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On the cover: David Villatora, of Stonework by Santo in Potomac, Md., reinstalls stone veneer after applying proper water-management layering and through-wall flashings on a Washington, D.C.-area home. See the story on page 29. Photo by Doug Horgan.

FEATURES

DEPARTMENTS

THE JOURNAL OF LIGHT CONSTRUCTION (ISSN 1056-828X), Volume 40, Number 5, is published monthly except combined issues in Jan/Feb, July/Aug, Sept/Oct and Nov/Dec by Zonda Media, 1152 15th St. NW, Suite 850, Washington, DC 20005. Annual subscription rate for qualified readers in the construction trades: $39.95; nonqualified annual subscription rate: $59.95. Frequency of all magazines subject to change without notice. Double issues may be published, which count as 2 issues. Publisher reserves the right to determine recipient qualification. Canada Post Registration #40612608/G.S.T. number: R-120931738. Canadian return address: IMEX, PO Box 25542, London, ON N6C 6B2. Periodicals postage paid at Washington, DC, and at additional mailing offices. POSTMASTER: Send address changes to JLC, Box 3530 Northbrook IL 60065-3530.

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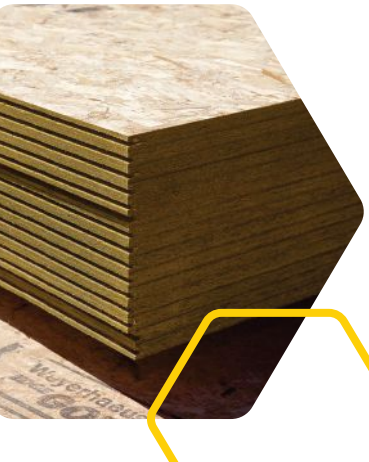

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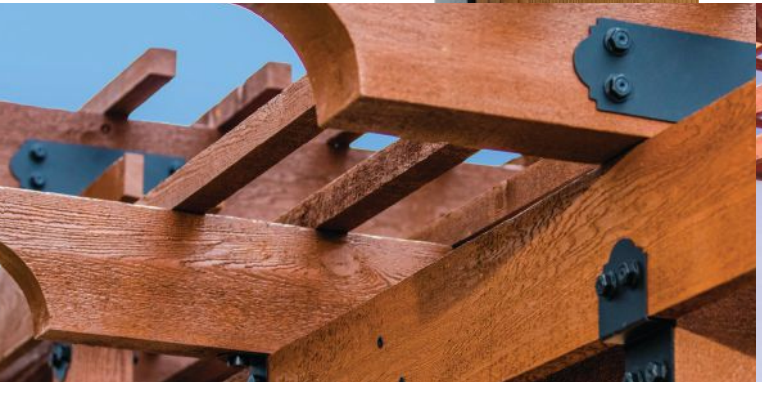

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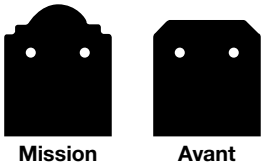

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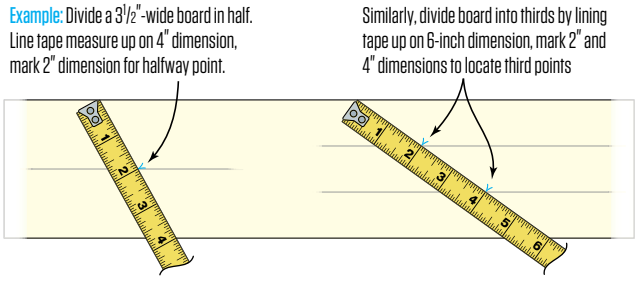
BY JLC STAFF

Geometry for Carpenters

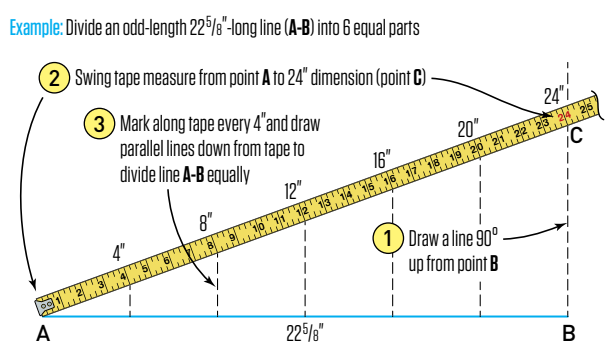
Math is fundamental to building. And while there is no escaping the need to be proficient with numbers and algebra, learning some geometry can go a long way in helping carpenters be more efficient. In this article, we'll introduce a few methods for dividing, measuring, and laying out shapes that can save time and take some of the head scratching out of many layout jobs.

The first principle we'll address is the idea of using a scale of known increments (a tape measure) to divide a line or area. In the first two examples below, we don't need to know the width of the board we want to divide, or make any calculations. We simply hold the end of tape along one edge and run it out to the opposite edge. The distance and angle of the tape don't matter, as long as we align the opposite edge with a number on the tape that we can easily divide by 2 or 3 (or any divisor we want). This same concept can be used to divide an uneven distance into a number of equal segments without having to pull out a calculator. And the idea of marking off even segments can be useful when laying out various curves, as shown in the examples at right.

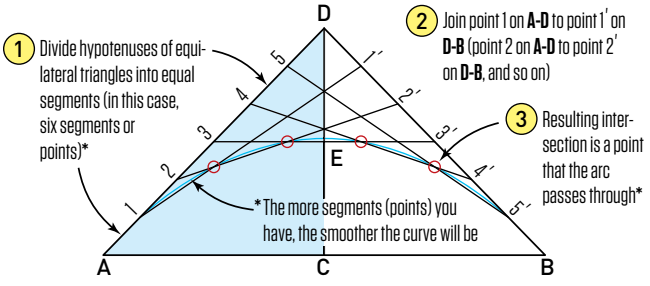
Dividing a Board



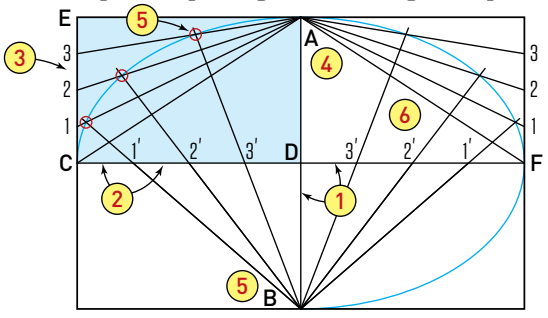
Dividing a Line



Making an Arch (Straight-line Method)

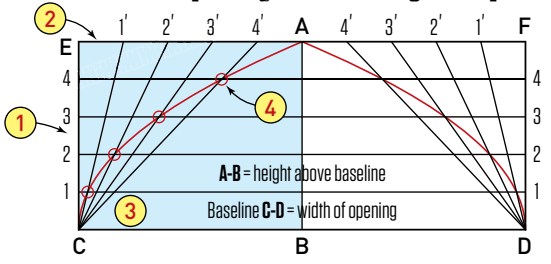


Elliptical Opening in a Rectangular Space



1. Draw the lines **A-B** and **C-F**. **2.** From the center **D**, divide **C-D** into any number of equal segments (say 4) at 1', 2', and 3'. **3.** Divide **C-E** into the same number of equal segments at 1, 2, and 3. **4.** Join point **A** with points 1, 2, and 3. **5.** Join point **B** with points 1', 2', and 3'. The resulting intersections are the points that the ellipse passes through. **6.** Repeat the steps above for each quadrant (only two for an arch, or all four for a full ellipse).

Parabolic Opening in a Rectangular Space

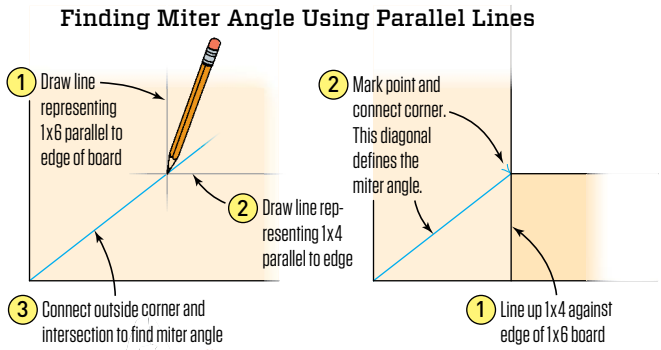


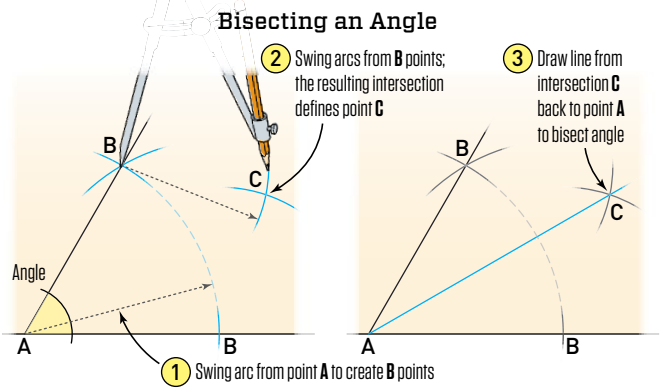
1. Divide the height of the rectangle into equal segments (in this case, 5 segments), and draw parallel horizontal lines dividing the rectangle. **2.** Divide the length of the rectangle in half, and divide each half into the same number of segments as the height. **3.** Project lines from ends of the baseline to each of the points dividing the length of the rectangle (1', 2', and so on). **4.** The intersection of these projections with the parallel divisions of the rectangle define a parabolic curve in each half of the rectangle.

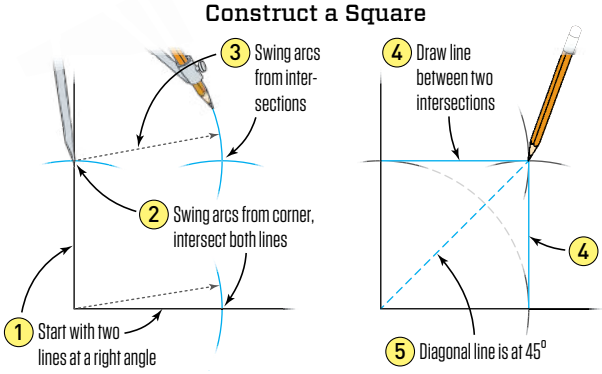
Illustrations by Tim Healey

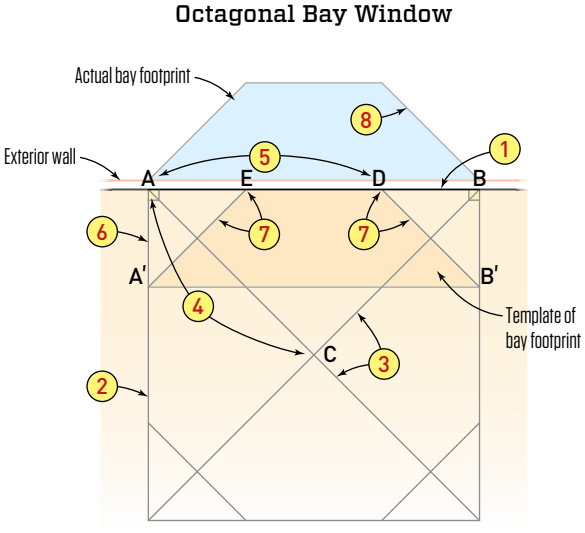
Angles are fundamental to joinery. Most of the time, we are dealing with right angles (90 degrees) and regular miters (45 degrees). What happens when we encounter other angles? Our inclination is to measure that angle in degrees somehow (with an electronic angle finder or a protractor, for example) because the table on a miter saw is set up with degree adjustments. However, a lot of times we don't need to know the numbers. The miter for joining boards of unequal width, for example, is an acute angle less than 45 degrees, which we can lay out using parallel lines, as shown at right. Once we understand this idea, we can just measure the width of one meeting board off the end of the other and join the diagonal.

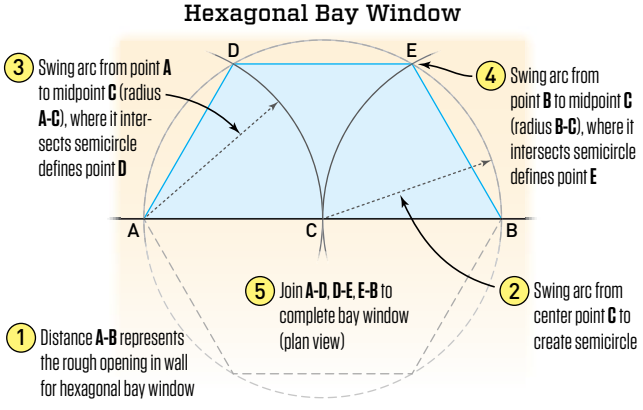
Or we can lay out any angle using a compass and a straightedge to bisect the angle. If we do this on a scrap piece of wood, we can cut the angle we've drawn by aligning it with the blade on our miter saw—no numbers needed. The same concept of swinging an arc (either with a compass or with a tape measure) can also be used to lay out different shapes, such as a square, a hexagon, or an octagon, as shown below.











1. **A-B** is our interior wall line where we'll set a bay window
2. Draw a square with sides equal to **A-B**.
3. Draw the diagonals to locate the center of the square, **C**.
4. Measure the length from the center to one corner of the square (equal to **A-C**).
5. Measure this "half diagonal" distance from each end of the wall line (from left, **A-D**, from right **B-E**).
6. Define the rectangle **A-B-B′-A′** with the short side equal to **A-A′**.
7. From the corners **A′** and **B′** connect the diagonal to points **E** and **D**. The section **A′-E-D-B′** defines the template for the bay window.
8. Use template to define the footprint of bay window on the exterior of wall **A-B**.

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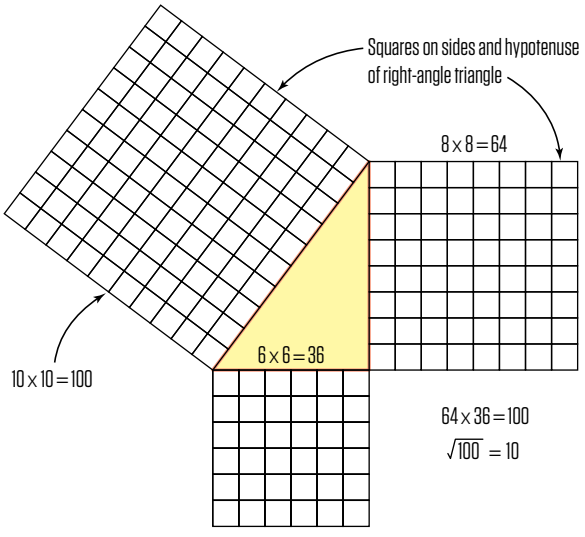
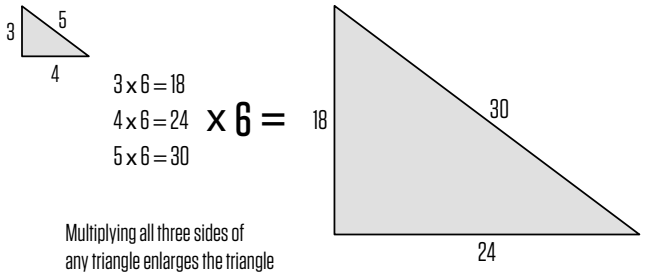
Leveraging the Pythagorean theorem. When we frame roofs or square large areas like a floor frame or lay out plates in preparation to stand walls, we can't avoid the Pythagorean theorem: $a^2 + b^2 = c^2$. If the abstract nature of this formula makes you nervous, it may be helpful to see the equation spelled out in geometric form, as shown at right. (This visual explanation also gives us a construction of the square root function that maps the area of a square to its side length.) The example shown here is a 6-8-10 right triangle—a larger form of the all-powerful 3-4-5 right triangle; if one leg of a triangle measures 3 and the other 4, we know by the Pythagorean theorem that the diagonal measurement will be 5. But we don't have to calculate this. Rather, we can use these dimensions as a check for square for any right angle: By measuring out one side equal to 3 units (inches, feet, anything) and the other side equal to 4 units, we know the hypotenuse connecting these sides will equal 5 units—or any multiple of 3-4-5: 6-8-10, 9-12-15, 12-16-20, and so on. When you're squaring a floor or a foundation (see example, below), it's always most accurate to use the largest multiple for the walls that you are laying out.

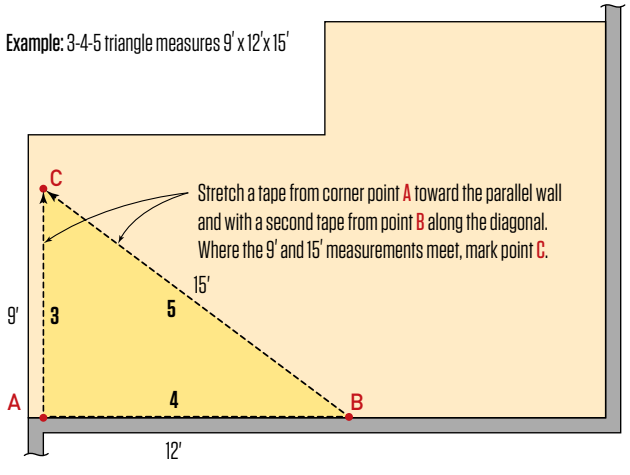
Additionally, the Pythagorean theorem relates to more than roof framing and right-angle layout; it can also be used to define the ellipse created where a vent pipe passes through a sloped roof. When the roof deck is part of the air barrier, we want to create a hole for the vent that can be tightly sealed.

Pythagorean Theorem Explained

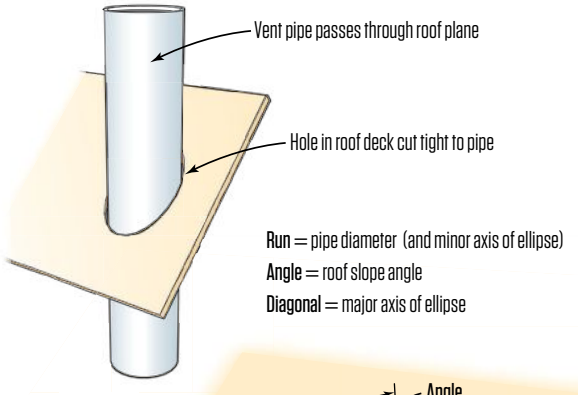


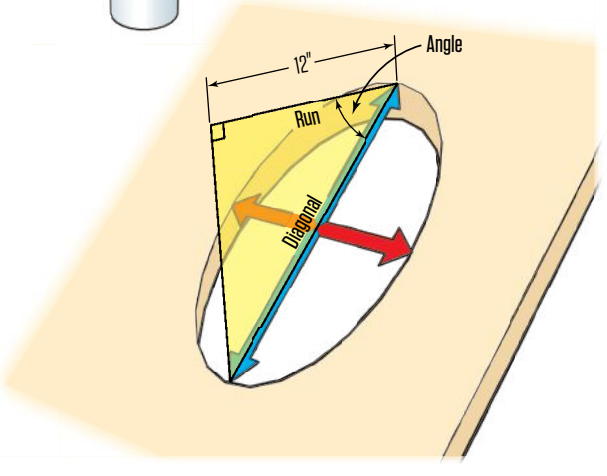
3-4-5 Triangle





Intersection of Pipe Through Roof





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Q Should interior doors be installed before or after the finish flooring is installed?

A *Nathan Nebbia, owner of Built Better by Nate, based in Berwick, Maine, responds*: We have installed prehung interior door units both ways—before the finish flooring is installed and after. Doing it before is easier for the door installer, but that can lead to problems installing the floor.

When the doors are installed before the flooring, we usually undercut the jambs with a Japanese pull saw, laying the saw on a scrap piece of flooring. This results in an undercut of the jamb with the thickness of the saw blade taken out of it. If the flooring material running through the doorway is all the same height, you're in the clear to make that cut all the way across the jamb. It sounds simple enough to do, but I've seen some pretty sad attempts at it. It gets much harder if there are flooring transitions occurring in the doorway (hardwood transitioning to tile, for example). If the meeting floors are different in height, you have to cut the jamb at one height from one side and make a cut at the other height from the other side. And installing the floor gets tricky because you have to get it underneath the jambs. Using a threshold can help, but that's not always what the architect or owner wants.

When I'm the one who's doing everything, I install the floors first, when nothing is in my way. After that's done, I scribe the door jambs to the floor. This adds some extra steps to the door install, but they are minimal, and it's much easier to define the height of the gap you want under the door. I like to go with a 1/2-inch gap, but sometimes that's not large enough if there will be rugs on the floor. When I know the gap size, I mark it on the jamb below the door on the hinge side **(1)**. Then I pull the hinge pins and detach the door so I can work the jamb.

Often, you need to cut the jamb down in length so the jamb can be stood in the doorway for scribing. I make all jamb cuts using a miter saw on the floor **(2)**. Without the door, the jamb legs will flop around, so I attach a temporary stretcher 12 inches up from the bottom. Note in the photo below I am using a framing square as my stretcher—a fast solution that works for a 2'-0" door.

Before I do any cutting, I find the difference in level on the floor. (I use a laser, as it works with any size opening and helps to align multiple doors where trim runs together). With the hinge side as the high point, I cut the leg, leaving it as long as I can while still allowing the jamb to fit in the rough opening. With the jamb in the RO, and the head checked for level, I set scribes to the mark made on the hinge side **(3)** and scribe both legs before making the final cuts.

When installing the jamb, I always set the head of the jamb flush with the drywall on both sides. If the wall is out of plumb, the legs will be out of alignment with the wall, but that problem is easier to hide with the casings

Photos by Nathan Nebbia

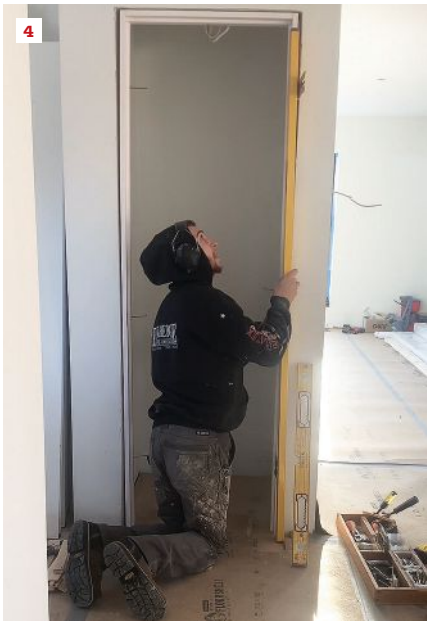
than trying to fix it at the head. We use ball-bearing hinges, and ghost doors result when they are the slightest bit out of plumb.

Once the hinge side is screwed in plumb both ways **(4, 5)**, I add structural screws behind the hinges to take the weight of the door, then I hang the door again **(6)**.

Next, I shut the door to the latch side of the jamb and align the top with the drywall, keeping an even reveal (the gap between the door and the jamb), then shim and screw it **(7)**.

Make sure the door hits against the stops consistently from top to bottom. Once it does, shim and screw the bottom, leaving the proper reveal.

I then shim behind the strike plate until the gap is correct. You might need to shim in some more spots to keep a nice, even reveal all around the door. Just make sure to add a screw to keep all the shims in place. Finally, I shim and screw the head jamb to keep it from sagging **(8, 9)**.



Q Standard-width batts don't fit in I-joist floors or steel-stud walls. How should these be insulated?

A *Nathan Shirai, principal of Insulation Unlimited, based in Chattanooga, Tenn., responds:* I-joists? Steel studs? 19.2-inch framing layout? Fear not! There's a batt for that.

Judging by what's available off the shelf in the big box stores, and even most lumberyards, you can easily get the impression that batt insulation is available only in 15- and 23-inch widths. And before the proliferation of framing products like I-joists, metal studs, and open web trusses, that's all anyone would have needed. Nowadays, we might encounter cavity widths of 10 1/2, 12, 14 1/2, 16, 19, and 22 1/2 inches, sometimes all in the same house. But the insulation manufacturers have adapted to evolutions in framing over the years and now offer batts in many widths for various applications.

We're all familiar with standard 2-by framing on 16- and 24-inch layouts, and the associated 15 1/4- and 23-inch-wide batts that friction fit in cavities of those sizes. Every now and then, you might run into 12-inch layout, and there are 11-inch-wide batts available that prevent the need to rip a 23-inch batt in half.

Floor, ceiling, and roof assemblies using I-joists might pose concern for the conscientious builder who wants a "Grade 1" job (no voids, gaps, or compression) but may not have the budget for anything more than the humble fiberglass batt. There's no need for concern, though. Batts are available in full 16- and 24-inch widths that fill the additional space created by the narrower OSB web of an I-joist on standard layout—no need to rip down a 23-inch batt for a 16-inch-wide cavity and waste the offcut, or crosscut a regular piece into 16-inch lengths that you then painstakingly cobble into the run sideways to fill the width. Putting a 15 1/4-inch-wide batt between those I-joists is simply not an option because the gap that results will allow air movement beside the batt that can reduce its effectiveness by a staggering degree.

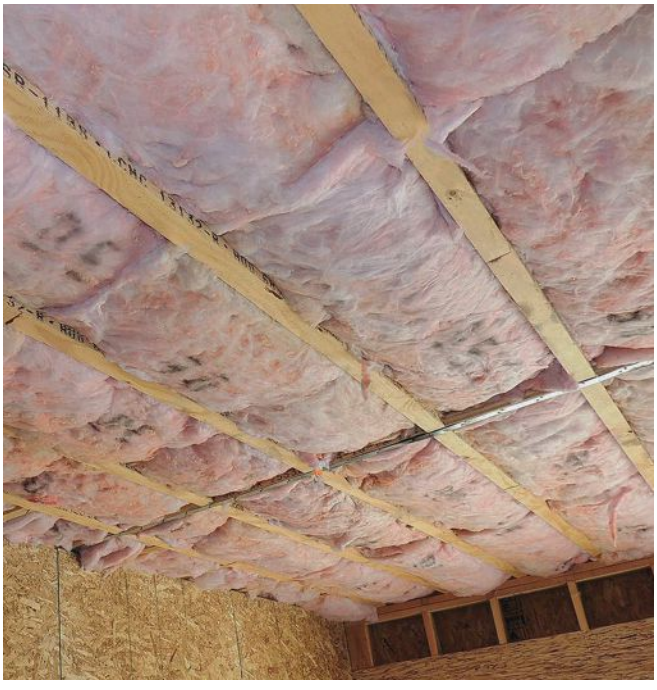
Sometimes, you might see I-joists on 19.2-inch layout (an even division of 96 inches—the length of OSB and plywood panels). There's a batt for that too. Most floor and ceiling batts (R19, R30, R38, etc.) are available in a 19-inch width that fills this cavity perfectly.

A loose-fill approach, such as dense-packed cellulose or fiberglass BIBS (blow-in blanket system), or spray polyurethane foam, will, of course, result in a more perfect fill around the irregular profile where the I-joist chord meets the web that translates into better performance. But when budget constraints eliminate those options, the full 16-, 19-, and 24-inch-wide batts can make for a correct and convenient installation with minimal compromise in performance.

The 16- and 24-inch-wide batts are technically manufactured for metal studs so that the extra inch of width can fill into the C-shaped profile without leaving a gap. It's critical to mention that if you are insulating for thermal control, cavity insulation by itself is almost pointless without an exterior thermal break for steel metal framing. Most metal stud applications are found in commercial projects where sound attenuation, not thermal protection, is the goal.

All in all, fiberglass insulation is available in sizes including 11-, 12-, 15 1/4-, 16-, 19-, 23-, and 24-inch-wide batts. The variety of offerings can vary slightly from manufacturer to manufacturer. For example, not all R-values are available in all widths, and vice-versa. The higher-density batts (R15 as opposed to R13, for example) tend not to have as many options compared with standard-density batts. As an insulation contractor, I am able to order the most commonly used R-values in just about any width required from my distributor, and often help supply small quantities for local builders and remodelers who may have a project too small to justify subcontracting the insulation work.

If you're having trouble finding the size batt you need for an unusual framing cavity in a small project, try reaching out to a local insulation contractor. If you're subcontracting the insulation work, ask your contractor how they plan to handle areas where unusual-size material may be needed, and always insist on a proper "Grade 1" cavity fill.

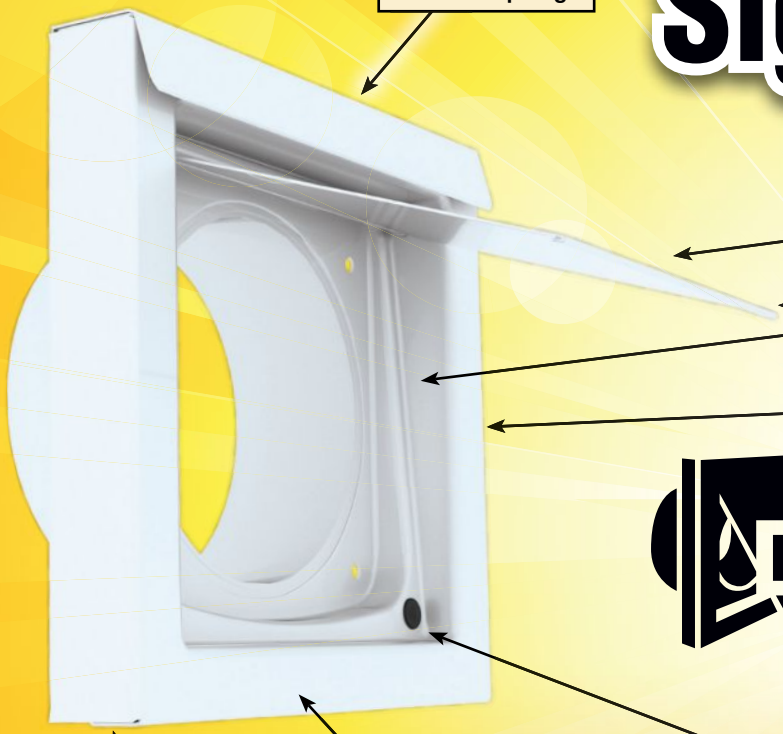


Use full-width batts for insulating between I joists.

Photo: Steve Easley & Associates

Upon Closer Inspection Excellence Stands Out

Sight To See



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Installing a Pocket Door

BY EMANUEL SILVA

Because a pocket door disappears into the wall instead of swinging into the path of travel, it can often solve awkward design problems, as it did in the basement renovation project I completed recently in a home in Reading, Mass. With the basement's long hallway and doors providing access to a laundry room, a garage, a staircase to the main level, and the living area shown in this article, pocket doors were a good fit.

I've installed dozens of pocket-door kits over the years, including Johnson's heavy-duty, commercial-grade frame (the one shown here). But kits change as manufacturers tweak their products, so I carefully read the installation instructions for every kit I install. To re-familiarize myself with how everything fits together and figure out what I'll need from the lumberyard, I start by unpacking and laying out all the kit parts and fasteners.

In new construction, floors and ceilings are usually level, which makes framing a square, plumb, and level rough opening straightforward. In a renovation, floors and ceilings are rarely level and walls rarely plumb. On this project, the basement floor had been covered by a carpet over a pad that concealed the waviness of the slab. And because the ceiling drywall had been fastened to the floor joists instead of to furring strips, the ceiling was a little wavy too.

Renovation plans called for new, vinyl plank flooring after the existing carpet had been removed. Over old concrete slabs, I usually install pressure-treated 2x4 sleepers—which are easy to shim over low spots—followed by 3/4-inch plywood subfloor sheathing. To gain a little headroom, I installed thinner-profile 2-by-2-foot Dricore panels over the slab, followed by 1/2-inch AC plywood sheathing to make the subfloor feel more solid and provide a smooth substrate for the click-lock vinyl flooring. The thickness of the panels (and the shims needed to level them) along with the sheathing had to be accounted for when I established the height of the header for the new door.

As I framed the rough opening in the new 2x4 wall separating the living area from the hallway, I used a laser level to establish a benchmark elevation for setting the door header and aligning the heights of my new door openings with the existing ones. Following the instructions that came with the kit, I added 4 1/2 inches to the height of the door (80 inches) to establish the minimum height of the header. Then it was time to tackle the installation of the frame for the 2'-8" x 8'-0" solid-core door.

Contributing editor Emanuel Silva owns Silva Lightning Builders in North Andover, Mass.

Photos by Emanuel Silva

Following the frame manufacturer's installation instructions, the author framed the new pocket door's rough opening so that the width was equal to twice the door width (2 x 32 inches) plus 1 inch, and the height at least 84 1/2 inches (the height of the door plus 4 1/2 inches). Visible in the background is another recently framed pocket door leading from the basement hallway into a laundry room **(1)**. A pocket-door kit typically includes a frame header assembly, split steel studs, door hangers, and all other components needed to assemble the frame **(2)**.


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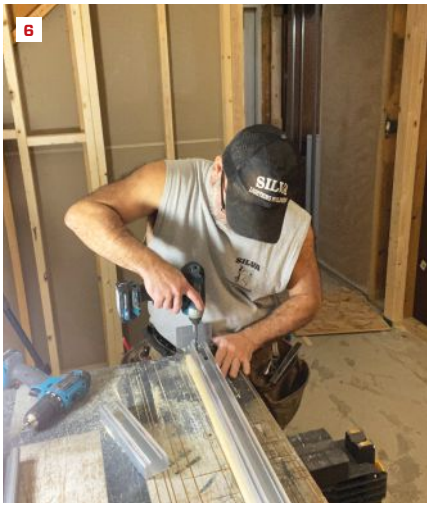
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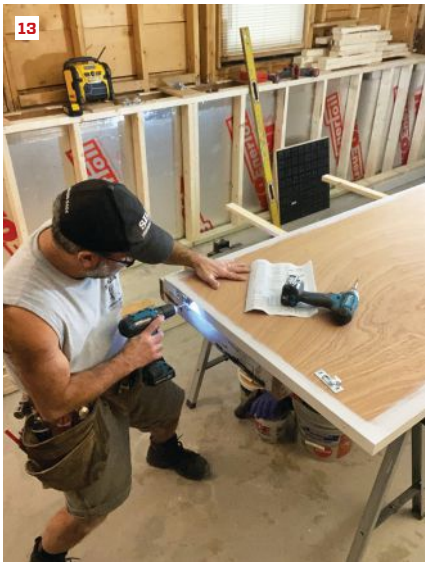
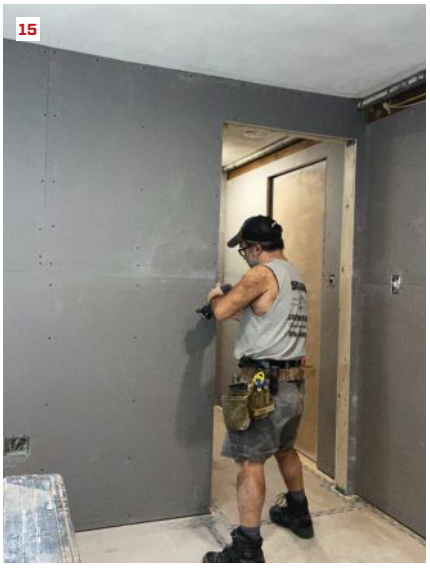
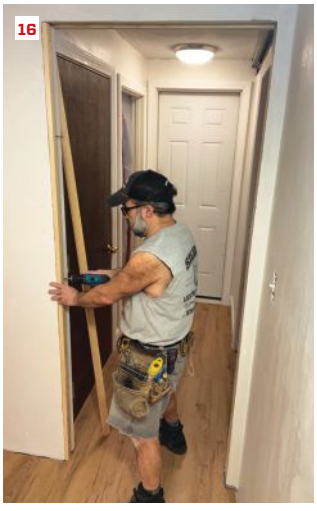
To help locate the frame header brackets, the author partially nailed a flat-head nail into each trimmer on either side of the opening so that the nails were 80 3/4 inches above the finish floor and centered on the trimmers. The nail heads were left proud by about 1/8 inch so that the end brackets of the frame header could slip over the nails **(3)**. Because a subfloor will be installed over the concrete slab basement floor, the author set up a laser line to establish a benchmark elevation. This frame was sized for a 3'-0" x 6'-8" door, so the author had to cut the frame header to fit the narrower, 2'-8" x 6'-8" door used on this project. He started by unscrewing an end bracket **(4)**, then he carefully cut the track to length, first cutting the wood header, then flipping the assembly over and cutting the metal track 1 3/8 inches shorter than the wood header **(5)**. Finally, he re-fastened the bracket to the track **(6)**. The frame-header end brackets have slots that allow them to slide down over the nail heads, making it easier to accurately locate the frame header **(7)**. After making final adjustments so that the frame header would be perfectly level, the author fastened the brackets to the trimmers with screws supplied by the manufacturer **(8)**. Next, he inserted a floor plate into the ends of one of the two pairs of split steel studs **(9)**.





The first pair of split steel studs was positioned so that the tops of the studs butted against the header nailer; the author fastened them with pan-head screws **(10)**. Because of tight clearances between the new door opening and an existing wall, a right-angle drill was needed to drive some of the screws **(11)**. Chalk lines snapped on the concrete floor to mark the rough opening were used to align the floor plate, which was fastened to the slab with Tapcon concrete screws **(12)**. The second pair of split steel studs was installed in the same manner midway between the end pair and the trimmer. Prior to installing hardware and mounting the door onto the track, the author primed and painted the edges of the solid-core door, then mounted the two door plates on the top edge of the door 2 3/4 inches from the edges **(13)**, along with a rubber bumper on the back edge of the door 40 inches from the bottom. The author then inserted the wheeled hangers into the track and used a flat bar to lift the heavy door so that the hanger pins engaged the door plates **(14)**. With the pocket door installed in the frame, the author laid down the Dricore panels over the concrete slab floor, shimming them as needed to level the floor, then installed 1/2-inch plywood subfloor over the panels, staggering the seams and covering the new subfloor with Ram Board temporary protective floor covering. When installing the drywall, the author used short self-tapping screws to attach the drywall to the steel split studs **(15)**.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With the finish flooring installed, it was time to trim the door opening. To accurately locate the holes in the narrow edges of the split steel jambs for the trim screws and avoid deflections that could bend the flexible steel jamb, the author first partially drilled through the wood trim to mark the screw locations, then removed the trim piece to finish drilling the holes through the steel **(16)**. He followed the same careful process when installing the split header trim **(17)**; note that these trim pieces must be removable in order to remove the pocket door from the pocket-door hardware. Before casing the door opening, he shimmed the latch-side jamb to evenly contact the edge of the door **(18)**, then prefabricated the casing for tight miter joints **(19)**. Plastic guides are included with the pocket-door kit, but the author made his own guide blocks out of scrap PVC that provided a better fit and more durability **(20)**. To accurately position the latch, he first made a template to mark its location **(21)** and clamped a plywood backer to the back of the door before cutting out the latch opening with a jigsaw to prevent tear-out **(22)**. Ready for finish paint, the installed door may rarely be needed but slides smoothly out of the wall when a little privacy is desired **(23)**.

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BY MELANIE HODGDON

Recognizing Earned Income

To understand true profitability, it's important to look at earned revenue instead of cash received. For example, if you require a 20% deposit at contract signing, and the job is sold at $100,000, the $20,000 check you receive shouldn't be classified as earned income because you don't have any costs to record against it.

There are several ways that you can end up with the desired result, which is to see only earned income on your profit and loss statement (P&L). Be aware that if the method used ends up with your having dollars of payments in a liability account, in terms of tax reporting, "cash is cash"; that is, if you file your taxes on a cash basis (check with your accountant on this), any dollars—earned or unearned—that you receive from customers must be reported as income. This is typically handled at year end by the tax preparer making a journal entry to temporarily classify these dollars as income on the last day of the tax year (December 31 for calendar year filers) and then reversing the entry on the first day of the following year (January 1 for calendar year filers). Doing so properly adds the received dollars to the P&L where they can be included as taxable income, but the reversal keeps things accurate for the following year.

METHOD 1: T&M INVOICING

In this method, the job is sold with the understanding that actual costs (burdened labor plus actual material and subcontractor costs) will be reported, an agreed-upon markup will be applied, and the customer will pay as the project progresses.

Pros: For contractors who have limited confidence in their estimating abilities, this can be a safe option.

It can also be useful when costs fluctuate wildly due to supply issues.

If payments are scheduled on a regular basis (say, every Tuesday following submission of the invoice on Monday, when all costs from the prior week have been assembled), the customer will be dealing with bite-sized outlays of money, and the weekly payment will be expected and hopefully planned for.

Cons: For the customer, there is no way to have a budgeted cost up front. If things crop up, too bad; they still have to pay.

Also, because invoices are generated as the job progresses, it's impossible for the contractor to avoid shelling out money before it is reimbursed by the customer. This breaks the rule "Always pay for the project using the customer's money." For example, with a contract price, an invoice typically accompanies the signing of the contract. These bucks are designed to cover the startup costs (and accompanying overhead) that inevitably occur prior to what the customer would call "the start of the job." With T&M invoicing, if state law permits, it's best to request a "deposit" amount beforehand. This can be sold as a way to "hold your slot in our schedule" or anything else that sounds reasonable. These dollars can then be credited back to the customer on each invoice. The customer will end up paying the same amount, but the contractor won't have to carry the job between signing the contract and creating that initial invoice that follows the first visible work on the project.

With T&M invoicing, the harsh fact of the markup amount will be in the customer's face with every invoice. With contract pricing, the markup is embedded, as it is with virtually any other product we buy, from groceries to tools.

The contractor may feel compelled (by a desire for total transparency or in response to customer demand) to provide detailed information regarding time spent and actual costs incurred. This can be time-consuming, although with the proper preparation, reports can be memorized (a QuickBooks function) and easily run for each billing period. Under no circumstances should the contractor feel compelled to provide paper copies of everything.

T&M jobs have a tendency to go on and on. While there should be an agreed-upon scope of work, T&M projects seem to expand more easily than contract price jobs. One reason may be that with a contract price job, changes are recorded as change orders, which must be reviewed, agreed upon, and paid for by the customer. But with T&M jobs, the creation of change orders may not occur. Such changes may simply be viewed (sometimes by both parties) as an expansion of the existing job rather than as reason to commit to a separate agreement.

Because the customer will see actual costs (the level of detail

provided will probably vary from company to company), the harsh fact of the markup amount will be in the customer's face with every invoice. With contract pricing, the markup is embedded, as it is with virtually any other product we buy, from groceries to tools.

With fixed-price invoicing, your financials will show income based on the scheduled payments, not on earned income.

METHOD 2: PERCENTAGE-OF-COMPLETION INVOICING

On the surface, this may seem identical to T&M invoicing. However, the difference is that there is a set budget (the sale price) to which all parties have agreed. The scope of the job is understood, and the payment schedule may be time-based (invoice every week or two) or milestone-based (payments tied to milestones within the project). Just avoid creating milestones based on "completion of" since supply delays, inclement weather, crew injuries, or any number of delaying events can happen. Instead, tie to "start of" or "ready for" milestones that provide more flexibility.

Pros: Because, in theory, invoices are based on actual costs incurred to date, this method conforms to the Matching Principle, which states that revenue is earned at the same proportion as costs are incurred. For instance, let's say the project budget is $100,000 and the project was sold at a 50% markup for $150,000. Then if you have spent $35,000 in costs (and remain on budget), the project is considered 35% complete, and you have earned 35% of the job sale price ($52,500).

Everybody knows ahead of time what the job will cost (excluding any change work).

Cons: Success is completely dependent upon accurate job costing. Errors such as not using fully burdened labor costs when calculating how much the company has spent on labor can cause huge problems if the cost of the job was estimated using burdened labor costs. (For more, see "Getting Labor Burden Right," Apr/22.)

Cost overruns must be tracked carefully. If the budget for materials was $100,000, but somebody cut the Parallam 5 inches too short, the additional cost of replacing it (or even the time required to figure out and execute an acceptable workaround) can't contribute to the original budget, because doing so would artificially decrease the percentage of completion. Deviations from the budget must be tracked carefully and a predictable method for reviewing, adjusting, and then calculating percentage of completion must be established (and followed).

A reasonable method of tracking and invoicing change work must be established, incorporated into the contract, and explained to the customer. Some contractors prefer to invoice 100% of the change order, treating it more or less like a small separate job. Others prefer to add the estimated cost of the change order(s) to the original contract and then calculate percentage of completion based on the revised budget. Whatever you do, just be sure it's consistent.

METHOD 3: FIXED PRICE WITH PAYMENT SCHEDULE (NO WIP)

The job is estimated, markup is applied, and the price is set. The contractor sets up a schedule of payments that will provide positive cash flow. A method for handling change work is incorporated into the contract.

Pros: All parties agree to the price and the payment schedule before the job starts. The customer knows upfront what the payments will be and can make whatever preparations are required to cover the costs as they arrive.

The contractor can front-load to cover startup costs. Typically, the first invoice is "at signing," and these funds will cover any costs incurred (including a portion of the job's "fair share" of overhead). No, this payment should *not* be used to make up for the last job's profit shortfall! While accurate job costing is always important (so you can spot discrepancies in expected costs and take action as the job progresses), invoicing is not dependent on it. Another nice feature is that customers typically review, approve, and then pay for change work as it occurs.

Cons: Your financials will show income based on the scheduled payments, not on earned income. So let's say you have three jobs with contracts that were signed in April. They won't start until May or June. You record the "at signing" payments as income, but none of the jobs have identifiable costs associated with them. So April's income and gross profit look fantastic, but wrong.

Note: Some companies try to avoid this by simply recording a credit to accounts receivable instead of creating an income-based invoice. The problem with this is that your overall accounts receivable will be inaccurate, as they will contain a bunch of negative figures. This also affects your current ratio, which provides a measure of positive cash flow.

METHOD 4: FIXED PRICE WITH PAYMENT SCHEDULE (WITH WIP)

This method is exactly the same as Method 3, described above, but on a regular, periodic basis (typically monthly), a WIP (Work In Progress) calculation is made and financials are adjusted based on the results.

WIP is based on the Matching Principle (defined in Method 2, above). Revisiting the example used in Method 2, if the project budget is $100,000, and it was sold at a 50% markup for $150,000, then if you have spent $35,000 in costs (and remain on budget), the project is considered 35% complete, and you have earned 35% of the job sale price ($52,500). But if you have front-loaded your payment schedule (which is advisable in terms of cash flow), and you have actually invoiced $60,000 instead of the earned $52,500, then you have overstated your income for that period and must make a correction. This is called the WIP adjustment. In this example, if you look at the P&L for that job for that period, you will

see $60,000 in income. But you should see only $52,500. Therefore, you will need to subtract $7,500 from that job's income. It is best to create a new income account called WIP Adjustment and make the adjustment there. The result might look something like this:

WIP Adjustment Account on P&L

INCOME	PROJECT X
Construction Income	$60,000.00
WIP Adjustment	$(7,500.00)
Total Income	$52,500.00

Depending on where each project is (start, middle, end), how the payment schedule has been set up, and the nature and extent of cost deviations from budget, the WIP adjustments might be either positive or negative.

Pros: If the contractor is already doing fixed price with payment schedule, this method only requires him/her to add the WIP adjustment step to increase the accuracy of the financials.

Cons: Everything said in the methods above with regard to the importance of accurate job costing (especially cost overruns) applies here. If you don't have a good handle on job costing, don't even try this, as the results will create more problems. It's one thing to have numbers that you know are accurate (the number of dollars invoiced in a given period) but misleading (they aren't all earned), and it's quite another to "improve" things by making adjustments that are wrong.

WIP Adjustment Account on P&L

INCOME	PROJECT X	PROJECT Y	PROJECT Z	TOTAL
Construction Income	$60,000.00	$137,500.00	$45,250.00	$242,750.00
WIP Adjustment	$(7,500.00)	$(13,825.00)	$3,125.00	$(18,200.00)
Total Income	**$52,500.00**	**$123,675.00**	**$48,375.00**	**$224,550.00**

Because WIP adjustments are reversed each month, income on financial reports will be correct only 12 days out of the year—one day each month when you're making WIP adjustments.

Unless you keep a separate spreadsheet for tracking which customers are overbilled (you have invoiced more than what the job has earned) or under-billed (you haven't invoiced enough to cover the costs that have been incurred, which really means you're financing the customer's job), it can be challenging to know where each customer stands.

There's much more to calculating and tracking WIP, but this should give you the gist of the issues.

METHOD 5: THE "TWO-JOB" SYSTEM

This represents a blend of percentage-of-completion invoicing and contract price with payment schedule. Two "jobs" are created for each project. One job (the "payment" job) is used only for invoicing according to the payment schedule, and all payment dollars are considered liabilities. Invoices for the payment job affect accounts receivable but not income. This avoids including payment-schedule invoices as income on the P&L. The second job (the "project" job) is used for estimating, job costing, and invoicing percentage of completion. These invoices are "paid" immediately using a credit memo from the liability account, so the accounts-receivable balance on project jobs will always be $0.

Pros: No adjustment to income is needed because all income on the P&L is earned. It is generated via percentage-of-completion invoices on the project job(s).

Because a single liability account (typically called "customer deposits" or similar) is used, it is easy to generate a report that shows each customer's balance in the liability account. Customers with positive balances have been invoiced for more dollars than the job has earned; customers with negative balances have been invoiced for fewer dollars than the job has earned.

On the balance sheet, the balance of the account reveals the net amount of unearned dollars the company has collected. A positive balance indicates that the company has collected dollars that have not been earned. This is great for cash flow, but it's important to remember that your cash balance has been inflated by these dollars. In other words, if you have $100,000 in your checking account but $79,000 in your customer-deposit liability account, you really have only $21,000 in "available" cash to spend.

This account can also be easily reconciled at the end of each job to confirm that the amount invoiced via the payment job matches the amount of income reported for the project job. For tax purposes, at year-end, a single adjusting entry can be made to zero out the balance in the customer-deposit liability account with an offset to income. As with any such tax-related adjustment, the entry would be reversed on the first day of the following year.

Cons: Unlike WIP adjustments, the two-job system typically uses periodic costs rather than cumulative costs. In other words, costs for a given period (usually a month) are included in a report that forms the basis of the percentage-of-completion calculation. This requires careful dating of bills, paychecks, etc.

As with WIP, it's critical to take into account change orders and projected deviations from estimated costs. Otherwise, your percentage-of-completion invoices will be inaccurate.

Because income-related invoices for the project job are always paid using a credit memo to apply the customer's dollars from scheduled payments to the project job, it's all too easy to over-credit. In other words, it would be possible to "pay off" the income-recognizing final invoice for this job based on the Matching Principle and using liability dollars in the customer deposit account.

Melanie Hodgdon owns Business Systems Management, which provides management consulting and coaching for contractors.

BY DAVID GERSTEL

Building Well in the 21st Century: A Review of *Pretty Good House*

Just five decades back, when I was a union framer, we were focused on building houses that were durable and architecturally engaging. That was the full extent of our writ. If someone had asked "what about performance," we would have been puzzled. "Performance? We're building houses, not hot rods."

Fast forward to the 21st century. Performance has become a central concern, pushed to the front by a cascade of changes that have, in turn, been stimulated by three forces: Innovation in material technology. Acceleration in the cost of energy and dependence on imported fuels. Concern about historically rapid climate evolution.

The introduction of plywood and drywall made houses more resistant to airflow and slower to dry. Moisture retention and resultant decay were compounded by the addition of insulation. That prompted focus on water resistive barriers. New building wraps and flashings showed up on the market. Rainscreens to protect the water barriers appeared in architectural drawings.

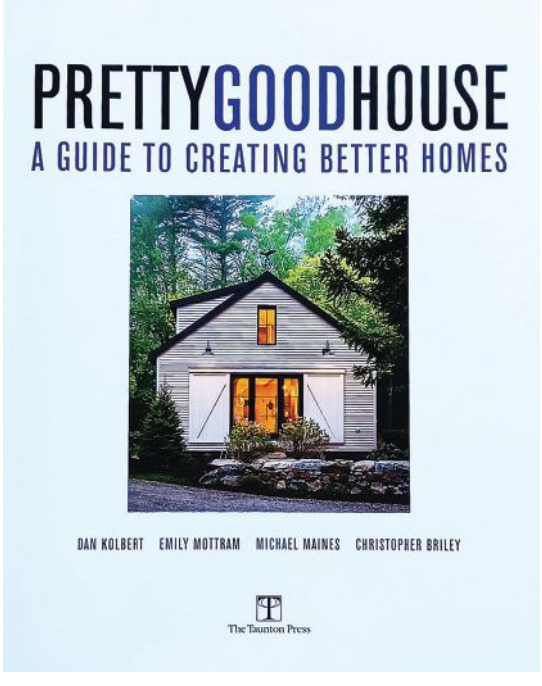
Even well-wrapped and flashed buildings allowed streams of air to shoot into and out of buildings. That impaired energy efficiency and carried moisture into the framing cavities. We began to bear down on air-sealing, another term that would have elicited puzzlement on jobsites during an earlier time.

The changes kept coming: Vapor barriers. Heat- and energy-recovery ventilators (HRVs and ERVs) to get rid of the pollutants that built up in the tight 21st century homes. And other gadgetry, from monitors for tracking temperature, humidity, and indoor air quality, to solar panels and batteries, to smart this and that.

In just one lifetime, houses had evolved from simple shells made of sticks and ground-up minerals (concrete, masonry, and gypsum), with a few pipes and wires winding through, into complex devices. Their emergence birthed whole new trades: Building scientists. Enclosure designers. Third-party inspectors and verifiers, people who inspect houses to make sure they perform as intended.

Meanwhile, we were still trying to build homes that were affordable and architecturally appealing. The immensity of the challenge became clear to me when I designed and built a house intended to meet 21st century requirements and chronicled the effort in a book, *Crafting the Considerate House* (Latitude 67, 2010). About the time I was taking on the challenges for a West Coast site, four other construction pros—Dan Kolbert, a builder, and three designers, Emily Mottram, Michael Maines, and Christopher Briley—were taking them on in southern Maine and getting together to share accounts of their struggles and victories. They have now pooled their expertise in a book: *Pretty Good House* (Taunton Press, 2022).

***Pretty Good House* (*PGH*), for all the modesty of its title, is an ambitious book.** The authors aim to empower designers, builders, and their clients to construct homes that are architecturally pleasing, high performing, durable, comfortable, and yet affordable.



Title page of a pretty good building book.

In just one lifetime, houses evolved from simple shells into complex devices.

They even hope, by promoting more energy efficient construction, to help rein in global warming. Did they succeed with their book? In certain respects, not quite. In large part, yes.

From the first pages onward—and through most of the "case studies" that close out each of their 10 chapters—the authors keep cost control front and center, encouraging volumes and rooflines that are easy to frame and to insulate. Though simple in form, the buildings they display are sometimes striking. My favorite is not a house but the "pretty good garage," a charming, compact, multi-use structure designed by Maines that draws on his experience as a timber framer.

Good design, *PGH* drives home, is about more than visuals: "We've been conditioned to have emotional attachment to things we can see, but what about key elements that we can't, that affect our well-being, both physical and emotional," like how the house regulates "temperature, humidity, and air quality?" *PGH* provides a comprehensive primer on air, moisture, and temperature management as well as energy efficiency. High performance around those issues, the authors emphasize, cannot be tacked on toward the end of design with specification of green gadgetry. It must be put in place from the outset of a project, beginning with the creation of an owner-designer-builder team committed to working collaboratively.

PGH is resolutely specific with its recommendations for a team:

- Their work must take into account local climate and the constraints at their building site. No transplanting a Spanish revival from the sunny Southwest and putting it on a lot in frigid Maine with big windows facing north to capture forest views.
- Rather than being built with concrete and steel—whose production contributes roughly a sixth of annual global carbonization of the atmosphere—basement slabs can be constructed with foam and locally timbered wood.
- For framing, double stud construction that makes room for deep insulation gets *PGH*'s persistent endorsement, though it also introduces the more exotic "Larsen truss," deep furring attached to wall framing to make space for "outsulation." Happily, *PGH* encourages "frugal framing," as I call it. By making use of 24-inch-on-center rather than 16-inch-o.c. layout and other smart economies, frugal framing reduces framing costs for a house by roughly a third even while improving energy performance by reducing thermal bridging.

***PGH* focuses most intensely on the construction that will determine house performance.** It gives due attention to equipment selection. Several pages tally the pros and cons of various ventilation systems. A chart ranks six different heating systems from wood stoves to air-source heat pumps (ASHPs) around seven different factors from life span to operating cost. ASHPs come out on top overall. Wood stoves place last.

The authors emphasize, however, that equipment selection is just a third player in achieving high performance. Good design and a properly specified and installed building envelope come first. And that's where *PGH* primarily directs our attention. The installation of the four "control layers" is covered in three chapters amounting to nearly a quarter of the book. Here we are plunged into building enclosure engineering—a topic that would have drawn blank looks from designers and builders 50 years ago, and continues to bewilder many today. Mercifully, the authors start us off with a drawing that clearly displays the control layers, one

A CASCADE OF CHANGES

Beginning even earlier, but accelerating in the latter part of the 20th century, a cascade of changes around energy use, moisture control, and material technology transformed home construction. Among the most impactful are:

- The widespread adoption of structural plywood and OSB.
- Wide use of air conditioners and central heating.
- Insulation requirements for walls, floors, and ceilings.
- The elaboration of water-resistive building wraps and flashings.
- Rainscreens with insect barriers.
- Vapor barriers.
- Insulated glass and low-e coatings.
- Air-sealing.
- Blower door testing.
- Heat- and energy-recovery ventilators.
- Heat pumps.
- Photovoltaics.
- Indoor air monitoring devices.
- Building science and enclosure engineering.
- Performance codes and special inspections.
- Commissioning of building systems.
- Additionally, a stream of new materials including pressure-treated wood, three-tab and laminate asphalt shingles, fiber-cement siding, PVC trim, rigid- and spray-foam insulations, and composite fiberglass windows and doors.

each for weather, air, thermal, and vapor. Of those layers, weather management comes first because, the authors explain, "If you can't keep the rain outside the building envelope, none of the other layers really matter." Your building is toast.

As you would expect, *PGH* advocates rainscreens. But it also suggests less-commonplace water management such as capillary breaks at foundations to prevent moisture from wicking upward through concrete into the frame. I am particularly appreciative of *PGH*'s discussion of vapor barriers. It demystifies them, making clear that their purpose is to prevent water vapor from reaching and condensing on cold surfaces.

At its discussion of the thermal layer, *PGH* delivers a pair of key lessons on the wise use of dollars for 21st century home construction. First, a graph illustrates the rapidly diminishing effectiveness of wall insulation beyond R-20 (see original graph from Allison Bailes, right). And that suggests there may at times be better ways to budget your money than building double stud walls or Larsen trusses with ultra-thick insulation. Second, the authors underscore the fact that a quarter of a typical home's heat escapes through the cracks and seams in the building envelope. Preventing those leaks, they remind us, is the most cost-effective way of reducing loss of conditioned air.

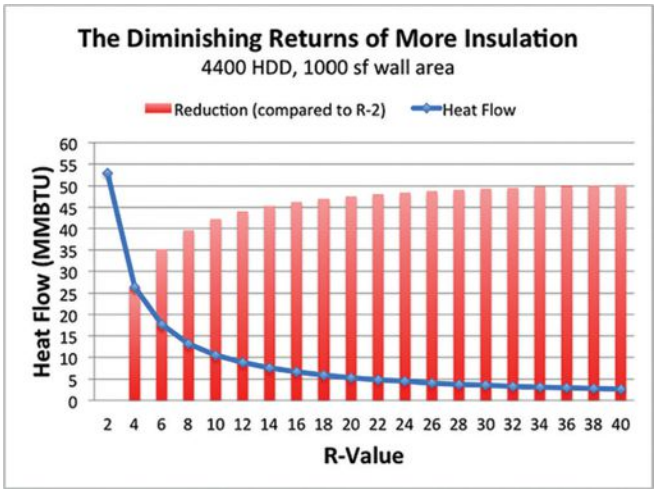
To reinforce that point, the authors put down what they regard as the nonsense "that houses must breathe." Humans must breathe, they say. Houses must resist water and air penetration. So, the need for humans to breathe should be taken care of not by building leaky houses but by ventilation systems, ideally HRVs or ERVs.

Moving beyond air-sealing, *PGH* goes on to discuss health issues and material choices. A chart lays out in detail the authors' take on seven categories of siding and trim. Locally sourced wood gets applause. Vinyl is frowned upon.

Though they bear down on performance, Kolbert, Mottram, Maines, and Briley are not house hot-rodders. They are not bent on accelerating to net zero and beyond or speeding across the line that would bring them platinum stars from "green" rating agencies. They want to keep an eye on cost as well as performance. They want to build houses that are relatively affordable. That concern extends into their detailed discussion of a particularly brutal cost of construction—doors and windows. Pay attention, *PGH* instructs, to U-factor, solar gain, light transmission, and condensation ratings (all of which the book explains clearly) to maximize utility for your bucks.

For all the authors' practicality, the pretty good house they prescribe is a pretty darn complicated device, incorporating all of that technology alluded to at the outset of this article. While they are emphatic that it is all necessary for building well in the 21st century, the authors are aware of the additional burdens the new complexities place on designers, builders, and owners. They note that a pretty good house not only must pass the straightforward building inspections that were required since I was first learning to drive nails but also must be "commissioned"—its envelopes and mechanicals tested for leakage and function—by a new class of qualified verifiers.

Owners, the authors urge, must be equipped to manage their devices in order to prevent failure and deal with malfunction. Houses should be equipped with monitors for tracking interior humidity, temperature swings, presence of organic compounds, and multiple other conditions. And finally, the authors urge, builders and designers should provide clients with an operation manual such as would be provided with a new car.



***Pretty Good House*, for all its thoroughness, does come up short in several respects, ranging from coverage of technical issues to overall organization and editing.** Martin Holladay, the respected former editor of *Green Building Advisor*, has questioned a few of *PGH*'s prescriptions for vapor barriers and ventilation systems. While I can't argue those, pro or con, I was surprised to see how thin is *PGH*'s coverage of MPE other than mechanical. Plumbing and electrical deserve more attention than they are given. Both are huge factors in determining the energy consumption as well as the livability of a home. But plumbing is given only one pretty picture unaccompanied by useful explanation and a few paragraphs of general tips. It is not even mentioned in the index. Coverage of electrical is more extensive but, other than the discussion of lighting, is superficial. (Windows and doors, by contrast, get 17 pages.)

PGH's value is compromised by a built-in provincialism. Its authors are three designers and one builder of custom homes. All operate in Maine. Consequently, they tell us about building houses that are, for all *PGH*'s focus on cost control, actually affordable only for folks who are among the most economically privileged in the world: Americans who can finance homes designed by architects supported by a team of engineers. (For an enlightening contrast, see Fernando Ruiz Pages' *Building the Affordable House*, in which the author describes the construction of pretty darned good houses that are, nevertheless, within the financial reach of people of modest means.)

Because the authors' work experience is largely in Maine, their

DANGEROUS DEVICES?

The authors of *PGH* understand that houses have evolved from rudimentary shelters into complex devices. They know such homes can be dangerous and guide builders to a website where they can get help creating a manual that instructs owners on the safe operation of their homes.

I am skeptical about the effectiveness of such manuals. The great majority of car owners neglect the maintenance recommended in their car manuals. Why should we think pretty good house operators will do better?

I doubt they will. I fear that the greater likelihood is that as HRVs, monitors, and the like wear out, go offline, or are otherwise disabled, owners will ignore maintenance and may end up breathing unhealthy air.

In other words, the 21st century houses we are building now may, by the 22nd century, have brought forth problems as severe as those we now have with our leaky, inefficient, climate-damaging 20th century houses. —*D.G.*

book is highly New England-centric. When they discuss conditioning of indoor air, their focus is almost entirely on heating. They decry tubular skylights as "energy sucking holes." However, tubular skylights, if carefully installed to control air and water, can provide pleasing, low-cost lighting without significantly compromising energy efficiency.

PGH has problems more severe than its scattered technical shortcomings. They arise from the poor editing. The book is frequently redundant. Though it is intended for owners as well as construction pros, specialized terms like "stack effect" and "vapor variable membrane" are dropped into the text with no explanation. In some cases, technical terms are not even defined in the anemic glossary or referenced in the stingy index.

What is particularly irksome is that the reader is regularly forced to flip back and forth through the pages to find complete explanations of a concept brought up in one chapter but not adequately covered until later. Thus, blower door tests are introduced briefly on page 106. But after a mention of "theatrical smoke machines" (whose function goes unexplained), the reader is referred forward for an explanation of the tests—but with no page number indicated.

Occasionally, the poor editing has left in place muddy presentation of key subjects like heat pumps. Several pages of text and photos are devoted to them. But no clear explanation of how they work emerges. Similarly, as was pointed out to me by another knowledgeable reader of *PGH*, the discussion of heating systems separates "radiant" systems" from "hydronic" systems, when they are, in fact, the same. "A close reading," the reader noted, "suggests that the authors specifically mean to address 'radiant slabs' separately from other hot-water distribution, but their presentation muddies the waters (pun intended)."

Surprisingly, for one does not expect weak graphics from the publisher of *Fine Homebuilding* magazine, illustrations are occasionally indecipherable. Some photos are blurry. Text in graphics is sometimes so tiny or obscured it is unreadable. And certain drawings resemble puzzling modernist gargoyles more than the enclosure sections they are intended to portray.

While reading *PGH*, I sometimes felt yanked from one subject to the next and fire-hosed with information that, though valuable, was not delivered within a well-structured framework. The problems arise, I suspect, partly from the authors' admitted lack of experience at book writing. Though several had produced articles for publication, none had ever written a book before. With *PGH*, they were trying to write one collaboratively, each taking on a chunk of it, firing emails back and forth to coordinate their efforts.

Though I have written six books, I can't imagine attempting that. It would be like constructing a house with three other builders, each designing and constructing a portion of it. Without an uber-GC to coordinate our efforts, the result would be disconnects, omissions, and redundancy. Likewise, *PGH*'s four authors needed able coordination by a general editor. Because the authors clearly did not get that support, *PGH* is more difficult to read and less useful as a reference than it could be.

For the reader willing to wade past its deficiencies, *Pretty Good House* will prove a useful and engaging read. It can ground homeowners eager to build their own homes in design fundamentals from climate consideration through choice of finish materials. For both owners and construction professionals, it offers a comprehensive overview of building enclosure engineering. In sum, it is a valuable if not well-organized and, on occasion, technically questionable manual for the construction of 21st century houses. Of course, it's debatable whether building ever more single-family homes is a wise path forward for our society or good use of our skills as builders and designers. But it's evident that is what our clients want and what we are going to continue to do for the foreseeable future. We may as well do it with as much consideration for the environment and the clients as we can manage. The authors of *Pretty Good House* have made a spirited attempt to push us down that road.

High performance, the authors emphasize, cannot be tacked on toward the end of design with specification of green gadgetry.

David Gerstel is a veteran builder and construction industry educator. You can review his books about estimating and bidding and about achieving financial freedom at DavidGerstel.com and at Amazon.

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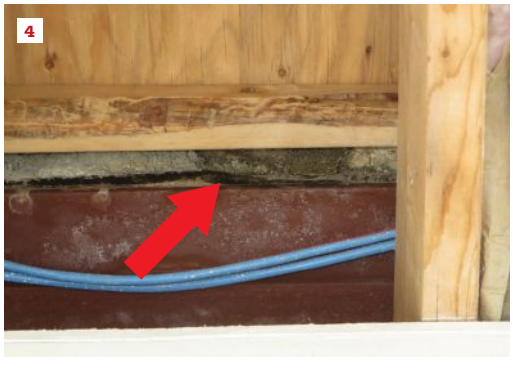
SIDING & ACCESSORIES TRIM & MOULDINGS ROOFING STONE WINDOWS OUTDOOR LIVING

BY DOUG HORGAN

Getting to the Bottom of a Stone-Veneer Leak

The roof over a bump-out abutted the second floor's stone-veneered wall. Water-testing progressed upward: First, the soldered metal roof was water-tested **(1)**, then the counterflashing and the sealant joint just above the roof **(2)**, and last, the stone wall above the flashing **(3)**.



After 10 minutes, water appeared inside the house at the bottom edge of the felt WRB, which terminated at steel angle shelf **(4)**. Removal of a stone confirmed that through-wall flashing had not been installed **(5)**.

Photos by Doug Horgan; illustrations by Tim Healey

New clients had a problem with their existing home: A projecting bay would leak at the ceiling during a heavy rain shower. It had happened often enough that they had removed the drywall and insulation, ready—we imagined—to place buckets below to catch any incoming water.

Located on the first floor, the 4-foot-by-10-foot bumped-out bay had a soldered metal roof that appeared to be in good condition. We water-tested the roof and found no leaks **(1)**. We didn't want to test the whole structure at once; we wanted to start at the bottom and work our way up so we could locate the issue. So next we moved our gentle water spray up onto the flashing, aiming the water downward to avoid wetting areas above the flashing. The flashing itself didn't leak, so we moved a bit higher, to the sealant joint at the top of the flashing **(2)**. This too didn't seem to leak.

We then started spraying the stone wall just above the flashing **(3)**. While roofing and flashings often leak within a few minutes, our experience with masonry is it can take 10 minutes or longer for water to leak all the way through and appear inside. Sure enough, after about 10 minutes, a steady drip started off the bottom edge of some building felt that terminated at steel angle shelf **(4)**.

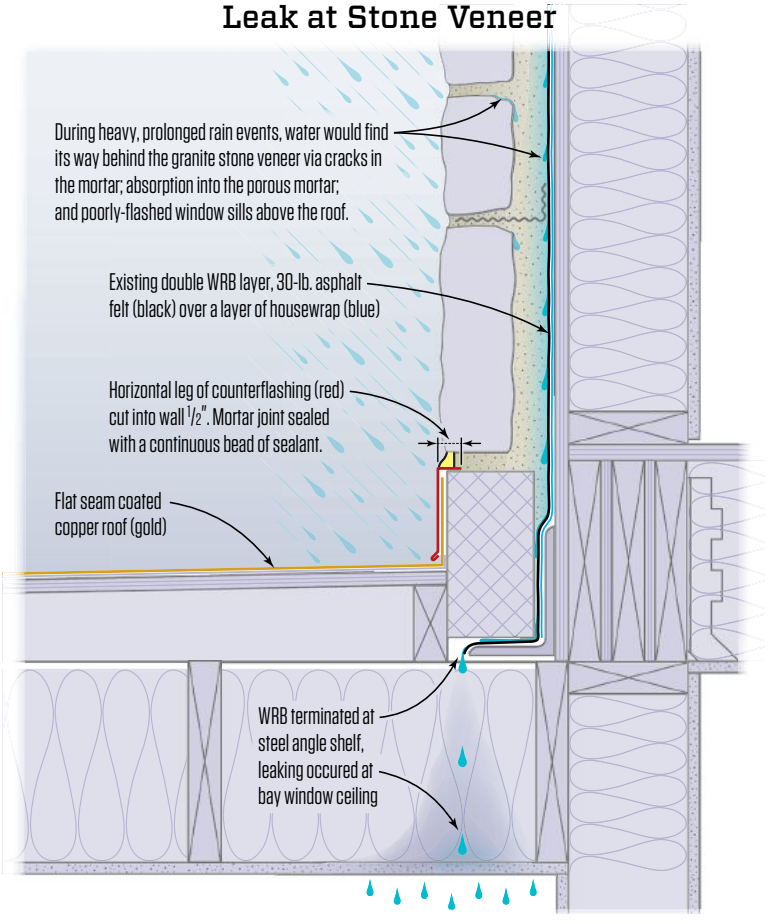
At this point, we were pretty sure the masonry was missing a through-flashing that would direct water out of the wall above the roof, a common and easily avoided problem we find fairly often in our area. To confirm, we removed some stone above the roof to see how it had been built **(5, 6)**.

We discovered the roof flashing was cut into the face of the stone and went in only about 1/2 inch **(7)**. Any water draining down within or behind the stone veneer would simply run down past the roof into the ceiling inside the house (see "Leak at Stone Veneer," next page).

A multilayered solution. We removed the stone down to a block starter course **(8)**. The existing double WRB layer, which consisted of 30-lb. asphalt felt over a layer of Tyvek, was also removed. (Ultimately, we discovered enough problems with the stone veneer that we ended up removing all of the stone on the addition portion of the home.)

For the first layer of our multilayered solution, we installed a flexible, self-adhesive membrane through-wall flashing over the existing block starter course and up

The roof counterflashing was inserted into the face of the stone **(6)** about 1/2 inch **(7)**. The continuous bead of sealant at the saw-cut-in flashing may have helped keep bulk water outside during lighter rain events, but when it rained long and hard enough, water draining down behind the stone veneer would simply run down past the roof and into the ceiling below (see illustration, right). The existing mortar had been mixed up dry on site and so was very loose and porous. The stone had been laid up without an air space, which was code-legal for a brief while in the vicinity where the author works. Though it was common practice, it was not ideal from a water-management perspective. Installing proper through-wall flashing entailed having to remove the granitic stone veneer **(8)**.



After the self-adhering membrane backup flashing was installed, the metal through-wall flashing was installed over it (seen here on an adjacent roof) **(9)**. The exposed face of coated copper flashing was protected with blue tape, then the water management layers were installed on the wall **(10)**. Self-spaced corrugated plastic weeps provided enhanced draining **(11, 12)**.

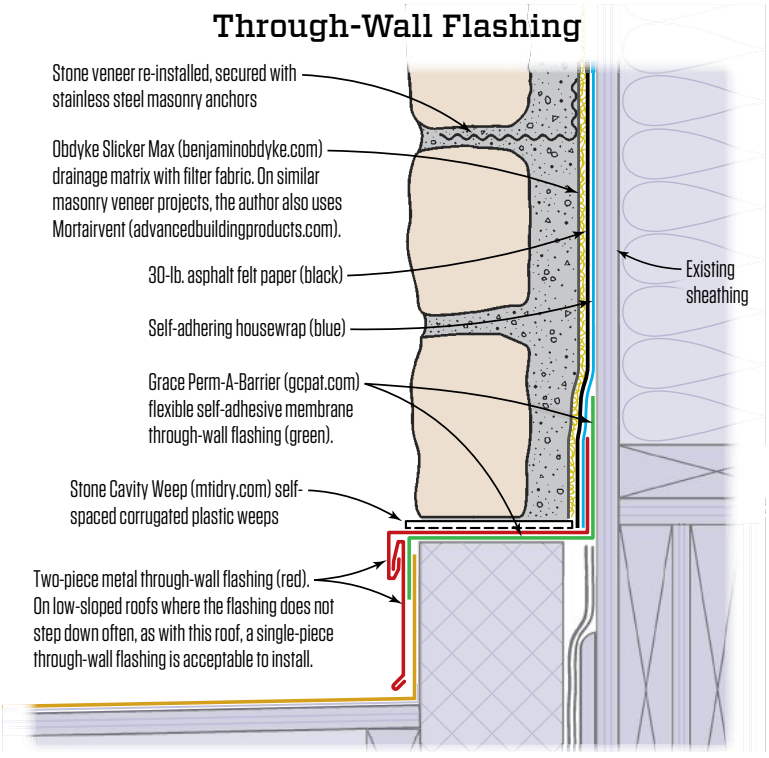
the wall sheathing. The membrane flashing helped dry in the roof-to-wall juncture and would serve as a backup flashing under the metal flashing; metal flashings have a tendency to leak at seams over time.

At roof-to-wall junctures, we typically install a two-piece through-wall flashing, which allows the roof to be repaired more easily later on **(9)**. The first, "through-wall" piece is fabricated with a 1-inch-tall vertical leg with a hook strip on the outside edge. The second piece, which can be removed and reinstalled as needed, is run vertically between the flashing's horizontal leg and the roofing and is clipped into the hook strip (see "Through-Wall Flashing," right).

We installed the water-management layers on the wall so they landed on the through-flashing; any water entering the stone now is directed out onto the roof by the through-flashing. In this case, we used a self-adhered WRB—because of the multiple existing nail holes in the sheathing—added a layer of building paper and a masonry drain-mesh material, and reinstalled the stone veneer **(10, 11, 12)**.

Doug Horgan is vice president of best practices at BOWA, a design/build remodeling company in McLean and Middleburg, Va.

Through-Wall Flashing



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Deep Energy Retrofit
Part 2: Doors and Windows

BY PHILIP ARMAND

Around 10 billion donuts are sold each year in the United States. Around 65 million windows and entry doors are sold each year in the United States. You can see through the middle of both, and that's about the extent of the similarities.

Why bring up donuts? Stay with me a minute. Buying windows today is not unlike shopping for a luxury car. After figuring out what size, type, and brand of windows and doors you prefer, then you have options in color and materials for both the interior and exterior; grilles or no grilles, or grilles in a huge variety of geometry; hardware in various colors and finishes; number of panes of glass and the coating on that glass; even the simple bug screen now has options in color and material. The nuance in options is as vast as the variety at your local (and here we are) donut shop.

Now imagine selecting your donut of choice: "I'll have the one with chocolate frosting and rainbow sprinkles." And your donut purveyor says, "Perfect choice, but before you can have it, I need to tell you all the details about where we sourced the flour and frosting." The face you would invariably make is not unlike one I have seen on my clients when I'm explaining the need for high-performance windows.

AESTHETIC CONCERNS

The most efficient window is small and doesn't open; of course, that rarely meets the clients' expectations and may not satisfy building code requirements. We can have endless building-science-nerd talk about window ratings; however, there is a priority that trumps performance: appearance. We love and care for beautiful things, so our buildings need to be pretty, and for my clients, that is the main priority when they're selecting products for their homes. I rarely have much input on window style and am

Photos: Philip Armand

The new design included 50 double-hung, four casement, and three fixed arch-top windows, three entry doors, three sliding patio doors, and one massive double entry with sidelights.

These Weather Shield Signature double-hung windows are integrated with the proper tape for the application—Zip Tape on the right and Henry Weather Barrier Tape on the left. You can see the DuPont FlexWrap NF peeking out under the lower flanges.

mostly at the mercy of what the architect and the clients prefer.

My window dealer, David Hauser from Morningstar Doors and Windows, has had similar experiences. As he puts it, "Higher-end clients tend to care more about aesthetic. They typically have architects and designers involved. The husband or wife wants a certain look and efficiency is not at the top of the list. The look is paramount. Recently, I was working with a client on their 15,000-square-foot home on the North Shore (of Long Island). I suggested high-performance glass and my suggestion was overridden for a clearer window, no low-e coating at all. The designer and clients' priority was not performance."

On the project we began coverage of in "Deep Energy Retrofit: Part 1" (Mar/23), we were aiming for efficiency within the boundaries of geometry, aesthetics, and budget. The owners had their preferences and the village architectural review board had to approve their desired look and materials. The nearly 5,000 square feet required 50 double-hungs, four casements, three fixed arch-top windows, three entry doors, three sliding patio doors, and one massive double entry with sidelights. A ton of glass, and a ton of potential air leaks.

PERFORMANCE PRIORITIES

Allocating resources for high-performance doors and windows is my second priority when I'm approaching a deep-energy retrofit. A window or door is always the lowest-performing aspect of a well-built wall assembly, yet is an indispensable part of the building envelope and is critical in keeping a home airtight.

It is easy to make a solid wall airtight and stuff it with insulation. In contrast, a window or door has to open and close, and it has to remain operable over a long period of time while consistently performing like a wall when closed.

Performance doors and windows, which have lower U-factors and improved airtightness limits, are now relatively accessible, and slowly, the narrative is changing as awareness about efficiency is being forced on homeowners and contractors alike by increasing energy costs. At the same time, however, high prices in building products are squeezing window and door budgets. We seem to be in transitional throes that may result in remodelers and home builders changing how they build and detail the building envelope, particularly as the EPA implements Energy Star 7.0 (due October 23, 2023). This new specification will mandate improvements to windows, doors, and skylights and has manufacturers scrambling to update their product lines to meet the more stringent guidelines. Indeed, there is transformation all around.

Only occasionally am I hired because I have the knowledge to "up-level" a basic set of blueprints into an energy-efficient final product. I am always hired because my end product looks beautiful, and clients are satisfied. I tend to impose my world-view that homes should also perform well. Sometimes a client agrees, but often we compromise.

Most of the homes I work on aim for a specific look (usually traditional), and when it comes to windows, double-hungs are most common. Performance windows, however, are generally hinged, allowing for a dramatically tighter seal. The only means I have to improve performance with a double-hung is to request the highest-performing glass and proper low-E coating within the selected product line and budget—often working directly with the vendor to avoid the donut face from the client. If a specific look is desired

Keeping continuity of layers is important. In this case, the author's WRB is Henry Blueskin, and the inside of the window is the connection point. The crew used a closed-cell polyethylene foam backer rod and a flexible sealant (Sashco Big Stretch and DAP Extreme Stretch) to connect the window to the WRB. They added the extension jambs during the finishing process. Keeping the extension jambs off until later allows the air barrier connection to be placed as close to the exterior as possible.

and the client is amenable to shopping different brands, then I hunt for performance. I also try (with marginal success) to convert any windows that will likely never be opened into fixed units.

SELECTION

The client on this project shopped brands. The architect recommended Weather Shield Windows and Doors, a family-owned manufacturer in Wisconsin. I was impressed by a sample window; the gaskets and build were robust, and the unit looked like it was going to last. The aluminum-clad unit has integrated nail fins; no floppy, removable business here. The sill dam is tall, seating the window nicely into a corner, lowering the possibility of leaks or drafts. The upper and lower sections overlap at a hardy weatherstripping and an interlock—another fail-safe against drafts and flimsiness. These units were made with performance in mind. Had we zoomed in on my face while I caressed the sample, you would have thought I was shopping for a sports car. The windows look like they should cost more than they do; I assume the firm allocates its marketing budget to making a better product. Up until this project, I had never heard of the brand.

SUPPLY LIST FOR INSTALLING WINDOWS AND DOORS

Tools:

- A good caulking gun (preferably one with an adjustable thrust ratio of 24:1 to 12:1).
- Caulk sealing caps (latex glove for your caulk tip).
- Putty knives, 1- and 1½-inch.
- Spray-foam sealant gun and plastic gun tips to protect the gun and allow easy access to tight gaps and cracks.
- Tape roller for pressure-sensitive tapes.
- Rubber gloves and eye protection.

Materials:

- Henry Blueskin VP 100 self-adhered water-resistive air barrier membrane.
- Weather barrier tapes including Henry Weather Barrier, Zip Tape and DuPont FlexWrap NF (9-inch).
- Closed-cell polyethylene foam backer rod: ½-, 1-, and 1½-inch.
- Sealants: Henry Moistop Sealant for the exterior, Sashco Big Stretch and DAP Extreme Stretch for the interior.
- Low-expansion insulating foam sealant.

Our selection—Weather Shield Signature casements and double-hungs—have a U-factor of 0.3 and a solar heat gain coefficient of 0.19, comparable to the other brands that were in the running, and that's where the similarities ended. The AAMA (now called FGIA, Fenestration and Glazing Industry Alliance) rated the exterior cladding of our selected units at 2605—double the score of the comparably priced alternatives. The alliance rates by testing color retention, chalk resistance, gloss retention, erosion resistance, salt spray, and humidity; the 2605-rated windows have double the warranty of comparable options. The air infiltration rating on the double-hung windows is 0.12, a great score for double-hungs in this price range; the comparably priced brands have a 0.25 rating or worse. The four casements we chose had an air infiltration rating of 0.01.

I spent an evening doing a deep dive on window ratings. If every manufacturer participated in all the available third-party testing offerings, every new window would be plastered with rating reports. Some of the ratings are listed using scoring codes and methods that require a deep-brain squint to fully comprehend. If you head into the weeds on this topic, bring a sharp machete and a gallon of highly caffeinated coffee.

I requested a low-e coating, as the back of the home faces southwest and blasts full-day sunlight into the home. Though we extended the eaves and gable ends, they had a limited impact on shading most of the windows. Another strategy was to order units with short or no extension jambs. This allowed me to install rod backer and caulk as close to the exterior as possible. Some of the walls had a final thickness of 9 inches, so a built-in jamb would have made properly sealing the window impossible. We build the extensions

Where exterior insulation without sheathing was added, the crew created window bucks to project the windows to the proper plane. Impeccably wrapping the buck is critical in keeping the barrier congruous.

After wrapping the window bucks, the crew installed exterior insulation abutting them.

Strips of 1/4-inch marine plywood act as the rainscreen. The windows are open to drain behind the siding and out.

during the trim process and then install additional insulation and air-sealing with canned foam. We always caulk the extension jambs to the window, adding another layer of air-sealing.

CONTROLLING THE INSTALLATION

In my area, the framers generally install the doors and windows. On my jobs, however, even if a framer is involved, my crew always handles the door and window installation, to avoid what Hauser has experienced. "Builders generally sub out their window install to the framers. They are aiming for speed and cost," he says. "We often find no back caulk, improper flashing, no shims, and roofing nails that are too short. This is also true for the high-end market. We try to inform the client directly how the windows should be installed at the front-end." Installation is what I have control over, and this is where we make certain the only shortcomings of a door and window are built-in, not induced by installation negligence.

Before installing the windows and doors, I watched the manufacturer's installation training video and asked my rep a few questions. There was nothing dramatically different from any flanged window installation. I did bend up and braze a few lead-coated copper drip caps for a few of the single windows that may see rain; the doubles and triples came assembled with an integral drip cap.

To promote drainage, we made all the rough openings 3/8 inch taller than the call-out to accommodate a piece of cedar clapboard wrapped with Tyvek FlexWrap NF. We glued and stapled the clapboard to the sill framing, then wrapped it with the FlexWrap. This allowed us to make a continuous sill pan going about 6 inches up the sides. The rippled texture of FlexWrap is a built-in drainage plane; if water intrudes, it can drip under the lower flange and out.

There is no caulk used between the siding elements and the window or door units. This reduces future maintenance. Water intrusion can drain and dry. The rainscreen is a combination of marine plywood strips and Benjamin Obdyke Slicker Rainscreen. The Slicker on the lower section inhibits bugs from getting into the air cavity behind the siding. The rainscreen is pressure balanced, allowing air to flow up from the bottom and into the soffit.

Smoother stretch tapes also work for sill-pan applications but require plastic shims to be installed under the lower flange to allow water intrusion to rectify to the outside. On rigid, aluminum-clad windows, I found the rippled tape reduces the need to worry about an extra step.

On the exterior, we used Henry Moistop Sealant on the upper and side flanges; on the bottom flange, only the nail holes were given a dab of sealant, allowing an opening for water drainage. After plumb and level was established and any shims added to support the bottom of the window, we filled every nail hole, making sure the roofing nails penetrated into the framing a minimum of $1^1/_2$ inches. Top and side flanges were detailed with a weather barrier tape.

We used a closed-cell-polyethylene foam backer rod and caulk to seal the units from the inside. I have often seen insulation companies using low-expanding foam (not on my jobs), but this is not best practice, and I have also seen a lot of voids and failures. A flexible caulk is most effective and most commonly recommended by window manufacturers. On this project, we used Sashco Big Stretch and DAP Extreme Stretch. Sealing the window on the interior—the conditioned side of the window, protected from ultraviolet light and harsh weather extremes—allows the seal to last the life of the unit. After sealing the windows and doors and allowing the caulk to dry, I did a quick inspection, adding sealant if needed. Later, as we prepped for trim, we adhered the extension jambs with DAP Big Stretch and filled the void between the jamb and framing with low-expanding foam, further blocking leaks and adding R-value.

Impeccability in the installation of door and window units is more critical than in the air-sealing process for opaque walls. I made certain to remain involved with every unit's install, as this is the most critical step in keeping a home airtight. Once we had established process and installed a few units, we gained momentum and moved quickly with prep through install. Every manufacturer and style window may have a different installation process, so I always check the resources available before any install. Even a great window, improperly installed, can lead to poor performance. I now also make sure to look at a sample window if a client has locked in a specific brand that I am not familiar with. This extra effort allows me to see if there are any obvious design flaws that need extra attention during install. I then research installation process and pitfalls; the internet is an amazing tool for learning from others' mistakes.

While donuts remain (mostly) round and sweet, windows continue to advance quickly. European and Canadian Passive House-rated windows are widely available, with some even manufactured locally. The new stringent standards are already yielding improved ratings. Even a double-hung window, installed properly, can yield an amazing blower door score and perform admirably. As craftspeople, we can't always control the products that go into the making of a home, but we can advocate and educate our clients about good products and work unceasingly to add impeccability to our installations.

Philip Armand is a craftsman, designer, and general contractor serving Eastern Long Island, N.Y.

Photo: courtesy SpacePak and Excel Plumbing & Heating in Mendon Vt. [Steve Ellerin, owner]; all illustrations by Tim Healey.

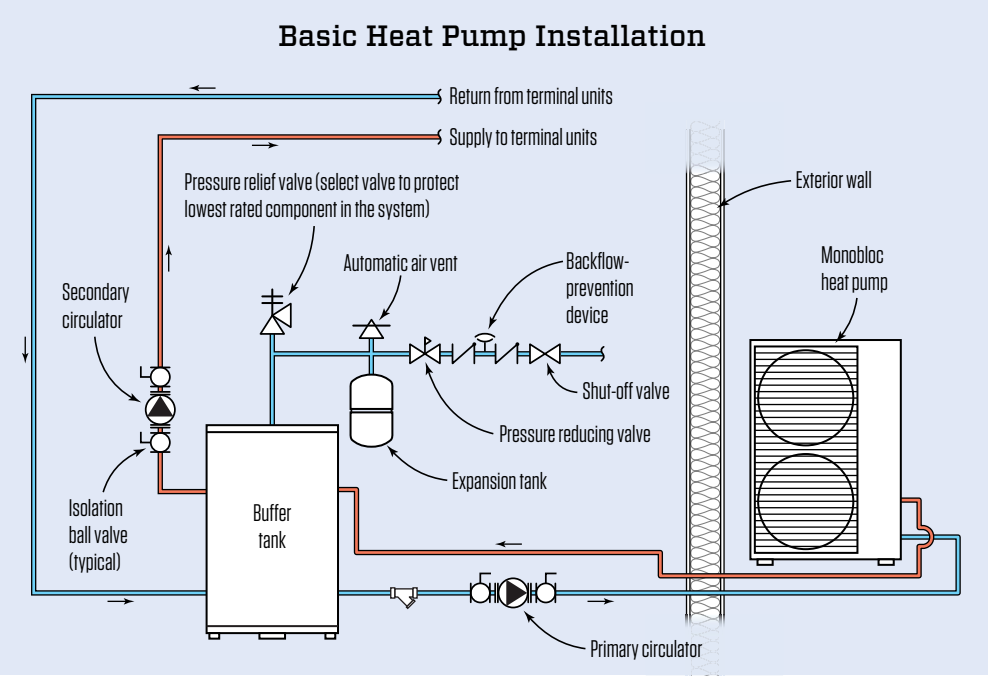
Air-to-Water Heat Pumps Come of Age

Simple system designs reduce costs and improve efficiency

BY STEVE SPATZ

Heat pump equipment has become a ubiquitous part of the HVAC landscape in northern climates over the past decade. Here in the Northeast, the demand for heat pump equipment in new and existing homes has been outstripping the capacity of the contractor base to keep up in recent years. Equipment options and efficiency have continued to expand year over year, to the point that there seems to be a excellent heat pump system for just about every building type or application, so long as the appropriate considerations are made for the application. Here in the heating-season-dominated Northeast where I work, we have a high percentage of hydronic heated homes and an experienced contractor and supply-chain base that supports this type of heating distribution. In this article, I will look at some of the considerations for new and retrofit residential applications using air-to-water heat pumps.

The expansion of options for heat pump equipment for cold climates over the past decade has primarily been focused on air-to-air equipment, most often with ductless systems. But as more homeowners seek to take advantage of the opportunities that heat pumps provide, the demand for whole-house solutions is increasing. At the same time, state and federal policies pushing away from fossil-fuel equipment and focusing on efficient electric heating and cooling have driven the demand for practical and efficient whole-house heat pump systems.



Simple layout. While an air-to-water heat pump can be tied in to a domestic water heating system, careful consideration needs to be made regarding the capacity of the heat pump when it must accommodate shared demands at differing water temperatures. In contrast, a simple layout such as the one outlined at left will result in easier installation and maintenance, and the overall cost of the installed system will be considerably lower.

EVOLUTION OF HEAT PUMPS

Early adopters of heat pump equipment in cold climates were mostly limited to ductless mini-splits. Over the years, cold climate inverter-driven ducted heat pump equipment came into play that could be added to existing ducted heating and cooling distribution systems and air handlers or could be ducted independently. Geothermal or ground-source heat pump systems have been a part of the picture for all climates for decades and offer the benefit of being able to work with both ducted and hydronic distribution, though the upfront cost to install the ground-loop side of the system has limited geothermal's market reach. But in the background, there was buzz about air-source heat pump equipment that could be used to make hot water for hydronic distributed heating systems. Rumors? Hearsay? Just something those Europeans across the pond were messing around with?

Truth is, these air-to-water heat pump systems have been around the whole time, finding their way into effective applications residentially and commercially. But just as the other air-source heat pump equipment was being adapted to applications in cold climates, air-to-water heat pumps also evolved to become viable options for integrating as whole-house systems in heating-dominated climates.

Air-to-water heat pumps use the same refrigerant process and cycle and have the same functional components as air-source heat pump equipment. One primary difference is that there is a heat exchange from the refrigerant cycle to a water loop. Air-to-water equipment is used extensively in mixed heating and cooling climates in Europe and Asia and elsewhere, with millions of units being installed annually across the globe. Air-to-water equipment has been sneakily showing up in applications in cold climates as well over the past decades, primarily for use as chillers for high-velocity ducted AC systems. Ducted AC with hydronic air coils is still a common application for air-to-water heat pump systems today, though air-to-water equipment is coming into its own as a whole-house heating option equivalent to other fuel-fired systems commonly in use.

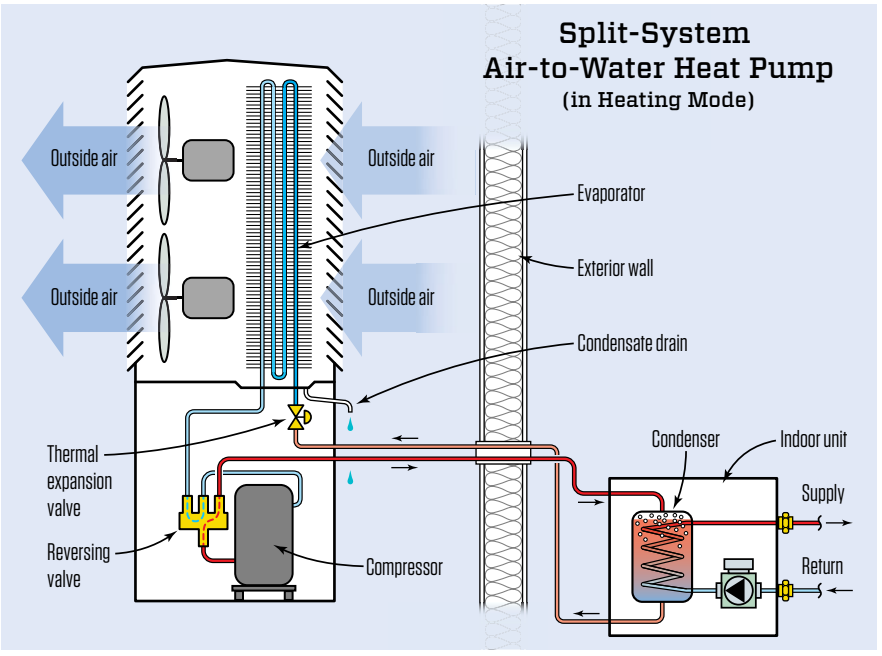
AIR-TO-WATER SYSTEM APPLICATIONS

The refrigerant cycle is highly efficient at transferring heat energy between its source heat sink and heat rejection mediums. For air-source equipment, this source is obviously the air. Because the boiling point of modern refrigerants is so low, there are still plenty of valuable Btus to be harvested from air that is well below 0°F.

While heat pumps are highly efficient at transferring Btus between two sources, there are limitations on the intensity and volume of Btus the heat pump can move. As a result, heat pump equipment is primarily a low-temperature delivery mechanism. For hydronic heating, this is a beneficial match for need.

LOW-LOAD DISTRIBUTION

Historically, hydronic heating distribution systems relied on high-temperature water generated by a fuel-fired boiler distributed through high-Btu output emitters in the home—think fin-tube baseboard and cast-iron radiators. This was a good match when buildings needed high Btu output to overcome the substantial heat loss occurring from building envelopes that left a lot to be



A monobloc system packages all the system components, including the fully-charged refrigerant components, electronics, and heat exchanger, in a single outdoor unit. This outdoor unit (above left) has a slightly wider cabinet to accommodate all the components compared with a comparable split-system shown on the opposite page.

desired. High heat loss and large swings in temperature were a fact of life for these buildings. But as our housing stock has improved (and is being retrofit through weatherization) and energy codes continue to push the performance of the building envelopes to low convective and conductive losses, our buildings are trending toward needing less Btu input to keep occupants comfortable. Consequently, the demand for output on the heating equipment for these buildings is becoming lower, and the divergence in the capacity of traditional fuel-fired high-temperature distribution systems from what the building actually needs has become greater. We are at a point that whole-house heat pump systems are becoming a practical and logical match for the demands and loads these buildings are seeing.

EQUIPMENT OPTIONS

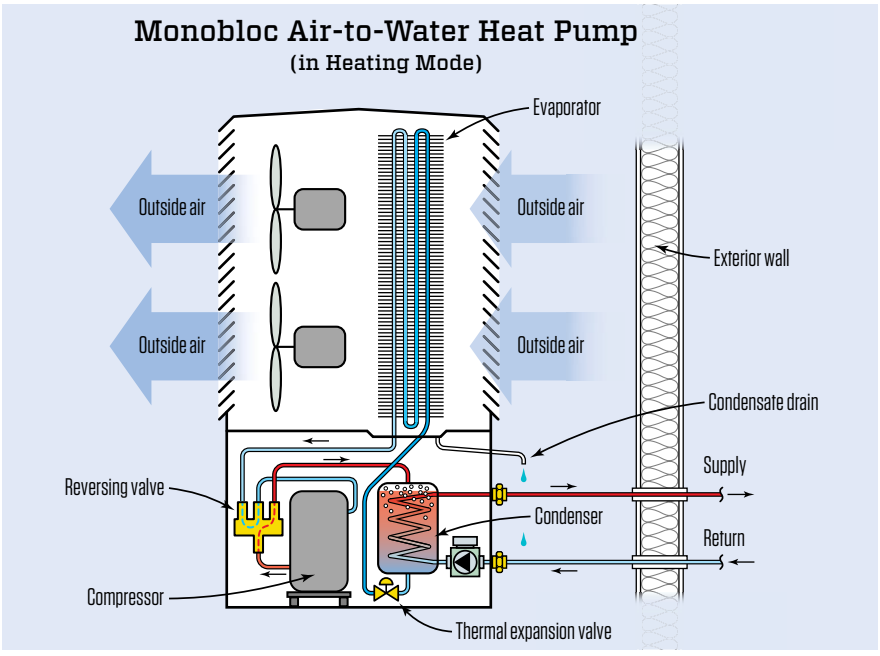
There are two types of equipment for air-to-water heat pump systems, monobloc and split-refrigerant. There are about eight manufacturers actively supplying equipment options for cold climates: Aermec, Arctic Heat Pumps, Chiltrix, Enertech, Nordic, SpacePak, Stiebel Eltron, and Taco Comfort Solutions. Nominal capacities for these manufacturers range between 2 and 6 tons. These cold-climate-rated models can maintain varying levels of capacity and varying coefficients of expansion (COP, a measure of heat pump efficiency) below 0°F, but all are designed for cold ambient temperature applications.

Monobloc systems package all the components of the system in a single outdoor unit that includes the fully charged refrigerant system components, electronics, and heat exchanger from refrigerant to water. Because these systems package everything in the outdoor unit, they require a glycol-mix supply-and-return loop for the water from the storage tank within the house out to the heat pump.

Split-refrigerant systems look and function similarly to other split-system air-source heat pump equipment, with an outdoor compressor/evaporator unit that pipes the compressed refrigerant to an indoor condensing unit. The indoor unit is about the size of a typical mod-con wall-hung boiler that contains the refrigerant-to-water heat exchanger and all of the electronics and controls. The outdoor units for both systems typically have two fans moving air across the refrigerant coils and are about the size of a standard multi-zone ductless unit. Outdoor equipment needs to be set on a frost-protected foundation and with appropriate clearances and considerations for snow and ice as with other air-source heat pump equipment.

The heart of an air-to-water system, though, is the buffer tank. Buffer tanks are thermal storage tanks that are sized in capacity based on the design load for the house and demands on the system. The buffer tank is a thermal battery, storing Btus generated by the heat pump for distribution as needed to the building zones. A buffer tank allows the heat pump (or any other heat input) to run at a steady state with a stable load to attain the highest efficiency. Typically, these buffer tanks also include one or two electric resistance

Photo courtesy SpacePak



A split-refrigerant system has an outdoor compressor/evaporator unit (above left); it pipes compressed refrigerant to an indoor condensing unit (which is about the size of a typical wall-hung modulating condenser boiler; not shown in photo) that contains the refrigerant-to-water heat exchanger and all of the electronics and controls.

elements within the tank that can add Btus or take up the load of the heat pump if it is struggling to maintain the tank temperature. A well-designed and commissioned system, however, will likely never need to rely on the resistance elements.

Given that the heat pump is simply maintaining water temperature in a storage tank for distribution, domestic hot water can also be provided by an air-to-water setup, as well as cooling so long as appropriate emitters are used to accommodate the cooling demand. When additional loads such as DHW or cooling are added to the overall systems design, the capacity of the heat pump as it relates to shared demand for Btus needs to be carefully considered. The simpler the distribution design and the fewer the demands on the heat pump's Btus, the simpler the installation and maintenance and therefore overall cost of the installed system will be.

ENVELOPE REQUIREMENTS

So what determines if an air-to-water system is a good fit for a building? It all comes down to knowing what the Btu demand of the building and individual rooms are.

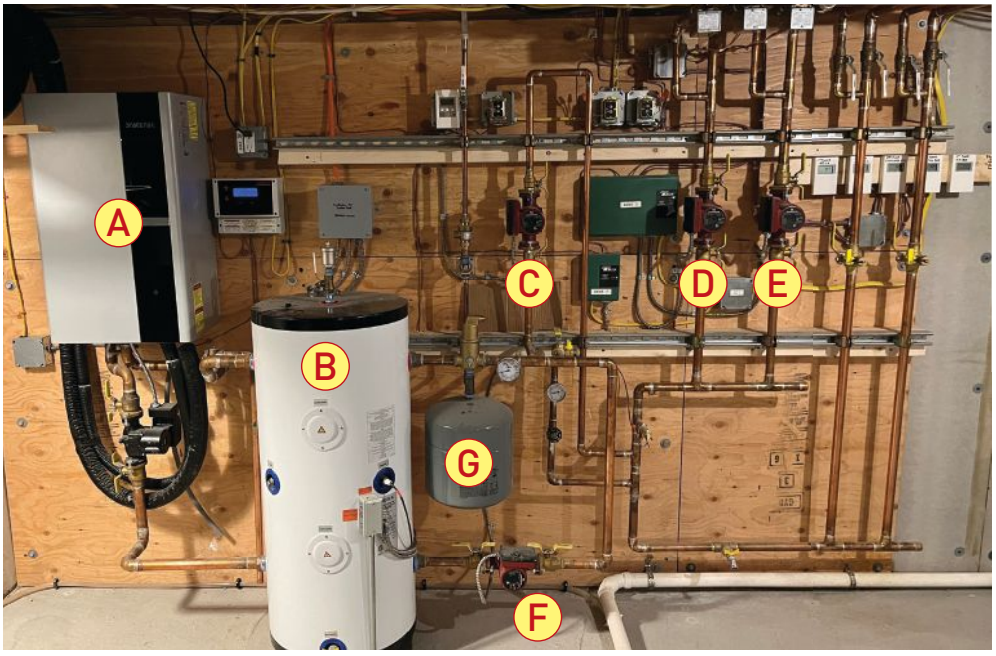
The foundation for designing any HVAC system is accurately calculating the heating and cooling demand for the specific building the system is being designed for. There are industry standards and practices referenced in the IECC that specify the procedure for calculating these loads, namely the ACCA Manual J procedure. Manual J considers the specific building envelope dynamics, including the building volume, exposure, climate zone, and defined design temperature. Design temperature varies by climate zone and by what individual jurisdictions define in their local energy codes. Design temperature is typically defined as the temperature that a location stays above a certain percentage of the hours in a year. This is typically defined as the 99% design temperature, meaning the location will stay above this temperature 99% of the hours of the year.

It gets cold in the northern area of the U.S. and in climate zones 5 and above. So, don't we need to worry about what happens when it starts to dip below zero? Should we worry about the one-percenters?

As noted above, the design temperature typically used to define building loads represents the 99% design temperature. This means that on those nights when the temperature outside drops down to -15° or -25°F, the number of hours actually spent at those temperatures will be few. By the time midmorning comes after those bitter nights, the outdoor air is back up to around zero or above and the heat pump is back in its happy place for efficiency and Btu output. Output and efficiency will suffer when it gets bitter cold, but the duration is minimal and the electric resistance elements in the buffer tank are there to maintain the tank temperature for distribution. And because you have done a bang-up job on lowering the distribution needs of the system down to 100°F delivered water, those electric resistance elements may not need to be doing much if anything at all to maintain the system set points.

Air-to-water heat pump equipment is optimized around

Photo courtesy SpacePak



Typical interior split-refrigerant system setup:
A. Indoor split-refrigerant system components.
B. 40-gallon-capacity buffer/thermal storage tank with 6-kw/20-kBtu backup electric resistance elements.
C. Buffer tank injection pump.
D. First-floor-zone, 3-speed, 3/4-hp circulator pump.
E. Second-floor-zone, 3-speed, 3/4-hp circulator pump.
F. Return-side 3/4-hp circulator.
G. Expansion tank.

delivering water at 120°F or less for distribution. Most air-to-water equipment can provide higher delivered water temperatures, but the lower the outgoing water temperature and the return-side water temperature back to the heat pump (Delta-T), the better the overall efficiency and COP of the system. Most air-to-water equipment on the market can maintain a COP of around 2.0 at 5°F outdoor temperature with varying load maintenance/Btu output at that temperature and below. As with other air-source heat pump equipment, Btu output drops along with COP as the outdoor ambient temperature drops, but as I mentioned above, the buffer tank has electric resistance elements to make up for any shortcoming in Btus from the heat pump.

LOW-TEMPERATURE DISTRIBUTION

Water as a medium for moving heat energy is superior to air by a wild percentage. A given volume of water can absorb almost 3,500 times as much heat as the same volume of air. What that translates into for the distribution components of an installed system is a 3/4-inch-diameter copper (or PEX-equivalent) tube carrying the same heat energy as the area of an 8x14-inch sheet-metal duct in a forced-air system. This has a major impact on the feasibility and cost of installing a distribution system for a home and frees up space for other ductwork needed for whole-house ventilation systems in modern homes.

There are a variety of low-temperature hydronic emitters available that can be flexible and intermixed for various application needs in a building. Examples of low-temp emitters include low-temperature baseboard units, wall panel radiators, low-mass radiant floors, ductless wall- or floor-mounted fan-coil units, and even hydronic air-coils for use in fully ducted distribution delivery systems. The shared characteristic of all these emitter types is that they are optimized for low-temperature water by maximizing the surface area that the water "sees" while moving through or across the emitter. The choice of which emitter type to use can depend on the aesthetic choice of the occupants, but also more importantly, the Btu input needs of the individual rooms within a home.

RETROFIT APPLICATIONS

Air-to-water heat pumps can also be used in retrofit applications to replace or supplement existing fuel-fired equipment. But again, the important factor for the viability of such retrofits is predicated on an accurate basis of design load for the total building and the room-by-room loads needed for distribution. An existing hydronic distribution system designed for high-temperature water oftentimes cannot be used as is when homeowners move to low-temperature water delivery.

Knowing what the individual rooms of a building need for delivered Btus to maintain set point defines how much surface area the emitters need to have in each room. Sometimes, the existing fin-tube baseboard in a room is oversized for the need, and in these instances, the existing baseboard can be adapted as is to lower water temperatures. But oftentimes, the room-by-room emitters may need to be replaced with low-temp-specific equipment. An easy win for retrofitting air-to-water equipment is in homes where the existing distribution is radiant floor systems that are already operating at 120°F or lower. This is an easy match for a heat pump to deliver.

Another factor with retrofit applications is that there is less control over the existing building envelope, and thus the existing heating and cooling loads for the building. Weatherization is an

Photo: Steve Spatz

Two low-temperature distribution options. Low-temperature, above-floor radiant distribution (far left) proves more responsive than radiant slabs. This example uses 5/16-inch PEX tubing set in channeled panels installed directly over 3/4-inch subfloor. A low-temperature panel radiator, such as the Mestek thinwall heating/cooling fan coil shown at left, is another distribution option that is both more efficient and more responsive than a traditional fin-tube radiator.

ideal match of work scope when considering a heat pump retrofit to lower the existing loads as much as possible before trying to match a system. While that can work wonders, oftentimes it may still be necessary or prudent to leave the existing fuel-fired system as a backup to the new heat pump.

KEEP IT SIMPLE

First, air-to-water heat pumps are nothing special if we are being honest. This is not some new, unproven, space-age technology; it's simply a heat pump heating water for distribution. Easy peasy. So, what that boils down to is that this is equipment that is approachable and applicable to just about any well-rounded HVAC professional as a system option like any other for heating and cooling. There is equipment being sold in many regions of the U.S. that is well supported by suppliers and manufacturers helping to design and commission these installations.

When considering using air-to-water heat equipment for a project, keeping it simple is always the foundation for system design. The simpler the system, the lower the cost of installation and the more efficiently the system will run overall. Being accurate and realistic with inputs for block load and room-by-room calculations is crucial for sizing equipment and distribution that will meet the building demands efficiently. Old-school rules of thumb for oversizing or estimating capacity do not apply to modern-day HVAC systems. And this goes for mod-con gas boilers as well; garbage in equals garbage out.

Simple delivery equipment for distribution is also key. Keep zones simple, and design for lowest possible drawdown of Btus per loop and lowest delivered water temperature overall. Right-size the buffer tank to maximize the potential for drawdown of Btus as well, so that the heat pump can run in steady state as often as possible to maximize overall system COP.

That said, you can decide what you want to have the heat pump do for the building. Domestic hot water can be included, as can AC, and mixed distribution types (radiant floors and ducted delivery). This all can be available because again, the heat pump is being used to store energy in a buffer tank for use by the building. To add these other functions, you need to add other tanks to the system. This is all on the table for options, though for each additional output type added to the demand on the heat pump, the complexity of the installation, wiring, piping, sequencing, and overall system operation becomes more complex.

There's a lot to offer in this brave new world where, for better or worse, we seemingly are heading toward a future of fully electrified buildings. If this is to be successful, a foundation in sound HVAC design is absolutely necessary to make this objective functional. Installing adaptable, low-temperature distribution systems into new homes (and retrofitting into existing homes) offers resiliency for the future. Air-to-water heat pumps are well supported with a long track record of successful applications to be used now. If Elon comes up with some new alien tech that supersedes the current benefits of refrigeration equipment, a well-designed, low-temperature, whole-building distribution system will be adaptable to future technology to heat and cool our buildings.

Steve Spatz is an energy consultant and supply-chain account manager at Efficiency Vermont who has worked with hundreds of builders, architects, and mechanical contractors, partnering on the design and implementation of durable residential building systems in Vermont and northern New England.

Photos: left, John Spier; right, Steve Spatz

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1 | REPAIR. Almost every remodeler encounters rotted framing in the course of their work. Whether it be poor design, issues with ventilation or lack of maintenance, homes may have rotten areas that need to be removed and replaced. The OMT gives the flexibility to knock out smaller sections of rotting lumber in tight spots. With the right attachment, this tool can also cut through nail-embedded wood, saving a lot of time and hassle.

2 | DRYWALL. Anyone who has worked with drywall knows that neat, precise cuts are key to less patchwork and finishing. A specialized attachment enables OMT's to cut out outlets and other forms in drywall neatly with no overcutting.

3 | METAL CUTTING. Removing a rusted-out bolt that will not budge is possible with an OMT and specialized metal cutting blade. Often these bolts are in tight spots or corners increasing the need for a lightweight, smaller profile tool.

4 | GROUT REMOVAL. A very common bath remodel issue is stained or old grout that needs removal. To freshen and improve the look of bath tile there is no better solution then a specialized carbide grit OMT blade for grout. Purchasing a premium attachment with the right cutting width will make the removal portion of this job quick and easy.

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6 | KNIFING. These days there is always a plethora of cardboard boxes not just on the job site but at your shop or home as well. A good hook knife blade attachment can save energy and time by breaking down these boxes for disposal with ease.

7 | SCRAPING. The OMT can be used for a variety of scraping applications including removing glue, paint, caulk, and other adhesives. For tougher scraping jobs, a rigid scraper will provide the best performance. For soft adhesives and caulk, use a flexible scraper.

The Oscillating Multi-Tool (OMT) has become a go-to option for many contractors in situations where a job needs to be done quickly and correctly. Diablo Tools offers a full range of carbide and bi-metal OMT accessories that fit any multi-tool, including those with a Starlock interface. If you plan to utilize OMT consider upgrading to the premium solution in OMT Accessories. ■

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What's Ahead for Decks in the 2024 IRC

by Glenn Mathewson

In the April issue of *JLC*, I discussed some of the major new provisions that are being included in the 2024 edition of the International Residential Code. In that article, I focused on the changes that are most likely to affect general contractors and remodelers; here, I'll focus on the new provisions that deck builders will need to be aware of.

Beam sizing. Since 2015, deck design codes have been closely scrutinized and modified with each new edition of the IRC, including the most recent, and soon to be published, 2024 IRC. For example, the relationship of joist back span to joist cantilever, and then joist cantilever to beam span, has been a complicated one to present in pre-engineered design tables. This is due to the fact that the length of a joist cantilever affects the load on the beam supporting the joist, and thus the maximum span of the beam.

Previous editions of the IRC simplified this relationship in the beam sizing table by assuming that all cantilevered joists extended the maximum length allowed beyond the beam. When there was no joist cantilever, however, beams were being greatly oversized and thus overpriced. In 2021, the IRC included a cumbersome method that allowed the values in the table to be adjusted using a modifier value based on the ratio of joist span to cantilever. That sentence alone is cumbersome, so imagine the code. While this method did allow users of the beam sizing table in the IRC to more accurately size a beam, a new approach was approved for 2024.

In the new beam sizing table, the heading of the beam span tables where the "joist span" (with fully assumed cantilever) is listed was expanded to reveal combinations of span and cantilever that would result in the same beam load. For example, the column for "10-foot span" in the 2021 IRC was changed in 2024 to show the column works for a 10-foot span and 2 1/2-foot cantilever, or a 12-foot span and 1-foot cantilever, or a 14-foot span with no cantilever.

Ledgers. The first prescriptive design provisions for decks appeared in the 2009 IRC; they were about ledger connections. Addressing the well-known issue of ledger failures from nailed connections was the intent, and including prescriptive details in the code has provided the country with much-better-connected decks over the last decade.

However, a connection is only as strong as the two components that are being connected, and the IRC has never provided guidance for flashing a watertight connection between the ledger and house to preserve the integrity of the wood materials, which won't hold a connection very well if they decay.

What the watertight flashing would connect to has also been a moving target. Do you flash behind the ledger or behind the water-resistive barrier? What if it's a rainscreen system? What if there's no WRB, as permitted in certain conditions in early editions of the IRC? Decks are attached to houses built with a variety of methods and materials, both current and outdated, and these questions are going to get their first round of standardized answers in the 2024 IRC.

The approach will be that the exterior wall covering—whether clapboard siding, stucco, brick, or something else—is the bulk water control layer, while the WRB is—as its name implies—the final water barrier. For this reason, the 2024 IRC will require that ledger flashing be tight to the WRB, when one already exists or in new construction. The flashing can lace shingle fashion into the WRB laps, or it can be sealed to the face of the WRB with a self-adhering membrane. This will allow the flashing to be installed at a separate time from the WRB and alleviate concerns many deck builders have about cutting into an existing WRB to lap it with their ledger flashing.

In existing construction without a WRB, a deck ledger is replacing the function of the siding, but a ledger supports human occupancy and siding doesn't. So, to protect the integrity of both the wall and the ledger connection, a WRB must be installed only in the area behind the new ledger and high enough that the ledger flashing can be sealed to the membrane. The flashing and the WRB must extend at least 2 inches above the top of the ledger and a self-adhering membrane strip must then be sealed over the 2-inch vertical flashing leg and sealed at least 2 inches onto the sheathing above the flashing.

When a rainscreen type of wall covering is installed and the ledger is spaced from the exterior wall to create a continuous drainage plane, the flashing does not have to seal or lace into the WRB, so it only goes behind the covering. When a ledger is installed with alternative methods (such as structural brackets) that space it from the wall covering by a minimum of 1/4 inch, flashing is not required at all.

Flashing can be placed behind the WRB in shingle fashion, with at least a 2-inch lap or can be sealed to the face of the WRB

with a self-adhering membrane. On the other edge, flashing must extend beyond the face of the ledger and down a minimum of 1/4 inch, but alternatively, it can extend horizontally and over the joists by a minimum of 4 inches beyond the ledger face. All shingle-fashion lapping must be at least 2 inches, but there are exceptions for when a door or window is directly above the deck. The window flashing can then integrate with and take the place of the deck flashing.

Decay resistance. Clarifications were made regarding when decay-resistant wood is required for different wood members of a deck. All joists, beams, posts, decking, and stair stringers must be decay-resistant, meaning either preservative-treated in accordance with the AWPA U1 standard, or a naturally durable species of wood. In Chapter 2, the 2024 IRC defines "naturally durable" species as being only redwood, cedar, black locust, or black walnut, with each piece having no more than 10% sapwood on each face. In theory, this controversial measure eliminates all the common hardwood decking species from use under the IRC, but it's unclear how it will actually affect the marketplace.

Selecting wood decking of the listed species under this clarification is likely to be a significant challenge, as it eliminates all sapwood grades of redwood and cedar from use in the residential decking market. B-grade redwood, for example, has much more than 10% sapwood and thus is not compliant as decay-resistant. However, there is an exception to this requirement in regions where climatic experience has demonstrated that decay resistance is not required. Talk to your building official. I expect this subject will come up again in the 2027 IRC proposals, as even those organizations that supported this change admit it may unnecessarily exclude many historically viable wood decking materials.

Stairs. The IRC has always required that all exterior stairs have a landing at their base that is at least as wide as the stairs, but without clearly specifying materials that the landing must be made from. On low-level decks where the deck stairs access grade, homeowners often want to have grass or gravel landings. However, per the IRC, a landing must have a surface stable and consistent enough to be a measurable surface that is limited to a 1/4:12 slope in most cases. This can create design issues when a ground-level deck has a couple of treads that wrap around the perimeter of the deck. If the local building department requires a hard surface landing, the owner may not be happy about having to replace 3 feet of lawn around the deck perimeter with a concrete or flagstone landing.

For this reason, the 2024 IRC includes a new exception for the bottom stairway width, specifically for exterior stairways serving a deck, porch, or patio (basically a backyard deck). If the stairway has three or fewer risers and if no handrail is required, the bottom landing can be only 36 inches wide. This exception does not apply to required egress doors.

Guards. Guards received some attention from the committee, thanks to the increased scrutiny of guard connections to decks and floors in the 2018 and 2021 editions of the IRC. This drove nailing down the deflection limit, as you can't fully evaluate guard connections without it.

Including prescriptive details in the code has provided the country with much-better-connected decks.

Generally speaking, deflection is the limiting factor in all structural designs, and the IRC provides deflection limits for various structural elements, such as floors and roofs, in construction. But how much can a guard deflect, and how do you measure it? This question has never been clearly answered in the IRC, partly because guards have typically been built in the field, without engineered plans or tested installation instructions.

As manufactured deck guards have become more popular, testing protocols have established deflection limits for products, but not for custom-built guards from wood materials. Those deflection limits aren't identified in the code, so they aren't universally applicable to all guards. There were a lot of ideas and discussion for how to address guard deflection in the IRC, but the proponents and the committee couldn't reach a consensus on how to evaluate it. As an interim measure, the 2024 IRC clarifies that the current deflection limits of L/240 for "all other structural members" does *not* apply to guards. This subject will have to be discussed again for the 2027 edition.

Many issues were addressed for the 2024 IRC; some were resolved, and others were not. Regardless, the IRC code development process is open to anyone to participate, so nothing is ever "settled," and everything can be revisited and revised with a simple proposal. I encourage professionals in the deck industry to make themselves familiar with the current, 2021 IRC and the changes soon to be published in the 2024 edition. With that baseline understood, new ideas can build on it. The future codes are decided by those who speak up and make themselves heard. ❖

Glenn Mathewson is a frequent presenter at JLC Live and a consultant and educator with BuildingCodeCollege.com.

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Installing a Patio Cover

Polycarbonate panels covering this free-standing pergola let in light and block out the rain

by José Mullet

Recently, my company installed a patio cover for my aunt as part of a full exterior makeover of her house. The project also included a complete gut and interior and exterior rebuild of her rental property next door. The covered pergola described in this article was the finishing detail of the fairly involved makeover of the two properties, which are located in a small, rural town on the outskirts of Waco, Texas.

We had closed in the original front porch to add some living space, so we designed the pergola to provide a new sheltered entry and some curb appeal as well. But while my aunt wanted a covered porch, she also wanted to allow natural light into the front windows of the house, particularly the front kitchen window. These considerations guided her choice of a clear cover. Our research led us to Regal Plastics' Hercules System, which consists of commercial-grade, four-walled polycarbonate sheets and the accessories needed for their installation.

The 8mm-thick sheets measure a little less than 24 inches wide and are available in 12-, 16-, 24-, and 28-foot lengths. Custom lengths are also available; we ordered for coverage of 12 feet 6 inches and received 13-foot-long sheets. We installed what the company calls "clear" sheets, which offer 69% light transmission; bronze (32% light transmission) and ice white (22% light transmission) are also available. The UV-resistant sheets have a standing seam design to prevent leaks and are rated for winds up to 125 mph and snow loads of 40 pounds per square foot.

This was our first time using this particular system, and we found the panels to be a much higher quality product than what is often sold with greenhouse kits. They can be ordered directly through the manufacturer's Cover Your Pergola website (coveryourpergola.com) and delivered directly to the jobsite, but in this case, we picked up the panels at the company's nearest warehouse, which for us is in Austin, Texas.

PHOTOS BY JOSÉ MULLET

Figure 1. The pergola's support posts bear on the concrete patio and on 16-by-16-inch piers (A). The author uses one jig to shape the ends of the double 2x12 beams (B) and another one to shape the 2x6 rafters (C). Decorative hardware is used to hang the 2x12 beams from the pergola's 6x6 support posts (D). A simple guide made out of scrap material allows the author to make the clean and accurate 45-degree-angle cuts needed for the diagonal braces that reinforce the post-to-beam connection (E). Long structural screws fasten the 2x6 rafters to the beams (F).

Foundation

We had initially sized and poured a patio for a smaller, traditional front porch, but as our client's plans for the porch changed and its size grew, we decided to go with a free-standing structure instead of attaching it to the house. To clear a hipped roof corner on one end, we pushed the overall height of the pergola up above the eaves with a beam bearing on three 6x6 posts. These posts are located close to the front of the house and are connected to the patio slab with decorative powder-coated galvanized-steel post bases made by Ozco Building Products.

Since the concrete patio that we had placed wasn't deep enough to support the posts for the front beam of the larger porch roof, we formed and poured in place three 20-inch-deep 16-by-16-inch concrete piers (there's no frostline in Waco) reinforced with a simple #4 rebar grid. These piers are located 10 feet from the front of the house and have a washed aggregate finish so that they will blend in with the owner's future landscaping plans.

Figure 2. Angle brackets are used to fasten the rafters to the beams, along with structural screws driven down through the tops of the rafters (A). The roof panels are supported by 2x4 purlins and are fastened to them with special metal clips (B). Friction-fit connector caps are tapped into place with a mallet to cover the raised seams between panels and prevent leakage (C), then plugged with matching end caps (D). The ends of the hollow panels are covered with a special vent tape followed by a flute cover, allowing for ventilation while blocking access to insects (E). The outside edge of the last panel is cut to fit, then covered with a metal U-edge profile that is screwed to the purlins (F).

Framing

We framed the roof structure with rough-sawn western red cedar, using 6x6 material for the posts and diagonal braces, 2x12 stock for the two double beams that bear on the posts, and 2x6 stock for the rafters, which are spaced 24 inches on-center.

Beams. Prior to installing the double 2x12 beams, we profiled their ends using a router guided by a jig that my dad had made for previous projects. After lifting the beams into position, we connected them to the posts with black Ozco hardware that matches the post-base hardware. I've been fortunate to learn from multiple talented old-school craftspeople, so making jigs to minimize human error has become a natural part of the way I work.

Diagonal braces. We don't build a lot of pergolas or work with large timbers often and don't have a beam saw with the capacity to cut through 6x6 stock in one pass. So I made a quick 45-degree jig to make the cuts for the diagonal braces; along with the jig, I used a circular saw

Figure 3. Raising the inner beam of the free-standing pergola above the eaves of the home's hipped roof allows for air circulation as well as the recommended slope (1 inch in 4 feet) for the polycarbonate roof panels (A). The panels chosen for this patio cover allow plenty of natural light into the home while providing shelter from rain and snow (B).

to make clean cuts on both sides of the workpiece and then finished the cut with a reciprocating saw. To ensure nice fits, I cleaned up high spots as needed with a 24-grit sanding pad fitted to an angle grinder. I used Simpson Strong-Tie Outdoor Accents structural screws to fasten the diagonal braces to the posts.

Rafters. After making the seat cuts on both the upper and lower ends of the rafters, we profiled them using a router and another jig with a slightly different profile than the one we used on the beams. We fastened the rafters to the beams 24 inches on-center with 8-inch-long Simpson Strong-Tie structural screws. On the low side of each beam, we added Ozco rafter clips, which helped plumb the rafters.

Purlins. To support the roofing panels, we installed 2x4 purlins 16 inches on-center, fastening them to the rafters with 3-inch-long stainless steel screws.

Roof System

Everything needed to install the Hercules roof panels was supplied with the order, and the panels proved to be fairly simple to install. They come with a protective film on both the top and the bottom of the panel; we removed the bottom film prior to panel installation. We left the top film in place until the sheets had been installed, and even then only partially removed it along the edges to install the seam covers. Only after we finished the install did we fully remove the top film. Following the manufacturer's instructions, we covered the top edge of each panel with the supplied vent tape, then installed the flute covers over the vent tape prior to lifting the panel up into position.

Starting at the middle of the porch, we installed the first panel using the supplied metal clips along both edges. Then we worked toward both ends of the porch, connecting each panel along one edge to the clips holding the previous panel, and fastening down the other edge with more metal clips. As each new panel was installed, we used a rubber mallet to tap down the connector caps that cover each seam. Those caps then were fitted with end caps.

As anyone who has installed metal roofing panels can tell you, roofs are rarely perfectly square. Because these panels arrived a few inches longer than their nominal length, we could easily trim them to length and—at the edges of the porch—to width with a circular saw. Those cuts were later covered with edge U-profile trim pieces, which added another 1/2 inch to the length and width of the panel (and thus must be accounted for when calculating the size of the end panels). Stainless steel screws driven through the metal trim pieces—but not through the panels themselves—secured the perimeter of the roof covering to the framing. ❖

José Mullet operates Mullet Carpentry and Remodeling along with his father, Alfredo, who owns the Waco, Texas-based company. He currently is the director of construction for Waco Habitat for Humanity. You can find José on Instagram @mullet_carpentry and on TikTok @josemullet.

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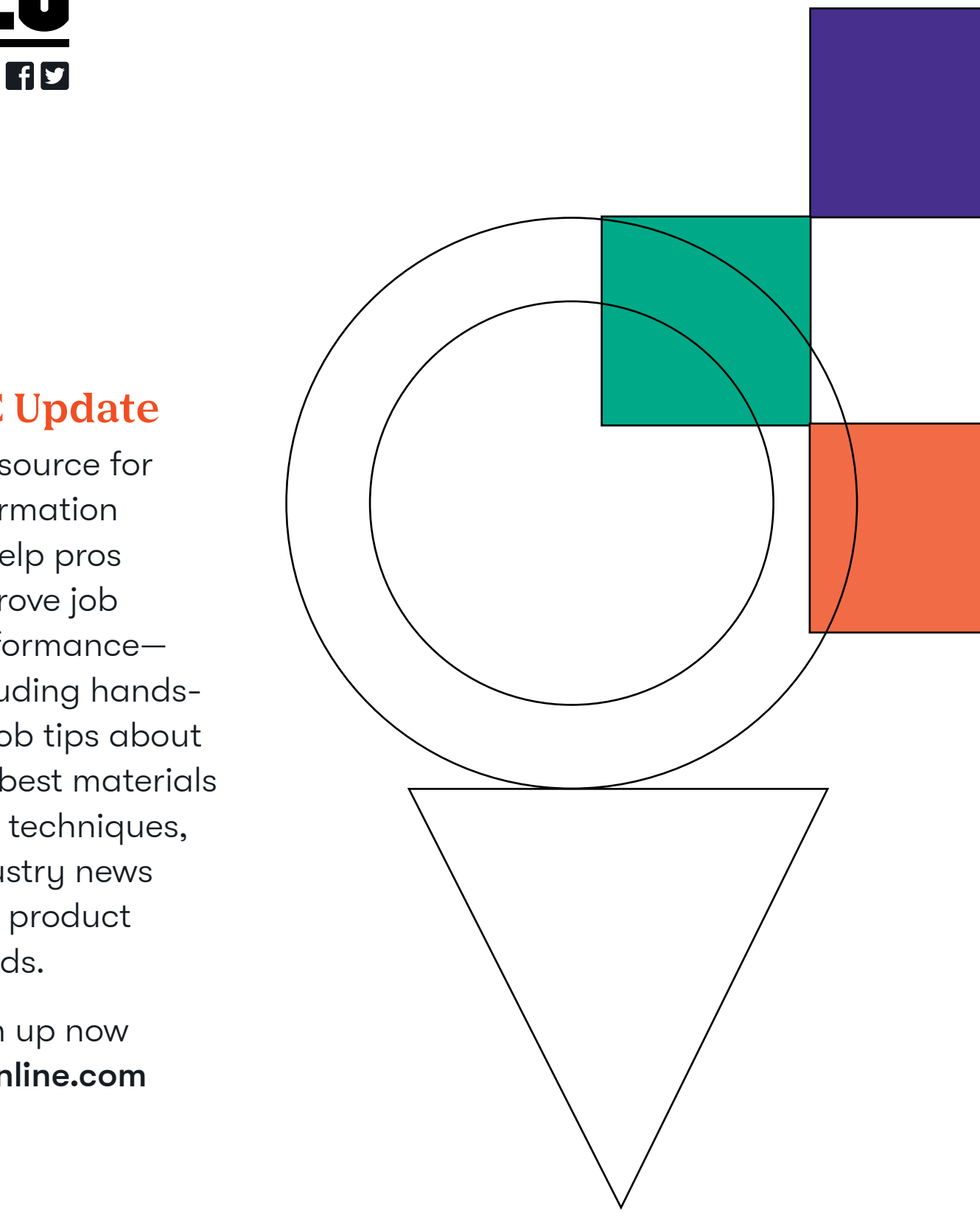

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Streamlining Your Deck Business

Eliminate errors and boost profits with repeatable processes and standard details

by Greg DiBernardo

PHOTO BY JOHN HUMPHRIES; INSET BY GREG DIBERNARDO

Most of our clients don't start out a renovation project with any kind of plan. They may have a general sense of what they would like to end up with, but rarely do they have specific details on hand when they're shopping around for contractors. In my career as a deck and porch building specialist, I hear the same things repeatedly, such as "I want to redo my deck," or "We want to rebuild our deck and add a screened area." These vague, open-ended concepts are not very useful starting points for coming up with a plan, but I don't blame prospective clients for being unprepared; in our market, it is commonplace to start with a contractor instead of a design professional.

My first job as the contractor is to move the clients past their vague concepts through the design process and into an executable contract. My contracting firm is small, consisting of a full-time office/business manager, a project manager keeping the wheels on the bus every day, and me. We don't have a dedicated design staff to work through all the decision forks to nail down details in order to create a scope of work and a budget, which on a big project, can take weeks or months and become a significant cost factor. Like the majority of residential contractors, I have to work through the design while keeping up with all the other daily requirements of running the business. To do this, I've come up with a system that helps streamline the process.

Processing Leads

The first part of streamlining is developing a sales-call process that is consistent and repeatable with every new lead that comes in. What I mean by this is, how do you handle the "first touch" with a new lead? Do you call or text or email them? How long do you wait to respond back to them? What is your deadline for this? How do you track that correspondence

systematically so you can keep track of whom you are talking to what about? What questions do you ask the first time you communicate with prospects? Do you even have a list of standard of questions? (Spoiler alert: You should.) What kind of information does that client need to give you before you consider taking a meeting with them (general scope, how much research have they done, budget, time to start, etc.)? What information do they need to know about you (lead time to start, area of expertise, budget compatibility, etc.) before they take a meeting with you? (See "First Touch Lead Questions," below right.)

Scheduling estimate meetings. One effective way that I've found to make this process easier is to determine what the best times are for me to meet with prospective clients. I let the clients work around my schedule; I don't work around theirs. If they are serious, they will carve out the time to meet with me. I say, "I have this time, this time, or this time available to meet with you ... which one would you like?" You tell them, not the other way around. This is the same concept as setting up a doctor's appointment or a dinner reservation.

I have eight appointment slots every week. This never changes—ever. The slots make the best use of my time, dodge bad traffic conditions, and work to my advantage. Driving is unproductive time for me, so I minimize it. All of the slots are during standard office hours, and all are guaranteed to get me home no later than 5 p.m.

During the home visit. When I am meeting with prospective clients for the first time, I am like a robot. It is not that I'm mechanical or not personable, but I know what I need to find out, what I need to discuss, and what details I need to take back to the office with me to get a design going. I created a worksheet that I always bring with me to take down relevant information and use for a drawing (**Figure 1**).

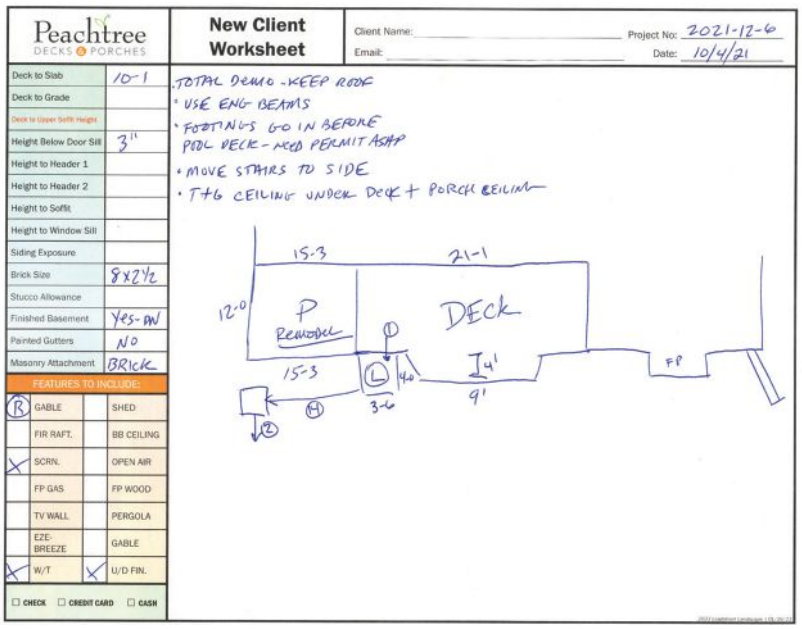


Figure 1. During his preliminary site visit for the project shown on the previous page, the author recorded basic measurements and the client's design goals on his company's "New Client Worksheet," then used this information to create his proposal and estimates.

First Touch Lead Questions

1. Is now a bad time to talk?
2. How are you hoping that I can help you?
3. Part one: Can you give me an idea of where you're at in this process?
   Part two: Have you talked to other contractors yet?
4. How long have you been thinking about doing this project?
5. What has made you decide to want to do it now; what's changed?
6. When are you hoping to have it done?
7. Have you worked with other contractors or have you done similar projects? Have you ever hired a contractor for any project in your house before?
8. Who else is excited about this project?

Always remember that you are the professional, and you run the show. Even though it is their house and their project, you are the one steering the ship and conducting the meeting. The last thing you want to be bogged down in is paint colors and door knobs when the client doesn't even have a scope of work. If you let Mrs. Jones go down rabbit holes of Pinterest day-bed swings she likes at this meeting, you are doing it wrong. All you need to know is that Mrs. Jones wants an area to hang a swing—that's it.

To keep conversations moving in the right direction and not get into the weeds, create a repeatable meeting template and use it. It can be very simple (see "Meeting Template," opposite page).

Custom Look, Standard Details

The word "custom" is thrown around quite a bit in our industry, but what is

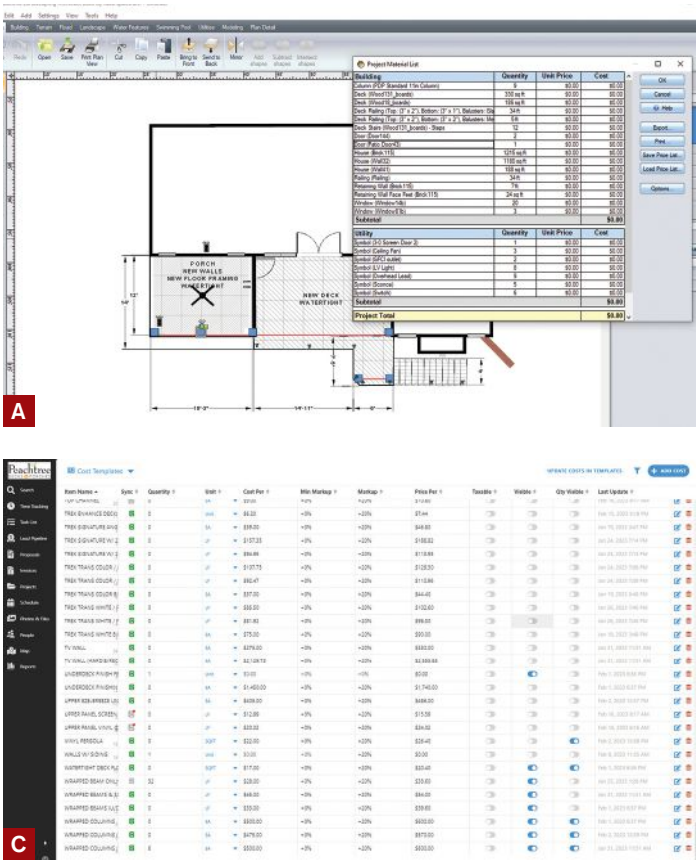


Figure 2. The author uses information from the client worksheet and his library of standard details to create plan views (A) and 3D renderings (B) in Realtime Landscaping Architect CAD software. He then loads the deck's square footage and component list into Projul construction management software, which he has preloaded with pricing, to determine a project's estimated cost and share it with a client in the proposal (C).

the true definition of "custom"? Every job I have ever built is custom in the sense that no two are alike. So, I consider our work to be custom in every respect when describing it. But to make designing and building much simpler—and less expensive—for both me and my clients, we have developed a library of repeatable details that we work into every project. These details allow me to design, estimate, and build considerably more efficiently than if I had to go to the drawing board every time I met with a new prospective client.

It is an approach that can be scaled up or down as needed for your particular enterprise, though it may require taking a step back and looking at your existing processes and how you execute them to embrace it to its fullest potential. Here's how it works:

Design phase. After the estimate meeting with a client, I take the data and measurements that I've collected and work on a design using our standard design features. These features are versatile and look great on almost every home style we work on in our area. The look we have developed for our projects is upscale and impressive, so that our clients will feel that their project will be the nicest one in their subdivision when done.

I have prebuilt pricing models for everything in our repertoire, and they make designing and estimating efficient. For a typical deck and porch project, I can design it and have a proposal prepared in under 30 minutes of seat time. I don't have to wait on pricing from suppliers or do many, if any, calculations. I use

Meeting Template

1. Greeting.
2. Small talk to establish empathy (Do the clients have a dog? Ask about it. Interesting thing on the wall? Where did you get that? And so on).
3. Look at the work area together and listen to clients as they explain their ideas.
4. Propose potential ideas you see for the project and see if they are in agreement.
5. Take measurements and documentation while they look at your portfolio (before/after photos are great here).
6. Answer questions that they might have.
7. Discuss timeline for your proposal.
8. Leave them with a clear understanding of what their next step should be.

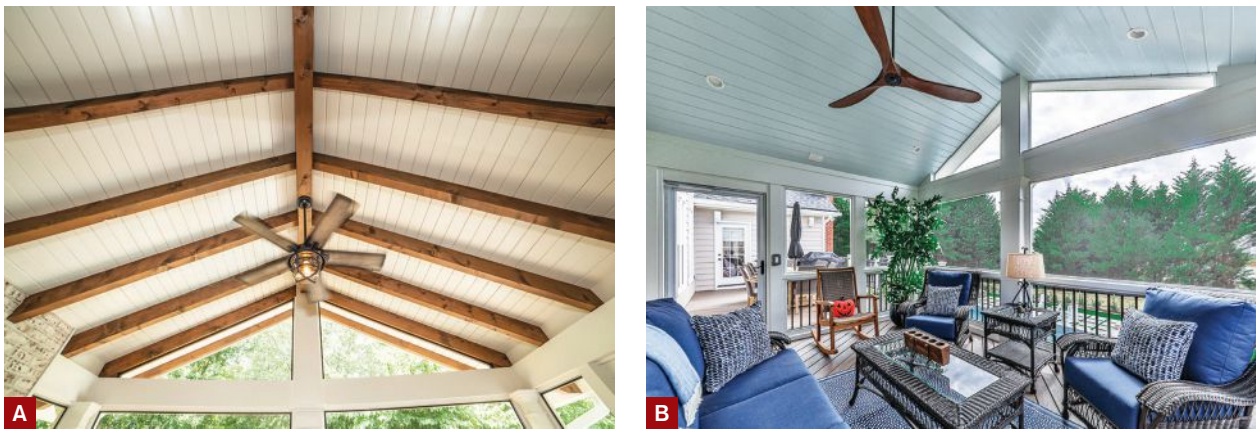


Figure 3. Two standard porch ceiling options offered by the author include exposed Douglas fir rafters and T&G roof decking (A) and standard roof framing with a T&G ceiling (B). Pricing for both is based on roof pitch and square footage.

Figure 4. Another way the author streamlines the design and estimating process is by offering a limited number of railing options. Here, the same black aluminum railing panel is shown with two different post styles (A, B).

the standard design features as building blocks and am just entering quantities in my estimating software. That being said, I have invested a significant amount of time on the back end to make this quick day to day. It is worth it. If you have not invested in an estimating system, you should (**Figure 2**).

Standard details. A standard detail is exactly what it sounds like: your company's default method of building a component using the same materials, dimensions, and finishes. Or, if your work requires components that have a lot of variables, start your estimating with the most popular recurring option to establish a baseline budget. Take a door, for example. A 3′-0″ x 6′-8″ entry door could vary in cost from $350 to $10,000. Find a popular door that you like and that most of your clients like and make it a standard design feature for the sake of getting your proposal out quickly.

For instance, if you remodel bathrooms, you might want to have three standard shower-door options in your library to use as a basis for a preliminary budget. During your estimate meeting, ask your client to pick one for now—the choice can always be changed later, but you need a starting point. The goal here is not to get too specific too quickly. Your client came to you with nothing, and you are helping her through decision forks by limiting options at this stage. When you have standard features that can be plugged into a design, you can develop budgets quickly and keep the design process moving along. It's not until a client is under contract that I get quotes on custom items; otherwise, it would probably be a waste of both my and my vendors' time.

Our company includes three brands of decking, four different railing systems that can be mixed and matched, and two different roof design styles among our standard details. How we install and build these never changes, so it is easy to estimate and—more importantly—easy for my crews to build them in the field (**Figures 3, 4, 5**).

Finalizing the design. Once a potential client is under contract, we use our standard details to build their project. Here's the thing—clients don't necessarily look at them as standard details. Walking through our showroom, they see these details as beautiful options that can be worked into their project. It's like selecting items from a menu: A little of this,

PHOTOS: GREG DIBERNARDO; EXCEPT 3B, JOHN HUMPHRIES

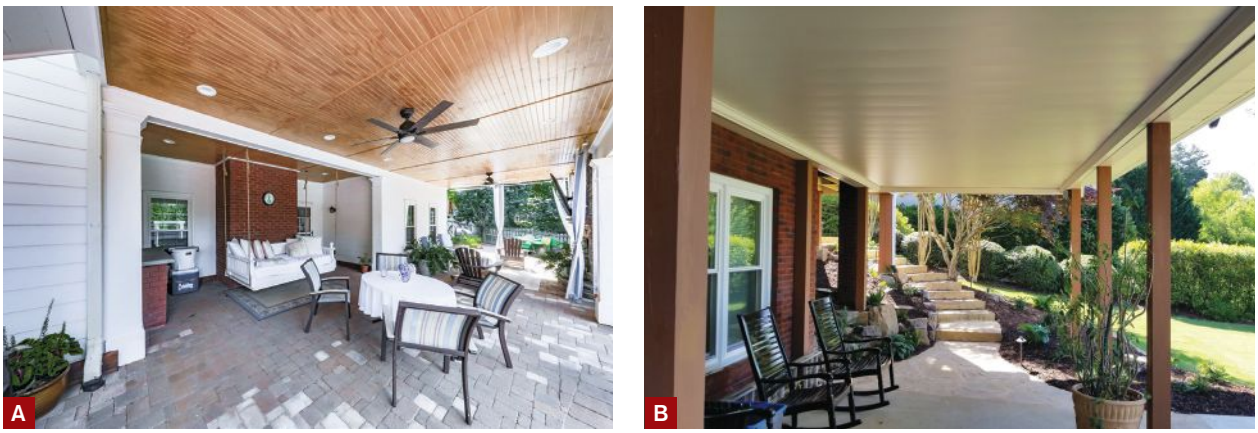


Figure 5. Under-deck ceiling options can also be standardized. The author's premium waterproofing package includes column wraps, wood ceiling, and crown molding (A). The basic package uses an aluminum under-deck system and costs considerably less.

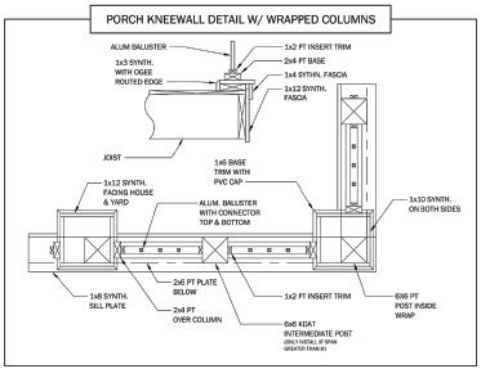


Figure 6. Workers in the field can refer to the author's cloud-based library of construction details, such as the porch knee-wall detail shown here, which have been standardized to eliminate errors and produce repeatable results.

some of that, and in 30 minutes, we will have designed and specced out a $150,000 outdoor project. It's painless for them—fun, even—and easy for us. Everything is black and white and locked in.

Sure, there are times when we do add custom components. We would be crazy not to offer them, but working with standardized options is much easier. The feedback I get all the time from clients is that they hate having to make decisions when there are too many options. Three to five options is a good range for most people. In some cases, we simply say, "This is the way we do it because we've found it's the best way," and they typically will defer to our judgment.

Standard Details in the Field

Creating standard details that are repeatable in the field is where the rubber meets the road. Several factors make me a strong believer in developing repeatable construction details.

The primary reasons are that it saves time, eliminates errors, and tends to produce better results with time. The less my crews and subs have to think in the field, the more time they are in "go" mode making things happen. Standardized details also save my project manager's time because he doesn't have to worry about so many minor specifics. It sounds crazy, but you can start to take certain things for granted once your team has the standard details down to a science. Every project has nuances we have to worry about, but I don't want to waste time even thinking about a column trim detail we have built a thousand times—we just want it done.

The way we do this is by drawing out the details in plan and section form and saving them in a library of drawings in the cloud that the crews can access at any time if they have a question. What we've found is that most of crews memorize the details after a couple of jobs. They love the fact that they aren't standing around scratching their heads on every job and can just do what they know (**Figure 6**).

Using standard construction details results in fewer estimating/take-off mistakes, which means more profitability. We know exactly what we'll need on site to build them. No less, no more. And because the crews have had a lot of practice building the same thing the same way over and over, we see a lot fewer mistakes. They know exactly what materials and tools they'll need that day to complete the job.

Lastly, training is much simpler. The quality of labor is not likely to get better any time soon, if ever, so it is important to simplify as many things as we can to keep build quality up with a less-experienced work force. The simpler we can make it, the better off everyone is. ❖

Greg DiBernardo owns Peachtree Decks and Porches in Alpharetta, Ga. (peachtreedecksandporches.com). Follow him on Facebook.com/peachtreedecksandporches.

PHOTOS: 5A, JOHN HUMPHRIES; 5B, GREG DIBERNARDO

Quicker Stair Stringer Support

Pylex screw piles might let you skip the concrete

by Calvin Cerilli

Stairs are an essential part of any decking installation. Not only are they functional, creating a more versatile deck by allowing easy access to a yard, but they are also an important part of the design of the structure. Stairs face a lot of use and abuse, too, being exposed to the elements and supporting the weight of people walking up and down. If not properly supported, the stairs can shift or sink into the ground, requiring repair or replacement.

One way to keep them in place is to use 4x4 posts or concrete piers bearing on concrete footings to support the stringers. Another approach is to form and pour a concrete landing pad and attach the stringers to the pad. But in our area—Winnipeg, Manitoba—frost can reach 50 inches or more into the ground, which requires very deep footing holes and the labor to dig and pour them, and not all our clients like the look of a concrete landing. Instead, our company, Blue Chip Decks, has adopted a different approach for some of our deck stairs that incorporates Pylex adjustable screw piles.

Pylex Screw Piles

Approved in many areas for small decks (always check with your local inspector), Pylex screw piles consist of a 6-inch-diameter spiral steel disk welded to a powder-coated 1 1/4-inch-diameter steel tube. They are smaller than structural helical piles, which we install with a machine and use to support decks. Pylex piles can be quickly and easily fitted into the ground using a low-speed, high-torque power drill or by hand using a special T-handle that attaches to the top of the pile and is offered by the company.

The piles are available in 32- and 50-inch lengths, with either fixed or adjustable saddles sized to fit a 4x4 post. We typically use 50-inch piles with adjustable saddles, which are needed if a 24-inch extension is used when a pile

PHOTOS BY CALVIN CERILLI

Figure 1. The 50-inch Pylex screw piles (A) with an adjustable saddle (B) that the author uses to support his deck stairs are designed to be installed by hand (C). The manufacturer offers a T-shaped fitting that fits over the shaft of the screw pile; longer lengths of steel rod can be added to the fitting for more leverage (D). Once the pile is embedded in the ground, the adjustable saddle is added to the assembly (E).

needs to be installed deeper. According to the company, the piles can support 5,000 pounds of load in sandy soil, and 3,500 pounds in clay (**Figure 1**).

Installation

We started using Pylex screw piles for deck stairs a few years ago. One advantage over traditional concrete footings or a slab is that it takes only 10 minutes or less to install a pile. In addition, with the extension, the screw piles go far deeper into the ground than usual concrete alternatives, allowing them to provide greater support.

Pylex piles are particularly well-suited for the disturbed soils found near newly-built homes where we do a lot of our work, which allow the piles to penetrate deeply into the ground. For unfamiliar soils, the manufacturer recommends pounding a length of #4 rebar into the ground where the pile will be located to see if any rocks or roots will block its path. The rebar can then be left in the ground and used to guide and reinforce the pile. When the soil is unsuitable for piles, we break out shovels and bars and take a more traditional approach.

A 4x4 post installed vertically can be screwed directly to a pile, but we often install the piles after we've cut the stair stringers and hung them from the deck framing. The stringers are just resting on gravel that we've spread on the ground and leveled after removing sod and covering the ground with landscape fabric. We install the first pile between the first and second stringers at one end of the stair, roughly centering the pile between the stringers.

It usually takes only one man to screw the pile into the ground, though a second

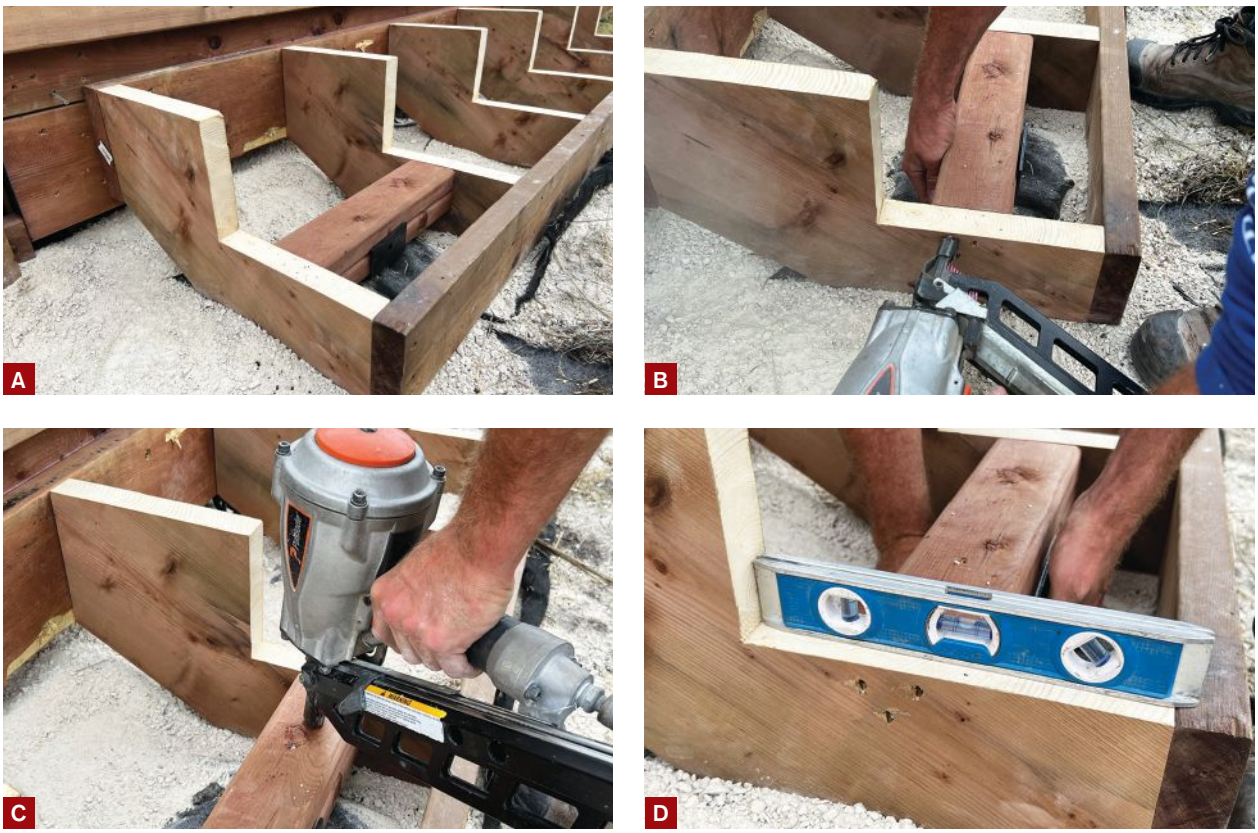


Figure 2. Here, the author is installing double 2-by blocking cut to fit between a pair of stringers (A). After nailing off the stringers to the blocking (B) and nailing the double blocking together (C), he turns the nut underneath the saddle until the stringers are level (D). Then he repeats the process for each pair of stringers until the stair is level from side to side and from front to back.

pair of hands can be used when a little more leverage is needed. We prefer not to install the piles with our big drill, which can create too much torque and actually break the shaft. As we screw the pile into the ground, we occasionally compact the soil under the disk by using a sledgehammer to pound in a block fitted to the saddle.

Once the top of the shaft is flush with the ground, we drop in the adjustable saddle, which can be raised up to 6 inches if needed. The saddle accommodates double 2-by pressure-treated blocking installed horizontally, which we cut to fit snugly between the stringers. After checking that the stringer is level and adjusting the saddle as needed by turning the nut on the threaded shaft, we nail off the stringers into the blocking. We also drive structural screws through the saddle into the blocking (**Figure 2**).

We install the next pile between the stringers on the other side of the stairs, following the same procedure and making sure that the stairs are level from side to side as well as from front to back. We typically support each pair of stringers with a pile and blocking. For example, a 36-inch-wide set of stairs with stringers 12 inches on-center (for composite decking) would require only two piles. A similar set of stairs that's 60 inches wide would require three piles.

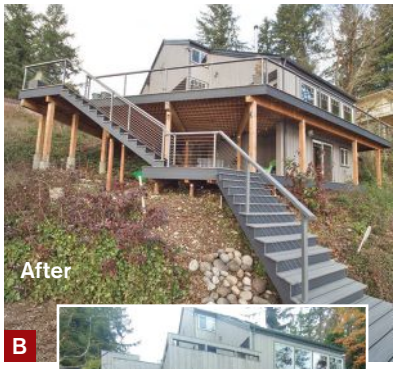
Performance

Over the course of the four years or so that we've been installing piles, we've found that the structure of stairs supported by them remains more stable than stairs that are supported by wood posts bearing on concrete footings, and they're more capable of withstanding freeze/thaw cycles that impact the soil and accelerate sinkage. Because the screws are placed so far into the ground, they are also far better at withstanding water buildup.

Alongside providing exceptional support to deck stairs, Pylex screw piles are a far more affordable alternative to the more traditional concrete piers or posts supported by concrete footings. We pay about $40 (Canadian) for each pile. ❖

Calvin Cerilli is co-owner of Blue Chip Decks in Winnipeg, Manitoba.


A



B


C


D

The Seven-Level Deck

by Kim Katwijk

Building (or rebuilding) a lakeside deck often comes with unique challenges, from navigating tricky watershed zoning regulations and changing water levels to working on a steeply sloped site. A recent project on Washington's Offutt Lake, a small body of water about 15 miles south of Olympia, had all of these, along with a huge stump, which couldn't be easily removed, lurking beneath the existing deck.

The homeowners wanted to expand and modernize the outdoor living space surrounding their 1970s vintage home. They also wanted to open up their views of the nearby lake, which were partially blocked by the solid porch railing enclosing the deck on all levels.

With about 20 feet of elevation difference between the driveway entry level at the back of the house and the water level in front, my goal for the project was to provide a functional outdoor living space that wrapped around three sides of the house **(A)**. To avoid overly long runs of stairs, I tried to minimize changes in elevation from level to level.

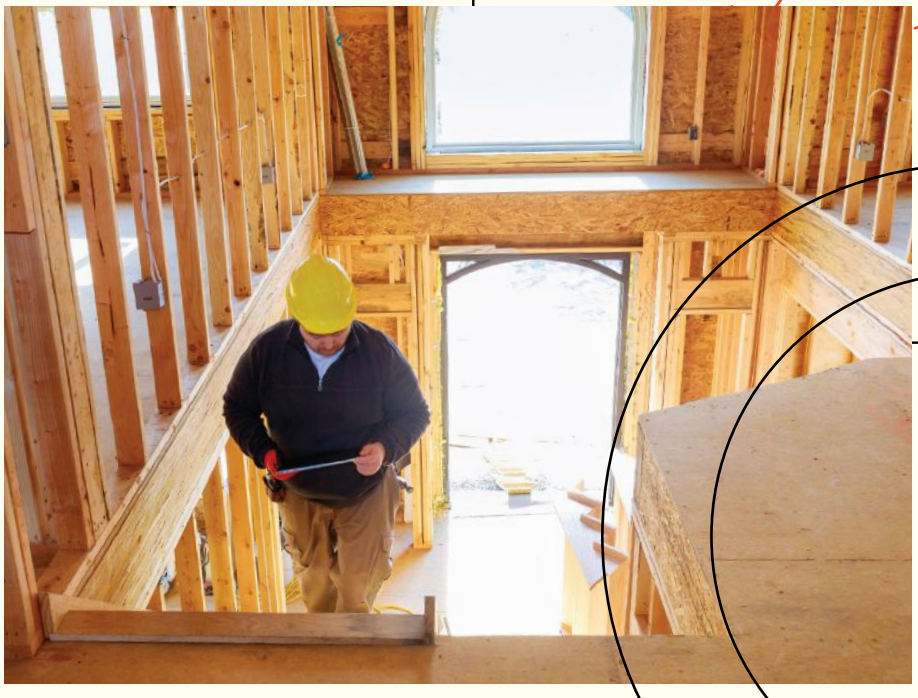
We mixed the concrete on site for the footings that support the deck framing, and we used pressure-treated glulam beams to accommodate the long spans over the lurking stump and to minimize the number of footings needed. We replaced the existing cedar decking with low-maintenance Deckorators composite decking **(B, C)**.

The minimalist surface-mount railing was supplied by Innovative Aluminum Systems, a company located in British Columbia that we frequently work with. We fabricated the cable-rail infill on site using our own system of cable and fittings. The total deck area measures a little over 1,000 square feet, with about 200 lineal feet of railing **(D)**. ❖

Kim Katwijk is a deck builder in Olympia, Wash.

PHOTOS BY KIM KATWIJK

JLC



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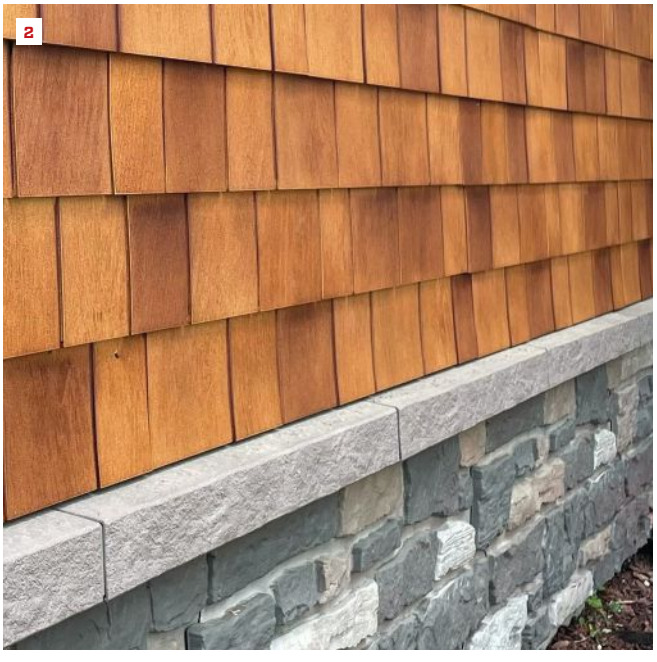
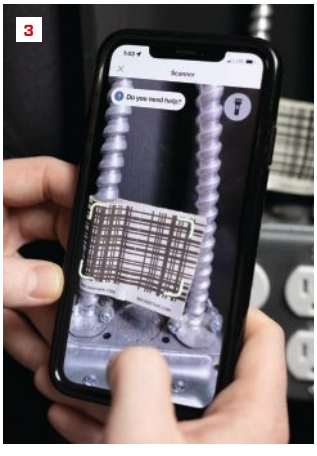
BY VINCENT SALANDRO





1. Panelized Mortarless Veneer System
Cornerstone Building Brands' ClipStone ProPanel is a panelized mortarless stone veneer with two large-format panel sizes: 20 inches by 7 1/4 inches and 12 inches by 7 1/4 inches. Requiring no special tools to install, the panels mechanically fasten to walls with mounting clips that create space for drainage, promoting drying in exterior applications. We found a box (a mix of the two panel sizes covering 5 1/4 square feet) of Mystic Northern Ledge for about $125 online. cornerstonebuildingbrands.com

2. Low-Maintenance Beach House Shake
Tando's Beach House Shakes are designed as a low-maintenance alternative to natural cedar shakes. According to Tando, the composite shakes come in panels for faster installation, will not discolor, fade, or stain, and do not need to be painted. The resquared and rebutted shakes have a 5-inch exposure and are available in four colors inspired by natural cedar tones. A box of 50 square feet sells for about $390. tandobp.com

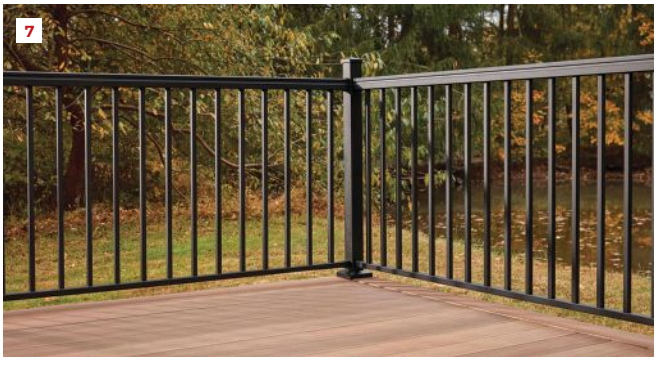
3. Scannable Jobsite Tape and Labels
Developed in partnership with Nastro Technologies, Duck Pro by Shurtape BR Code Scannable Solutions is a line of adhesive tapes and labels printed with scannable codes that can help builders organize and track jobsite information. The tapes and labels can be used to pinpoint locations of building components and supplies, create installation and repair notes, upload files relating to specific components, or link the code to already existing job data through the BitRip app. shurtape.com

4. Code-Listed Hurricane Tie
Sized for nominal 2-by lumber and designed to install with fewer, shorter nails, the H1A hurricane tie from Simpson Strong-Tie is rated for high allowable uplift and F2 loads to meet building safety needs in seismic and high-wind regions. The U-shaped tie holds a rafter or truss on both sides, providing lateral load resistance, and embossments add stiffness for improved performance; flanges can be installed facing inward or outward. The H1A is available in standard G90 galvanization or with Zmax coating for corrosion resistance. strongtie.com

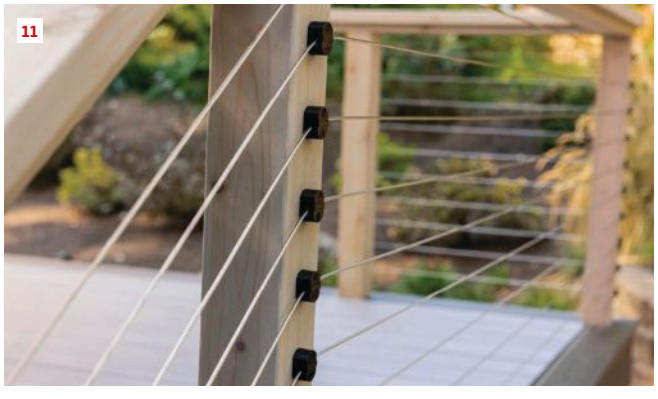
5. Weatherproof Electrical Covers
Constructed of PVC or polycarbonate and engineered for highly corrosive areas or wet outdoor locations, O-Z/Gedney weatherproof single- and two-gang boxes, covers, and lamp holders help prevent entry of dirt, dust, and moisture into electrical systems. According to the manufacturer, continuous box and cover compression ensures complete sealing at the gasket interface. In addition, the manufacturer says, the products resist impact, mold, and distortion from extreme weather temperatures. All products in the collection are cULus-listed and UL- and CSA-certified. o-zgedney.com

6. Vertical Board and Batten Siding
Westlake Royal Building Products has added an 11-inch board-and-batten profile to its Celect Cellular Composite Siding line. The manufacturer says the low-maintenance vertical profile is easy to install and has an interlocking seam design that keeps moisture out. With the aesthetic of wood and available in 15 fade-resistant colors and in ready-to-paint Celect Canvas, the siding is treated with Kynar Aquatec coating for protection against UV, dirt, insects, and seasonal staining. westlakeroyalbuildingproducts.com

7. Composite and Aluminum Railing
MoistureShield's Solid Core Composite Railing and Compass Aluminum Railing offer moisture resistance and performance to withstand harsh elements, the manufacturer claims. The composite railings have various options available for top-rail profiles, including T-rail and bread loaf, as well as for infill and finish. The powder-coated aluminum railing comes in preassembled panels with 3/4-inch balusters, in 36- and 42-inch heights, and in two finishes, matte black and matte bronze (top rails sold separately); for cable rail, beam kits are available (infill sold separately). moistureshield.com



8. Luxury Composite Decking
Positioned as the company's top-of-the-line product, Trex Signature wood-plastic-composite decking is crafted with the natural look of interior hardwoods but engineered to withstand harsh exterior conditions. The decking is made from recycled and reclaimed materials and requires only a periodic cleaning with soap and water. It will initially be offered in dark brown and variegated gray hues. trex.com



9. High-Performance Laminate Shingles
GAF's laminate Timberline UHDZ shingles feature the company's LayerLock asphalt-to-asphalt seal, StrikeZone 1.81-inch-wide nailing area, and Dual Shadow Line, which creates deep, sunset shadows at all hours. GAF says these shingles are thicker and 20% heavier than its Timberline HDZ shingles and have 10% more time-release algae-fighting material than its other shingles. Available in a variety of colors, they're eligible for GAF's Wind-Proven Limited Wind Warranty when installed with qualifying accessories. gaf.com

10. Curb Appeal–Promoting Siding
James Hardie has added the Artisan Profile series to its recently launched Hardie Architectural Collection. The manufacturer says the addition provides tiered offerings within the collection to achieve contemporary exterior looks for a variety of home styles. Artisan Profiles include square-channel siding, shiplap siding, and V-groove siding, all of which come primed for paint. The fiber-cement panels in the Architectural Collection can be oriented vertically or horizontally, James Hardie says. jameshardie.com

11. Simplified Cable Railing System
Express Mount Brackets from RailFX eliminate the need to drill holes through each deck post. Instead, users can simply install the bracket on the outside of an end, corner, or intermediate post, feed the cable through the bracket, and tighten the cable to secure it. The brackets are visible only from the outside of the deck, creating an illusion of floating cables and improving sight lines from the deck. railfx.net

12. Weather-Resistant Mortarless Stone Veneer
The Belterra Collection from Silvermine Stone is a mortarless stone-veneer product that offers moisture protection and the aesthetic of real stone. Because the manufacturer's flashing and fastening system creates a shingling effect on the wall to keep water away from the home's substrate, only a single layer of weather resistive barrier and no drainage plane or multilayered systems are required. The 24-inch-by-6-inch flat panels are attached with pan-head screws without the need for lath, scratch-coat, or mortar. The veneer is priced at $18 to $20 per square foot. silverminestone.com

13. Lightweight Deck Trusses
FastenMaster's Icon Screw Joists feature double-threaded screws as the web members of a truss with 3 1/2-inch-wide pressure-treated top and bottom chords. According to the manufacturer, these deck trusses are lighter in weight than traditional joists and dead flat, and the top chord comes pre-coated with a waterproof asphalt coating. A builder can send the deck dimensions to FastenMaster, which will provide the engineering and stamped design drawings, along with the components. For the initial rollout, the joists will be available only in Massachusetts, Rhode Island, and Connecticut. Check with the manufacturer regarding availability in other areas. fastenmaster.com

14. Combo Adjustable Wrench and Pliers
Klein's new 10-inch Plier Wrench brings together the functionality of an adjustable wrench for working flat-side fasteners with a pump plier for pipe and other round objects. The tool has a 2-inch maximum jaw opening and 20 adjustment positions to minimize hand travel and allow adjustment in confined spaces. kleintools.com

15. Pre-strung Cable Rail
Barrette Outdoor Living has introduced RDI Elevation Rail—pre-strung infill cable-rail panels that can expand up to a maximum of 6 feet between posts. Designed for both decks and stairs, the rails, posts, and caps are made of cast aluminum, while the continuous cable is 316 stainless steel. According to the manufacturer, no specialty tools are needed, except maybe good cable cutters to prevent fraying the cable. barretteoutdoorliving.com

16. Airtight, Watertight Continuous Insulation
ThermalTight combines a semi-vapor-permeable Neopor GPS rigid insulation panel with a vapor-permeable WRB laminated to the exterior face. The nonwoven, nonperforated polypropylene WRB extends 2 inches beyond the edges of the insulation panel on all four sides, resulting in flaps that are sealed with the manufacturer's double-sided tape. This seal allows the WRB to function as a continuous air barrier as well as a water barrier. The 4-foot-wide ThermalTight panels are available in three thicknesses—1 1/16 inches (R5), 1 1/2 inches (R7), and 2 1/8 inches (R10)—and three lengths—8, 9, and 10 feet. thermaltight.com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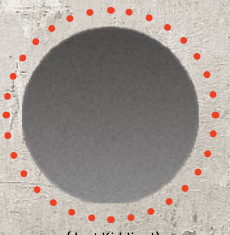

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Milwaukee M18 Track Saw

BY IAN SCHWANDT

The Milwaukee M18 Fuel track saw is powered by a single 6.0-Ah battery, which mounts in a convenient and easily accessible location **(1)**. Compatible with tracks from Festool and Makita **(2)**, the saw has the finesse to trim doors and the power and cutting capacity to slice through framing stock and engineered lumber **(3)**.

Photos: 1, Ian Schwandt; 2, 3, Martin Gutierrez

Few tools have garnered as much anticipation among our crew in recent years as the Milwaukee M18 track saw did when the company announced it was rolling out the saw to compete with several other new entries in this growing category. We're several years into the switch over to cordless tools, and many tradespeople have found themselves—by choice as well as inadvertently—in a committed relationship with a single battery platform. And rightfully so; batteries are expensive, and if you are all in on cordless tools, you no doubt have developed work habits that are more efficient and much easier to follow if you are on a single platform. I have met and worked with many carpenters who were hesitant to step outside the Milwaukee M18 battery family and introduce a whole new set of batteries and chargers to their kit for a high-dollar purchase like a track saw. These holdouts for the M18 track saw have finally had their patience rewarded.

Earlier this year, the team at TDS Custom Construction got our hands on a new Milwaukee M18 Fuel 6 1/2-inch 2831-21 track saw kit, which included one XC6.0-Ah battery pack, an M18 and M12 rapid charger, and a 24T framing blade, all inside a Packout XL Tool Box. This kit retails for $640, while the bare tool can be had for $400.

I suspect that the bare tool will be the preferred purchase for M18 platform users unless they put a high value on the Packout XL Tool Box. My carpentry crew at TDS found the Packout XL box overly bulky when compared with cases for our Makita, DeWalt, and Festool track saws. Currently, Milwaukee does not offer the 2831-21 kit with the track included, unlike its competitors in this space, which offer kits either with or without track. The track is available separately in 31-inch, 55-inch, and 106-inch lengths ($80, $130, and $250, respectively); we tested the saw with two lengths of 55-inch track joined together with a set of Guide Rail Connectors ($30). Guide Rail clamps with standard screw handles are also available, for $40. The Milwaukee track is nearly identical to the tracks offered by Festool, Makita, and Triton, which means that the Milwaukee M18 track saw will work interchangeably with track from these manufacturers.

Features. One of the first things we noticed about the saw is its light weight; at 9.13 pounds (without battery), the saw weighs less than the other three saws in our shop. There was some concern that this would cause the saw to have stability issues, but so far that has not been the case. Even when ripping a 1 3/4-inch LVL to fit into an existing floor system as a flush beam, the saw showed plenty of power and stability.

The depth stop is easy to set, with 1/8-inch graduations, and the saw can bevel from -1 to 48 degrees, with a stop at 22.5 degrees. It

has a 2 1/4-inch depth of cut at 0 degrees and a 1 5/8-inch depth of cut at 45 degrees, enough to rip a 45-degree bevel in 2-by lumber.

The plunge action of the saw is a hinged, tipping-forward motion, which is something that I greatly prefer over a straight-down plunge motion. The plunging motion is controlled by a simple thumb switch and a locking tab that is fully visible to the user, a feature that many people may not quite realize the importance of until they have tried to address a cut with a track saw only to have the saw refuse to plunge due to buildup of sawdust at a hidden locking tab.

Speaking of sawdust, Milwaukee claims 90% dust recovery when the matching dust bag or a dust extractor is used. In practice, we found this claim seemed about right, though—as with most track saws—the large hole in the side shroud of the saw that is necessary for the removal of the blade allows some dust to escape and has a dulling effect on the strength of a dust extractor.

But thanks to that large access hole and a positive spindle stop level that holds the saw in the right place for a blade change, switching out a saw blade is simple. Currently available through Milwaukee are a 24-tooth framing blade (the one we used for all of our testing), 40-tooth finish and 52-tooth fine-finish blades, and fiber-cement and laminate blades to fit the saw's 20mm arbor.

One additional feature of the saw is a splinter guard that can be installed in place of the blade-viewing window at the toe of the saw. This guard can be used to prevent splinter damage to the sawn-off workpiece that is not protected by the track's splinter guard strip.

Performance. Cutting with the Milwaukee M18 track saw, as with most of the track saws on the market, is a joy. The brushless motor on the saw has plenty of power cutting and ripping all framing materials and doing light surgical demo work—one of our carpenters used the saw to make a straight line cut in a roof deck that allowed us to tie a new addition roof in while giving the roofer a clean line to patch to. Using a wheel-style speed selector, the brushless motor can be set to produce 2,500 to 5,800 rpm with a max of 6,300 rpm under load. The saw has shown it has plenty of power for all the framing applications that we've put it through and plenty of finesse for the standard track-saw application of cutting finish-grade sheet goods and trimming interior doors.

For M18 battery platform users who have been waiting years for this saw, I suspect that you will not be disappointed. At $400, the bare tool is economical, and the money saved over the kit could allow you to purchase the 106-inch track in addition to the versatile 55-inch track. milwaukeetool.com

Ian Schwandt is the production manager for TDS Custom Construction in Madison, Wis.

The Shinwa Neo chalk box has a rugged ABS case and a thin braided line for snapping fine chalk lines **(1, 2)**. It comes with both a regular hook and a pin receiver with a thin needle that can be inserted into drywall or wood trim for solo work **(3, 4)**.

A Fine Chalk Line

BY TOMMIE MULLANEY

I've used a lot of different chalk boxes over the course of my carpentry career, but when it comes to snapping clean and consistent lines for interior carpentry, there's only one that I carry with me in my toolbelt. The Shinwa Neo from Japan is my "go-to" chalk box, and has been for many years.

Line. The Shinwa Neo has a much thinner line than other brands do, measuring only 0.020 inch thick. Even so, it can span distances up to 50 feet, suitable for even my longest length projects. The thin line is great for trim projects with tight tolerances, such as coffered ceilings, compared with the thicker lines left by most other chalk boxes. Those bold lines can measure up to 1/8 inch thick, more suitable for framing carpenters who need to mark rough surfaces.

While the special woven threaded line is fine, it has proven to be durable and can handle daily jobsite use. It also accepts chalk easily, with an internal felt pad in the chalk box to ensure good chalk-powder distribution. The pad also helps to eliminate chalk from spilling out of the top.

For consistent lines and full functionality of the chalk box, I use Tajima's micro powder chalk. It comes in a variety of colors, such as blue and red, which is useful for projects that need multiple lines of reference.

With a low gear ratio and folding crank handle, manually

Photos: Tommie Mullaney

Makita 18V LXT ½-Inch Hammer Drill/Driver

BY ANDREW WORMER

If you're an old-timer like me, you probably remember the iconic Makita 6093D cordless drill, which was powered by the company's 9.6-volt stick-style NiCad battery. I purchased mine well over 30 years ago and still have it, along with one or two other more recent (but still "antique") Makita drills with NiMH batteries. All of them would probably still run if I could find replacement batteries, but I'm not even tempted to look, because I have Makita's XPH14 18V LXT hammer drill/driver, which is better in every way than its well-regarded predecessors.

I've been using this drill for over a year now and have really come to appreciate its high-torque, 1,250 inch-pound motor. In low-speed mode (0–550 rpm) and fitted with a mixing paddle, the drill is great for mixing up batches of mortar for tile. I've even chucked in a special bit that fits into a sailboat winch, attached myself to a halyard, and had my son use the drill to safely and smoothly power me up to the top of a 50-foot mast. That's not something that any of my other cordless drills would have been capable of, and it brings that same kind of power to situations where you might need to drive a big auger bit through studs for tasks such as running electrical cable. To handle all this power, it comes with a secondary handle.

With a high-speed range up to 2,100 rpm, an adjustable clutch, and compact size, it functions well as an everyday drill/driver. It weighs 5 pounds 2 ounces with the 4.0-Ah battery I typically use, and measures only 7 inches in length, still leaving plenty of room for a big, 6-inch-long bit to fit between 16-inch-on-center studs. And if you need to install some anchors into masonry, it functions as a hammer drill too, with a rate of 0–8,250 bpm in low and 0–31,500 bpm in high. Currently available for $111 as a bare tool on Amazon, it's a steal. makitatools.com

The Makita XPH14 18V LXT hammer drill/driver has a powerful, high-torque motor.

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retrieving the line is simple and fast. Once the line is secured, the quick flip handle sits flush inside of the body to ensure zero interference when you're slipping the chalk box back into your tool pouch.

Body. Weighing in at 5.3 ounces, the body is made from a tough ABS resin that has held up to numerous typical falls off scaffolding and ladders, so durability has not been a concern. The transparent body offers quick viewing of the amount of chalk left inside, with an easily operated access door for quick refills. I especially like the way that this design doesn't interfere with the line like typical top-threaded chalk boxes. Once the door is closed, the body is sealed to prevent powder from leaking and humidity from entering.

Hooks. The Shinwa Neo offers two attachment options. There is a standard hook—the type that is commonly seen on most chalk boxes—that can be used for metal and concrete parts. There is also a pin receiver (a sharp needle with plastic housing for easy insertion) that solves one of my biggest gripes about snapping lines: having to place a nail or screw into the wall to attach the chalk line. The pin receiver, which works well on both wood and drywall, makes my life easier and is the feature that makes this chalk box stand out from other ultra-thin-line chalk boxes. Once the line is snapped, only a pin-sized hole is left, making this the least intrusive option when snapping lines by yourself on those types of surfaces.

Tool dealers such as Taylor Toolworks (taytools.com, a favorite with woodworkers) sell the Shinwa Neo chalk box, but you can also venture over to Amazon and find it for around $21 to $25. The chalk box does not come with any chalk powder, so don't forget to pick up the color of your choice.

Tommie Mullaney owns Black Label Carpentry in central Florida. You can visit his web page at blacklabelcarpentry.com or follow him on Instagram @BlackLabelCarpentryCo.

The author uses Tajima's micro powder chalk, which is specially formulated to produce fine lines, to fill his Shinwa Neo chalk box.

Photos: top, Andrew Wormer; bottom, Tommie Mullaney

Festool RSC 18 Cordless Reciprocating Saw

BY CLAYTON DEKORNE

Festool's new RSC 18 cordless recip saw seems to be an especially nice version of this tool of all trades. Though we haven't put it through its paces, the tool that we inspected in the Festool booth at JLC Live in Providence, R.I., exuded power on a well-charged battery. Like many powerful reciprocating saws, it includes an adjustable power stroke (Festool calls it the "pendulum stroke," similar to Bosch's orbital, or elliptical, action) that kicks the blade back and forth as it saws up and down, helping to clear the kerf of dust and speed the cutting action. Yet, with all this power, what's happily missing is vibration; it's not hard to imagine this would result in much less fatigue through long and grueling cuts.

A few exceptional features on the RSC 18 make it a standout tool in the field of cordless recip saws. Chief among those is an adapter that allows you to position the end of a vacuum hose on the shoe to collect dust coming off the blade. Another feature we liked is the blade collar, which seems especially well thought out for quick blade changes. The blade can be ejected by simply rotating the collar, so there's no danger of burning your fingers when removing a saw blade. The clamped blade can also be rotated by 180 degrees, so you don't have to take it out and reinstall it when you need to cut in the opposite direction. This saw also comes with a ladder hook. The RSC 18 is due in the U.S. this month; the expected price is around $600 with two 5.0-Ah batteries, charger, Systainer box, and vacuum attachment. festool.com

Festool's new RSC 18 cordless recip saw promises smooth power and has a mounting system for dust collection.

A Safe and Powerful Cordless Coring Drill

BY TIM HEALEY

Plumbers and electricians will be interested in Milwaukee Tool's new MX Fuel hand-held core drill, which is able to core holes up to 6 inches in diameter in reinforced concrete. The drill can be powered by either its XC lithium-ion battery pack (reportedly capable of fully charging in 90 minutes) or its more compact CP battery pack (fully charging in as few as 45 minutes). We checked out the tool at JLC Live, where Milwaukee's Christopher Losch told us, "If you're coring 3- to 6-inch-diameter holes, you'd probably want to use it in tandem with our compact core drill stand for added drilling confidence. For holes 3 inches or less, you can usually core concrete or block while holding it in your hands."

Runtimes vary depending on the hole diameter and the material being cored into. For example, with the CP battery, you can core nine 3-inch holes in concrete block or five 3-inch holes in 6-inch-thick concrete, and with the XC battery, 18 3-inch holes in concrete block.

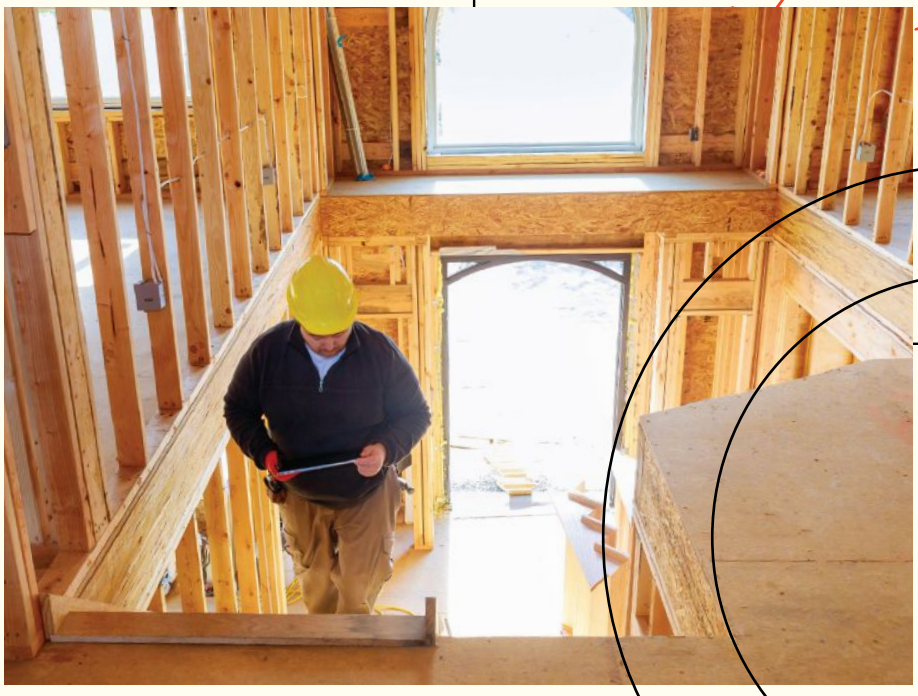
Regarding safety, Losch said, "The MX is the safest hand-held core rig available. It has our patented Autostop technology, which cuts the drill off automatically when you feel it torquing. This is particularly important if you happen to be working above your head or on a ladder." Other features include a better clutch, a self-leveling function, and a performance meter to tell you if you need to apply more or less pressure to extend the life of the tool and the bit.

The drill can be run wet or dry. For coring concrete dry, the manufacturer recommends using its dry coring dust extraction attachment, which allows you to be OSHA-compliant when drilling. Losch also told us that Milwaukee plans to release a new drill capable of coring 14-inch-diameter holes in concrete later this fall (2023). Estimated cost with stand is $4,000. milwaukeetool.com

Milwaukee's MX Fuel core drill can be hand-held (left) or mounted in a drill stand for holes larger than 3 inches (right).

Photos: top, Clayton DeKorne; left, Tim Healey; right, courtesy Milwaukee Tool

JLC



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BY CLAYTON DEKORNE

The Book of Trades

First published in 1568, *Das Ständebuch* (which is typically translated as "The Book of Trades," but is more exactly translated as a book of rank or class) by the German woodcut artist Jost Amman illustrates 113 professions, beginning with the Pope and ending with the Jester, each with a short verse written by Hans Sachs. It follows a Renaissance tradition of "encyclopedias," which cataloged knowledge of the sciences in lists of known things like plants, animals, and constellations. Some included geographies with illustrations of the customs, costumes, and professions of each land's people. One of the most famous and comprehensive encyclopedias, the *Historia Naturalis* by Pliny the Elder, is mentioned in the introduction to the *Ständebuch* by the publishers, who felt that Pliny's treatment of ethnography and anthropology left out an immense variety of human arts and crafts.

The *Ständebuch*, according to its publishers, was intended to expound the "virtue of all people who served God." In the final verse by Sachs, the intention of the book is described as a model for the great varieties of trade and craft people who should refrain from idleness, avoid all vices, and "praise and love God Who feeds us all." Yet unlike the elaborate religious allegories of the time, in the *Ständebuch*, "it is the craftsmen themselves who replace abstract allegories as the vehicles of moral content," writes Benjamin Rifkin in his introduction to the Dover edition.

Some evidence of this moral content is especially evident in the example of the Carpenter, shown below among three examples from the building trades. Lying on a sawhorse in the foreground is a large feathered wing, a symbol of Daedalus. In Greek mythology, Daedalus is an architect and craftsman credited with the invention of carpentry. As the legend goes, his nephew was also a gifted inventor who was inspired to replicate the spine of a fish in iron to create a saw and who connected two pieces of iron rod with a rivet to make a scribe. Seeing these, Daedalus grew envious of his nephew's talent and threw him off a building. Daedalus was convicted of attempted murder and exiled to the island of Crete, where he lived in hiding with his son Icarus. As the authorities kept watch on the ships leaving the island, Daedalus was unable to escape, so he built sets of wings for Icarus and himself. While Daedalus managed to fly to safety, his son Icarus tried to fly to the sun, which melted the wax holding the wings together, and the boy plunged to his death. The wing lying in front of the Carpenter serves as both a symbol of the trade's mythological origins and a reminder to stick to the work at hand and not fly too high.

Among the many trades represented in *Das Ständebuch* are Der Zimmerman, carpenter **(1)**; Der Schreiner, joiner or cabinetmaker **(2)**; and Der Steynmetz, stone mason **(3)**.


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