

BEST NEW PRODUCTS FROM THIS YEAR'S BUILDERS' SHOW

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The Appeal of Double-Stud Walls

Superinsulated, inexpensive, easy to build, and resilient—what's not to like?

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**2020
HOUSES
AWARDS**

**The Best
Homes of
the Year**

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Salvaging
trees for
lumber

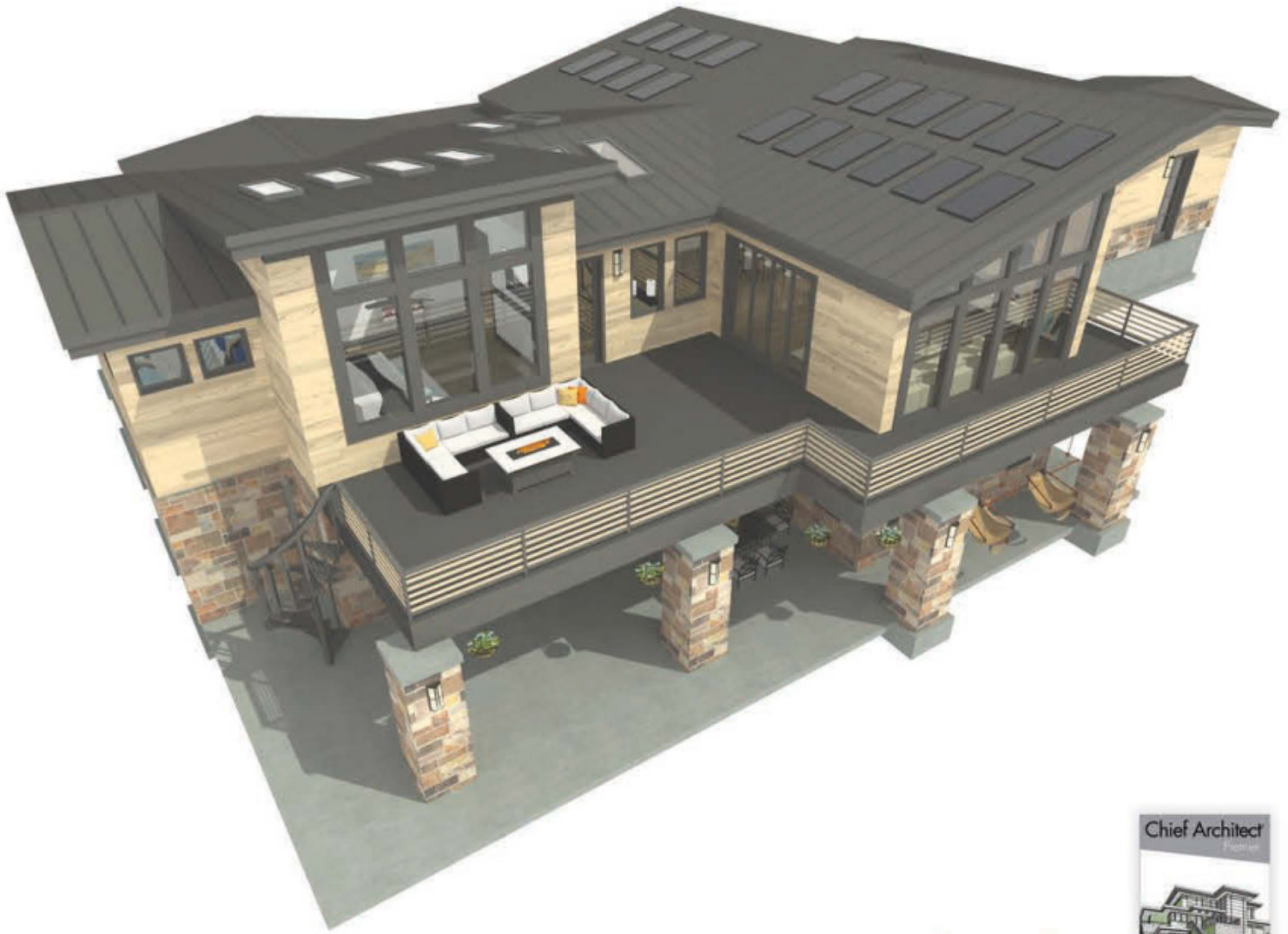
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Energy-
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water heaters

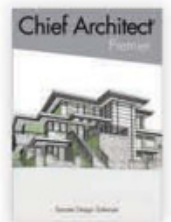
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Build a
craftsman-
style mantel

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Cover photo by Scott Gibson



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ENERGY-
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LAUNCHES JULY 1



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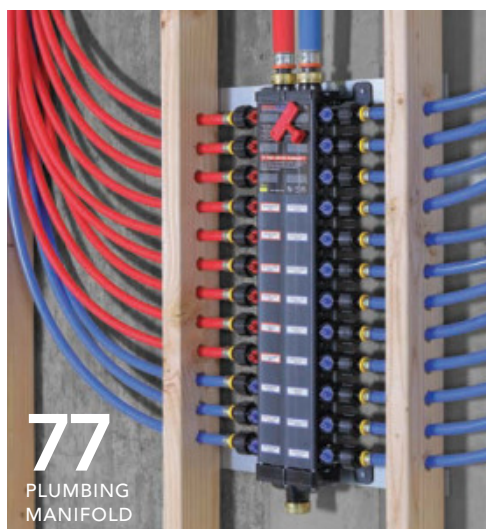
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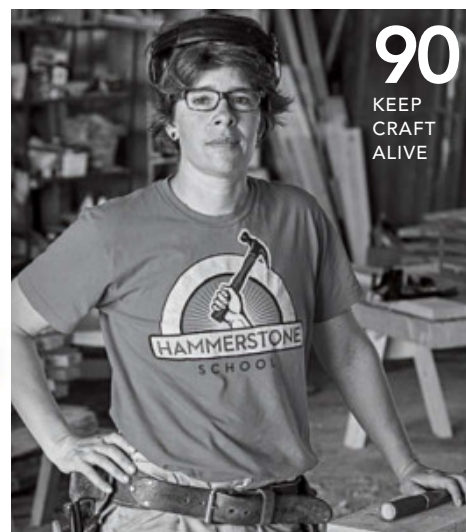
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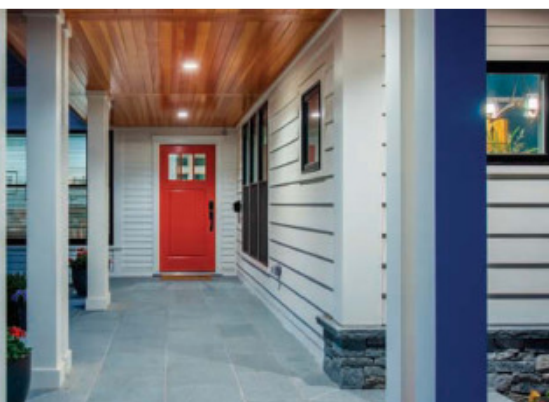
Our annual HOUSES Awards celebrate the most progressive design ideas and construction techniques being executed by today's architects and builders. Not only do we aim to recognize these houses for the quality of their design, but we strive to highlight the valuable design lessons within each project. Go to FineHomebuilding.com/houses to submit a project and become eligible to win one of our HOUSES awards. Submissions may also be emailed to fhcallforentries@taunton.com or mailed to our offices at: Fine Homebuilding, 63 South Main St., Newtown, CT 06470.

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Atypical approach

This year's Reader's Choice Award winner honors New England's farmhouses and covered bridges. See more of the home online at FineHomebuilding.com/houses.



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Ep. 230: Setbacks and Housing Affordability

The podcast crew tackles the topic of affording high-performance homes and takes a listener question on the right foundation for a room addition. Visit FineHomebuilding.com/podcast.



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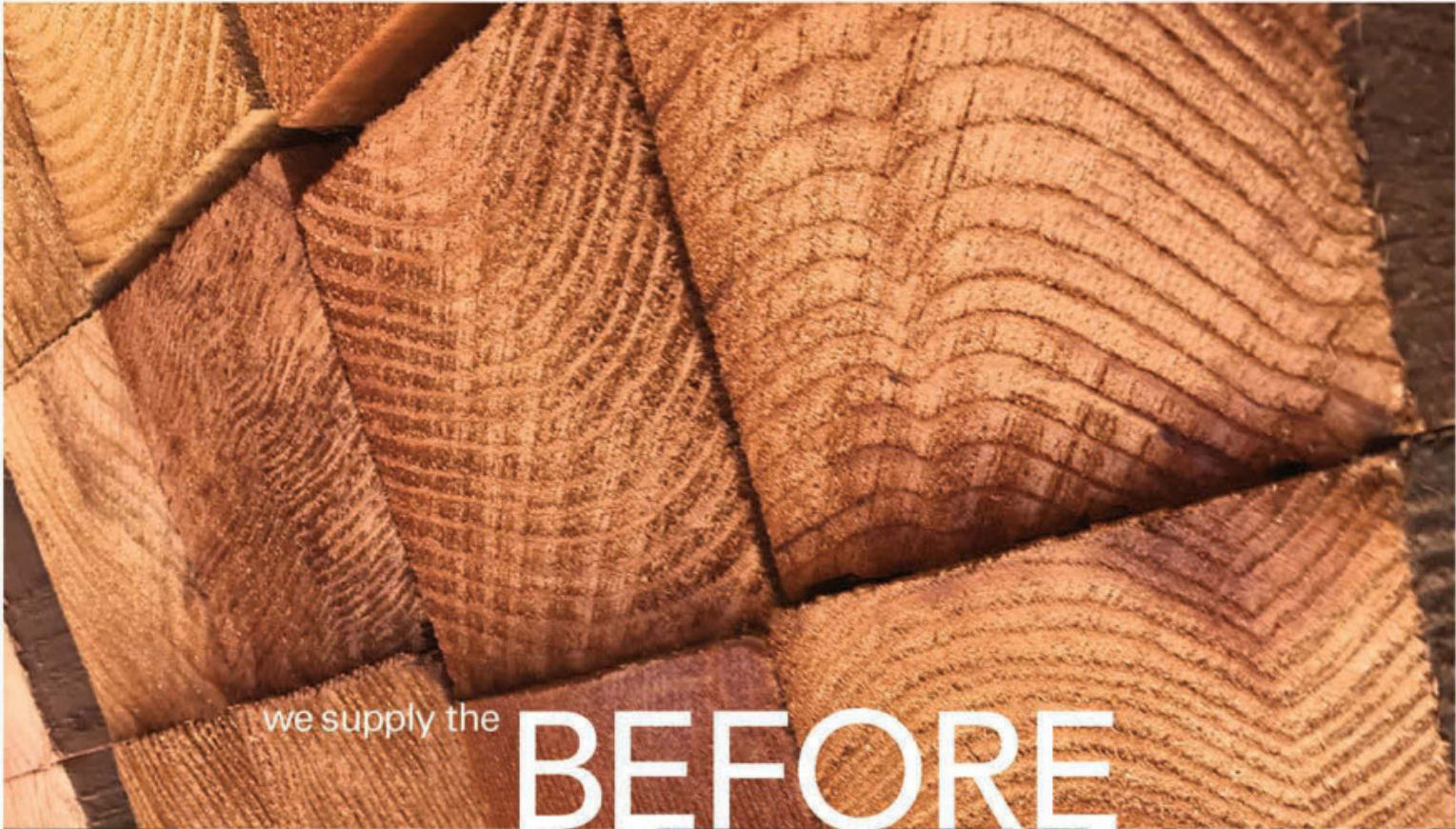
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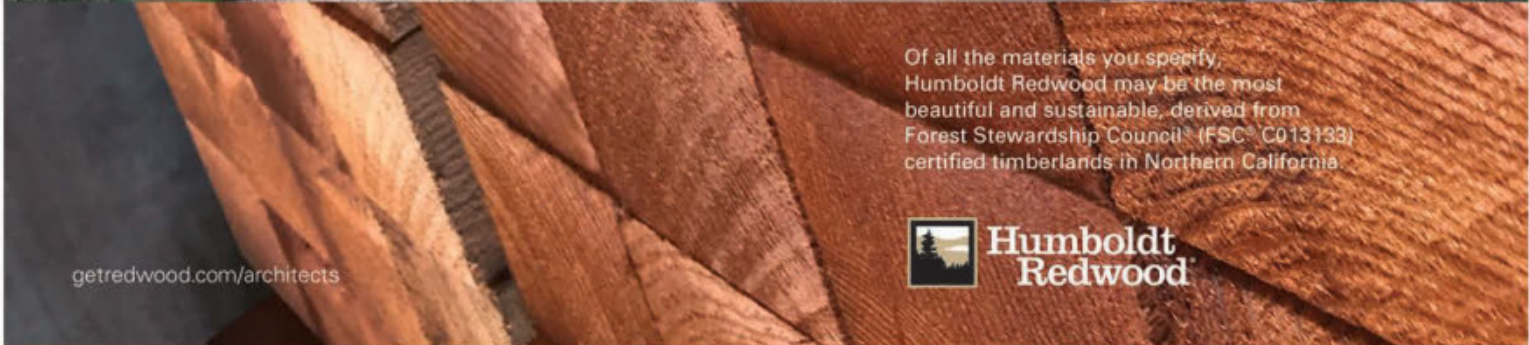
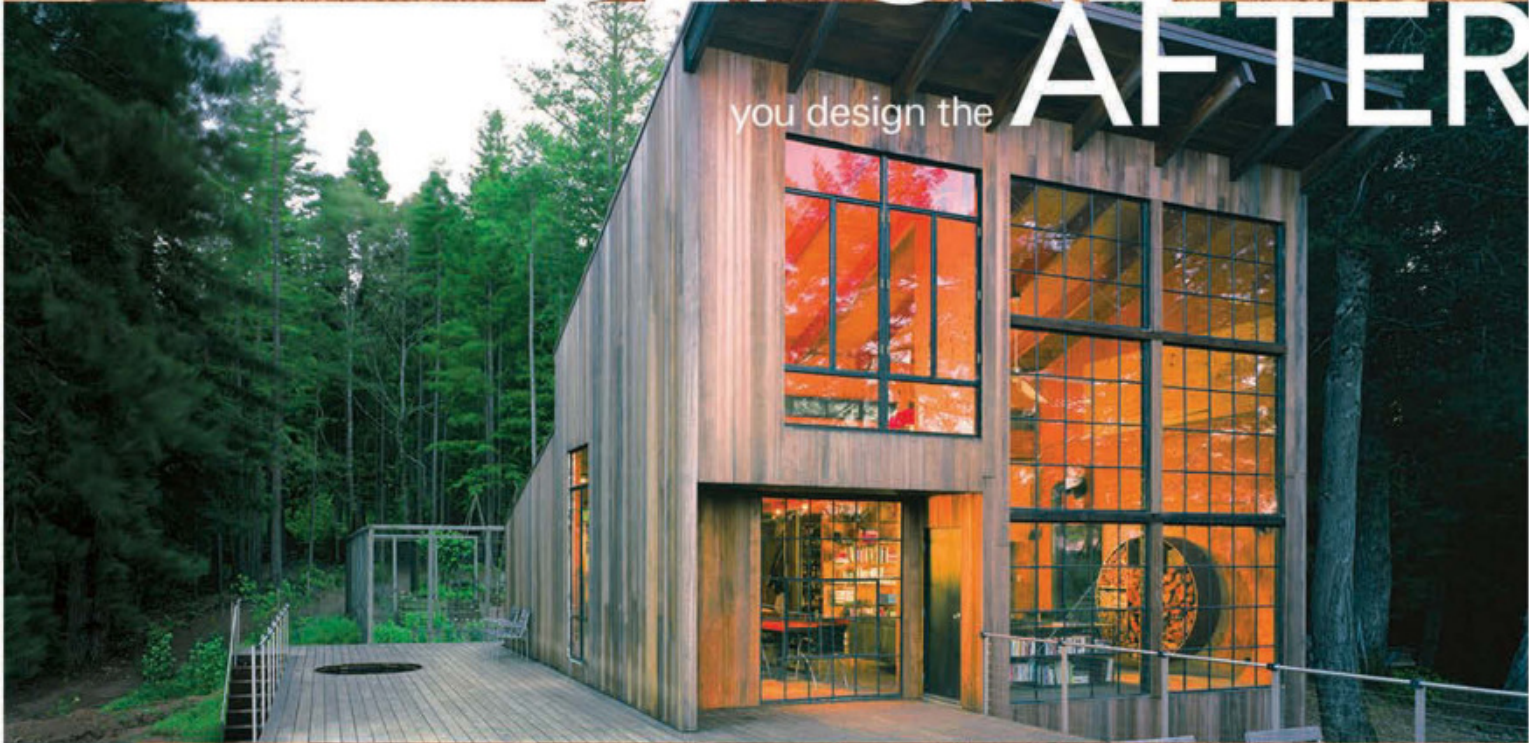
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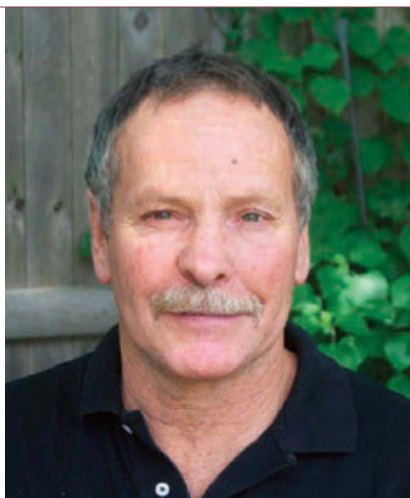
contributors

THE VOICES OF EXPERIENCE



MIKE DiBLASI ("Stripping Wallpaper," pp. 38-43) painted his first house as a favor to a friend in 1986, and has continued painting on a full- or part-time basis ever since. In 1995, he quit his job and started his own business, working mostly for private homeowners. In 2000, Mike was introduced to the science and chemistry behind paint, including how it works and how it's changed over time. He now owns DiBlasi Painting with his two sons, and manages several full-time employees.

TOM MEEHAN (Ask the Experts, pp. 82-84) is a second-generation tile installer and co-author of *Working with Tile* (The Taunton Press, 2011). He is a member of and an ambassador for the National Tile Contractors Association. Tom has written dozens of articles for *Fine Homebuilding* magazine and has spoken around the country at various trade shows. He and his wife reside in Harwich, Mass., where together they own and run Cape Cod Tileworks, a full-service tile showroom that offers sales, design, and installation.



DAN KOLBERT ("A Case for Double-Stud Walls," pp. 32-37) has been a carpenter and contractor in Portland, Maine, for three decades. He has written for various trade publications, including *Fine Homebuilding* magazine, and for the past 10 years has been moderator of the original Building Science Discussion Group in Portland, Maine, where the Pretty Good House idea originated (read more about the Pretty Good House standard on pp. 44-49).

write an article

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Beware of bolts. Some metal will change composition and lose strength when welded, so be sure to use bolts made from weldable steel.

Steel-stair feedback

“Site-Built Steel-Stringer Stairs” (*FHB* #288) is a great article. Good content, pictures, diagrams, and useful detail.

For any builders looking to get into structural metalwork, I’d suggest asking their local building inspectors if any special engineering or approvals are needed.

Transitioning from wood to steel, particularly where welding is involved, will not be intuitive for most carpenters. For example, the photo captioned “Weld the top” (reprinted above) shows a critical attachment where bolts are welded to a stringer cap. Welding will change the metallurgy of those bolts, and perhaps their strength. Imagine that stair flight packed with people posing for a holiday photo and the benefit of an expert review is clear, whether an inspector demands it or not.

—BEN ZARLINGO
via email

Author Josh Edmonds responds:
I agree that builders should check with their local inspectors

prior to tackling new projects. When we do structural metalwork, it’s always accompanied by engineered plans, and most of the connections are made using bolts with the grade of bolt specified.

On this project, the stringers are anchored into the concrete at the bottom and are unable to slide out even if the top bolts are completely removed. Still, you are correct that welding some bolts can harm their strength. Grade 8 bolts, for example, are heat-treated and would be compromised by welding. But many common bolts are made from weldable steel, including the type we used. I forgot to point out that detail in the article—nice catch.

Beware grilling on decks

I particularly enjoyed “Guardrails vs. handrails” by Glenn Mathewson (*Know the Code*, *FHB* #289), as I recently completed a multilevel deck project of my own and wrestled with my county’s code requirements.

However, as a career fire-suppression officer, I was surprised to see an illustration showing a person using a charcoal grill atop a deck in close proximity to a residential structure. Fire codes vary geographically, but uniformly prohibit this type of activity.

—MICHAEL HUDSON
Baltimore, Md.

Walking on metal roofs

We reroofed our home with a lightweight concrete-tile roof. It looks lovely, but it cannot be walked upon by mortals such as myself. That makes it tough to service our solar hot-water system, install/service solar electric

panels, check chimneys, clean gutters, etc. Can a modular metal roof, mentioned in Scott Gibson’s recent article, “The Rise of Metal Roofing,” (*FHB* #289) be walked on, very occasionally, without damage?

—JOHN TROLLMAN
via email

Contributing editor Scott Gibson responds: According to Ken Gieseke of McElroy Metal, all types of metal roofing can handle foot traffic—standing-seam panels, through-fastened panels, and modular (shingled) surfaces. Gieseke’s only caveat is that it’s best to avoid walking on seams or ribs of metal panels. When it comes to modular metal roofs, Todd Miller of Isaiah Industries recommends stepping on the parts of the roofing profile closest to the roof deck.

When in doubt, check with the manufacturer about the particular roofing profile you’re working with—but in general, foot traffic should be OK.

The skylight problem

I see in your *Kitchens & Baths* issue the use of skylights in bathrooms, specifically one located near the shower (*Great Ideas*, *FHB* #287). This design detail can cause real headaches for the homeowner a few years down the line. Living in a northern climate means that snow could be covering the outside of the window while steam from the shower hits the inside pane. I had such a setup—after about eight years, the seal between the glass panes failed, and replacement glass was no longer available.

—WES POTTER
via email

your safety

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

—JUSTIN FINK
editorial director



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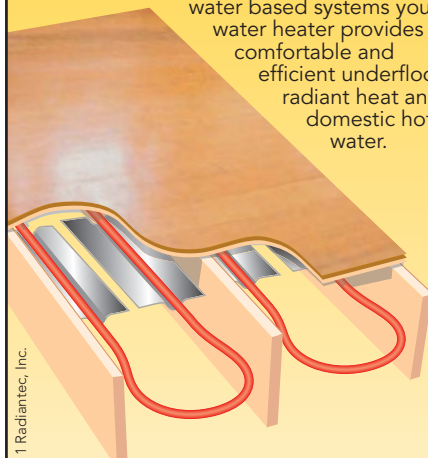
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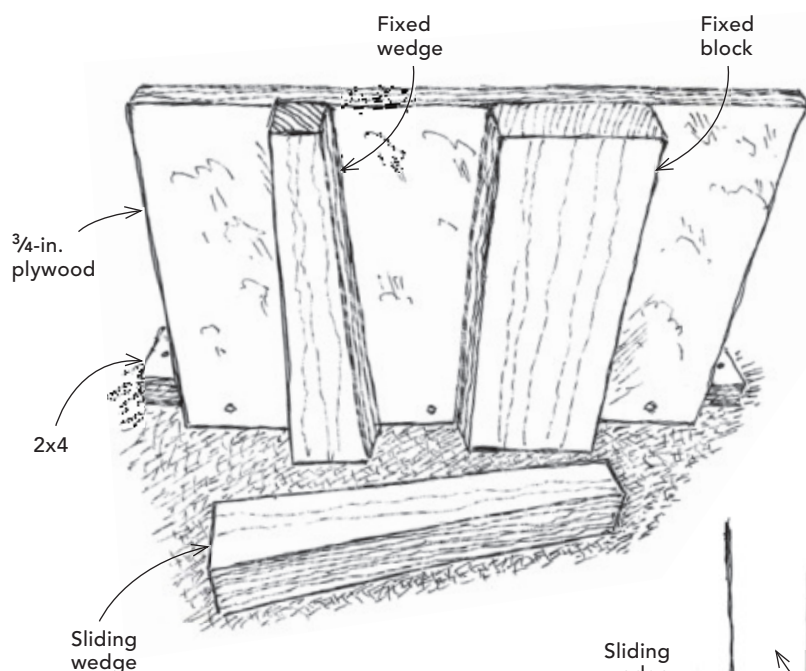
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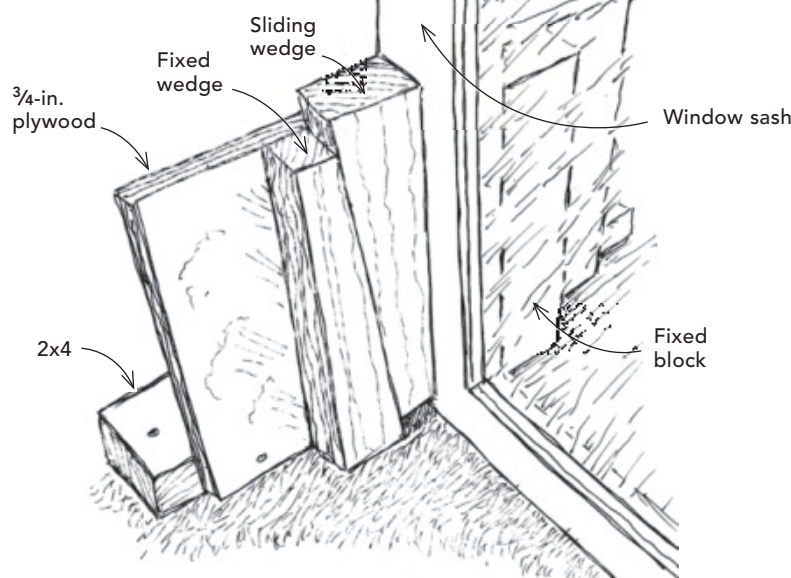
Model
1190



Sash stand

Made in a few minutes from some 2x4 scrap and a piece of plywood, this jig is perfect for holding window sashes for painting, planing, or whatever else needs to be done. First, get three pieces of 2x4 about 12 in. long and cut one in half at an angle, creating two wedges. Next, screw one full 2x4 and one of the wedges to a piece of 3/4-in. plywood. Finally, screw the other full 2x4 to the bottom of the jig as a base for clamping or screwing the jig to a bench. Place the sash between the wedge and 2x4, then drop in the sliding wedge to anchor it.

—GERRET WIKOFF
Los Angeles, Calif.



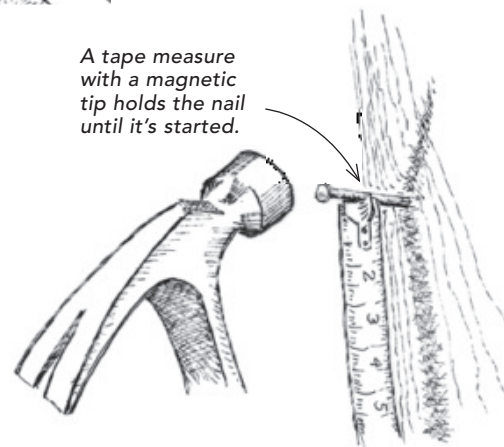
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Magnetic nail holder

As a remodeler, my work varies from day to day. On several occasions I could have used one of those magnet nail starters sometimes found on framing hammers. Since I don't have a hammer with this feature, I put the nail on the magnetized tip of my tape measure, extend the tape, and hammer the nail to start it. This method also works better than needle-nose pliers for tiny finish nails.

—RICHARD QUAGLIA
Fletcher, N.C.



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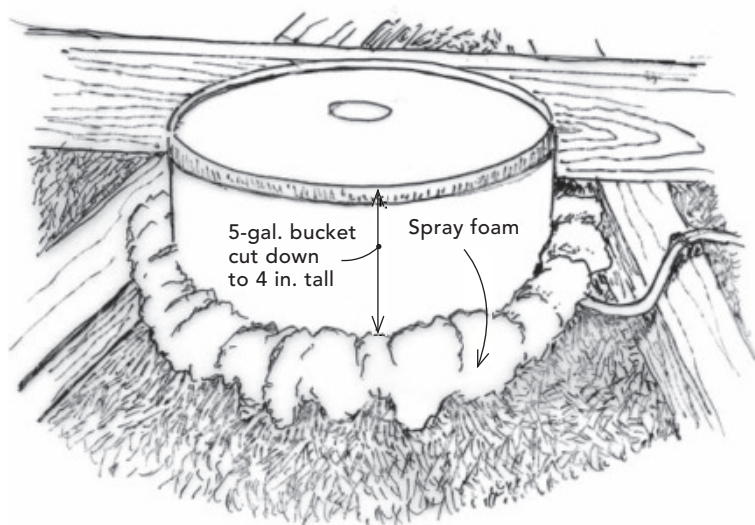
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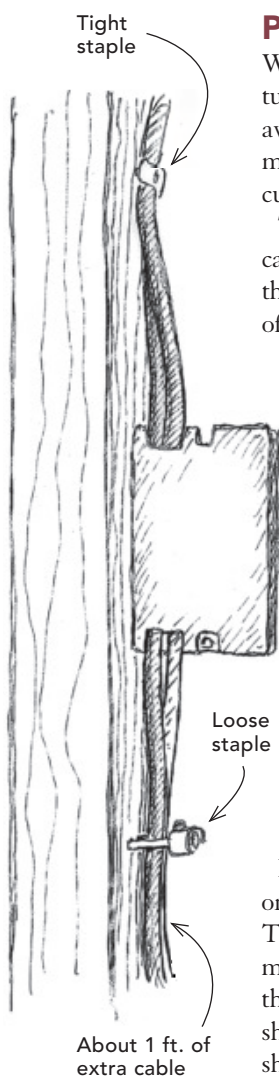
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Effective can-light cover

I was looking for a way to air-seal ceiling electrical boxes and IC-rated can lights, and I also wanted a way to prevent blown cellulose insulation from covering the light. That way, if I ever had to replace the fixture, it wouldn't create a mess. There are recessed light covers at big-box stores for this application, but they are way overpriced. Instead, I took 5-gal. buckets (\$3 each) and cut them down to about 4 in. tall. Then I placed them over the fixtures and sprayed foam around the base. Once the foam cures, the caps are rock-solid and tightly sealed.

—AARON MILLER
Pollard, Ark.



Protecting communication cable

When you rough in nonmetallic sheathed cable, you can tuck it into the very back of the box so the drywallers avoid it when cutting out the boxes. But TV and communication cable is not as stiff and can fall out and get cut by the drywall router.

To solve this problem, we have our electricians run the cable into the top of the box, where the top staple holds the cable snug. The cable then continues out the bottom of the box where it's held in place with a staple that's not quite tight. They leave about 1 ft. of extra cable on the loose side that can be pulled back into the box when it's time to install the jacks.

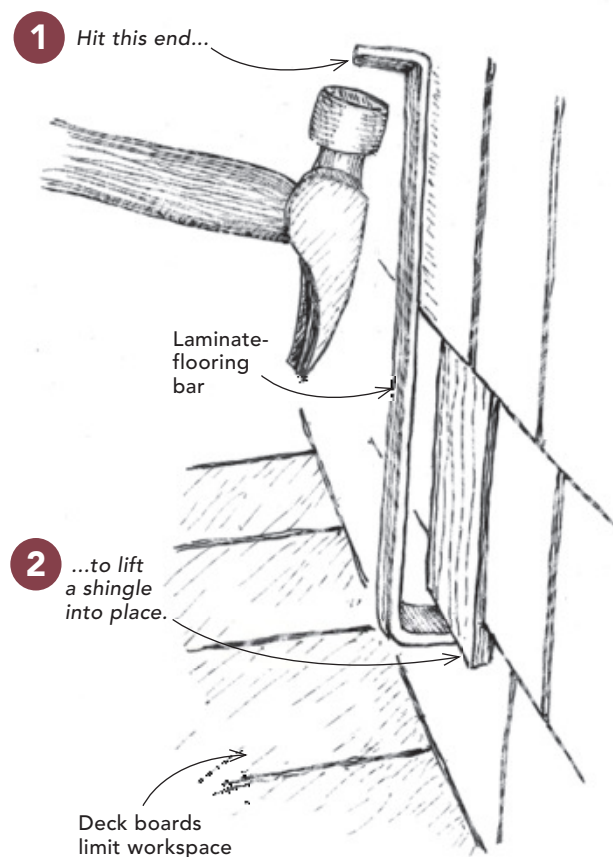
—JAKE BRUTON
Columbia, Mo.

Save those shins

I was helping my plumber run vent pipes in an attic. Even when wearing knee pads, crawling across and kneeling on the ceiling joists took a toll on my shins. The plumber didn't suffer, though. He could kneel comfortably for long periods with his shins lying across the joists. When we climbed out, I asked him about his kneepads. "Hockey shin guards," he replied.

I dusted the cobwebs off my hockey gear and strapped on my old shin guards the next day. What a difference! The hard shell and thick padding covers from above my knee to the crook of my ankle. Two straps hold them comfortably in place and the articulating knee-to-shin joint doesn't restrict movement. Now my hockey shin guards live in a gear bag ready for tile-setting, baseboard installation, and crawling around attics.

—MIKE GUERTIN
East Greenwich, R.I.



Shingle-replacement tool

Whenever there's not enough room to swing a hammer, such as when replacing shingles close to a deck or intersecting roof, I use a laminate-flooring bar to tap the shingle into place. See the drawing above: I hit the flooring bar at the top (1) and it drives the shingle up from below (2).

—ARON JONES
Grand Manan, N.B.



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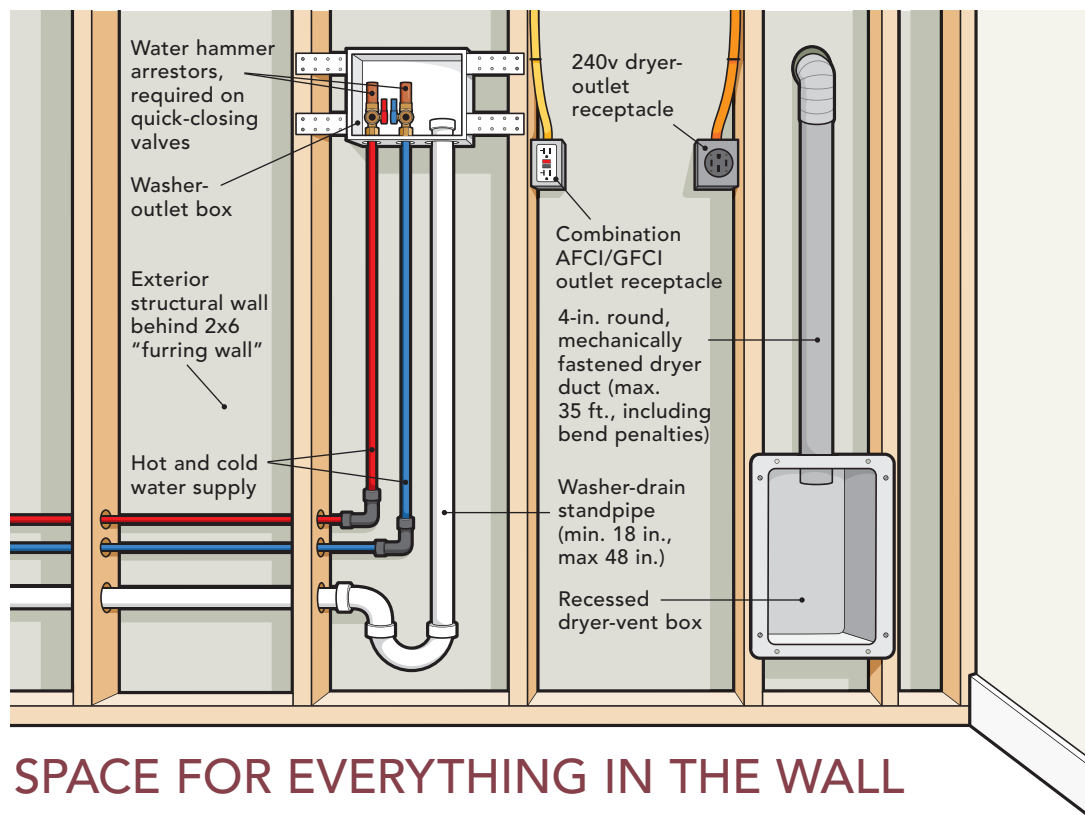
The laundry wall laundry list

Interior walls do a lot of things, from defining spaces to providing a landscape for receptacle outlets and family photos. There are some special walls, however, that contain and conceal the conduits for the systems that make our homes more than simple shelters. The laundry wall is one of them.

Drain and vent pipes, water supply lines, exhaust ducting, and electrical cables all share the space inside laundry walls, while receptacle outlets, recessed washer boxes, and dryer-vent-connection housings penetrate the real estate on the surface. The codes that address these various things are organized across many chapters and pages, and the hands that have a part in making it all work include the top four trades—building, plumbing, mechanical, and electrical. If the laundry wall happens to be an exterior wall, energy-conservation codes get dragged into the mix as well. It's no surprise that this wall is a common place for inspection failure.

Mechanical issues

In modern homes, most interior walls are framed with 2x4s, which aren't actually 2 in. by 4 in.—they're 1½ in. by 3½ in. This creates something of a geometry problem when it comes to installing the code-



SPACE FOR EVERYTHING IN THE WALL

The code sections that cover the components of a laundry wall are scattered across various chapters. On exterior walls, the best solution to accommodate everything is to construct a "furring wall" in front of a structural wall to allow full-depth insulation.

minimum 4-in.-diameter dryer-exhaust ducts—something that's been in model residential codes since 1995. A common solution to the incompatibility of a 4-in.-diameter round duct in a 3½-in. wall cavity is to simply squish the duct to fit. It took code writers a couple decades to catch on to this practice, and in 2018 the International Residential Code (IRC) added a sentence to the

section on dryer-duct installation (M1502.4.2) to kill the practice: "Where dryer exhaust ducts are enclosed in wall or ceiling cavities, such cavities shall allow the installation of the duct without deformation."

The argument that landed this in the code involves the mathematical certainty that an oval duct with the same circumference as a round duct is

always smaller in cross-sectional area. Though some don't believe the math, it remains true that squishing ductwork out of round reduces its performance. This can be avoided by simply attaching 1x furring strips to the face of the studs, but the plumbing may supersede that idea (we'll get to that).

Geometry arguments aside, there's a reason codes specify

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round dryer-exhaust ducts: They move air more efficiently than any other duct shape. Other shapes may be allowed, but they have to be upsized to perform as well as round ducts. The maximum duct lengths specified in codes are derived using round, metal ducts with smooth interiors (not flex duct). They take into consideration the minimum amount of pressure necessary to push lint, heat, and moisture past the backdraft damper and away from the

duct directly to the straight portion of the duct through a boxed recess in the wall. If that straight 4-in. duct is compressed in a 2x4 wall, it can be difficult to connect the round transition duct to it. Even if local code jurisdictions haven't yet adopted the prohibition on squished ducts, it just doesn't make sense to squeeze something in where it doesn't fit. And depending on how you orient the fasteners in the duct joints, the outer diameter of

learned that dryer ducts get full of lint anyway. Because of that, it's generally recommended that dryer ducts be cleaned periodically. The abrasive scrubbing, combined with jamming cleaning rods through the sharp bends in fittings, puts duct connections to the test. The taped and mastic connections of the past are notorious for failing inside the walls during vigorous cleaning. The choice to mandate fasteners and merely limit the protrusion length rec-

for a dryer—even a small laundry closet designed with plumbing for a stackable unit. Exceptions to general code provisions that affect permanent construction based on a choice of a temporary and movable appliance, however, are ones to be cautious of. They are indeed “code minimum.”

Plumbing and building compatibility

In 1967, the Uniform Plumbing Code increased the minimum diameter of a clothes-washer drain and trap to 2 in., and that standard still holds today. Beginning in 1973, the notching of nonbearing wall studs was limited to 60% of the stud width—this also remains in effect. Removing 60% of a 2x4 leaves you with a maximum hole diameter of 2³/₃₂ in. A common 2-in. schedule 40 PVC pipe has an outside diameter of about 2³/₈ in. Unless an approved stud shoe is installed or an engineered repair is designed, a 2x6 stud is the minimum required for the horizontal passage of a 2-in. drain. In other words, 2x4 walls are effectively prohibited from acting as laundry walls unless all the drain plumbing runs vertically in a single-stud bay.

Electrical anomalies

Electrical codes for the laundry wall have also evolved. Chapter 39 of the IRC and Article 210 of the National Electrical Code (NEC) state that where there is an “area designated for laundry equipment,” a receptacle outlet must be “installed within 6 feet of the intended appliance location.” This is meant to prevent the use of extension cords to bring power to washers and

Though some don't believe the math, it remains true that squishing ductwork out of round reduces its performance.

building, and the losses from friction and turbulence in these smooth, round ducts. That maximum length—35 ft.—does not include the transition duct from dryer to wall (which can be up to 8 ft. long), but instead is measured from where the duct starts in the wall to the point it exits the building. (Note: Manufacturer instructions, if different, should be followed, but must be provided to the code inspector; otherwise, duct requirements default to table M1502.4.5.1 in the IRC). You also have to figure in penalties from fittings, which can eat up many feet of allowable duct length. For instance, a single 4-in. 90° mitered elbow is equivalent to 5 ft. of straight round duct—and gets counted as 5 ft. of the allowable 35 ft.

To gain that 5 ft. back, builders often eliminate the first 90° fitting at the wall behind the dryer and attach the transition

a 4-in. duct could increase. What's that? Fasteners in the dryer duct? Yeah, that's a thing.

The decades-long prohibition of screws or fasteners protruding into a dryer exhaust was turned completely around in 2012, when the IRC began requiring that dryer ducts be mechanically fastened. This essentially mandates some kind of penetration into the duct, though the protrusion of these fasteners—either sheet-metal screws or rivets—is limited to 1/8 in. This abrupt change may come off as a major correction, but it's really more of a concession necessitated by the need to balance competing hazards.

Protrusions inside dryer ducts capture lint from the air stream, which reduces the internal diameter of the duct, increasing friction and turbulence, and raising the risk of fire. But over the decades when protrusions into ducts were prohibited, we

ognizes that a dirty duct can be cleaned, but a broken duct must be repaired—if and when it is finally discovered—so it doesn't keep dumping hot, moist air into the wall.

Related to the subject of lint collection inside a duct, recent code editions have also added the requirement for nail-plate protection when the duct is less than 1 1/4 in. from the nailing surface, such as when passing through top or bottom wall plates of 2x6 walls. I don't think it's worth building a laundry wall out of 2x8s just to avoid using nail plates.

Those who want to avoid dryer-exhaust ducting altogether do have an option: Get a condensing dryer. The exhaust system can be omitted if the appliance is installed prior to occupancy (at final inspection). If it's not there yet, though, a duct system must be provided wherever a space is provided

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dryers. More recently, codes have begun requiring all 125v, single-phase, 15-amp and 20-amp receptacles located in laundry areas to have both GFCI (ground-fault circuit interruptor) and AFCI (arc-fault circuit interruptor) protection. One protects people from electrocution; the other protects them from fire. There are various acceptable devices and methods for providing this dual protection, but the protection devices must be readily accessible. “Readily accessible” is defined in the code and includes a prohibition on having to remove obstacles—like a washer full of wet clothes—for access. These protection devices can also be installed at the electrical service panel, but

when installed at the receptacle they must be installed above or beside the appliances or in an otherwise accessible location.

Energy conservation

Considering all these features and rules for the laundry wall, I don’t recommend having it be an exterior wall, even though that’s commonly done because it allows for a direct and simple exhaust duct. IRC sections P2603.5 and P3001 allow water distribution and drain/waste/vent pipes in an exterior wall, but only if you “protect them from freezing by insulation or heat or both.” This is generally translated to requiring insulation between the pipes and the exterior side of the wall cavity, but then minimizing the insula-

tion between the pipes and the heated interior.

Some will argue the full R-value of the thermal envelope is not being realized when pipes, ducts, and washer boxes take up space meant for insulation, and they’re correct. However, the code accepts this reduction, as implied in table N1102.4.1.1, which states that insulation batts shall be cut to fit around plumbing and blown insulation blown behind plumbing. The intent here is to intentionally bleed heat into a reduced thermal envelope in order to keep the pipes warm.

The better (above code) design is to construct a clean thermal envelope filled with insulation and, if the insulation is air-permeable, covered on the

inside with an air barrier (taped drywall, for instance). In front of that assembly, construct a 2x4 wall for the service lines. As long as the dryer-exhaust duct runs straight through the two walls, larger studs or furring aren’t necessary. As for drilling holes for plumbing, do not let your eyes deceive you. This is not a wall; it is merely furring in front of a wall. The drilling limitations are meant for walls that have to resist lateral loads. Being adjacent to an exterior structural wall, that concern is no more. Go ahead and over-drill the 2x4 furring strips—but don’t forget your nail plates.

Glenn Mathewson is a consultant and educator with buildingcodecollege.com.



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PPE PACKER

I may be a slow learner, but the longer I'm in the trades, the better I am at wearing personal protective equipment (PPE). The key, in my experience, is to make it easy. To this end, I created a kit with all my personal protective gear, first-aid supplies, and related items in one organized bag that moves from my truck onto every job site. I've found that if you have to go back out to the truck, you might be tempted to skip a safety measure.

My kit is reasonably compact, convenient, and light. I use a medical bag from **Ergodyne (Arsenal 5215 Large Trauma Bag)** that costs about \$50. It has Velcro dividers for configuring the space to suit your needs, and I like that it has the medic logo and reflective trim that makes it easy to spot. It also makes it obvious to anyone on-site where the first-aid kit is. It has sturdy handles, a carrying strap, and generous side pockets. Besides a first-aid kit, I carry all the safety gear that helps me avoid needing medical supplies in the first place. I also throw in a few convenience items that make life more comfortable on the job site.

Brian Campbell, a carpenter in Minneapolis.

- 1 High-visibility safety vest
- 2 Flashlight
- 3 Parachute cord
- 4 Extra socks
- 5 Pens
- 6 Gloves in nitrile (shown), regular work gloves, coated cloth work gloves, and chemical-resistant gloves
- 7 Safety glasses in clear, light tint, and dark tint
- 8 Reading glasses (for the not-so-young finish carpenter)
- 9 First-aid kit
- 10 Toilet paper
- 11 Facial tissue
- 12 Hand sanitizer
- 13 Insect repellent
- 14 Sunscreen
- 15 Foam earplugs
- 16 Swiss Army knife
- 17 Carabiners
- 18 Hearing-protection headphones
- 19 Kneepads
- 20 Salt and pepper
- 21 Plastic cutlery
- 22 3M 6291 half-mask respirator with P100 particulate filters





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Wonder wipes

Nothing screams amateur hour like grubby fingerprints on freshly painted surfaces. I work on old houses, and there's always enough hidden grime to cause smudges at any stage of construction. No matter how careful I am, my hands are always dirty, and it's all too easy to mess something up. I decided to try Miracle Brands' MiracleWipes, which were on display at the home-center checkout. I was surprised at how well they work. Wiping my hands between tasks eliminates handprints on walls and ceilings, and a fresh wipe easily cleans smudges with no need for touchup. At \$15, they aren't cheap, but they're an easy way to up your game.

Andrew Grace, a remodeler in Ligonier, Pa.

Speedy sprayer

A roller or brush can never replicate the glass-smooth finish of a pro-grade airless spray rig. The only downside is the time it takes to set up before painting and clean up after you're done. I'm a remodeler, not a professional painter, so I typically get asked to paint a few doors or the odd cabinet or piece of furniture. I needed a way to save time on my small spray jobs, so I bought a Graco Ultra cordless airless paint sprayer. It's a true airless tool, made to spray heavier-bodied latex and oil-based paints, and is capable of spraying about 1 gal. of paint per charge of the 2-amp-hr. DeWalt 20v Max battery. The tool uses a piston pump that can be swapped out with only a screwdriver, just like full-size rigs.

The Graco uses the new-style green FF LP tips. "FF LP" stands for "fine finish, low pressure." These tips are designed to provide a pro-quality finish at 50% of the pressure of regular airless tips with less overspray. Paint is supplied from a plastic liner (about \$2 apiece) that can be washed out or tossed after use. The liner fits inside a hard plastic support that threads onto the sprayer housing, but leaves room for you to squeeze the bag to push air out through a one-way valve in the lid. Setup couldn't be easier: You fill the disposable liner with material, squeeze the liner to purge the air, prime the pump, and then set the switch to spray.



Dial it back. A thumb wheel at the back of the sprayer allows for pressure adjustment as needed.



Graco Ultra Cordless Handheld Airless Sprayer (17M363)

\$570 (includes FF LP 514 tip, four FlexLiner bags, and two 2-Ah batteries with charger)

I have tried handheld sprayers in the past, but they were more toy than tool and yielded questionable results. Not so with the Graco Ultra. I got a sable-smooth finish with minimal learning curve, and the FF LP tips had noticeably less overspray. I was able to spray eight raised-panel interior doors in 30 minutes. To me, the Ultra really shines when it's time to clean up. I rinse the paint-cup lid, clear the purge valve, and swap in a clean liner. A quick shake with clean water, a few seconds of priming to rinse the pump and spraying to clear the tip, and the sprayer is ready for the next job. The whole process takes less than 10 minutes.

If there is a drawback to this tool, it's the weight. At a few pounds, it's considerably heavier than an airless spray gun and hose. That said, there's no hose or cord to drag around, and because the sprayer only holds a quart of paint, it's not for whole-house projects that would require many refills and extended use. If you're like me, and have a lot of small spray jobs, this is the perfect sprayer. It provides a professional finish with a fraction of the setup and cleanup time of a full-size model. It's a no-brainer for a remodeler, and I bet more than a few pro painters have one in their arsenal for working on small jobs.

A.G.



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Back specialist

The best tool for attaching cabinet backs and building jigs with thin material is an 18-ga. narrow-crown stapler. The staple's large head (compared to a brad) prevents it from blowing through the thin plywood, and its pair of legs holds tenaciously. The most feature-laden narrow-crown stapler I've come across is the recently introduced V3/90.40 from Cadex Tools, a Canadian company known for its high-quality pin nailers and brad nailers. The new stapler has an on-board blow gun, adjustable depth of drive, and a rotating hook so you can put it on either side of your belt. It's not a tool you'll use every day, but when you're attaching cabinet backs, it's the right one for the job.

Patrick McCombe, senior editor



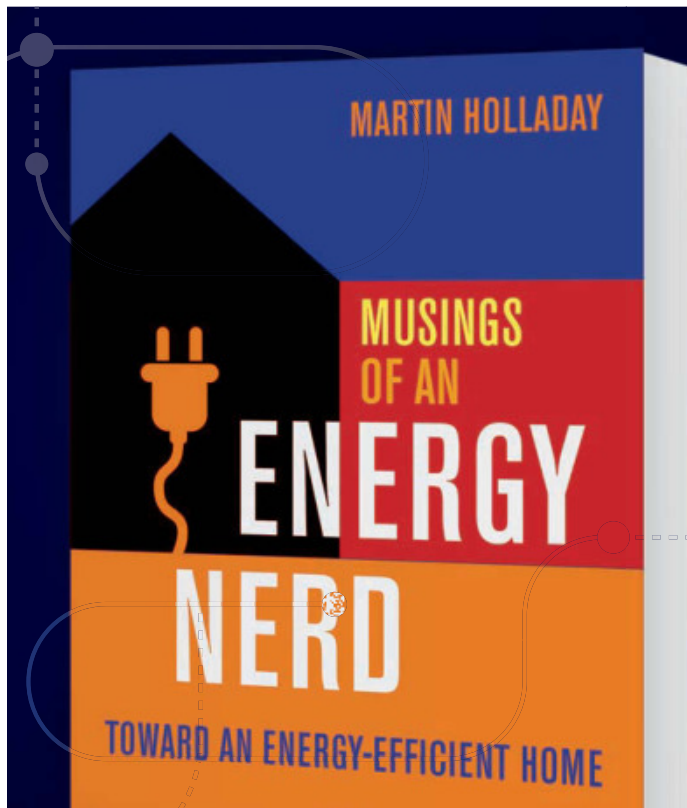
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narrow-crown stapler**

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Photo: Melinda Sonido



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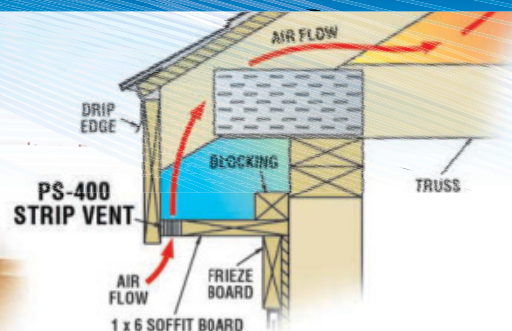
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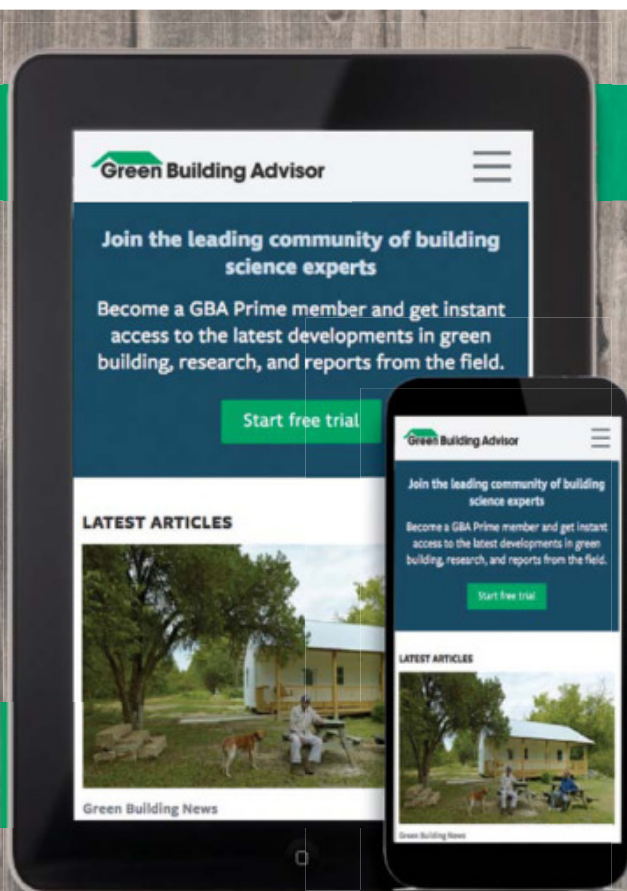
Construction-ready cooler

Cold drinks are a necessity when the summer sun drives the temperature on roof decks toward the triple digits. I provide ice and drinks for my crew, and I've always used cheap coolers because the investment in a boutique model never made sense to me. But after hearing loads of positive feedback and adding a few more guys to the crew, I decided it was time for an upgrade, so I purchased an RTIC 110 hard cooler for about \$355. The "110" describes the capacity: 110 quarts of liquid, or 110 12-oz. cans. Translation: It's a huge cooler. And it's heavy—the rotomolded plastic shell and thick insulation drive the weight up to almost 50 lb. when empty.

Everything about this cooler is pro grade. It has stout rope handles, and heavy-duty rubber T-latches hold the lid closed. The lid seal works almost too well—if the lid drops closed, it vacuum-seals shut, and you have to pry it open with a flat bar. RTIC claims it will keep ice solid for 10 days. I haven't experienced that level of longevity, but two 27-lb. bags of ice will last all week. It might seem like a lot of money for a cooler, but the RTIC saves me over \$25 a week in ice purchases. And judging by the abuse it has already taken, I expect it to provide ice-cold drinks for my crew for many more summers.

A.G.

Photo: courtesy of RTIC



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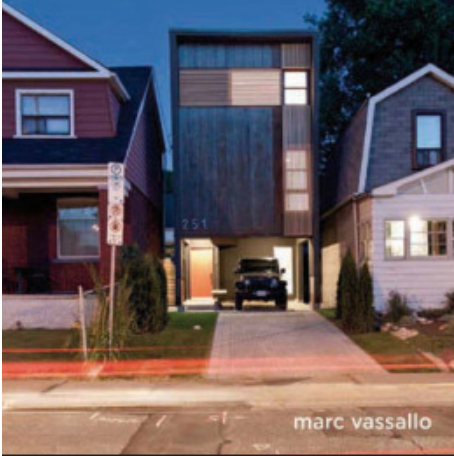
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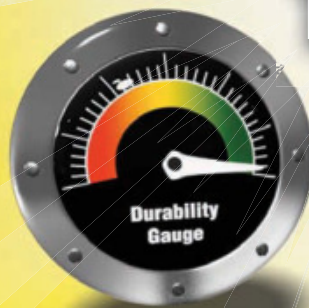
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A Case for Double-Stud Walls

Straightforward construction, common materials, and low embodied carbon are just some of the benefits of this superinsulated assembly

BY DAN KOLBERT

The ideal wall is debated constantly among conscientious builders, and unsurprisingly, opinions vary. Since my company is focused mostly on renovations, and we rarely build more than one new house per year, I have a lot of time to rethink my wall sections between each build. In the end, I keep coming back to the method we've used since we built our first high-performance home more than a decade ago—double-stud walls filled with dense-pack cellulose insulation. This double-stud wall approach not only uses an insulation you can feel good about, but it's relatively affordable, easy to build, and can dry in both directions.

Even the best-performing wall design will only succeed if it's buildable. The more complex water management, air-sealing, and other details become, the more likely you'll fail.

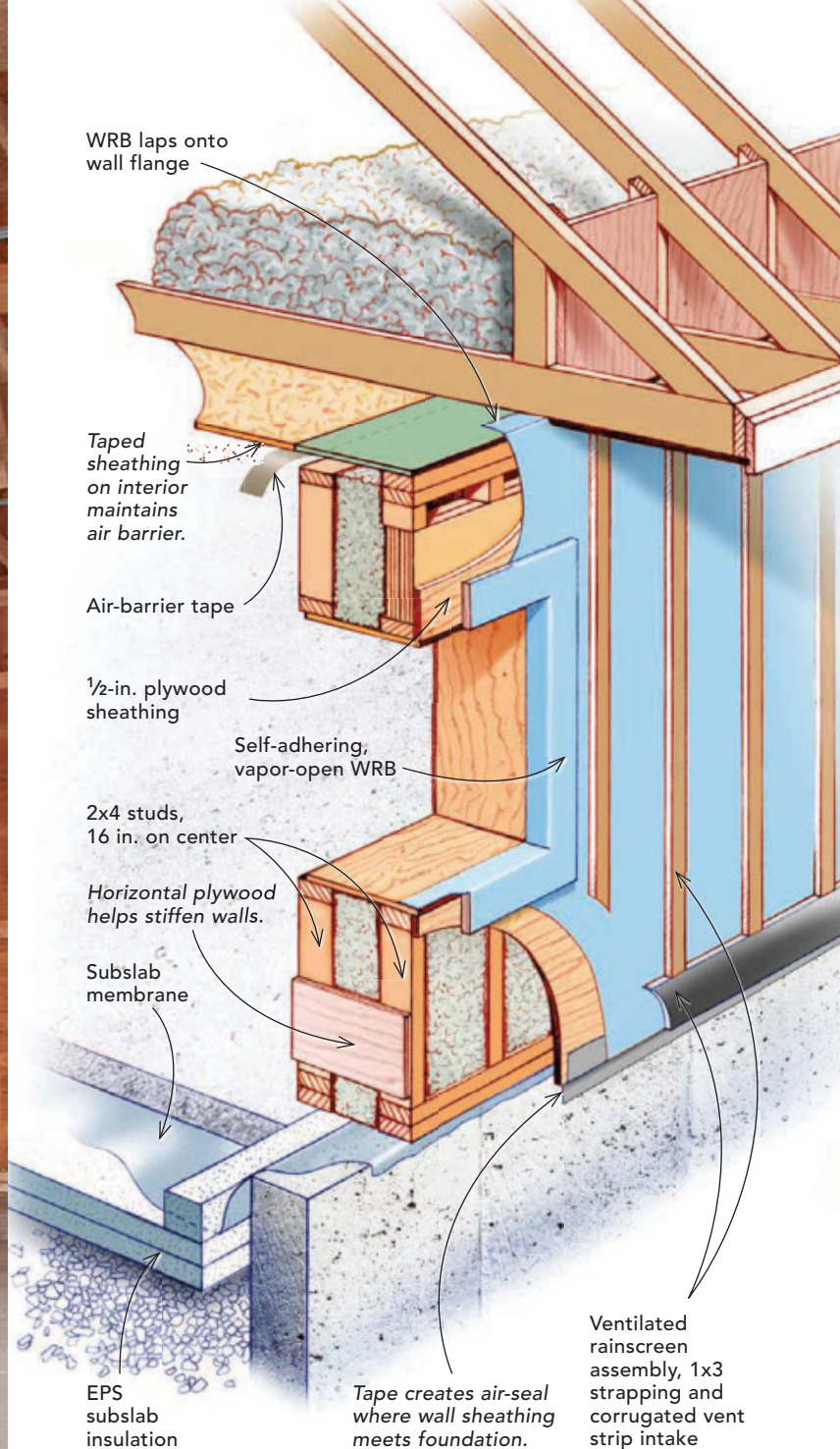
There's nothing in a double-stud wall that a competent carpenter doesn't already know how to do. We make our walls about 12 in. thick, for an R-value of about R-44, with a full 5 in. of thermal break between the two 3½-in.-thick stud walls. By contrast, other methods

of building high-performance, thermally broken walls, like installing rigid foam or other continuous exterior insulation, require additional detailing to get the flashing and air barrier right, and to provide adequate nailing for trim and siding. Plus, exterior insulation has to be protected from rodents and insects. With double-stud walls, all of the insulation is inboard of the sheathing.

Sequencing the build

There are different ways to build a double-stud wall, but my preference is to keep it as much like building a standard house as possible.





A VAPOR-OPEN ASSEMBLY

Our 12-in.-thick double-stud wall assembly includes two 2x4 walls separated by 5 in. of uninterrupted insulation space. Though we're confident that these walls have no greater chance of moisture issues than any other assembly, we use plywood sheathing, which becomes more permeable than OSB when it gets wet; a vapor-open, fully-adhered water-resistive barrier (WRB), which also provides the exterior air-sealing; and only a class III vapor retarder when combined with ventilated cladding. Cellulose insulation is used because it can absorb and redistribute moisture, then dry when conditions are right.

This means the exterior walls are built first and are the load-bearing portion of the assembly. This is one area that's actually easier than single-wall construction—the exterior walls are 2x4 rather than 2x6, so they're faster to build and easier lift into place. With 2x4 exterior walls, keep in mind that you may need an engineer to sign off on your wall design, especially if the walls are taller than normal or you want to space studs 24 in. on center, and that you will need to size your headers to fit on 2x4 jacks.

We typically get the entire exterior of the house framed all the way to the ridge, then come back and build our interior walls. Since

OUTER WALLS

SET THE STAGE

After snapping lines for the walls, we fasten a pressure-treated sill plate to the foundation. Although a redundant measure, we always include sill seal under the plate for air-sealing.



OUTER WALLS ARE EASY We rely on the outer walls to carry the loads of the structure, but since there isn't much concern about limited cavity insulation or thermal bridging, we use 2x4s and space them at the conventional 16-in. layout.



WHY PLY We prefer plywood, which is relatively vapor-open compared to OSB options, to allow the wall assembly to dry to the exterior. We pad out window and door openings to match the thickness of the rainscreen before installing the self-adhering WRB, making it easier to integrate the window flashing later.



THINK AHEAD Split-release air-sealing tape is a clean and effective way to connect the wall framing to the foundation below. Apply it before the WRB and rainscreen system are installed, overhanging it to be adhered to the concrete after the wall is tipped into place.



LET IT BREATHE The vapor-open nature of plywood only helps if you choose a vapor-open WRB and provide ventilation between the WRB and the cladding.

FURRING WHILE IT'S FLAT

Before lifting or tipping the wall into place, we like to get the rainscreen system in place. Our go-to is a corrugated plastic intake vent and 1x3 battens.



they're not load bearing, there are no structural headers in the interior walls. You can align the interior wall plates against the exterior walls and transfer window and door locations, and then frame the interior walls short enough so that you can lift them into place under the ceiling joists or strapping. Another benefit of double-stud walls is that you can lay out the exterior walls specifically for sheathing and the interiors specifically for drywall.

Some builders have tried to use 2x3s for the interior half of double-stud walls. It may seem like a good idea, but it's not worth the trouble. The quality of 2x3 lumber is typically awful, and even if the pieces are straight when you get them, they tend to warp and twist after installation.

If your house is slab-on-grade, the double walls may not be sitting on much. We typically have an 8-in. foundation wall, then 4 in. of perimeter foam, then the slab. With a 12-in. wall thickness, our interior wall is sitting on top of foam. To deal with this, we cut scraps of 2x or strips of scrap plywood to 12-in. lengths and use them to connect the two walls at the base to hold the interior wall rigid.

There's a lot to like about cellulose

I'm always looking for ways to simplify the construction process, and I think a building with one insulation material is better than one with

multiple. Cellulose allows us to use the same material everywhere except at the foundation and slab. It is an affordable material, has very low embodied energy, can be repaired, and works very well as a buffer when vapor drive spikes. It can hold and redistribute moisture, releasing it to the dry side, in ways that foam, fiberglass, or mineral wool can't. Finally, using wood rather than foam or other petroleum-based materials is key to reducing the carbon footprint of new buildings, and cellulose is wood. (On that note, it's important to make sure that the cellulose your installer uses is a borate-treated product for resistance to fire, insects, and rot.)

While our climate is overwhelmingly heating dominated, with vapor drive to the exterior for much of the year, our summers are getting hotter and more humid. This increases my interest in wall assemblies that allow drying in both directions—another reason why skinning a house in rigid-foam insulation makes me more nervous than the cold-sheathing risk of a double-stud wall packed with cellulose (see "Modeled risks remain unproven in our builds," p. 37).

It is critical to note that all of the houses our firm builds include a rainscreen of some sort, which varies depending on the siding. We typically use a three-dimensional mesh product like Benjamin Obdyke's HomeSlicker for shingle siding, and 1x3s or plywood ribs for clapboard siding. This allows any moisture from vapor drive in

INNER WALLS



CAP THE WALL To connect the inner and outer walls and maintain the continuity of the air barrier, we install strips of sheathing to the outer-wall top plates, overhanging toward the inside. The flanges should be a few inches wider than the total wall thickness.

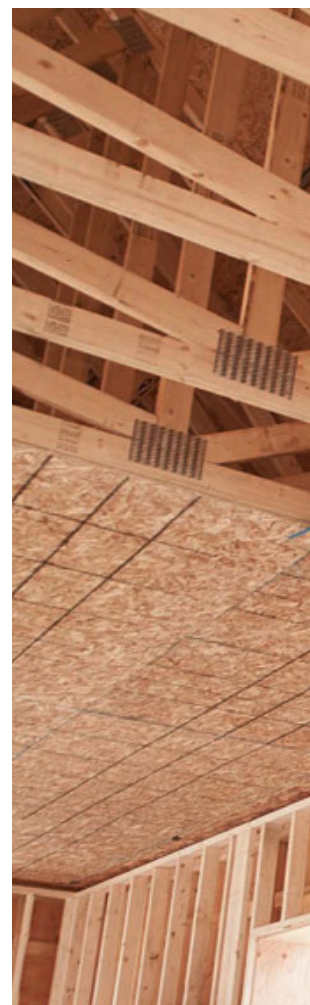
OUTER MARKS THE INNER We build the inner wall using a double bottom plate. The first bottom plate is fastened to the slab, and then the second is held, along with the top plate, against the outer wall for marking, eliminating concerns about offset framing.



ROOM TO RAISE To make the inner stud wall easy to tip into place, we frame it 1½ in. shorter than the exterior—easy to do by simply using one less plate than the exterior wall.



FASTEN THROUGH TO FRAMING Once the wall is upright, it has to be plumbed in both directions before being fastened. We use screws driven through the top plate and into the flange above, which should already be backed up by the ceiling framing.



either direction to drain or evaporate instead of getting trapped and rotting out the siding, sheathing, or both. I think it is very dangerous to not include a rainscreen in any superinsulated wall assembly.

A skilled insulation installer is a must

Once the house is framed, things progress pretty much as on any other house. Unlike with other thermally broken methods, window and door installation and flashing is the same as on a “standard” assembly. The drainage plane is in line with the window flanges, making lapping of materials simple. And our clients love the deep interior window stools these thick walls create.

Since we’re not production builders and all of our projects are custom homes, it’s hard to develop meaningful cost comparisons. The exterior walls are less expensive than most high-performance assemblies, since 2x4 walls use less material and less labor. The interior wall adds cost, but the walls are easy to lay out and fast to build, and electricians and plumbers love that they can do their rough-in with far less drilling. The insulation will cost more than in a code-level wall, but not necessarily more than a home with continuous exterior rigid foam and cavity insulation. On top of all that, you have to weigh the savings in the homeowners’ heating bills, and in the durability of the home itself.

Double-stud walls do require highly skilled installers to get the right density of the cellulose insulation. We break up walls by blocking between bays with plywood or netting so the installers don’t have to dense-pack huge volumes.

A common question is whether you can use batts instead of dense-pack cellulose. We’re cautious of that approach. I think the reason that moisture-profile modeling of double-stud walls misses the mark is that it doesn’t take into account the moisture-buffering capacity of cellulose. No other readily available insulation can mimic this phenomenon of absorption and redistribution. Dense-pack cellulose is fairly common in New England, less so in other parts of the country.

There are other blown-in products available, such as mineral wool and fiberglass. Mineral wool may have sufficient density to mitigate convective loops or moisture transport, but I have less faith in blown-in fiberglass. And batt insulation of any type is extremely difficult to install well enough for safety. Finally, while I am undecided on the need for a “smart” vapor retarder with cellulose, with any other product I would definitely recommend a variable-permeance membrane like SIGA’s Majrex, CertainTeed’s MemBrain, or Pro Clima’s Intello. □

Dan Kolbert is a builder and remodeler in Portland, Maine.
Photos by Scott Gibson.



KEEP IT CONTINUOUS

After skinning the ceiling with sheathing, we tape all the seams, including the connection to the double-stud wall flange, to maintain the continuity of the air barrier.



Modeled risks remain unproven in our builds

The main argument that I hear against dense-packed double-stud walls is the concern about “cold sheathing” that comes up when the assemblies are computer modeled. I consider this the Yeti of building science—it is much discussed, yet rarely seen.

We returned to our first double-stud house several years ago to replace a window with a door. The window was on a wall that was not only north-facing, but faced the water as well. If there was anywhere on the house where we should have seen moisture problems, it was here. Nevertheless, when we cut into the wall we saw no signs of condensation or leaking on the sheathing.

On several more recent houses, we have buried OmniSense wireless monitors in the walls and ceilings to measure temperature, relative humidity, dew point, and wood moisture content. Nothing in the data indicates the kind of problems that the modeling suggests is unavoidable, at least in our area (climate zone 6). Even so, if these walls are even theoretically dangerous, why do we continue with them? Simply put, I think they are better walls on almost every front.

Stripping

Tips to take
your wall from
paper to paint with
minimal damage

BY MIKE DiBLASI

In the 30 years I've been a professional painter, I've stripped a lot of wallpaper. The fundamental idea is to make it as easy as possible to remove so you don't damage the wall underneath. To do that, it helps to understand how wallpaper is made.

Wallpaper has two layers: facing and backing. The facing has the pattern, and can be made of vinyl, paper grasses, fabric—almost anything. No matter what the facing is, you need to get past it so you can get to the backing, which is held to the wall with water-soluble adhesive. Unless the paper was hung using the wrong glue or applied to an unprepared wall, the wallpaper paste should give up its grip after a good soak with water. Many folks are under the impression that you need to use a steamer to release the glue, but the reality is that only 1% of our work pulling off wallpaper requires a steamer—almost always because the walls were improperly prepared. I'll talk more about how we wet the glue later. First comes the prep.

Protect the house

Before any wallpaper removal starts, it's important to protect the house and



Wallpaper

its occupants' stuff from the dust that often comes from the removal process. We remove all of the furnishings from the space and cover the entire floor with Ram Board surface protection, using blue painter's tape at seams and around the perimeter. Once the floor is covered, we close off the workspace by taping plastic over doors or building temporary walls with plastic sheeting and support poles. If the floor is especially valuable or easily damaged, we coat the floor protection with water-based polyurethane, which adds to the board's water repellency and dries quickly with little odor. It can take a long time to cover the floor and build enclosures, so we include this work as part of any proposal and remind potential clients we're doing all we can to protect their house and belongings.

Just scratch the surface

The facing on vinyl wallpaper, owing to its tear resistance, usually pulls off as a single piece. Start at the top or bottom of a panel and try to lift a corner and begin the separation. If you can get the facing to split from the backing, continue to pull slowly and steadily. Unfortunately, the facing on paper wallpaper rarely comes off its backing as a single piece. Instead you have to sufficiently abrade or score it to create openings to access the backing. Zinsser has sold a tool in hardware and paint stores for decades exactly for this purpose—PaperTiger—which has several spiky wheels that move in a random pattern as you roll it across the wallpaper. It works, but I don't like it because its spikes leave thousands of tiny holes in the drywall or plaster behind the paper. If the wall is being painted (instead of repapered), all those tiny holes will have to be repaired, which wastes a lot of time.

A faster and less-damaging way to get through the facing is to use a random-

PULL OFF THE FACING



TRY PEELING FIRST

Wallpaper is made up of two layers—a facing and a backing—and you need access to the backing because it's the layer that's glued to the wall. If you're lucky, the facing will separate easily with the help of a putty knife, so always start there before trying more involved methods.



SAND THE FACING

If the facing tears off in small pieces, you'll need to settle for leaving it in place and abrading it so that you can access the backing in order to wet and remove it. Sand the whole surface, using 36-grit paper in a sander connected to a vacuum, always wearing a respirator.



PLASTIC PREVENTS A MESS

After sanding, tape 3-mil plastic to the baseboard with high-humidity masking tape to catch and contain the wet, gluey wallpaper as it's removed. Fold over the untaped edge so the plastic holds any water that runs onto the floor. Leave the very top of the baseboard exposed so you can reach all the way to the bottom of the wallpaper.

GET AT THE GLUE

MAKE IT WET

The key to removing wallpaper is to wet the backing and not rush the process. Let nature's universal solvent do its work. If we can make a mess, we'll use a garden sprayer because it puts out a lot of water quickly. In finished spaces, we use an airless sprayer, which keeps the floor relatively dry.



WAIT FOR BUBBLES

You can tell when the water has done its job because the backing will start to bubble, usually about five to 15 minutes after you wet the surface. You can start scraping a few minutes after the first bubbles appear.



orbit sander. Good dust collection while sanding is a must, so we hook the sander to a dust-collecting vacuum and use filter bags and HEPA filters, and we also wear respirators because even with a good vacuum there's still a lot of dust in the air. On this project, we used a Festool ETS 125 with their Saphir 36-grit sandpaper. The sander is connected to a Festool CT 36 Dust Extractor. I also have a Bosch 3725DEVSN and a Fein Turbo II vac that work just as well.

Before tearing into the paper with the sander, it's important to know whether you're dealing with plaster or drywall underneath. If the wall is plaster, you can sand a little more aggressively, because the plaster surface is tougher than drywall's paper surface. If you're working over drywall, you need to go slow so you don't burn through the drywall's white-paper face. If you reach the drywall's brown-paper layer, you will have to repair and prime the surface before painting or repapering. Sometimes we'll dial back the power on the sander to avoid burning through.

Sanding the two walls in the stairway shown in the photos took about an hour. You can tell when you've sanded enough because you start to see the backing in spots. There's no need to remove the entire paper facing, you just want to get through the facing's protective coatings so the water can reach the backing and reactivate the paste.

SCRAPE TO GET STARTED

Use a 4-in. tapping knife to start removing the paper. Plaster walls are somewhat wavy and the small knife is less likely to catch on the uneven surface. Once a few inches of paper are separated from the wall, pull gently on the lifted section. If the wall was properly prepared and the paste is completely wetted, the paper will pull off easily with only occasional scraping necessary.



RINSE AND REPEAT

After pulling the wallpaper panels from a section, wash the wall with warm water and a grout-scrubbing sponge. The sponge and water remove any remaining paste from the wall. Change the water about every 300 sq. ft., and finish rinsing each stripped section before wetting the next.



WORK IN SECTIONS

Once you've removed the paper and rinsed the wall, start over by wetting another three or four panels. Don't leave the wet paper during lunch or the glue can set up again and you'll have to wet it and wait again.

Improper prep

Occasionally we run into wallpaper that's been applied to the wall without sizing. Applied like paint or primer, sizing creates a slick surface that allows you to easily position the paper while you're hanging. It also makes it easy to remove the paper when it's time for a change. If the wall wasn't prepped correctly, wallpaper removal becomes much harder. When this happens with a plaster

wall, we can usually just sand all the way through the wallpaper to remove it, but if it's improperly prepared drywall, you will almost certainly damage the drywall's paper surface. You can fix damaged drywall by sealing the surface with a specialty primer (see "Toolbox," p. 43). Fortunately, the plaster walls in this early-20th-century farmhouse were in good repair, and properly prepared with primer and sizing.

The fact that the walls were in good repair brings up another point. Sometimes plaster walls are in such rough shape that the only thing that's holding them together is the wallpaper. You can often tell from bulges in the paper, but sometimes the plaster's poor condition isn't obvious. In an old house, you'll usually see some localized damage from leaks or broken pipes. Whether the damage is localized or widespread, I advise

PREP FOR A NEW FINISH

CLEAN UP RIGHT AWAY

Once you're finished pulling off the paper in the entire room, carefully roll up the plastic and wet paper. If you leave it there, someone will inevitably walk through the wet mess and get wallpaper paste on something in a neighboring room.



GIVE IT A GOOD LOOK

Using a bright raking light, look over the entire wall for damage and feel the surface to be sure there's no remaining wallpaper paste. Areas that feel rough or have a nonuniform sheen need to be rinsed again with clean water.



TEST THE WALL

When burnished with a rag dipped in denatured alcohol, water-based paint will rub off on the rag, meaning it's suitable for an acrylic-latex topcoat. Oil paint is unaffected by the burnishing test. If the paint is oil, we top-coat a small section as a test. If the test patch dries without sags or wrinkles, we paint without priming. If the patch wrinkles or sags, we prime with a hi-bond primer.



clients that we will have to make plaster repairs before we can prime and paint. If the damage is widespread, it may make more sense to put on another layer of wallpaper over the existing wallpaper instead of making extensive repairs.

Use hot water

When it comes time to wet the backing, we always use the hottest tap water we can get. If the paste is especially tough, we'll boil water

with an induction tea kettle. It's impossible to handle boiling water, so we pour it in roller pans and apply it with 9-in. rollers. There are chemicals sold to make wallpaper easier to remove—DIF from Zinsser is a common example. It works well, but I try to avoid it because it smells really bad and is not typically necessary with properly prepared walls.

Removing the wallpaper happens in sections. I wet the wall, wait five to 15 minutes, and then scrape off three or four panels (6 ft.

to 8 ft.) at a time. Once I've scraped off the paper, I rinse the wall with water.

Prep for a new wall covering

If we're going to repaper and the wall is in good shape, we re-size with whatever sizing the paper manufacturer requires. If we're going to paint, we need to determine if the underlying paint or primer will create adhesion problems with the new layer of paint, so we paint a small area using the planned



PATCH IT UP

Before painting, fix any damage to the wall with joint compound and spot-prime the repaired areas with a general-purpose primer, like Fresh Start from Benjamin Moore or Multi-Purpose Primer from Sherwin Williams.



MAKE REPAIRS CONSPICUOUS

It's easy to miss a spot when you're applying compound to walls coated with white primer. Adding some blue chalk to all-purpose joint compound highlights patched areas so they can be sanded smooth before painting or repapering.



GARDZ from Zinsser (about \$30 per gal.) is a special primer made for sealing damaged drywall before skim-coating or repairs. It works well for repairing the damage that comes from pulling wallpaper from improperly prepared drywall.

BONDING PRIMER can often solve adhesion problems from oil-based primers sometimes found under wallpaper. They are meant to stick to slick surfaces and are compatible with almost any water or oil-based topcoat.



At \$280, a SureFire **RECHARGEABLE HEADLAMP** may seem like an extravagance, but its perfectly even light, free of hot spots, makes it easy to search the wall for damage and to ensure all of the glue residue has been washed off. The Fenix rechargeable headlamp (above) has a hot spot in its beam, but at \$75, it's a more reasonably priced second favorite.

Skip the sponges in the home center's paint and decorating aisle. Instead, go to the tile section and buy a **SCRUBBING SPONGE** for grout. Its textured side is good for removing any remaining bits of paper, and it costs half as much as a wallpaper sponge.



topcoat as a test. If the test area ends up showing sags or wrinkles, we re-prime with a bonding primer and then paint with the chosen topcoat.

Removing wallpaper may not be fun—and the process may be more involved than you would expect—but it is satisfying. □

Mike DiBlasi is a painting contractor in Pleasant Valley, N.Y. Photos by Patrick McCombe, except where noted.



The Evolution of a Pretty Good House

A detailed look
at the new
low-carbon
edition of the
grassroots
building
standard

BY MICHAEL MAINES

Have you heard about the building standard that's completely voluntary and has no set requirements? It's called the Pretty Good House (PGH), and the idea is to use good design and proven building science to reach a practical level of performance in a durable, lovable, net zero energy-ready structure. The PGH was conceived in 2011 at a building science discussion group hosted by Performance Building Supply in Portland, Maine. Dan Kolbert, a builder in Portland and moderator of the discussion group, had grown frustrated with other performance-rating programs for being too restrictive, too resource-intensive, and too hard to convince clients to invest in. We brainstormed about what practi-

cal level of performance—and other features—a PGH would include. I wrote a blog post summarizing our discussion on [GreenBuildingAdvisor.com](https://www.greenbuildingadvisor.com) (GBA), and the idea took on a life of its own. Recently, we updated the PGH concept to address the urgency of the climate crisis.

Incorporating embodied carbon

The release of the United Nations's 2018 climate-change report highlighted the need to considerably reduce global warming emissions and also made evident the building sector's significant contribution to the problem. Over the last eight years, many of us in the discussion group have developed a deeper understanding of high-performance building, so we decided to review

our initial list of PGH attributes. Surprisingly, little had changed—a testament to the practical nature of our original ideas. The most critical addition was the carbon footprint of a house.

“Carbon footprint,” or “upfront carbon emissions,” can be defined as the sum of carbon emissions over a product’s lifetime—from the extracting of raw materials to its processing, shipping, assembly, maintenance, and eventual disposal or recycling. “Carbon emissions” is shorthand for carbon dioxide (CO₂)—equivalent emissions. As a prevalent greenhouse gas, CO₂ is used as a unit of measurement, meaning the effect other greenhouse gasses have on trapping heat are expressed as the equivalent in CO₂. This matters because there is more CO₂ (and other greenhouse gasses) in our atmosphere than there has been for at least 800,000 years. In fact, there is nearly 50% more carbon in the atmosphere now than there was at the start of the Industrial Revolution. Time is running out—if emissions continue at their current rates, temperatures will continue to rise. The U.N.’s team of scientists says we need to reduce emissions by 50% by 2030, and by 100% (net-zero carbon) by 2050. Those ambitious targets don’t guarantee a safe future, but they do improve the odds.

An effective forum

No discussion about the PGH is complete without talking about the group process that birthed it. I believe the Portland group was the first of its kind, but there are now several around New England, and they are starting to pop up in other regions too. While online groups, books, webinars, and conferences all have their place, it’s easy and fun to get together informally over drinks to talk about building science. For the group I started in central Maine, I chose the name “BS and Beer”—“BS” stands for building science, of course. Others are welcome to use it (but please don’t try to copyright it). Get in touch at prettygoodhouse.org so we can add the group to the list. The website includes guideposts to help designers, builders, and current or aspiring homeowners understand and think through all the elements when creating their own PGH.

A final note: *The New Carbon Architecture* by Bruce King is a must-read for anyone who wants to learn about low-carbon building. In a GBA comment, King wrote, “Borrowing from Michael Pollan: Build, but not too big, and mostly with plants. Nuff said.” □

Contributing editor Michael Maines is a residential designer and building science consultant in Palermo, Maine.

WHAT MAKES A HOUSE PRETTY GOOD?

Now is the worst time in human history to dump heavy carbon loads into the atmosphere, but that’s exactly the result of many construction practices. Even builders who are concerned with energy efficiency often front-load enormous amounts of carbon-intensive materials with the expectation of savings over the building’s life cycle. So, we must ask ourselves: If we have only a decade to mitigate the worst impacts of climate change, what should we do instead? Building Pretty Good Houses is one answer, and they should:

Include **photovoltaic panels** or be PV-ready. Panels pay their carbon debt in 2 to 4 years.

Have **good windows and doors**. Even the best of these components perform like an R-10 wall, which is pretty bad, so don’t skimp here.

Be part of a **sustainable community**. Plan for access to community solar, jobs and services that minimize driving, and shared infrastructure such as roads, internet service, and the electrical grid. A one-hit wonder in the middle of the woods often comes with a bigger carbon footprint than a community-based home.

Invest in the envelope and other parts that are hard to change later. **Insulation and air-sealing** should be good enough that active heating and cooling systems can be minimal.

Be a **renovation rather than a new build**. The embodied carbon of an existing house has already been sequestered. When renovating, aim for at least the current International Residential Code performance for new homes.

Use **air-source heat pumps for heating and cooling**. Minisplits can be efficient to -15°F or below, are affordable (especially for the sizes and number of units needed in a PGH), and are relatively simple to install. In some locations, other systems make more sense, but in most places it’s hard to go wrong with a minisplit.

Have balanced mechanical ventilation with heat recovery for **high indoor-air quality and low energy usage**. Be sure to commission the equipment after installation—it often needs to be adjusted.

Be **as small as possible**—specifically 1000 sq. ft. for one person, 1500 sq. ft. for two, 1750 sq. ft. for three, and 1875 sq. ft. for four. (Some people find these numbers too low, others say they are too big, but they are Pretty Good targets.)

Be built with **wood and plant-derived materials**. Ensure wood is sustainably harvested and locally sourced, if possible. Otherwise, healthy forests are better left to remove CO₂ through photosynthesis, sequestering it in the plants and soil. In general, the more that materials are processed, the higher their carbon footprint.

Be **simple and durable**. Simple shapes are easier to air-seal and insulate, they perform better in harsh weather, and they require fewer materials and less maintenance than more-complicated buildings.

Follow our version of the “KISS” principle: Keep It Simple and Safe. A house should be **easy to understand and operate**.

Be **cost-effective**—i.e., make improvements until they stop making financial sense.

PGH 2.0 WHAT MAKES A PRETTY GOOD HOUSE EVEN BETTER?

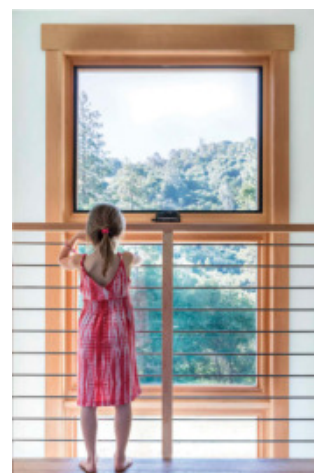
I've written previously about a few techniques I use when designing high-performance, low-carbon homes, such as building a concrete-free slab foundation (see "Minimizing concrete in a slab-on-grade home," *FHB* #282). In the pages that follow are two concept houses showing examples of how proponents of the original Pretty Good House movement can incorporate low-carbon strategies. While somewhat more complicated and more expensive than code-minimum assemblies, they provide much better comfort and energy savings. They also allow for smaller heating and cooling systems without much increase in embodied carbon or changes to conventional practices.



Foundation

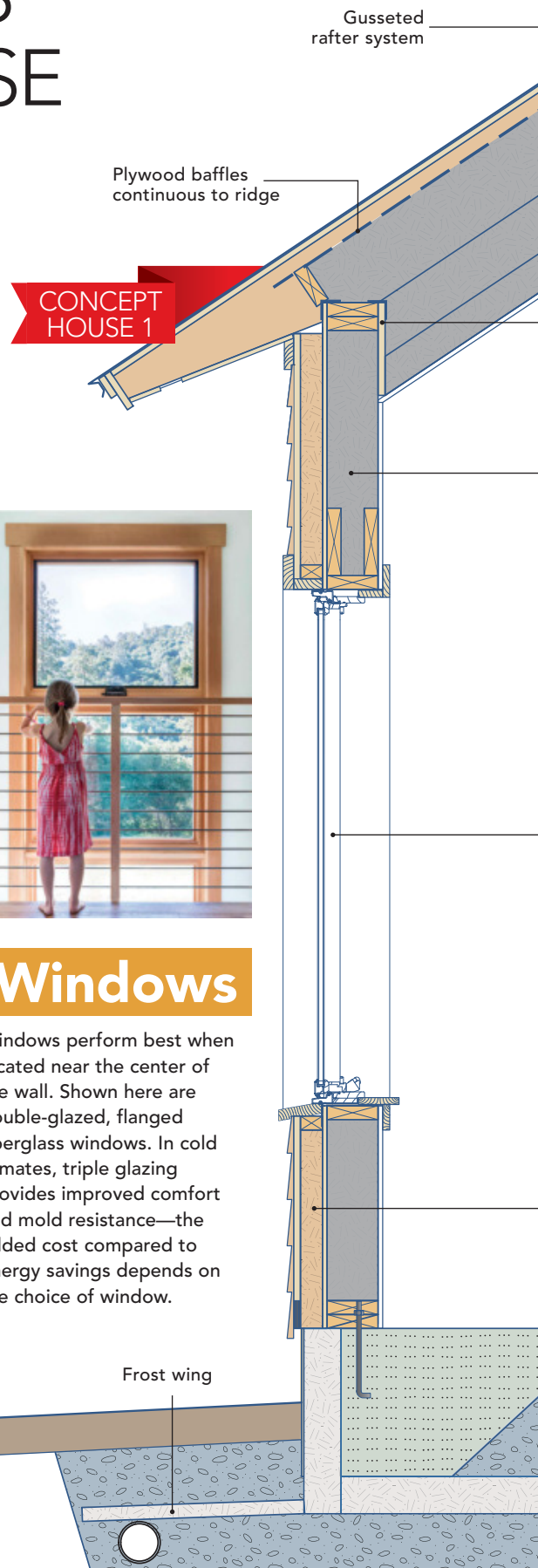
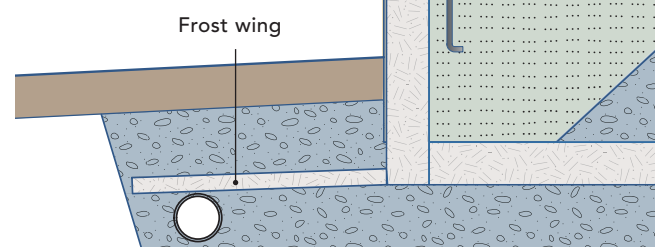
Concrete has high embodied carbon, but a slab on grade with sealed concrete as the finished floor is usually the least expensive approach, and up to 50% of the carbon-polluting Portland cement can be replaced with pozzolan admixes. With most slab-on-grade homes that have insulation under the slab, the insulation is located directly below the concrete, but this makes it hard to do a good job with the insulation, and there should be insulation below the turned-down footing anyway. A simple approach is to grade and compact crushed stone, then form the perimeter with foam, add a layer of foam, and top with compactible fill. I spec borate-treated EPS insulation for use below grade; recycled XPS is another option. Don't use polyiso because it absorbs too much water, and don't use new XPS because the energy savings will

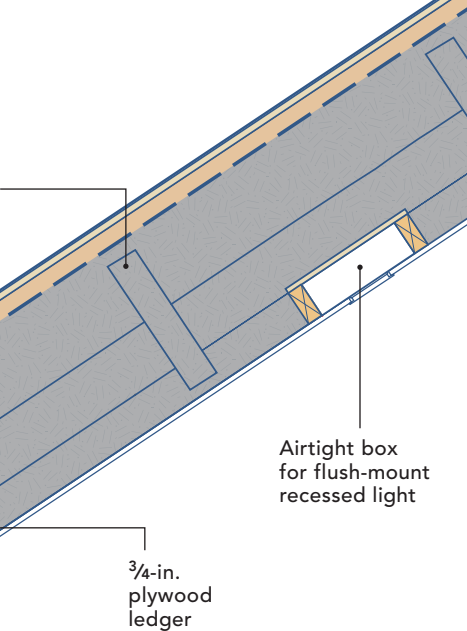
never make up for the climate impact of its manufacturing process. For the form edges, consider WarmFörm by ByggHouse (photo above). Compact the fill in 6-in. lifts, cover with a heavy-duty vapor retarder, add reinforcing steel where necessary, use a concrete mix with microfibers to reduce fine cracking, and allow the mix to damp-cure slowly to improve the strength—most concrete needs to be kept damp for a week to reach 90% of its design strength. In cold climates, consider adding a frost wing even if it's not required by code—thick insulation under the footing can leave it susceptible to frost heave. The thermal mass of this floor system will help maintain even heat levels. (Don't bother with in-floor heating—in a well-insulated, air-sealed house, you won't get the warm-floor effect.)



Windows

Windows perform best when located near the center of the wall. Shown here are double-glazed, flanged fiberglass windows. In cold climates, triple glazing provides improved comfort and mold resistance—the added cost compared to energy savings depends on the choice of window.





The roof framing is a gusseted rafter system, which is a good way to get decent levels of insulation and ventilation without having to use foam. To maintain ventilation space between the roof deck and the insulation, I spec 1½-in.-thick AccuVent from Brentwood Industries. It is made of 100% recycled PVC. (PVC, an environmentally damaging plastic, should generally be avoided unless the material has been fully recycled). If you can afford the cost of a bit more labor and materials, an even better approach is to make your own insulation baffles from ¾-in. plywood and softwood 1x2s (photo left). Conventional lightweight foam baffles won't stand up to dense-pack cellulose insulation, which is installed here at 16½ in. thick for a total of R-60. Dense-pack fiberglass or wood fiber are other insulation options. At the interior, painted drywall can control air and water-vapor movement, but for safer performance (in Maine's cold climate) I usually spec a variable-permeance

Roof



membrane. In New England we always fur down ceilings with strapping, but with the gusseted rafter system it's not necessary. (Where there are lights or other penetrations in the ceiling, don't rely on airtight fixtures, which are never truly airtight—instead, make a simple box from 2x4s, plywood, and tape.) For airtightness, it's important to connect the air control layer at the wall—in this case, the sheathing—to the air control layer at the ceiling—in this case, drywall. A continuous plywood ledger provides nailing for the subrafters and code-required fire blocking; when taped to the top plate, it also acts as the air control layer.

Suggested benchmarks

The original PGH had simple rules, borrowed from Dr. Joseph Lstiburek of Building Science Corporation. In a Green Building Advisor comment, reader Doug McEvers suggests using the advice of Harold Orr, a mechanical engineer and pioneer of high-performance building, whose research led to the creation of the Passive House standard. For superinsulated buildings, Orr advises dividing the location's heating degree days (HDDs) by 180 to get the R-value for a wall, and by 120 for a roof (this is close in line with Lstiburek's advice).

In a cold climate, such as International Energy Conservation Code (IECC) climate zones 5 and 6, use:

R-10 SUBSLAB

insulation (expanded polystyrene, mineral wool, or recycled XPS)

R-20 FOUNDATION

WALL, frost wall, or slab-perimeter insulation (or build on piers)

R-60 ROOF

R-40 WALLS

R-5 TO R-8 WINDOWS

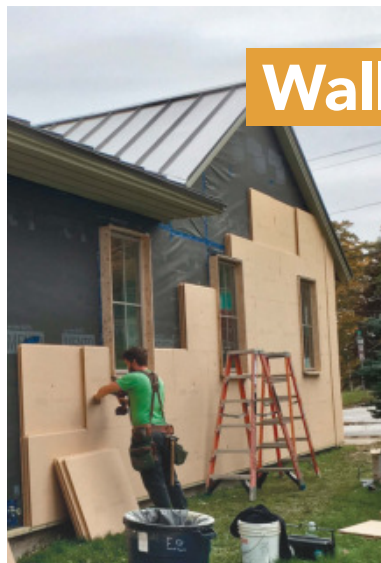
(U-0.20 to U-0.13). Even the best windows make lousy walls, so don't over-glaze.

1.0 ACH50

That's the maximum air-leakage target many of us are using. Others say 1.5 or 2.0 ACH50 is tight enough. (Tighter than 1.0 ACH50 may not add significantly to the home's performance.)

Window near center of wall

Walls

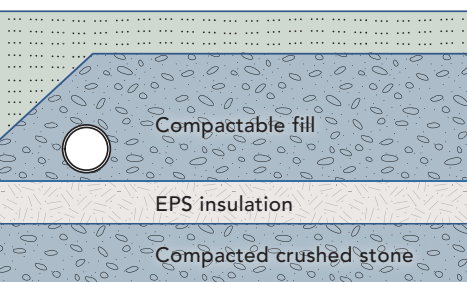


Rigid wood-fiber insulation

Continuous exterior insulation essentially eliminates thermal bridging and keeps the sheathing warm and dry. Rigid foam is the typical choice, and recycled foam of any type can work; new foam comes with relatively high embodied carbon. Rigid wood-fiber insulation, such as Gutex (photo left) or Steico, is a great choice.

Even after shipping from Europe, the carbon footprint is smaller than alternatives, and it's easy and safe to work with. Its price tag is on the high side, but GO Lab is gearing up to start producing wood-fiber insulation in Maine, with plans for an affordable price point. Siding is real wood over a ventilated rainscreen, which greatly extends the lifespan of the wood and any coatings. Framing is 2x6 with dense-pack cellulose in the bays. Cellulose has the lowest upfront carbon

emissions of any commonly available insulation, and it has several performance and safety advantages. GO Lab also has plans to produce a wood-fiber product that will compete with cellulose. Another option is to fill the bays with fiberglass. Although many environmentally minded designers and builders prefer mineral wool to fiberglass, mineral wool has much higher upfront carbon emissions. Fiberglass installed tightly in a fully airtight cavity, with exterior insulation, performs as advertised. With acrylic tape sealing the joints, the sheathing doubles as the air control layer.



PGH 2.0 WHAT MAKES A PRETTY GOOD HOUSE EVEN BETTER? CONTINUED



Windows

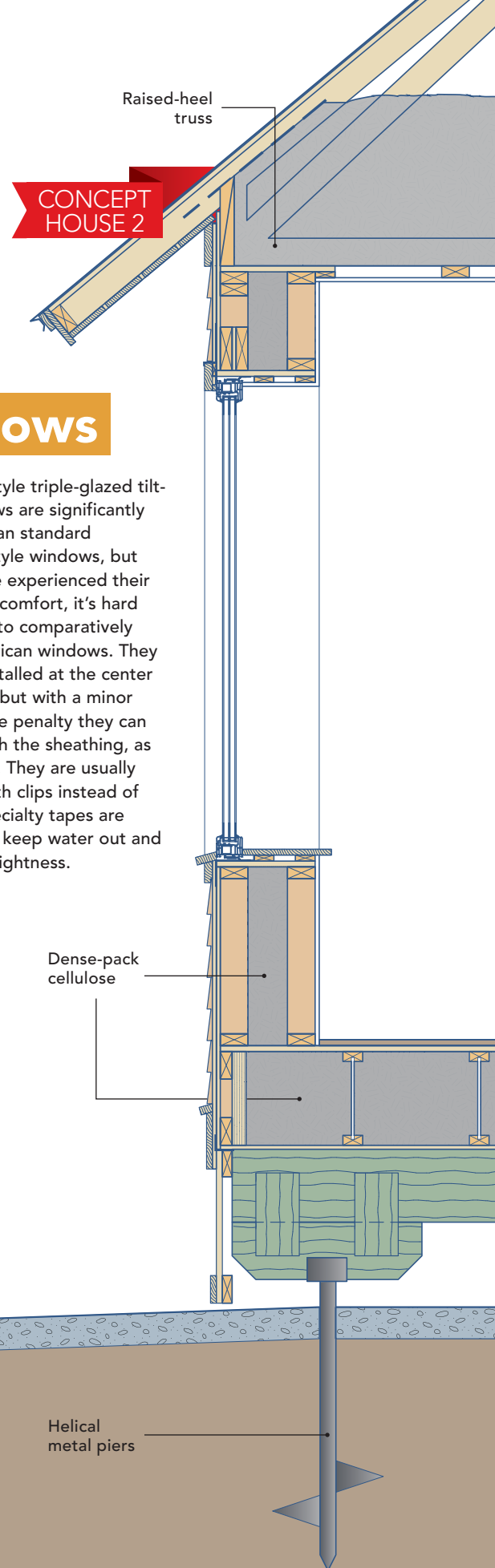
European-style triple-glazed tilt-turn windows are significantly different than standard American-style windows, but once you've experienced their quality and comfort, it's hard to go back to comparatively flimsy American windows. They are best installed at the center of the wall, but with a minor performance penalty they can be flush with the sheathing, as drawn here. They are usually installed with clips instead of flanges; specialty tapes are available to keep water out and provide airtightness.

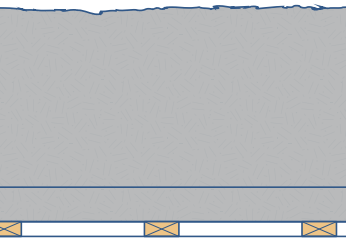
Performance-based approach

An integral part of the PGH is keeping things simple, and you can build a decent house, or even a PGH, without energy modeling. But modeling does have several advantages, and it's not that hard to do once you learn how. It allows you to optimize construction details, especially when it comes to fine-tuning window-performance values. BEopt from the U.S. Department of Energy is a good, simple, free software program. It has an optional feature to automatically determine the most cost-effective path to reaching net-zero operation. Also, you can use it to balance expenditures and gains and to help calculate return on investment. Ekotrope, Wrightsoft, and REM/Design are a few mentionable programs. Some BIM (building information modeling) programs also have energy plug-ins. Passive House practitioners use the PHPP or WUFI Passive energy-modeling programs, which are labor-intensive to use but appropriate for extremely low energy-use homes.

Air Conditioning Contractors of America Manual J calculations are regularly required by newer energy codes to attain heat-loss calculations—they can be done by hand or with a computer program. Supply houses that do them often end up grossly oversizing equipment, leading to inefficient operation.

Additional reasons for using energy modeling include the fact that you can compare the effect that different assemblies will have on a building's energy usage, fine-tune window specifications for the lowest energy use, and determine heating and cooling loads for the house.





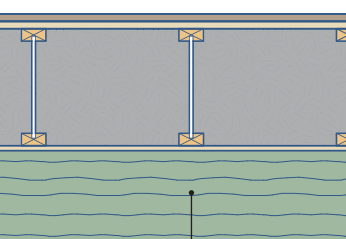
The least expensive, lowest-carbon way to build and insulate a roof is usually a raised-heel truss with loose-blown insulation. I typically spec R-60 cellulose at 16 in. deep. Raised heels can make walls look tall, so I reduce the insulation depth at the eaves to 10 in. to 12 in. The air control layer is at the ceiling, in the form of a variable-permeance membrane, but taped 1/2-in. sheathing works too. Inside of that, install furring to create spaces that can be used to install lights and run wires without puncturing the air control layer (photo above).

Roof



Walls

Builders have strong feelings about double-stud walls, but they have a long track record in New England, and the builders I work with tend to like them. In a cold climate, they need to have a ventilated rainscreen so they can dry easily to the exterior. In cold climates I am most comfortable when a variable-permeance membrane is used at the interior, though many builders just use painted drywall. With a 12-in. insulation cavity, the wall will perform at about R-40. The sheathing doubles as the air control layer.



Pressure-treated wood beams

Foundation

A pier-and-beam system using helical metal piers (photo right) has much lower upfront carbon emissions than a concrete foundation. Piers are located to carry pressure-treated wood beams to support the floor framing. When the top of the piers are more than a few inches above grade they need bracing, so instead I'm showing a bolster system (see drawing) to create the height needed to allow code-minimum 18-in. clearance from grade to the bottom of the floor system. The beams are inset enough to allow for ventilated skirting. The floor system can be dimensional or engineered lumber; I prefer I-joists because the narrow webs nearly eliminate thermal bridging, allowing for about R-40 for the whole floor system when insulated with dense-pack cellulose, wood fiber, or fiberglass. To keep out air and critters, 1/2-in. sheathing is installed below the joists and sealed to the beams. (If you're in an earthquake-prone zone, this system may not work for you, but it pairs well with a partial basement that can provide additional lateral support and a place for utilities.)



Products to minimize or avoid

✗ **Concrete**—specifically Portland cement, which contributes over 8% of all global warming emissions. Consider modern additives such as CarbonCure or more traditional pozzolan admixes. Helical metal piers, which are screwed into the soil to support structures, are gaining ground as an alternative foundation to concrete pours. Steel is also carbon-heavy, but emissions from this type of foundation are much lower than from a concrete foundation.

✗ **Foam**, particularly hydrofluorocarbon (HFC)-blown closed-cell spray foam and extruded polystyrene (XPS) rigid insulation. A PGH uses no foam above grade. If you do use it, try to find a source for recycled rigid foam, or use foam with relatively low global warming potential, such as EPS and polyisocyanurate instead of XPS, and spec hydrofluoroolefin (HFO)-blown spray foam rather than HFC-blown.

✗ **Combustion appliances**, especially those that burn fossil fuels. You can have a woodstove in a PGH, but make sure it is EPA-certified and properly installed; and use dry, sustainably harvested firewood.

✗ **Unhealthy materials**. Fortunately asbestos is no longer allowed in homes, but fiberglass fibers have a similar shape, which is not a problem for occupants if the batts are sealed inside a cavity, but can be an issue if air moves through the assembly. Formaldehyde is commonly used as an adhesive in sheet goods such as those in inexpensive cabinets—avoid it. Avoid, also, plasticizers in flexible vinyl products such as shower curtains; choose nylon curtains instead. Carpeting, even with natural fibers, collects detritus, which can affect air quality. In general, natural products are safer than manufactured products.

Build a Craftsman-Style Mantel

Simple joinery and layered construction
create a rock-solid, refined centerpiece

BY GARY STRIEGLER

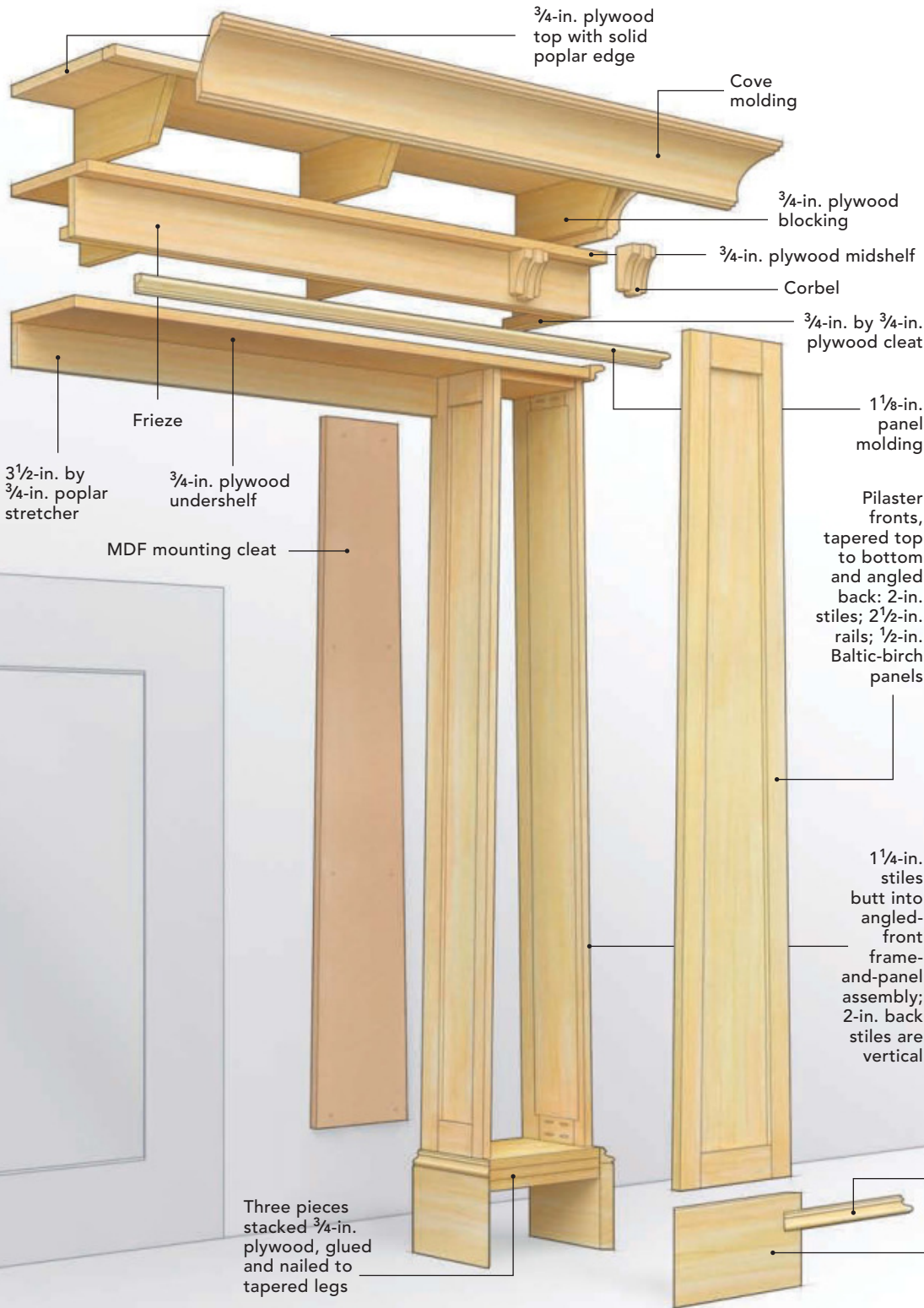


MANTEL MAKEUP

This mantel is made from many layers—some visible and some not. Those that aren't seen in the final product add rigidity and strength, and provide backing for nailing other layers. Moldings are used strategically to hide plywood edges and joints. The joinery is kept simple for quick production and minimal fuss. Though it looks complex, I built this in my shop in a day using basic carpentry tools.



To see a slideshow of the mantel installation, visit FineHomebuilding.com/magazine.



Building mantels has always been one of my favorite finish-carpentry jobs—I'm pretty sure I've built more than 200 of them. I love highly detailed mantels, but a lot of fireplaces today have a simple timber mantel or no mantel at all. So I was thrilled when a client asked me to build what I call a craftsman-style mantel. There are some distinguishing

characteristics of this style, notably tapered columns, straight lines, and the use of stain, rather than paint, to accentuate the use of natural materials. The biggest difference between my version and the original craftsman pieces is the construction. Building with traditional joinery and solid wood is expensive and time consuming. To lower the cost and build time, I used a mix of Baltic-birch

plywood and solid poplar, and put it all together with a variety of fasteners and wood glue. The homeowner loved the finished piece, and immediately asked about adding other trimwork to the job. That is the greatest compliment a trim carpenter can receive. □

Gary Striegler is a trim carpenter in Fayetteville, Ark. Photos by Matthew Millham.

START WITH THE LEGS

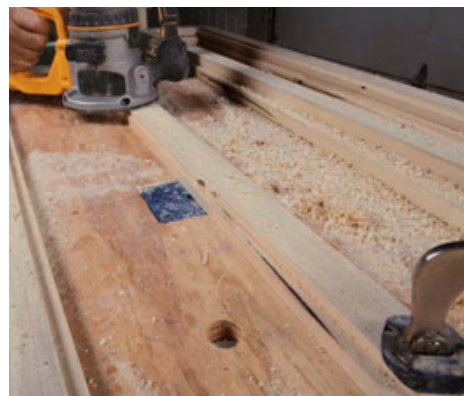
The tapered portions of each leg are made from three butt-jointed frame-and-panel sections. After assembling each section's frame, undercut its bottom to match the slope of the taper to cleanly meet the backing for the vertical base.



DRAW THE LEGS Make full-scale drawings of the tapered legs on 1/4-in. plywood to determine the cut angles needed for the rails—in this case, 2°.



GLUE AND SCREW Drill two pocket holes into the back of each rail, apply glue to the ends, and secure them to the rails with pocket screws.



ROUT A RABBET Set the router depth to the thickness of the panel and rout a rabbet around the interior of the back of each assembled frame-and-panel section.



SET THE FRONT PANELS Clip the corners of the plywood to fit in the rabbet, then apply a bead of glue around the panel edge, set it in place, and secure it with 5/8-in.-long crown staples.



ATTACH THE PIECES Apply glue to the side stiles and tack the front assembly to the sides with headless pins.



CLAMP IT UP Make sure to undercut each frame-and-panel section before assembling them into legs. Leave the panels out of the side sections until after glue-up to make space for clamps.



ADD A CAP

Fit a piece of $\frac{3}{4}$ -in. plywood into the top of each leg assembly, and secure with $1\frac{1}{2}$ -in. 18-ga. brad nails.



MAKE THE TRANSITION Add three layers of $\frac{3}{4}$ -in. plywood to the bottom of each leg, flush all around, for solid attachment of the base detail and panel molding.



COVER THE JOINT Apply $1\frac{1}{8}$ -in. panel molding so it just covers the joint between the bottom rail and the first plywood backer.



ADD THE BASE

Glue and nail the base to the plywood backers with 2-in. brad nails.



MARK AND PLUMB

Mark the center of the tapered columns top and bottom, then use a level and shims to plumb them up.



CHECK YOUR WORK

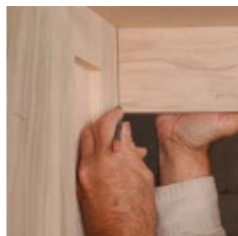
Space the legs apart according to your planned mantel dimensions, and use a level to make sure the legs are in plane, shimming as necessary.

TOP IT OFF WITH THE SHELF

The mantel shelf is built in layers, using moldings to cover the edges of the plywood and joints, and blocking to add strength and backing for nails. Rather than use a tape, I measure and mark everything in place.



JOIN THE LEGS Rip a piece of $\frac{3}{4}$ -in. plywood to match the depth of the legs, cut it to length, and nail it flush with the outside edges of the legs using 2-in. 18-ga. brad nails.



MARK THE STRETCHER Cut one end of the stretcher to match the angle of the tapered legs, then mark the other end in place, cut it to length, and drill pocket holes in each end.



GLUE, NAIL, SCREW

Apply glue to the top and ends of the stretcher, tack it in place with brad nails through the undershelf, and pocket-screw it to the legs.



USE CLEATS Glue and nail cleats of $\frac{3}{4}$ -in. plywood to provide a place to attach the plywood frieze. Mark the frieze in place, miter the corners, and attach it with 2-in. 18-ga. brad nails.



BUTTRESS AND CAP Pocket-screw blocks of $\frac{3}{4}$ -in. plywood roughly every 16 in. into the undershelf behind the frieze to add support for the plywood midshelf. Panel molding attached with headless pins covers the joint and the edge of the plywood.



ADD THE CORBELS Attach the corbels using headless pins through the bottom face of the lower steps and down through the top of the midshelf. The midshelf projects $\frac{1}{2}$ in. from each side and $2\frac{1}{4}$ in. from the frieze to extend $\frac{1}{8}$ in. beyond the corbels.



See how it's done

For a slideshow of the corbel-making process, visit FineHomebuilding.com/magazine.



RIP THE COVE Change the spring angle of standard cove to make it sit more vertical by ripping a steeper angle on the back bottom edge. I cut this to 60°.



ATTACH THE COVE If working alone, tack a support block to the underside of the midshelf to support the cove at one end, align the other end to the corner of the midshelf, and attach the cove with 1³/₈-in. or longer headless pins along its length.



FIT AND FASTEN Assemble the cove's miters with glue and headless pins before fastening the cove's returns to the midshelf. When fitting pieces like this cove, mark them in place to get their lengths spot on. Cut the miter at one end to start, then mark the other end in place—both for the long front piece and the shorter side pieces.



ASSEMBLE THE SHELF This top shelf is ³/₄-in. plywood edged with 1¹/₂-in.-wide shop-made poplar molding glued and pocket-screwed to hide the exposed edges.



SAND AND DETAIL A couple of sawkerfs add some detail without a lot of fuss. The sawkerf at the edge of the molding also obscures the joint between molding and plywood.



ADD BLOCKING AND SHELF Cut blocking at an angle to match the angle of the cove to provide additional attachment points for the cove as well as support and nailing for the top shelf. Finish by pinning the cove to the top shelf.



Stiebel Eltron
Temptra Plus

Choosing an Efficient Water Heater

Heat-pump water heaters offer the most energy savings, but they still struggle for a toehold in the market

BY SCOTT GIBSON

A long-running ad campaign for Maytag featured an affable but underworked repairman who spent his days snoozing in an office chair because the appliances he sold rarely needed any attention. “I’m the loneliest guy in town,” he complained with a sigh.

The story line may ring a bell with John Miles, who heads Eco Systems, Sanden International’s heat-pump water heater operation in the U.S. Although the products he represents are among the most efficient water heaters on the market, Miles is still waiting for that breakthrough year when consumers and HVAC specialists finally wake up to the unique advantages heat-pump water heaters offer.

They are head and shoulders above anything else that’s available, but command just a little over 1% of the market—of the more than 8 million residential water heaters sold in the U.S. last year, roughly 100,000 of them were heat-pump appliances, Miles said in a telephone call, and Sanden accounted for only a small percentage of that.

“It’s been a hard nut to crack,” said Miles.

Heat-pump water heaters are unfamiliar to many U.S. consumers despite widespread success in Japan and Europe. Like other types of air-source heat pumps, including appliances used for space heating, they extract residual heat from the air without burning any fuel directly. But they are just one option among many for residential water heating. Water heaters with integral storage tanks powered by either gas or electricity are the industry’s old standbys. Manufacturers have increased the energy efficiency of gas models with condensing burners that wring almost all of the potential heat from flue gases. There are also various on-demand tankless water heaters that don’t have the standby losses associated with storage tanks.

Homeowners may be focused on price and capacity, but efficiency counts. The U.S. Department of Energy (DOE) estimates that domestic hot water represents between 14% and 18% of total home-energy use, more than all other household appliances combined and second only to space heating. At an average of 64 gal. of hot water per day, U.S. households spend between \$400 and \$600 a year.



TANKLESS WATER HEATERS

Often chosen for their compact size and endless stream of hot water, these so-called “on-demand” water heaters are most commonly fueled by gas (photo top right), but electric models are available (photos facing page and below right). Because they heat water as it’s needed, hot-water production is measured in gallons per minute (gpm), and depends on the temperature of the water entering the heater. Comparing gpm ratings from one brand to another isn’t straightforward, as the temperatures used in these calculations often vary and don’t reflect actual usage.



Bradford White Infiniti



Rheem Professional Classic

Chiseling away at those numbers can add up to big savings over time, but buying decisions are often made quickly and under duress. Miles estimates that more than 75% of all water heaters are sold on an emergency basis—that is, only when an existing water heater springs a leak or otherwise fails. Homeowners are likely to buy what the plumber has on the truck, not on the basis of what will produce hot water most efficiently. That’s too bad. A little homework would go a long way toward lowering energy costs.

How the government measures efficiency

When someone goes shopping for a new car, one factor to consider is how many miles the vehicle can travel on a gallon of gas. The DOE has developed a similar metric for water heaters called the Uniform Energy Factor (UEF). It’s based on standardized tests administered by the DOE and ranks performance numerically—the higher the UEF, the greater the energy efficiency. UEFs range from roughly 0.6 to 0.95 for gas and electric models and up to 3.7 for heat-pump water heaters.

The UEF does not appear on the EnergyGuide labels you may see on water heaters at your local big box store. That’s because, in the U.S., there are three separate agencies that work on this issue. According to Chris Granda of the Appliance Standards Awareness Project, the EPA runs the Energy Star program, the DOE sets minimum energy standards and administers UEF testing, and the Federal Trade Commission (FTC) is responsible for the labels consumers see in the store. “The reason why you don’t see the UEF on the energy label is because no one at the DOE, which is charged with coming up with the UEF and administering it, is talking with the FTC,” Granda said.

The FTC singles out two other numbers for the EnergyGuide labels: the estimated annual cost of hot water, and the amount of hot water the appliance will produce in the first hour of use (the first-hour rating, or FHR). You can find UEF ratings either from the manufacturers or in an online database maintained by the DOE.

There are other important caveats to UEFs. The ratings are based on four levels of hot water use—very small, low, medium, and high—

and the DOE warns consumers not to compare the UEF in one usage category with a UEF for a different usage category. If you're trying to track down the most efficient electric storage water heater in a single volume category, comparing the UEFs (if they are provided) will be useful. Not so much when comparing a "very small" hot-water household to a "medium" household, and certainly not when trying to choose between a gas-fired and an electric model.

Still, Granda says, the UEF is important because it's a common metric that everyone can understand, and it can be reliably replicated.

If electricity is the fuel, go with a heat-pump unit

Although heat-pump water heaters cost more than those powered by electrical resistance heating coils, they are far more efficient. At best, a standard electric water heater could have a theoretical energy efficiency of 100%—all of the energy potential in the electricity converted to hot water. But heat-pump water heaters can return three or more times the energy they consume in the form of hot water and typically show a UEF of more than 3 (this is sometimes referred to as the Coefficient of Performance when speaking of heat pumps).

Another consideration is where a heat-pump water heater can be installed. The heat pump will lower the temperature of the air in that location, which may be problematic in some climate zones in fall and winter. There also are minimum space requirements. A.O. Smith, for example, recommends a heat-pump water heater be installed in a space with a total volume of no less than 750 cu. ft. Installations are possible in smaller spaces with a ducting kit that controls where air is drawn from and where exhaust air goes.

Sanden's SanCO₂ is different from the rest of the field in two respects. First, the compressor

Rheem Hybrid Electric Water Heater



HEAT-PUMP WATER HEATERS

Most water heaters in this category combine heat pumps with conventional electric resistance coils that are activated when the heat pump can't keep up with demand. (While they are very efficient, heat pumps do work slowly.) When comparing models, consider the first-hour rating, which is the number of gallons of hot water the heater can supply per hour (starting with a full tank of water).

Most heat-pump water heaters combine the heat-pump compressor and tank in an integral unit. Sanden's SanCO₂ is unique in the U.S.—it's a split system with the storage tank inside the house and a separate compressor outside. Even more unique is the fact that it uses CO₂ as the refrigerant rather than a hydrofluorocarbon.



goes outside and the storage is located inside; they are connected only by water lines and a communication cable. That keeps the compressor noise out of the house and eliminates any concerns about cooling the space it's in. Second, the unit uses CO₂ rather than a conventional refrigerant. With a global warming potential of 1, CO₂ carries much lower environmental risks than the fluorocarbons that are typically used in heat pumps. According to Miles, the technology also produces higher water temperatures than other heat-pump water heaters and does so without any backup resistance coils.

Sanden's biggest problem has been cost. A residential system, Miles said, runs about \$3500, double the price of other heat-pump water heaters on the market. High efficiency and other benefits should help the company grow in the U.S., he added, but these appliances now face the same uphill fight that ductless minisplits once did.

"Certain industries have a huge amount of inertia," he said. "And sadly, the HVAC industry is one of those industries. It's taken 20-plus years for minisplits to get to a position where seeing one is no longer like seeing a white rhino. Everyone has been conditioned to look at the first cost and not calculate out the life-cycle cost. If you looked at that, you'd say, 'My hot water will cost me \$500 or \$600 a year for the next 10 years—\$6000. If I invest a couple of thousand more, all of a sudden that number becomes negligible.'"

The best gas models are condensing

Although not the most efficient on the market, a tank-style water heater that burns natural gas is an economical way of providing domestic hot water in many markets. There are two basic choices in this category: standard and condensing. A conventional gas-fired water heater vents exhaust gases into a masonry or metal flue. A condensing unit includes an extra heat exchanger that pulls residual heat from the flue gases before they go out. Efficiency goes up, and the temperature of the exhaust goes down. The stack temperatures are low enough to allow the use of plastic pipe for the exhaust rather than a conventional chimney.

Keith Kuliga, assistant product manager at Bradford White Corp., says condensing gas water heaters are typically 5% to 10% more thermally efficient than noncondensing models.

Tankless (on-demand) water heaters also are available in both condensing and noncondensing models. Condensing models are more expensive but also more efficient. Rinnai lists the UEF

for noncondensing models from 0.79 to 0.82; for condensing models the range is from 0.85 to a high of 0.93. They're also more efficient than conventional tank-style gas units. The DOE's directory of water heaters shows tankless gas appliances typically have UEFs in a range of 0.80 to 0.90 and up while tank-style water heaters show UEFs beginning in the 0.60 range.

Electric tankless heaters are another option, and they report very high UEFs, up to 0.98. But this thermal efficiency comes with some inconveniences—mainly a huge power draw. Rheem's RTEX-24, for example, draws 100 amps at 240v and requires three 40-amp breakers. Given that some older houses still have 100-amp panels in the basement that run all appliances and plugs in the house, and the standard for a new home is 200 amps, that's a lot of electricity. Critics also point to the intermittent but significant spikes in electrical demand as a problem for the grid.

What's in the future?

At the moment, an electric heat-pump water heater holds a sizeable lead in the efficiency department, although that comes with a higher initial cost. There are at least two, and probably more, emerging technologies that should help reduce the upfront costs of energy-efficient water heating.

One is a heat-pump water heater whose compressor is driven by gas, not electricity. The technology is at what the Northwest Energy Efficiency Alliance (NEEA) calls the "nascent stage," under development for the residential market but not yet available commercially.

Aaron Winer, senior program manager for NEEA, said one manufacturer expects to have such a water heater on the market by 2022. Larger, commercial units are already available. The UEF of these appliances can hit the range of 1.2 to 1.4, a big step up from the most efficient gas-burning water heaters currently available but still far below the efficiencies of electric heat-pump water heaters.

"A big difference between these units is that the currently available technology costs in the range of \$4000 for the unit and installation," Winer said by email, "where a gas heat-pump water heater is projected to cost \$3000 or less—all while delivering a significantly higher level of energy savings."

The other area for improved efficiency is not in the equipment itself, but how it is used. "We see improved technologies and/or solutions based

A.O. Smith
Vertex 100 Power
Direct Vent



CONDENSING WATER HEATERS

An upgrade from a standard gas water heater, condensing models pull residual heat from exhaust gases, increasing efficiency and decreasing flue-gas temperatures, the latter allowing for direct venting through plastic pipe. The trade-off is a higher price tag, which manufacturers argue is offset by utility savings over the life of the unit. They fall well below heat pumps in terms of efficiency, but also cost less and produce hot water more quickly than those units, and are typically 5% to 10% more thermally efficient than standard gas tank water heaters.

on a systems approach," says Geoff Wickes, another senior program manager at NEEA. "Plumbing equipment; appliances that use less water; shorter, more appropriate plumbing runs; drain-water heat recovery; proper use of on-demand circulator pumps; and better insulation on pipes."

Manufacturers also are adopting Wi-Fi technology. For households, the equipment allows greater control over when and how hot water is produced. For utilities, it means the potential for better managing loads on the grid and avoiding construction of new power plants. Rinnai, for example, now offers Wi-Fi features on a couple of its tankless heaters and says they can be paired with smart-home technology, such as Amazon's Alexa devices, to allow homeowners precise control of a hot-water circulation system. A third-party device called the Aquanta is an add-on that allows water heaters to be controlled remotely.

Another demand on manufacturers is the increasing pressure to eliminate anything that burns any fuel—wood, oil, gas—and replace it with an appliance powered by electricity. Ideally, electricity derived from renewable sources. Even companies completely invested in gas technology, such as Rinnai, are keenly aware of the trend.

In the meantime, the question for heat-pump water heater manufacturers is how to get their market share out of the basement.

"There are many parts to this," Miles said, "especially as at least 75% of the water heaters sold are for customers who need a unit on an emergency basis."

Better consumer understanding of potential savings would help, as would government and utility rebates, and more decisive government directives on efficiency. And then there are the plumbers.

"The majority of plumbers hate new technology, especially when they can install a gas or electric water heater and not see it again for 5 to 10 years and then just replace it at that time," Miles said. "The outcome from this is that they don't want to install a new product they may have to service unless the homeowner really wants it and they are going to lose a sale."

"It has taken tankless products over 20 years to become about 20% of the 4.2 million gas water heaters sold annually," Miles concluded. □

Scott Gibson is a contributing writer at GreenBuildingAdvisor.com and *Fine Homebuilding* magazine. Photos courtesy of the manufacturers.

Two Structures,

A restored farmhouse receives a regionally inspired addition



BEST REMODEL

The commitment of architect Nicole Migeon and builder Chris Seaver to honorably restore a late 18th-century house and add to it in the form of a barn-inspired gathering space made it a pleasure to give them this year's Best Remodel Award. The poor condition of the original house and the complexity of the new build made the three-year-long project a demanding effort and hard-earned triumph.



Two Treatments

BY NICOLE MIGEON

Located on a river in western Massachusetts, this 1785 Federal-style home has been in my firm's charge for more than three years. The clients bought the property with the intention of restoring the original portion of the house and replacing a decrepit existing addition. This was accomplished in two phases, beginning with the historic structure. Given the old home's small rooms and low ceilings, we agreed it would be used for more private activities like sleeping and reading, whereas the addition would house an open-concept space for socializing and allow for easy access to the outdoors. Our plan was to restore or replicate the details and materials in the farmhouse where we could, and build an addition with natural, durable, and sustainable materials.

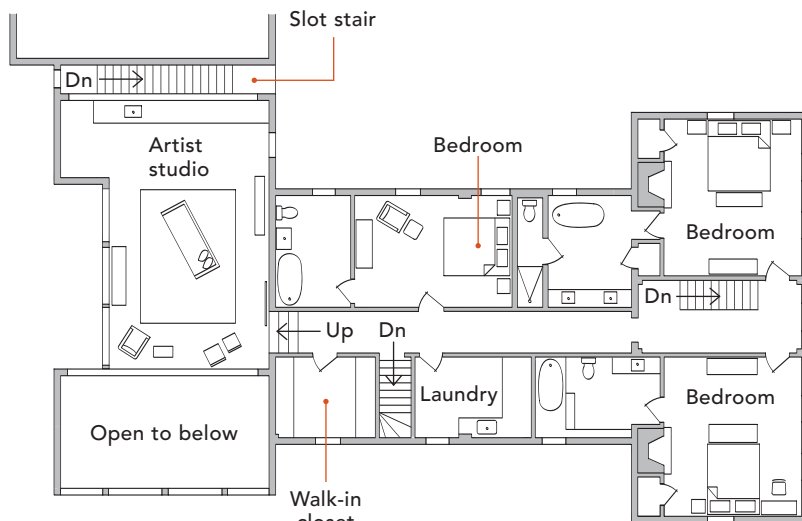
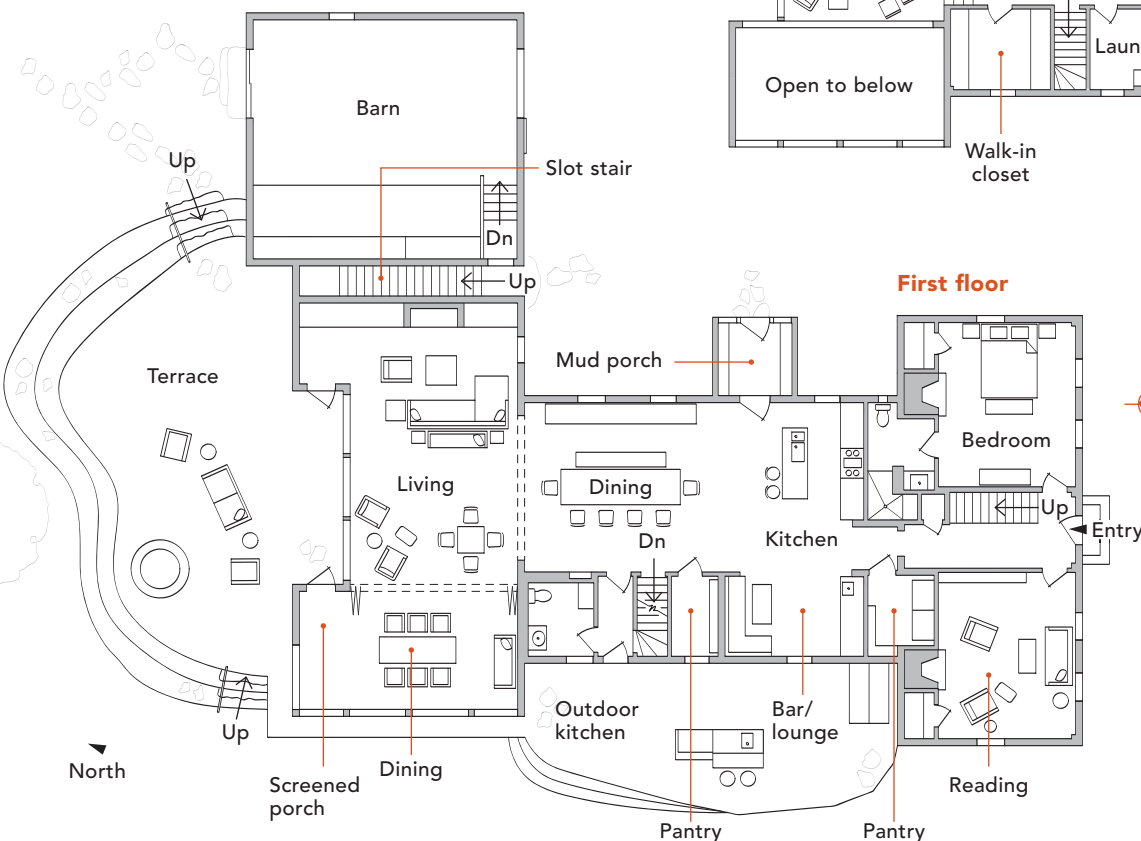
I think designing and engineering the trusses in the new guesthouse, as well as the screening assembly and slot stair, were the most gratifying aspects of the build. And, of course, anytime you are restoring or renovating a period home, there are unanticipated hurdles and creative opportunities that require a good team. The builder, Chris Seaver, and I worked with several local craftspeople and artisans. I attribute the high



Restoration motivation. After years spent admiring this 18th-century house, the clients purchased the property, and have retained the original structure's facade.

UNIFIED FOR FLOW

The floor plan did not change in the original house, and the new addition was designed for easy access to the stone terrace and private entry to the studio. While a previous addition required occupants to take a steep, awkward step up or down, excavating the slope at the rear enabled its replacement to be positioned 3 ft. above grade, putting it on the same level as the original structure.



Second floor

0 4 8 16 ft.

SPECS

Bedrooms: 4

Bathrooms: 4½

Size: Main house, 3500 sq. ft.; addition, 1500 sq. ft.

Location: Western Mass.

Architect: Nicole Migeon Architect, migeonarchitect.com

Builder: Seaver & Sons, seaverandsons.com



Shifty sideboard. To disguise the sag of the 230-year-old floor—nearly 3 in. out of level in a span of 15 ft.—the builder made a base with different-length legs. The gap between the bottom rail and floor varies along the length of the piece, but because the shadowline masks the incremental height differences, the eye doesn't pick up on it.



Strategic arrangement. The kitchen is divided into separate but connected rooms and storage areas. There's a central main space, which is devoid of large appliances, as well as a lounge/bar area with seating, a full-size pantry that houses a fridge and freezer, and a dry-goods pantry.



A space to create. The orientation of the building maximizes desirable northern light in the artist's studio, where the intricacies of the trusswork (see "Customizing trusses," p. 64) are on full display.

level of design and construction details on this project to their care and expertise.

Back from the brink

In the existing house, we restored where we could and renovated where we had to. The entire framing structure and the floors were in exceptionally bad shape—everything needed reinforcing, and the roof was a complete redo. Plus, the siding was full of rot. In short, it was a near-total gut job.

We decided not to change the floor plan, and started by removing all of the features that were not part of the original house. We salvaged materials when possible, including the wood-plank floors, the plaster walls and ceilings, some moldings, and the stone fireplace mantels and hearths. The original roof was slate, but we wanted the house and addition to relate, so we went with standing-seam zinc on both. All of the windows were damaged and replaced with historical replicas by Marvin—the new wood-divided lites match the size and scale of the originals. We also restored the glass transom above the entry door. Custom casings, moldings, and baseboards were milled locally—again to rep-

licate what was endemic to the house. Additionally, the walls were covered in historical-style wallpaper and the ceilings were tea-stained, as they might have been during the late 1700s and early 1800s.

Inspired addition

A previous addition had been tacked onto the rear of the original building—it was dark, dank, and full of mold. It was an easy decision to demolish it to make way for a guesthouse and an artist's studio. The clients love old New England barns, which inspired the new building's form. To come up with a design, we studied hay and tobacco barns, which are common in the area.

The placement of the 1500-sq.-ft. slab-on-grade structure was something of a head-scratcher out of the gate. Originally we thought to position the addition on the other side of the house so as not to repeat what had been done previously. We did ultimately add to the rear of the house, which is more in line with what would have been done traditionally, but in a different orientation than that of the previous addition.

Addressing natural elements

The site's topography influenced the design too. Runoff water and heavy snow loads were major considerations, complicated by a steep slope at the



Rustic respite. LVLs wrapped in chestnut warm the partially conditioned interiors, which are separated from the screened porch by a NanaWall that disappears from view when open.

CUSTOMIZING TRUSSES

After the rough truss framing went up, the builder wrapped every surface with the highest-grade quartersawn clear Douglas fir, chosen for its consistent grain.

He used $\frac{3}{4}$ -in.-thick 1x12s for the finish wood—ripping miters at every corner—to create the look of solid timber and left an $\frac{1}{8}$ -in. gap on each side of the trusses for expansion/contraction to protect the mitered corners from popping apart with humidity.

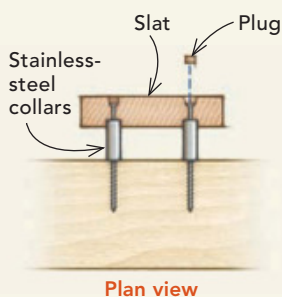
The trusswork includes two webs infilled with glass to separate the conditioned space from the unconditioned screened porch (see p. 63, top photo). The glass was cut to be sandwiched between the finished trusses.

The same approach was used on the opposite end of the room, with the added complication of a chimney running through the assembly.



ATTACHING VERTICAL SLATS

The bandsawn 1x5 clear red cedar vertical boards on the new addition are a reference to the region's tobacco barns, which typically have vertical siding with top-hinged vents. Fastening them to the timber structure presented an issue. The original drawing had the boards—some of which



are 24 ft. long—face-screwed to the framing, but there was concern that water would collect in the space between the board-to-board assembly and cause rot. Instead, they used two 1½-in. stainless-steel collars at each point where the boards contact timber to create air space for the assembly to dry out. To make it work, the collars had to be countersunk ⅛ in. into the back side of the slats. To smooth out the finish, the screw holes in the face of each board were filled with cedar plugs.

rear of the house. We chose to excavate to create a more gradual slope, and then raise the building roughly 3 ft. above grade. This was done for two reasons: to protect the structure from moisture and to make the transition from the addition to the existing house an even plane. Excavating also gave us the opportunity to add an elevated stone terrace.

For passive solar control, we designed a three-layer shading system to cover the west-facing gable end. It allows natural light into the screened porch while deflecting heat and glare. Douglas-fir-clad timbers make up the framing structure, insect screening allows for comfortable outdoor living, and vertical slats of reclaimed clear cedar create deep shadowlines, adding texture and depth to the exterior. This wall also features a pulley and rope attached to an upper-level swinging window—a nod to the traditional hay barn.

The eave-side cladding is quartersawn red cedar coated with Cabot bleaching oil, a semitransparent stain with an additive that accelerates the graying process and produces mottled tones. The slats were given the same treatment for contrast with the fir timbers. Multisash Marvin windows with large four-over-four divided-lite transoms were installed on the second floor, while the lower level has 5-ft.-wide by 7-ft.-tall fixed windows with four-lite operable transoms. A lot of thought went into the screening panels and trimwork to make the screens blend well with the windows. In fact, from a distance, the screens look like windows.

Social space rich in detail

Inside, a large entertainment space is divided into separate areas for socializing, watching TV, playing games, and reading. Everything is centered around a custom gas fireplace. A NanaWall makes it possible to open the interior conditioned space to the screened dining porch. Seaver says detailing the ceiling above the main living area was tricky, and required wrapping the partially exposed LVL joists in reclaimed chestnut. When installing the finish wood, he scribed and coped every board abutting the stone chimney and wall. It took two weeks to finish just one section of the ceiling. To give the room the feel of an old milking barn as the clients



Creating a slot stair. A 38-in.-wide “slot” stair in the studio separates an older restored barn from the new structure. Because *Galaxy Schist*, a locally sourced stone, was used for the landings, treads, and risers, the stairs needed to be engineered to handle the added weight. The stairwell is clad in whitewashed tongue-and-groove chestnut finished with rubbed urethane.

requested, the reclaimed chestnut that covers the joists and walls was whitewashed, making for a lighter atmosphere.

All told, the addition warmly supports all of what was outlined in the design program. Architecturally, it is a masterpiece of craftsmanship. □

Nicole Migeon is principal of Nicole Migeon Architect. Photos by Taggart Cojan Sorensen, except where noted.



Nicole Migeon, AIA, ASID, is principal of Nicole Migeon Architect, PLLC (NMA), a full-service, New York-based firm specializing in residential, commercial, hospitality, and spa and salon design. Nicole has practiced architecture and interior design for more than 20 years. She is also a tenured assistant adjunct professor at the Fashion Institute of Technology in New York, teaching design studios and lighting.



Chris Seaver manages Seaver & Sons Custom Builders in Charlemont, Mass. He grew up the son of a custom builder, and attended Hampshire College, where he studied ecological architecture. After completing a certificate program in architecture at the Harvard GSD, Chris obtained his Construction Supervisor's License. He has been designing and building energy-efficient homes and remodeling projects for 30 years.

Science DRIVES Design

The need for special indoor conditions affects the shape and layout of a new build

BY PHIL KAPLAN



BEST NEW HOME

When the teams from Kaplan Thompson Architects and Thompson Johnson Woodworks were given the parameters surrounding this new build, they knew they were up for the challenge. What began with a program that included meeting a medical requirement, preserving museum-quality artwork, and managing storm water on-site resulted in a high-performance house remarkable for its unconventional yet site-appropriate architecture.



My firm, Kaplan Thompson Architects, builds a lot of high-performance homes—it's familiar ground for us. But this project required something we had never encountered: The house needed to maintain higher than normal humidity to support the client's physical health, and that stipulation became a key design driver. The homeowners also asked that we design for aging in place, which influenced some of our material selections. And because we wanted to work with the natural topography to manage stormwater runoff, the site itself helped to shape the house. Then there was the clients' art collection to consider—we had to protect a significant painting from sun exposure, which influenced the location of some windows. It was clear from the onset that this was going to be a uniquely challenging job, but we, alongside builder Heather Thompson and her team, were excited to dig in.

Science first

From experience, we know we can count on our builds being tight, and we know how to ensure air changes every three hours, but an increase in relative humidity meant rethinking the envelope. My project team, including Danielle Foisy and Sam Funari, and I had to determine what maintaining high humidity in the house year-round would mean in terms of moisture in the building assemblies. The mechanical engineer advised us to move all of the insulation outboard because the required interior vapor loads meant the structural sheathing needed to be kept warm so it wouldn't be a condensing surface. We decided to leave the 2x4 structural wall cavity uninsulated so the 7/16-in. ZIP System sheathing—the primary air and vapor control layer—would stay well above the dew point even dur-

Cutting embodied carbon

When possible, we make decisions and selections that will result in lower embodied carbon than more conventional choices. There were a handful of opportunities to cut the upfront carbon load of this project. Using local tradespeople and vendors minimized the fossil-fueled transportation of contractors and building materials. The same is true of the locally harvested and milled white-cedar siding we selected. The majority of the framing members were Maine-sourced, as were the 1x3 pine boards for the rainscreen and shiplap siding. And we chose an ICF foundation because it provides built-in insulation and uses less concrete (a 6-in. core of concrete has far less embodied carbon than a typical 8-in. to 10-in. stem wall). We also spec'd EPS insulation because it has the lowest embodied carbon of all the rigid foams. Likewise, the painted galvalume standing-seam roof has a far longer lifespan than that of asphalt shingles.

Positioned for protection.
To keep direct sunlight from damaging a 6-ft.-wide by 3-ft.-tall painting, it was hung with its back to the sun on a wide span of south-facing wall.

ing the coldest months. We fastened 12-in. I-joists vertically outboard of the sheathing to create exterior insulation cavities (see “A vapor-open assembly,” facing page), and used highly permeable VaproShield as a vapor-open water-resistive barrier (WRB) on the exterior side of the I-joists. With dense-pack cellulose, we reached R-43 in the wall assembly. It’s worth noting that the location of the ZIP System sheathing on the warm side of the thermal control layer doesn’t maintain the interior relative humidity at any given percentage, it just mitigates the risk of the walls getting wet.

The form unfolds

This was a classic case of “form follows function.” The superinsulated thick walls coupled with the shading requirements for the artwork (photo above) inspired a distinct building shape with lots of character. The architecture is straightforward but dynamic—there’s a lot of interest without complicated detailing. Effectively, the house is divided into two boxes; each has a simple span and a shed roof. The primary shed faces south and carries a 6.7kw solar array; the other faces north, where the bedrooms are located. A dormer sits at the end of the south corner.

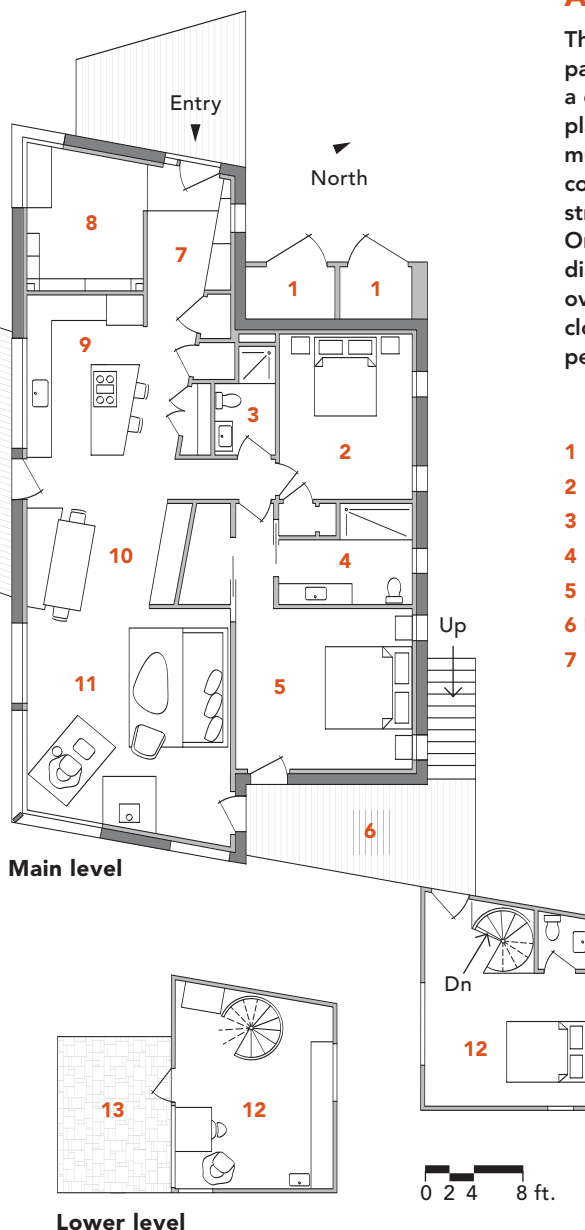
We played with the dormer’s shape to give the house some spice. A true butterfly roof is not practical in New England because of snow loads, so we gave it the appearance of a butterfly roof from the end elevation (see dormer drawing, facing page).

The framing was a little different in that we essentially built two walls: an uninsulated standard 2x4 assembly, and outside of that a 12-in.-thick cellulose-filled I-joist frame, which hangs on the main frame and is non-load bearing. It’s effectively a Larsen truss, which is a nonstructural, typically site-built truss installed on exterior sheathing to hold blown-in insulation, but we used I-joists rather than 2x3s or 2x4s and plywood. The I-joists come assembled, so they’re fast to



A DIAGONAL PLAN

The main spaces occupy a parallelogram-shaped footprint with a diagonal orientation. The floor plan opens up off a narrow entry/mudroom, creating a feeling of compression and expansion—a design strategy for making rooms feel larger. Orienting the dining area along a diagonal allowed space to be given over to the master-bedroom walk-in closet. That shift exaggerates the perspective seen from the entryway.



- | | |
|--------------------|-----------|
| 1 Exterior storage | 8 Office |
| 2 Bedroom | 9 Kitchen |
| 3 Bathroom | 10 Dining |
| 4 Master bath | 11 Living |
| 5 Master bedroom | 12 Studio |
| 6 Deck | 13 Patio |
| 7 Mudroom | |

SPECS

Bedrooms: 2

Bathrooms: 2

Size: 1750 sq. ft.,
not including studio

Location: Peaks Island, Maine

Architect: Kaplan Thompson
Architects, kaplanthompson.com

Builder: Thompson Johnson
Woodworks, tjwhome.com

install. There may be a slight increase in thermal bridging with our assembly compared to that of a Larsen truss, but it required much less labor.

Mixing windows

The extrathick walls provided an opportunity when it came to window placement. Even though the most energy-efficient window location is in the center of the wall, we knew we could get to net-zero using a mix of innie and outie windows, which we wanted for architectural interest (photo right). Putting the windows in the first-floor living area to the exterior meant we were able to incorporate a window seat. Above it we used innies, which work to passively shade the lower level—they are pulled in 16 in., so even though they are on the same wall, the juxtaposition gives the space depth (photo p. 67).

Working with the landscape

The property has rocky terrain and is wet on the low end, which made for a tight build and meant we had to pull the house up to the road. At the rear, we built on board-formed piers to support natural drainage. We also liked the idea of the house floating above the landscape. Orienting it parallel with the slope discourages damming. As a result, the house has a thin street face, with a wide face running in the direction that water naturally follows. There are no gutters or downspouts. Cumberland Ironworks fabricated a metal scupper for the rear of the house; it is sited for overflow to land in a rock bed below. This low-impact water-management system negates the need for supplemental watering of the landscape.

This project was gratifying because of the nature of the restrictions placed on the design. We love how it's a little quirky, yet fits in nicely with older homes on the island. □

Phil Kaplan is co-owner of Kaplan Thompson Architects in Portland, Maine. Photos by Irvin Serrano, except where noted.



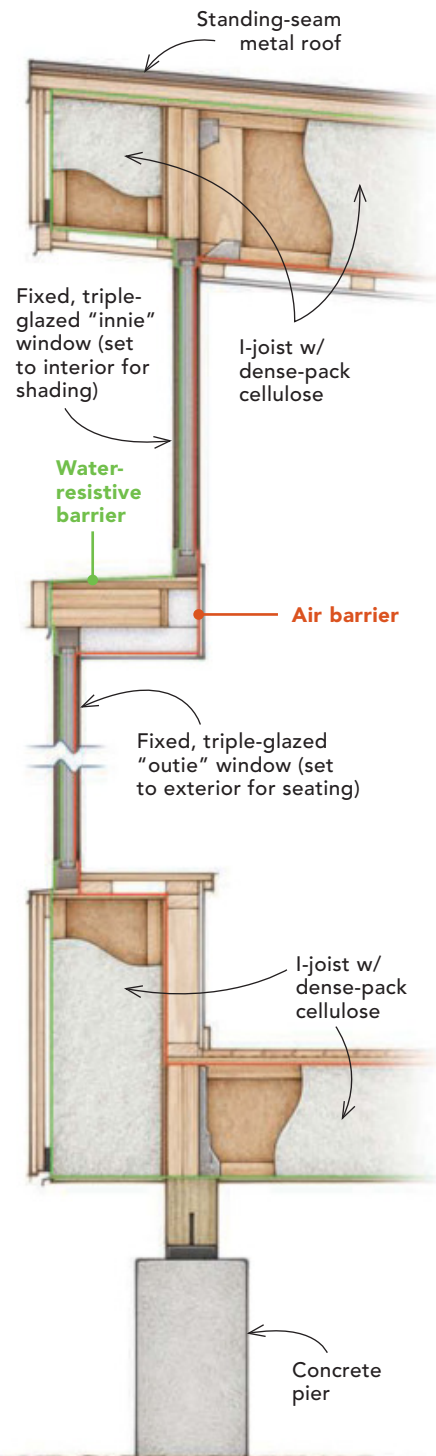
Phil Kaplan and his firm, Kaplan Thompson Architects, founded in 2004, have received numerous accolades in the world of design and high-performance building. The firm's motto, "Beautiful Sustainable Attainable," reinforces the commitment to creating vibrant, healthy, and durable buildings for all. His other venture, BrightBuilt Home, aims to provide more affordable, modular net-zero homes.

The pop-up dormer has a butterfly-roof profile; the angled valley acts like the valley of a 3-in-12-pitch roof. In combination with the sharp eyebrow created by the slant of the southern edge, it creates the illusion of architectural complexity.



A VAPOR-OPEN ASSEMBLY

The structural ZIP System sheathing is the primary vapor control layer, and is backed up by painted drywall on the interior. On the exterior, there's a vapor-open water-resistive barrier. Not only is the cellulose insulation vapor-permeable, but it can actually hold moisture until conditions are right for drying.



After receiving a Bachelor's of Art in sculpture from UC Santa Cruz in 1995, **Heather Thompson** co-founded a furniture-building company—in 2001, they began renovating houses. In 2011, she became sole owner of the company, now called Thompson Johnson Woodworks. Her team of 10 is committed to high-performance building and carbon-sequestering practices.



Island Inspiration

BY KILEY JACQUES

An admirable team effort results in a modest, modern home at ease in its rural setting

Jerry Keith lives at the end of a 25-mile-long dead-end road in a village of roughly 50 houses—most of which can be described as fishing shacks. The retiree enjoys the peace and beauty that is Elliott Island on Maryland's eastern shore. His son and son's young family live elsewhere, but they decided to build a weekend house next door. "The idea was to create a kind of camp for seasonal trips to spend time with the client's father," says the principal of David D. Quillin Architecture, the firm responsible for the build. "They wanted a rustic feel, but they love modern design." To Quillin, that meant the house

needed to blend into the remote community, yet have a contemporary sensibility. "It was right up my alley design-wise," he says. "I've spent a lot of time studying the architecture of this region and what makes it wonderful."

Quillin describes the area's homes as pared-down, without a lot of architectural ornamentation. They also have a weightlessness to them. "The surrounding houses look like they could be picked up by the wind at any moment—we wanted that quality in a casual-modern style," he explains.

Striking the right aesthetic tone and organizing the house to function well in terms of privacy and family gatherings were top pri-



EDITOR'S CHOICE

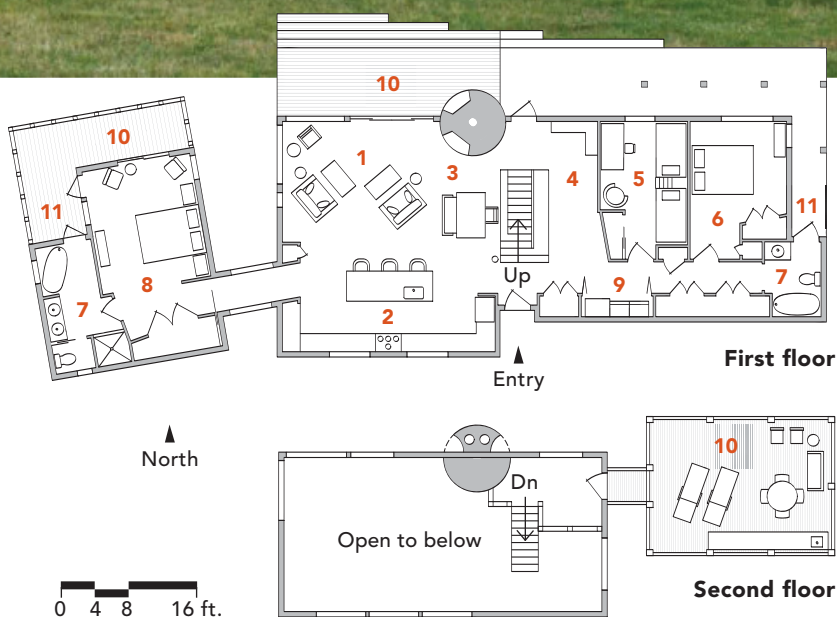
When selecting a project for the Editor's Choice Award, we look for a house that can be studied for months without tiring of it. The moment we saw this design by David D. Quillin Architecture, we knew we'd found the 2020 winner. Its measured proportions, gentle aesthetic, and clean detailing make it a stunner, but it's the affection with which the team describes their time together that makes it a house with heart.



ARRANGED FOR FAMILY

The open floor plan facilitates relaxed socializing by orienting the common spaces toward the water views. The kitchen island and stair cabinet break the volume into distinct zones for different activities for adults and kids.

- | | |
|-------------------|-------------------|
| 1 Living | 7 Bathroom |
| 2 Kitchen | 8 Master bedroom |
| 3 Dining | 9 Laundry |
| 4 Kids' playspace | 10 Deck |
| 5 Kids' bedroom | 11 Outdoor shower |
| 6 Guest bedroom | |





Rear in steel. Because the windows are concentrated on the back side of the house, which faces the water and is vulnerable to strong northwest winds, the engineers recommended steel framing. Wrapping the SIPs around structural steel presented a challenge that the builder resolved by welding bolts to the beams and then bolting 2xs to them. To avoid penetrating SIPs, the steel beam in the roof plate was stopped just short of the exterior wall and made to bear on a metal post.

SPECS

Bedrooms: 3

Bathrooms: 2

Size: 2176 sq. ft.

Location: Elliott Island, Md.

Architect: David D. Quillin Architecture,
daviddquillinarchitecture.com

Builder: Andy Bukovsky

Construction manager:
Jerry Keith



Floor meets shore. In combination with all of the glass, the at-grade position of the floor creates the sensation of sitting on the beach even when indoors.



Built-in accessibility. Oak cabinets and drawers in the kitchen were designed to be particularly deep to provide added storage. Some are split to accommodate shallow boxes above and deeper ones below. The rollout butcher-block cabinet located beneath the oven was an idea the builder got from "Universal Appeal," FHB issue #239.

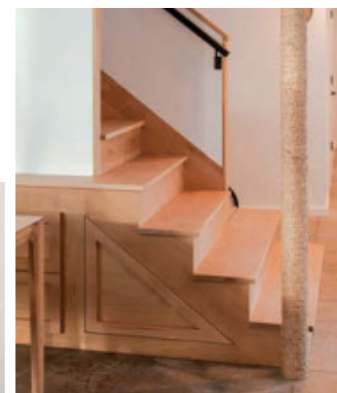


orities but not unusual design goals. What was a bit unconventional was the team that pulled it off. The clients hired Andy Bukovsky, a local master cabinetmaker but first-time home builder, to serve as the general contractor. And Jerry Keith, the homeowners' father, acted as construction manager. Because Keith uses a wheelchair, the first move was to make the job site fully accessible, which means accessibility was built into the plan from the start. It is one of several ways the team demonstrated a shared sensitivity to what this home was to be all about—unity.

Built for respite

To give the homeowners some privacy, Quil-lin set the master suite off from the main house, connecting it with a glass bridge. Spatially removed and built on wood pilings, the bedroom has a treehouse feel and is something of a retreat space. Its separation from the main house is also meant to be suggestive of the way island properties tend to evolve over time as a series of separate dwellings. Though the majority of the foundation is slab-on-grade, pilings made sense here because the topography slopes away on that

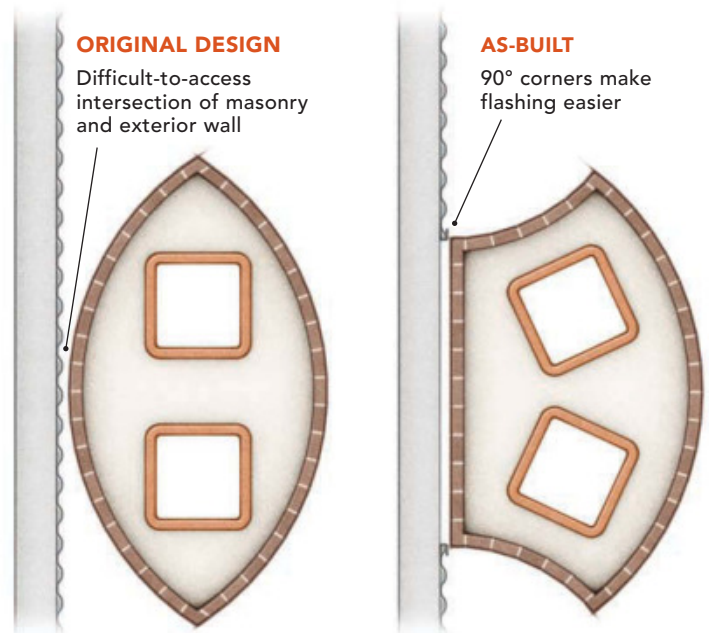
Master-level cabinetry. An interior white-oak stair/cabinet divides the main space, separating the living area from the playroom. One tread wraps around the unit to serve as a shelf in the main room; another becomes the top of a toy box in the kids' area.





A CHIMNEY TAKES SHAPE

The original design called for two separate fireplaces—one in the great room and the other on the rear deck. It was decided they would share a chimney. A new concept was developed for a 7-ft.-diameter drum that reduces to a smaller tower. The chimney's initial shape was football-like, but the mason, Joe Pete, said flashing that curve would be difficult. Instead, he suggested having the brick meet the siding with 90° corners, which not only made flashing easier, it also reduced the amount of brick-cutting he needed to do.



side of the property, and there are a number of nearby pine trees whose roots needed protecting. Additionally, runoff water is naturally directed beneath that portion of the house, creating a pleasant stream that is visible from the bedroom.

While the bedroom is loftlike, the main house is solidly rooted to the site. That connected feeling is heightened in the central space, where glazing is concentrated on the north side to dramatize water views. Quillin describes the room, which includes a creative play area for the kids, as “loose and organic.”

His idea was to encourage family time. “It facilitates roughhousing rather than ceremony,” he says. “The concrete, brick, wood, and metal materials contribute to the rustic camp feeling we were going for.”

Island character

Asked about a favorite feature of the house, Quillin points to an aesthetic detail. “The cedar siding grayed out wherever the sun hits it, but at the recessed entry it hasn’t weathered. It has an orange-gold color; it’s like a beacon that guides visitors to the front

door.” It also works to further break up the different volumes by adding contrast to the color palette. “The wood treatment helped the house settle into the surroundings,” he adds. Arguably, the house harmonizes so well with its setting because of a hundred decisions made during the build. Like most designs of distinction, it is the result of creativity, flexibility, inspired craftsmanship, and straight-up heart. □

Kiley Jacques is design editor. Photos by Danny Bostwick, except where noted.



David Quillin is founder and principal of David D. Quillin Architecture, a small firm that focuses on sustainable design and working with nonprofits, when possible. The company does both residential and commercial work, and has done projects as diverse as a national monument and the first Energy Star-certified Habitat for Humanity home in the mid-Atlantic area.



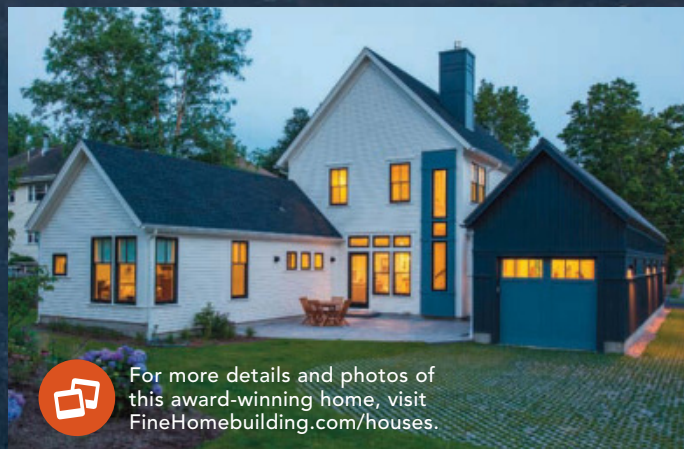
Andrew Bukovsky started a carpentry crew at his high school in 1976, and has been a carpenter and cabinetmaker ever since. He came to this project with little home-building experience, and working for the first time as a general contractor has given him a new appreciation for home builders. He’s now involved in a few restoration projects on the island.

Contemporary Farmhouse

A narrow lot and custom garage drive the design of this four-volume home



SMOOK Architecture & Urban Design looked to New England's traditional architecture to inform this 2800-sq.-ft. new build in Needham, Mass. It was decided that four stretched forms would make the best use of the narrow half-acre lot. The garage is a response to the owner's growing automobile collection; it has a linear configuration with entrances at both the front and rear, and a 13-ft. stud-wall height accommodates lifts, allowing space for up to six cars. The board-and-batten cladding, linear paneling, and trim wrap on the garage were inspired by the region's covered bridges. Permeable pavers provide discreet access to the rear entrance. The section of structure that houses the dining room sits to the front of the composition. A cornerstone of the design, it is detailed with asymmetrical windows, wide clapboard siding, a steep metal gable roof, a stone plinth, and a contemporary front porch. □



For more details and photos of this award-winning home, visit FineHomebuilding.com/houses.



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SPEC

NEW AND NOTABLE PRODUCTS

TOP FINDS FROM THE BUILDERS' SHOW

One of the highlights of attending the International Builders' Show is walking the trade-show floor to discover the latest products and materials available to architects, builders, and homeowners.

Here's a selection of some of our favorite offerings from this year's exhibitors.

DELIBERATELY REPURPOSED BOARDS

All of the architectural wood products from Centennial Woods, including the rustic paneling shown here, follow a unique and deliberate path on their way from the lumber mill to your home. The barn-siding look comes from the years the wood spends in its first life as snow fencing along the highways and fields of Wyoming. Centennial Woods removes and repurposes the boards once the weather has given them just the right patina but before they've been consumed by the elements, which not only provides you with a beautiful surface but also makes Centennial Woods a world leader in sustainable building materials. The paneling is made of a variety of western softwoods, comes in 20-sq.-ft. bundles of various lengths, and is available in eight unique finishes. —Rob Wotzak, digital brand manager



SLIDING SECRET DOOR

Fulfill your childhood dream of having a hidden passageway in your home with the MonoFlat Unison door kit from Sugatsune. A departure from typical hidden-door options that rely on recessed hinges or rotating bearings, this hardware turns any flat panel into a flush-mounted pocket door. To open, push on the surface of the door, causing it to swing inward before sliding sideways into the adjacent wall. You could build your door and wall to look like matching paneling for a true stealth look or use a contrasting door with Sugatsune's elegant flush door pull if you want to make your door a focal point. The MonoFlat Unison kit sells for around \$820 and comes in left- or right-hand models. —R.W.

PLUMBING PEACE OF MIND

Our homes are full of smart devices that protect us from theft, fire, and carbon monoxide, but what about water damage? The Flo leak-detection-and-prevention system by Moen allows homeowners to monitor and track water usage in real time from a smartphone. The system includes a smart water-shutoff valve that attaches to your main water line and automatically shuts off the home's water when unusual activity is detected. Diagnostic tests with Moen's Microleak technology are run daily to check the home's full water-supply system for leaks as small as a drop per minute. FloProtect, a subscription service through Flo, allows you to track your water usage down to the gallon per fixture for a comprehensive history.

For extra protection in places that are particularly vulnerable to leaks, you can add Smart Water Detectors that sense elevated moisture levels and freezing temperatures. Both the Smart Water Shutoff and the Smart Water Detectors send you real-time alerts by email, by text, and through the Flo app. Flo Smart Water Shutoff starts at \$500 and the Smart Water Detectors are \$50 each. —Jessica Chaloux, associate content producer



IT'S NOT A TREND. IT'S A REVOLUTION.

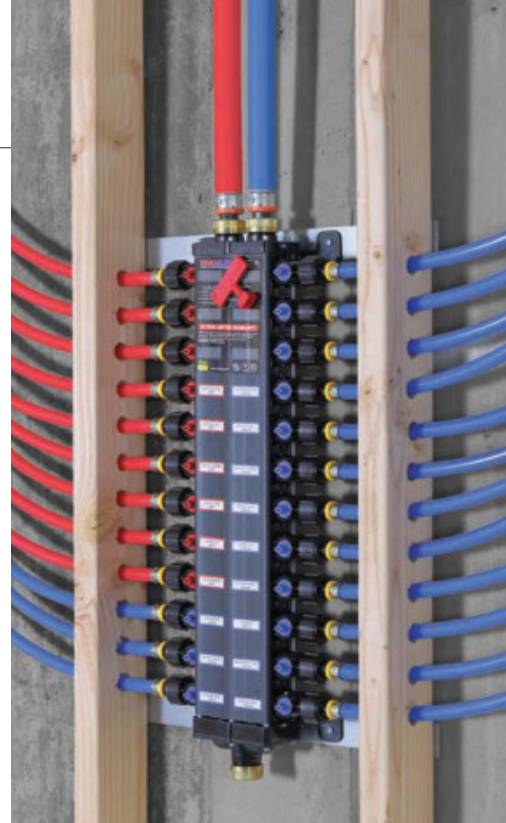
Visit ZIPRevolution.com to learn how easy it is to make the switch.

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SLINKY SHADE SCREENS

These attractive and durable outdoor curtains are really just a bigger version of the classic wire-mesh screens you've probably seen in front of an old fireplace. But when scaled up and hung from sleek stainless-steel tracks around your favorite outdoor space, the coiled-wire-fabric custom patio dividers by Cascade Home Decor take on a decidedly modern look. Every screen is custom-made to perfectly fit the style and size of your patio, with options for different metals, powder-coated finishes, shading values, wire sizes, and more. When you're ready to design yours, there's a form on Cascade's website where you can configure an outdoor divider with the options you want and get an instant price estimate. —R.W.

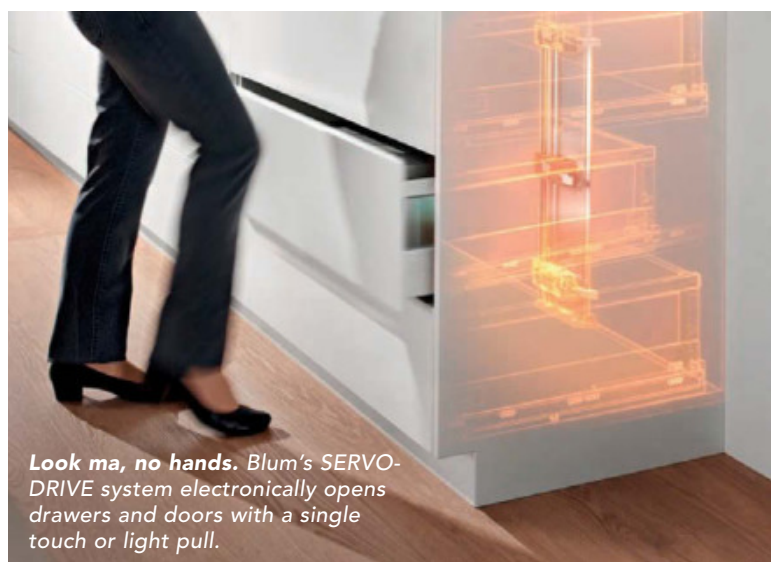


EFFICIENT WATER DISTRIBUTION

The fastest way to get water to all of a home's plumbing fixtures is for all of the water lines to branch out from one central location. You could piece this system together with a bunch of short lengths of PEX tubing and lots of tees—or you could use the Viega ManaBloc. With models ranging from 14 to 36 outlet ports (\$135 to \$320), plus the ability to gang multiple manifolds together, the ManaBloc is adaptable to any size plumbing system and compatible with a wide array of connector types and sizes, allowing for a truly custom installation. Plus, each port has its own built-in quarter-turn shutoff valve, meaning you can add to or repair individual components in your home's plumbing without turning off any other fixtures in the house. —R.W.

HANDS-FREE KITCHEN DRAWERS

If you're looking for one more way to take your kitchen into the 21st century, the Blum SERVO-DRIVE drawer system might be just the way to do it. This collection of electric actuators works in conjunction with a variety of Blum's slides and hinges to open drawers and overhead doors with a gentle tap, allowing you to put things away without putting them down to open your cabinets. And if your primary motivation is creating a minimalist aesthetic, the SERVO-DRIVE openers preclude the need for handles and pulls, leaving your cabinets free of visual clutter. If the SERVO-DRIVE seems a bit extravagant for your home, there is one place in the average kitchen where it's arguably worth the investment: the trash and recycling pullout. For just over \$200, you can get a self-contained kit that will service one drawer. If you want to add SERVO-DRIVE to multiple drawers or doors, it's easy to assemble a complete system out of Blum's collection of plug-and-play components. —R.W.



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YOUR QUESTIONS—PRO ANSWERS

Tiling a porch

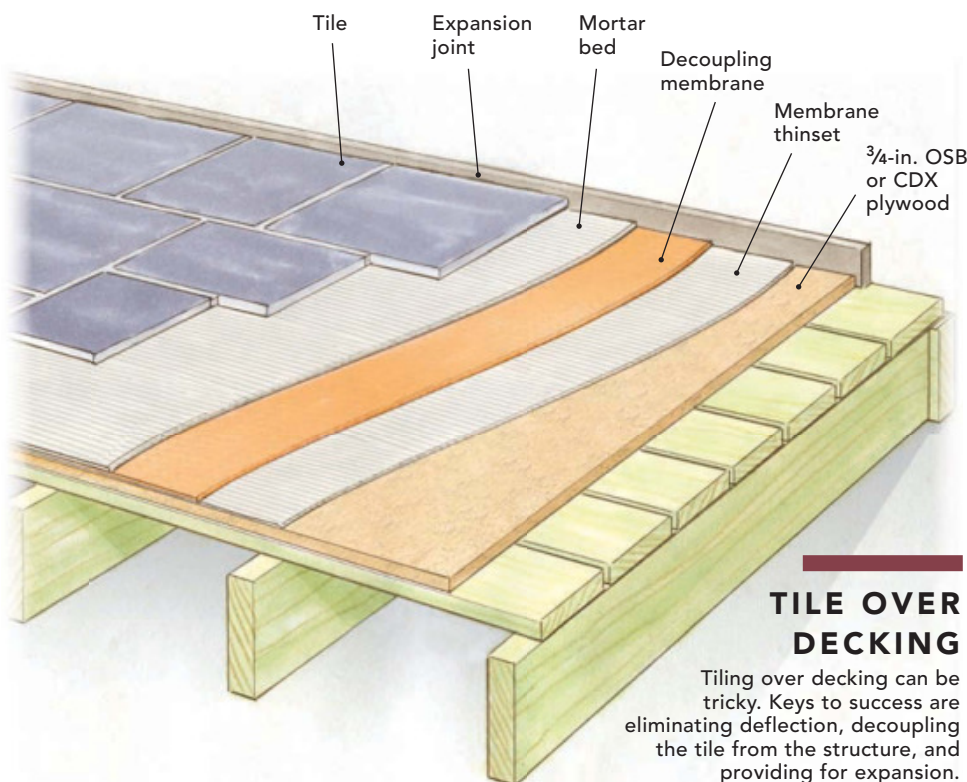
We have a covered side porch that we'd like to tile. It has standard pressure-treated deck framing, with 5/4x6 deck boards. Is there a way to tile that will hold up to New Hampshire's climate?

—DAVE AND KATHY
via email

Tom Meehan, owner of Cape Cod Tileworks, replies: Particularly in New England, with our seasonal temperature swings and damp climate, tiling an outside room is challenging. The freeze/thaw factor combined with a good dose of water, whether it be from rain or snow blowing in, will put any floor to the test. If you can do something to keep the weather out, that would be ideal. As for the tile itself, here's what I'd do for the best chance of success.

The first priority is that the floor is stable and there is no deflection when it's walked on. If it is an open porch, then the floor should be pitched so that water does not pool and can escape to the outside. Install a layer of exterior-rated sheathing over the 5/4 planking, either 3/4-in. CDX plywood or 3/4-in. AdvanTech. This will strengthen the floor and prevent cracks that could be caused by the planking telegraphing up through the floor. You also need expansion joints at the perimeter all around the room to allow movement within the floor. The compressive polyethylene used by masons for expansion joints in concrete flatwork is perfect for this.

For waterproofing and movement control, I use a membrane over the sheathing—either Schluter-Ditra or Noble Company's



TILE OVER DECKING

Tiling over decking can be tricky. Keys to success are eliminating deflection, decoupling the tile from the structure, and providing for expansion.

Noble Deck. If the floor is large enough, the Tile Council of North America recommends expansion joints in the tile every 8 ft. to 12 ft. Schluter makes expansion joints in colors that closely match their grouts.

Proper installation of the tile is key. Follow the membrane and tile manufacturers' recommendations for tile mortar, grout, and trowel-notch size. It is very important for the mortar to cover at least 95% of the back of each tile. As you're installing the tile, occasionally pull one up and verify the coverage. Finally, apply two coats of a very good sealer such as Miracle Sealants 511 Impregnator Sealer, again following the manufacturer's instructions.

How efficient are heat pumps, really?

We're building a detached garage with an in-law apartment above it. We're uncertain how to heat and cool it, but we're hear-

ing a lot about minisplit heat pumps, and wondering if they are really more energy efficient (and cheaper to run) than standard fuel-burning heating equipment. Are they?

—AMANDA
via email

Former Green Building Advisor editor Martin Holladay replies: In this context, efficiency is a measure of the amount of heat energy that is delivered to the house as a percentage of the energy consumed by the heating appliance. A furnace or boiler that burns fossil fuel (natural gas, propane, or heating oil) will have an efficiency that ranges from about 78% to 98%. In the case of a heat pump, the fuel is electricity. A toaster or electric baseboard heat has an efficiency of 100%. A heat pump has a higher efficiency—usually in the range of 200% to 300%, although higher efficiencies are possible, especially for well-designed ground-source heat-pump

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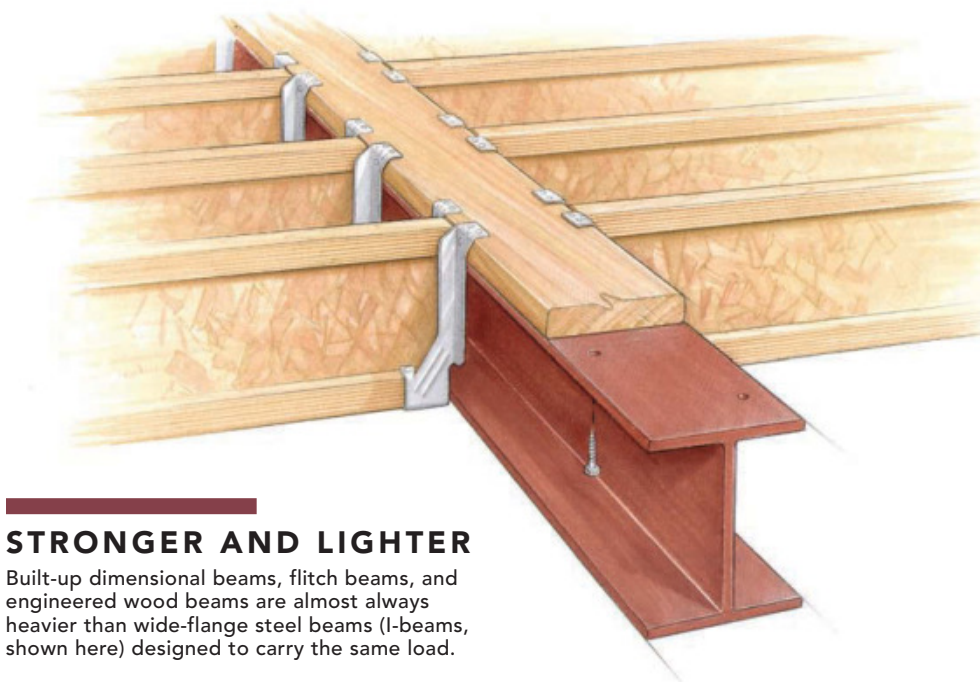


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STRONGER AND LIGHTER

Built-up dimensional beams, flitch beams, and engineered wood beams are almost always heavier than wide-flange steel beams (I-beams, shown here) designed to carry the same load.

systems. (Note that well-designed ground-source heat-pump systems are rare.)

The reason that a heat pump can have an efficiency greater than 100% is because most of the delivered heat is collected from the outdoor air. The heat pump absorbs heat from the outdoor air, and delivers the collected heat to the house. (A small percentage of the delivered heat consists of waste heat from the system's fans.)

Homeowners choosing between an air-source heat pump (for example, a ductless minisplit) and a fuel-burning furnace rarely care about the relative efficiency of the two approaches. The fact that a heat pump has an efficiency of 250% and a furnace has an efficiency of 92% doesn't tell you much. Most homeowners care about the relative cost of the two approaches, not the efficiency numbers. In the U.S., heat from an air-source heat pump is usually cheaper than heat from a furnace that burns propane or oil, but more expensive than heat from a furnace that burns natural gas. There are exceptions to this generalization, however. The lower your cost of electricity, the more attractive a heat pump is from a financial standpoint.

Finally, some homeowners don't care about efficiency or cost—they care about their carbon footprint. If you're that type

of homeowner, note that an air-source heat pump has a low carbon footprint in areas of the country (like the Pacific Northwest) with an electricity grid that depends largely on hydroelectricity or other renewables, but has a relatively high carbon footprint in areas of the country (like West Virginia) with an electricity grid that depends on coal.

Steel with wood framing?

I'm planning a second-story addition for my house, and the builder is saying we need to use a flitch beam in the new floor framing. I was hoping we could use engineered lumber. Bottom line, what are my options?

—JEREMY
via email

Structural engineer William Porter, with C.A. Pretzer Associates in Cranston, R.I., replies:

A number of design considerations go into deciding what member is right for a job. The top two come from the building codes. First is strength—does the beam have adequate structural capacity for the loads upon it? Next is serviceability—will the member bear those loads without excessive deflection? There are usually other constraints such as schedule, budget, and whether the beam will fit the space, so the right solu-

tion for one owner or builder may not fit another.

While complicated to discuss in absolute terms, there are two instances where flitch beams—beams made of plate steel sandwiched between wood—are top options. The first is a flush beam in a floor with dimensional lumber joists. While engineered lumber maintains its cross-sectional dimensions with changes in moisture content, dimensional lumber swells and shrinks. An engineered flush beam paired with dimensional lumber joists that do shrink can lead to a humped floor above or a cracked ceiling below. A flitch beam with a steel plate that's slightly shallower than its wood members can offer the spans of engineered lumber and move with dimensional lumber to keep everything flat.

Flitch beams can also work well when beam depth and width both matter in terms of fitting other members to or around it, such as ridge beams, structural hips, or structural valleys. In these instances, a flitch beam built up of two plies of dimensional lumber and one steel plate performs similarly to a three- to four-ply engineered-lumber beam of the same depth.

It's my opinion that there's almost always a better option than a flitch beam. The plates can be awkward to handle on the job, and flitch plates require lead time for fabrication.

You should also consider wide-flange beams—more commonly called I-beams. The strength and rigidity of a steel member markedly increases if there is more steel closer to the top and bottom of the member. Wide-flange beams put the steel where it counts, in the flanges. I often find that serviceability, not strength, is the governing factor when designing steel members for residential construction. The serviceability of a W10x12 steel beam is nearly identical to that of a ½-in. by 11-in. steel plate, but the beam weighs only two-thirds of what the plate does. Steel is often priced per pound, so savings in weight means savings in dollars. The wide-flange beam will also be easier to handle since it weighs less, and it has a stable cross-section that can be seated upon supports without high risk of rolling over.

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*Interior
Demolition*

*After
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Deconstruction Underway

At the 2020 Fine Homebuilding House, interior demolition took place during the cold and rainy months of January and February. All of the trim and flooring was carefully removed and salvaged, drywall and insulation removed, and some non-load bearing walls pulled down. With the framing exposed, the crew turned their attention to the structural changes, framing some temporary interior walls to carry the weight of the building as the large central chimney was removed and new beams and posts installed to open up the first floor. A towering vaulted room also got a new floor system to create a playroom beneath the rafters.

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Salvaging trees for lumber

Back in the late 1970s, my wife and I purchased 25 acres of forested mountain land in Virginia with the intention of homesteading. In the ensuing years, careers developed, the kids grew up, and the homestead never happened—but we kept the land anyway. Call me a tree-hugger, but there was something satisfying about keeping that little piece of Creation wild.

Meanwhile, the forest kept on growing. We cut firewood as needed, but had no real desire to harvest timber. The situation changed recently, however, due to a freak storm and an insect blight. The storm knocked down a number of mature hardwoods and the blight, caused by the emerald ash borer, is gradually wiping out an entire species. We had to decide to either salvage the trees or let them rot in the woods.

Our situation is not unique. According to the U.S. Endowment for Forestry & Communities, there are an estimated 10 million family forest ownerships across the United States that collectively control 36%—290 million acres—of the nation's forestland. That's a lot of lumber. In an ideal world, these forests would be harvested and replanted on a regular rotation, producing long-term



SAWMILL ON-SITE

Hired by the hour, portable bandsaw mills can turn felled trees into stacks of lumber, saving downed trees from becoming firewood or just rotting in place.

income for their owners while they capture carbon through photosynthesis. But the geophysical realities of the 21st century throw several monkey wrenches into that happy picture. Some of the impacts are direct consequences of climate change. Storms of greater

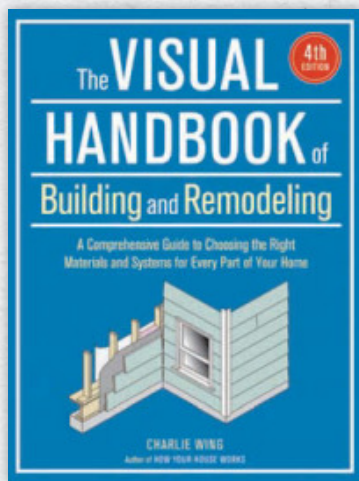
intensity and frequency mean more trees blowing down, and warmer temperatures have allowed native insect species such as the western pine beetle to survive winters, resulting in massive damage to U.S. pine forests already weakened by drought. Another mass tree-

killer is the spread of invasive species, such as the ash borer—a wood-boring beetle.

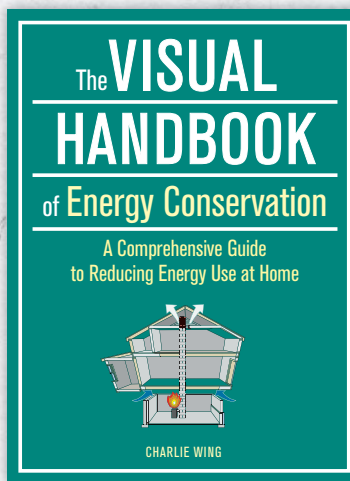
As a builder and woodworker, my instinct was of course to salvage the wood from our doomed trees. That turned out to be more challenging than I realized it would be. There are

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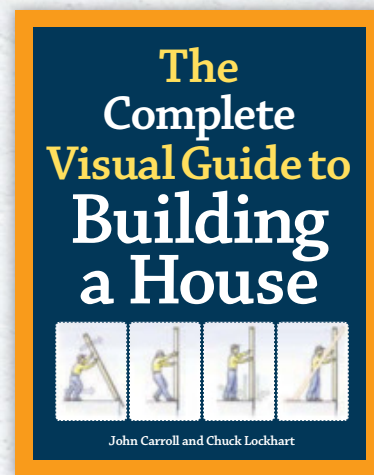
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four distinct issues that need to be addressed in order to convert trees to lumber: logging, milling, drying, and storage.

Logging

Logging (or “timber getting,” as the English call it) involves cutting and transporting logs. This is a famously dangerous business; unless you’ve had plenty of experience in the woods, your best option is to hire a logger, at least to fell the trees. That’s what I did. Watching a professional drop a 36-in.-diameter tree in a matter of minutes so it falls where it’s supposed to might lead one to think there’s nothing to it. In fact, that kind of efficiency is only gained by cutting thousands of trees; it’s tougher than it looks.

Cutting up trees into sawlogs (“bucking”) is also dangerous because of the reactions of the fallen trees. Logs can roll and branches can whiplash. At the least it can be devilishly difficult to avoid binding your saw.

Transporting logs to a central location (“skidding”) can also be a major expense. Production loggers do this with a no-nonsense juggernaut called a skidder, but for a landowner who is concerned with minimizing environmental impact, there are more nimble options. In my experience, a skid steer works best, preferably on tracks rather than a rubber-tire model. A grapple attachment facilitates log handling by capturing the log, but a grapple weighs much more than forks. Thus, forks sometimes work better for a heavy log to keep the machine from tipping forward.

Landowners may be tempted to use the family tractor for skidding, but there are potential dangers, especially on steep

ground. A tractor’s high center of gravity makes it susceptible to rollover. Chain-dragging logs with a tractor on steep ground is also dicey because a log can roll, pulling the tractor with it.

Milling

Milling is the most enjoyable part of the process, at least for a woodworker. It’s like being a kid in a candy factory. Which type of mill you work with depends on how much physical

sawn lumber can be moved directly from the mill to the drying stack. Sawing services don’t come cheap, though. In my area, the going rate for bringing in a medium-size mill with hydraulic log loading and turning is \$90 to \$100 per hour.

Another cost of lumber-making is dealing with waste, even if you burn wood for heat. The unruly shape of sawmill slabs makes them tedious to cut up and handle for firewood.

requires one year for each inch of board thickness. It’s also worth noting that air-drying won’t kill insects, such as the powderpost beetle, that affect certain woods.

A kiln can deliver 6% MC (moisture content) lumber in weeks or even days depending on wood species and type of kiln, and it also kills any insects in the lumber. A poorly managed kiln, however, can produce defects such as checks and

An honest assessment of how much lumber you use and how much storage space you have is in order before succumbing to the lure of “free wood.”

labor you’re up for and how much control you want over cutting decisions. At the easy-and-simple end of the spectrum is dropping off your logs at a commercial sawmill. But keep in mind that these outfits typically deal in trailer loads of logs, and don’t welcome walk-in business. You may find a smaller operator that will saw for a fee or “on shares,” which means they keep half of the lumber. If you want anything fancy done with your logs, such as quartersawing, you’d better discuss that in advance, because things move very fast in a production mill.

The most popular option nowadays for getting small batches of logs milled to order is the portable bandsaw mill. Because the milling is done on your property, the cost of trucking logs to a mill is avoided and

The alternative is to stack them in a pile for burning, but that’s a project in itself and the pile is an eyesore while it dries.

Drying

Lumber is dried by air-drying, kiln-drying, or a mixture of both. Air-drying is a gentle and free-of-charge way to dry lumber, but there’s still a lot of work in stacking. Green (unseasoned) lumber must be stickered—layered with ¾-in.-thick strips of wood—to allow even airflow around all of the boards. It must also be protected from the weather, either stacked in a well-ventilated barn or covered with sheets of metal roofing. There’s also a sizable upfront investment of labor in ripping spacer sticks and constructing solid, straight drying platforms. Bringing the cut lumber from wet (“green”) to dry generally

warpage. If there’s a dry-kiln in your neighborhood, ask around to see how it worked out for other users before committing.

Storage

Storing lumber after it has dried can be an issue that overwhelms a craftsman-turned-lumber maker. A single premium log contains hundreds of board feet, so you may go from squirreling away every little cutoff to suddenly finding yourself awash in wood. An honest assessment of how much lumber you use and how much storage space you have is in order before succumbing to the lure of “free wood.”

If I haven’t discouraged you yet, here’s one final word of caution: Don’t even think about using hardwoods for stick-framing. If you do, you’ll have the strongest and “crookedest” house in the neighborhood.



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Scott McBride is a builder and writer in Virginia.

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CELEBRATING PASSION FOR BUILDING

Maria Klemperer-Johnson has always been surrounded by the handmade. Growing up, her mother—a fiber crafter—made her clothes. Her father was a woodworker, building simple furniture that she still uses today. Even some of her lamps were made by her grandfather. “In my family, when we need something, we just build it,” she says.

It’s a pragmatic approach to living that seems to serve as the underpinning of Maria’s personal and professional life. When her home burned down in 2006, she took it as an opportunity to learn timber-framing in order to construct a new one. At the frame-raising, Maria was eight months pregnant and actively working as carpenter.

For her, building is more than a means to an end. After all, she didn’t walk away from a future in computer science after earning a degree from Stanford or drop out of grad school at Cornell solely for the sake of self-sufficiency. “I hated sitting at a desk and looking at a screen,” she says. “I wanted to be outside using my body and my mind.”

Maria eventually started her own contracting business, Hammerstone Builders, serving the Finger Lakes region of New York. Being a woman in construction drew attention that was initially a bit thrilling, but after a while grew tiresome. “I started to wonder when people told me I was doing a good job, if they were saying I did a good job, or a good job ‘for a woman.’ And I got tired of being the representative for my entire gender. It occurred to me that the only way this would change was if there were more women represented in the trades.”

So, she created Hammerstone School and began teaching carpentry skills to women. Some of her students go on to pursue a profession in the trades. But all leave with new skills, strength, and independence. In 2018, Maria also became an instructor in the Residential Construction associates program at SUNY Delhi, a New York State trade school. There she teaches planning, CAD, timber framing, light framing, and finish carpentry. She also teaches a small-business class for residential construction, and helps create a support network for the few female students there while working to shift the perceptions of male students who may have never worked alongside a woman before—improving an aspect of the industry that is in desperate need of improvement, one student at a time. —Rob Yagid, executive director, Keep Craft Alive

“I encounter people all the time who, like me, can’t imagine living without making.”

MARIA KLEMPERER-JOHNSON
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