighter filter helps prevent rain and snow from entering through and under the vent. No caulking is needed and three coils of 1 3/4-inch nails are included. About \$90 for a box of 10. [gaf.com](http://gaf.com)



### Energy-Efficient Entry

ProVia's Embarq Fiberglass Entry System uses added thickness (2 1/2 inches) and foam-filled channels in the side rails and header to achieve a third-party-tested U-factor of just 0.1 (about R-10). Dual perimeter seals eliminate drafts, and four heavy-duty ball-bearing hinges support the increased weight (65 pounds). \$3,900, installed. [proviaproducts.com](http://proviaproducts.com)



### Solid Footing

The Podium Ladder's large platform allows users to face in any direction, while a waist-high guardrail improves safety and holds tools. Werner's Edge360 system includes edge protection, bracing, and over-sized foot pads. Ladders come in 5-to-12-foot sizes with platform heights of 3 to 10 feet, respectively. A 10-footer costs about \$150. [us.wernerco.com](http://us.wernerco.com)

## Products



### Custom Storage

In the FreedomRail modular storage system from Organized Living, uprights hanging from a bracket can support up to 150 pounds per square foot. Components are made from low-emitting materials and can be adjusted without tools. Options include shelves (wood or ventilated), “O-boxes” (which accept doors or drawers), clothes rods, baskets, and more. Cost averages about \$99 per linear foot. [organizedliving.com](http://organizedliving.com)



### Asphalt-Free Underlayment

Made from two layers of kraft paper laminated using a polymer, this new Floor & Tile Underlayment from Barricade contains no asphalt. According to the maker, the material helps prevent cupping and buckling of wood flooring by slowing vapor transmission without trapping moisture in the subfloor, letting flooring acclimate gradually. Available in 36- and 48-inch rolls for about 3 cents per square foot. [barricadebp.com](http://barricadebp.com)



### Light Slide

Makita's 8 1/2-inch slide compound miter saw (LS0815F) is light (31 pounds) and features a direct-drive 10.5 amp soft-start motor and linear ball bearings. The saw crosscuts 12 inches at 90 degrees and 8 1/2 inches at 45 degrees; it miters 50 degrees left and 60 degrees right, with multiple positive stops on both sides. \$349 with carbide-tipped blade. [makita.com](http://makita.com)



### Knife Groove

Luxe Linear Drains' stainless steel knife holder creates a barely visible groove in the countertop to keep sharp blades safely out of the way but close at hand. The stainless slot, which can be inlaid, takes up less counter space than a knife block. The holder is available in 14-, 18-, and 22-inch lengths for \$78, \$88, and \$98 respectively; custom sizes are available at additional cost. [lineardrains.com](http://lineardrains.com)

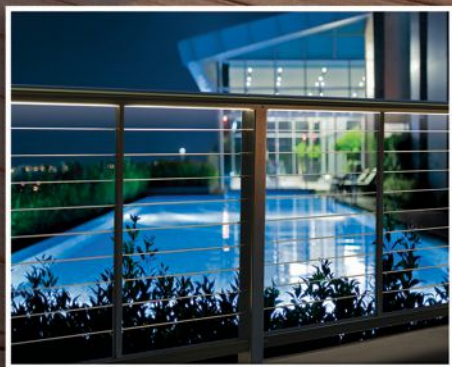


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## Products



### Quad-Glazed Windows

The new ZNC (Zola No Compromise) window features a slim 3-to-4.5-inch profile, concealed hinges, and powder-coated aluminum “rainscreen cladding” mounted on rails over rigid insulation. The ZNC is PHIUS certified and, according to the maker, is the first window on the market available with R-15 quad glazing. Available in several configurations in sizes up to 8x10 feet (WxH). Priced by custom quote. [zolawindows.com](http://zolawindows.com)



### Door Saver

The Ultra Jamb Reinforcer from Structural Protective Products is designed to prevent or repair the kind of jamb damage that's caused by a screen door caught in a gust of wind. The kit consists of a  $\frac{3}{16}$ -inch-thick oversized (1  $\frac{3}{4}$  by 5  $\frac{1}{2}$  inches) reinforcing plate, a metal bracket, and screws that provide universal attachment of existing door closer hardware. All components are nickel-plated. Retail cost: \$14. [ultrajamb.com](http://ultrajamb.com)



### OSB App

Designed to provide builders, framers, and remodelers with easy access to information in the field, Norbord's free Onsite mobile app provides illustrations and how-to videos about installation, care, and storage of OSB products. An integrated troubleshooting function lets users upload pictures to get feedback from the company about issues encountered on site. For iOS/Android. Also available in Spanish. [norbord.com](http://norbord.com)



### Spaced Out

Used to promote air circulation and help prevent water and debris from collecting behind deck ledgers, these fiberglass-reinforced polypropylene spacers are  $\frac{5}{8}$ -inch-thick and 2  $\frac{1}{2}$  inches in diameter, and have an  $\frac{11}{16}$ -inch-diameter hole for a bolt or lag. Test results of connections made with the spacers are available at the company's website. About \$25.50 per dozen. [deck2wallspacer.com](http://deck2wallspacer.com)



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## Two Cutting-Edge Cordless Circular Saws

BY JOHN SPIER

**Two new cordless circular saws**, the 18-volt Milwaukee M18 Fuel and the 36-volt Makita 18V X2 LXT, claim to wed corded performance with cordless convenience. Can these new saws really stand in for corded framing saws and do serious production work? After putting both saws through their paces over several months, I'm ready to report my opinions.

### MILWAUKEE M18 FUEL

The 6 1/2-inch left-bladed M18 Fuel (model 2730-22) is the first cordless circular saw with a brushless motor, and it is part of Milwaukee's Redlink Plus advanced electronics system, which the company says protects against overloading, overheating, and overdischarging.

The shoe and the blade guards are made of rigid lightweight magnesium, and the saw bevels to 51° and can cut through a 2-by at 45°. The saw is also equipped with an electric blade brake, an LED headlight, a pivoting rafter hook, an onboard blade wrench, and an easy-to-read accurate depth gauge. The kit's 4-amp-hour

batteries have built-in fuel gauges and take about 1 1/2 hours to fully recharge.

According to Milwaukee, the saw cuts up to 30% faster than other 18-volt models and can consistently crosscut more than 225 2x4s per charge under optimal testing conditions. I didn't do my own tedious runtime testing, but I have cut a wide range of materials using this saw, including all of our routine framing materials. I have found it to be smooth, powerful, and well-balanced.

That said, what matters is how fast you can push the blade through the wood you're cutting. While this saw performed well, it isn't as fast as a corded Milwaukee sidewinder, which spins at 5,800 rpm versus 5,000 rpm for the M18 Fuel. Although higher rpm ratings don't always translate to higher cutting speeds, coupled with the larger blade circumference of the corded saw, the difference is definitely noticeable.

Nevertheless, the lightweight Milwaukee has become my go-to saw for small jobs and for quick cuts. My



**1.** The 6 1/2-inch Milwaukee can cut through a 2-by at a 45-degree bevel. **2.** Unlike the Makita, the Milwaukee has a built-in rafter hook. **3.** The author did some serious framing using the 7 1/4-inch Makita, including trimming LVLs.

crew and I have used the M18 Fuel a lot on staging and roofs, where it has been perfect for adjusting our trim cuts and sawing red-cedar roof shingles and caps. I have also used it for breaking down materials at the lumberyard and the Dumpster. I already have a fleet of compatible M18 tools, so I always have plenty of fully charged batteries on hand.

Like other cordless circular saws, this one has a safety that you have to press with your thumb before pulling the trigger. Milwaukee's safety is easier to operate than others I've tried, but when cutting in awkward positions, I wish it wasn't there.

**MAKITA 18V X2 LXT**

Like the other tools in Makita's unique 18V X2 LXT line, the new 36-volt, 7 1/4-inch, right-bladed sidewinder (model XSH01X) is driven by two batteries from the company's flagship 18-volt LXT platform (which now includes more than 80 tools). The shoe and the blade guards are made of magnesium, and the saw bevels to 50° and has a positive stop at 45°. It has protective electronics, a blade brake, and an onboard blade wrench; unlike the Milwaukee, the saw doesn't have a rafter hook or a headlight.

The X2 is clearly designed to replace its corded counterparts on the jobsite. According to Makita, it crosscuts up to 250 2x4s per charge, and cuts as fast as its corded 7 1/4-inch model 5007F sidewinder. I've comfortably framed with it all day long, cutting mostly 2x4s, 2x6s, plywood, and LVLs. It's

rugged, smooth, powerful, and nicely balanced despite the two batteries.

On the downside, the blade wrench quickly fell off the saw and disappeared, the depth scale is inaccurate, and the trigger safety is a bit of a stretch for my average-size hands.

This saw would fit seamlessly into a collection of 18-volt LXT tools. But I don't have other compatible 18-volt Makita tools, so the kit's single-port charger created a battery management problem. Each 3-amp-hour battery can fully recharge in less than 30 minutes, but I can't simultaneously charge both of them at lunchtime or overnight. This means that they don't stay equally charged, and when one is depleted, the saw shuts down. And although there are two LED lights on the tool that tell you when a battery is almost dead, there are no fuel gauges on the tool or the battery.

**THE BOTTOM LINE**

If I had to choose one of these saws to keep on the truck, I'd go with the Milwaukee M18 Fuel. It can handle most cutting tasks where corded sidewinders would be impractical, it has a rafter hook, and it provides fuel gauges on the batteries.

That said, if you've already bought into Makita's 18-volt LXT platform and are ready to cut the cord on your circular saws, the 36-volt dual-battery Makita appears to be capable of handling the job. The saw might also be ideal for mobile applications, such as cutting floor joists in place or building concrete forms.

The two-battery Milwaukee and Makita kits that I tested are pretty pricey, but you can buy the bare tools for about \$200 less. Milwaukee also sells a one-battery kit.

**Milwaukee 2730-22 Specs**

- Blade diameter: 6 1/2 inches
- Battery: 18 volt, 4 amp hour
- RPM: 5,000
- Weight (with blade and battery): 8.5 pounds
- Cutting depth at 0°: 2 3/16 inches
- Cutting depth at 45°: 1 5/8 inches
- Cutting depth at 51°: 1 7/16 inches
- Price: \$400
- Included in kit: two 4-Ah batteries, charger, blade, blade wrench, and tool bag
- Warranty: 5 years tool, 3 years battery

**Makita XSH01X Specs**

- Blade diameter: 7 1/4 inches
- Batteries: dual 18 volt, 3 amp hours
- RPM: 4,800
- Weight (with blade and batteries): 10.4 pounds
- Cutting depth at 0°: 2 5/8 inches
- Cutting depth at 45°: 1 7/8 inches
- Cutting depth at 50°: 1 11/16 inches
- Price: \$420
- Included in kit: two 3-Ah batteries, charger, blade, blade wrench, and tool bag
- Warranty: 3 years tool, 1 year battery

*John Spier is a builder on Block Island, R.I.*

Photo 3: Scott MacMillan



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1. A 12-inch tie is coiled to secure a power cord. 2. Shown are 18-, 24-, and 32-inch ties. Also available are 3-, 6-, 12-, and 64-inch ties.

## Nite Ize Gear Ties

BY DAVID FRANE

**About a year ago** I was in a big-box store and happened upon a display of Gear Ties—brightly colored twist-tie wraps that consist of wire with a grippy ribbed rubber coating. They looked interesting, so I bought a few, took them back to the shop, and used them to secure some air hoses and electrical cords. They worked great, so I ordered more online—medium (12- and 18-inch) ones for the shop and small (3- and 6-inch) ones for the office and travel. Nite Ize also makes larger (24-, 32-, and 64-inch) ties, and it’s just a matter of time before I find an excuse to try them out, too.

Gear Ties can be coiled around the item to be secured or twisted like a twist tie—either way will work. In the shop, I use them on hoses and power cords. In the office, I use them to organize cords for electronics: chargers, USB cords, ear buds, and the like. But these things are not just for cords, they can be used to tie or hold just about anything you can fit them around. The same ties can be used over and over again. I suppose the wire core might eventually succumb to metal fatigue, but that has yet to happen to any of mine.

As for their handiness, Gear Ties are second only to duct tape. I use them all the time and yet it didn’t occur to me to write about them until I was reviewing a video shot at JLC LIVE. The video showed the interior of Brian Way’s Cool Shop on Wheels, and there on the wall (at about the 1:50 mark) were a bunch of hoses secured with Gear Ties. Brian and I have never discussed Gear Ties, but I figure that if we both like them, then they’re probably worth talking about.

The items shown here are simple ties, but Nite Ize incorporates the same twist-tie material into a variety of products that can be clipped to or mounted on different types of surfaces.

### Gear Tie Specs

**Lengths (inches):** 3, 6, 12, 18, 24, 32, 64

**Country of origin:** USA

**Available:** single, multiple, or assorted packs

*This review first appeared on JLC’s sister website, [toolsofthetrade.net](http://toolsofthetrade.net).*

### CRESCENT CONNECT MODULAR CLAMP SYSTEM

Each clamp in the Crescent Connect Modular Clamp System has 500 pounds of holding power, 60% more than similar clamps, according to the manufacturer. And these clamps are more versatile, thanks to a unique cam-like connector at the end of each clamp head that makes it possible to connect clamps to one another through a full 360° rotation.

Together with the Twin Lock Connector accessory (sold separately), you can position a series of clamps in a variety of positions and at unusual angles, making it possible to clamp corners, for example, or to use one clamp to support another. (Go to the Crescent website to see photos from users showing the clamps in action in a variety of configurations.)

Flipping the heads transforms the clamp into a spreader. In addition, removing the protective rubber pads exposes an area of the head that can clamp onto a pipe or other round object. A pair of 12-inch clamps costs about \$40; two 6-inchers run about \$35. The Twin Lock Connector accessory adds about \$6. [connectclamps.crescenttool.com](http://connectclamps.crescenttool.com)



Photos: 1, 2, David Frane



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BY JON VARA



## Saving City Bees

**Wasps and hornets are familiar** occupational hazards of the building trades. Honeybees are not. But honeybees—those faithful, hard-working pollinators of crops and makers of honey—do sometimes set up house indoors. And when they do, the man to call—at least if you happen to live in San Francisco—is beekeeper Philip Noe, who runs an animal rescue service for honeybees.

According to Noe, San Francisco is home to about 1,000 urban beehives. When a colony is dissatisfied with its living quarters—perhaps because a novice beekeeper somehow failed to meet its needs—it will form a swarm and abandon the original hive to look for a new home.

About half of Noe's calls come from homeowners with a swarm on their property, and in this case the remedy is straightforward: He gathers up the swarm, puts it in a box, and brings it back to his own bee yard and establishes it in a new hive.

Because bees in a swarm have no existing honey or brood to protect, Noe says, they're generally docile and unlikely to sting. "I always encourage the homeowner to poke an index finger into the middle of the swarm," he says. "It feels really interesting—kind of warm."

Things get more complicated once the swarm has

settled into a structure, typically in an uninsulated stud cavity—the urban equivalent of a hollow tree. Because the cavity containing the hive is usually a couple of degrees warmer than those on either side, Noe uses an infrared thermometer to pinpoint its location before opening up the wall using a cordless reciprocating saw. To prevent the bees from escaping, he prefers to work from inside the structure, but will sometimes have to cut through an outside wall instead.

Either way, once he's uncovered the hive, he uses a specially constructed vacuum to suck the bees into a screened box, then removes the wax combs that contain bee larvae and the colony's honey stores—50 pounds of it or more, in some cases. The site is then carefully scraped clean to eliminate any wax or honey residue that might attract another colony to the same site.

Noe's services aren't inexpensive, but homeowners who hire him have one sweet consolation: Framing-cavity honey is as tasty as any other, and before driving away with the rescued bees, Noe makes a point of sharing the comb honey with the homeowner. "They like that," he says.

*Jon Vara is a JLC contributing editor who lives in Cabot, Vt.*

Photo, left: Helene & Kev, flickr



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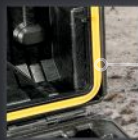
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