

Fine Homebuilding

ISSUE 340 // JULY 2026

ON-SITE WITH A PANELIZED BUILD

A wall and roof installation on a high-performance build showcases the pros and cons of factory-built panels





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Cover photo by Brian Pontolillo

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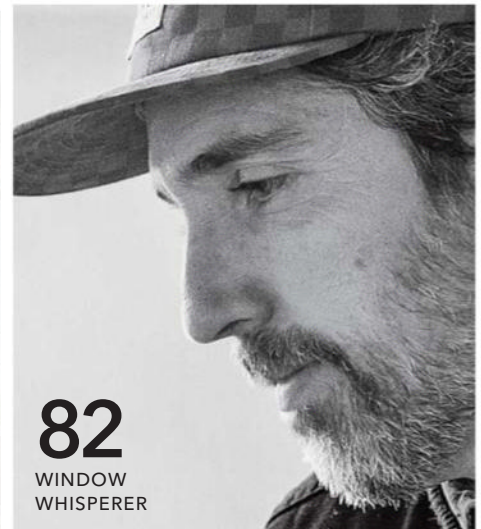
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Tickets are available for this year's can't-miss event dedicated to innovation in residential design and construction. [FineHomebuilding.com/summit-26](#)



■ SHARED ON SOCIAL MEDIA

Behind the Byline: Mike Guertin

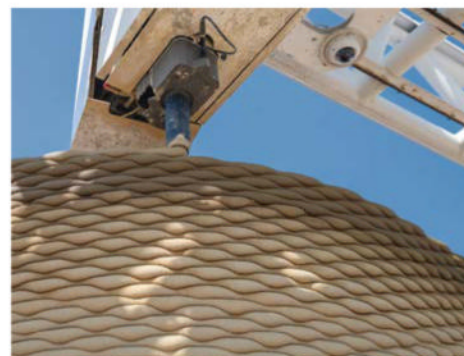
You've read his articles and seen his work, now get to know the seasoned pro behind it all in this new series highlighting some of our longtime contributors and sharing the stories you don't always see in print. Read more about Mike Guertin on Instagram [@finehomebuilding](#).



■ HEARD ON THE PODCAST

A closed-cell conversation

In this Segment from Ep. 728, the podcast crew discusses using closed-cell insulation behind wood paneling without air or vapor control. [FineHomebuilding.com/pod-728](#)



■ AS SEEN ON VIDEO

On-site with ICON

Ever wonder what happens on a feature photo shoot? Take a peek behind the scenes with editorial director Brian Pontolilo as he recounts his experience on a 3D-printed construction site. [FineHomebuilding.com/3d-printed-homes](#)

■ FROM THE FORUM

How can I prevent roof leaks at valleys and flashing points?

Hop onto the forum to chime in or to ask your own building questions. [FineHomebuilding.com/340-forum](#)





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THE VOICES OF EXPERIENCE



DEAN KILGORE is a Texas-born attorney with more than 50 years of experience trying and mediating civil lawsuits. A large number of his cases have been construction and design disputes. In this issue, he writes about how to establish good construction contracts ("Better Contracts for Builders and Clients," pp. 54-59). Dean and his wife live in Central Texas in their forever home. When not mediating, Dean can be found running a chainsaw, working as an amateur blacksmith in his forge, or fly fishing.

Various owner, publisher, and editor-in-chief of *Old-House Journal* for 47 years, **PATRICIA POORE** ("Practical Preservation," pp. 46-53) launched multiple extensions including *Old-House Interiors* and *Arts & Crafts Homes*. Her own restorations include a 1911 limestone in Park Slope, Brooklyn, and a 1904 Elizabethan/Shingle-style house in Gloucester, Mass. Last year Patty announced a soft path to retirement, but, as editor emeritus, she continues to contribute to every issue of *OHJ*. As she puts it, "I just plain love my job!"



The new author of *Fine Homebuilding's Houses by Design* column (pp. 70-75), **LAUREN JONES** is a Texas-based journalist who's always been fascinated by what makes people tick—and what they build because of it. Maybe that comes from her psychology degree. These days, she writes about architecture and design for *Dwell*, *Metropolis*, and *Architectural Digest*. She's also written two articles for *FHB*: one exploring 3D-printed construction (*FHB* #337) and another profiling a home with no exterior windows (*FHB* #338).

Write an article

Fine Homebuilding welcomes articles from our readers. We'll acknowledge all proposals and return any we can't use, and we'll pay for any articles we publish. For details, check our website at FineHomebuilding.com.

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On the bleeding edge

Editorial director Brian Pontolilo reminded me recently that we don't just write about topics on the leading edge, but also about those on the bleeding edge. While "the leading edge" suggests working with emerging technologies on their way to broader adoption, "the bleeding edge" implies real exposure to uncertainty. Things on the bleeding edge are still in flux, standards are unsettled, products change while you're writing about them, and best practices haven't fully coalesced.

Fine Homebuilding has always been on the bleeding edge. In 2014, we published a six-part series by architect Steve Baczek (*FHB* #240 through #245) on constructing a passive house in Falmouth, Mass. At the time, the standard was still very niche—it wasn't until the following year that the Passive House Institute US split from the Passive House Institute in Germany and developed a standard tailored to North American climate data. Today, passive house standards have evolved to be more adoptable, as builder Josh Salinger wrote about in 2024 ("Passive House 3.0," *FHB* #328). They are now used by a growing number of high-performance builders.

We've taken a similar early look at building methods. Our first article on framing with panelized walls came out in 2005 ("Better Framing With Factory-Built Walls," *FHB* #169) and covered a simple framed-and-sheathed wall-panel installation. Since then, off-site construction has come a long way. In this issue, 11 years after that first article, Ben Bogie discusses building a house with straw-insulated wall panels with integrated water, air, and vapor control layers, and what he learned about working with these high-performance, factory-built assemblies (pp. 30-37).

Jon Harrod's article on air-to-water heat pumps (pp. 38-45) covers a product category on the bleeding edge. Air-to-water heat pumps are new in the United States and are still not widely understood. In the four months I spent editing the article, many of the products changed, and one was discontinued as the company transitions to a new refrigerant standard. All the HVAC experts I spoke to had limited experience with these systems. But that's exactly why it's so important that we cover them now: To adopt something so very new, people need a deep dive into the topic from the few people who have experience with it. As more contractors and homeowners come to understand these systems, and more products become available, this category will grow, and awareness will too.

When brand-new performance standards, building practices, products, and materials emerge and are tested in the real world, *Fine Homebuilding* will report on them—with the most up-to-date information we can gather, even as they continue to change. Yes, on the bleeding edge things are still raw and risky, but that's where exciting progress takes place.

—SAMANTHA MAVER
Executive editor

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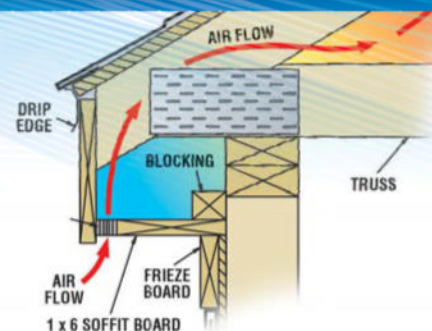
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Know the MASTER THE RULES OF HOME BUILDING CODE

Exterior doors decoded

BY GLENN MATHEWSON

Most people think of an exterior door as the connection between a home's interior and the outdoors. They appreciate that doors keep out noise, the elements, and unwanted guests. Doors are also admired as attention-getting architectural elements for both homeowners and passersby. However, the 2024 International Residential Code (IRC) is less concerned with these experiences and more focused on how doors perform as energy-efficient building components; barriers against fire, carbon monoxide, and other pollutants; and safe exits for occupants in an emergency.

The IRC's rules for doors depend on a door's location and what's behind it, and whether it will be used for emergency escape or to fulfill the requirement for egress. There's a lot to know, and the rules can be confusing. Inspectors take the IRC provisions for doors seriously, because the separation they provide between likely sources of fire, carbon monoxide, and flammable gases makes homes safer, allowing people to escape and survive situations that might otherwise be deadly.

Here, I'll discuss some of the relevant rules for exterior residential doors, but this is not a comprehensive list. There are additional codes related to lighting, proximity to receptacles and their spacing, and safety glazing of nearby glass, plus requirements for automatic garage-door openers and fold-down attic access doors when installed. The International Swimming Pool and Spa Code has pages of rules related to doors and gates meant to keep unattended children out of the water.

And there may be more requirements to come. At recent code-development hearings, there have been proposals for an appendix with security requirements for doors, including dead bolts and hardened frames. Although such an appendix has yet to be approved, some jurisdictions have implemented security requirements for exterior doors. To see if these apply to you, check the rules in your area.

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



**PRIMARY
SAFE PASSAGE**
So all occupants can escape in an emergency, egress doors must be accessible from every level of the home via code-compliant stairs. Levels without stair access must have their own egress door.

EGRESS DOORS

According to section 318.2 of the IRC, regardless of the size of the house, one and only one egress door is needed to provide a safe exit in an emergency. This door must be side-hinged and have a clear opening no less than 32 in. wide measured from the door stop to the face of the door when the door is open 90° (and it must be able to open 90°). This requirement acknowledges that the door may be close to a corner or furniture that prevents it from opening completely. The egress door height, measured from the top of the threshold to the bottom of the doorstop, cannot be less than 78 in. These minimum measurements explain how 36-in.-wide by 80-in.-tall entry doors (3-0/6-8) have become the standard size.

The requirement for a single egress door assumes every habitable level and the basement are connected with a code-compliant stairway or ramp to the level with the egress door. If one or more levels are not connected by code-compliant stairs, then those levels must have their own egress door. For example, if the basement is accessible only by an exterior door with no interior stairway to the floor above, the exterior door accessing the basement must also meet egress-door requirements.

To ensure that an egress door is easy to use during the panic of an emergency, you must be able to open it from the inside without the use of a key, special knowledge, or effort. Therefore, a double-cylinder dead bolt that is keyed on both sides of the door is not allowed. (However, those locks are allowed on other exterior doors unless a door is acting as the required "emergency escape and rescue opening" from a bedroom or basement, as described on the facing page.)

With at least one egress door established, there are no requirements or limitations on the number or the size of any additional exterior doors.

EMERGENCY ESCAPE
AND RESCUE OPENINGS

Per IRC section R319.3, every sleeping room (bedroom), basement (finished or unfinished), and habitable attic must have one “emergency escape and rescue opening” (EERO). Windows are often used as EEROs (commonly described as “egress windows”), but exterior doors can serve the same purpose. *FHB* #282 describes rules for EEROs in depth, but in short, windows and doors serving as EEROs have identical requirements: They must be able to be opened from the inside without the use of a key, tool, or special knowledge, and they must have a clear opening no less than 20 in. wide, 24 in. tall, and 5.7 sq. ft. in area, or 5 sq. ft. for a “grade-level opening,” which is defined as an opening where the bottom is within 44 in. above or below the finished ground level adjacent to the opening.

A SAFE SECOND WAY OUT

An emergency escape and rescue opening (EERO) doesn’t have to be a window. It can also be a door as long as it meets the minimum opening dimensions and can be opened easily, meaning no complex hardware or hidden latches.



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LOOK FOR THE LABEL

Exterior doors must meet air-leakage and U-factor requirements based on climate zone. These values can be found on manufacturer websites and on labels commonly stuck on new doors.

EFFICIENCY REQUIREMENTS

All doors and access panels between conditioned space and unconditioned space—that is, all egress and other exterior doors, EEROs, and attic and utility access panels that separate unconditioned spaces from a home’s interior—must meet the energy conservation requirements found in chapter 11 of the IRC. Table N1102.1.2 provides maximum U-factors for these windows and doors, which are described as “vertical fenestration.” The U-factor requirements are based on the International Energy Conservation Code (IECC) climate zones, with colder climates having more-stringent requirements. U-factors range from 0.50 in climate zone 1 (Miami) to 0.27 in climate zone 7 (Vail). Translated to R-value, this ranges from R-2 to about R-3.7.

Air leakage around doors also significantly affects comfort and the efficiency of heating and cooling. Section N1102.5.3 requires hinged doors in the building’s thermal envelope to have no greater than 0.5 cfm of air leakage per sq. ft. of door area when tested using one of two referenced standards or by an independent laboratory. This information should be provided by the door manufacturer with a label on the door. There is an exception for site-built doors, but the building still must pass the overall building airtightness requirements described in the IECC or in local or state amendments.

Though the IRC demands minimum thermal performance from all exterior doors, it recognizes that using a solid wood front door or garage-to-house door, new or historic, has been common. For this reason, since the first IRC was published in 2000, there has been an exception to allow one opaque door not more than 24 sq. ft. to be exempt from maximum U-factor requirements. (You’re unlikely to get a much better U-factor than 0.46 with a solid wood door.) This single door is commonly found in front entries or where garages are separated from living spaces. Opaque doors used for garage separation are not allowed to have any glass unless the door has a 20-minute fire rating from an approved agency. (See more on garage separation doors on the following page). Other opaque doors under this exception can be up to half glass.

DOOR SWING AND STAIRS

Per section R318.3, all exterior doors can swing in or out provided they do not swing over a step down. (Storm or screen doors are permitted to swing over steps at the exterior.) That said, the landing on the inside of an exterior door that's not the required egress door can be up to 7¾ in. below the threshold, which is helpful when the floor joists extend beyond the exterior wall to support a cantilevered balcony. This allows for a step down on the exterior to keep out rain and snow. There is only one door that must swing outward: Section P2708.1 requires hinged shower doors to swing outward so that if someone falls in the shower, their body won't block the door, preventing a rescue.

GARAGES AND SHARED UTILITY SPACES

Almost since the invention of cars, building codes have addressed the hazards associated with storing gasoline-powered vehicles in garages. The spread of fire from gasoline and automotive chemicals is an obvious concern, but so is the risk of carbon monoxide—a toxic, odorless gas that's a by-product of fossil-fuel combustion. One of the oldest provisions in model building codes is that there can be no doors that open directly between an attached garage and a sleeping room. The hazards of fire, smoke, and carbon monoxide are too great when occupants are sleeping.

Section R302.5.1 requires that doors connecting garages to other dwelling spaces must be suitably resistant to fire and sealed against smoke and combustible gases. The door must be a minimum 1¾ in. thick and made from solid wood, solid or honeycomb-core steel, or have a 20-min. fire rating from an approved testing laboratory. The door must also be self-closing so it can't be left open.

In the 2024 IRC, section R302.3.6.1 added new requirements for fire protection for two-family dwellings (duplexes) that connect via a shared accessory room, such as a laundry or storage room. To prevent the spread of fire between dwelling units, doors accessing these rooms must comply with the same requirements as those separating garages from dwelling spaces.

PROXIMITY TO POLLUTANTS

If an open door has a high potential for allowing hazardous or noxious contaminants into the house, that's a problem. Section R325.4.1 requires a 10-ft. separation between "mechanical or gravity outdoor air intake openings" and nearby sources of contaminants, including chimneys, ventilation outlets, plumbing vents, streets, alleys, parking lots, and loading docks. Mechanical intake openings include those used in HRVs, ERVs, and makeup-air systems for large kitchen exhaust hoods. Doors, windows, and soffit vents are examples of gravity outdoor air intakes.

Whether occupants plan to use them for ventilation or not, this means operable windows and doors must be 10 ft. away from vents, chimneys, plumbing vents, streets, and parking areas. An exception allows the door or window to be less than 10 ft. from these contaminant sources when the opening is at least 3 ft. below the contaminant source.

Exhaust from bathrooms and kitchens is not considered a noxious contaminant, and proximity to door openings is not limited. Section M1502.3 provides specific limitations for clothes dryer exhaust. The distance to openings must either be specified by the dryer manufacturer or no less than 3 ft. when the manufacturer doesn't specify a distance.

Vents from fuel-burning appliances also have special requirements and clearances, found in IRC chapters 18 and 24. For these systems, separation distances are also governed by their own specific safety and performance standards rather than the general intake clearance rules.



LIVING-SPACE SEPARATION

If not made from code-approved materials, a door that connects a dwelling unit to a garage must have a 20-min. fire rating. The door must also be self-closing and weatherstripped to prevent smoke and combustible gases from entering the home.

SEPARATION FROM BUILDINGS AND PUBLIC WAYS

Preventing the spread of fire between buildings and across neighborhoods is one of the earliest hazards building codes were meant to address. To prevent fire from spreading from one house to a neighboring house, table R302.1 specifies that all doors and windows in exterior walls, even windows with inoperable sashes, must be at least 3 ft. away from property lines between lots and from the centerline of adjacent streets, alleys, or public spaces. This is not to be confused with setback requirements; instead, it ensures that door openings across property lines will not be less than 6 ft. apart. (For more about fire separation distance, see "Know the Code" in *FHB* #319).

A World of Opportunity



We're at a pivotal point in society, where a new generation of young folks are trying to make their way in a world where career paths are largely undefined. The trades offer a fantastic opportunity for anyone wanting to make a good living, learn new skills, discover new technology, and see real, tangible results in a world that often feels very virtual.

But how do we get that message to the people who need to hear it? That's the role of #KeepCraftAlive—to connect people passionate about their careers with those who may not have considered the trades as a possibility. To that end, we're working on more programs to help amplify the stories of our audience as well as to get Fine Homebuilding's vast archive of articles and videos in front of students, trade organizations, and educators.

Want to share your story? Send us a note to
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The Restorationist

OBSESSING OVER OLD HOUSES

Demystifying old-growth lumber

BY JUSTIN FINK

If you've ever spent some time amongst old-house lovers, and especially the craftspeople who work on them, you'll no doubt have heard mention of "old-growth lumber." It's a material that's spoken of with reverence, usually as supporting evidence for the "they don't build 'em like they used to" argument, and always contrasted with today's lumber, which is deemed comparatively subpar. So what is it about old-growth lumber that makes it

so legendary, and if it's so great, why don't we use it anymore?

"Old growth" describes a set of forest conditions rather than a species of wood or a checklist of traits. The U.S. Forest Service describes old-growth forests as ecosystems "distinguished by old trees and related structural attributes that have developed over long periods of time without major disturbance." So yes, the trees are generally between 100 and 150 years old, but old-growth lumber is also char-

acterized by competition to survive and disturbance history. In other words, if the forest is left alone for long enough, and no natural disasters reset the clock, you end up with old-growth trees. So it's not that we can't produce old-growth lumber now, it's that it doesn't fit our production needs.

Exhausting old growth

Most of what we consider old growth was cut down and milled in the 19th and early 20th centuries. Much like our country, this work started in the east and moved west, and by the end of the 1800s sawmills

ECHOES OF OLD GROWTH

This enormous felled trunk highlights the stark difference between the dense old-growth lumber of the past and today's faster-grown wood from managed forests.

in the east had already burned through the old-growth wood. By around 1920, estimates suggest that more than two-thirds of American forests had been leveled at least once. The trees that came after that time period are referred to as second growth, third growth, and so on.

This implies that the forests we harvested in the 1800s were

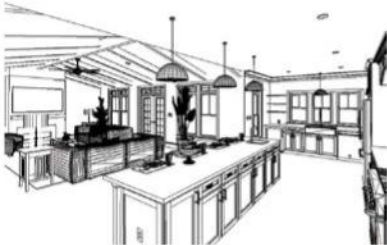


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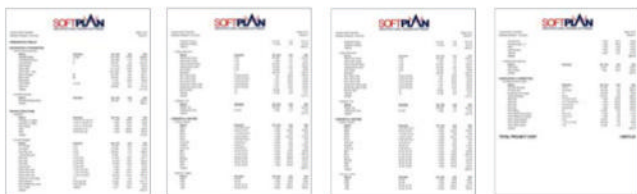


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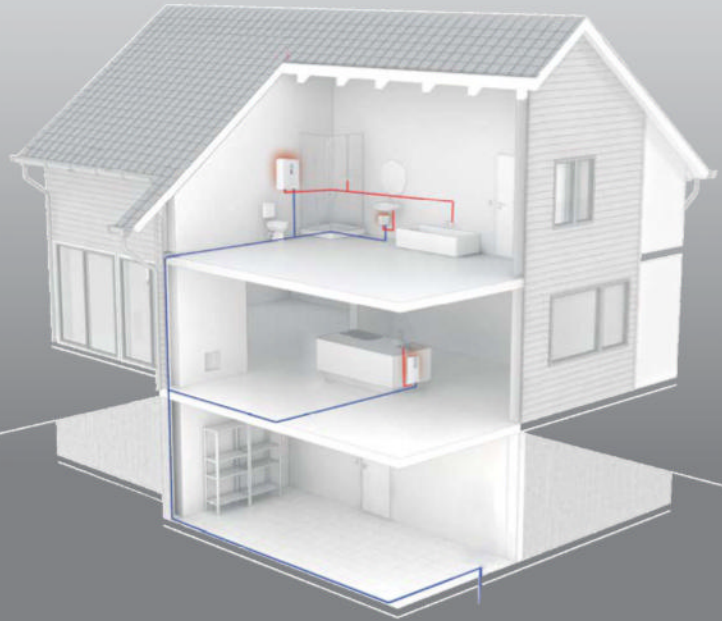


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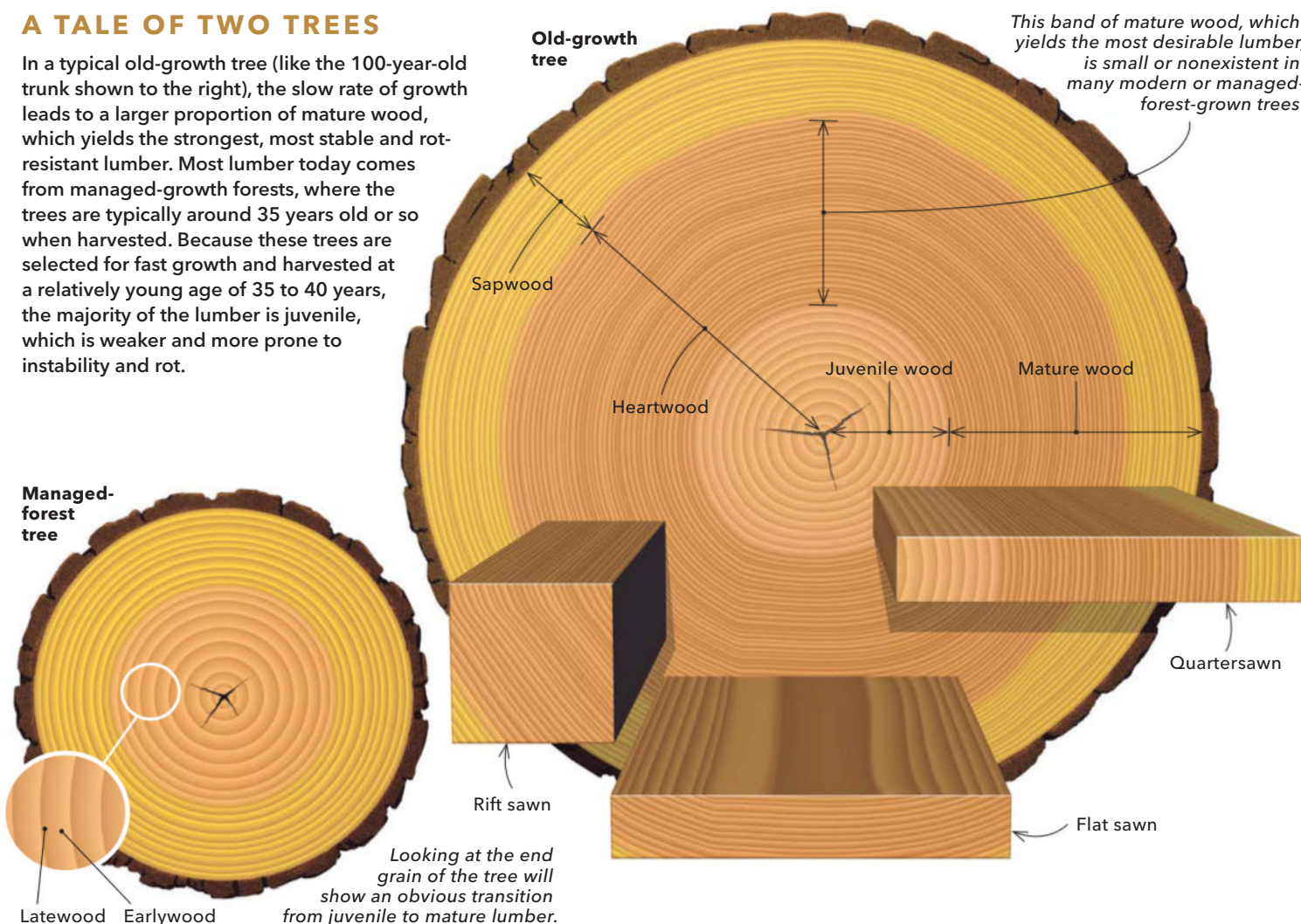
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A TALE OF TWO TREES

In a typical old-growth tree (like the 100-year-old trunk shown to the right), the slow rate of growth leads to a larger proportion of mature wood, which yields the strongest, most stable and rot-resistant lumber. Most lumber today comes from managed-growth forests, where the trees are typically around 35 years old or so when harvested. Because these trees are selected for fast growth and harvested at a relatively young age of 35 to 40 years, the majority of the lumber is juvenile, which is weaker and more prone to instability and rot.



EARLYWOOD VS. LATEWOOD OFFERS CLUES ON QUALITY

Each year a tree adds another growth ring made up of two distinct parts: a lighter band called earlywood (springwood) which is lower density and weak, and a darker band called latewood (summerwood), which is higher density and relatively strong. In the dense forests where old-growth trees come from, competition for sunlight and water is fierce, and this yields tightly spaced rings with a low proportion of earlywood in each band. In managed forests where trees are spaced to optimize sunlight, the trees grow quickly, yielding wider bands of earlywood.

SAPWOOD VS. HEARTWOOD INFLUENCES DURABILITY

The outer zone of a tree trunk consists of sapwood, which is responsible for transporting water and nutrients. The inner zone of a tree trunk consists of heartwood, which is sapwood that has been biologically deactivated and, in some species, infused with tannins and other extractives that make the wood naturally rot resistant. No matter how big the tree gets, the amount of sapwood remains relatively constant, but the amount of heartwood is always increasing. Because old-growth trees are larger, their proportion of heartwood is greater than that of modern trees from managed forests.

JUVENILE VS. MATURE WOOD IMPACTS STRENGTH AND STABILITY

Trees produce juvenile wood in their early years, and then there is a transition period that happens anywhere around 5 to 25 or more years of age. All the wood that is produced after that transition, known as mature wood, is stronger and less prone to shrinkage. Old-growth and managed-growth trees both have mature wood, but old-growth trees have at least 75 years worth of mature wood, while a managed-growth tree might have only 10 years worth or even less.

GRAIN DIRECTION PREDICTS THE BEHAVIOR

Wood shrinks and expands perpendicular to its grain, which means its position and orientation in the tree trunk greatly influences how it will behave once cut and installed in a house. Quartersawn and rift-sawn lumber are the most stable options, and flat-sawn lumber is the most likely to cup, especially in a wide board. When cutting lumber from a large-diameter old-growth tree, it's easy to yield quartersawn and rift-sawn lumber. In smaller-diameter trees, most of the lumber ends up being flat sawn.

the “first,” but in reality there were many thousands of forests that came before them. So it’s not that old growth means “original” to the planet—it just means that the trees in the forest went a long time before the last cycle of wildfires, catastrophic storms, pest outbreaks, flooding, or other major push of the reset button.

It wasn’t until around the 1870s that people started talking about actively replacing the trees that were being harvested for lumber, and it took another 30 or more years to actually move from theory to action. Until then, the idea of reforestation just wasn’t considered, and lumber was treated as an inexhaustible resource. By 1930, reforestation became a standard practice. Today, our lumber comes from what we call managed forests.

Making managed forests

Today, we rely heavily on managed forests to grow our lumber, and everything is designed to maximize yield. The seeds, which are usually all the same species and selected for genetic advantages like fast growth, are planted at consistent spacing that is calculated so the tree receives maximum sunlight on all sides, and the soil is often fertilized to promote growth. As the trees grow, the forest is intermittently thinned to improve growth. Growth is quick in the early years, but slows once a tree matures. Once the trees reach the point of economic maturity, which is when they will maximize return on investment (30 to 40 years or so), they are harvested, the land is cleared and prepped, and the next round of trees is planted.

The trunk tells the tale

There are several factors that influence how a piece of lumber will perform. The biggest

indicator of the strength and stability of a piece of lumber is whether it is juvenile or mature wood. The rings nearest to the center of the tree are juvenile wood, which is formed in the early years of a tree’s life, and tends to be lower in strength and stiffness and more likely to warp, twist, and check. Surrounding the juvenile wood is the mature wood, which tends to be more dimensionally stable, and is stronger under load.

Here’s the key to remember: No matter how old or big the tree is, the juvenile portion of the trunk is relatively consistent at somewhere around 15 to 20 rings (15 to 20 years of growth). So, in younger trees from a managed forest, a large

you get. Old-growth trees tend to be larger, which means they contain a higher percentage of heartwood compared to younger trees grown in managed forests.

Finally, it’s important to understand growth rings, and more specifically earlywood vs. latewood, because they influence the density and wear resistance of the wood. A tree adds one growth ring per year, and each ring can be divided into two bands: earlywood and latewood. Earlywood forms in the spring with large, thin-walled cells, while latewood forms later in the season with smaller, thick-walled cells that make the wood denser and stronger. A higher proportion of latewood

“Today, we rely heavily on managed forests to grow our lumber, and everything is designed to maximize yield.”

percentage of the trunk diameter is juvenile wood, making it unavoidable in the lumber that is cut from the log.

When it comes to rot resistance, it’s all about sapwood vs. heartwood. Sapwood is the outermost band of rings, responsible for moving water up the tree trunk. As the tree grows, new outer rings of sapwood are added, and the innermost rings are deactivated and transformed into what we call heartwood—the darker inner wood that, in many species, contains extractives that improve decay resistance. The important thing to remember here is that no matter how big the tree gets, the layer of sapwood stays about the same width, so the bigger the tree, the more heartwood

generally means stronger, more stable wood, and directly influences the density and wear resistance of the lumber. In old-growth forests, slower growth led to tighter rings with a greater share of dense latewood, but in modern, managed forests—where trees are encouraged to grow quickly—rings tend to be wider and dominated by softer earlywood.

What should you source?

Due to shorter rotations and smaller average log diameters, trees from managed forests yield a lower amount of quality lumber. To offset this disadvantage, and to maximize return on investment, much of the material from smaller logs is used to create engineered products like

OSB, LVLs, Glulams, finger-jointed boards, and so on. But solid-sawn lumber is still a major need, so how do you give plantation-grown lumber the best chance of success?

First, pay attention to grain direction, which greatly influences stability. Flat-sawn boards tend to have cathedrals of grain on the face, and if cut from small-diameter logs, will often have the pith (the center of the tree, with the juvenile wood) right in the center of the board. Whenever possible, avoid boards where the pith runs along the face of the board.

If you can, dig through the lumber pile to find boards with mostly quartersawn or rift-sawn grain, which runs perpendicular or on a diagonal relative to the surface of the board. This grain direction isn’t exclusive to old-growth lumber, but it is more common in old-growth lumber due to the larger diameter of the trunk. This is especially important in wide boards, which are more likely cup if flat sawn, but also applies to interior millwork and other situations where stability and reduced seasonal movement are important.

No matter how you look at it, growing lumber is a slow return on investment, but a 30- to 40-year turnaround time is quick compared to the 100 to 150 years needed for an old-growth tree, and fills a need fast. That’s not good or bad, it just is. The best we can do is understand the trade-offs and factor them into how and where the lumber is put to use.

But if your home, or the homes you’re working on, have old-growth lumber, I urge you to choose maintenance over replacement. It really is as good as the old-timers say it is.

Justin Fink owns Fink and Son Historic Restoration in Plainville, Conn.

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Price \$1000; optional air-supply hose and adapter, \$235

Air scrubbers are a critical part of how I protect both my clients' homes and my own health during remodeling projects. Simply put, air scrubbers are housed fan units designed to filter airborne dust. They help prevent dust and fine particles from migrating beyond the work area. But on small projects, it can be difficult to haul a large industrial scrubber in and out of the home, and sometimes I used to think that going without one made the most sense.

The Festool SYS-AIR HEPA solved that problem for me. It's a compact, fully enclosed air scrubber designed specifically for smaller-scale work and

tighter workspaces. For projects involving exploratory demolition, small ceiling or wall openings, flooring repairs, or interior cutting, it allows me to maintain professional-level dust control without the hassle of a full-size unit. The scrubber is housed in a Festool Systainer-style case, making it easy to transport, stage, and store. Setup is straightforward: Simply set the unit in the work area, plug it in, and power it on. It's quiet, well built, and small enough to bring onto jobs where a traditional scrubber would normally be left in the van or in the shop. Also available is a 20-ft. hose that is sold separately and comes with its

own Systainer-style case. The hose works well when I need to capture dust directly when cutting openings or working in a confined area, and it also allows me to create a negative air space by venting the unit outdoors.

This SYS-AIR HEPA is not intended to replace a high-powered industrial air scrubber on large demolition projects, and it shouldn't be viewed as such. It doesn't move the same volume of air or have the same filter capacity. But it does excel on smaller jobs where dust control often is compromised due to logistics. In those scenarios, it's irreplaceable.

This isn't an inexpensive investment—the unit is \$1000,

with an added cost for the optional 20-ft. air supply hose and adapter. Replacement filters are also a consideration: The prefilter runs about \$93, with \$285 for the main HEPA filter. But health, values, and reputation are not areas where I'm willing to compromise. For contractors who already own larger dust-extraction equipment but find themselves skipping air scrubbers on small jobs, this tool fills a critical gap. It has made my workspaces cleaner and safer while reinforcing the level of care and professionalism I aim to bring to every project.

Tyler Grace, a general contractor in Medford, N. J.

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FASTER FROST-PROTECTED SHALLOW FOUNDATIONS

With built-in screed-board slots and combined slab-edge and wing insulation, Mono Slab EZ Form lets builders prep and pour FPSFs in one efficient sequence.

Simpler slabs for cold climates

In climate zone 7, where I live, building codes typically require footings to be at least 5 ft. below grade. When you're already digging that deep, the cost difference between a slab and a full basement starts to narrow, which explains why basements were once standard in this region. Today, in an effort to address the challenges of affordable housing, more builders in cold climates are turning to frost-protected shallow foundations (FPSF), a proven method that uses insulation to allow the slab to remain near the surface.

For a FPSF, a monolithic slab with a thickened perimeter that functions as a footing is poured at a shallow depth. Rigid insulation at the slab edge and a horizontal "wing" of insulation extending outward help retain heat in the soil mass under the slab, preventing frost from penetrating beneath and heaving the foundation during freeze-thaw cycles. When properly detailed, the system provides reliable frost protection without deep excavation.

Mono Slab EZ Form is a concrete form system that simplifies this process. It provides both the slab-edge and wing insulation in a single, cast-in-place form made from EPS foam. Two main configurations are available: the Commercial Form, a simple 24-in. by 24-in. wedge that's 8 ft. long, and the Adjustable Form, which is 20 in. tall and up to 31¼ in. wide by 8 ft. long. The adjustable model includes additional pieces that can extend the wing for colder climates requiring more frost protection.

The exterior forms include a slot to hold screed boards, which can be adjusted to achieve a level slab without having to fuss around with perfectly precise form placement. An EPS extension is added to the slab side of the screed board to provide insulation continuity across the slab edge. Once the concrete is poured, the screed boards can be removed. The savings in the system are achieved mostly through labor, as installing the foam and forming the slab are done in the same process. And builders appreciate the benefit of being able to perform the light excavation, form a slab, and backfill all on the same day.

For builders looking to reduce foundation costs and simplify installation in cold regions, Mono Slab EZ Forms offer a fast, code-compliant approach to FPSFs. The forms are made in the United States, and an 8-ft. section of the Adjustable Form costs about \$125. More information is available at monoslabezform.com.

Randy Williams, editor, *GreenBuildingAdvisor.com*

Smarter chalklines

I recently discovered the innovative new Line Anchor from Akribis Leather. Like most chalkline hooks, it lets you anchor a line on the edge of a board or panel. With other hooks, if your starting point is somewhere in the middle, you typically need to drive in a "helper" nail or screw to hook onto. The Line Anchor is designed to eliminate that step. Pressing down on the metal hook reveals a sharp pin that you can drive into the surface of the material you're marking with one hand and then snap a line from anywhere on the surface. The Line Anchor is rugged and feels built to last. I've already used it when framing, on formwork, and for general carpentry. At \$25, it won't take long to pay for itself. You can buy one at akribisleather.com.

Aron Jones, a carpenter on Grand Manan Island, N.B., Canada.



NO HELPER NAIL NEEDED

The Line Anchor from Akribis Leather lets you start a chalkline from any point on a board.

Simply press to expose the pin, drive it with one hand, and snap a line.

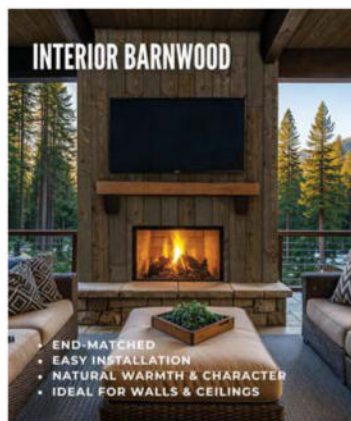
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Level up your rough openings

When installing a door, it's important to know how level the floor is in the rough opening from one jack stud to the other. Unfortunately, most rough openings are not 2 ft., 4 ft., or 6 ft. wide, the three most common level sizes. That means I usually end up using a laser or cutting a perfectly straight 2x4 to set on the ground beneath a smaller level.

To solve this problem, Johnson now makes an extendable level in two different sizes: 24 in. to 42 in., and 48 in. to 80 in. I don't think Johnson invented this tool, but I do know these levels work well. Both sizes feature a locking button conveniently located on the side. A ruler built into the extended portion allows you to see what length the level is extended to. The edges of the levels are on the same plane, making it easier

to mark scribes and visibly identify material discrepancies. Also, the center vial is magnified, making it slightly easier to read.

The 24-in. to 42-in. Extendable Box Beam Level costs \$80, while the 48-in. to 80-in. model sells for \$115. Both are available at Amazon. Since I've owned them, I have found many uses for both levels, earning them a permanent spot in my jobsite cargo trailer.

Aaron Miiller, a contractor in Pollard, Ark.



HANDLE REAL SPANS

Extendable box-beam levels adjust to match openings of any size, locking in place for more-accurate layouts and easier scribing in rough openings and other spaces.



MARK AND MOUNT

The Kreg Laser-Mark combines a magnetic stud finder with a switchable laser that projects the stud location onto the wall, making it easier to lay out cabinets, shelving, and fixtures.

Laser-focused stud finder

It's satisfying when a new tool brings extra joy to the job, and even better when that tool is simple to use and easy on the wallet. I've been using the Kreg Laser-Mark magnetic stud finder for a few months, and it has been very useful as well as an excellent value at about \$30. Similar to other magnetic stud finders, this tool has two rare-earth magnets on the back that enable it to latch onto metal studs or metal fasteners in wood studs. For this stud finder, Kreg has upped the game by adding a switchable laser that's projected on the wall below the tool. A built-in plumb vial ensures that the laser line accurately locates the stud location along its length. I've used it for hanging cabinets, installing shelving, and mounting fixtures, and the laser line makes these tasks faster and more precise. Simple and affordable, the Kreg Laser-Mark makes everyday layout work faster, more accurate, and a little more fun.

Arthur W. Henderson III; an ER doctor, cabinetmaker, and serial remodeler

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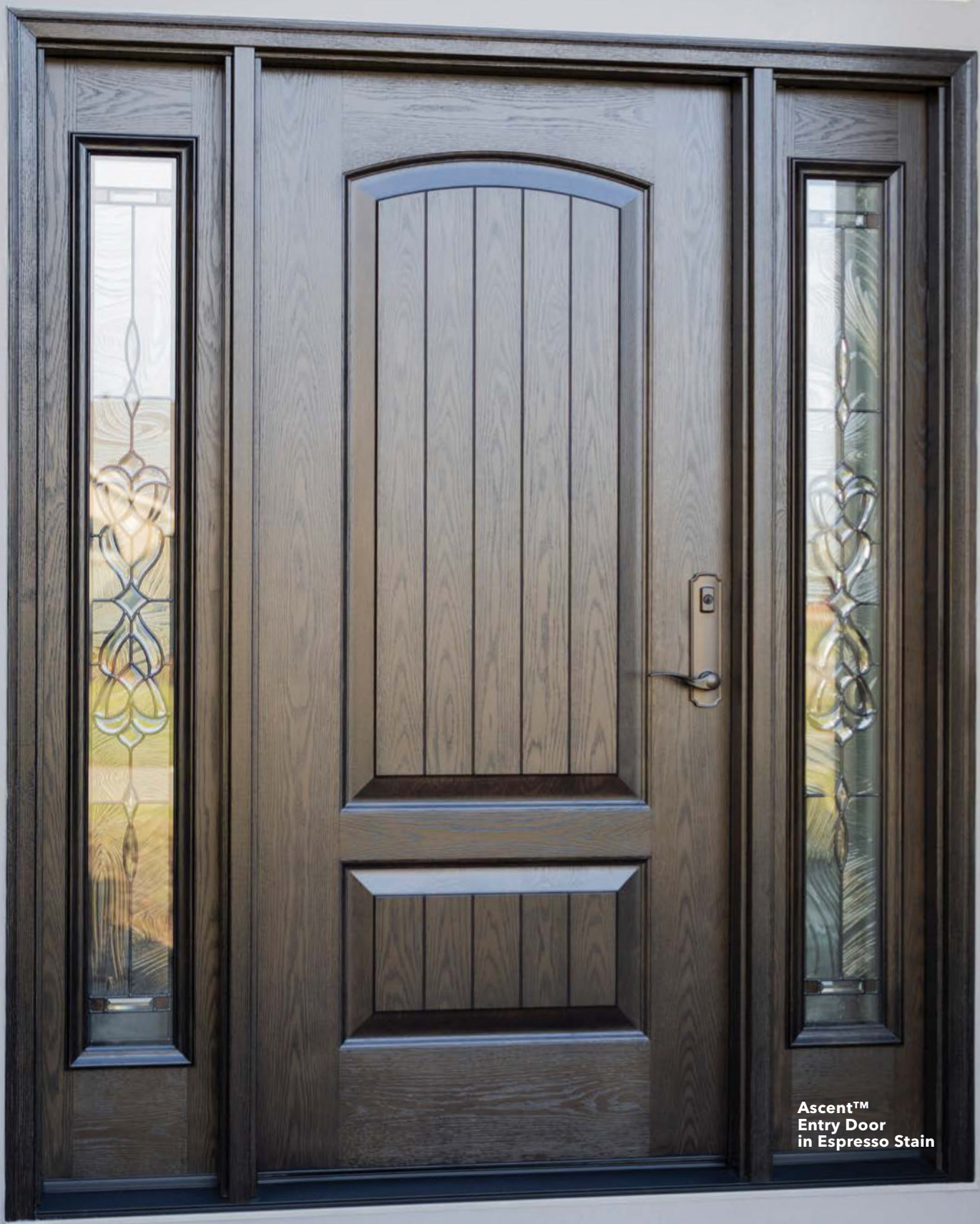
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As a builder, you stake your reputation on your reliability, your craftsmanship, and your choice of high-quality building materials. Your clients trust you to guide them through thousands of decisions, including choosing a front door that they will cherish for its style and value for its durability. ProVia has a new option for you, launched just this year, that combines the low maintenance of fiberglass with the timeless look of wood.

Ascent™ doors are built to last, with construction details that include 2⅝-in. stiles and rails that are glued and doweled for a strong, rigid assembly. The frame is constructed from solid wood combined with a composite bottom rail designed to resist moisture accumulation and rot. Ascent doors are insulated with a polyurethane foam core that delivers exceptional insulation value for improved energy efficiency in both warm and cool climates. Fiberglass skins bonded to the door faces provide a durable, weather-resistant exterior. And all the trim details on these doors are free of visible fasteners, so the Ascent line will meet your expectations as a builder who prides themselves on craftsmanship.

Whether the project requires the look of a stained wood door or a painted finish, the Ascent line includes both options. Ascent White Oak doors replicate the grain and

New Ascent entry doors combine the look of wood with the durability of fiberglass and offer design options for homes ranging from traditional to modern

texture of this impressive hardwood using a laser/acid etching process, including at the slab edge where other fiberglass doors often lack a realistic pattern. Smooth styles feature a delicate brush-textured, embossed finish, available in a wide palette of standard, trending, and custom paint colors.

Your design partners are sure to appreciate the versatility in the Ascent line. The doors are available in a range of sizes including narrow, tall, and extrawide configurations. There are panel styles and glass options that range from traditional to modern, and matching sidelites are available. Hardware styles and finishes can be selected to match any home design, and if your designer or the homeowner wants a truly custom feel, Ascent doors are available with five inscriptions that will add a signature look to your project.

Clearly, when the ProVia team developed the Ascent line, they had builders in mind. "Ascent was designed in-house, which allows us to maintain its integrity and make improvements as needed to ensure consistent quality and performance," said ProVia product manager Joelle Longo. "It also provides dealers with a dependable solution, offering durable construction, premium finishes, and a wide range of design options to meet project needs while delivering the elevated look homeowners want." Check them out at provia.com/entry-doors/ascent.



**Ascent™ Inscribed
Entry Door in
Aged Barrel Stain**





The term *off-site construction* is a relatively new catch-all for the variety of ways houses are built in shops and factories. It includes a wide range of panelized assemblies, the most basic of which arrive on-site as stick-framed walls with sheathing on the outside. Others come much more complete—a water-resistive barrier (WRB) on the exterior, windows installed, even insulation in the cavities and drywall on the interior. The category includes factory-framed floor and roof panels, structural insulated panels (SIPs), and solid-wood CLT panels, as well as stick-framed modules. The way houses are built off-site often differs little from how they are framed on-site, but the work is done indoors, and the panels or modules are delivered to the site on a truck.

The owners of this southern New England home had ambitious goals for the project: meet the passive house standard, minimize embodied carbon,

and use locally sourced materials where possible. The 20-in.-thick wall and roof panels are structural and insulated with straw to about R-70, according to Maine-based manufacturer Croft. There's little reliable data about the R-value of straw insulation; most sources put it around R-1.2 to R-1.7 per in. The folks at Croft say they have had their panels' straw infill tested by two labs to the ASTM C518 Standard for thermal transmission, with the results averaged at R-3.5 per in. Because straw sequesters carbon, the panels would help achieve the goal of a low-embodied carbon building. With such high insulation values, they would help the project attain the low-energy loads required to meet the passive house standard.

There are pros and cons to off-site construction, but we didn't have to weigh them on this project; the owners had already decided on the Croft panels when they brought my company, BPC Green

These wall and roof panels are made in a modern facility, install quickly, and are at the core of a high-performance enclosure. Is panelization right for your next build?

BY BEN BOGIE

An On-Site Look at Off-Site Construction

Builders, on board. In fact, these clients came to us well informed with a lot of ideas for their house. While they gave us permission to “kill their darlings,” my main argument against using the Croft panels was cost. My estimate showed that they could have saved a lot of money (and met their other goals) with a house that was stick-framed on-site. But the cost did not deter them. They were actually willing to give up some more-expensive finish options to keep the straw panels in the budget because of their belief in the potential of the product and process. Perhaps it was a good decision for this project and their goals. But before diving into how the panelization process works, it helps to understand the pros and cons.

To off-site or not to off-site

Despite the myriad ways of building a home or parts of a home in a factory, the benefits that proponents of off-site construction want you to know are similar: quality control, resource efficiency, speed, and cost.

When it comes to quality control, nothing happens in a factory that we can't achieve on-site. No matter where the work is being done, attention to detail is the responsibility of the builder and tradespeople doing the work. But it's also true that it is easier to control quality when working in a clean, climate-controlled factory than when standing in mud, or on a ladder, or when working in the rain. Off-site construction also reduces the risk of damage, weathering, biological growth, twisting and splitting of materials, and other things that often occur on the jobsite before we get the building dried in and conditioned, or before we get materials covered that need to be protected from UV light. For example, most WRBs, roofing underlayment, and flashing tapes should be left exposed for no more than a few months, despite what the manufacturers allow.

Unfortunately, my experience is that factory-built components often arrive on-site in poor condition. Croft and a few other boutique manufacturers that I have worked with are the outliers, delivering well-built and detailed panels. These panels arrived with Siga Majvest as an exterior WRB and air barrier, and Siga Majrex on the interior for air and vapor control. Still, we did have a few quality issues to deal with, including a bowed panel and another that wouldn't sit flat. Just as with a site-framed home, the longer panels or modules sit exposed to the weather, the more these materials can degrade.

CRANE-READY

Off-site construction projects generally require access for delivery trucks and a suitable location for a crane. Between the truck and their final destination, the panels have a stop along the way, where they are re-rigged from their delivery setup to the setting position. Make sure you and your crew are familiar with the common hand signals crane operators use if you are planning to try a project like this.



SIZE MATTERS The size of the crane is determined by the weight of the panels and the distance the crane needs to reach.



LANDING ZONE You'll need a flat location to set the panels after they are lifted off the truck. If you don't have a framed floor, make a suitable space on the ground.



A BIT OF RE-RIGGING Brackets, blocking, and straps are removed, and the panels are re-rigged into setting position.



LIFTOFF Now hanging vertically, the panel is ready to be set and installed.

There are a few ways to look at resource efficiency. The first is in the design of the building, but this isn't inherent to off-site construction. We can design any home to minimize waste by using value-engineered framing, which includes details like spacing studs on 24-in. centers and designing walls and roofs with 16-in. or 24-in. increments to not waste sheet goods. The potential advantage of off-site construction emerges when there is waste. Factories can be organized with dedicated storage for offcuts, and workers can be trained to head there for a short piece of blocking instead of cutting it from a full stick of lumber. Once again, however, a conscientious builder can achieve this level of resource efficiency on-site. It simply requires an intention to not be wasteful, regardless of where you are building.

We installed the wall and roof panels on this project in about two and a half weeks, in the dead of winter, with a few minor weather delays. This timeline also included stick-framing the floors and a one- or two-day buffer to ensure we were ready for deliveries. Realistically, the installation was even shorter. If we had stick-framed the house on-site, we'd have been looking at probably six to eight weeks to get the house dried in. At that time of year, who knows how often the weather would have stopped us or slowed us down? So the on-site work can happen breathtakingly fast when you choose some sort of off-site construction for your project. Speed is a real advantage, especially at times of the year when weather is less favorable or predictable. And remember, the two weeks it took to install the roof and wall panels on this project ended not just with the walls and roof framed, but with a fully layered assembly: insulation in place, a WRB and rainscreen furring on the exterior, an interior air barrier and vapor-control layer, and horizontal furring that creates a built-in service cavity behind the drywall. We could immediately start installing windows, doors, siding, and trim outside, and begin mechanical rough-in inside.

When it comes to custom homes, my experience is that there is no cost advantage to off-site construction. It simply costs more to buy and install these panels than it would to stick-frame equivalent walls. Based on my estimations, that was true of this project, though we did minimize the increased cost by using a local framing crew for installation. Costs are even higher when the factory sends a crew to do the installation, which often requires them

to travel and stay in your area for the length of the installation. But my experience with higher costs may not be the case for everyone. The folks at Croft say that in their local area, they often reduce a builder's costs for the scope of work they are involved in by 15% to 20%. And some of my colleagues who work on production and multifamily projects find that with scale and when repeatable panels or modules are needed, there is enough efficiency in off-site construction that it can become a more affordable way to build. That said, we're working on another project now—a modular home—and our experience has been the same: We could have stick-framed it for less.

At the end of the day, there are pros and cons to both types of construction, and designing and building a high-quality home takes an experienced and conscientious team, whether it's framed in a climate-controlled factory or outside during a cold New England winter. My experience may not be indicative of the industry at large, which is very different from one part of the country to the next, so weigh the pros, cons, and costs for yourself when considering a project using off-site construction.

Particular preconstruction

With off-site construction projects, it's critical to have the entire design and build team on board as early as possible; that's true of any high-performance home, particularly when new assemblies or materials are involved. On this project we worked with Cat Santos Young of Tama Architecture and one of our regular framing crews, JK Custom Carpentry. We knew they would be capable and keen to try something new. We had a good experience installing these panels, but there is still a bit to know about the preconstruction phase.

First, you are going to spend more time in the preconstruction period to reap the benefits of off-site construction. Not that it's ever ideal to start building before plans are complete, but on a site-framed project, you could be changing details until the day framing begins. And the truth is, on site-built projects, builders are commonly moving a door, window, or partition wall on the fly, or even after the fact, when someone realizes that the plans were wrong, or the homeowner tours the site and decides they just don't like something. That's not happening on a project like this. Moving a window opening in these walls would be very expensive. That should encourage the design team to finalize its development work well before the plans go to the factory. In a per-

FAST FRAMING

Once the factory-framed wall panels are set in the right location, fastening is straightforward and the important details are no different than with site-framed walls. The panels need to be tight to each other and braced level and plumb before the second-floor framing is done and the second-story panels are set. Because of the simplicity of this part of the process, it goes very quickly.



A LITTLE PERSUASION A skilled crane operator can get the panels very close to where they need to be. A sledgehammer helps nudge them the last little bit.



NICE AND TIGHT Ratcheting panel pullers are screwed to adjacent panels and used to pull them tight. When needed, the pullers can also be used to push panels where they need to go.



LOCATION, LOCATION, LOCATION Fastening locations are determined by the manufacturer, and the fasteners are all the same structural screws.



SEALED UP

Because the screws penetrate the water-resistant barrier and air barrier, they must be covered with flashing tape.



BRACING BASICS As with a stick-framed wall, the panels need to be braced plumb and straight before framing the second floor or stacking panels.

fect world, this how all preconstruction would happen, but it's not always the reality, so it is something to be particularly aware of with off-site construction.

Once the plans go to the factory team and you get a delivery date, it's your job to prepare the site and be ready for installation day. The factories are not going to store your panels or components because you're not ready for them yet—not without charging you, that is. So it's important either to be certain you will be ready for delivery, or to make sure that the storage fee is in your budget. The foundation needs to be built—and in the case of a project like this, the first-floor system framed—by delivery day. Again, remember that there is very little wiggle room with a panelized or modular project. The foundation and floor framing need to be precise.

You'll also need to make sure the site is big-truck ready. Even though we were fully aware of the access limitation on this site and told Croft that a 52-ft. trailer wouldn't be able to get to the house, that's what the first delivery came on. One of the turns in the driveway was too tight for the big rig, but we were wise enough to have asked our excavator to be on-site for the first panel delivery, and he was able to widen the turn and get the truck in.

Finally, you need to determine what type of machinery is needed to set the panels. On most projects it's a crane. The size requirements of the crane will depend on the weight of the panels, which the factory will provide. The folks at Croft actually wrote the weight on each panel, which you might see in the photos. This also allows the Phius rater to verify the amount of insulation in them because weight equals density, which translates to R-value when it comes to straw insulation. You'll need this info for the crane company long before delivery.

On projects like this, I prefer to evaluate the site plan with the crane company to make sure there is an appropriate space for the crane to sit between the delivery truck and the building with plenty of room for the crane to swing. This is important because not only will the crane company need to know the panel weights to know what size equipment to bring, but the company also will have to know the distance the crane needs to be able to reach. Finally, at least two people on the installation crew should know how to communicate with the crane operator via common hand signals. Most crane operators know OSHA's hand signals, which are easy to find online and

to learn. It's also a good idea to have walkie-talkies on hand, as well as hard hats.

Setting panels is straightforward

In addition to being helpful during the design process, Croft also wanted to ensure that the installation went smoothly. Even though we used a local crew to set the panels, the company sent someone who knew the panel system to the jobsite. He worked hands-on with us and was very helpful, though the learning curve isn't steep for a crew of experienced framers.

The Croft panels came with a combination of straps and hooks installed, so we didn't have to determine how to lift them, but it is a two-step process. The panels are rigged to be delivered and moved to a flat surface, where the rigging is reconfigured into the setting position. If you don't have a floor deck to do this work, like we did, have a flat area ready.

As the crane operator moved the panels into place, we fine-tuned their position, sometimes with a sledgehammer, and pulled them tight to each other with Rothoblaas panel pullers. Panel pullers are turnbuckle-like tools that are screwed to the panels and ratcheted to pull them together or even push them apart. (I've become pretty fond of this tool and find a use for it on most framing projects.) The panels were fastened to the floor framing and to each other with long GRK structural screws at locations marked out by the folks at Croft. Because our airtightness goal on this project was very important, we had the framing crew cut pieces of flashing tape for covering the holes in the WRB and air barrier as they drove the screws. Plumbing and bracing the walls is common to any framing project, though there's not much straightening to do with these panels.

This home has some two-story walls that were created by stacking panels on top of each other. Where there is a second floor, it was framed with floor trusses and LVLs, as usual, on top of the first-floor panels.

As on any building project, some problem-solving may be involved with panelized or modular construction. For example, on this project we had a panel that wasn't sitting flat on the subfloor, and therefore the top of the panel was not level. We had to fix this before we could stack a panel on top of it. After kicking around a few ideas, one of the crew members suggested using the panel puller vertically. He screwed it to the panel and to the rim joist and was able to pull the panel down tight to the subfloor before driving the structural screws a bit deeper to hold it down.

GOING UP

With the first-floor panels set, the second-floor framing can be done. In this house, that means LVLs and floor trusses and nothing out of the ordinary. Second-floor walls are set just like the first-floor walls, then the roof panels can be flown in and, once again, installed the same way as the wall panels.



TRUSS ME The second-floor framing is set directly on top of the first-floor panels.



A LULL IN THE ACTION Be prepared with ladders, scaffolding, and other platforms for second-floor work.

ROOF-READY The roof panels land right on top of the walls and are also fastened with structural screws.



The roof panels were installed just like the wall panels, and just as quickly, leaving us with only a few details to attend to before moving to the next phases of construction. As you can see in the photos, the panels arrived on-site with the rainscreen furring held short of the top and bottom of the walls, for two reasons. First, our engineer confirmed that by extending the furring strips from the wall to the rim joist and between floors, we would meet the structural requirements to prevent uplift. Second, this allowed us to connect the air barrier from the walls to the foundation, between stacked panels and floors, and from the top of the walls to the roof. Continuity is key when it comes to air-sealing, and this house needed to meet tight passive house requirements, which it did.

A final thought

Off-site construction is an interesting approach to building homes in a low-impact way, and Croft's product is high-quality and could be a good fit for projects with the right budget. That said, I don't think off-site construction is ready to be adopted at a scale that could benefit the building industry at large. Like it or not, we've become very efficient at building light-framed wood structures on-site. □

Ben Bogie is production manager and director of outreach and education at BPC Green Builders in Newtown, Conn. Photos by Brian Pontolilo and Andres Samaniego, except where noted.

NEXT STEPS

Once the final roof panels are set, there are just a few minor details to take care of before the house is ready for windows, siding, trim outside, and mechanical rough-in inside.



FROM Air TO Wa

Air-to-water heat pumps use water, not air, to deliver heat. They're an emerging product we're starting to see more often. Here's how, and where, they work.

BY JON HARROD

I've been an HVAC installer and project manager for the last 10 years. Most of the heat pumps I've seen during that time have been air-to-air systems. These are the most common type, and I've written about them for both *Green Building Advisor* and *Fine Homebuilding*. I've also worked on a few ground-source heat pumps, which exchange heat with the ground, rather than the air, using buried loops of pipe. But there's a third category that opens the door to hydronic heating without the cost and requirements of ground-source heat pumps: air-to-water, or A2W, heat pumps.

A2W heat pumps exchange heat with the outdoor air, just like air-to-air heat pumps. But inside the house, they circulate water to hydronic emitters, similar to those used with boilers and some types of ground-source systems. I've written about heat-pump water heaters—which extract heat from indoor air and store it in a tank of domestic hot water (“FAQs on HPWHs,” *FHB* #330)—but A2W heat pumps are different. Heat-pump water heaters, though they move heat from air into water, are appliances for making hot water stored in a tank, not systems for heating a house. A2W heat pumps operate as a central mechanical system that replaces a boiler, providing whole-home heating—and also hot water when connected to a water tank.

Common in Europe and parts of Asia, A2W heat pumps are beginning to make inroads in North America. They offer an efficient, fossil fuel-free option for hydronic heat at a lower cost than a ground-source system. And because they don't require a loop field, they can be installed on small lots and sites with finished landscaping.

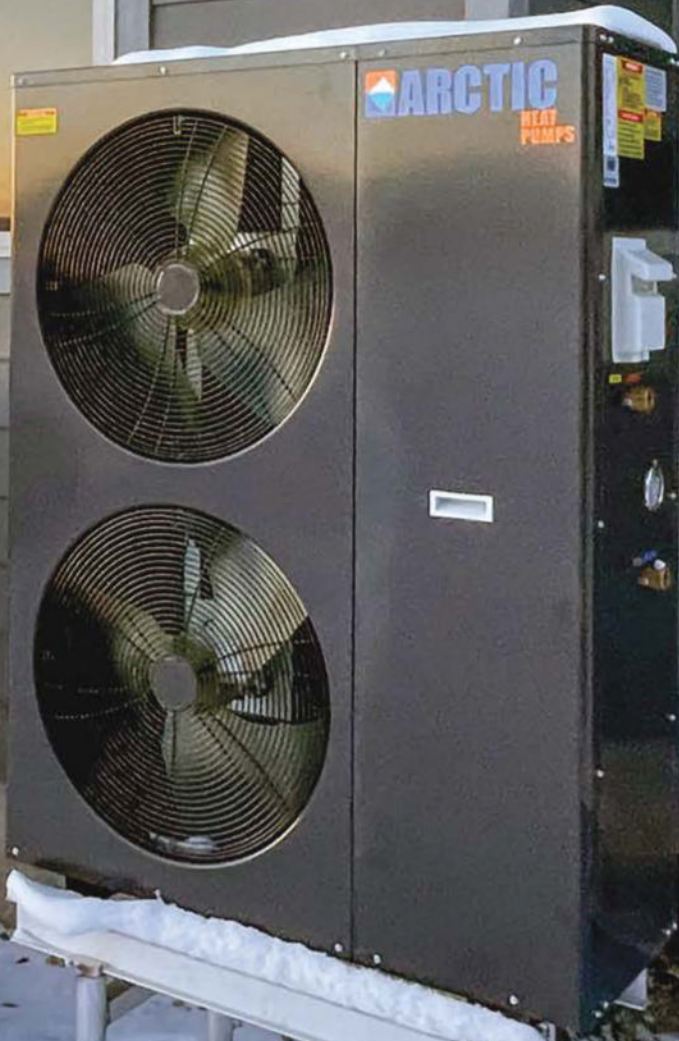
Seven or eight years ago, when I first started looking at air-to-water heat pumps, I got the impression that the technology, while promising, wasn't ready for widespread adoption. The systems have come a long way since then, with a larger industry base, improved cold-temperature performance, and the emergence of a small but growing contractor base comfortable with the technology. It's finally practical to talk about A2W systems for residential homes.

How A2W systems work

All heat pumps use the vapor compression cycle to move energy. A refrigerant circulates through a closed loop split into high- and low-pressure sides by a



ter TO Warmth

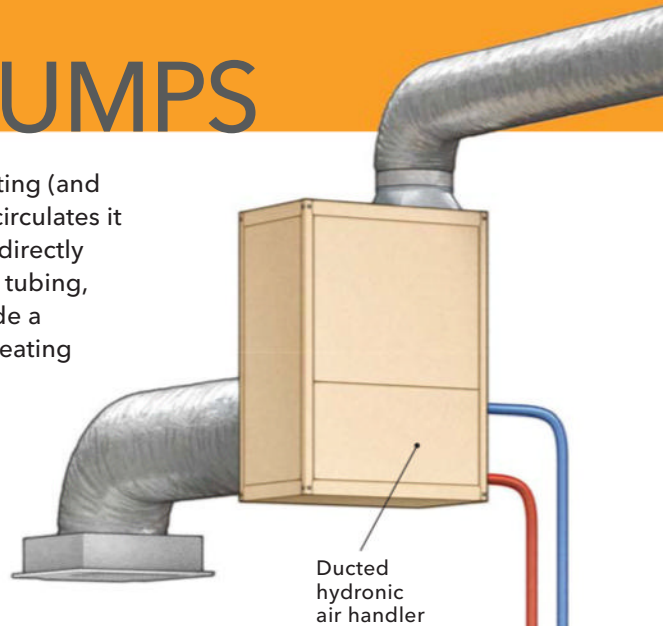


HEAT FROM COLD AIR

Like the more well-known air-to-air systems, air-to-water heat pumps rely on outdoor air to provide heat. But instead of distributing that heat through air, they circulate heated water to hydronic emitters like radiators, effectively replacing a boiler.

HYDRONIC HEAT PUMPS

This drawing illustrates how an air-to-water heat-pump system delivers heating (and cooling) to a home. Outside, the heat pump extracts heat from the air and circulates it through the system. The water either passes through a buffer tank or flows directly to the home's hydronic emitters. These emitters can include in-floor radiant tubing, fin-tube baseboard, and a panel or baseboard radiator; they can also include a ductless fan coil and/or a hydronic air handler, both of which can provide heating and cooling. Retrofits that include existing emitters like fin-tube baseboard are tricky; existing baseboard heaters often can't keep up with the lower water temperatures produced by an air-to-water heat pump and may need to be supplemented or replaced. A domestic hot water tank can also be connected to the system, providing heated water for sinks and showers. The drawing shows a monobloc air-to-water system. A split system operates similarly but also exchanges refrigerant with an indoor unit located near the buffer tank.

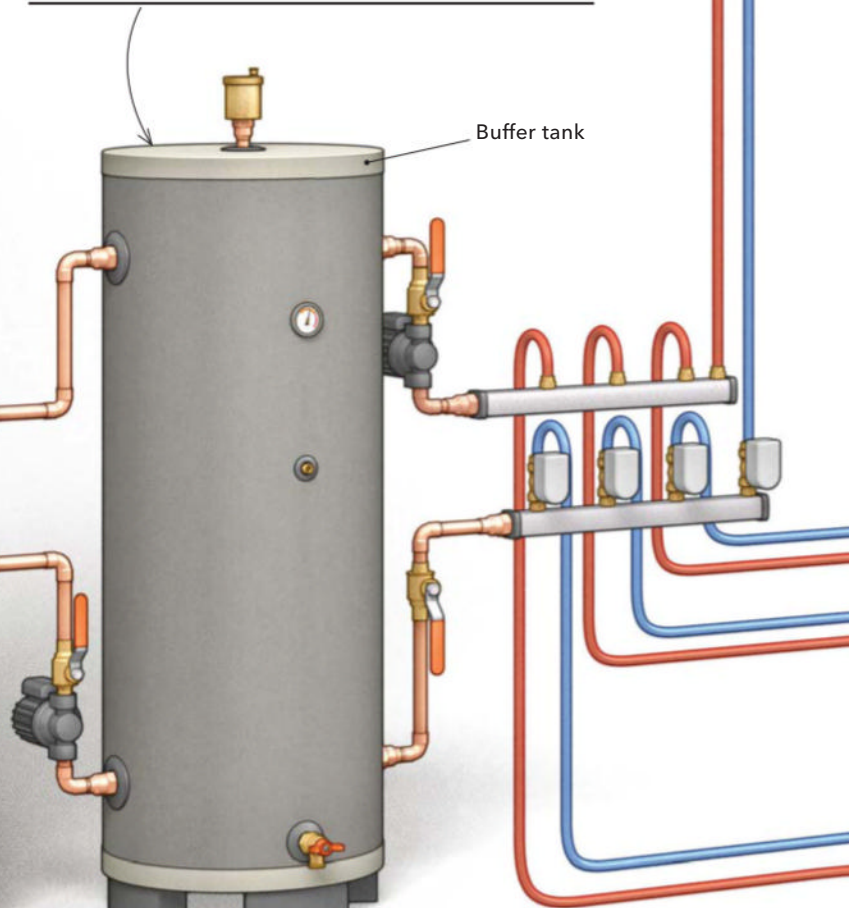


Air-to-water heat pump



The buffer tank stores heated or chilled water to prevent the heat pump from short-cycling, and it allows the heat pump to be programmed to operate when the electrical grid is in lower demand. With the buffer tank, the system can respond more smoothly to variable loads and multiple zones, but buffer tanks are optional in smaller, simpler systems with a close match between the heat-pump output and the heating/cooling load.

Buffer tank



THEY CAN COOL TOO

Much of an air-to-water heat pump's activity is in heating rooms and water. But with the right system, it is possible to cool a home with an air-to-water heat pump. The challenge is that air-conditioning doesn't just cool the air—it also removes water vapor. Under most conditions, running chilled water through a panel radiator or radiant floor would lead to condensation and a wet, slippery mess. Radiant cooling is possible in very dry climates, when system temperatures are carefully controlled to keep chilled surfaces above the dew point. The more common way to provide cooling with air-to-water heat pumps is to use a ducted hydronic air handler or ductless hydronic fan coil. These units have condensate pans that collect liquid water dripping off the cold coils and drain it to a suitable location.

Ductless hydronic fan coil

The floor- and wall-mounted convectors shown here are supplied with hot or chilled water for both heating and cooling. Other convectors designed for low-temperature systems may look similar to these units, or be low and linear like fin-tube baseboard. But without a hydronic fan coil, they provide heat only.

Ductless hydronic fan coil

Radiant flooring

compressor and a metering device. The cycle starts at the compressor, which draws in low-pressure refrigerant vapor and compresses it, raising both its pressure and temperature. That hot refrigerant flows to the condenser, where it releases its energy. From there, it passes through the metering device, which drops its pressure and temperature. The now-cold refrigerant moves to the evaporator, where it absorbs energy before returning to the compressor to repeat the cycle.

Unlike air-to-air heat pumps, which transfer heat directly from refrigerant to indoor air, A2W systems transfer heat from refrigerant to water, which is then circulated through the home. If you're interested in the science, water-side heat exchangers are coaxial coils with a water tube nested inside an outer tube carrying refrigerant. The inner tube has spiral grooves, which increase the surface area available for heat transfer. This tube-within-a-tube is itself wound into a coil to save space. A pump forces water through the water-side heat exchanger. Additional pumps circulate the water to the heat emitters.

Though less common, some A2W heat pumps are "split" systems. In these, the air-side heat exchanger and compressor are located in the outdoor unit. The water-side heat exchanger, which interfaces with the hydronic distribution system, is located indoors and connected to the outdoor unit via refrigerant pipes. Split air-to-water designs don't require freeze protection; all water piping is inside the house, making them a good fit for cold climates where outdoor piping is at risk of freezing. However, there are some downsides: The use of field-installed refrigerant means piping must be connected, pressure-tested, and evacuated by a qualified technician, who may also need to adjust the refrigerant charge. Split systems tend to require more refrigerant and to be more prone to leaks than factory-sealed systems. Most air-to-water heat pumps in the United States today use R-32, a refrigerant with lower global warming potential than earlier options—but it's still a potent greenhouse gas. Also, R-32 is mildly flammable and requires extra safety considerations.

In monobloc A2W heat pumps, the entire refrigerant circuit—the compressor, both coils, and the metering device—is contained in the outdoor unit. The monobloc design has several advantages. All refrigerant connections are made under controlled conditions at the factory. This eliminates the

need for a refrigerant tech. It also reduces the potential for leaks and the total quantity of refrigerant needed. And because all the refrigerant is outdoors, refrigerant leaks can dissipate rapidly rather than accumulate in an indoor space. This feature provides an added layer of safety for systems using mildly flammable refrigerants. Keeping flammable refrigerants completely outside the building enclosure also paves the way for a future switch to highly flammable refrigerants with very low global warming potential, such as propane (R-290).

The downside of monobloc heat pumps is the upside of split systems: In a monobloc system, the pipes running in and out of the house carry water, not refrigerant. If the heat pump stops running (due to equipment failure or an extended power outage), those pipes can freeze. For this reason, most manufacturers recommend using a water-antifreeze solution rather than pure water.

Whether the system is monobloc or split, the next step is the same: transferring the heat from the water to the living space. Hydronic heat emitters come in several types. If you've lived with a boiler, this part will feel familiar; these are the same hydronic heat emitters used in traditional fossil-fuel systems. One of the most common is fin-tube baseboard. Another type is radiators, a category that includes cast-iron radiators; sleek, modern panel radiators; and radiant floors.

Hydronic air handlers are a third category of hydronic emitters. Hydronic air handlers are less common with traditional boilers than baseboard or radiators, but they're by no means unusual—especially in homes that already have ductwork. They're also the only common hydronic emitters that can deliver whole-house cooling (see “They can cool too,” p. 41). Ducted hydronic air handlers distribute heated air through ductwork, much like an air-to-air heat pump or a fossil-fuel furnace. Nonducted hydronic fan coils resemble ductless air-to-air heat-pump heads in form and function, distributing heated air directly into the living space.

A factor that affects performance

Outdoor temperature and water temperature both affect how well a heat pump performs. As outdoor temperatures drop, it becomes harder for the system to pull heat from the air, reducing both capacity and efficiency—even with modern features like variable-speed compressors and enhanced

vapor injection that have made heat pumps operate more efficiently at lower temperatures. While lowering the temperature of the circulating water increases the efficiency with which a heat pump captures heat, it makes it harder to transfer that heat into the house. If the emitters can't meet the home's heating requirements at a lower water temperature, the water temperature will need to be raised, and performance will suffer.

Why does this matter? Some hydronic emitters can deliver higher heat outputs at lower water temperatures. Radiant slabs are one example. The higher thermal conductivity of concrete and the large heat-transfer area (the entire floor) allow these systems to perform well at water temperatures below 120°F. While staple-up radiant systems often require higher water temperatures, radiant subfloor systems like Warmboard and above-subfloor systems like Viega Climate Panel can also achieve good heat transfer at temperatures below 120°F.

Panel radiators like those made by Buderus and Runtal are used with a range of water temperatures. Although their outputs drop off at lower water temperatures, their output per linear foot can make them a good solution in locations where wall space is limited. For example, a 4-in.-deep, 24-in.-tall panel

radiator can deliver 500 Btu to 700 Btu per lin. ft. with 120°F water, which is more than twice what a baseboard convector can provide at the same temperature. Air handlers can also accommodate a range of water temperatures. For any emitters used with air-to-water heat pumps, it's important to check the manufacturer's charts to ensure that the units deliver the desired heat outputs at lower water temperatures.

To maximize the efficiency of an air-to-water system, it's best to select and size emitters that can provide the desired heat output at low water temperatures. John Siegenthaler, a mechanical engineer with over 36 years of experience in designing modern hydronic heating systems, recommends sizing heat emitters so that they can provide sufficient heat output at water temperatures of 120°F or lower. Siegenthaler has written that outdoor reset controls can eke out extra efficiency by lowering the water temperature even further in mild weather when less heat output is needed.

The bottom line: Knowing the circulating water temperature is critical for selecting and getting the most efficiency out of your equipment. The lower the water temperature needed by your emitter, the better your A2W heat pump will perform.

A2W OPTIONS

MORE THAN A DOZEN MANUFACTURERS now offer air-to-water heat pumps for the North American market. The list includes big-name HVAC manufacturers like LG and SpacePak, and air-to-water specialists like Chiltrix and Arctic. While R-410A refrigerant has historically been used in conventional HVAC equipment, air-to-water heat pumps are moving toward refrigerants with lower global-warming potential, like R-32, and all of these product examples use R-32 in their presently available configurations. A few companies are moving their offerings toward R-290 (propane), which isn't yet approved for use in the United States. (For example, Steibel-Eltron, which initially had an air-to-water heat pump, has withdrawn its product from the North American market as it transitions to R-290.)

An air-to-water system needs to include the heat pump, a compatible water loop, and any necessary controls or buffer tanks to operate safely and efficiently. The four units shown here come in additional sizes to match homes with a range of loads. Their actual heat output varies with outdoor and water temperatures; we've listed heating capacities at 5°F outdoor air with 110°F leaving water temperatures (written as “A5W110”). Equipment prices have been compiled from online retailers, but any cost considerations must factor in the variable price of installation.

SPACEPAK 45CC32-40

Heating capacity @ A5W110 26,649 Btu/hr

Type Monobloc

Retail price \$11,510

SpacePak, best known for its compact, high-velocity forced-air systems, also manufactures air-to-water heat pumps. The 45CC32 also comes in a smaller and a larger size for homes with lower and higher loads.

SpacePak offers hydronic air handlers compatible with its heat pumps and has partnered with radiant subfloor manufacturer Warmboard to offer design services for air-to-water systems.

Best suited for Whole-home systems that combine hydronic heat with ducted air distribution for heating and cooling



CHILTRIX CX40X

Heating capacity @ A5W110 26,701 Btu/hr

Type Monobloc

Retail price \$7499

Chiltrix, a U.S.-based manufacturer, offers two air-to-water heat pumps: the CX40X and the larger CX65X.

Chiltrix also sells ductless fan

coils, ducted air

handlers, buffer tanks, and water heaters for use with its heat-pump units.

Best suited for Mixed systems using fan coils or air handlers where cooling is a priority alongside heating



Advantages and some drawbacks

Why might a homeowner choose an air-to-water heat pump? The first set of arguments applies to all hydronic systems, including both heat pumps and fossil-fuel boilers, and explains why many homeowners prefer hot water over forced air. Many users feel that hydronic systems provide a better overall experience: slow, steady heat with no noise or perceptible air movement. (To be fair, those issues with forced-air systems can be mitigated with good design.) Water-based systems are also more space-efficient: heating is delivered through $\frac{3}{4}$ -in. pipes rather than 6-in. and larger ducts. Unlike ducts, which may require soffits, hydronic pipes can be run through holes drilled in joists. Smaller pipes are easier to insulate and have less surface area for heat loss, and in general the electric power required to move heat by pumping water is less than that needed to move heat by blowing air with a fan. Another advantage that applies to radiant emitters specifically is comfort; the heat they radiate warms our bodies directly, allowing us to feel comfortable at lower air temperatures.

Hydronic heating offers other advantages. Zoning—including microzoning, in which each room has its own independent controls—is simpler and more cost-effective. If

you choose an integrated system, the same heat pump or boiler that provides space heating can also heat the domestic hot water tank, providing not only heating and potentially cooling, but hot water for the whole house.

Another interesting feature of hydronic systems is that they can incorporate some thermal storage. In forced-air systems, the fossil burner or compressor operates whenever there is a call for heating or cooling. In hydronic systems, the equipment can heat (or chill) the water in a buffer tank. The stored water is only circulated to individual zones when a thermostat calls for it. This arrangement offers some important advantages for heat pumps. The extra mass of water in the buffer tank leads to longer run times and less short-cycling. In regions with time-of-use electric pricing, the heat pump can be programmed to heat or cool the buffer tank when electric rates are low, minimizing operation during expensive peak periods.

The key advantage of A2W heat pumps is simple: If you want a practical, efficient, all-electric hydronic system, they're a cost-effective choice. They also hold up better over time. With air-to-air systems, the refrigerant lines are tied to a specific unit and often need to be replaced when the system wears out. With hydronic systems, the pipes

and heat emitters can stay in place. If they're designed for low water temperatures, they'll likely work with future heat pumps too, so you're not starting from scratch every 15 to 20 years. Extending the useful life of these components also avoids the environmental impacts of producing replacement materials.

Air-to-water systems do have some significant drawbacks. One is cost. On the equipment side, an A2W heat pump is often two to three times more expensive than a fossil-fuel boiler. Lower water temperatures mean that larger radiators or convectors may also be needed. There are also all the additional components that go into any hydronic system: pumps, piping, expansion tanks, controls, etc. If the system provides air-conditioning (and filtration and distribution of ventilation air), one or more air handlers will be needed. Labor costs for a complete system are typically more than for a fossil-fuel hydronic system or for a ducted or ductless air-to-air heat pump. Overall costs are generally somewhere between an air-to-air system and a ground-source heat pump.

A2W heat pumps are also complex and still rare in many areas; it may be hard to find HVAC contractors with the knowledge to design and install these systems. That said, I expect that with ongoing interest in elec-

A2W OPTIONS CONTINUED

ARCTIC 035ZA/BE

Heating capacity @ A5W110 19,900 Btu/hr

Type Monobloc **Retail price** \$6736

U.S.-based Arctic Heat Pumps offers air-to-water heat pumps at a lower price than many other manufacturers. The 035ZA/BE is suitable for small, well-insulated homes, while homes with larger loads can use the 050ZA/BE or the 060ZA/BE. In addition to the A2W heat pump itself, Arctic offers composite buffer tanks, high-efficiency hydronic fan coils (wall-, floor-, and ceiling-mount), central hydronic air handlers for heating/cooling, radiant-floor systems, and complete hydronic distribution packages.

Best suited for
Well-insulated small homes using low-temperature emitters like radiant floors or panel radiators



NORDIC ATW-65-HACW

Heating capacity @ A5W110 29,900 Btu/hr

Type Split

Retail price \$17,616

Nordic's ATW Series is a split system that pairs an outdoor air coil with an indoor module containing the compressor, controls, and electronics. Unlike most split systems, which place the compressor outdoors, Nordic's indoor-compressor design protects sensitive components and simplifies maintenance in cold climates. The ATW-65 is suited for moderate loads, with other models in the ATW Series available for smaller and larger applications. Nordic sells compatible hydronic air handlers and fan coils (the AHW/AH4P Series) that transfer heated or chilled water into the air for forced-air distribution.

Best suited for Cold-climate homes and retrofits where keeping water lines indoors is a priority



trification and the entry of larger equipment manufacturers into the North American air-to-water market, both equipment availability and training opportunities will increase.

A new system for existing homes

At least 5 million homes in the United States have hydronic heating; the vast majority use fossil-fuel boilers. Do A2W heat pumps represent a viable path to electrify these homes? The limitations of air-to-water systems impose some special challenges for retrofits. Older homes generally have inefficient enclosures. Compared to homes built to modern codes, they have less insulation, poorer-performing windows and doors, and higher rates of air leakage. These factors mean their heating loads can be significantly higher than those of newer homes of the same size. In addition, the distribution systems in these homes were usually designed for higher-temperature water. For example, most baseboard convectors are sized based on circulating water temperatures of 160°F to 180°F.

Retrofitting these homes with air-to-water heat pumps often requires a comprehensive work scope and is not as simple as just replacing a boiler. The best place to start is by improving the enclosure. Targeted insulation, air-sealing, and window upgrades can significantly reduce the amount of heat needed. The next step is to carefully assess the existing emitters and compare their outputs (at low, heat pump-friendly water temperatures) with the heating requirements of each room. Now that the enclosure work has reduced the heat loads, will the existing emitters deliver enough heat to keep those rooms warm?

If the answer is no, there are a couple of options to consider. One is to add more emitter capacity. You can replace standard residential baseboard with high-output commercial convectors or panel radiators. You can also install staple-up radiant tubing to supplement the existing baseboard. Adding ductless hydronic fan coils can also boost heating output while adding cooling capabilities. Many homes in southern New England and the Mid-Atlantic have base-

board hydronic heat and a separate duct system for air-conditioning. In some cases, the air-conditioning unit could be replaced with a hydronic air handler to provide cooling and additional heat output.

Another solution, advocated by hydronics expert Siegenthaler, is to add an air-to-water heat pump while keeping the existing fossil-fuel boiler, which may still have several years of useful life. During the milder conditions that make up most of the heating season, the heat pump can keep the house warm with about 120°F water. During extremely cold weather, the boiler takes over, generating the hotter water the home needs.

This dual-fuel approach offers several advantages. It makes it possible to eliminate most on-site fossil-fuel use with a smaller, less expensive heat pump and less extensive distribution upgrades. It provides redundancy, providing backup heat if the heat pump is out of service. The fossil-fuel boiler will still need electricity to power its burner, controls, and pumps, but much less than a heat pump needs. This makes it easier

to power the heating system with a standby generator or battery bank during a power outage. The ability to automatically switch to fossil fuels during periods of high grid demand can also help homeowners reduce use during expensive rate peaks. In addition, the boiler's higher capacity and operating temperature can improve domestic hot water recovery rates during periods of peak use.

Any successful A2W heat-pump project requires a designer and contractor knowledgeable in both general hydronics and the nuances of air-to-water systems. This is especially true in retrofits.

Where air-to-water shines

The biggest challenges of A2W heat-pump retrofits can be avoided in new construction. We can build a tight, well-insulated enclosure to reduce heating and cooling requirements. And we can design the distribution system for low-temperature water. New homes are also good candidates for air-to-air systems, which are less expensive, and ground-source systems, which are more efficient and longer-lasting.

So in what situations do air-to-water systems make sense? For heat pumps in general, I'd start with homes and clients who want all-electric heating, either for environmental reasons or because a heat pump's operating costs will be lower than options like oil or propane. When considering an air-to-water heat pump, they should also express a preference for the experience and aesthetics of hydronic heat—and have the budget to support it. They should have some appetite for a technology that, while proven, is still uncommon in many areas. And they should also rule out ground-source heat pumps based on cost or site conditions. If these criteria are met, the home and clients may be good candidates for an A2W system.

Increasing equipment options and improving cold-temperature performance, along with the push for electrification and greater awareness of refrigerant impacts, should drive growth in A2W heat pumps. While I suspect that air-to-air technology will continue to dominate the North American market for several decades, A2W heat pumps may become an increasingly practical choice. □

Jon Harrod is a writer, HVAC project manager, and building science consultant based in Ithaca, N.Y. Photos courtesy of the manufacturers.

KEEPING TRACK OF HEAT-PUMP TYPES

With so many heat-pump options, it's easy to get lost. Here's a quick look at how air-to-air, ground-source, and air-to-water systems deliver heating and cooling, along with their pros and cons.

AIR-TO-AIR

Most of the heat pumps installed in North America are air-source heat pumps, also called *air-to-air* heat pumps. They absorb heat from, and release it to, the outdoor air, and they provide heating or cooling via forced-air systems—either a ductless head or ducted air handler. Ducted air-to-air heat pumps can, with minor modifications to the ductwork, serve as direct replacements for fossil-fuel furnaces, providing a relatively straightforward way to electrify homes with existing forced-air ductwork.

STRENGTHS Low upfront cost, straightforward installation, easiest to retrofit

WEAKNESSES No radiant heat or integrated hot water, highest risk of refrigerant leaks

GROUND-SOURCE

Ground-source heat pumps exchange heat with the ground rather than the air, usually by circulating a water-antifreeze solution through buried loops of polyethylene pipe. Ground-source systems come in two main types: *Water-to-air* ground-source heat pumps heat and cool via forced-air systems. *Water-to-water* ground-source heat pumps use hydronic (water-based) heat emitters such as radiators, radiant floors, and hydronic air handlers. Ground-source heat pumps can also heat water for fixtures like showers and sinks when connected to a domestic water heater.

STRENGTHS Exceptional efficiency, good cold-temperature performance, long service life

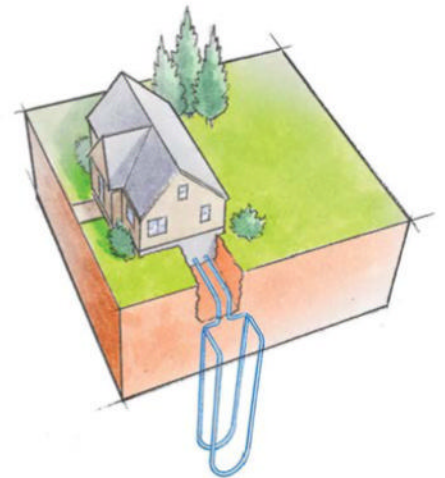
WEAKNESSES High upfront cost, requires drilling or trenching

AIR-TO-WATER

A2W heat pumps exchange heat with the outdoor air, just like air-to-air heat pumps. But inside the house they circulate water to hydronic emitters, just like some types of ground-source systems. A2W heat pumps operate as a central mechanical system that replaces a boiler, providing whole-home heating—and also hot water when connected to a water tank. There are two types of air-to-water heat pumps—monobloc and split—and the more common monobloc systems keep all the refrigerant outdoors, which is a safer, more controlled setup. Like some types of ground-source heat pumps, A2W heat pumps can heat water for domestic use when connected to a home's water heater.

STRENGTHS Allows for radiant heat and integrated hot water at a lower cost than ground-source systems

WEAKNESSES Limited U.S. manufacturer and contractor base; retrofits may require major upgrades



GROUNDWORK REQUIRED

Ground-source heat pumps exchange heat with the earth through buried pipe loops—a highly efficient approach but one that often requires significant excavation and a site that can accommodate it.



OLD HOUSE, NEW CHAPTER A familiar and timeless form, this foursquare house with a front-facing gable and Colonial Revival details was built in 1912 in St. Paul, Minn. For a rear addition, the owners designed a kitchen updated in the early-electric era of the 1920s. The result is a convincing blend of nostalgia and function.

Practical Preservation

The longtime editor of *Old-House Journal* explains why preservation is often more interesting and budget-friendly than remodeling

BY PATRICIA POORE

I still remember my Irish grandmother's reaction, many years ago, when I told her about my job. As I explained the concept behind *Old-House Journal*—people fixing up their homes to look original, not modern—she said, “You mean people buy old houses on purpose?” To her generation, and my parents', settling for an old house meant you weren't rich enough to afford a new one. So, you tried to make the old house look newer by remodeling.

I grew up in suburban houses without pedigree—just housing, really. My parents were buying a roof and just enough room, and what they considered to be “a decent yard.” Maybe they would carpet a bedroom or hang wallpaper in the dining room. Then, we lived there, with no further thought to interior design or fine collectibles.

Enlightenment was gradual. In first grade, my friend Barbara inhabited one of the original Dutch Huguenot

houses in Bergen County, N.J.; its core dated to 1693 and the “new” kitchen to 1810. It gave me little-girl chills to follow the hollowed-out treads up the dark stairs to her bedroom tucked into the eave of the gambrel roof. Later, my heart pounded when I visited a relative staying in a First Period house in Ipswich, Mass., an antique hardly changed but for rudimentary electrical service and indoor plumbing. In my 20s and 30s I lived in brownstone Brooklyn, discovering not only an aesthetic previously unknown to me—12-ft.-tall mahogany pocket doors, massive brass gasoliers, intricate parquet floors—but also the concept of livable, human-scale housing density.

Then came *Old-House Journal*, a Brooklyn brownstoners' newsletter I joined in 1978, becoming its owner as we grew into a national magazine with several title extensions, including *Old-House Interiors* and *Arts & Crafts Homes*. I found myself in an ever-expanding world with a vocabulary that engenders deepening appreciation: ashlar, belvedere, catslide, dentil, entablature, fretwork, finial, jerkinhead, lintel, modillion, oriel, pilaster, quoin, scagliola, wainscot. (My favorite one to say out loud is “Wissahickon schist.”) When you learn the words, you see more. And you start to care.

What is an “old house”?

It is not easy to define. Guidelines say an antique is over 100 years old, while the Dept. of the Interior says a historic building is at least 50 years old. I prefer to ask, what is an old-house person, or owner? Plenty of people who own old houses think of them as little more than affordable shelter; they don't wonder about architectural style or history. They are not old-house people, they're people who happen to own old houses. Someone might buy a



DEFINING AN APPROACH

Preserving what you can doesn't require historical restoration and certainly doesn't require a museumlike interior. Let's face it, replacing elements that have failed or gone missing is often prohibitively expensive, if not impossible. Furthermore, making things "better than the original" is not necessarily virtuous. Simply put, preservation means taking it easy on the house (something you may wish previous owners had done!).

Once you've gotten to know the house a little better—its age, style, history of remodeling, neighborhood context—the next step before planning is to refine your approach to the work. Will you preserve what's there, restore what's missing, renovate systems and the kitchen, remodel the rear façade to add a mudroom and deck? In most residential cases, you'll probably combine multiple approaches. With a nod to the Secretary of the Interior's Standards for Rehabilitation, here is how I've defined these approaches for homeowners in *Old-House Journal*.

ADAPTIVE REUSE Recycling an old building for a use other than that for which it was originally constructed—like a grange hall into a residence, or a school into apartments. A neutral term, it might involve a sensitive rehab that retains much of the original character, especially on the exterior. Or it can mean extensive remodeling of the structure and details.

INTERPRETIVE RESTORATION A less scholarly approach than the historic restoration employed by museum houses, this involved keeping original architectural features intact while reconstructing missing elements as faithfully as budget allows. The decoration and furnishing of interior spaces may be appropriate to the style and era of the house, but there is no attempt to duplicate what was there originally. It's a "might have been" approach—what might have been if the original owners had your taste, say. Most homeowner restorations are interpretive.

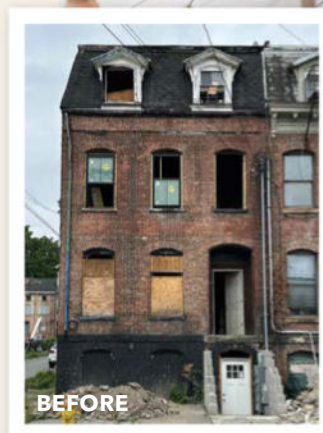
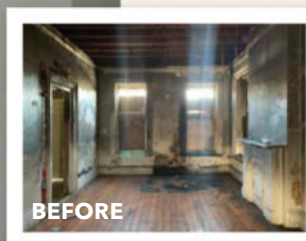
MODERNIZING The intention is clear in the word itself: to make the exterior or interior

of a building more contemporary in use or appearance or both.

PRESERVATION An umbrella term these days, it has meant keeping an existing building in its current state by a careful program of maintenance and repair. Such organizations as Historic New England, in the forefront of preservation practice, prefer this approach to more invasive ones, including restoration. Essentially, preservation means leave it alone and do no harm.

RECONSTRUCTION Re-creating a historic building that has been damaged or destroyed by erecting a new structure or part of a structure that resembles the original as closely as possible.

RENOVATION To "make new." This approach is often more extensive than rehabilitation in that a greater proportion of new materials and elements is introduced, along with changes to accommodate modern expectations.



RESTORED WITH INTENTION After years of abandonment, this ca.-1870 brick townhouse in Newburgh, N.Y., was fully restored by Office Mien Ye. Outside, the cornice and windows were carefully replicated. Inside, the building now houses four occupied units. Historic features were preserved, while rooms were finished simply for durability and everyday use.

Photos: Courtesy of Office Mien Ye





REHABILITATION To make a structure sound and usable again, without attempting to restore the original appearance. Sensitive rehabilitation respects the character-defining features of a building and retains them when possible.

RESTORATION The term has a specific meaning in the museum world: the meticulous return of a building to its exact appearance during a chosen period. It may even involve removing later additions. Historic restoration is a scholarly approach adopted by house museums. When the word is used in the context of a private house, it usually means sensitive rehabilitation. See Interpretive Restoration, above.

REMODELING Changing the appearance and style of a structure, inside or out, by removing or covering original details and substituting new materials and forms.

1970s architect-designed Organic Modern house and instantly know what he or she should do to honor it. That's an old-house person, even if the house isn't very old. Other people build new houses using traditional building practices, employing local craftspeople and integrating salvaged elements. They, too, are old-house people. It's an attitude.

The houses I've showcased in *OHJ* date from three centuries plus. Some have been period pieces, largely original or restored to a particular time, even decorated according to period conventions. Others were preserved with later changes left intact, or renovated in an interpretive manner. Still others were a study in bringing minimalist decorating to an interior redolent with antiquity, the underlying architecture intact but for white paint. Some have been over-the-top mansions, but others were restored on tight budgets.

A common theme has been preservation of original elements, even if they are worn. Another thread is the creation of a "scenario"—an imagined timeline or backstory that suggests a continuum between what was part of the original building and the often-needed addition or renovation. The imagined scenario might inform today's design of, say, a new bathroom in an outhouse-era Colonial, or a Depression-style kitchen fitted into a Victorian row house.

Indeed, old-house people buy old houses on purpose—for their charm, their evidence of the past, their unique details, their craftsmanship, and their embodied energy. (We have long said that the greenest house is one that already exists and that doesn't go to the landfill. One might quibble over specific cases, but it's generally true.) Old-house people leave things better than they found them.

Often, an apathetic owner converts to being an "old-house person" with very little persuasion. It might happen when a neighbor tells them theirs is Sears kit house. Or when they realize their house has a style that fits into a certain era. Or when they find archival photos of the house, perhaps before some unfortunate changes were made.

Persuasive arguments

OHJ's message has been simple and consistent since 1973: Don't destroy the good work of the past. That guideline has more than one underpinning: Don't destroy craftsmanship you can't replicate, don't destroy materials that no longer exist with such quality or affordability, don't destroy what the next owner may have cherished, don't destroy the historical record.

Consider, too, that a cluster of old houses defines, and often protects, the neighborhood. The house may predate you by a century and will undoubtedly outlive you. Preservation—that is, retention of original elements and regular maintenance—maintains property value. Continuity maintains the local sense of place.

I can think of some practical, everyday reasons for preservation. First, to protect the quality. Old-growth hardwood, sound- and fire-resistant three-coat plaster, fine craftsmanship, and surviving folk graining represent intrinsic value and for that reason are worth saving.

Second, to avoid design mistakes. In an unremodeled house, many elements represent the intention of the original design. A new owner might be forgiven for tearing out something that seems sullied or feels anachronistic. But what does that element tell us about original proportions or style? Cleaned up, that very item—a mantel, a stained-glass window—may restore a focal point. Removed, it's lost to history and often too expensive to replace.

A third practical reason for preservation is to enhance the neighborhood. Old houses have a context in the streetscape and for the

IDENTIFYING STYLES

When a phony-colonial fiberglass entry treatment goes on a midcentury-modern house, or a rustic lean-to joins a house neat with white clapboards, cacophony (or hilarity) ensues. Even when historic colors and period interiors are not the preferred treatments, additions and major changes should speak the original language. Understand the defining traits of a home's style to avoid confusing changes.



GREEK REVIVAL Dubbed the “national style” of the new Republic (1825-1855), this style touched civic buildings, mansions, and cottages alike. Hallmarks include a temple form with a front gable and columns or pilasters (half-columns engaged in the wall). Classical motifs occur.



CARPENTER GOTHIC An American version of the 19th-century Gothic Revival, these wood-framed houses often had vertical board-and-batten siding, as well as Gothic-style “gingerbread” at the porch and eaves (bargeboards). Look for finials and hood molds over windows.



TUDOR This English Revival style (ca. 1890-1940) takes cues from Tudor and Elizabethan period architecture. Look for steep roofs, prominent chimneys, decorative half-timbering, window bays and oriel windows, and multi-light sashes. Stucco and brick are prominent.



QUEEN ANNE The quintessential Victorian house with nooks and crannies was popular from 1874-1910. Asymmetrical, often with a verandah and tower or turret, it was adapted from the English Queen Anne movement. Multiple surface textures include clapboards and fancy-cut shingles.



BUNGALOW Low-slung and with exaggerated structure, the Bungalow in its heyday (ca. 1898-1930) was prized for its exotic, Anglo-Indian associations and for the artistic naturalism that tied it to Arts & Crafts. Other hallmarks include the use of natural, local materials, battered piers, and knee braces.



AMERICAN FOURSQUARE These cubic houses ca. 1890-1930 provide lots of space in an efficient, affordable envelope. Early examples have Craftsman or Prairie details; in the 1920s they're Colonial. Most of these houses have at least one dormer in a hipped roof, and a front porch.



DUTCH COLONIAL Essentially a new suburban style at the turn of the 20th century, its gambrel roof was associated with rare Dutch or Flemish originals in New York and New Jersey. Long dormers allow a full second story. Colonial Revival elements include cutout shutters, a portico, and a sunporch.



CONTEMPORARY A popular iteration of midcentury-modern design, such postwar houses appealed to families with their low, embracing rooflines, expanses of glass, open interiors, and use of new materials. The style dates to the late 1940s and into the 1970s.

neighborhood. For example: Despite the difficulty and expense, neighborhood pride may lead owners to restore their Victorian porch, a public amenity. Yet those same owners might prefer a white interior furnished by West Elm, and that decision is compatible with their preservation of architectural elements.

And finally, one reason for preservation is to anticipate the future. Before a house became historic, it was merely vintage, and before that, "used." Preservation even of houses built after 1945 assures that they last long enough to represent a moment in building history.

In a nutshell: let it be

To clear up one misconception, taking a preservation approach is not the same as calling for period rooms. Many people don't want the fuss or expense of a revival interior. Preservation still allows for painting the plaster walls white and hanging modern art. Furthermore, preservation doesn't demand putting back what already has been lost.

Unlike restoration, which can be conjectural and expensive and is rarely a mandate, preservation is an easy call. At the core, it means "let it be." Whether the work at hand will involve restoration, rehabilitation, or remodeling, a preservation mindset is good because it helps avoid destruction.

Much of our old housing stock holds rare material, magnificent craftsmanship—and our cultural history. Old houses often suggest what has worked over decades or centuries. Their building systems, from wood and plaster to masonry, are long-lived and designed to be refinished or repaired—this is a lesson for what has become a disposable society. Mantels and staircases are a tangible record of historical styles and craftsmanship. Consider the retractable pocket doors that slid between the parlor and the dining room: Aren't they proof that an open plan sometimes needs to be closed?

As temporary inhabitants, we should resist destroying things, especially the good work of the past and anything that managed to survive decades or centuries of use. We should respect the workmanship we find, and honor materials that may be no longer available or affordable. It's best to repair rather than replace elements, because eventually, after generations of replacement, a house is no longer original, and probably not coherent.

It's critical to understand the difference between what is permanent (ripping out the main staircase) and what is ephemeral (painting a bedroom blue). Not that it's always so clear, of course: Painting original, natural-finish quarter-sawn oak comes to mind. It's reversible, sure, but only after pain and suffering, and with an environmental cost.

We'd have more preserved old houses if generations of owners had taken to heart that, in the long run, their own taste doesn't matter. I have seen a carved Eastlake mantel discarded "because it's fussy" and endless original bits thrown away for being "old-fashioned" or the "wrong" color. A house represents a particular time and style. It's easy enough to live around that. As we learn more, our changes are likely to be in keeping with the original design intent. The mid-20th-century proclivity to turn Victorians into Colonials, for example, did not work out. Stripping off the gingerbread trim and painting out these houses only succeeded in making them ugly "white elephants" that would prove very expensive to restore. From repairs to additions, any new work should enhance and clarify the original design intention, or at least not detract from it.

A harder sell is retaining elements that make the house a cultural artifact. Perhaps the current owner doesn't use the narrow, boxed stair

at the rear of the house, or the cold pantry, or the fireplace in the dining room. Take them all away, though, and the house has lost the significance of its history. We should be careful about how much we change—because there is a tipping point. Most of us fell in love with an old house, not a new house made of old materials.

The significance of style

Owners who just bought an old house universally want to know, “what style is it?” People love labels—for plants, dogs, clouds. Having a name for something opens the door to learning more. And that’s the real point: Knowing something about the style and era of a house directs renovation and helps avoid mistakes.

Homeowners ask about style because they’ve seen something they like or don’t quite understand: an odd roof shape, tapered columns resting on stone piers, round-arch windows. They recognize that these are clues but can’t yet read them. Already their interest is piqued.

This pursuit leads to an understanding of design intention that will guide renovation. An owner (or designer or contractor) who recognizes original, style-defining details will be less likely to remove them in ignorance. If the front door needs to be replaced, it’s more likely that the choice will be in keeping with the house. The integrity of the architecture depends on respecting the language.

Style markers abound not only on the exterior but inside, in such built-ins as buffets, mantels, and staircases. Original wood trim, flooring, and tile offer more clues. It’s likely that an architect-designed house will have been treated well by subsequent owners. These examples are easier to label and attract buyers likely to preserve or restore

them. But even “regular” old houses had an original architectural concept. Understanding that helps an owner figure out what is original, what has changed, and what is missing.

If an old house is of indeterminate pedigree—or if it’s had its pedigree remodeled right out of it—you can use an understanding of period design to enhance what it does have to offer. This doesn’t require adding period-correct replications. It just means adhering to the general style sense and proportions. Basic knowledge also prevents ridiculous anachronisms. How many of us have seen a phony-Colonial entryway added to a midcentury ranch, or a pseudo-Victorian door with curlicue appliques used on a Prairie-style bungalow?

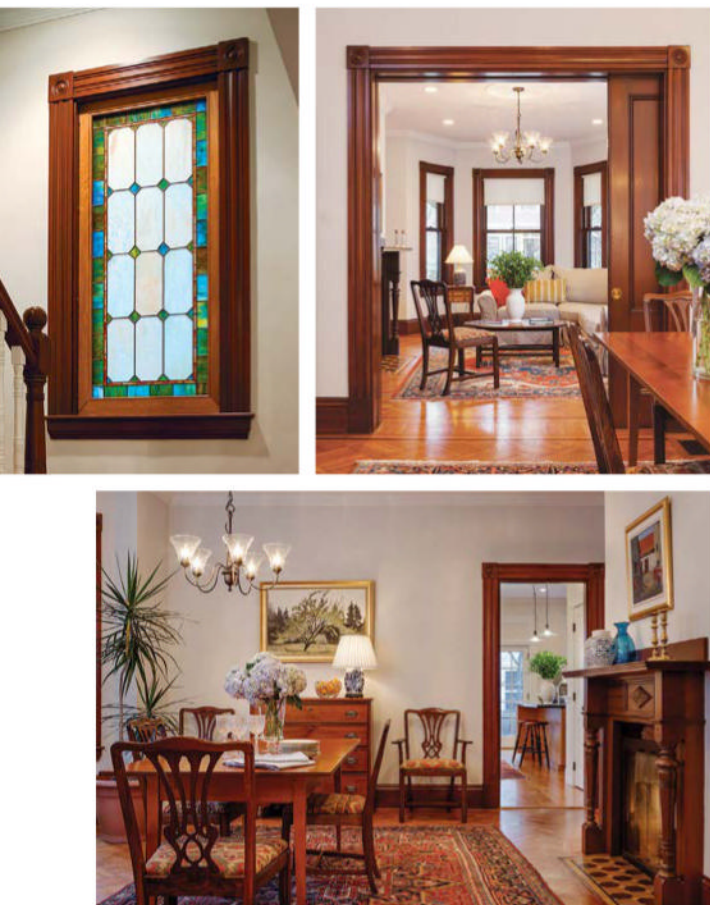
Take the idea inside, where judicious choices during renovation can create a cohesive interior where once blandness or confusion reigned.

Are there any rules?

Is there general advice that might save an owner from obvious traps and expensive mistakes? As in most creative endeavors, the best work is done by people who have learned the rules and thus when to break them. Over the years, *OHJ* has repeated some guidelines, however, that may help.

Knowledge is power—Understanding the period and style of a house mercifully narrows choices, giving a head start. More importantly, that knowledge teaches us to differentiate between what is original and what was remodeled, guiding future work.

Respect the architecture—Future owners will curse big changes that obscure the original design and period integrity in favor of individual taste and passing trends. You saw that when you were house



VICTORIAN MINIMALISM? It may sound like an oxymoron, but it is possible. Architect John Altobello balanced exterior restoration (including a polychrome paint job that brings out texture without being flamboyant) and preservation of original interior details with clean white walls and restrained furnishings.



BEFORE

MODEST MADE MEMORABLE The smaller builders' houses found in early-20th-century suburbs are often discounted as "nothing special." Reasonable restoration efforts and a compatible paint job, as seen on this owner-designed Dutch Colonial in New Jersey, can bring out such houses' inherent charm.

hunting. Paint the plaster walls chartreuse or fuchsia if you like, but don't be the first one to paint 140-year-old figured mahogany intrinsic to the 1880s opulence of the dining room.

Live in the house—Wait months, or a year, before making any big plans. Trust me, you will learn more, and possibly change your mind.

Try cleaning or stripping—Whatever it is may be salvageable. Once general surroundings have been brought up to a consistent level of cleanliness and repair, what was once "old and dirty" becomes "original detail."

You get what you pay for—Do without, wait and save up, rather than subbing in short-lived materials or settling for poor craftsmanship.

Personal taste has its place—In your home, express yourself through paint colors, wallpaper, textiles, lighting, and furniture. Don't alter main features.

Don't discard history—If you do choose to swap something out, such as a light fixture or a built-in cabinet, preserve and store it away for the future.

In a practical sense, preservation is different from nostalgia. It is stewardship. We are temporary caretakers of buildings that continue to prove their worth. Yes, an old house demands attention, but it offers durability and character not easily replaced. I've also found that the learning is a lot of fun for the owners. □

Patricia Poore is editor emeritus of *Old-House Journal*. Then a hands-on restorer, she joined *OHJ* in the late 1970s, when it was a Brooklyn-brownstoner newsletter, and over the years has been its owner, publisher, and editor-in-chief.

Better Contracts for Builders and Clients

A seasoned attorney/mediator shares his advice
on how healthy relationships translate into better contracts

BY DEAN KILGORE



In my 30 years of mediation experience, I've witnessed a lot of ugly construction disputes. And many times, it was evident that these disputes weren't really caused by bad construction work or a flawed contract—they happened because the relationship between the builder and the client broke down. These experiences taught me that success on a construction project requires building a healthy relationship before a contract is ever inked. If parties focus on the relationship first, the contract becomes a guide to success rather than the rules of war.

How do I know these things? After graduating from the University of Texas School of Law in 1975, I went to work practicing heavy civil litigation in the courtroom, representing and often defending large clients like oil companies, aircraft manufacturers, drug companies, doctors, and hospitals in heated civil lawsuits. But 20 years later, I found myself growing weary of litigation. Outcomes depended more on lawyering than what was "right," and even winners often felt they lost. Whether or not you are successful, litigation will steal your time, your money, and sometimes even your health and well-being, all for the stressful roll of the dice in the courtroom.

Around that time, Alternative Dispute Resolution (ADR), mainly mediation, was really coming onto the scene in Texas. Mediation is a process in which a skilled middleman (a mediator, often a lawyer) works with both sides of a dispute (the parties and their lawyers) to avoid or stop costly litigation proceedings by reaching an acceptable compromise or settlement.

In 1995, I shuttered my litigation practice and devoted my career solely to mediation. Since then, I've had the privilege and opportunity to mediate over 2000 cases, in which the parties were able reach settlements about 80% of the time. While I've mediated all types of commercial cases (as opposed to family matters), a very large number, perhaps 800 to 1000, were construction and design disputes, at least half of which were home-building cases.

By sitting through and mediating these construction disputes for the past 30 years, I've seen and learned a great deal about construction, design, where these projects so often go off the rails, and how different personalities act when in dispute. Here, I'll share some acquired wisdom about how you, either as the contractor or the client, can prepare your relationship and your contract to effectively manage disputes, or just plain avoid them altogether.

As a disclaimer, neither I nor the magazine are providing you any legal advice. These are general educational comments, but may not reflect the contract needs or requirements in your jurisdiction, nor reflect the circumstances of your project. Always consult a licensed attorney before entering into any contract.

Focus on the relationship first

Home building, especially building a fine home, is inherently stressful. Time and money are scarce resources, and they must be budgeted carefully. Understanding and honoring design intent is deeply important. Sourcing quality materials and skilled tradespeople can be difficult. Without a healthy builder-client relationship that can deal with those stresses, a project is doomed to encounter issues.

Unlike one-time transactions that prioritize exact exchanges, relationships require sustained contact and communication. A good relationship prioritizes compatibility, along with respect, communication, and under-

standing. We don't (or shouldn't!) date or marry people we don't like, and you shouldn't contract with someone you don't like or trust.

Power imbalances in relationships often lead to dispute. If you feel the slightest hesitation about another's integrity, just walk away. Pay attention to all red and yellow flags. Ask yourself, can I work with this person? Can we solve matters when stresses arise? If you don't feel good about a relationship, look elsewhere. If the potential relationship seems good, promise each other that you will work together to get the job done. Commit to mutual success.

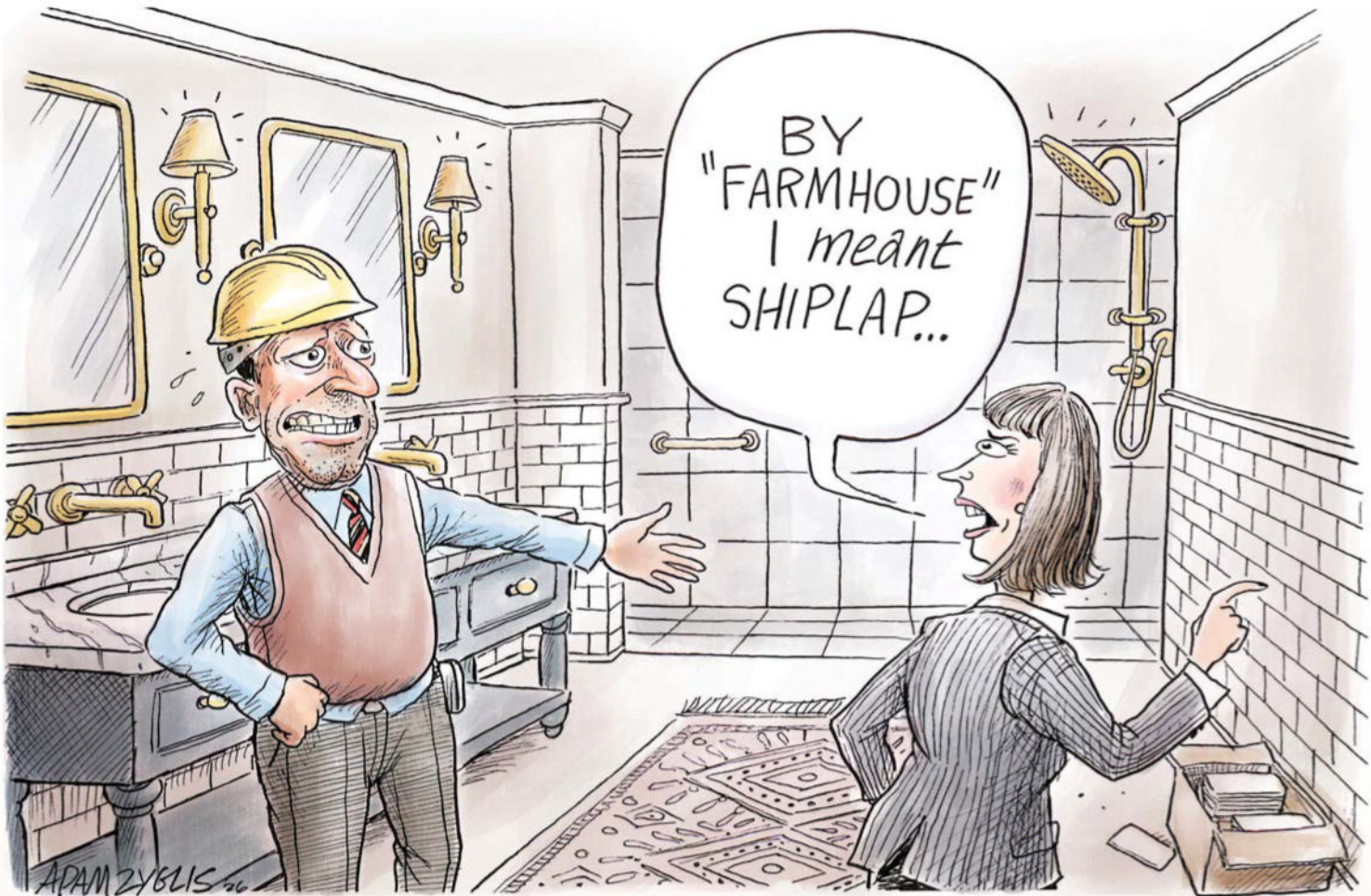
For a builder-client relationship to be healthy, the builder's primary job must be to strive to satisfy the owner's needs and design intent with a quality product at an agreed-upon budget, on time. If maximizing job profit comes first, at the expense of the owner's priorities, problems will follow. Likewise, the owner's primary job is to be clear about design intent and budget constraints, pay promptly as agreed, be careful with changes, understand and be tolerant of the inherent difficulty of pulling resources together, and work hard to support the contractor in getting the work done (for example, choosing fixtures on time). If the owner prioritizes

Whether or not
you are successful,
litigation will
steal your time,
your money, and
sometimes even
your health and
well-being, all for
the stressful roll
of the dice in
the courtroom.

MUST-HAVE NO. 1 THE PARTIES

Defining who the parties are in the relationship and subsequent contract may seem simple, but there can be a few wrinkles. A contractor, especially if building a new home, should assure that the "owner" is really the legal owner of the project site. Otherwise, it will be impossible for the contractor to have a lien against the property to assure payment. Make sure both members of a couple sign the contract if both have ownership of the property. Likewise, both members of a couple should be participants in the builder-client relationship.

As an owner, you should know if the contract with the "builder" is with the individual with whom you have talked, or a corporation or other entity owned or controlled by that person or someone else. This does not imply that the builder is doing anything sketchy—most builders operate as legal entities that can protect their personal assets in the event of a real project failure—it just means that the owner should understand who carries the real responsibility to build their home.



MUST-HAVE NO. 2 **A CLEAR SCOPE**

An essential pillar in the builder-client relationship, and the successful contract that comes from it, is a clearly defined scope of work. One of the biggest drivers of construction disputes is a disagreement over the final product and whether it is what was intended or promised. Success in construction is largely dependent on people (often lots of people) doing what they say they are going to do, when they say they are going to do it, in a manner that's acceptable and meets the requirements of the project. If you haven't identified these project requirements in some detail, then it is unclear whether you will meet them.

On larger projects, defining the scope of work starts with a clear and complete set of documents, plans, and specifications, often produced by an architect or designer and engineer. As a client, one of your most important roles during the preconstruction process is defining your expectations, committing to them, and doing what it takes to make sure they get translated correctly into the plans and specifications. As a builder, you should also be closely reviewing plans and specifications for constructability and clarity. Is the intent of the design and its details clear? Can I build what is drawn without concerns? If you see something that might be out of the ordinary, talk about it with the owner or designer before it becomes a serious job disruption.

A small project needs detail too. Often, a small job has the same number of trades involved as a whole-house project. While smaller projects can sometimes rely on rough, "back of napkin" designs instead of full-blown construction documents, it is still critical that the contract captures what both parties are actually agreeing to. A good scope of work doesn't need to be complex or confusing, just clear and specific. The time a contractor spends detailing the proposal will pay enormous dividends in preventing misunderstandings and potential disputes down the road.

Additionally, a clear and defined scope can help to alleviate or highlight financial strain. If a builder is given an accurate and complete set of plans, that allows for a more precise, less risky cost estimate.

The contracted scope of work should also reflect the expected quality. Quality belongs to that class of things that are hard to define, but you know it when you see it. As an owner, ask to see the builder's other projects, or at least photographs. Show the builder photographs of things you like. You can even reference these items in the scope of work. Get on the same page for project expectations. The more the builder and owner talk about such variables, and then include them in the contract, the better the odds that there will be fewer do-overs.

getting more out of less or squeezing a contractor to deliver more than is reasonable, or is not respectful of the complexity of the contractor's job, problems will follow.

The contract follows the relationship

I believe in keeping contracts and their language simple, and using them to reflect what you've committed to in the relationship. Once you've hashed out the basic questions and concerns over items like scope and timeline, and have had the hard and honest conversations over items like budget, creating the contract is straightforward, and it becomes the tool to capture, support, and further strengthen the relationship to help each party in accomplishing their job.

While the actual contract you sign will have more to it than we can discuss, there are some basics that every construction contract should have. How these things are written in each individual contract will vary, and I recommend consulting an attorney with specific questions, but the concepts will remain the same.

The six basics "must-haves" are the parties (the "who"); the scope of work (the "what" is to be built); the cost or budget (the "how much"); a change process for any adjustments; the schedule (the "how long"); and dispute resolution, which defines how you'll avoid litigation in the event of a problem. Most contracts will also include supporting provisions that deal with the legal stuff, such as warranty, liens, financing, insurance, and termination—but those are beyond the scope of this article.

What about "big scary" contracts?

Before I dive into these basic contract provisions, let me address long-form or more detailed contracts. An experienced or sophisticated builder will often use a prepared contract form that is much more specific than the type of contract I have discussed. For instance, form contracts from the American Institute of Architects (AIA) are sometimes used to document home-construction projects.

If you are presented such a form, do not panic or take it as a red flag. The builder may be very experienced and has come over time to rely on strong legal forms, and may well be the most reputable builder you interview. If you have the sense that the fit is good, have an attorney walk you through the documents,

MUST-HAVE NO. 3 THE BUDGET

In today's financial climate, even the most basic residential construction projects can carry large price tags. Both parties must understand and come to grips with budget realities early in the process. Contractors must estimate accurately, and owners must be willing to be honest about what they can afford and are willing to pay for the things they want, including predictable and unpredictable changes (see must-have no. 4). By far the biggest source of construction disputes that lead to the courthouse is money—what things cost or should cost, and who has paid or must pay.

A construction contract must include the cost of constructing the agreed-upon scope of work—the "base" price for the job. The base cost must define the manner of pricing, often fixed-cost ("lump sum") or cost-plus a specified fee or percentage. In any case, the contract should clearly define the agreed price.

It's also important to detail how and when progress payments ("draws") are made and on what basis—once a week, once a month, on particular milestones, or otherwise. The parties might also agree upon some level of retainage of the final payment to assure final completion (all details buttoned up) beyond substantial completion. Simply speaking, clarity and accuracy when it comes to payment make life easier and help eliminate misunderstandings.

During the project, contractors should never vary from the contracted basis of billing, unless the owner has clearly agreed otherwise. If the builder has promised the job or any part of it at a stated price or on a specified basis, it is potentially fatal and always toxic to try to fudge the numbers. Owners (and judges and juries) will think you dishonest if you try to make back even a dollar by altering or varying from what was agreed. Additionally, builders should keep accurate and detailed records of costs (especially for cost-plus agreements), and be prepared to walk through how the totals were calculated.

Likewise, an owner's temptation to nitpick billing to save a dollar can be strong, but is equally toxic to the relationship. If you have agreed to pay a certain price, trust the builder to bill you accurately unless you have strong reasons to believe otherwise. And don't second-guess a contractor's choice of subcontractors, especially for pricing concerns. A seasoned builder will have a stable of subcontractors who have earned his confidence for a reason.



MUST-HAVE NO. 4 A CHANGE PROCESS

As the old saying goes, the only constant is change. Whether we like it or not, some aspect of every job's scope of work will change, sometimes in significant ways that considerably impact the budget.

Understanding the impact of scope changes often is not easy for owners. Contractors know that changes add costs and affect job scheduling and timing. A change that interrupts or extends the work of one trade often impacts other trades and the order of their work. Sometimes a worker or trade is delayed by a day, but cannot reschedule for a week. That costs money and time.

An up-front conversation and understanding between owner and builder about the risk, cost, and timeline effect that change orders can have on a project is critical and should be reflected in the contract. Owners must thoroughly understand that while changes can be made, they should expect that the builder will charge for each and every change and that the schedule will slow.

Every contract should include a process for project changes and how they are priced. Perhaps the builder and client can agree up front that simple changes only require a text message confirmation between owner and builder, which will help keep the project moving. Conversely, large changes and major adjustments to scope should almost always be priced and agreed to in some form of writing before work moves forward. And remember, the change-order process itself often delays the schedule, while work is stopped as decisions are made.

One other type of change merits a mention: an unintended change based on unexpected circumstances. Perhaps a manufacturer has ceased making a specified item, raised an item's price, or reported a supply-chain issue. More sophisticated contracts may include a force majeure (or "Act of God") provision that excuses delays caused by events outside the parties' control, and a materials escalation clause that allows the contract price to adjust if the cost of building materials rises significantly. These things happen, and the contract needs to prepare for them.



and understand that this particular builder may be a bit more formal in communications. It will still be the quality of the relationship that drives the project, not the fine print.

If, on the other hand, you are presented with a contract that seems one-sided or has abundant provisions that seem harsh to you as either the client or the builder, it is fair to take that as a caution flag. Carefully check out references, which is a good idea in any circumstance. If the party has a reputation of repeated conflict, or bullying tendencies, be exceedingly careful or walk away. Someone prepared that contract with dispute in mind. You may be next.

Communication is key

After the project begins, reality sets in. Maybe it rains, and the owner sees their beautiful lot tracked up and rutted. The builder sees that they will miss the time slot with the framer if the foundation subcontractor doesn't add resources. This is where a strong relationship must keep the job moving and morale high. But how?

Communicate, communicate, and communicate some more. Poor or infrequent communication is the fastest way to derail and harm a builder-client relationship, and have a problem spiral out of control. Builders should advise clients regularly of progress or potential slow-downs, and ask early for owner decisions. Regular reports help owners understand and deal with both progress and difficulties.

The parties should also have a clear understanding of communication protocol on the job. For instance, most builders and clients do not wish to be approached on-site in front of workers and be loudly advised of some disappointment. An owner should never attempt to direct or alter a subcontractor's work. Avoiding unnecessary griping is also a good idea. In general, value the relationship and handle things with respect and productive communication.

And lastly, when you sign a contract, either as builder or owner, understand and mean to honor it. Above all else, be honest and commit to upholding your side of the agreement. During the project, respect, understanding, and communication will be your tools to see the job succeed. The contract is just how you put that relationship in writing. □

Dean Kilgore is an attorney/mediator in Austin, Texas. Drawings by Adam Zyglis.

MUST-HAVE NO. 5 THE SCHEDULE

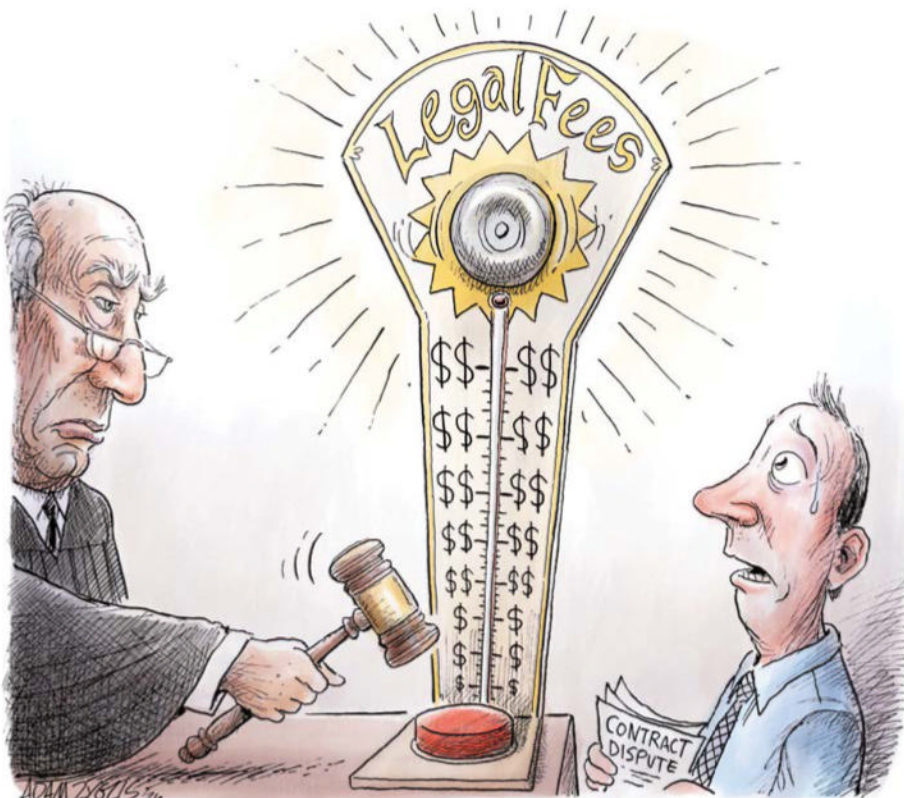
It's exceedingly rare for a residential construction project to have no time constraints. Most homeowners want quality at a reasonable budget, delivered in a reasonable amount of time. And timing is another cause of bitter construction disputes.

Most contracts will include an estimation of time to complete the project. Some have hard and fast completion dates with financial penalties for missing them. Builders and owners should share an understanding of these time provisions. Owners are typically deeply committed to moving into a completed home when promised. Time delays are emotionally (and financially) draining. For contractors, schedules can be difficult to manage, so do not overcommit and raise expectations—be honest and even liberal when it comes to time estimates. The schedule is your responsibility, so do not cramp yourself to get a job. You will make more money if the schedule stays

under control, and the owners will love you for it.

By the same token, owners should not ask contractors to shorten timelines or speed up construction. Hurrying is counterproductive and likely to reduce overall quality or result in work that must be redone. Make finish or

other selections (lights, plumbing fixtures, appliances, etc.) timely and decisively. And lastly, be understanding when delays occur, because they almost certainly will. Respecting the complexity and resultant lack of predictability in construction is a good way to avoid extra stress.



MUST-HAVE NO. 6 DISPUTE RESOLUTION

Even a contract based on a good relationship must include a process for handling disagreements, mistakes, or misunderstandings before they become legal disputes. This provision reflects the strength of the builder-client relationship when problems arise, and should take the form of a promise to continue to work together even when things get hard. As an example, my last home-construction contract had the following provision:

"Disputes. The parties agree that they shall attempt first to resolve any disputes between them by informal negotiation, then by mediation, all as a condition to taking any further legal action."

Simply put, this is a promise to work things out, ensuring neither side will run to the courthouse without trying to resolve a matter. It defines the type of relationship builders and clients must have to be successful—they must be in it together.

Simple Rules for Finish Carpentry



A back-to-basics paneling project highlights how great trimwork often comes down to simplicity, creativity, and an understanding of acceptable tolerances

BY GRANT BAVER

When one of my friends contacted me recently about helping him with some finish carpentry work on the modern farmhouse he was building, my mind was immediately flooded by fond memories of the first complete house I ever trimmed by myself—which is still one of my favorite trim projects. I closed my eyes and instantly recalled the Craftsman-style trim details I had installed on that house, all milled on-site out of flat-stock lumber with my limited selection of carpentry tools. I can still hear the songs playing from the radio that had a piece of copper wire for an antenna, feel the worn grip of my hand-me-down pneumatic trim nailer, and smell the fresh sawdust from hand-routing over 100 ft. of beaded 5/4 moldings with a homemade jig because I couldn't afford a router table.

Even though my finish carpentry ability, efficiency, and tool set have improved with experience, that first big project taught me three important lessons: It's the archer, not the arrow; keep things simple; and if it looks good, it is good. To this day, I still live by those rules whenever I work on finish-carpentry projects, and I am a better finish carpenter because of it.

The project shown here, a tall wainscoting wrapped around an open-concept dining area, provided the perfect opportunity to demonstrate those rules in action as well as the Craftsman style. Standing at 6 ft. tall, this paneling was built entirely from off-the-shelf materials with a standard set of finish-carpentry tools. Its design is simple and uses proportion and balance rather than intricate details to add interest to the room. And importantly, the design and process I used are adaptable to imperfect conditions, making it possible to create visually appealing work without spending hours chasing perfection.

Modern farmhouses seem to be one of the most popular styles for new homes today, and their trim is essentially what we've long known as Craftsman style. Craftsman-style trim is known for its simplicity—often just flat stock, or flat stock with occasional edge profiles including a slight roundover or chamfer and maybe a bead. Plinth blocks may be used at transitions between baseboard and casing, and sometimes the head trim over doors and

PLEASINGLY PROPORTIONED

A large part of making a wainscoting project pop is getting the proportions right. Although the exact details are largely up to personal preference, here are some general guidelines to help you with designing one-third-, two-thirds-, and full-height panels.



ONE-THIRD-HEIGHT PANELS are a good way to combine a wainscoting with chair-rail details. Narrower stiles often look correct here because the stiles are shorter. Narrower stiles also allow the stiles to be positioned closer together if desired. A chair rail is a good choice to cap the top of these panels in lieu of a bulky cap molding.



Because the stiles are taller, **TWO-THIRDS-HEIGHT PANELS**, as shown on this project, often look the most proportional with wider stiles that are spaced farther apart. When the stiles are wide, shrinking the face reveals in the corner often provides for a better-looking, less bulky corner. The tall height also allows for a more pronounced cap molding if desired.



FULL-HEIGHT PANELS are often the focal point of the rooms they are in. If you try to keep the width of the stiles proportional to the height, the stiles will often become too wide. Instead, try arranging regular or narrow stiles in a geometric pattern to add personality to the wall.

DEFINE THE DETAILS

Figuring out the dimensions of your wainscoting panels and how the different layers of trim will come together is often one of the hardest parts of a wainscoting installation. Mocking up the panels and details full-scale in the room, rather than trying to make each element the exact same size, is the best way to make sure everything looks right.



TEASE OUT THE TERMINATIONS Make a full-size mock-up to ensure that the wainscoting looks right where it terminates against other trims. It's important to get these details dialed in first, especially when sizing a custom backband.



FINE-TUNE THE HEIGHT First, determine how tall you want the panels to be on the wall. A laser makes easy work of projecting that height around the room, but if you don't have a laser, drawing a line with a level also works.



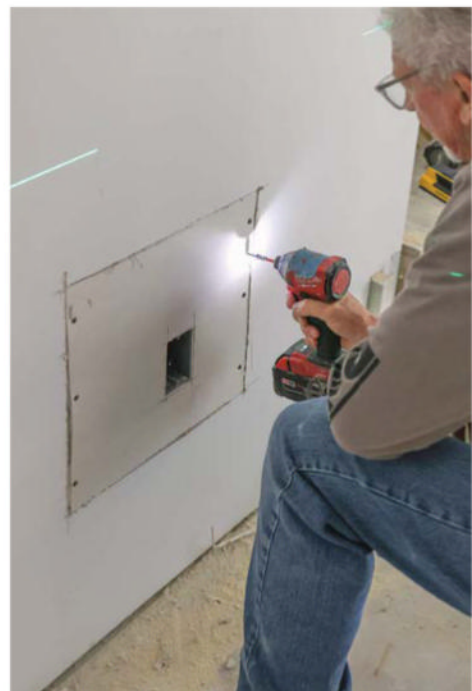
TACK UP SCRAPS Rather than making a bunch of marks and lines, it's faster to tack up scrap material of the proper sizes to help with measuring and visualization. This is especially helpful at corners, where one side of the corner needs to be smaller to keep an even reveal.



START AT THE SMALLEST SECTION The spacing of the stiles is almost always driven by the smallest walls or by special obstacles. On this project, we started our mock-up with the smallest wall that would have intermediate stiles.



SHIFT OBSTRUCTIONS, NOT SPACING Sometimes you are forced to work around obstructions. But when an obstruction is easily movable, such as an electrical box, it's usually easiest to shift the box and keep the stile layout balanced.





A BALANCING ACT Larger sections should have a similar stile spacing to smaller sections, but they don't need to be exactly the same. Take your time and play around with stile spacing until you find a layout you like.



SCRIBBLE THE STUDS Before moving on to the backing panels, use a stud finder to mark all the studs and the approximate stile locations just above the reference line, where they will be covered later by the cap rail.

windows is wider and sits proud of the casing legs. That's about as ornate as the style gets. Craftsman-style cabinetry and paneling are similar to the Shaker style, with square cuts and butt joints, and a board-and-batten detail here or there. Not only does the simplicity of Craftsman-style trim add an unobtrusive character that doesn't clash with the modern trends of today's homes, but it also makes these details easier to execute.

Rule 1: The archer, not the arrow

In my portfolio of interior trim projects, those I enjoyed the most all started with a big stack of S4S (surfaced four sides) flat stock. I'm not a philosopher, but I think any carpenter who's ever stood back and admired a finished product that was once just a stack of boards on the floor gains a much deeper understanding of what Michelangelo was saying about setting his angel free from a chunk of marble.

As a carpenter who's always prided myself in the work, I strive to find and operate in the sweet spot between convenience, character, and craftsmanship. Certainly there are times when factory-milled and -shaped moldings and flashy tools make sense in order to save time, effort, and cost, but I believe the mark of the best carpenters and craftsmanship is the ability to use the tools at hand to create great-looking work out of basic stock. In other words, it's the archer, not the arrow.

For this paneling, I used off-the-shelf lumber—no exotic or hard-to-source materials. I kept my specialty and expensive tools (like my Festool Domino) in the truck, and instead relied on a core set of tools that you may already own. A miter saw, a tablesaw, a Kreg pocket-screw jig, a router with a couple of bits, and a biscuit joiner are all you need to make a project like this come to life.

Rule 2: K.I.S.S.

When we break this project into its basic components—a backer, a frame, and termination moldings—the design of this wainscoting follows my second rule of finish carpentry: K.I.S.S., or “Keep it simple, stupid.”

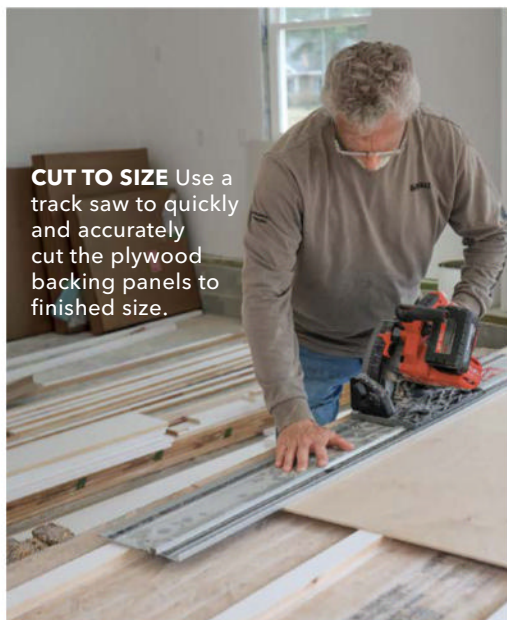
The backer is the material that creates the finished face of the panels. On this project I chose to use ¼-in.-thick birch plywood, which provides a smooth finish over the drywall and more impact resistance. If the project were going to be spray-finished, I would have considered using ¼-in. MDF, as it provides a smoother paint finish.

One way to make a project like this more budget-friendly is to use the drywall that's already installed on the walls and simply apply the frames over it. When I go with this route, I usually cover the area with a light skim coat of drywall compound so I can sand it perfectly smooth.

When building these wainscoting accent walls in areas that don't have any window or door interruptions, or in areas that have questionable stud frequency and locations, I commonly use a thicker hardwood plywood or MDF (usually ½ in. or ¾ in. thick) as the backer. By making the backer thicker, I can attach the face frames directly to the backer without having to worry about hitting studs. However, this extra thickness

PREPARE FOR PANELS

While ultra-budget-friendly wainscoting uses the drywall itself for backing, installing thin sheet goods as backing is a worthwhile upgrade for a smoother finish.

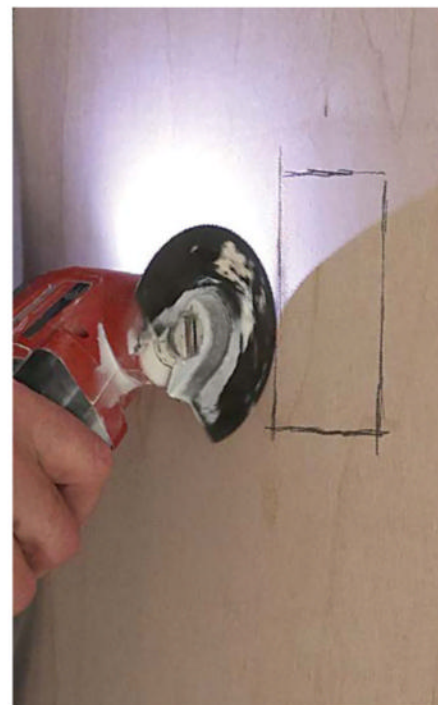


CUT TO SIZE Use a track saw to quickly and accurately cut the plywood backing panels to finished size.



EASILY MARK OBSTRUCTIONS

Set a laser line to the edge of any obstructions, such as electrical boxes, before holding the panels in place. This makes marking for cutouts much quicker and more accurate.



A QUICK ZIP Use an oscillating multitool to quickly and cleanly cut out boxes without having to take the sheet back to the worktable.



GLUE IT UP Use a construction adhesive like PL Premium to help hold the backing panels to the wall. This step helps eliminate any voids, hollows, or movement between the drywall and the plywood.



STAPLE IT OFF

An 18-ga. narrow-crown stapler is great for attaching the panels to the wall. Staple at the studs (which are easily located by the marks made previously) only in areas that will be covered later by the frame.



MILL THE CUSTOM MOLDINGS Using a tablesaw and a router, mill any custom-size moldings needed for the transition points, such as the backband.



BRAD IN THE BACKBAND Cut any transition moldings to fit, such as the backband, and then send them home with an 18-ga. brad nailer.

can make for an awkward transition where the wainscoting meets other casings or trim elements.

I also keep the frame material selections simple. For this project, I used off-the-shelf finger-jointed primed trim boards, the kind you can pick up at any lumberyard. This material works well and is easy on the budget, but if I can get it, I like to upgrade to a premium primed trim board (like those made by Windsor One) for better consistency, quality, and straightness. Finally, for projects with the biggest budgets, highest expectations, or smoothest finishes, I generally use poplar for the frame material.

When choosing the dimensions for frame stock, I also keep things simple. On this project—as with almost all my projects—I used $\frac{3}{4}$ -in.-deep stock for the frames, since it provides a good depth of reveal and shadow to the backer. I used a 1x4 for the top rails, and a 1x8 for the bottom rails to match the height of the baseboard. Because these panels had a wide space between the stiles, I also used 1x4s for the stiles. However, if the spacing between the stiles had been tighter, I would have gone with 1x3s or 1x2s for the stiles to keep things proportional.

I kept the corners where the frames meet symmetrical but shrunk the reveal by the thickness of the overlapping frame, as keeping the full stile width creates a corner that looks too thick. In other words, since my stiles were $3\frac{1}{2}$ in. wide, I made the corner reveal on each side $2\frac{3}{4}$ in. However, if I were using a stile with a smaller width, like a 1x2, I would keep the corner reveal the same width as the stile ($1\frac{1}{2}$ in.), or the corner would look too narrow. This is easily done by making wider the end stile on the frame that extends blindly into the corner.

When choosing the height of the panels, most common wainscoting designs are either one-third or two-thirds the height of the wall (and sometimes half the height, although I have not found this to be as common), give or take based on client preference. On this project, I capped the two-thirds-height panels with a cap molding made from $\frac{5}{4}$ stock. One-third-height panels are typically capped with a chair rail, often one with minimal projection so it doesn't feel like it's taking away from the space in the room. When panels are the entire height of the wall, I like to set off the design by using 1x2 stiles in some sort of a pattern, such as diagonal, herringbone, or geometrically spaced. Not only does this add interest to the wall, but it also keeps the panels from looking too tall compared to their width.

To keep frame construction simple, I almost always reach for pocket-hole joinery and wood glue to attach the stiles to the top and bottom rails. It's quick and affordable, especially when you use one of Kreg's benchtop jigs. It also allows me to use a spacer block to space the stiles perfectly, which is easier than pulling out a tape and making marks.

I sometimes attach the backer directly to the back of the frames with short staples instead of putting the backer on the wall first like I did on this project. That works well if I'm assembling the frames off-site and transporting them. It also keeps the backer tight to the frames around the inside perimeters of each panel, but it can sometimes create hollow areas behind the assembly on wonky walls. On this project, I

FASHION THE FRAMES

Recheck measurements once the backing is installed, as sometimes the backing will throw off the original calculations. Take a measurement for the top and bottom rails, and recheck the stile spacing.

GANG 'EM UP When possible, gang-cut the rails and the stiles for each section of frame so they are the same. A clamp makes it easy to hold the layers of stock together, and a stop block makes quick work of cutting all the stiles to the correct length.



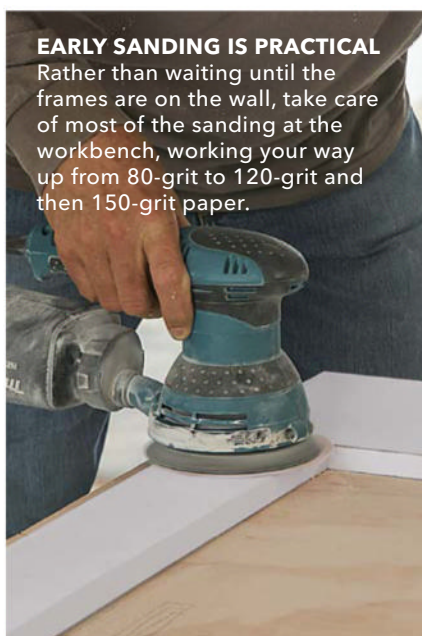
BIG TABLES RULE On this project, the largest frame is 6 ft. tall and 8 ft. long. Having a double 4-ft. by 8-ft. worktable provides enough room to assemble the frames while keeping them flat. A Kreg jig makes pocket holes quickly on the back side of each end of the stiles.



KEEP CORNERS SIMPLE Corners are made with simple butt joints held together with glue, biscuits, and brads. You could miter these, but butt joints are easier to assemble, more resistant to damage, and less sharp.



THE BIG EASE Soften all the inside edges of the frames with a $\frac{1}{8}$ -in. router bit, and touch up the corners with sandpaper.



EARLY SANDING IS PRACTICAL

Rather than waiting until the frames are on the wall, take care of most of the sanding at the workbench, working your way up from 80-grit to 120-grit and then 150-grit paper.



FASTEN THE FRAME Apply a bead of construction adhesive (PL Premium), and fasten with a combination of 16-ga. nails at studs and 23-ga. pins in between.

LEAVE ROOM TO SCRIBE On panels that abut other panels, $\frac{1}{4}$ in. of extra length provides room to scribe them for a perfect fit in wonky corners.



THREE STEPS FOR PERFECT SCRIBES

Here's a process for cutting scribes that's both efficient and accurate. First, remove the bulk of the material using a track saw set with a 2° to 5° back bevel. Then sneak your way up to the line using a power planer, and finish by smoothing it all out with a belt sander.



SNAP IT IN You've aced the scribe when the panel snaps in place with a smooth push thanks to the slight back bevel. If you need a mallet to beat it in, you should probably scribe again.

decided to apply the backer to the walls first because I needed the thickness of the backer under the backband to make the reveal work with the $5/4$ plinth block at the casing (and because I didn't have short staples in my truck).

When determining how and what transition moldings to use for the cap and backband, I let depth and reveals drive my decisions. For instance, any casing will inform the thickness and dimensions of the backband, which is typically proud of the casing. Similarly, I select my cap-molding size based on visual preference. If the owner wants a lot of projection on the cap molding—to lean pictures on, for instance—I often add a piece of cove under the projection so that it doesn't look like it's sticking out so far. For modern looks, I keep the cap tight to the face of the panel with minimal projection.

The concept of creating depth and character also applies to detail moldings, or moldings that are applied to dress up the inside perimeter of the panels. In this case, the owner wanted a true, squared-off Craftsman look, so we didn't apply any detail moldings. If you wanted to create a more refined Craftsman or Colonial look to match existing conditions, you could easily add a bead or scotia cove molding to dress it up.

Some purists will hate me for this, but my preference on paint-grade wainscoting in high-traffic areas is to use butt joints covered by corner moldings at outside corners. I've installed lots of paneling with mitered outside corners, and it does look nice and clean, but it's almost always more difficult to get right, especially if the walls are out of whack, and I've found that keeping it simple is always best. I've been called back more than once to fix a damaged miter tip from out-of-control furniture and been asked to sand or router the miter point to create a rounded point that's less likely for toddlers to knock their heads on. So if I can make it work and the owner likes the look of it, I use a simple butt joint covered with a tacked-on corner molding, which can easily be replaced if any future damage occurs.

Rule 3: If it looks good, it is good

I've built my reputation on being a meticulous carpenter, and there are some details in construction you just have to get right (most of them, actually). However, once you get into the finish-carpentry stage of a project, you'll come to realize that the mark of truly exceptional finish carpenters is their ability to take not-so-perfect situations and make them indiscernible to the eye of the onlooker. Corners are often out of square, jambs are frequently proud, and walls can be wonky. For wainscoting, when it comes to the spacing of the stiles and the fit at corners, I've found that replicating exact dimensions can't be the goal. Instead, if it looks good, it is good.

When I was a young carpenter and first started building wainscoting, I used to torture myself trying to get panel dimensions the same from wall to wall. I wasted a lot of time before I realized it would never happen. Get the idea that you will make every panel the same size out of your head now.

I now do all my layouts with scrap pieces full scale in the space, and I worry more about getting the right visual appeal than the perfect dimensions. I focus on symmetry and having consistent panel spacing on each length of wall. Usually I

TOP IT OFF WITH TRIM

Small details take this installation to the next level. For instance, a well-proportioned cap molding provides a finished look to the upper part of the panels, while meticulous paint preparation is key to making sure the panels get the perfect finish.

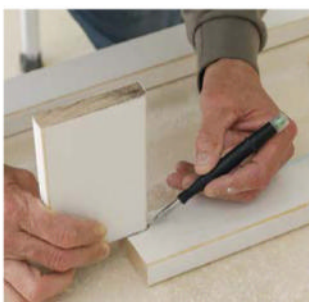


CORNERS ARE NEVER SQUARE

It's unlikely that drywall corners will ever be perfectly square, so before cutting the finished stock, bisect a measurement of the corner and use it to cut tester blocks out of scrap to fine-tune the fit of the miters.



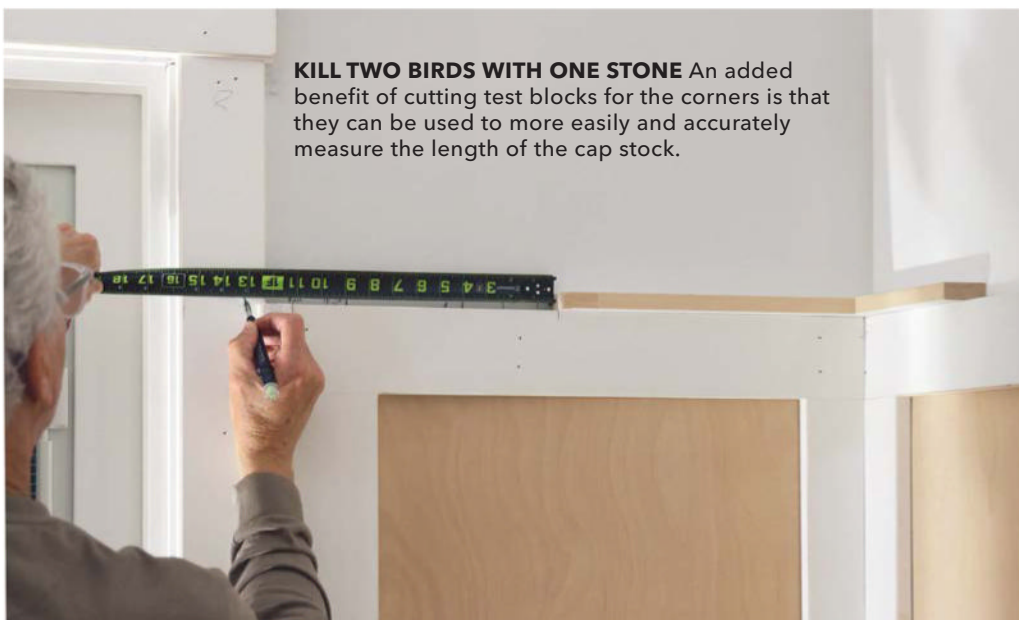
MITER OVERRIDE Because the actual miter cut is almost always different than 45°, using the detent override helps to more easily dial in nonstandard angles.



FORTIFY THE CORNER A thin corner-guard molding dresses up the butt joint while also providing extra protection from damage. Attach this molding with a 23-ga. pin nailer so that it is easy to replace in the future when it becomes damaged.



KILL TWO BIRDS WITH ONE STONE An added benefit of cutting test blocks for the corners is that they can be used to more easily and accurately measure the length of the cap stock.



DITCH THE TAPE MEASURE To get a perfect-fitting cap after cutting the pieces to length, forget the tape measure and make the rest of the marks and notches by holding the piece in place.



BE CREATIVE WITH YOUR DETAILS A handy detail when finishing a wainscoting cap is to use a roundnose/core-box router bit to add a shallow groove in the top of the cap about ½ in. from the outer edge. This groove securely holds the bottom edge of pictures, decorations, or plates that are displayed on top of the cap.



NAIL IT HOME After assembling any miters with CA glue (Titebond Instant Bond) and a few brads, place the cap on top of the panels and fasten it with brad nails and a few well-placed trim screws. Even if a painter will be prepping and painting the wainscoting, it's good to hand-sand your work at this point.



PREPARE FOR PAINT Use a premium flexible painter's caulk where the frames meet the backing, and wood filler on the nail holes. For best results, do two passes of filling and sanding with the wood filler to make sure any nail holes or divots are completely filled.

start with the shortest wall that has an intermediate stile and determine the spacing when it's placed dead center. Then I move to the next longest walls and see if I can create a layout with a similar spacing. This may take some trial and error, and it may be necessary to move obstructions (like electrical boxes) or shift the layout to make it work. On this project, I found the best layout and most consistent spacing came if I moved the outlet box on the wall to the left of the stairway (the wall I started the layout on).

A common adjustment happens where panels wrap around cased windows. Rather than worrying about keeping the panels all the same size, it often looks best to adjust the spacing either to line up the stiles under the window with the casing or to balance them on the center of the window so it looks symmetrical on each side. You can vary your panel spacing a few inches—even on the same wall—before anyone will ever notice, as long as you keep it symmetrical and intentional.

The finished appearance also informs the installation at inside corners. I used to focus on getting all corners perfectly plumb and square, and I would even go so far as to cut out drywall or build up corners with mud or shims. At times I still go to that level of detail, especially if the project or condition calls for it. But for many installations and budgets, I find that within about ⅛ in. of plumb is an acceptable real-world tolerance. I've also learned the hard way that a perfectly plumb wainscoting corner can look out of place when the drywall corner above it isn't plumb.

If an inside corner isn't close to any other reference lines—casings, mainly—and the corner is pretty close to plumb, instead of focusing on getting a perfectly plumb corner, I spend my time achieving a good-fitting scribe where the panels meet. If the scribe is tight, the slight variance in reveal on each side of the corner will never be noticeable.

If an inside or outside corner is close to another vertical line such as a door casing, I make sure the visual line in the corner where the panels meet is the same as that of the edge of the nearby casing. This is important because our eyes, when given something to compare, will pick up and register a divergence between two lines more often than they will register if something is out of plumb. Fit your panels so they look good to the eye, rather than focusing on what the level says.

Over the years, I've found that following these basic rules consistently has made me a better finish carpenter. If you keep refining your creativity and pushing your skill set, keep designs simple and executable, and trust your eye to judge when something looks right in the space, your projects will benefit. If you're new to finish carpentry, following these rules will help you get your first project off the material stack. If you're an experienced finish carpenter, you've likely already arrived at many of these same conclusions through your own work in the field. Still, it's useful to step back from time to time and put those instincts into words. These aren't just principles for getting started; they're habits that lead to consistently well-executed work. □

Grant Baver is *Fine Homebuilding's* associate editor. Photos by the author.

HOUSES

ARCHITECTURAL CHALLENGES AND SOLUTIONS

BY DESIGN

BY LAUREN JONES



A CABIN WITHIN A CABIN

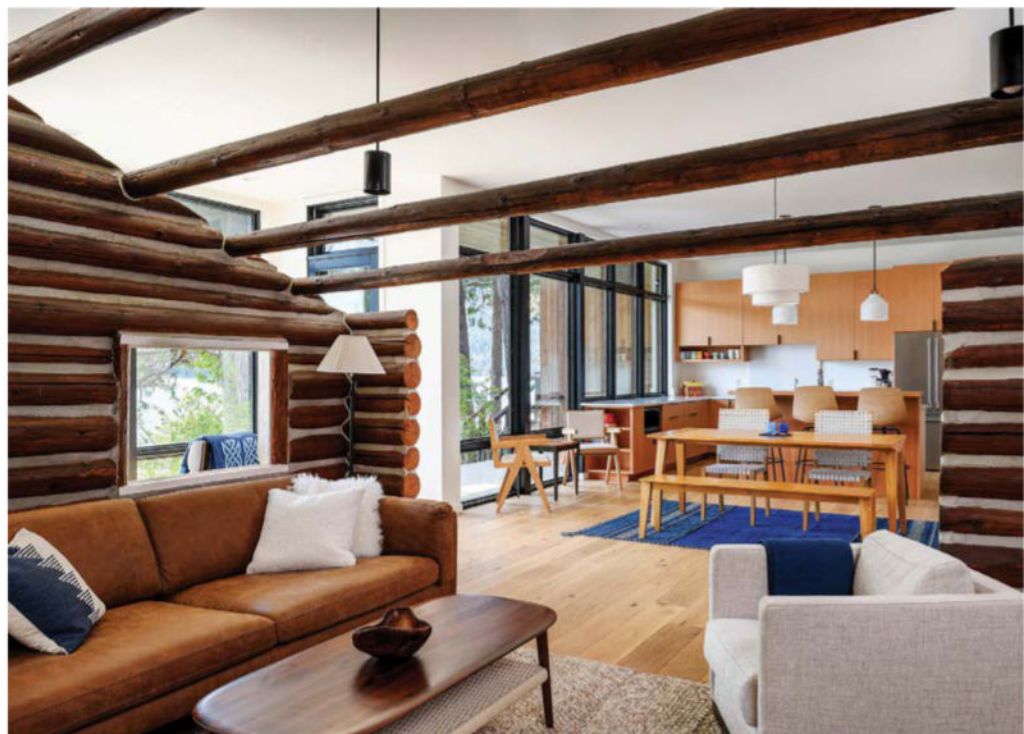
Preserving historic buildings often means accepting their limitations. But for a waterfront retreat on Lake Wenatchee in northern Washington, Leavenworth-based design firm Syndicate Smith saw the constraints of a 1915 log cabin as an opportunity rather than an obstacle. Instead of demolishing the fragile structure, which had received several additions over the years, the architects asked how it could be preserved and remedied for the next generation. Their solution was to build a modern, glass-encased house around the original 16-ft. by 18-ft. cabin.

Working with Timberwood Construction, the team carefully removed the additions and temporarily shored up the cabin. A new concrete raft slab foundation was poured beneath the building before framing began on the new surrounding house. Inside the finished home, the preserved cabin functions as the primary living space. Its compact footprint bisects the kitchen and dining areas, while circulation paths flow past the cabin's stone chimney toward a two-story guest wing. Original chinking—the mortar between the logs—was restored, while salvaged timbers were reused for the front door, cabinetry, and a custom TV enclosure.

Today the project reads like a diorama: a contemporary shell with the original cabin suspended in time, a clever championing of regional vernacular. “It’s like looking into a natural history museum exhibit,” says architect Todd Smith. “You’re simultaneously looking at the cabin and through it to one of the great landscapes of the Pacific Northwest.” Just beyond its preserved walls, a pair of lounge chairs recreate the front porch experience, turning it from an object of observation into one oriented with its setting.



Architect Syndicate Smith, syndicatesmith.com **Builder** Timberwood Construction, timberwoodconst.com
Location Lake Wenatchee, Wash. **Photos** Will Austin



HOUSES

BY DESIGN

CONTINUED





COTTAGE REVIVAL

Maintaining the charm of a compound of quaint 1920s cottages while doing the structural upgrades and energy improvements they desperately needed was the challenge for this Ojai, Calif., remodel project. The fragile cottages had low ceilings, narrow doorways, small windows, and timeworn construction details that required surgical structural repairs that would not disrupt their historic architectural context. Meeting current structural codes meant rebuilding the cottages from the foundation to the roof.

In the living room of one cabin, the ceiling was vaulted to create a more comfortable interior. To better support the roof loads, the 2x4 rafters were doubled up and steel rafter ties were added to keep the walls from spreading. Both details lend appropriate proportions and style to the cabin. In the kitchen, the 3-ft. entry door was widened to 6 ft. The new door pockets into the exterior wall, which required some structural gymnastics, but the effort was worth the payoff of better access and connection to the outdoors. While the original single-pane doors and windows needed to go for the cabin to meet energy-performance requirements, modern products wouldn't meet the architectural goals, so the team designed, engineered, and fabricated new doors and windows that successfully echo the past. The gut rehabs were completed over two years, with Shaker cabinetry, reclaimed barnwood, and appropriate antiques embedding character into the intricate remodels.

The petite cottages, each of which measures under 800 sq. ft., are divided by function. One holds the living room, dining room, kitchen, and powder bath, while the other contains the bedrooms, bathrooms, and laundry. Outside, olive trees, decomposed granite, and a fire pit provide low-maintenance landscaping and easy indoor-outdoor living. Once segmented and cramped, the compound is now livable and with its spirit intact.



Architectural designer Sol Haus Design, solhausdesign.com
Location Ojai, Calif. **Photos** Stephanie Helguera



HOUSE ON THE GREEN

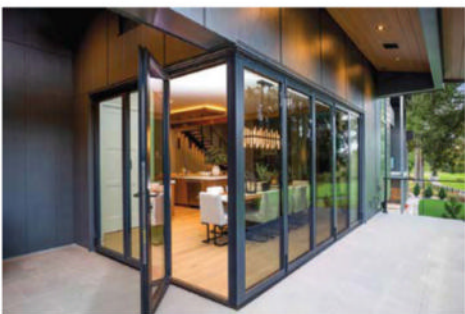
When you build on a golf course overlooking Mt. Hood and Washington State's watchable wildlife, capitalizing on views just makes sense. The Fairway Edge project, a 5445-sq.-ft. home on a fairly small, sloping lot, has a maximized footprint and daylighted basement to take advantage of the topography. It also has 1500 sq. ft. of glass. But for builder Jerud Martin of Urban Northwest Homes, views weren't the only important goal. This house is also designed to be accessible and energy efficient.

There are glass expanses in nearly every space of the home, including lots of floor-to-ceiling windows and skylights. Even in the primary bathroom, where there's a walk-in shower, freestanding tub, and stone pillars, windows balance privacy with diffused daylight. In the dining room, a NanaWall folding-glass wall system makes the corner of the space literally disappear. "There's no post in the corner, so not only do you get that view, but you get this sense of bringing the outside in, as well as the inside out without barriers," says the builder. But that's not all that is impressive about this glass-wall system. It also has a low-profile draining saddle sill with an optional swing door for daily use, details that not only meet universal design standards and are ADA compliant but that also prevent water from seeping in on drizzly Pacific Northwest days.

The home is admittedly an expensive, luxury project, and yet it doesn't ignore the important details that make a home durable, comfortable, and responsible. The project was built to the National Green Building Standard and is certified net-zero energy, with solar power, a smart thermostat, energy-efficient appliances, and bidirectional EV charging that provides whole-home power backup in case of an outage.



Architect/builder Urban Northwest Homes, urbannw.com
Location Camas, Wash. **Photos** Colby Wisen



Ask the

YOUR QUESTIONS // PRO ANSWERS

EXPERTS

Insulating sash-weight pockets

I recently removed 30 double-hung windows from my 1926 home and installed new double-hung replacements. I would like to insulate the empty pockets where the sash weights used to be, but I would rather not remove all the plaster covering each one of the 60 pockets. After removing the trim from around all the windows in preparation to insulate the cavities, I cut back plaster covering one side of one window. That process was time consuming and extremely messy. I know I could use expanding spray foam, but I'm leery of the mess and the risk of the foam finding its way through the mounting screw holes or other gaps in the frames of the new windows. I also thought about cutting 3-in. access holes through the plaster at the top of the pockets and pouring Perlite into the voids. Can you recommend a method to insulate these pockets without having to remove all the plaster?

—BILL R.
Seattle

Editorial advisor Mike Guertin replies: This is familiar territory for me. My great-grandfather and great-uncles founded Darlington Sash and Door, a family shop that made hundreds of double-hung windows for homes built in the Pawtucket, R.I., area from the early 1900s through the 1960s. Double-hung windows made from the 1700s through the 1950s often were designed with counterweights called sash weights, which helped balance the mass of the sashes. The sash weights allowed the windows to be opened with little effort and



FILLED WITH FOAM

One way to insulate sash-weight pockets without cutting back the plaster and lath is to remove the trim, drill a few small holes, and inject low-expansion spray foam into the pocket. Apply a flexible plastic hose on the nose of the foam applicator. Insert the hose through lowest hole until it reaches the bottom of the sash pocket. Slowly withdraw the hose while filling, then repeat with each higher hole until the pocket is fully filled.

stay in place at any height without slamming shut. The sash weights were hidden in a hollow space between the rough-opening framing and the window jamb. When installing replacement windows, only the existing sashes are removed, which leaves the sash-weight pockets in place.

There are many ways to insulate and air-seal old sash-weight pockets. The greater

your access, the better the options. Cutting back the lath and plaster to access the sash pockets is messy, but doing so allows you the best options for insulating and air-sealing the cavity. For instance, you could cut, cobble, and caulk pieces of rigid foam to fill the spaces, or stuff the spaces with batt insulation after caulking gaps in the sheathing, framing, and window jamb. Cut-

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ting back the plaster also gives you access to apply one- or two-part spray foam to fill the cavities, or to use some combination of these methods.

Even without cutting back the plaster, don't count out the spray-foam option. With careful application, it's not a messy process. You can drill $\frac{3}{8}$ -in. to $\frac{3}{4}$ -in. holes into the cavity through the plaster and lath every 12 in., then inject one-part spray foam into the holes. For this task, use a professional foam gun with low-expansion foam and a flexible plastic hose extension. Starting at the bottom hole, insert the hose until it reaches the bottom of the cavity, then slowly withdraw it while injecting the foam. Have a rag handy to wipe off the hose before inserting it into the next hole up, and repeat. Low-expansion foam is unlikely to ooze out of small holes and gaps. But just in case, keep a spray bottle of water handy and mist any foam that happens to seep out of larger gaps. One-part spray foam is moisture-cured and the mist causes the foam to crust over and reduce further oozing. If any foam does ooze out, let it cure and cut it off with a knife or scraper. This method provides the best balance between the benefits and the mess.

Your idea of pouring Perlite into the cavities through access holes could work, but it's likely the least effective and worthwhile option. Perlite is a granular material often used to insulate the open cores of CMU walls. It has a lower R-value than batt insulation or foam products, and it won't block air movement. The biggest challenge will be pouring the material into the cavities without making a mess. If you go this route, I suggest cobbling together a hopper and funnel out of plastic or thin sheet metal. Perlite contains a minimal amount of silica, so make sure to wear a dust mask when doing the work. Perlite will settle over time if it's not consolidated, but you can help by tapping on a block of wood placed against the wall. Move the block up and down over the cavity area while tapping it with a hammer. Once you've topped off the Perlite through the hole and it no longer settles with tapping, you can fill the small space remaining with some fiber-batt insulation or a little spray foam.

Door-gap dilemma

I am installing new prehung interior doors in my not-so-well-built 1970s home. When

evaluating my door openings for plumb and level, I found that my floor is often not level from one side to the other, with some places off as much as $\frac{3}{8}$ in. With the new door frame installed properly plumb and level, should I cut the door bottom square, or scribe it to have a consistent gap to the hardwood floor when the door is in the closed position?

—JIM H.
Westwood, N.J.

Associate editor Grant Barver replies: Often in old houses we are forced to make choices and compromises so that not-so-perfect situations look good. When faced with a decision like this, first consider how often the door is viewed and from what angle. For instance, if it's a door in the living room that is seen from chair level all the time, an uneven bottom gap might be more noticeable than if it were a hallway door. I'd also suggest looking at the original doors for guidance. Were they scribed, or were they hung straight? And did you ever notice?

A second factor in deciding whether to scribe the door bottom or cut it square is personal preference. Some people are sensitive to seeing an uneven gap at the bottom of the door, and some aren't. Personally, I notice the tightness and consistency of the reveals around a door long before I ever

look at the gap on the bottom. Even as a picky carpenter, I can't remember a time when I noticed that the bottom of a door was crooked, unless the door was not operating properly.

If you are leaning toward scribing the bottom of the door to match the slope when closed, you should first look at all points through the swing arc. If you scribe a door and the hinges are on the high side, the strike side of the door may drag when it's swung open. Conversely, if you scribe a door and the hinges are on the low side, it may leave an unsightly gap at the bottom when opened.

In your case, I recommend starting by hanging the door with a square-cut bottom, leaving about $\frac{1}{4}$ in. to $\frac{3}{8}$ in. between the high point of the floor and the bottom of the door. This limits the largest portion of the gap under the door to $\frac{3}{4}$ in. Then I suggest living with this setup for a while to see if the uneven gap is noticeable and bothersome. If it is, the next step is to scribe a line across the bottom of the door using either a piece of scrap or scribes that correspond to the largest point of the gap. Remove the door and use a track saw or circular saw with a straightedge to cut the taper on the bottom of the door. Hang the door again after cleaning up the cut edges with a light hand-sanding.



SQUARE-CUT OR SCRIBED TO FIT? Whether you're trimming a door bottom straight or cutting a taper to maintain a consistent gap between a new door and an old floor, a track saw is the perfect tool for creating straight and accurate cuts.

Tech-tooling up

When I moved out on my own a few days after my 18th birthday, I brought along a small collection of hand tools. I also brought a laptop. Growing up with five siblings, I was the handy one who fixed the garbage disposal, painted the deck, and repaired the gate. I was also the techie who retrieved the “lost” file, configured the software, and figured out why the printer wasn’t working. I like knowing how things work and improving them, in both the real and digital worlds.

We work in one of the few industries that allows us to point to something tangible at the end of a workday: a wired-up sub-panel or a built-in that fits the space just right. But technology is becoming part of our everyday work. The software programs we use to look at construction drawings, track budgets, and map out schedules on phones, tablets, and laptops are increasingly common on jobsites.

Many people grow up with a hodgepodge of tools inherited from a grandparent or picked up at garage sales. Builders often do the same with tech tools, tossing this calendar app and that file-sharing program into their toolbox willy-nilly. But your projects will run more smoothly if you have an intentional collection of tech tools that suit the work you do. For instance, if you’re a two-person tiling crew, you’re going to keep different hand and power tools

in your van than your colleague who runs a 36-person electrical company. Similarly, you may need just a few basic digital tools—email, a calendar, and a file-sharing program—to keep everything running smoothly. But your friend’s electrical

company may need a whole suite of tech tools to keep track of where each crew needs to be each day as well as all the plans, estimates, and invoices for the current jobs.

I’ve worked with a lot of companies in the design-build

world and used a lot of different tech tools, from simple task lists to full construction-management suites. I’ve learned that having the right tech tools is critical for productivity. In my role as a project manager at HELM Construction

THE STARTER TOOLKIT COMMUNICATION AND FINANCES

The basic tools are those that facilitate communication and track finances. Whether your company is large or small, it’s a good idea to set up your communications systems first because everything else will likely rely on them.

EMAIL

Gmail is ubiquitous because it’s user-friendly and integrates easily with some of the third-party apps discussed below. You can set away messages, filter emails into client folders, and set up branded signatures. My favorite feature is the “snooze” button, which reminds you to follow up on messages.

I recommend starting a Google Workspace account with company-domain emails for each team member. There is a small monthly fee per user, but you can manage accounts centrally, which is vital for accessing employee communications. Gmail does offer free accounts, but switching later costs more in hassle and headaches.

PHONE

You can keep employees’ work and personal lives separate by providing a company cell phone, but a more affordable option is to set up a work number through an app such as Google Voice, OpenPhone, Grasshopper, or RingCentral, which forward calls to personal phones. This allows team members to turn on notifications only during work hours. Some apps offer free versions for basic calling and texting, while paid plans add features like shared lines and call routing.

INTERNAL COMMUNICATIONS

A chat platform comes in handy because, unlike text chains, shared “threads” keep you organized by team, client, and project, allowing you to share information quickly and easily. I’m a fan of Google Chat; other options include Slack and Microsoft Teams. Basic versions are often free, while paid plans add features like message history, integrations, and admin controls.

VIDEO MEETINGS

Video calling is now essential for client and team meetings. Zoom is my favorite app because it includes on-screen annotation and superior noise cancellation, though some advanced features require a paid plan. Google Meet is also popular and is included as part of a Workspace account.

FINANCIAL MANAGEMENT

Beyond handling taxes and invoicing, financial software can generate reports that help guide smarter business decisions. While there are construction-specific bookkeeping options, QuickBooks Online (QBO) is the go-to for small businesses. It’s a subscription-based tool, with costs increasing as you add users and features. For detailed job-cost

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Solutions, I bring these perspectives to my work with clients. Here, I've included some of my most frequent tech tool recommendations.

Several of my top picks are part of the Google suite. That's not because I have any loyalty to Google, but because Google Workspace is like a 6-in-1 screwdriver. It doesn't ratchet and the grip isn't ergonomic, but it's versatile enough to meet a variety of needs. Google Workspace offers basic, functional software that has become as ubiquitous as that screwdriver in the kitchen drawer.

There are also several all-in-one construction suites that specialize in building, including Procore, Buildertrend, and JobTread. These programs enable builders to keep most of their tech tools—from submittals to estimates and from plans to meeting notes—inside one platform. Think of these construction suites like a kit of Makita power tools. They're more powerful and specialized, enabling you to do better work with less effort. Even better, they're compatible with other tools in the kit (like those interchangeable batteries).

Unfortunately, they don't do everything equally well, and pricing varies based on seats or sales volume. For smaller construction firms, starting out with Google Workspace and supplementing with additional tech tools a la carte is likely more cost-effective. As your company grows, you might upgrade to a construction-specific software. In the meantime, these suggestions will help you get digitally tooling up.

Lina Menard is a project manager at HELM Construction Solutions.

accounting, pairing QBO with construction-specific software like Buildertrend or JobTread allows you to track spending during different project phases and identify scopes of work that you've been underestimating.

TIME TRACKING

Everyone wants to get paid, so a time-tracking program is essential. These tools include features like geofencing (to ensure the field crew clocks in on-site) and idle detection (to confirm office staff are working on the right tasks). Time tracking isn't about

micromanagement; it's about determining true costs for more accurate estimates.

Choose user-friendly software that integrates with your financial systems. I prefer Harvest because it's intuitive and allows you to track against budgets. Other options include QuickBooks Time (formerly TSheets), BusyBusy, Clock Shark, and Toggl. Some have free options, but paid plans offer features like integrations, reporting, and team management. Whichever you choose, track time for each scope of work, which informs future estimating and financial forecasting.

ADDING TO THE TOOLKIT COLLABORATION AND PRODUCTIVITY

As your company grows, more advanced digital tools keep your team organized and up-to-date. Many of these tools offer free versions, with paid plans adding the most useful features.

CALENDARING

We all need to prioritize time, schedule meetings, and assign team members to projects. Google Calendar is free with any Google account and works well for small teams to plan meetings and block out time away. Google Workspace adds shared calendars and appointment slots, making it easier to manage multiple users and projects.

FILE STORAGE AND SHARING

The file-sharing goal is simple: Give everyone access to the latest plans, estimates, and schedules. There are various programs for this task, including Dropbox, Box, and OneDrive, but Google Drive is my favorite because of the integrations across Google Workspace.

SPREADSHEETS

For everything from project budgets to window schedules, a spreadsheet can save your sanity. While Google Sheets covers basic needs, Smartsheet is a game-changer. It lets you "roll up" information—for example, lumber takeoffs can roll up to the division level so your client sees just the rough-carpentry budget while you see a line item for each window header. It's also built for scheduling, with Gantt charts to visualize timelines, dependencies to show which tasks rely on others, and critical paths to highlight the tasks that determine the project's finish date. Smartsheet features make it easy to gather or share information and track project progress.

TASK MANAGEMENT

Many design-build companies have project checklists that include the right steps in the right order. Setting these up in a shared task-management system to use consistently helps you replicate what works and stop repeating costly mistakes. You can always remove tasks not required for a specific project, but the checklist catches things you tend to forget—like doorbells!

Your software should be scaled to your company's needs: robust enough to prioritize and assign, but not overwhelmingly complex. My favorite is Todoist. Google Tasks is a basic alternative, Trello offers a visual interface, and Asana facilitates full project management.

MARKUPS AND TAKE-OFFS

Bluebeam Revu is handy for marking up drawings and doing take-offs. You can import a set of plans and annotate them digitally, and you can use the count tool during estimating to tally windows, door hardware, and other components. Once the drawings are calibrated to scale, you can measure the length and height of walls and the area of rooms, making them more useful in the field than multiple paper plans. Revu has been discontinued for Mac, so Apple users will need to run Parallels, which lets you run Windows applications. Alternatives like Plangrid and STACK offer similar features for markups and takeoffs and work on both Mac and Windows systems.



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KeepCraftAlive

CELEBRATING PASSION FOR BUILDING

Dan Palmer turned a lifelong interest in art and a degree in environmental sciences into Palmer Woodcraft, a business specializing in custom, high-performance windows and doors.

What began as a temporary carpentry job after college quickly became something more. Dan loved the creative process and began to see carpentry as his calling. The builder he worked for was on the cutting edge—for the late '90s—of building science, which helped him envision a career path that blended craftsmanship with environmental responsibility.

After traveling for a couple years through Australia, New Zealand, and Asia—picking up carpentry work along the way—Dan returned to the U.S. He worked briefly as a finish carpenter on the Oregon coast before moving to Portland, where he spent more than 15 years with eco-conscious builder Hammer & Hand, helping to found and manage its custom workshop. Over time his focus shifted to windows and doors. He learned by trial and error, taking apart the worst-performing windows and doors on projects and dissecting them to better understand their failures and to improve them.

Although his work approached the high-performance standards of European models, Dan was limited by the hardware available in the U.S. That changed after a client challenged him to reach passive house levels of performance. He toured several European workshops, connecting with suppliers who could provide the hardware and gasketing he'd been missing. With access to these components—and upgraded European machinery and tooling—he began producing windows and doors that rivaled top European units.

"I could get close before," he recalls, "but this finally let me match what was available in Europe, with an aesthetic tailored to North America."

In 2021, Dan moved back to New York and founded Palmer Woodcraft. Today he focuses on high-performance windows and doors, often for historic homes. From the outside, the designs faithfully replicate the original details, while beneath the surface they incorporate advanced performance features like triple seals. "It's a combination of art and science that I really appreciate," he says. —Jennifer Morris, editorial assistant

**"There's an
environmental ethos
to building something
made to last."**

DAN PALMER
WINDOW AND DOOR BUILDER
TRUMANSBURG, N.Y.



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