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check is a set of procedures you must do to check to see if you have air leakage around the edges of the respirator. This must be performed each and every time you put on a tight-fitting respirator and before entering the hazardous area. If you cannot achieve a tight seal, you need to readjust the respirator and straps and then redo the user seal check. If you still cannot obtain a good seal, then you will need to try another model of respirator. Manufacturers usually offer a variety of models with different designs and features so you have a better chance at finding one that fits your facial shape and size to help achieve a proper fit. So, take a look at what's out there. If a certain model isn't giving you a good seal, try out a different one. As a bonus, you may even find it to be more comfortable. And, of course, remember to shave. ■

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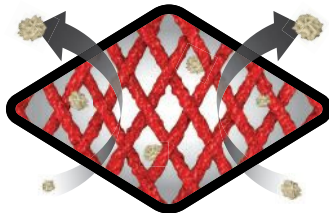


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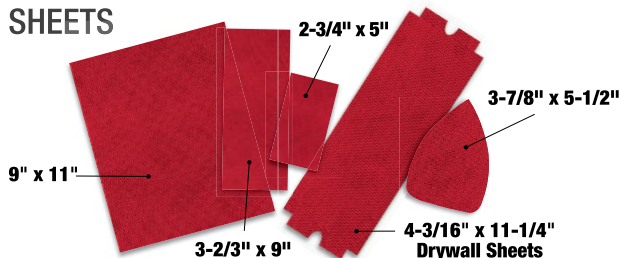
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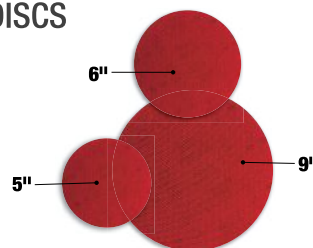
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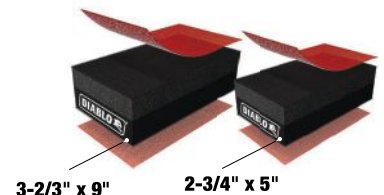
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On the cover: Gary Striegler installs one of the plywood supports for a built-in bench seat on a remodeling job in Goshen, Ark. See the story on page 41. Photo by Gary Striegler.

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KILZ: How would you sum up your main mission?

DANIEL: My mission is to enhance and beautify people's ideas and help bring those ideas to fruition.



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KILZ: Painting for you started as a family affair. Was your father a tradesman?

DANIEL: My father was a “Jack of All Trades” but he mastered a few. As our family grew, so did our home. He was always adding to the house to improve life for us and I always enjoyed working by his side, grabbing hammers, screw drivers, etc. It always ended with, “Well, now we have to paint.” I always found painting easy and enjoyable. So, I just kept doing it. Back in Mexico, my father and grandfather were farmers and handymen. They carried that work ethic with them into the States. I get it from them.



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DANIEL RUIZ

Professional Painter / Street Art Enthusiast

As a child, Daniel’s father was always doing construction and improvement projects around his family home. One day, he picked up a roller to help. That ignited a love-affair with painting that has become his path in life for the last 22 years.



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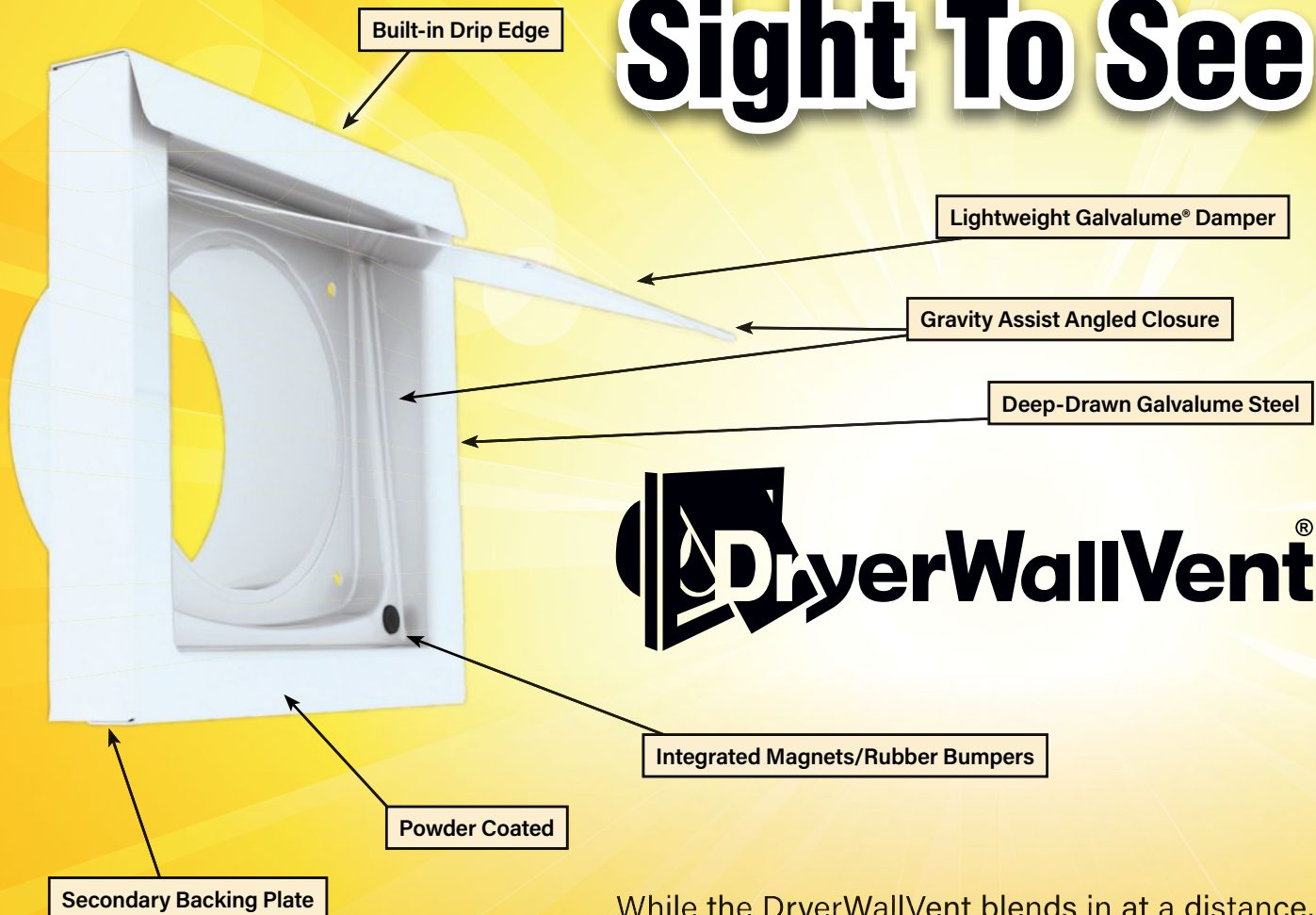
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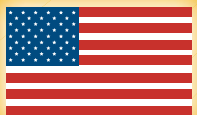
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Beam Stress and Strain: A Lesson in Statics

Beams are the horizontal supports used throughout a structure to carry and transfer loads across wall openings and floor and roof spans. While individual joists, rafters, and trusses also function as beams, I want to concentrate your attention in this article on headers and beams that carry distributed loads, such as tributary floor loads or walls running parallel to the beam. (See “Structural Design Basics,” Oct/21, for an introduction to simple supported beams and tributary loads.)

Engineers refer to beams as “flexural” members: In other words, beams bend. We can’t avoid their bending; we just don’t want beams to bend too much. In fact, this tendency to bend, or elasticity, is essential to a beam’s strength. Materials without elasticity are brittle and subject to shattering—the sort of sudden and catastrophic failure we’d prefer not to have in a structure. Better that the structure be able to absorb some of the force, which causes the beam to deform, or bend into a curved shape. This deformation is normal as long as the loads are limited and the beam returns to straight once the load is removed. But when it bends too far, the deformation will set—it sags and won’t bounce back. Sagging is itself a failure, but it’s better than shattering, and we can limit such a permanent deformation by understanding the elastic constraints of structural materials.

A beam (an early Old English word for tree; “baum” in German and “boom” in Dutch, which also survives in modern English as a type of beam common to cranes, lifts, and sailboats) is governed by five principal factors that engineers must account for when designing a structure: the beam’s material, length, load, and cross section, as well as the configuration of the building elements that support the beam. I am going to focus this discussion on rectangular wood beams that are supported at each end (a “simply supported beam”), but by the end of this article, you should have an appreciation for how each of these factors plays a role in the beam’s strength.

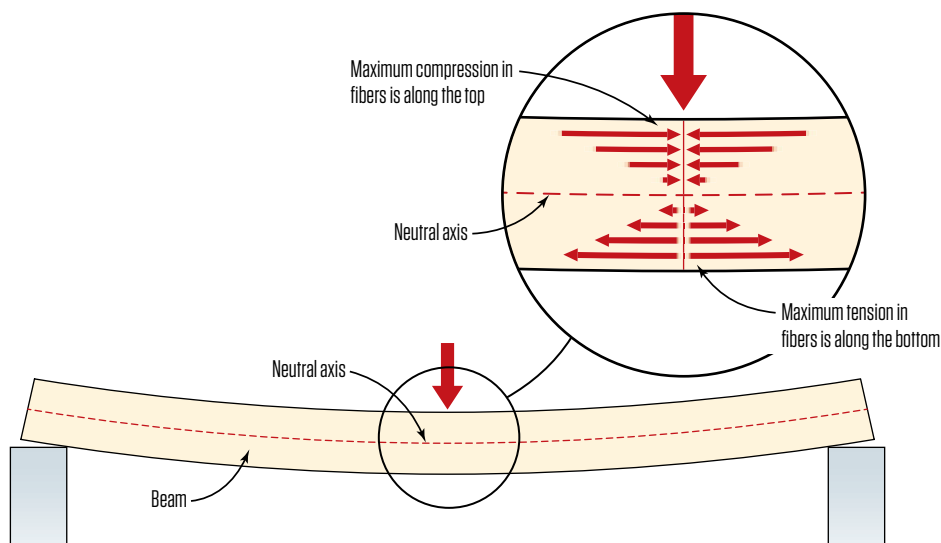
STRESS AND STRAIN

Let’s start with a few key terms:

Stress. In popular language, stress (the physical sort, not the emotional or mental kind) is a force exerted on a material, and this force causes the material to deflect. Even if you can’t tell that a concrete foundation deflects when you walk along a sill plate, there is a reaction force. As J.E. Gordon put it in *Structures: Or Why Things Don’t Fall Down*, “When you climb the tower of a cathedral it becomes shorter, as a result of your added weight, by a very, very tiny amount, but it really does become shorter.”

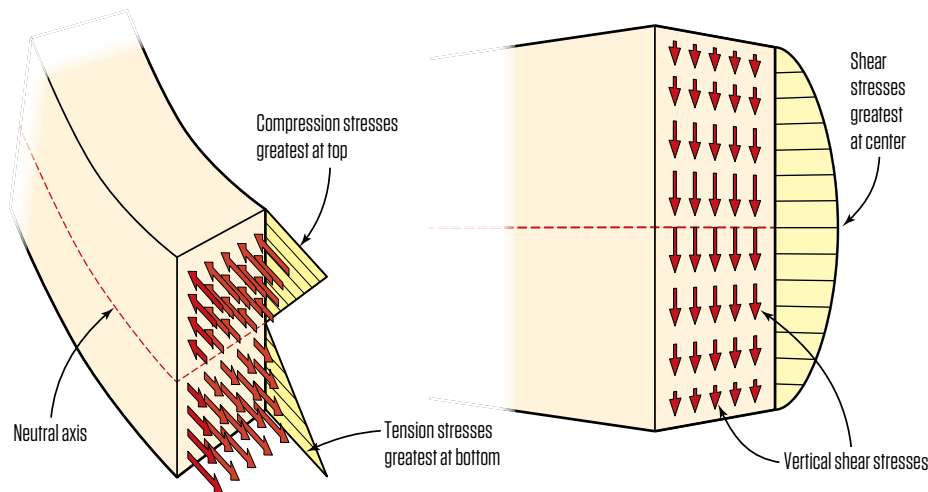
In a strict sense, stress specifically refers to an internal force in a

Bending Stresses in a Beam



When a beam bends, the fibers along the top edge are squeezed, or compressed, together. At the center of the beam, the direction of stress reverses. Below this, the fibers are stretched, and the distance they are stretched reaches a maximum tension stress along the bottom edge. At the point where the bending stresses reverse direction, the longitudinal stress is zero. This point lies along the neutral axis of the beam, which lies at the center of gravity.

Bending Stress and Shear Stress



Bending stresses (at far left) act perpendicular to the cross section of a beam, and include both compression stresses (at the top of the beam) and tension stresses (at the bottom). This view shows how those stresses are distributed across a beam section. In a symmetrical cross section (such as the rectangle of most wood beams), the center of gravity lies at the middle between the top and bottom edges.

Shear stresses (at near left) act parallel to the cross section. The maximum vertical shear stress occurs at the center of this section.

material that resists an external force. This idea was first applied to structures by Robert Hooke, though a lot of folks today tend to know it as Isaac Newton's third law of motion: For every action, there is an equal and opposite reaction. This is an essential concept in statics. Think of a force, such as a weight, pushing straight down on a beam that is supported at each end; there is an upward reaction equal to half the total downward force at each end of the beam. The reaction forces are smaller at each end of the beam, but together they balance the total load pushing down on the beam.

We don't want motion in buildings, we want balance. For all the weight of the building plus snow and wind exerting loads on a beam, we want the fibers in the beam to resist the load without excessive deflection. Some of the force will be absorbed in the beam, causing it to bend, but the majority will transfer to the ends, where we want the foundation supporting the ends of the beam to resist the forces, transferring them to the earth, which we want to stay put for as long as the building stands.

Figuratively, we can think of this balance as a game of push hands: If you push against a person with a certain force and they push back with the same amount of force, you both stand still. That's the way we want our buildings to stand. Do the fibers in the beam, or the foundation or the earth push back? Well, yes, they actually do. Zoom in on the stresses in the beam and imagine the molecules that comprise the beam's fibers. As the beam flexes downward, the fibers on top are shortened; they get pushed together or compressed (see "Bending Stresses in a Beam," page 11). The fiber molecules near the top of the beam are squeezed, and as when the positive poles of two magnets are pushed together, the atoms in those molecules resist changing the distance between the electrons and the nucleus, and do, in fact, push back with force. Similarly, the molecules in the

fibers that are stretched in tension along the bottom of the beam are pulled apart. Their reaction is to pull inward because of the attraction of particles. Hooke didn't know as much as we do about the laws of chemistry; he described the effects, which he witnessed by testing different materials under load, as analogous to springs that pushed and pulled to create the reaction forces he observed, but he was definitely onto something.

Strain. Beams are not held in perfect static equilibrium. They move. (Remember that tiny, tiny movement that shortens the cathedral tower?) The amount of that movement is strain—the measure of deformation that occurs in a material under stress. For the fibers along a beam, which is subject to a load pushing straight down, the strain is defined mathematically as the change in length (after the beam is squeezed at the top or stretched at the bottom) divided by the original distance (the length of the beam before applying a load).

Hooke's brilliance was that he related stress and strain, articulating what is known as Hooke's law: For every stress, there is a proportional strain. Or, put another way, the amount of deformation of an elastic material is proportional to the stress applied to it.

Hooke was thinking in terms of whole structures and his theories didn't always hold up perfectly to testing. But a couple of hundred years after Hooke, the English physicist Thomas Young took the concept further to arrive at a method of calculating the ratio of stress to strain at a given cross section through any material. (In a wood beam, this cross section is a rectangle.) His formula, $\text{Stress}/\text{Strain} = E$, is known as Young's modulus, or the *modulus of elasticity* ("modulus" means "ratio").

If you plot stress to strain on a graph, the values form a straight line in the region where Hooke's law applies (where they are directly

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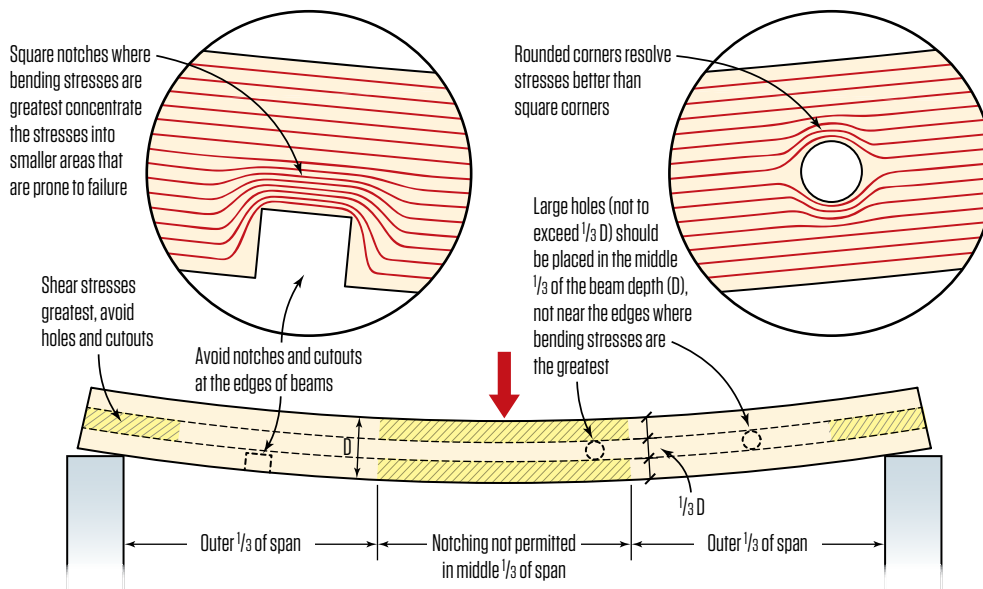


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Stress Concentrations in a Beam



The lines running along this beam in the inset views represent longitudinal stresses. Whenever these run into a notch or a hole, the stresses become concentrated around the edges of the cutout. The concentration is acute at corners and more gradual around curves. Because the bending stresses are greatest at the edges of a beam, it becomes immediately apparent why we want to place large holes and cutouts close to the neutral axis (in the middle of the beam section). Knots and wane edges create similar stress concentrations, which is why lumber is graded to limit such defects.

proportional and the material remains elastic). The material remains elastic so long as it returns to its original shape when the stress is removed (strain = 0). This region where Hooke's law applies is commonly referred to as the *allowable stress*, since no permanent deformation occurs. For example, the beam supporting a floor might deflect when you walk across it, but it doesn't remain in a sagging position when your weight is removed.

As stress increases, a material reaches its *elastic limit*. This is above the allowable stress and overloads the beam. As the stress increases above this limit, the strain increases at a geometrically greater rate relative to the stress. This pushes the fibers in the beam beyond their ability to recover their original shape, and the deformation becomes permanent (for example, the sag remains). If the stress increases even more, the material reaches a point where it reaches ultimate strength—the point where strain increases without limit: The beam breaks.

Every material has a definable modulus of elasticity (E). Each wood species has a different E , and most carpenters have a good sense for this: An oak beam is stiffer than a spruce beam, and so forth. E is not typically something engineers calculate, though they could; they look it up in the *Wood Handbook* or in the American Wood Council's *National Design Specification*.

BENDING STRENGTH

E is a measure of stiffness, not strength. The bending strength of a wood beam depends on a combination of factors:

First, think of the compression stresses in the top of the beam and tension stresses in the bottom. These are the reactions to the force applied to the beam, and when you have these reactions—

these tendencies to move in different directions—separated by a distance, you have a moment arm (in essence, a teeter-totter). As a load is applied to the beam and the bending stresses increase, there is a tendency for the teeter-totter to move or, rather, for the beam to rotate around the neutral axis, which in this circumstance is also known as the *axis of rotation*.

The *bending moment* can be calculated at any section of a beam using a distance (y) from the neutral axis. This moment is also a function of the load and the span of a beam (L). If the reaction stresses within a beam remain in equilibrium, the beam holds together. But if a beam's resistance to tension falls short of its resistance to compression (or vice versa), the rotational force will tear the beam apart.

The concept of a moment at a given beam section is important because it tells us a lot about the strength of a beam: The strength comes from holding the two edges together (the two areas where the bending stresses are highest) to maintain equilibrium. But the distance between those stress areas—the web that holds the top and bottom flanges of a wood I-joist or a steel I-beam together—is governed by *shear*, which we'll discuss below. Because the bending stresses are minimal in this middle area, this part of the beam can be slimmed down quite a bit (or punctured by holes or have the highest proportion of and largest knots) relative to the top and bottom edges.

Second, bending strength has a geometric element. We know that a joist held on edge is stronger than a plank of the same lumber dimensions lying on its face. This element is called the *section modulus*, or S —a relation of depth to the width. (The equation is not a direct proportion.)

Third, bending strength depends on the strength of the wood fibers in a beam. This is a property—*extreme fiber stress in bending*

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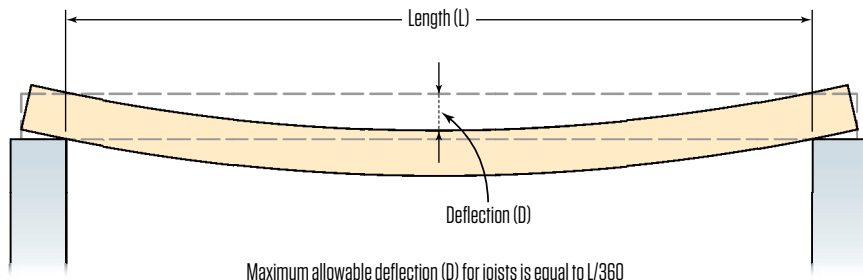
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For example, if $L = 20'-0"$

$$\text{Deflection (D)} = \frac{L}{360} = \frac{20' \times 12''}{360} = \frac{240''}{360} = .666 \approx \frac{5}{8}''$$

By code, the maximum deflection allowed under full load is the joist's clear-span distance in inches (L) divided by 360. $L/360$ means that a 30-foot—or 360-inch—span can safely deflect 1 inch ($360/360 = 1$). At a span of 20 feet, as in this example, the deflection is $\frac{5}{8}$ inch. (Illustration not to scale.)

(designated F_b)—that varies by wood species. Stronger woods will have a greater F_b .

To evaluate the bending strength of a beam, we can combine these three factors into the equation: $M = F_b \times S$. When M is equal to $F_b \times S$, the beam will break. As long as M is a lower number than $F_b \times S$, the beam is strong enough to bear the load.

When engineers design a beam, they know M by calculating a *maximum bending moment* from the unit load on the beam and the span. They then solve for an *actual bending stress* (f_b) to see if the load limits match the proposed F_b for a beam of a certain species.

SHEAR STRENGTH

Bending strength is only one value engineers look at when designing a beam. They also evaluate shear. Most of us are inclined to envision something like a pair of metal shears slicing through a piece of galvanized flashing. This applies, but the focus is on the two edges of the shears sliding by each other with force that shears off the metal between them. The word “shear” refers to the stress in a material that causes one part to slide past another part in a parallel plane. It’s often applied to a rock face, when one layer of rock fractures and slides past another. This same stress can act on a beam. Breaking a stick for campfire wood, either pulling it across your knee or leaning it against a rock and stomping on it, is a familiar example of applying shear stress when the break results in a split down the center. Horizontal shear failure in beams typically occurs in the same fashion along the center line.

In designing a beam, we are concerned first with vertical shear stresses through the same section that bending stresses are evaluated. Vertical shear stresses work opposite to bending stresses. Not only do they act parallel to the beam section (running down from the applied force)—as opposed to bending stresses, which act perpendicular to the section—but the maximum vertical shear stress is greatest at the center of the section, precisely where the bending stresses are zero (see “Bending Stress and Shear Stress,” page 12).

In our discussion of bending moment above, we noted that the

bending stresses are lowest in the middle “web” section. The actual upward reaction that enables a beam to sustain a downward load comes from the shear strength of this web, the ability of the material holding the longitudinal wood fibers together. Shear stresses acting on a rectangular section create tension and compression stresses at a diagonal to the beam section (in essence, the shear reaction is racking the rectangular section). This is why OSB, which is strong in all directions, is used for I-joist webs, and why the web members in trusses are positioned at 45 degrees to the top and bottom chords.

DEFLECTION

In the final appraisal of a beam, engineers also evaluate deflection. With floor beams especially (and floor joists and even floor sheathing when tile is going over it), they are often more concerned with deflection—the amount a beam will flex—than about failure in bending strength (breaking beams are rare). The calculation of *maximum deflection*—how much a beam will sag when the design load is placed on it—is one an engineer will make for all beams to ensure that the expected loads stay below the elastic limit, above which the beam will permanently sag. But carpenters should be able to measure the expected deflection to keep it within certain limits (see “Evaluating Deflection,” above).

$L/360$ is the maximum allowable deflection set by code. However, many feel $L/360$ is minimal and prefer to maintain at least $L/480$ (this would be $\frac{1}{2}$ inch in the example shown in the illustration above). To control floor vibration (the bounciness that causes the dishes to rattle when you walk across a floor), Frank Woeste recommends sizing beams to a limit of $L/600$ (a little over $\frac{3}{8}$ inch in our example) or limiting it even more, depending on the floor span, on-center spacing, and sheathing thickness (see “Controlling Floor Vibration,” Dec/15). And if large-format or stone tile is going over a wood floor, Michael Byrne recommends the floor members, including the sheathing spanning between joists, meet a maximum deflection of $L/720$ (a bit under $\frac{3}{8}$ inch in the example above; see “Tiling Over Plywood Subfloors,” Mar/11).

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Q I'm working on a remodeling project where the clients want to replace a modern-style fireplace mantel with a salvaged decorative one. However, the wood surround appears to be too close to the existing firebox opening at the sides and top. How close can a mantel surround be? Are the clearances different with manufactured fireplace inserts (in case their hearts are set on installing the decorative mantel)?

A Doug Horgan, a vice president of best practices at BOWA, a design/build remodeling company in Northern Virginia, responds: In my experience, there are two standards to follow with regards to fireplace mantel and surround clearances: With traditional masonry fireplaces, follow the code book standards, and with manufactured fireplaces, follow the installation instructions.

Traditional masonry fireplaces. For standard masonry fireplaces, fireplace codes are in Chapter 10 of the International Residential Code (or local versions, such as the Virginia Residential Code, that are based on it). Section 1001.11 "Fireplace Clearance" of the IRC (2018 edition), Exception 4 states the following:

"Exposed combustible mantels or trim is permitted to be placed directly on the masonry fireplace front surrounding the fireplace opening providing such combustible materials are not placed within 6 inches (152mm) of a fireplace opening. Combustible ma-

terial within 12 inches (306mm) of the fireplace opening shall not project more than $\frac{1}{8}$ inch (3mm) for each 1-inch (25mm) distance from such an opening."

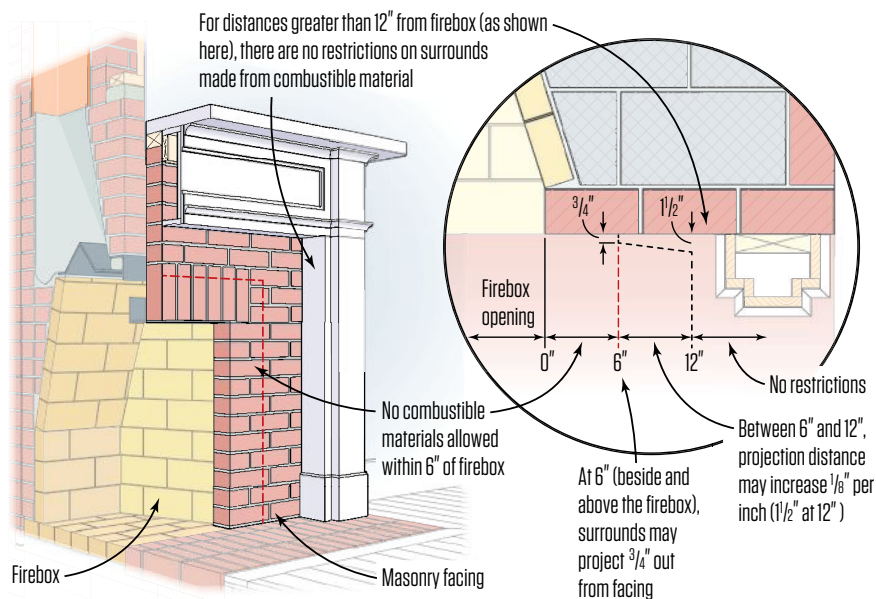
I think of these clearances as three areas: From the firebox opening to 6 inches out, no combustibles are allowed; from 6 to 12 inches away, you can put thin wood (at 6 inches, only $\frac{3}{4}$ -inch-thick stock is allowed, gradually getting thicker to $1\frac{1}{2}$ inches at 12 inches away from the opening). Beyond 12 inches, combustibles of any depth are allowed. Clearances are the same at the top and the sides (see illustration, below).

Some mantels have legs that project out 2 inches or more from the wall. To meet code, those legs have to be at least 12 inches away from the firebox opening. On the fireplace shown in the photo below, only 8 inches of brick is showing on the sides and top, however, while the wood trim of the contemporary-style surround is about 4 inches thick. To meet code, the surround's thickness would have



The modern-style mantel shown above does not meet code because the side trim projects roughly 4 inches out from the masonry facing within 8 inches of the firebox opening. No combustibles are allowed within 6 inches of the firebox (see illustration, right).

Fireplace Mantel Clearances



to be 1 inch deep or less at 8 inches from the firebox (because we gain $\frac{1}{8}$ inch per inch as we move from 6 to 12 inches from the firebox).

Manufactured fireplaces. With regards to manufactured fireplaces, mantels for metal fireplaces are installed per the fireplace directions (technically, the safety agency listing, which in practice is the same as the instructions). The mantel clearances are often more generous than the code, but not always. Recently, I was reviewing a product that allowed combustibles at a 50-degree angle past 6 inches. So traditional-looking projecting legs would probably work. But, this same fireplace said nothing projecting past 12 inches was allowed above the firebox, so that could trip us up.

There is simply no substitute for finding the directions and following them. It's also worth checking if there are any unusual hearth

requirements. I have seen some manufactured fireplaces recently that required fire-resistant materials, like four layers of cement board, under any tile or stone hearth. We would have to frame the floor system differently if we wanted the stone flush with the wood floor.

Another scenario we're often presented with is having to finish around older manufactured fireplaces. Before installing lots of expensive trim around an old unit, it's a good idea to have a professional evaluate its condition. Many fireplaces from more than 20 years ago are considered hazardous by today's standards or have rusted out and so become hazardous. With older fireplace units, it's possible to find the model number and search the internet for the installation instructions or contact the manufacturer. A fireplace professional may be able to help find the model number.

Can helical piles be installed at an angle to reinforce a retaining wall?

A Chad Smith, a builder who owns Distinctive Contracting Services in Arnold, Md., responds: My company has used helical piles for a number of applications besides house and deck foundations, including for retaining-wall tie-backs and to provide lateral stability for projects such as walkways and commercial signage. PierTech and Ideal (the brands we typically install), Techno Metal Post, and Goliath-Tech all publish design values our engineers can use in their designs; these values include allowable compression, tension, and lateral capacity.

On a recent project, for example, we used what are called "batter piles" installed at an angle and in line with the framing for a pedestrian walkway for a museum. While that design would perhaps be overkill for a residential project, the ipe walkway winds through a floodplain and is subject to commercial code. Requirements include higher design loads, and the engineer was concerned about the active loads from people walking on the pathway causing the framing to move back and forth. The batter piles help prevent that movement over the walkway's straight runs, some of which measure as much as 70 feet in length (1).

When we use batter piles in a tie-back application such as for a retaining wall, a few different techniques can be used. The design is based upon the application. If a batter pile needs to be serviceable (for tensioning, for example), we can install a sleeve for a threaded rod to pass through the wall, and reinforce the concrete



In this photo showing the framing for a commercial elevated walkway, one of the vertical helical piles is reinforced by a batter pile installed at an angle to limit lateral movement caused by foot traffic on the walkway. A threaded rod bolted to a plate that's welded to the vertical pile connects the two piles (1).

Photos: Chad Smith

with a rebar grid around the tension location. If the application is fixed, we typically either use a “new construction” pile T cap on the end of the pile, or install a threaded rod and embed a large steel plate or steel washer within the concrete wall, or create a rebar grid around the pile top. In less substantial load applications, a simple hole can be drilled through the end of the pile and one or two pieces of rebar can be inserted through the pile and tied to a rebar grid. The approach we use depends on the height of the retaining wall and the engineered design (required for all retaining walls higher than 4 feet).

Another example of an alternative use for helical piles is a sign pylon foundation we recently built. For this foundation, we installed opposing pairs of batter piles at a 7.5-degree angle from the vertical to anchor the sign’s steel framework (2). That orientation—rather than a completely vertical one—will provide better resistance to uplift once the piles are encased in a concrete base, which in this project will measure about 15 feet long, 7 feet wide, and 36 to 42 inches deep. The overall size of the mass of concrete not only offers ballast weight to the assembly but also helps increase the side-load shear factor.

To build a foundation strong enough to resist the lateral and uplift forces created by wind blowing against a large commercial sign, the author installed pairs of batter piles, which will later be encased in a massive concrete slab (2). After the slab is poured, the temporary plywood walls holding back the soil will be removed, and backfill will then be compressed around the slab to meet compaction requirements.



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The clients felt that the addition's mass was too big and its height competed with the main home's height (1). Here, the second-floor wall framing is demoed to make way for a revised framing solution (2, 3).



The wall of the second-floor shed dormer was moved 3 feet back from the first-floor's exterior wall (4). A "mass-reducing" roof with a built-in gutter was framed over the resulting exposed second-floor deck (5).

A Built-in Gutter Helps Solve a Design Problem

BY JONATHAN CURTIS

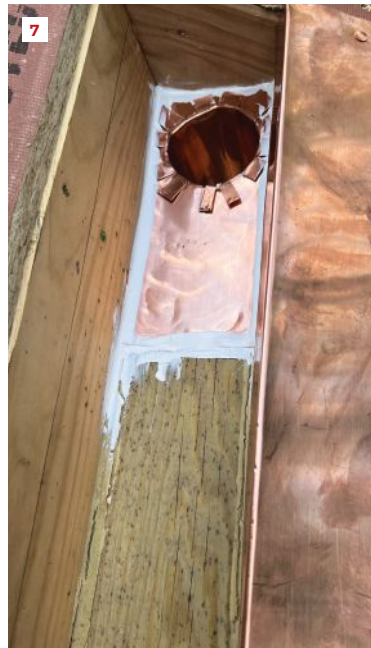
I'm a carpenter who primarily works in the Hudson Valley region of New York. Currently, I'm finishing up an addition-remodel of a Victorian-style home that the company I work for, New Dimension Construction, began this past January.

Central to the project is a two-story addition with a kitchen on the first floor and a bedroom on the second. In plan view, the addition forms what is essentially a new east wing, which changes the home's previous L-shaped building footprint to a U-shaped one. The existing west "wing" is a section of the home that we're renovating; it contains a new first-floor sitting room and remodeled second-floor master bathroom. The two wings are separated by a new stone patio area.

An interesting feature of the addition is a trellis that projects out from its north-facing end wall. Framed with pressure-treated 2x10s sistered onto the second-floor framing, the trellis cantilevers out 7 feet. To support the cantilever, we ran the trellis framing 14 feet back into the building and secured it to the floor joists with a tight on-center pattern of 12-gauge framing nails and 3-inch LedgerLok screws. (Mahogany will cover the trellis's framing, and steel cables will run up from grade to allow vines to grow onto the structure.)

Design problem. While we were framing the addition's roof, the homeowners visited the jobsite and noted that the addition looked too big and its height competed with the height of the main house (1). Also, they didn't like how the sight lines from the remodeled second-floor bathroom window would be blocked by the addition. We had framed the addition according to the design plans, so the architect was brought in to look for ways to reduce the mass of the addition.

The homeowners were reluctant to reduce the size of the kitchen, and they didn't want to give up the trellis. The only feasible option was to step back the second-floor's shed-dormer wall (offsetting it from the first-floor wall) and frame a small, sloped roof up from the ends of trellis joists to the dormer's wall. The hope was the small, 4:12-pitch roof would help to break up the imposing feel of the addition's end wall while also improving the sight lines from the remodeled master



At the trellis, the roof's edge is nearly in line with the face of the exterior wall below. The gutter's downslope edge is flashed with copper (6). A custom-built copper drop tube is installed at each end of the gutter (7).



The base coats (a tack coat with reinforcing fabric set into it and a saturation coat) are first applied to the trough and downslope portions of the gutter (8), then to the upslope (9). Two finish coats are applied (10). The fluid-applied system results in a 45-mil thickness.

bath's window. Also, the roof would be in keeping with the look of the rest of the home, as there were similar low roofs on the south and east elevations.

To manage run-off from the roof, we suggested a built-in gutter. Our company has installed a number of these over the years and has had success with them. With the trellis in the way, it would be impossible to pick up the water and prevent icing on the kitchen's slider step below using a conventional gutter. The homeowners and architect liked the idea and gave us the go-ahead to build it.

Framing "do-over." We demoed the gable and shed-dormer end walls (2, 3), then reframed the second-floor walls and roof, stepping the shed-dormer wall 3 feet back from the first-floor's exterior wall. Next, we started on the "mass-reducing" roof, framing it on top of the second floor's 3-foot-wide, now-exposed deck.

Gutter rough-in. After determining the roof and gutter dimensions, we made a sketch of the built-in gutter's profile to verify our cut angles. We planned for its side walls to be 90 degrees relative to its bottom, with beveled cuts at the tops to match the 4:12 roof pitch.

Working from a bench, we built the 19½-foot-long rough gutter in two 9-foot-9-inch-long sections out of pressure-treated 1-by stock. We wanted the gutter's high point to be in the middle, so we snapped lines onto lengths of 1x10 side-wall material representing the downward slope from the center point (at a ⅛-inch-per-foot slope, the gutter's depth varied about 1¼ inches from the center high point to the outside-end low points).

We clamped lengths of 1x10 side-wall material on edge spaced 5 inches apart, then fastened them through the face of 1-by stock into the sloping pressure-treated 1-by bottom to make two 5-inch-wide, U-shaped troughs. We glued and screwed all the seams, using Sikaflex sealant (sika.com) for its ability to stretch and prevent joints from cracking and opening up due to seasonal changes.

Finishing up, we bevel-cut the side walls to match the 4:12 roof slope (resulting in a 7-inch-high back wall





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Copper windowsill pan flashing is soldered to continuous apron flashing at the roof-to-wall junction. Standing-seam panels are locked into drip-edge flashing along the upslope edge of the built-in (11).



Shown in foreground, the addition forms a new east “wing” on the home. A future stone patio will separate the addition from the heavily remodeled existing west “wing,” shown here in the background (12).



The completed standing-seam copper roof (13). Copper downspouts will be installed later (14), as well as a copper gutter and downspout on the shed-dormer roof above.



and a roughly 5 1/4-inch front wall, as measured from the interior at the gutter's high point), then joined the two trough sections at the center high point and installed 1-by tapered pieces at each end. We lifted the completed gutter in place, checked it for straightness, and fastened it to the outer edge of exposed strip of the second-floor deck.

We framed the small roof with 2x6 rafters, attaching them to the back wall of the built-in gutter at the eaves and a ledger fastened to the stepped-back shed-dormer wall (4). After sheathing and taping the roof, we ran site-bent 16-ounce copper edge flashing around its perimeter (5). (The homeowners decided they wanted to dress up the lower roofs with copper; the upper roofs were asphalt shingle.) Then, we flashed the downslope edge of the gutter with copper (6) and custom-built copper drop tubes, one for each end. Prior to installing the two-piece drop tubes, we routed out the 1-by bottom about 1/8 inch to plane the flashing in to the rough gutter to avoid ponding, then set the flanges in Sikaflex (7).

Lining the trough. While metal-lined gutters are known for their longevity, they are not maintenance-free; soldered seams can fracture from expansion and contraction. We chose instead to line the gutter with Acrylabs, which is a less-costly, solderless alternative to a copper lining. Acrylabs is a seamless, fluid-applied acrylic elastomeric roof system that our company has used on a number of roofing projects (see “A Versatile Fluid-Applied Roofing Solution,” Nov/Dec/20). The system consists of a tack coat (with reinforcing fabric set into it), a saturation coat, and two finish coats that dry to an approximate 45-mil thickness.

We first applied the two-coat base with reinforcing fabric to the trough and downslope portions of the gutter (also covering the small roof areas on either side of the trellis framing) (8). We let each coat dry before applying the next. Then, we applied the Acrylabs reinforced base coat to the upslope, running it 18 inches up the roof (9). We applied the two finish coats, using a dark-colored finish coat to help hide the gutter (10).

Finishing up the roof, we laid down a high-temperature underlayment, then installed a copper apron along the roof-to-wall intersection. We integrated windowsill pan flashing into the apron, soldering the seams, then began applying the 16-ounce copper standing-seam panels, working left to right (11-13). Copper downspouts will be installed later (14), as well as a copper gutter and downspout on the shed-dormer roof above, which will help keep storm run-off from inundating the “do-over” roof and built-in gutter.

Jonathan Curtis is a carpenter at New Dimension Construction in Millbrook, N.Y.

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BY DAVID GERSTEL

Remodeling Your Thinking

When a friend asks me to recommend a construction contractor, I give them a name from the very short list of guys I feel I can suggest with confidence. “Bob,” as I call him in my new book, *Building Freedom, A Construction Pro’s Path to Financial Independence*, is on the list. Even so, when I recommend Bob, I do hesitate. That is not because Bob fails to check off all the boxes. He does. Bob produces first-rate work. If he gets a callback, he jumps on it. When he charges for preconstruction work, his estimate is transparent. He does not conceal overhead and profit in charges for labor and material. The guy practices integrity with every nail he sets and with every communication.

So why do I hesitate when I recommend him? Because I know that even as Bob takes good care of my friends, he’ll woefully undercompensate himself financially. Bob places mental obstacles between himself and the level of pay enjoyed by other well-established builders in our area. He’s in need of what I call “thought remodeling.” That’s a practice akin to the down-to-earth approach to mental health challenges known as “cognitive behavioral therapy (CBT).”

THOUGHT > EMOTION > ACTION

The core concept underlying CBT is: Thoughts precede and create emotion. Emotion undergirds action. That is, thought > emotion > action. The neurological underpinning of CBT, as I understand it, is that the more often we think a thought, the deeper its pathway in our minds. The deeper a pathway, the more likely our thoughts are to go down that pathway. Eventually, as a thought courses through our minds over and over, thinking it becomes a habit. And in due course, the habit can harden into a belief that rigidly governs our decisions and practices.

Therein lies our problem. Some thoughts are bad habits. They are, in the language of CBT, “thinking errors” that foster unhealthy emotion that, in turn, ignites ill-advised action. As construction pros, we can become habituated to thinking errors in our work life.

CONSTRUCTION INDUSTRY THINKING ERRORS

- Over-obedience
- Underpricing
- Revenue obsession
- Profit neglect
- Balance sheet pride
- Overhead obliviousness
- Name your own

Bob commits the thinking error CBT labels “mind reading.” He believes that his clients think of him as a mere “handyman” and not deserving of the pay commanded by top-drawer pros. To that he adds a second error, “catastrophizing.” If he submits a bid for a job and does not get it, he worries that he will never get another project.

Catastrophizing has driven Bob to push his prices so low that he “wins” seven out of 10 bids. More astute construction pros aim to win roughly three out of 10. If they are winning more than that, they conclude they are bidding too low and increase their prices. Meanwhile, Bob, gripped by his thinking errors, is trying to get his prices so low that he will win nine out of 10 bids!

Bob’s thinking errors have jeopardized his future. Soon he will be entering the “golden years.” Those years can be more like pitted copper if you have not piled up a fair amount of gold—namely, cash-producing investments that support a healthy and comfortable lifestyle. Bob has denied himself the income needed to build those investments.

He is not unique. Melanie Hodgdon described the situation in her *JLC* article “Job Pricing Blunders” (May/20): “The very characteristics that make contractors incredible neighbors all too often lead to decades of hard work with little to show for it.” They produce work that delights their clients. They treat employees like daughters and sons. But they neglect their own welfare. As they age and are no longer able to stand the stress and strain of construction, they find themselves facing a threadbare future. A variety of thinking errors, long rationalized or ignored, have come home to roost.

As they age and are no longer able to stand the stress and strain of construction, some contractors find themselves facing a threadbare future. A variety of thinking errors, long rationalized or ignored, have come home to roost.

COMMON THINKING ERRORS

During my decades in construction, I've observed a range of thinking errors across our industry. Below, I will discuss a few of the most prevalent:

Over-obedience. It's akin to what CBT terms "outsourcing happiness, giving outside sources the final say" in our thinking and decisions. A builder buddy of mine suffered from that error. Then one evening as we drove to a meeting of our association, he exclaimed, "Know what my problem is? Every time I hear someone in our group extol the latest and greatest thing they are doing, I think I have to do it, too, or fall behind." He was suffocating in the clutter of procedures he had adopted. He changed his thinking, cleared out the clutter, and remodeled his business into a leaner and more efficient operation.

His problem is widespread. One industry expert reports that when he starts with a new client, he typically finds that fully half of the procedures executed in their offices are of no value. One example (mine, not his) of valueless effort: compulsive job costing that wastes time at jobsites for the filling out of overly detailed time cards and in the office for getting the time card info into a job cost record—all without any verifiable benefit for project management or future estimating.

So much time spent on superfluities can distract from focus on work vital to the health of a company—notably bidding and estimating. Though the heartbeat of any construction company, bidding and estimating is often given short shrift. It gets done, but casually rather than systematically, with the imprecise results excused by clichés such as "estimating is an art, not a science" or "you can't know what a construction project will cost until it is over."

You may be a whiz at marketing, sales, and even production. But if you cannot systematically choose the right jobs to pursue and nail your estimates for building them, eventually you will be toast.

Underpricing can result from thinking errors that lead you to sell yourself short like Bob. The good news here is that errors can be corrected. Each time you catch yourself committing an error, you willfully replace it with better thinking. Eventually, the error will die out and the new and more functional thought will replace it.

Paul Winans, a builder who in time became the national head of NARI, was held back early in his career by thinking errors similar to those embedded in Bob's mind. Unlike Bob, Paul remodeled his mind, removing the errors and putting

new thinking in their place. In his memoir, *The Remodeling Life*, Paul recalls that early in his career he was not charging enough for his work. He thought and feared that if he raised his prices, he would not get enough work. He was challenged by a mentor to test his thinking. He did, gradually raising his prices. To his surprise, with each increase, he continued to get plenty of work. He quenched his old thinking and replaced it with a new belief: "I sell value, not price."

Paul's correction of his error helped motivate another builder to remodel his thinking. That would be me. I, too, underpriced due to flawed thinking. My thinking error was of a different type than Paul's. It was akin to what CBT terms a "false sense of responsibility." Though I had no real idea of a client's financial position, I would worry about an imagined burden the costs of their project might impose on them. On one project, I cut profit entirely out of my bid. Right after I completed the job, I spotted a brand new luxury camper van parked at the client's house. That experience definitely intensified my motivation to remodel my thinking about pricing.

Like Paul, I installed a new belief in my mind and presented it to clients. "We are not cheap, but we are a good deal. May I tell you why?" Generally, they said "yes," listened, and accepted my charges—including those for estimating and other preconstruction work.

Revenue obsession and profit neglect. Certain thinking errors come in pairs. One pair is "revenue obsession" combined with "profit neglect." Remarkably, those errors are sometimes fostered by the very folks who sell consulting services to our industry. When marketing their services, they trumpet the increases in top line revenue reaped by their star clients. Similar ballyhoo rings out at our meetings of our associations. If you attend them, you've heard the bragging—"We're doin' 20 mill this year." More substantial indicators of company health—employee morale and low turnover, percentage of work from references rather than marketing to strangers, and solid year-after-year profitability—are barely noted by the consultants or the braggarts.

Writing those lines, I think of my drill rig operator. He figured out it was not his gross sales volume that really mattered. "I take home more money and enjoy life more with just my one rig, operating it myself, than I did when I ran 20 rigs and had a far bigger top line number." I have lost count of the construction pros who have told me

Underpricing can result from thinking errors that lead you to sell yourself short ... The good news here is that errors can be corrected. Each time you catch yourself committing an error, you willfully replace it with better thinking.

a parallel story. I also know men and women who have successfully built sizable companies. They are amazed by what they have been able to do. However, it is not that top line, the gross sales, but their employees and profitability they focus on and are proudest of.

Balance sheet pride and overhead obliviousness. A second pair of thinking errors—namely “balance sheet pride” coupled with “overhead obliviousness”—is related to the first. They also divert attention from the factors that actually make for a financially healthy construction business. In *Building Freedom*, I wrote about them in detail. Here, I have room only to note that the balance sheet that feels good during boom times can turn on you when demand for construction shrivels. The warehouse, the big equipment, and the elaborate office that once stoked pride can transform into cash-eating predators. They become liabilities, not in the formal accounting sense, but in reality. As they sit idle, they gobble up capital reserves for payments, storage, maintenance, and security. Steadily, they slide toward obsolescence, losing value.

Balance sheet pride is joined at the hip with “overhead obliviousness.” We see that from the bottom to the top of our industry. We hear it from the startup guy who says, “I don’t have any overhead.” (Really? No truck? No phone or computer? No time spent meeting potential clients and generating estimates and bids? None of the dozens of other overhead costs I list in *Nail Your Numbers*?)

We find overhead obliviousness promoted by the advisors who service more established companies. One urged an audience of builders to focus on four numbers: You, as owner, concentrate on construction costs and profit margins. Have your production manager focus on sales and estimating. She assigned to no one the task of monitoring, managing, and containing overhead. The consequences of such negligence can be brutal.

If you are oblivious to overhead, your balance sheet can steadily become overloaded with “assets” of dubious business value. They may have been purchased for the sake of “professional image.” They may be “big boys toys” purchased on impulse. They may have been purchased in a misguided belief that they were essential to the operation of a real construction company.

Whatever the supposed “assets” are, in time, the costs of maintaining all the stuff listed on your balance sheet contribute to ballooning overhead. It can readily grow to half of the markup

you can get during times of strong demand for construction. Then an economic crunch comes. Now you can’t get projects with enough markup to even cover your inflated overhead much less anything for your own pay or company profit. You are hemorrhaging cash and teetering toward insolvency. If the recession that seems to be underway as I write this article does take hold, that is going to be the experience of construction companies caught in the thinking errors of balance sheet pride, overhead obliviousness, revenue obsession, and profit neglect.

ACQUIRING AWARENESS OF OUR THINKING

Take a close look at your thought > emotion > action pathways, and you may find that your errors are different from any I have mentioned. If you are able to spot them, you will have taken the hardest step toward thought remodeling. We construction guys, especially those of us who came up through the trades, are good at getting up early, grabbing a coffee, and cranking up production at the office or jobsite. At standing back, examining our patterns and the thought/emotion sequence that gave rise to them, we are not so good.

How can a construction pro acquire awareness of thinking errors that are getting in their way? To get started, you could adopt a practice encouraged by Gino Wickman in his book, *Traction*. Wickman advises this: Weekly, make an hour appointment with yourself. Make it at a quiet place well away from your office or jobsites. Keep the appointment without fail. Spend the hour reflecting about your practices and the thinking and emotions that give rise to them.

I have done that for years. I make my thinking appointment at a favorite café, treat myself to a latte, and sit for an hour considering my principles and practices and decisions about projects. It is hard work to just sit and think. But I have had a great run in construction, enjoyed working with many talented designers and craftspeople, and reached financial freedom. Those weekly think appointments help me to spot and remodel problematic beliefs and continue on my way.

David Gerstel is a builder and the author of the construction industry bestsellers Running a Successful Construction Company and Nail Your Numbers. This article is adapted from David’s newest book, Building Freedom: A Construction Pro’s Path to Financial Independence.

We construction guys, especially those of us who came up through the trades, are good at getting up early, grabbing a coffee, and cranking up production at the office or jobsite. At standing back, examining our patterns and the thought/emotion sequence that gave rise to them, we are not so good.

An Infinitely Configurable Material Estimating Tool

BY JON BEER

Material estimating can be one of the most tedious yet critical tasks for builders and remodelers. It's a familiar task: printing plans, using a ruler and calculator to measure based on the scale, and with notebook at my side, manually calculating the quantities needed for each project.

Then a few hours spent Googling and making phone calls to assemble pricing. Estimating always meant sitting down for several hours per project to figure these things out. If clients changed their minds, then you were literally back at the drawing board.

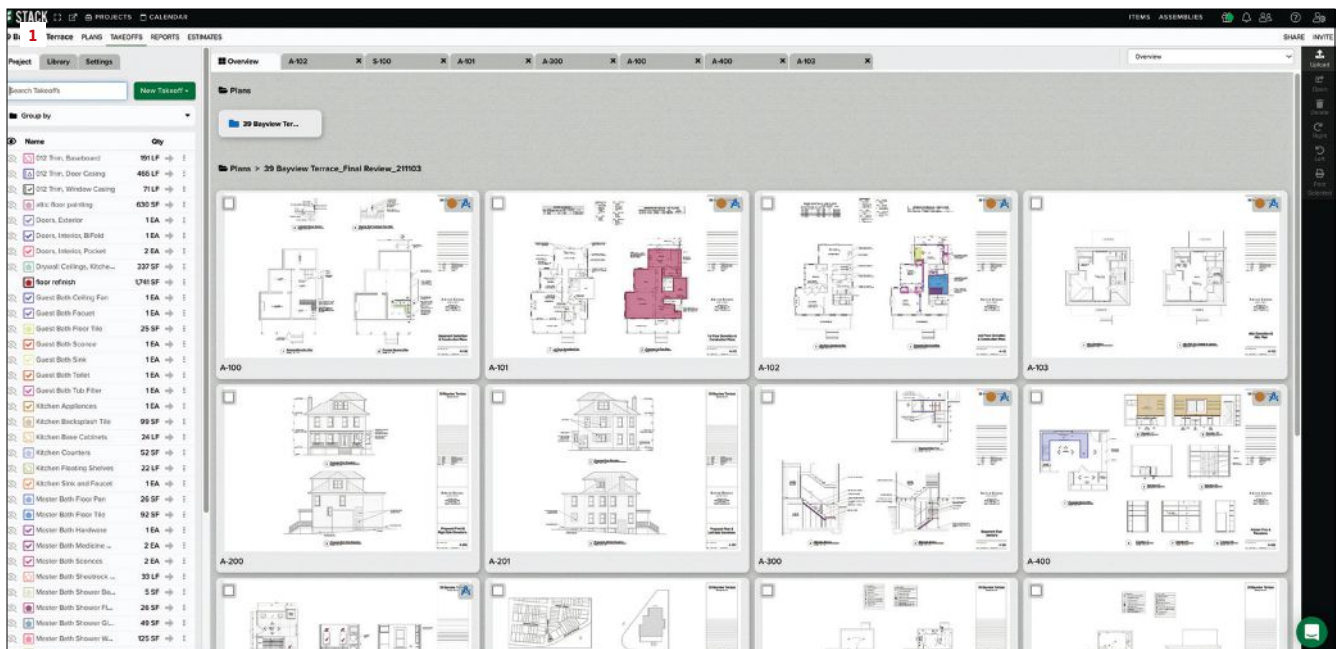
After a few years of this, I decided to try to improve the process using Excel spreadsheets with formulas to help do some of the math. I created a spreadsheet containing prices of frequently used materials. I even created a specialized one just for bathroom remodels. This was an improvement but still meant a lot of manual data entry, and the chance for making mistakes was high.

As my workload increased and my crew grew larger, I knew I needed to spend less time doing material take-offs. By chance I stumbled onto Stack. While doing a full-access free trial, I quickly realized that the cloud-based software was a robust solution to increase the ease, speed, and accuracy of material take-offs.

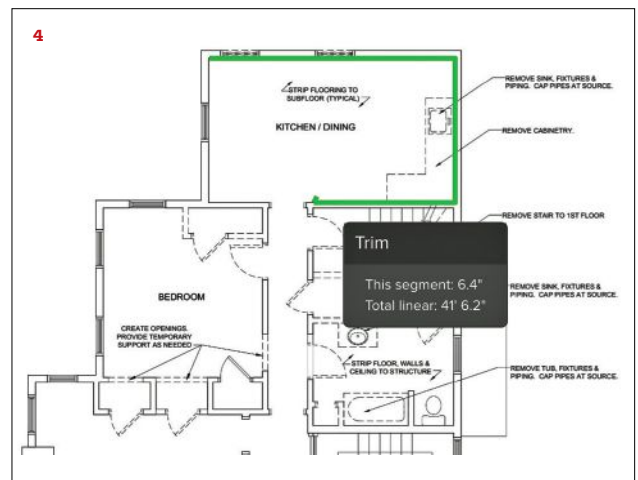
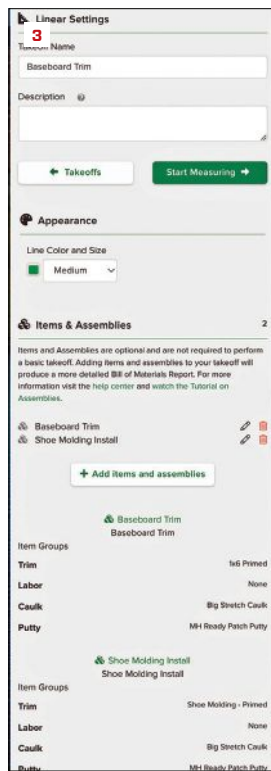
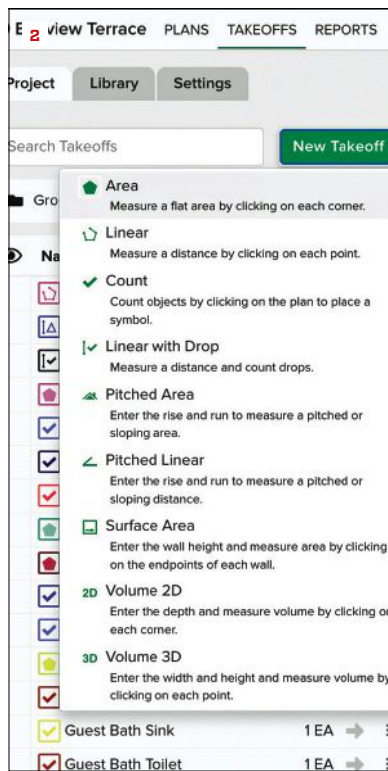
To get started, you log in to the website, create a new project, and upload a set of plans. Stack has some intelligent code that will read the title block and auto-organize the sheets for you. The program works directly off plans—so you measure directly on top of the drawings. Like most software, when you open it up for the first time, it can feel a bit overwhelming. But Stack comes loaded with a robust item-and-assembly catalog to get you estimating as quickly as possible.

Once the plans are imported, each project is built around “Takeoffs”—which are individual measured items that you apply “Items” and “Assemblies” to. For instance, if you want to measure baseboard and shoe molding in a room, you'd create a “New Takeoff,” select “Linear,” name it “Baseboard Trim,” set the scale, and click on the areas you want to measure. Once you've drawn all the areas you want to measure, you apply an assembly from your assembly database. Stack will then auto-calculate all the items included in the assembly and present them in a takeoff report that auto-updates as you build and add more measured takeoffs.

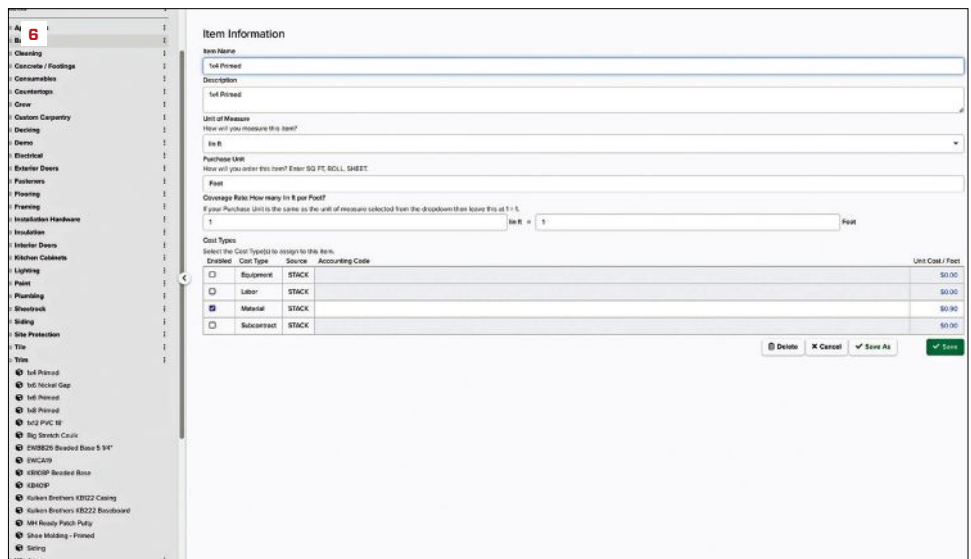
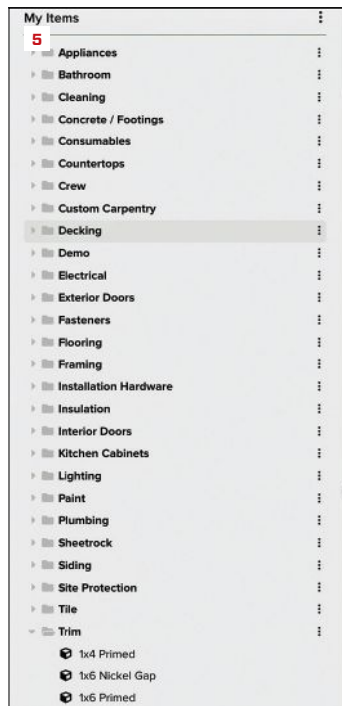
The power of Stack comes from its items and assemblies libraries. Let's say you do a lot of additions and often work with the



Stack is a cloud-based estimating platform that allows you to upload a set of plans. This is the first step in estimating a project. The program reads the title block, which helps you organize documents for different projects.



An estimate is built around multiple “Takeoffs” that you can define. The example here for estimating baseboard begins by selecting “Linear Takeoff” (2), defining the settings (3), and measuring directly off the plans where baseboard applies (4).



The power of Stack is found in the ability to define your own “Items” and build them into “Assemblies.” Here, we see the item library (5). Stack comes preloaded with a range of items, but users can modify them, as well as define new ones (6).

“Assemblies” can be built with “Items.” In this example, we see the assemblies library available to the author and a selected entry—“Window Trim - Linear with Drop” (7). Each assembly can be modified with a range of items, all of which are available in the drop-down menus in the “Assembly Options” window (8).

same group of materials—2x6 exterior walls with 7/16-inch Zip-System sheathing, R-23 Rockwool insulation, 1/2-inch drywall, 1x6 baseboard trim, and shoe molding. You can build a linear-measurement takeoff that has all those assemblies attached to it and measure them all in just a few clicks.

If you are a finish carpenter, you know how time consuming it can be to measure multipiece trim assemblies—in particular, door and window casing. I do all my painting in-house, and for that, I need to also estimate how much caulk and putty I need per job. So I built an assembly for that. More-complex formulas can require converting area measurements to linear ones but with the help of the Stack support team, we figured this all out. In a few clicks, I can now create a takeoff, measure it, choose my items (materials), and generate a report showing how much trim I need for all the doors and windows on a job.

Each takeoff report has pricing attached to it. The beautiful thing is that when you add an item to your item catalog, you can enter a price. You can duplicate and modify the Stack catalog, to get up and running faster. But when you begin using Stack, the majority of your time is going to be spent adding items and assemblies with prices to suit your needs. At the time of this writing, Stack added a feature that allows you to integrate current regional and national material prices directly into Stack, powered by cost data from BNI Building News *CostBooks*.

Stack can measure anything that can be translated into linear, area, cubic, or count measurements. That includes labor. Let’s say you hang drywall and work by the square foot. Build an assembly for it and add it to the drywall measurement takeoff! Maybe you’re an electrician and want to measure your wire length and charge by the receptacle? Build a takeoff that uses “linear with drop” measurement and calculate both at the same time.

In an effort to streamline my admin and back-of-house tasks, I have tried a lot of software, and I’ve found that most of it requires you to do double data entry. When you build a takeoff with Stack, however, you can save it to your “Takeoff Library.” This is a tab that is shown globally on every project, and you can quickly insert a prebuilt takeoff into a new project rather than having to duplicate it or redo it each time.

I can say that I have easily cut my estimating time in half since I got Stack configured. As a remodeling company, we do a lot of bathrooms. I can now estimate a master-bath gut remodel in about 10 minutes, instead of two or three hours.

Once you’ve measured everything, you can quickly turn the takeoffs into a “Proposal.” The current construction marketplace is a volatile place with extreme price changes. Stack allows you to modify item prices and add markup, sales tax, and unmeasured costs before completing your proposal. If you created a proposal six months ago and want to review older costs, no problem: Your previous version is saved for you. The export feature allows you to generate proposals with the option to toggle on or off line items or category details for as much transparency as you are comfortable with.

Training. I like to think I’m someone who is technologically savvy, and I was not scared to jump right into using the software. That said, if I had to do it again, I would have started with more training sessions. The staff at Stack Construction Technologies have helpful insights on how to organize and build an assembly library, set up your account, and connect additional software like QuickBooks, Procore, and Buildertrend. Taking the time to set it up correctly in the beginning will mean spending less time modifying things after the fact. (Ask me how I know.) The support staff is always available during business hours—just click the message icon on the bottom right of the screen to begin a chat. There have



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BY RANDY WILLIAMS

Single-Point vs. Multi-point Blower Door Testing

[Editor's note: This is the third article in a series by the author on using a blower door. The first article, "Setting Up a Home for a Blower Door Test," appeared in the April 2022 issue, and the second, "Calculating House Volume for Blower Door Tests," in July/August 2022.]

The main purpose of a blower door test is to confirm the integrity and continuity of a building's air control layer or air barrier. I have a few options for how to perform the test; the one I choose depends on the reasons for performing the test:

1. Testing to verify code compliance.
2. Testing as part of an energy audit.

3. Testing before, during, and after a renovation or remodeling project.
4. Testing during a new build.
5. Using the blower door to assist air-sealing.

In the case of a code-compliance test or an energy audit, I want the most accurate test I can perform. Accuracy typically improves when more data is included in the test. If we are simply looking for holes to seal in an existing home, though, I may not need lots of data; I just need to run the blower door to help find the holes. The conditions will dictate whether I use a single-point test or multi-point test—or just set the fan to operate on cruise control to hold a constant pressure to identify air-leak locations (1).



A single-point test measures air leakage at just one house pressure, of approximately 50 pascals, while a multi-point test measures leakage over a range of house pressures.

HOW A BLOWER DOOR OPERATES

Before we get into single-point and multi-point tests, let's review how a blower door operates. A blower door is designed to move air into or out of a structure through a calibrated fan. In residential construction, we induce a pressure difference of 50 pascals, or 0.2 inches of water column, between inside and outside the building. A manometer or pressure gauge is used with the fan to measure the amount of airflow moving across the fan. This airflow matches the airflow of the leaks in the building at the pressure of 50 pascals (the actual measurement details are little more complicated than this description, but this is basically how it works).

In the United States, airflow is measured in cubic feet per minute, or cfm. The airflow measurement can also be used along with the building volume or square footage to calculate other airtightness metrics, such as air exchanges per hour (ACH) or cfm of airflow per square foot of surface area.

The accuracy of the airflow measurement is dependent on several factors, including equipment accuracy and condition, wind fluctuations, and temperature differences between inside and outside the building. The accuracy (or measurement uncertainty) can be improved when more data is collected during the test.

HOW DATA IS COLLECTED

Data collection during a blower door test is most accurate if the process is automated. Blower-door



Two digital manometers (2): Retrotec DM32 (above, at left) and The Energy Conservatory DG-1000 (above, at right). Before the creation of the modern digital gauges, analog Magnehelic pressure gauges were used to perform blower door tests. This set (3) was part of an early (around 1990) Minneapolis Blower Door system.



manufacturers have software for quickly and precisely running a blower door test. For operating the software, smartphones, tablets, and laptops are all good choices; I use a Microsoft Surface Pro but have also used a Samsung phone and a standard laptop to perform testing. The choice of using a phone, tablet, or laptop may be limited by the pressure gauge or manometer used. The newer DG-1000 from the Energy Conservatory and the DM32 from Retrotec can communicate with a computer by a hardwire connection or wirelessly (2). Some manometers may need additional components to connect to some devices. Older manometers, such as the one pictured above right (3), are analog and require measurements to be collected manually.

SINGLE-POINT TEST

For a single-point test, we collect the airflow data (in cfm) at only one pressure point, typically 50 pascals. When we're testing using the ANSI/RESNET/ICC 380-2019 standard, the measurement of airflow moving across the fan is averaged over at least a 10-second time period. Simply put, the fan holds a steady 50 pascals of pressure difference between inside and outside the structure while the airflow across the fan is measured for 10 seconds. The data points collected over those 10 seconds are then averaged to arrive at the final airflow measurement.

It is possible to adjust the time period for collecting the data; in fact, there may be situations in which you want to collect data over a longer period. If it's windy, for example, increasing the period

from the minimum 10 seconds to 30, or even 60, seconds will help improve the accuracy of your results.

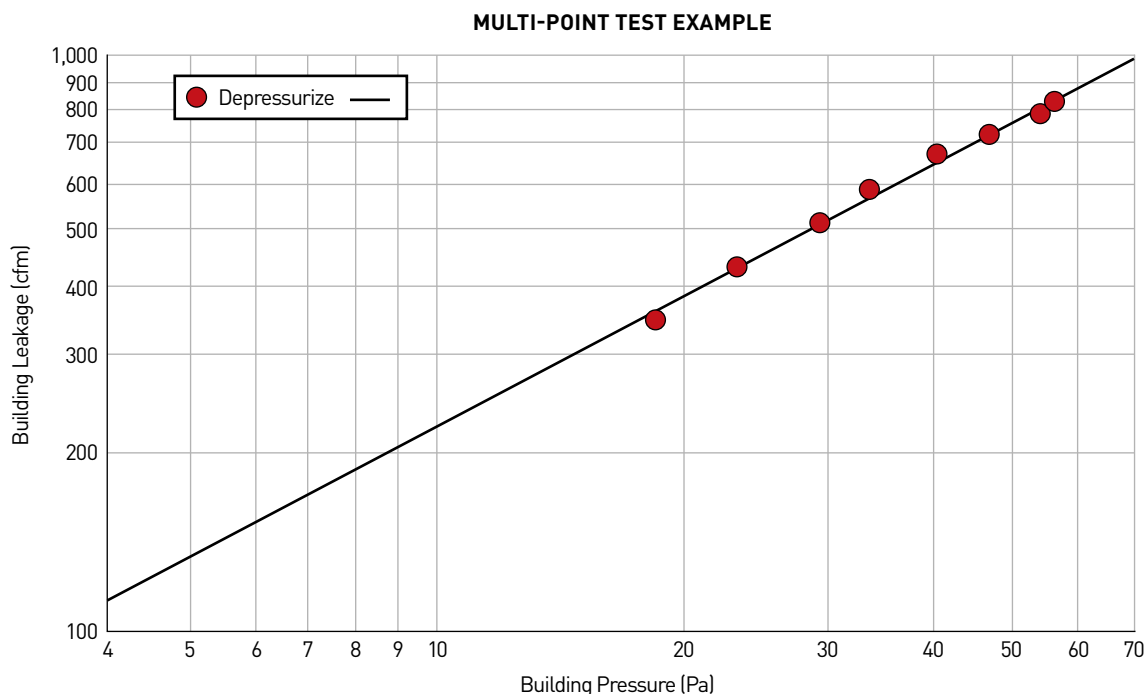
There are variations to a single-point test. A repeated single-point test is what it sounds like: Several individual single-point tests are performed, then the results are averaged. Another variation is to perform the single-point test in both directions, pressurized and depressurized, and average those results. Again, more data equates to more accurate results.

When you're performing a single-point blower door test to the ANSI/RESNET/ICC 380 standard (which is used for both a HERS rating and code-compliant testing), a 10% adjustment needs to be added to the final number to meet the requirement.

MULTI-POINT TEST

A multi-point blower door test is conducted at several different pressure points. The ANSI/RESNET/ICC 380-2019 standard requires testing at a minimum of five different pascals of pressure between 10 pascals and 60 pascals. The airflow data is collected over a minimum of 10 seconds at each of the pressure intervals.

Manufacturers make software designed to perform these tests to the required standard; for example, The Energy Conservatory's Auto Test software (which currently operates only on phones and tablets) has several multi-point test options. One of the options is the RESNET 380 multi-point test mentioned above. For that test, the pressure points are 60 Pa, 48 Pa, 35 Pa, 23 Pa, and 10 Pa. Another option in the software is the ASTM E779 multi-point test (another



This graph depicts a building-leakage curve created with the data collected from a multi-point blower door test. The test used eight different pressures to more accurately model house leakage rates at a range of lower, more-normal pressure differences between indoors and outdoors.

testing standard allowed by the IRC). There are eight different pressure points in this automated test: 60 Pa, 54 Pa, 48 Pa, 42 Pa, 36 Pa, 30 Pa, 24 Pa, and 18 Pa.

One reason for conducting a multi-point test is that it is more accurate for predicting building leakage at lower pressures. During normal operating conditions, a typical home rarely sees 50 pascals of pressure difference between inside and outside. More commonly, the pressure difference will be under 10 pascals. To predict the leakage rate at lower pressures, a building leakage curve is produced after a multi-point test is completed (see graph, above). Though the building leakage curve can be estimated using a single-point blower door test, the curve is more reliable when a multi-point test is used.

The test performed in the example above was an ASTM E779 multi-point test. The leakage rate at 60 pascals was 806 cfm, and at 18 pascals, 339 cfm. The curve shows us the predicted leakage rates down to a difference of 4 pascals of pressure.

What happens if you are unable to reach at least 50 pascals of pressure during multi-point testing? The 380 standard will allow a multi-point test to be used as long as at least 25 pascals of pressure can be reached. Less than 25 pascals and the test is required to be a single-point test. Most current software options will convert the test results when a “can’t reach 50” test occurs.

Returning to the point that more data means more accuracy, both single-point and multi-point blower door test results are only

as good as the information provided for the calculations. If you are conducting a test during the winter in a very cold climate, you will need to account for the difference in temperature between inside and outside the home, or if you live in a mountainous area, elevation needs to be accounted for. Another important piece of information is the baseline pressure (normal difference in pressure between inside and outside the building). When you’re performing an automated test using software, the software will perform a quick baseline test and automatically adjust the fan speed to account for the pressure difference. When performing a manual test, you will need to do the calculations by hand and make the adjustments manually.

There are many reasons to perform a blower door test. Sometimes we want to perform the most accurate test we can; other times we just need to run the blower door to help us find the holes. Having a basic understanding of the differences between a single-point and multi-point test can help you decide which test to perform. The only time I perform single-point testing is to confirm the leakage rate of a structure before setting the fan on cruise control to find the air leaks. In all other situations, I perform multi-point tests.

Randy Williams is a builder and energy auditor in northern Minnesota. Follow him on Instagram at @northernbuiltpro and his blog at northernbuilt.pro.



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INTERIORS



Built-in Bench Seating Pattern-routed supports guarantee a perfect fit

BY GARY STRIEGLER

Custom woodworking projects are the bread and butter of my construction business. Built-in desks, beds, and window seats are examples of projects that are popular with our clients. While the function and design of these custom projects may be similar, no two are ever exactly the same, because every homeowner has a different space, need, taste, and budget. Instead of reinventing the wheel each time, I have developed methods for each project that can be modified to meet each client's needs.

Recently, for example, we were asked to build booth seating that wrapped around a corner. I have done this at least three times before, but this was the largest bench that I have ever taken on—about 8 feet in one direction and 12 feet in the other—so I couldn't cut the back or the seat out of a single sheet of plywood. Instead, I would have to splice the plywood back. In addition, the homeowner want-

ed the seat to be made of solid lumber rather than plywood. Finally, the whole assembly had to fit precisely under the bank of windows on each wall.

My method for building seating like this is to make a pattern for one of the plywood supports, then make multiple support pieces off the pattern using a flush trim router bit. For the CliffsNotes version of the project, I attach the supports to the wall, add a plywood back, then fit the solid wood seat and add a little trim. Of course, that skips a lot of important details.

LAYOUT

On a project like this, I start by mapping out the available space so that I know the basic dimensions of the built-in. The homeowners were working with an interior designer who had provided

Photos by Gary Striegler



The author used the first plywood bench support that he made as a pattern to cut out the remaining supports, tracing its outline on a sheet of plywood (1), cutting out the piece with a jigsaw, tacking the pattern to the workpiece, and trimming the next support to size with a router fitted with a flush-cutting bit (2). Since the pattern was tacked in place with just a few brads, it was easy to pry the two pieces apart (3). He marked the support locations on the wall every 24 inches on-center (4).

us with a rough conceptual drawing of the bench, but we were left to sort out most of the structural details for ourselves.

Once I worked out the basic design, I made a pattern for the bench's plywood supports. Most chairs are around 18 inches high, so I started there and subtracted for the thickness of the stock that I would use to make the seat. I also subtracted 3 inches for the cushion that the homeowners planned to use on top of the seat. Eighteen inches is about the average depth of a chair seat, and that works well for bench seating like this too.

I like to build bench backs with a 10-degree angle. In addition, the designer's drawing called for a cantilever detail at the seat, which provides more room for feet when people are seated. The final piece of information for my seat-support pattern was the height of the seat back, as measured from the bottom of the window seat to the bottom edge of the window sill, minus an inch to accommodate the thickness of the 3/4-inch bullnose trim detail that I planned to use there with wiggle room to shim it level.

TEMPLATE

I like to make my plywood supports out of 3/4-inch-thick Baltic birch plywood, which is strong, lays flat, and doesn't have any voids in it, and that's what I used for this project. If for some reason Baltic birch plywood is unavailable, I have successfully substituted a high-quality domestic birch or maple veneer core plywood.

Once I had the support marked out, I cut it out as accurately as I could using a track saw and sliding miter saw. Next, I counted the total number of supports and used the pattern to lay them all out on plywood that had been ripped to the width of the supports so that the grain would be oriented vertically.

Removing a lot of material with a flush trim router bit is hard on the router and makes a big mess, so I first used a circular saw and jigsaw to rough-cut each support, trying to stay within 1/16 inch to 1/8 inch of my layout line. Then I tacked the pattern on top of the workpiece with a few 18-gauge brads and ran the router around each support with the bearing riding on the pattern to give me an exact



The author started installing the supports at the inside corner, nailing them to cleats fastened to the wall and the floor (5). He installed the next support as far as his 8-foot level would reach, then worked back toward the corner, using the level as a straightedge to ensure that all of the supports were in the same plane (6). Some supports needed to be trimmed along either their base or back to account for variations in the wall or floor (7). Long MDF trim pieces nailed to the bases and fronts of the supports tie the bench together (8).

duplicate of the pattern. When I was finished, I just pried the two pieces apart and worked the brads back and forth until they broke off, then repeated the process for the next support.

INSTALLATION

The framers I work with are very good, but walls and floors are never perfect. That meant that I had to make small adjustments to the supports so that the seat and back of the finished bench wouldn't have any dips or humps.

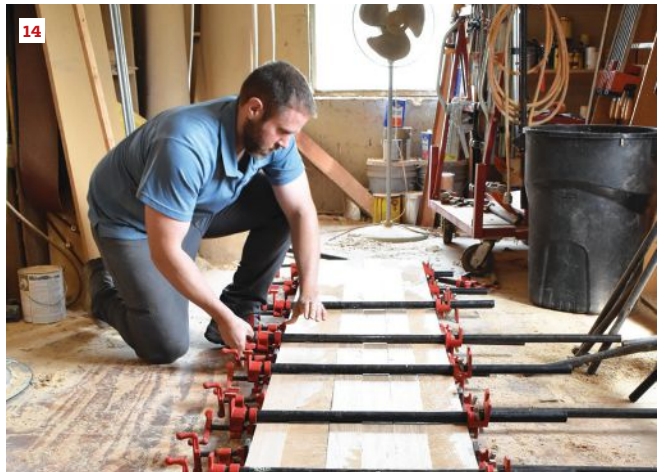
After laying out the support positions, I started my installation at the inside corner. I nailed and glued together the two corner supports with a small backing piece at the very outside edge where they meet at the front. Then I plumbed and leveled the supports and used cleats to fasten them to the wall and floor. I set the next support as far down the long wall as my 8-foot level would reach, using my long level to ensure that the supports were exactly horizontally aligned

and a shorter level to make sure the support was plumb. Once the support was in the right position, I fastened two wall cleats through the drywall into the wall framing and a third cleat to the subfloor, then fastened the support to the cleats.

I followed the same process to install the remaining supports, which are on 2-foot centers to support a $\frac{3}{4}$ hardwood seat (for a bench with a plywood seat, we install supports 16 inches on-center). Once I finished setting a support with a cleat on the floor, I checked it for square against the back wall before installing the upper cleat. Setting supports was a slow process because I needed to check each one in multiple places with the long level for humps, and had to trim a few of the supports using a bench-top jointer (a hand-held planer would also work) to make sure the tops were level and the fronts were in plane.

I was able to use a long strip of MDF shelf material, which comes in lengths up to 16 feet, for my front band, the first part that ties all the supports together.

BUILT-IN BENCH SEATING



Because one of the bench seat backs measured almost 12 feet in length, the author used Festool Dominos (9) and pocket screws (10) to glue together the two lengths of plywood needed to form it (11). The seat back is topped with bullnose trim shimmed for an even reveal between the seat and the window (12). Back in the shop, a worker used pipe clamps to laminate the 18-inch-wide bench seat out of $\frac{5}{4}$ white oak ripped to 3- and 4-inch widths (13, 14).



For the corners, the author used his pattern-cutting technique to make multiple identically curved pieces to glue into radiused blocks (15). Dominos join the two parts of the bench seat together where they meet at right angles (16, 17). The bench seat was given a paint finish to match the rest of the room's interior trim (18).

Plywood back. Since one side of the bench was over 8 feet long, we had to splice the plywood back. We located the splice so that it would fall over one of the supports, and used Festool Dominos for alignment and pocket screws to pull the joint together.

When installing the spliced back, I let one end run long into the inside corner, then took a measurement to scribe cut the shorter back. Any time I fit a joint like this, I like to under-bevel the cut a little for the best possible joint. A track saw is the perfect tool to make this cut.

After nailing the plywood backs in place, we trimmed out the bench top with a $\frac{3}{4}$ -inch bullnose piece shimmed to fit. A simple $\frac{1}{4}$ -by- $\frac{3}{4}$ -inch flat trim piece closed the gap between the bullnose and the plywood back and finished off the top. This was a good point to take measurements and go to the shop to glue up the seat.

Seat glue-up. One of my guidelines for glue-ups is not to use pieces wider than 5 inches, which tend to cup. I rip the material to width using a sharp blade or run the rippings through a bench-top planer to get rid of saw kerfs. I use plenty of clamps when gluing up the material, alternating the growth-ring orientation on each strip, and locate the clamps about 6 to 8 inches apart, alternating top and bottom. It's important to do the glue-up on a flat surface, using plenty of glue on both edges so that there is a little squeeze out—which can be wiped off with a damp rag or scraped off later (don't try to plane your glue-up with big globs of glue on it). Let it dry for half a

day, or overnight is even better. If you don't own a planer big enough to plane a 20-inch-wide seat, make two glue-ups, plane them, and then glue them together using Dominos or biscuits for a flush top.

The final drawings showed a curved front apron and seat. I made the curved apron by stacking multiple layers of MDF (using the same flush trim router trick). Adding the curved apron was a challenge and it changed the amount of overhang for the seat, but it added a nice touch to the finished product.

I couldn't get $\frac{5}{4}$ lumber long enough to make a miter corner joint in the seat, so we went with a simple butt joint using Dominos. After a dry test fit, we cut a curve at the corner of the top to follow the apron and rounded over all the edges but the very inside corner, which had to be done after the seat was in place. I wanted more holding power than nails, so we attached the top using $2\frac{1}{4}$ -inch trim-head screws.

We had a few exposed plywood ends to cover with flat trim and a base trim to add before we could call it done and bring in the paint crew. The size and curved elements of the bench made this the hardest bench project we have done so far, but it turned out to be a beautiful addition to this remodeling job.

Gary Striegler, a JLC contributing editor, owns Craftsman Builders (craftsmanbuildersnwa.com), in Fayetteville, Ark., and teaches workshops at Marc Adams School of Woodworking. Follow him on Instagram: @craftsmanbuilders.

INTERIORS



Moving More Than Walls to Open Up Space Efficiently relocating mechanicals is often the challenge

BY TRAVIS BRUNGARDT

Photos by Catalyst Construction

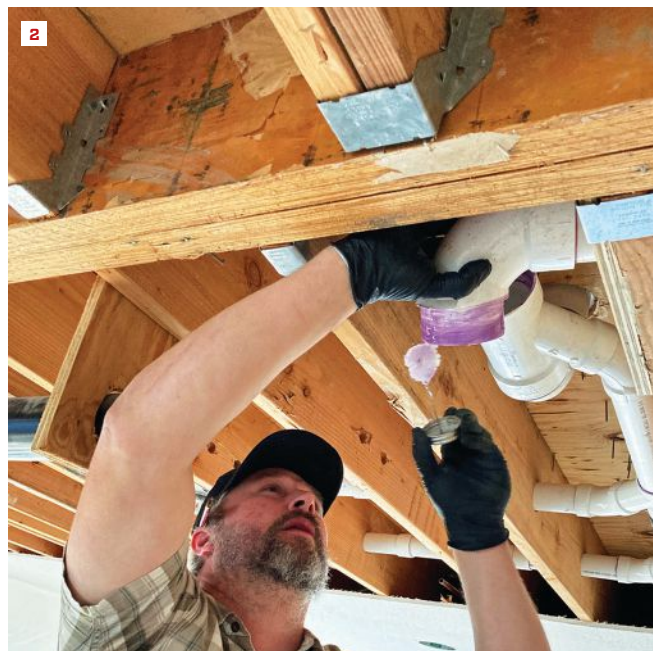
The see-through gas fireplace that separated the living room from the hearth room was a popular feature when this single-family home was completed in the 1990s. Since that time, the owners had grown increasingly frustrated that their growing family could no longer enjoy the holidays in the same room, as each of their three sons married and had children of their own. The solution was clear to them: Eliminate the 3-by-8-by-9-foot obstacle that split the rooms and relocate the fireplace feature to the exterior wall of the hearth room.

While the task of removing a large divider to create an open-concept living area is a familiar one, the challenge of maintaining the structural load path can never be taken lightly. Each wall removal must be treated with the same intensity of focus, lest the ceiling meet the floor. Our firm frequently removes bearing walls and replaces them with well-placed columns and flush-framed LVL or steel beams.

Demolition. The task of opening up living space typically begins with the selective demolition of interior finishes and construction of temporary walls to support the floor, ceiling, and roof during the removal of the existing support and installation of the new beam. After stripping back the drywall at the ceiling, we were pleasantly surprised to find that the original builder had already included an LVL beam to support the second-floor system and had not utilized the walls surrounding the fireplace for bearing at all. Short of adding a number of joist hangers and installing the proper nails in the existing hangers, we were able to start this project off with a quick leap ahead in schedule. This is notable, since it typically goes the other way, right?

Rerouting drain lines. The next task was the relocation of the supply and drain plumbing that served the master bath and hall bathrooms on the second floor overhead. The main 3-inch ABS stack was located near the center of the room and had to find its way to the exterior wall and down into the basement. With the 2x10 floor system in great shape and the closet flange for the master-bath commode already located within 12 inches of the exterior wall, this relocation was possible, but not easy.

My partner, Joe, is a licensed Master Plumber and quickly devised a plan to reroute the 3-inch drains through the joists as they made their way across the ceiling. Because it's important to keep penetrations through joists within the middle third where stresses are minimal, tolerances were tight. The top of the hole in the first joist near the new traps had to begin at the very top of the middle third so that the pipe would have adequate fall. Using his layout square, he scribed new marks for the center of the drain progressively lower by $\frac{3}{16}$ inch on each successive joist to create the proper fall ($\frac{1}{8}$ inch per foot). But to keep the holes within the middle third of the joist, he had to drill the joists out to the exact outside diameter of pipe. This made for a



Relocating the drain lines to the exterior walls proved to be challenging: To preserve the integrity of the joists, the holes needed to be within the middle third of each joist, but they still needed to drop to provide drainage. To succeed, Joe had to drill his holes to the exact outside diameter of the pipe, leaving very tight tolerances for running the pipe straight through (1). The old ABS lines were replaced with PVC (2) everywhere except where vent stacks tied in.



New supply lines tied into the existing copper with press fittings (3). Note the ABS vent connection using Fernco fittings with rubber sleeves and hose clamps. Before running new supply lines in the exterior wall, the author insulated the bay with rigid foam (4). A press tool was essential for joining new PEX to existing copper in tight framing bays (5, 6).



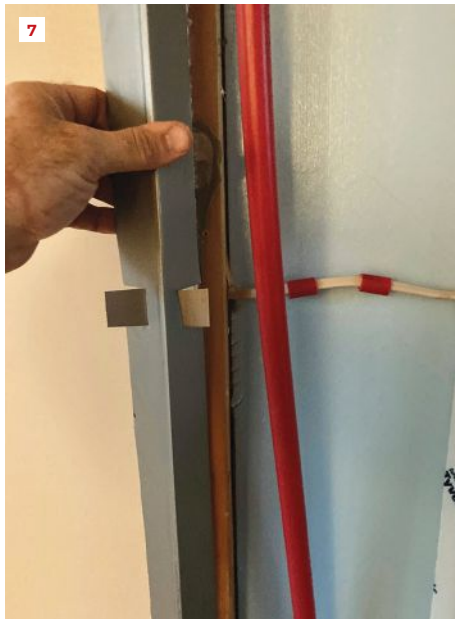
tougher install because he had no play to work the PVC into position. This worked all the way to the last joist, which was only 4½ inches away from the rim joist, where the hole had to drop below the middle third. Structurally, this was not a huge concern, because of the close spacing, but Joe still installed the required glued plywood reinforcement to the joist before drilling the hole and running the drain.

Vent connections. Local code allowed us to keep the existing ABS vent stacks in place but required PVC for all new drain work. Where the vent connections tie in, the code does not allow glued PVC to ABS connections for the same reason it doesn't approve of ABS in the first place: The glued joint is more prone to failure than the solvent weld achieved with primed and cemented PVC connections. Instead, wherever ABS meets PVC, the code officials here want to see Fernco fittings with their rubber sleeves and hose clamps.

New supply lines. The planning of the drain piping included a provision for Joe to access the existing copper supply lines that share that last 4½-inch bay. We use cross-linked polyethylene (PEX) for all our new work, but when we're tying into existing copper,

ProPress press fittings are indispensable for their speed and reliability. Also, not having to sweat copper fittings in the tight confines of narrow joist bays reduces risk. The one-handed operation of the slender press tool (we use a Milwaukee M12) worked well in that last slim joist bay, as well as below the floor system in the basement soffit area. Joe had to plan the connections and execute the installation of each fitting in order of access, and many of these had to be prebuilt and raised into position because only the final connection was reachable with the press tool.

One downside of running supply lines in exterior walls is the potential for freezing, which is always a concern here in climate zone 4. While we tend to prefer Rockwool insulation, we want to pack as much R-value as possible between the exterior and new supply lines, so we opted for the higher R-value of XPS rigid insulation, placing two 1-inch panels against the exterior sheathing. By air-sealing the perimeter of the rigid foam, we feel confident we have created an air space between the XPS and the drywall that will remain above freezing all winter.



To protect the new supply runs, the author used half of a metal-framing track to create an angled piece of steel. Short pieces of PEX cushion an electric line that runs behind the pipes (7) before the steel angles are taped in place against the foam (8) and the surrounding walls are insulated, ready for drywall.

ACQUIRING LICENSES IN THE MECHANICAL TRADES

The story of how my business partner, Joe Cook, and I acquired trade licenses was fueled in part by frustration with subcontractors in our market, particularly on smaller jobs like the one described in this article. But the story really begins with our particular experiences in the trades early on, which gave us a high level of confidence performing work in the mechanical trades. For me, this started with my first job, working for a father-and-son remodeling team who self-performed all their electrical work. The son, Bill, passed along the knowledge of pulling wire and wiring fixtures to me before I moved on to work as a production manager for a large home builder. Joe had done a fair bit of plumbing before working for a high-end remodeler. We decided to go out on our own, forming Catalyst Construction, following the recession of 2008, when work with our previous employers had slowed down.

Our third partner was a structural engineer, and in Kansas, engineers automatically qualify for a general contractor's license. So while we were up and running as contractors, we were often frustrated working with subcontractors in our market since many of the installers didn't have the skills we already possessed. Even those that did often made it apparent that they didn't care nearly as much as we did about doing quality work. To free ourselves from depending on them, we set out to obtain our own licenses. We scheduled a couple of hours a day for several days a week to study the relevant codes and scheduled our exams. Joe took the General Contractors licensing exam (based on IRC) while I took the Master Electrical exam (based on IEC and NFPA), both of which we passed. We immediately saw the benefits in cost and quality of keeping the electrical work in-house, so the following year, Joe studied up on the Plumbing Code (based on the IPC in Kansas), and he passed the test to become a Master Plumber with Fuel Gas certification. At that same time, I tested for an HVAC license, after studying the Mechanical Code (based on the IMC) and Fuel Gas Codes (based on the IFGC); it took two attempts at the HVAC exam, as a lot of the test covered boilers and other equipment I had no field experience with.

Each exam consisted of around 85 questions. You get several hours and are allowed to use the code books and a calculator (but no phones or tablets). The exams are very focused on the codes and even though the exam is open book, you need to know your way around them. For the plumbing and HVAC, we found it extremely helpful to take a test preparation course. These teach you how to work through the exam efficiently, and are well worth the time and expense (now around \$200 to \$300).

In Kansas, we can sit for the license exams without serving a formal apprenticeship through a licensed employer or union, and, on the basis of our Kansas licenses and with letters from license holders who vouched for our experience, we are licensed to do work in Kansas City, Mo., as well. The scheduling efficiency and quality control we enjoy on our in-house jobs is invaluable. We still use subcontractors on larger custom homes, where the jobs are large enough to get the attention of these outside firms. Still, our licenses are helpful on these jobs, as it levels the playing field: Knowing we are knowledgeable and licensed in their trades, the subs never try to pull anything over on us. Of course the respect is mutual, making for a much smoother job all around.—T.B.



To help the clients visualize the new fireplace wall, the author taped out the layout to scale (9). Once the position was set, he framed a bump-out for the fireplace, beginning with a platform floor (10) and the walls (11). The sides were built as shear walls to help support the platform.

Protecting pipes. We still had one more challenge to solve: Bringing the supply pipes near the interior leaves them vulnerable to puncture by a future picture hanger's errant nail or hollow wall anchor. To protect the lines, we split a length of metal-framing track down its center to create two 90-degree metal angles. The angle is important, as we aren't trying to stop a nail so much as redirect it to one side or the other. The track is of a heavy-enough gauge to keep a screw or nail from easily grabbing and piercing it, but light enough that it fits in the cavity and is easy to manipulate and fasten.

A 14-2 NM cable crossed behind the supply piping, so we clipped a couple of short sections of PEX to act as protective bushings where the metal might contact wire. To keep everything in place, we bent the flanges flat at the top and bottom and drove nails into the wall plates before grabbing a partial roll of old Tyvek tape (which sticks well to the plastic facer on the XPS) to keep the pipes and angles tight to the foam and clear of the drywall. This whole protection scheme cost only \$5 but could potentially save thousands in water damage.

Fireplace bump-out. While Joe was busy with the plumbing, followed by the relocation of the gas piping, I turned my attention to framing a bump-out on the exterior wall to accommodate the new fireplace.

Before framing the tiny, 42-by-22-inch cavity needed for the fireplace, I had to first design and lay out the mantel and flanking built-in cabinetry, and that included getting approval from the clients. The specifications for the gas fireplace they had selected were clear and included a helpful table relating vertical clearance from top of unit to horizontal projection of the mantel. Like so many of our clients, this one struggled to visualize the finished product in place based on CAD drawings or 3D modeling, so I taped out the layout of the fireplace, mantel, stone, and cabinetry to scale on the wall. We talked through potential furniture placements and circulation patterns based on the locations and reached a decision. That cleared the way, and I was able to accurately position the bump-out.

I started by framing a simple platform secured with structural

screws to the existing rim joist. This would be further supported on each side by OSB shear panels that acted as a sort of vertical ledger tied to the full height of the wall. Working alone, I built the floor system on sawhorses and screwed a couple of registration blocks to the existing rim and sill plate to make holding the assembly in place at the proper location as simple as possible. It was still too heavy to secure in a level position, so Joe helped me lift it into place and watched the level as I shimmed and screwed it plumb and level. I find FastenMaster HeadLok screws ideal for this application, as their larger, flat heads don't pull through framing as easily as LedgerLok screws.

I stick-built the side panels, rather than preassemble them, so I wouldn't have to interrupt Joe again. I began by building out secure columns on each side of the opening, in line with the platform, to tie the structural side panels to. Lapping the OSB continuously from the top of the wall to the bottom of the platform ensured that any wall and roof load pushing downward would have to overcome the shear nailing that secures that panel all the way up the wall in order to pull the panel away from the house or cause the platform to sag.

Benefits of self-performing work. With the framing complete, I just had to frame a simple shed roof and trim and side the walls before flashing and shingling the roof. We insulated the cavities, ran the gas and electrical, and were ready for the fireplace installation in a single day. This is one of myriad benefits we get from self-performing the mechanical trades. Joe carries our General Contractor license and Master Plumbing certificate, while I hold the Master Electrician and Master Mechanical (HVAC) licenses (see "Acquiring Licenses in the Mechanical Trades," page 49).

We worked hard to earn each of those licenses and pay a lot in insurance, continuing education, and licensing fees to maintain them, but the payback on these smaller projects means a net benefit. Not only would the permitting and coordination of the multiple trades cost us time, but the site management over multiple days would be terribly inefficient. Instead, we were able to work in tandem: I laid out the can lights and installed them while Joe was planning the drain. He completed the supply lines while I finalized design and framed the exterior. We were able to efficiently move through the various disciplines of the project, shortening the project duration and maximizing our profit.

To finish out the project, we worked together on the trim and custom cabinetry. We did subcontract out the hardwood flooring, fireplace, and stone installation, as well as the paint, but this all fell at the end of the job, when the impact of a sub not showing up doesn't create a bottleneck.

Travis Brungardt, co-owner of Catalyst Construction, builds high-performance homes in and around Kansas City.



Once gas and electric lines were run to the fireplace, the wall could be insulated (12), and the exterior siding, trim, and roofing installed (13). The author and his partner built and installed the cabinets, while subcontractors installed the fireplace, stone, and hardwood flooring (14).



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Burying Deck Support Posts Below Grade

by Glenn Mathewson

Though some deck builders take issue with the practice, decks have been—and will continue to be—built with support posts sunk into the ground. I typically see buried support posts primarily on grade-level decks, mainly for cost savings but also because this approach speeds installation since you don't have to wait for a footing to cure and then install a post base. The main argument against burying wood posts is that they won't last as long as they would bearing on concrete piers that extend above grade, but the longest possible life isn't the primary goal for everyone. Another argument against buried posts is that they are difficult to replace, but if you've ever worked on cars, you know that's not a good argument either.

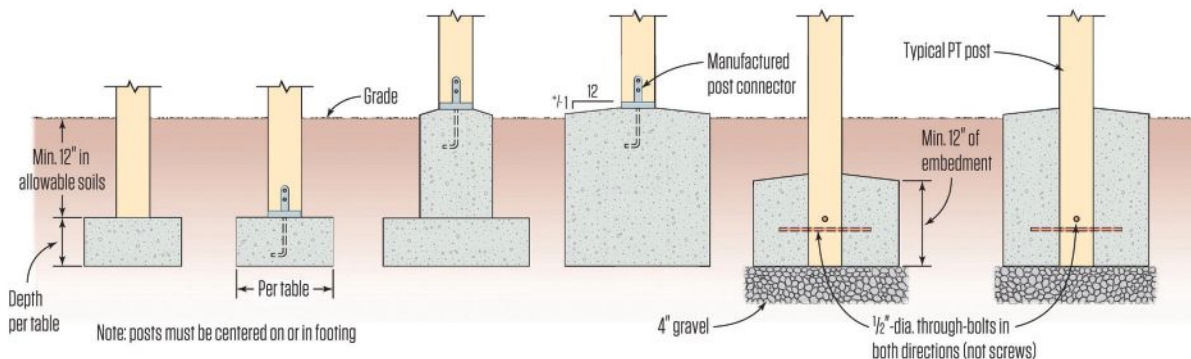
Regardless of your preferred method, burying deck posts in the ground is a code issue, and when we're talking about code, we aren't talking about "good design," which is a matter of opinion. With code, we need to decide on an opinion for everyone, so we decide the minimum opinion. So, sink your posts, but there are some new rules that you have to follow in order to meet code.

Use the right wood. The first rule is mandatory but not new: The posts must be decay resistant and suitable for ground contact. While naturally durable woods such as redwood and cedar meet the definition for decay resistance in Chapter 2 of the IRC, natural decay resistance is not suitable for

below-grade use as deck posts. Section R317.1.2 in the 2021 IRC requires preservative-treated lumber rated for ground contact to be used when posts are in contact with the ground or embedded in concrete in contact with the ground. These treatments must meet the AWPA (American Wood Protection Association) U1 standard.

Even if you're using the right material, you still have to prove to your building department that the structural design of your deck supports is adequate. Rather than have engineering done, a costly expense, you can use the prescriptive design methods the IRC provides in Figure R507.3, up to the limits. Of the six methods illustrated for the post-to-footing interface, four feature sunken posts. What all six have in common is the bearing area. The IRC provides only one method for sizing the area at the bottom of the hole, so these methods are mostly about different post connections and how those connections will distribute the load at the bottom of the post into the bearing area of the footing (see IRC Figure R507.3, below).

Excavation depth. Per the IRC, the minimum depth of a footing is 12 inches below undisturbed soil. This is only for lateral stability, as regions with frost will require greater depths. So, for example, in the most basic option shown in Figure R507.3, a footing can be poured at the base of an excavation that is deep enough to meet local requirements, provided



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Figure R507.3 in the 2018 and 2021 IRC allows for several different footing options including burying the pressure-treated post, an approach that provides lateral restraint and reduces the amount of concrete needed for the footing.

STRUCTURE

the footing size and thickness meet the requirements found in IRC design table R507.3.1. Note that, depending on the load-bearing capacity of the soil, live or ground snow loads, and tributary area supported by the footing, the footing thickness may be as little as 6 inches. On top of the cured footing, still below grade, the post can then be directly placed and approximately centered.

Lateral restraint. Section R507.4.1 requires lateral restraint at the post-to-footing connection. Theoretically, lateral restraint could be provided by a manufactured post base, though I am not aware of any that are designed for below-grade use. Regardless, the IRC presents this as an option in the second detail shown in Figure R507.3. Your other option is to excavate the footing to a depth sufficient to sink the post into at least 12 inches of soil above the top of the poured footing, as shown in the first detail. This is sufficient depth for lateral restraint of a footing, so it is also considered to be sufficient for a post. The backfill soil around the post should be tamped in place and compacted after the post is placed.

Drainage. Neither of the methods described above is like the familiar practice of sinking a post in a concrete-filled hole, but this next method (as shown in Figure R507.3's fifth detail)

is close. The concern with sinking a post into a bowl of concrete is the lack of drainage where water seeps around the post. For this method, the IRC requires a 4-inch bed of gravel to be placed in the bottom of the hole. The post is placed directly on the gravel, without concrete below. Concrete is then poured to its minimum thickness around the post and on the remaining exposed gravel. To transfer the gravity loads from the post to the wider concrete footing, two ½-inch-diameter galvanized bolts must be placed through the post at right angles to each other and extended into the wet concrete. Specifics for bolt length or exact location are not provided, so good judgment should be used. The bolts need to be completely encased in the concrete.

Alternatively, the final method shown in Figure R507.3 extends concrete to the surface. In areas of deep frost, that is a lot of concrete, in which case it probably makes sense to use either the third or fourth detail and keep the posts above grade. All the methods shown in R507.3 should satisfy your building inspector, but if you do choose to sink your posts, you just can't do it the way you probably have in the past. ♦

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



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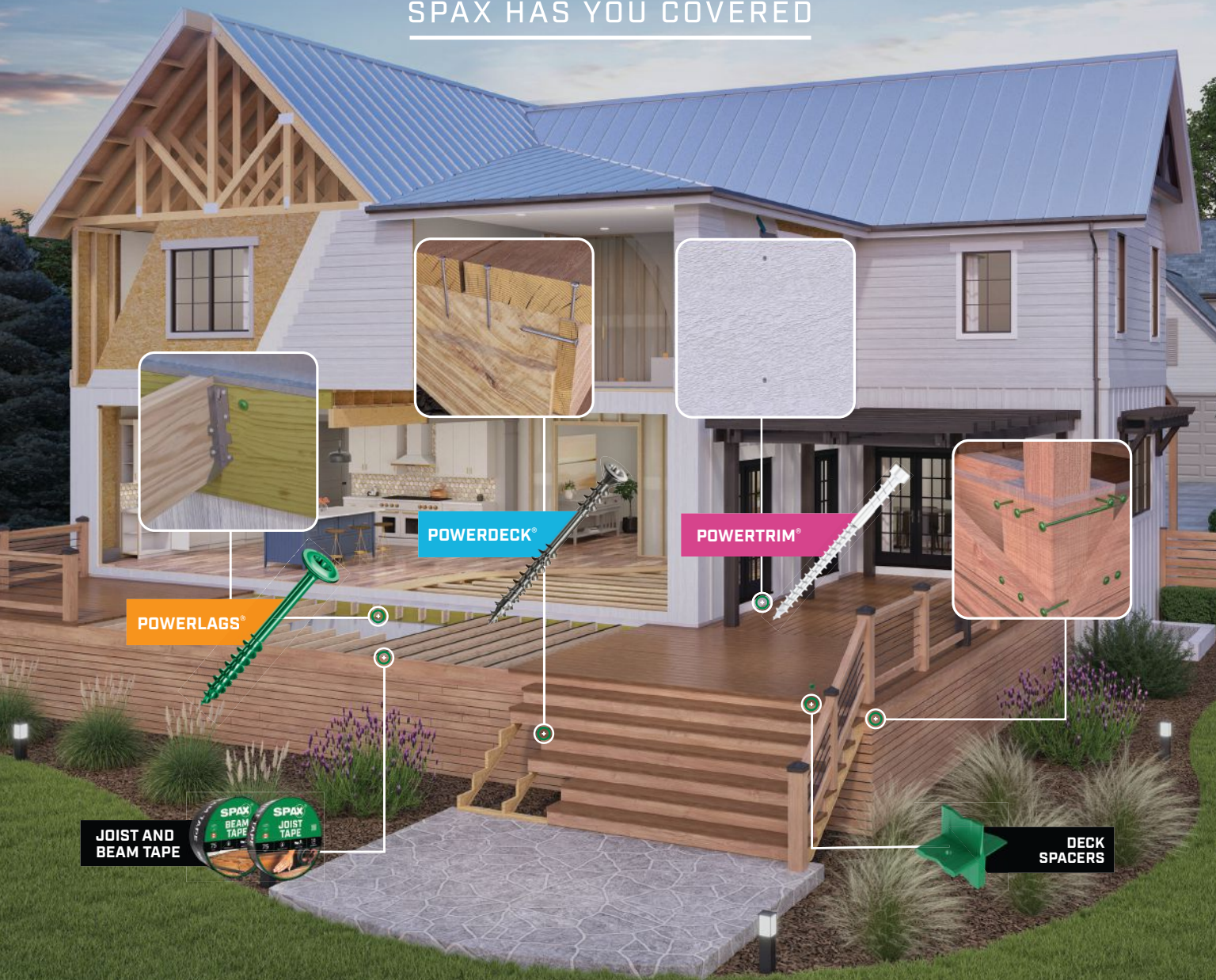
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On Site With Millboard Decking

by Andy Lindus



Though a composite decking material, Millboard has a realistic grain pattern and color (A). The author typically installs the decking on Fortress Evolution steel framing (B). Millboard is available in 12-foot lengths (C).

For the past year or so, my company has been installing a new decking product—called Millboard—that we feel is the most realistic-looking synthetic deck board on the market today. Our clients seem to agree with us: We built about 175 decks last year, and for around 75% of those projects, the owners chose Millboard over other composite and wood decking options.

The project featured in this article was located in Shoreview, Minn., a northern suburb of Minneapolis. The climate is challenging, with sweltering summers and frigid winters filled with ice and snow. In our experience, Millboard responds well to the swings in temperature and humidity in this area, offers great traction even when wet, and stays cooler underfoot in the summer than other manufactured decking we've used.

Prominent grain. Millboard decking

is manufactured in England and distribution is limited; we source our decking directly from Outlive, the sole U.S. distributor. While we can bring samples of the decking to show potential clients during sales calls, there is also a local showroom in St. Paul where the range of Millboard decking products is on display. Millboard is comparable in price to most manufactured decking offered in our market.

At its core, the decking is a nonporous blend of minerals and polymer resin, with characteristics similar to those of other types of composite decking. The difference is in the surface texture, as the boards are molded rather than extruded. Because the molds are cast from wood boards one at a time, there can be slight dimensional variations from board to board, but the resulting grain and texture is unmatched by any other decking that we've installed.

For this project, our clients chose antique oak from the company's "Enhanced Grain" collection, which is patterned with prime oak boards. Boards in the "Weathered Oak" collection have deeper graining and a rougher texture. Slip-resistant decking with integrated grip strips is also available for use around pools and on walkways.

Steel framing. We framed the deck with Fortress Evolution steel framing, an upgrade that we encourage, and that most of our customers opt for. With possible beam spans up to 20 feet and a contemporary painted black finish, Evolution framing was a good fit for our client's large, elevated deck, which overlooks a backyard pond.

Evolution framing comes configured for joists on either 12- or 16-inch centers, spans that match up well with the requirements of our decking offerings, including Millboard. When Millboard



A



B



C



D

After ripping a board to width, workers rout the cut edge to match the original profile and remove cut marks and any sharp edges (A). Cut edges and end cuts are then coated with a touch-up paint supplied by the manufacturer (B). When the decking is installed over steel framing, Plas-Pro plastic cleats must be first fastened to the sides of the joists so that the deck fasteners can be driven into the cleats instead of the steel (C). Fasteners can be driven through the edge of the decking or through the face of the board, where they will be concealed by the self-healing Lastane top skin (D).

is installed over a steel frame, however, the company's Plas-Pro recycled-plastic subframing material has to be mounted to the sides of the steel joists so the decking can be properly fastened with the manufacturer-recommended screws and maintain the warranty.

Installation. Before we found Millboard, TimberTech Azek decking had been the primary material we worked with, and the installation processes for the two are similar. Millboard is comparable in weight to most other manufactured decking, and the longest length available is approximately 12 feet. The material is easy to cut with standard

tools, and though the boards are shorter in length than most other manufactured decking on the market, they are also slightly wider—150mm, or 5.9 inches wide, by 32mm, or 1.26 inches, thick—than standard decking.

For edges, the manufacturer offers a 2-inch-wide board with either a square edge or a bullnose profile. These boards are flexible enough to bend around curves with a radius as small as about 4 feet. The company also has a standard-width (150-by-32-by-3,200mm) deck board for stair treads, with a bullnose profile along one edge and a thicker Lastane surface to resist impacts. For fascia,

there's a thinner, 146-by-16-by-3,000mm fascia board. This board is also flexible enough to bend around a 4-foot radius.

Hidden fastening. While many companies offer hidden fastener systems, Millboard doesn't require clips or slots. Instead, the boards have a "self-healing" Lastane rubber top coat; fasteners are driven through the face of the boards, and the screw heads are buried beneath the surface, leaving a barely visible witness mark behind. We use the recommended Durafix stainless steel screws offered by the manufacturer, coating them with a silicone spray (again per the manufacturer's recommendation) prior



The enhanced grain of Millboard decking offers good slip resistance (A). While bullnose boards are available for stair treads, the author typically uses standard square-edged boards with Fortress's steel stair framing (B).

to installation, no predrilling required.

Boards can also be edge-fastened, using the company's DuoFix guide. Millboard offers decking spacers to ensure equal spacing throughout the deck.

Cutting and touch-up. The boards don't require any special handling or

tools. We have had no problems with scuffs or blemishes from shipping to date. To prevent damage during construction, we locate our cutting station away from the deck. This helps keep the dust from blowing onto the deck—though if dust or dirt does get on the

surface, it washes off easily with a hose.

A thick, matching touch-up paint is sent to each job to paint and cover all cut ends. We also use it to coat edge cuts. ❖

Andy Lindus owns Lindus Construction in Baldwin, Wis.

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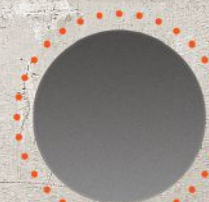
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Replacing a 'Deck House' Deck

Engineered wood beams were used to help restore a
Midcentury Modern-style deck to its former sleek aesthetic

by Kyle Diamond

A few years ago, I was contacted by a couple from New York City who wanted to remodel their Midcentury Modern “deck house” in the Hudson Valley. They had recently purchased the home to use as a get-away retreat from the city on weekends.

Built from prefabricated components circa 1970, their kit home had been manufactured by Deck Homes (a precursor to Acorn Deck House Co. out of Acton, Mass.). Typical of a deck house, it featured an exposed post-and-beam structure, a tongue-and-groove ceiling, and vast expanses of glass via sliding doors and casement windows. A large lot with trees in the front and side yards and a

large meadow in the back contributed to the signature meld-with-nature aesthetic.

Job Scope

The remodeling work mostly centered around the interior. We did a complete kitchen upgrade, installing a new skylight to add more natural light to the room and removing a partition wall with a narrow swinging door between the kitchen and living-dining areas to improve traffic flow (though deck houses are known for open-floor plans, this one had a congested feel to the main-level common areas). Also included was a planned new master bedroom suite added above an attached garage.

Outside, a deck running the length of the house’s rear elevation needed to be replaced. The decking sagged and felt soft in places, while the perimeter guard-rail with integral seating was rotted and unsafe. Also, new sliding glass doors leading out to the deck needed to be installed. The slider thresholds showed signs of water damage, and, more pointedly, they were awkwardly high. To walk onto the deck (and vice-versa into the home), you had step up and over an 8-inch-high rise.

We began demolition in early 2019 and after a few fits and starts, we managed to wrap up the deck and kitchen just before COVID heavily hit New York in 2020. The homeowners ended up living in the home

Replacing a 'Deck House' Deck



Figure 1. While removing the existing decking (A), crew members discovered the home's original 4x12 fir beams were encased in pressure-treated stock, not flashed, and severely deteriorated (B, C). The steel column connections that helped support the cantilevered ends of the beams had sunk into the rotted Douglas fir (B, inset).



Figure 2. Years of water infiltration had damaged the raised thresholds under the sliding doors (A). From the interior, the 4x12 fir beams that span the width of the home look intact (B), and it was assumed (wrongly) that the 14-foot "cantilevered" lengths of fir (which supported the cantilevered floor and original deck) had been removed when the original deck was replaced.

through the worst of the pandemic, so we held off work on the new master bedroom suite until the threat had subsided, finally completing our work this year.

In this story, I'm doing to focus on work related to the deck. The goal was to restore the deck with an in-kind replacement, staying true to the home's Midcentury Modern style.

Deck Restoration

The existing deck was built from pressure-treated stock, so we assumed it had completely replaced the original (PT wood wasn't commonly used in 1970).

The deck's 8-foot-wide by 50-foot-long surface was supported by seven 4x12

Douglas fir beams, which spanned the width of the house and extended 14 feet beyond the grade-level wall at the back of the house. Placed 8 feet on-center, these "cantilevered" beams carried the home's main-level floor (which projected out from the lower, grade-level wall roughly 6 feet), as well as the deck (which projected out another 8 feet from the main level's exterior wall). They were supported by 3-inch-diameter steel columns set back 4 feet from the deck edge, which helped with the illusion that the deck was cantilevered (see inset photo on page 11).

The six joist bays between the beams were framed with 2x6 PT joists running parallel to the beams. They were

flush-framed into PT ledger beams at the main-level wall running perpendicular to the built-up beams. At the outer edge of the deck, the joists were hung from rim beams that were also run perpendicular and flush-framed into the main beams.

A deck collapse waiting to happen.

When we started removing the PT decking, we discovered the exterior portion of the home's original fir beams had been left in place when work was done on the deck and were severely deteriorated. The previous builder had sandwiched the original 4x12s between two PT 2x12s (through-bolting them together) and ran a PT 2x4 on the bottom, encasing the fir



Figure 3. An ill-suited sunroom, not in keeping with the home's style, that had been built on the deck (A) was removed (B), as well as the bump-up transition on the main roof. During the project, workers posted up the cantilevered floor and roof as necessary (C).

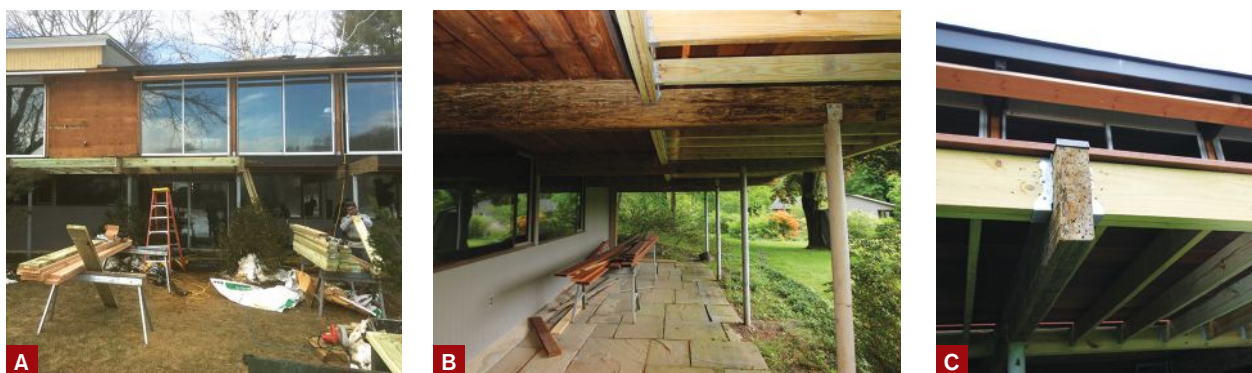


Figure 4. The cantilevered main-level floor and replacement deck are supported by seven 4x12 parallams, then flush-framed with 2-by pressure-treated stock (matching the previous deck's framing layout) (A, B). The existing steel columns were reused to support the ends of the parallams, while the new beams were cap-flashed to prevent rotting (C).

in a pressure-treated "U." In addition, the builder omitted cap flashing, allowing years of moisture to rot the Doug fir into something verging on compost. This was particularly dangerous because the saddle connections welded to the steel columns were "secured" to the rotted ends of the fir beams. It wasn't out of the realm of possibility that—loaded with partygoers—the 8-by-50-foot deck could have collapsed (**Figure 1**).

At the other end of the beam supporting the home's cantilevered main-level floor, the rot hadn't migrated under the conditioned space and compromised the structural integrity of the home, let alone damaged the floor assembly. Even so, the raised thresholds under the slid-

ers were heavily damaged from years of water infiltration (**Figure 2**).

Starting from scratch. We demoed the four easier deck bays (on the right) first, posting up the deck and roof as necessary. An enclosed sunroom had been built on top of two of the joist bays on the left side, and included an ugly pop-up roof on the main house that accommodated the sunroom's roof slope. We demoed the sunroom and pop-up and began the deck replacement from scratch (**Figure 3**).

Starting out, we installed seven 4x12 preservative-treated Parallam Plus PSLs to support the cantilevered 6-foot portion of main-level floor and the 8-foot-wide replacement deck. We inserted the PSLs in the pockets vacated by the demoed

fir beams at the grade-level wall at one end and set them in the existing saddles welded to the steel columns at the other. For cap flashing, we installed aluminum coil stock with a brown finish to make it less visible between the new deck boards.

Between the Parallams, we matched the flush-framed layout of the previous deck. We installed double PT 2x8s perpendicular to the 4x12s at the main-level wall and at the deck's outer edge, then infilled with 2x6 joists 16 inches on-center parallel to the main beams (**Figure 4**).

To support the edge of the cantilevered floor and the new doors, we installed steel angles between the Parallams, bolting them to the back of the doubled-up 2-by ledger beams and the underside

Replacing a 'Deck House' Deck

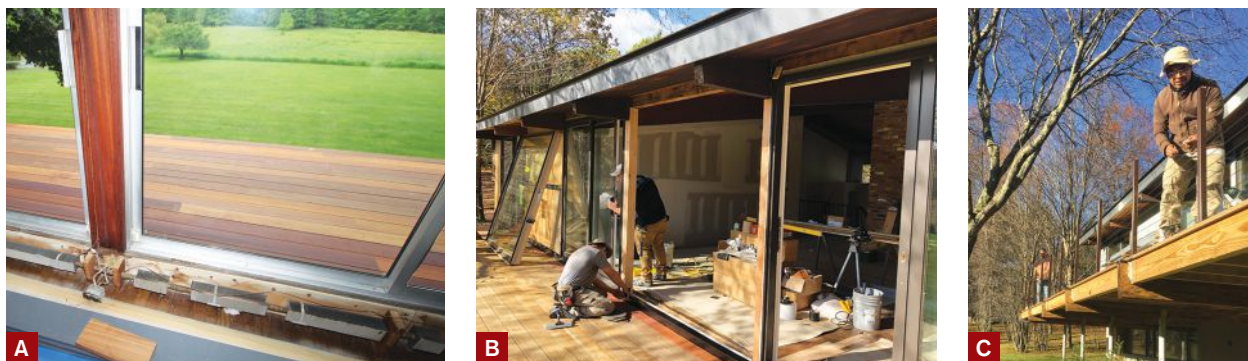


Figure 5. At the sliding doors, workers removed the 8-inch-high rise that accommodated hydronic baseboard (A) and replaced the three existing sliders with two Marvin Ultimate sliding patio doors flanking a fixed glazed center panel (B). Crew members installed a stainless steel cable-railing system (C), shown here before the ipe top rail was installed.

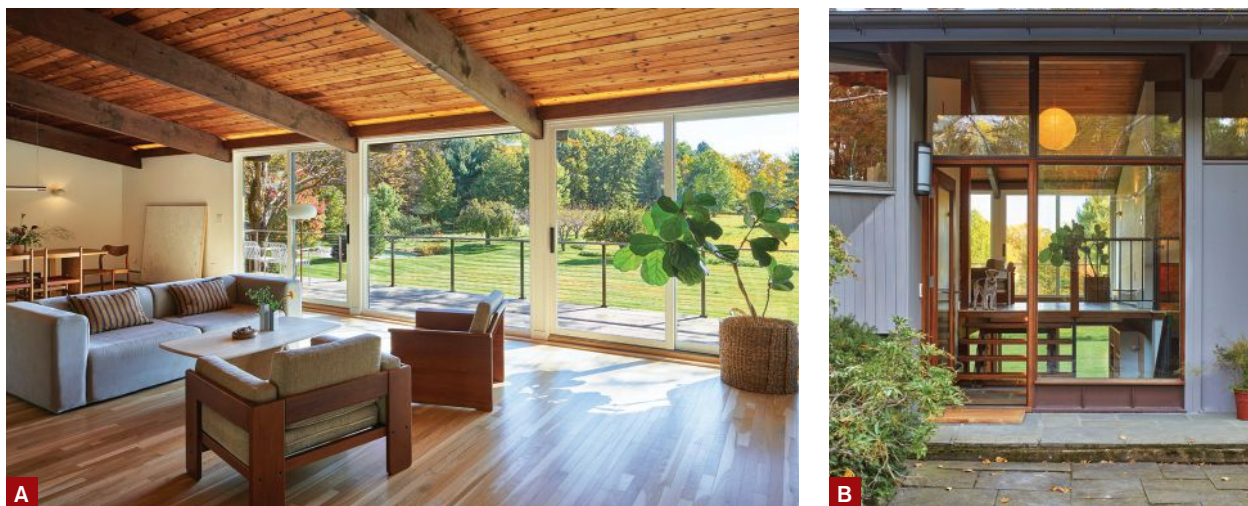


Figure 6. Shown here is the finished living-dining area with the replacement deck beyond (A). Signature “deck house” features such as exposed beams, a tongue-and-groove ceiling, an open floor plan, and lots of glass help connect the home to its scenic backyard, both from the interior and from outside the home’s front elevation (B).

of the exposed tongue-and-groove floor. The floor “system” consisted of just 2½-inch-thick tongue-and-groove planking (which spanned over the home’s 8-foot-on-center, exposed beam layout) and oak strip flooring.

Eliminating the step. Next, we installed the mahogany decking, which gave us a work platform as we replaced the sliders and removed the awkward step at the thresholds. We secured the 5/4x6 mahogany with Tiger Claw hidden fastening clips (fastenmaster.com), being careful to avoid fastening through the cap flashing covering the new Parallam beams.

The 8-inch-high rise had been needed to accommodate hydronic baseboard run under the length of the glazed wall. We removed roughly 20 feet of finned tube baseboard and cut the raised threshold down to the tongue-and-groove deck, then installed a trim piece to infill the remaining void. The hardwood trim lipped onto the existing oak strip flooring and was rabbeted so we could run the hydronic loop underneath. The infilled repair resulted in a threshold slightly higher than normal, but it was a much improved egress experience (Figure 5).

Finishing up. We trimmed off the

deck with ¾-inch mahogany, covering all exposed pressure-treated framing and the ends of the Parallams. In a departure from restoring the deck with an “in-kind” replacement, we installed a stainless steel cable railing system with a 4-inch-wide ipe top rail (atlantisrail.com). Its sleek design was in keeping with home’s modern aesthetic and offered unfettered views of the property’s expansive backyard. (Figure 6). ❖

Kyle Diamond co-owns New Dimension Construction in Millbrook, N.Y. with his father, Dale Diamond.

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Repairing a Screen Porch

This makeover was done with similar materials but better, rot-resistant details

by Emanuel Silva

While I was repairing shingle siding on a house last fall, my client asked me to look at some rot damage on her screen porch and give her an estimate to repair it. At first glance, the porch appeared to be in good condition, but with visible damage at the base of some of the posts. Then closer inspection revealed that previous repair attempts had masked the extent of the problem, and that the framing would need to be replaced.

My proposed solution involved removing the aluminum screen panels and the porch framing they were attached to, replacing the framing with new material, and trimming the porch exterior with low-maintenance PVC. The project would also include repainting and rescreening the existing panels, which were otherwise in good condition, and replacing the old screen door with a new unit.

The porch began life sometime in the

1970s, when the split-level home was built, as an uncovered porch framed on top of a small concrete slab leading into the back of the house. At some point—possibly when the backyard pool was installed—the small porch and slab had been replaced with a larger slab on grade and screen porch overlooking the pool.

It appeared that untreated fir had been used to frame the porch, including the 4x4 corner post and intermediate posts.

Repairing a Screen Porch



Figure 1. The roof of the existing screen porch was structurally sound (A), but the fir posts and sill plates were rotting where they were in direct contact with the porch's concrete slab floor and needed to be replaced (B). The aluminum screening in the aluminum-framed panels also needed replacement (C).

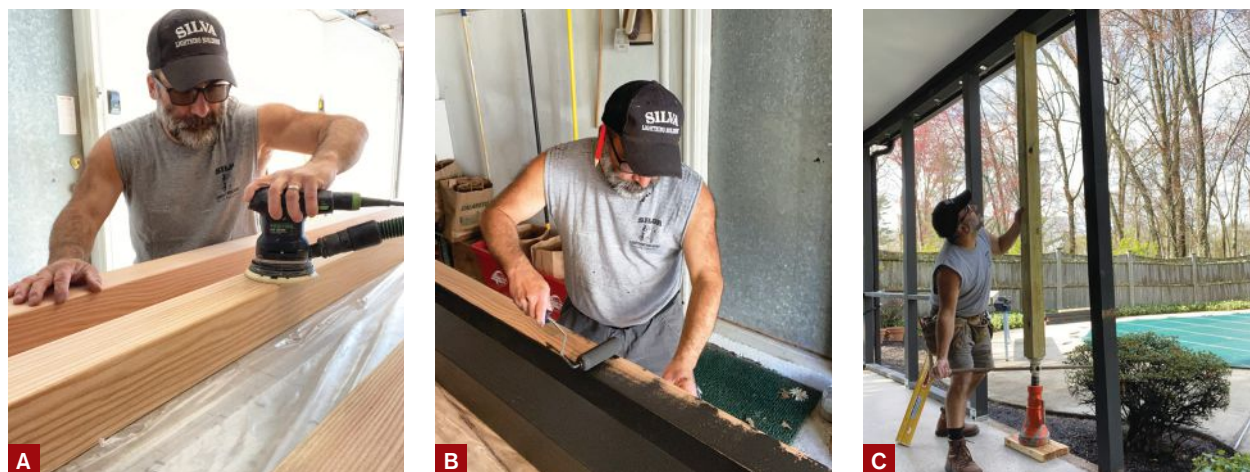


Figure 2. Prior to finishing the clear vertical-grain Douglas fir stock that the author used to replace the framing, he sanded it with 100-grit paper to open up the grain (A). This step was needed to help the wood more evenly accept the solid latex stain finish (B). The author replaced a pair of support posts at a time, centering the screw jack in the opening and raising it just enough to take the weight of the roof off of the two posts (C).

Fir, particularly the heartwood, has rot-resistant qualities but will eventually rot when bearing directly on a concrete slab that occasionally gets wet. Some pressure-treated material had been used to make repairs to the framing but mostly as applied patches to the sill plates rather than as replacements (**Figure 1**).

The concrete slab was in good condition and had been finished with an epoxy floor coating. It looked like the coating

might have contributed to the rot problem, as the seam between the coating and the framing appeared to have the potential to trap water blowing in through the screens instead of allowing it to spread out over the floor and dry.

New Framing

To match the look of the original porch as closely as possible on both the interior and exterior, I found a good source of

clear, vertical-grain Douglas fir. Because the stock came with a smoothly sanded surface, I decided to scuff-sand it with 100-grit paper to raise the grain so that it would better accept the finish. Then, before installation, I rolled on two coats of Benjamin Moore Arborcoat exterior solid stain, coating all four sides of each piece (**Figure 2**).

The roof framing was in good shape, so my plan was to use a screw jack to raise



Figure 3. At each post location, the author traced the post's footprint onto the slab (A), then recut the post to fit the metal post base and traced again around the post base (B). Next, he drilled a 1/2-inch-diameter hole for the 1/2-inch-diameter wedge anchor that he used to fasten the metal base to the slab (C). As he tightened down the nut (D), he checked the base for level and used metal washers to shim between the slab and the base as needed; a dab of adhesive sealant on the washers ensured that they'd stay put under the weight of the post during assembly (E). Then he inserted the post and fastened it to the metal hardware with structural screws (F).

the area around each post just enough to take pressure off of the post so that it could be removed and replaced. As it turned out, the process was a little too easy. While the posts were nailed at the top to the beam supporting the rafters, there was nothing connecting the bases of the posts to the slab, and I was able to just pull them free once my temporary support post was taking the roof load. The sill plates between posts weren't much more difficult to remove. They had been fastened to the slab with concrete

nails, and because of rot damage, the sills simply pulled free of the fasteners, leaving the nails embedded in the concrete. I cut them off with a reciprocating saw.

I worked one section at a time, placing the screw jack and temporary support post in the middle of an opening so that I could remove and replace two posts at once.

After removing a post, I carefully measured the distance between the slab and the beam at the post location and cut the new post to that length. Next, I positioned

the new post so that it was plumb in both directions from the bearing point on the beam, which I had marked in pencil prior to removing the original post. After outlining the position of the base of the post on the slab, I removed the post and trimmed it to length to accommodate the metal post base. Not only do the post bases anchor the posts to the slab, they also raise the wood above the concrete by an inch to allow for drainage and keep the base of the post from contacting the concrete (**Figure 3**).

Repairing a Screen Porch

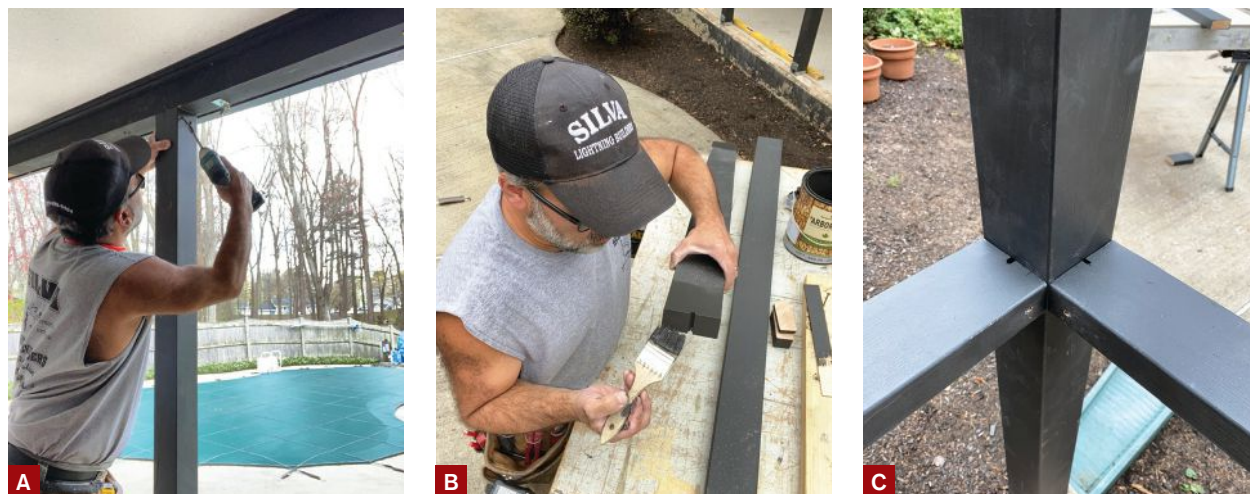


Figure 4. After anchoring the base of the post to the slab, the author checked that the post was still plumb and then drove coated U2 structural screws through the top of the post into the roof framing (A). When cutting the horizontal 2x4 framing pieces, the author notched the ends so that water could drain from the joint (B). Coating the end cuts and notches with stain helps prevent the end grain from absorbing moisture (C).

I used Cobra Parawedge 1/2-inch-diameter wedge anchor bolts to fasten the post bases to the slab. Prior to fastening the post to the post base and to the beam above with structural screws, I coated the end cuts with Arborcoat stain.

Rot-Resistant Details

The panel openings are framed by horizontal 2x4s that span between the posts both at their bases and at railing height 36 inches above the floor. To protect these framing members from rot, I didn't anchor the sills directly to the slab but instead left a 1/2-inch gap between the bottoms of the 2x4 sills and the slab, which would later be covered by PVC trim. I also notched the ends of all the 2x4s that make up the sill pieces and the intermediate railing sections to allow any water that collects at the joint between the horizontal and vertical framing members to drain instead of getting trapped (**Figure 4**).

I used U2 trim-head structural screws driven like toenails to fasten the sills and rails to the posts, first coating the cuts and notches with stain. After the new framing had been installed, I applied a touch-up coat of stain as needed.

Low-Maintenance PVC trim

To give the Douglas fir framing a bit of protection from the weather and reduce the need for maintenance, I clad the exterior with PVC trim, which I cut to size from 3/4-inch sheet stock, using a track saw. First, though, I rolled on a coat of Benjamin Moore's PVC-compatible Regal Select Low Lustre exterior paint that was color-matched to the solid stain I used on the Douglas fir framing.

After I cut the trim pieces to size, I routed a 1/4-by-1/4-inch groove down the middle of the back of each piece to create a drainage pathway for any water that might get between the PVC trim and the wood framing. I also routed three grooves spaced evenly apart and perpendicular to the long groove on the back of each horizontal trim piece, again for drainage.

When I ripped the claddings for the posts, I oversized them so that they would overlap the posts by about 3/4 inch on each side. This made the 4x4 posts appear to be a little wider and allowed for variations in the post locations of the old vs. the new structure. This was important because of the screen panel sizing,

which was based on the old post locations. Because the original posts were—in some cases—out of plumb, the screen panels would not have fit several of the new openings without the PVC overlay. To me, it was more important to fabricate the PVC trim so that the panel openings would be square and uniformly sized than to follow the roofline, which sagged a little bit. I also used a router to relieve the back of the trim at the bottom to fit over the metal post bases (**Figure 5**).

I fabricated the long fascia trim across the front of the porch underneath the eaves from three pieces of PVC cut from sheet stock. Instead of cutting butt joints or scarf joints, I cut half-lap joints using a router where the trim needed to be joined together. This detail allows the PVC to expand and contract with changes in temperature without creating a gap that would permit water to penetrate into the framing.

Along the side of the porch, which has minimal protection from the roof overhang, I beveled the top edge of the PVC fascia, then installed a sloped water table on top of that to direct water away from the wall. I kerfed the bottom edge of the

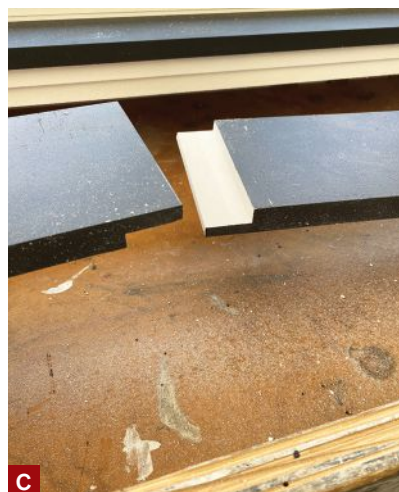


Figure 5. After cutting the PVC post claddings to size, the author used a router to relieve the backs to fit over the metal post bases (A). He also routed $\frac{1}{4}$ -inch square grooves down their backs to create a drainage channel (B). The long fascia was joined together from several pieces with half-lap joints, a configuration that allows the PVC to move with changes in temperature without opening up the joints (C). The author prefabricated the corner from two pieces of PVC joined together with PVC glue and Cortex screws (D). Cortex screws were used to fasten the PVC trim to the framing (E). Scribing the bottom rails to the irregular concrete slab ensured a tight fit (F).

water table to create a drip edge, and bedded the trim piece against the wall in a thick bead of OSI Quad sealant.

I prefabricated the L-shaped corner post trim using PVC glue and Cortex screws, which made it easier to plumb the trim in both directions while installing it. I fastened the corner and intermediate post trim to the framing with more Cortex screws, which I later plugged. Then I fastened the rail-level trim, again using Cortex fasteners (**Figure 6**).

Because the slab was uneven, I scribed

the base trim to get a good fit, which was necessary to keep insects out. At the corners where the screen porch meets the house wall, I scribed the end PVC trim pieces in a sawtooth pattern so that they would fit tightly against the shingle siding. For a three-season screen porch like this, I didn't think it was necessary to pull off shingles and rework the home's weather-resistant barrier to marry the two walls together. After the trim was in place, I touched up the cut edges with more paint, inserted the Cortex plugs,

then gave everything a second coat before installing the screen panels.

Screens

The frames for the screen panels were in good shape, but the existing aluminum screening needed to be replaced. After pulling out the splines and removing the screening, I cleaned up the frames and gave them a fresh coat of paint. I used the same paint that I had used for the PVC, first checking with my supplier to make sure it was compatible with aluminum.

Repairing a Screen Porch

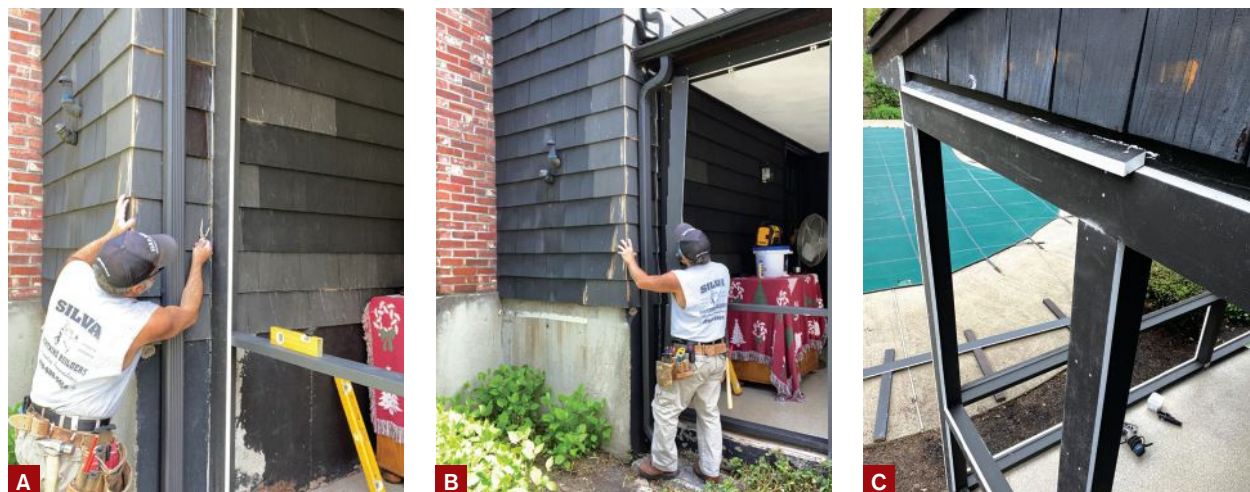


Figure 6. Where the screen porch is joined to the house, the author scribed and cut the trim pieces to fit tightly over the shingles (A, B). Along the side wall, a sloped PVC water table with a kerfed drip edge underneath was fitted to the beveled fascia and bedded in sealant to direct water away from the porch framing (C).

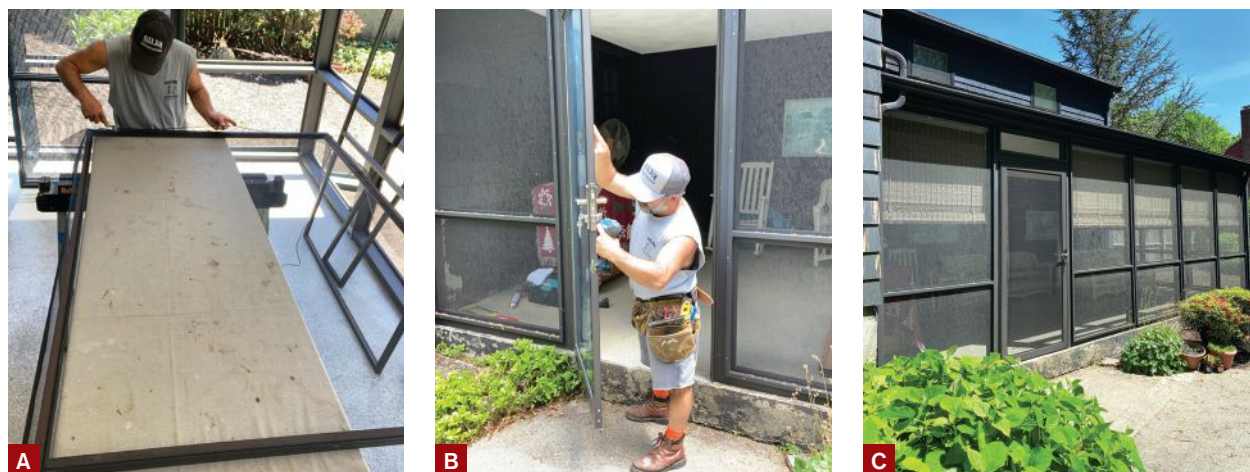


Figure 7. After cleaning and painting the aluminum screen frames, the author installed new fiberglass mesh screening (A). After reinstalling the screen panels, he wrapped up the project with a new screen door (B, C).

Choosing replacement screening with the homeowner proved to be a challenge. I'm not a fan of aluminum screening because it dents and deforms easily, so I recommended pet-proof fiberglass mesh screening as a durable replacement. After my client checked out samples with various colors and transparencies, she thought that pet screening was going to be either too dark with low visibility or not the right color for the project. But—a cat owner herself—she decided that durability was not that much of an issue,

and eventually we settled on a standard charcoal-colored fiberglass screen that was neither too dark or too light.

When splining screening into a frame, I've tried several different methods to apply uniform tension to the screening. I used to install separate splines for each side, first tensioning the longer parallel sides and then the top and bottom, but I've found it works just as well to use a single spline, starting at one corner and working my way around the screen frame to get a snug fit (**Figure 7**).

To finish up the project, I installed a new Andersen 6 Series Fullview Retractable Storm Door, which comes with both a glass panel and a screen panel. I suspect the glass panel will never be used; my client tells me that during the winter months, she just places all the porch furniture in the middle of the room and covers it until the following spring. ♦

Emanuel Silva, a frequent contributor to JLC, owns Silva Lightning Builders in North Andover, Mass.

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Radiant Compass Rose

by Brendan Casey

Back in 2015, my company built a standard 200-square-foot pressure-treated-wood deck onto the back of the new home that our clients had just built. A half-dozen years later, they contacted me about expanding the deck to accommodate a new hot tub and replacing the wood decking with composite. During my site visit to discuss the project, the wish list grew to include plenty of lighting and possibly a built-in fireplace as the deck's focal point.

Eventually, the fireplace idea was shelved but not the idea of a focal point for their new outdoor living space. To meet that goal, I showed my clients a design for a curved deck with a contrasting border and lighting around the perimeter. My clients liked the design and

were hoping to find composite decking with grays and tans to match the color of their house. At the time, Fiberon was planning to release some new colors that I thought would match perfectly, so we held off on the project until the new decking became available.

As we began taking apart the old deck and framing up the new one, I had an idea for a focal point to replace the fireplace—but I didn't tell the homeowners what it was. Instead, we left a blank area in the middle of the decking and assured them that if my inlay idea didn't turn out to be something they loved, we would remove it.

My crew leader and I traded some sketches before we settled on our "Divine Rose" inlay, which spans over 8 feet in

each direction. Working in our shop, we used two contrasting deck-board colors to create the star-within-a-star pattern. Realizing we couldn't create an astrological design without an element of light, we then added over 500 low-voltage LEDs to outline the inlay and create the impression of a Christmas star. Another LED at the center enhances the effect.

After we installed the inlay, we invited the homeowners back to "unwrap" their surprise. While they loved the design, it wasn't until later that evening—when they turned on their new deck lights—that they had a chance to fully appreciate our unique work. ♦

Brendan Casey owns Casey Fence & Deck in Frederick, Md.

PHOTOS: JENNIFER LEWIS



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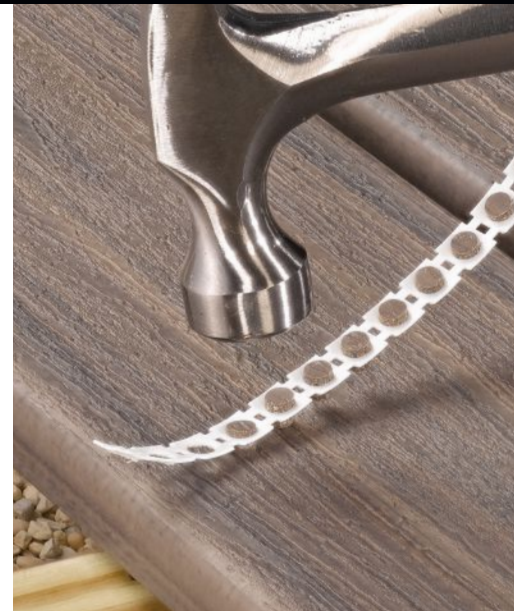
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BY VINCENT SALANDRO



1. Performance-Sealed Door System

Masonite says its Performance Door System can withstand storms with over 50 mph winds and 8 inches of rainfall. Doors have a rot-proof frame and feature a 4-Point Performance Seal that includes square edges, an Endura Products' Z-Articulating Cap Sill, memory-foam weatherstripping, and corner pads. A spring-loaded cap on the cap sill automatically adjusts to keep a tight seal and provide protection from leaks, drafts, and debris. The system will be offered with all fiberglass doors and three Shaker-style recessed panel designs. masonite.com

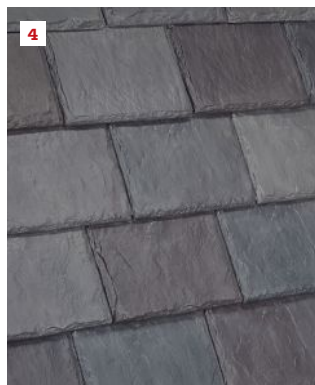
2. Elegant, Free-standing Tub

The free-standing Alva tub from MTI Baths sports an oval-shaped bowl with a semi-rolled rim and a low-profile base. Crafted with MTI's proprietary, organic SculptureStone, each soaker tub has a nonporous surface, which makes for easier cleaning and better resistance to mold. Available in six colors, the tub measures 74 inches by 36 inches by 20 inches and retails for \$8,990. mtibaths.com



3. Extra-Wide Deck-Ledger Tape

Designed for flashing deck ledgers, 11-inch-wide Trex Seal Ledger Tape combines butyl tape with a reinforcing aluminum liner. With the wider size, the tape doesn't need to be lapped, so it can create a seamless seal over the gap between the ledger and the house. A split release liner allows installers to attach half the flashing to the house wall, and then fold and attach the other half to the ledger. We found 50-foot rolls online for between \$235 and \$275. trex.com



4. Single-Width Composite Roofing Tiles

Province Slate composite roofing tiles from DaVinci Roofscapes are 12 inches wide with a fixed 8-inch exposure. The maker says the Class A fire-rated and Class 4 impact-rated tiles can resist severe weather, high winds, insects, algae, and fungus growth. Made from resins, ultraviolet and thermal stabilizers, and a fire retardant, the tiles have rear-side nail marking templates, enhanced rib support structures, and self-aligning edges. Tiles are available in six colors and are priced at \$450 per roofing square. davinciroofscapes.com

Products

5. Easy-Install Deck System

Grad Rooftop Decks pedestal and rail system can be installed quickly and easily and the boards can be removed, replaced, and updated hassle-free, the manufacturer says. Grad aluminum rails are snapped onto the pedestals, and then specially grooved boards (from Grad partners) are snapped onto factory-equipped clips on the rails—without fasteners and evenly spaced. The manufacturer says the finished deck is virtually maintenance-free and resistant to rot. Pedestals are ASTM D1929 and D635 safety-tested and the subdeck can be accessed at any time. Pricing starts at around \$5 per square foot and varies by project. us.gradconcept.com

6. Versatile Porcelain Floor Tiles

Crossville's Stone Fiction porcelain tiles combine the appearance of travertine with the performance of porcelain. The collection's four hues are offered in both an unpolished interior finish and an exterior option suitable for walkways and pool surrounds. Tiles are available in 12-by-24-inch and 24-by-24-inch sizes, supplemented by a 2-by-2-inch mosaic. The trim package includes bullnose and cove base to suit a range of applications. Pricing for the 12-by-24-inch tiles starts at \$4.90 per square foot. crossvilleinc.com

7. Speedy Deck-Fastening Tool

Designed for fastening Camo Universal Deck Clips, the Camo ClipDrive is a lightweight tool that attaches to any drill and fastens faster than standard methods, the manufacturer says. Installers can use the tool standing up to fasten any type of grooved deck board. The ClipDrive features a height-adjustable handle and weighted nose to allow users to quickly swing the tool from joist to joist and target exposed screw heads. The contractor-grade tool comes with a T-15 bit that can be quickly installed. It retails for under \$130. camofasteners.com

8. Mixed-Metal Door Fixtures

Baldwin Hardware's L029 and L030 Mixed Metal Levers are available as à la carte sets and are offered in 10 mixed-metal finish combinations. The levers are in Baldwin Hardware's Estate collection, with pricing starting at \$140 per lever set. Both models are made from solid forged brass and are available in brass, nickel, bronze, and satin black finishes. baldwinhardware.com



9



9. All-in-One Shower Pan Kit

The Johns Manville GoBoard Shower Pan Kit offers on-site shower-pan customization, allowing for same-day tile installation. The kit works with new shower build-outs or tub-to-shower conversions and accommodates center and offset drain locations and curbed or curbless applications. The kit includes a GoBoard Point Drain Kit, four GoBoard Wedges (presloped backer boards), two GoBoard curbs, and three tubes of GoBoard pro sealant. jm.com

10



10. Lightweight Tile Adhesive

Laticrete's Tri-Lite Rapid is a rapid-set thinset mortar that meets ANSI standards and contains no respirable crystalline silica levels that exceed the OSHA action level. The manufacturer says the adhesive is suitable for large and heavy tile, thin-bed, and wall installations. Tri-Lite can bond to most substrates and is ready for grouting in as little as three hours. The product's formula and consistency allow for a 27.5-pound bag to provide the same coverage as a traditional 50-pound bag of mortar, Laticrete says. laticrete.com

11



11. Deck Screen System

DSI's Westbury ScreenRail encloses decks, porches, or other outdoor structures, providing protection and privacy. Options include structural railing, heavy-duty kick panels, a mid-rail, or a frame only. Structural railing can be placed either inside or outside the screen area, and the kick-panel option protects the lower part of the screen from pets, children, or bumps. A full-screen view with an accent mid-rail offers extra support to keep the screen secure, while the frame-rail option can attach to existing structures to provide a full, unobstructed view. The system is available in 12 colors; pricing varies by project. diggerspecialties.com

12



12. Glossy Concrete Epoxy

The DaiHard Max Industrial Strength Epoxy Floor Coating Kit provides a gray gloss finish to interior concrete floors. According to the manufacturer, the one-coat coverage creates a high-performance surface that is resistant to chemicals and daily wear as well as stains, cracking, fading, peeling, blistering, and mold and mildew. The coating can be used to cover bare floors or smooth over previously coated ones. The low-VOC, waterproof kit covers 250 square feet and retails for under \$130. daichcoatings.com

GAF

Measurement innovations help contractors and customers

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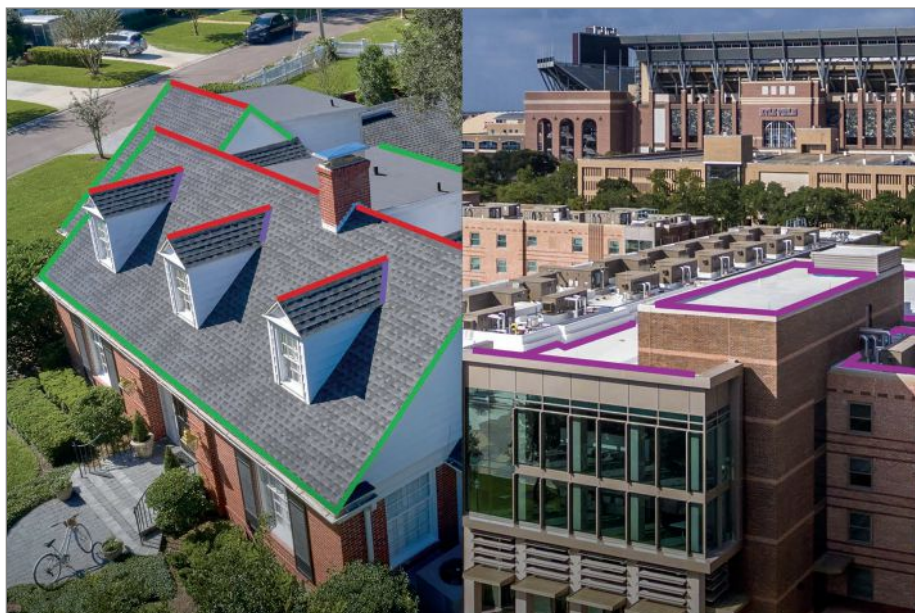
In recent years, even the most traditional of crafts have been transformed by the introduction of digital tools. Roofing, for example, still requires muscle-taxing labor and hard-won expertise, but the introduction of digital roof measurement tools has helped increase safety, improve contractor/customer communications, and streamline materials ordering.

Before roof measurement applications were widely available, a contractor had little choice but to climb onto the roof with a tape measure just to get the estimate started. Every trip onto a roof has inherent hazards from climbing the ladder, power lines, and other unexpected issues. Of course, measuring by hand also means carving time out of an employee's day — time that could be spent installing a roof, creating an estimate, or even getting home in time for dinner.

Today, as soon as a contractor has a lead on a property needing their services, they can order a digital roof measurement, and use it to prepare an estimate from the convenience of the office or the road. No unnecessary ladder-climbing. No need to schedule a property visit.

This can help save time, money, and effort for the roofer, and explains why satellite- and drone-based measurement services have exploded throughout the industry. What does this look like from the perspective of your customer, the property owner? Let's focus on a typical homeowner and see how their roofing experience changes with the introduction of a tool like GAF QuickMeasure reports.

Linda's house has been hit by a bad hail and wind storm. She needs a roofer — and



a new roof — stat. The problem is, she works full time, and can't take time off to meet roofers at her house. When she calls Bob for an estimate, he simply orders a QuickMeasure report (for a lot less than his own hourly rate — win-win) and has all the dimensions he needs to create an estimate in an hour. No visit. No ladders. No hassle for Linda.

When Bob emails Linda the estimate that afternoon, it includes photos and a 3D rendering of Linda's house, so she gets a clear picture of what needs to be done. And since Bob got a complete bill of materials with his QuickMeasure report, Linda gets an estimate based on current material costs. That means fewer surprises down the line. And finally, when Bob and Linda do meet to

choose roofing materials, Bob can use the 3D rendering interactively to help Linda "try on" different roof styles and colors and see what they would look like on her actual home.

Of course, innovations like GAF QuickMeasure aren't limited to residential properties. The same high-resolution technology is helping commercial roofing contractors to create estimates on complex structures like office parks, warehouses, factories, and more, with precision. In the competitive roofing industry, time and labor are precious assets. Roof measurement innovations like GAF QuickMeasure are helping roofers optimize both. Order your first report today at gaf.com/quickmeasure. ■

Learn more about how GAF QuickMeasure can help create estimates on complex structures at gaf.com/quickmeasure.

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TOOLS

OF THE TRADE

DeWalt 5-in-1 Drill/Driver Kit

BY NATHAN RINNE

As a carpenter and cabinetmaker, I sometimes find myself in predicaments where a regular drill just will not work. Whether it's an odd angle that doesn't allow me to get square with the screw head or a tight spot where I need to drill a hole but just can't quite squeeze the drill in, there have been plenty of situations where I wished I had a solution. Enter the DeWalt Xtreme 12-volt Max 5-in-1 drill/driver kit. With two speeds, 15 clutch settings, and four different interchangeable heads, it has a solution for every problem.

The first thing I noticed about this drill was its compact size and ergonomic grip design. It felt good in my hands, and I didn't have any problem keeping it in plane with the fastener heads, which was a concern of mine since I am so used to impact drivers. It comes with a compact 12-volt, 2.0-Ah battery, which adds little to the 5-inch length of the tool and weighs next to nothing. Add to that the fact that three of the four heads have quick release $\frac{1}{4}$ -inch chucks, and it would seem DeWalt covered all the bases with this one. For fit and user comfort, I give this drill a 10.

Of all the attachments, the standard quick-release head saw the most use while I had it in my shop, for obvious reasons. However, having the ability to quickly switch to a right angle or offset drill is a major plus. And if the ability to switch between heads isn't

enough, DeWalt even added a feature that allows you to position the attachment at any angle from 0 to 360 degrees—you aren't limited to 90, 180, or 270 degrees. The drill has positive stops all the way around the head that make for a quick turn to get into literally any space you could possibly need to access. I don't often need those attachments, but when I do, I need them badly. These heads are designed well and have saved me a good bit of fussing on more than one occasion.

My only complaint about this kit is that it is not an impact driver, so I tend to use it more to drill holes unless the occasion arises that I need to get into a tight spot to run a screw. But that isn't a deal breaker, and I would definitely recommend this versatile tool.

The DeWalt DCD703 kit includes the drill, a 12-volt Max DCB122 2.0-Ah battery, a charger, a kit bag, a $\frac{3}{8}$ -inch chuck attachment, a $\frac{1}{4}$ -inch hex right-angle attachment, a $\frac{1}{4}$ -inch hex quick-release attachment, and a $\frac{1}{4}$ -inch hex quick-release offset attachment. The kit retails for \$190. dewalt.com

Nathan Rinne owns Rinne Trimcraft, in Lake of the Ozarks in Missouri. He specializes in on-site carpentry with an emphasis on ornamental built-ins. Follow him on Instagram at [@rinne-trimcraft](https://www.instagram.com/rinne-trimcraft) and on Facebook at [facebook.com/rinnetrimcraft](https://www.facebook.com/rinnetrimcraft).



DeWalt's DCD703 5-in-1 12-volt drill kit includes a $\frac{3}{8}$ -inch ratcheting chuck (1), a right-angle attachment (2), an offset attachment (3), and a $\frac{1}{4}$ -inch hex quick-release attachment, along with a charger, 2.0-Ah battery, and bag (4).

Mini Form Buster Pry Bar

BY TIM UHLER

A good pry bar is a must-have tool for any framer. We use one for anything from demo to stripping forms to moving walls and big panels, and we've long been fans of the Burke Bar, Jr., a 47-inch bar with a curved, 3-inch-wide blade. Unfortunately, a couple of years ago, someone stole the Burke bars we had owned since the late '90s from one of our jobsites (I think it was some kids, because they left other things behind that were a lot more valuable), and I had to replace them.

Even though I loved the Burke bar, I'm open to trying new tools and noticed that Dude Tools was offering a similar pry bar in a couple of different sizes with some interesting features. I own several of the company's Dude Buster deep sockets and have been impressed with their American-made quality, so I decided to buy two of Dude's Mini Form Busters for my crew when I discovered them online.

There is a full-size Form Buster with a

48-inch-long handle and a 12-inch-long by 3-inch-wide curved blade. The Mini Form Buster that I ended up ordering is a little smaller than the Burke bar, with a handle measuring 36 inches long and a 12-by-2-inch blade, but I consider it an upgrade because it has a couple of additional features that work well. One is the "knuckle-saver bumper" under the handle, a welcome addition. I can't tell you how many times I've smashed my knuckles while stripping foundation forms; with the Form Buster, the bumper leaves a small space between the handle and the surface that momentum or a heavy form is trying to drive your hand into.

The other useful feature is the round metal knuckle right under the curve of the bar, which provides more leverage for prying. There's a hole through the knuckle to accommodate the axle for an optional wheel kit that can be added to the bar, but we didn't order that.

Besides working well to strip forms, the

Mini Form Buster is great for prying walls up enough to get blocks under them for either rigging or wall jacks. It's also great for squaring up a big wall; we just screw a block to the subfloor sheathing and use the Mini to rack the wall as needed until the diagonals are equal.

We frame, sheathe, and—often—install windows, siding, and trim on the flat before lifting walls into place. Those framed walls are heavy, but the curved blade on the Form Buster slips easily underneath them; from there, it's a matter of leverage and our Mini Form Busters help us maximize that leverage, making our lives easier. Once we've lifted a wall into place, we can put the curved end between a block and a 2-by brace to use the bar as a handle to move the wall to plumb. \$250. dudetools.com

Tim Uhler is a lead carpenter for Pioneer Builders in Port Orchard, Wash., and a contributing editor to JLC.



The Mini Form Buster has a curved blade for leverage (1) and a rubber bumper under the handle to save your knuckles (2). The metal knuckle under the bar is designed to accommodate an optional wheel kit (3) but also improves leverage (4).

Photos: Tim Uhler



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Tough Thermal-Imaging Smartphone

Anyone working on a building envelope knows the value of a thermal-imaging camera as a diagnostic tool. Thankfully, the price for a good one has dropped over the years from thousands to hundreds of dollars, making infrared cameras a lot more accessible. But as far as I know, up until the introduction of the AGM Glory G1S in late spring of 2022, the only IR smartphone option was the FLIR One, an oversized dongle that plugs into the USB-C port on an Android phone or the Lightning port on an iPhone. On the AGM smartphone, the thermal-imaging capability is built in, and even though it's controlled by an app on the phone, it functions just like a regular camera phone to take high-resolution 256x192 pixel stills (in comparison, the resolution of the FLIR One Pro is 160x120 pixels) and 25 FPS video in several different black-and-white and color palettes. Not only that, the phone's built-in camera has an outstanding IR night-vision capability.

All of this is packaged in a rugged Android phone with an IP68 rating (that means that it's resistant to dirt and dust and a 30-minute dunking in water up to about 5 feet deep). The company says it meets U.S. military specification MIL-STD-810H, where equipment is subjected to 29 tests for shock, vibration, freezing and thawing, and more. My test was to (accidentally) drop the phone on a concrete slab a couple of times, which it passed with flying colors.

The company says that the phone is 5G compatible on the T-Mobile network; I haven't attempted to connect the phone to the network yet, because I'm a slow adopter and coverage is sparse in my area, so I can't comment on how well the AGM works as a conventional phone. But for users of other Android phones, the interface will look familiar, and the form



The AGM's IR camera can show the temperature of the water in a teapot, as well as that of the burner next to it (left). Equally impressive is an IR night-vision photo of a furnace in a basement—taken in total darkness (right).

factor is nearly identical to my OnePlus 8 phone with a Spigen case, though the AGM's housing adds a bit more bulk to the phone. \$700. agmmobile.com —*Andrew Wormer*

Photos: Andrew Wormer



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BY CLAYTON DEKORNE

Review: *A Furious Sky*

Eric Jay Dolin's 500-year history of the hurricanes that have battered the United States is a brutal read. *A Furious Sky*, which was published in 2020, chronicles the most consequential impacts of more than a thousand storms that have swept into and across the country, beginning with those Christopher Columbus predicted and was able to dodge (having learned the signs from the indigenous Taíno of the Caribbean islands) to Hurricane Imelda in 2019.

"Coursing through the centuries like brawlers bobbing and weaving and slugging anyone and anything that stands in their way, hurricanes have left an indelible mark on American history," Dolin writes. "Since 1980, they have accounted for roughly 50 percent of the cost of all natural disasters in the United States that exceed \$1 billion in damage. And going back to the late 1800s, hurricanes have killed nearly 30,000 people."

Perhaps we've become inured to such a number of deaths after the 298,000 killed during World War II, or the 620,000 during the Civil War, or the astonishing 1.03 million U.S. deaths from COVID. But Dolin's accounts are painted in painful detail, stripping away any indifference we might hold onto as he reveals the physical and emotional turmoil inflicted on families and communities by these storms. After all, just one death can have a profound impact on those left behind, and it is all the more intense when the circumstances of that death play out like a nightmare.

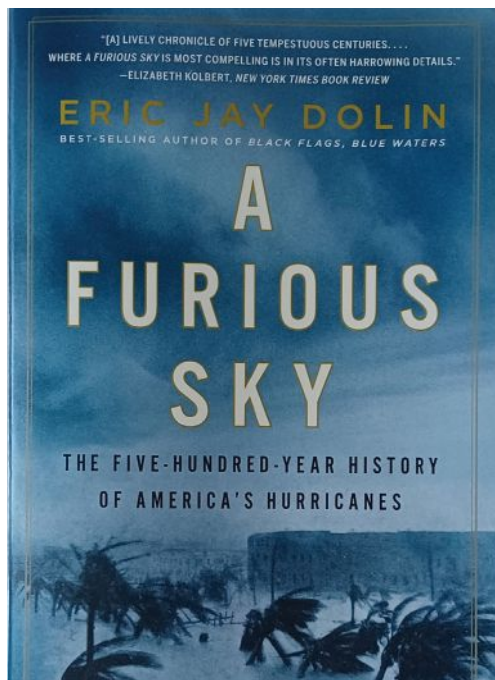
While his retellings of eyewitness accounts during storms are truly terrifying, it's the description of the storms' aftermaths, in duration and severity, I find most dreadful. "Even as the hurricane has passed, the water left behind remains a serious hazard," Dolin explains. "By destroying what humans have built, hurricanes liberate a host of toxins into the environment ... Regardless of the category and the amount of water that surges in or rains down, hurricanes have the humbling ability to strip away the trappings of modern society and return us, if only temporarily, to a time when electricity, clean water, sanitation and even a roof over one's head were unimaginable luxuries. By leaving behind the

detritus of civilization—mangled buildings and torn landscapes—hurricanes redefine reality and fracture people's lives."

Dolin delivers examples of redefined reality and fractured lives in spades, while weaving a diverse number of themes, including the storms' effect on war, governance, and the economy, together with portraits of charity and resilience to mirror all the devastation. Most intriguing to me, though, is the continuous thread he follows in our ability to predict, analyze, and understand the development of storms and influence the public, which has been a significant factor in the number of lives upended by each event. While Columbus listened to the Taíno and saved his ships, he was also accused of witchcraft, and not surprisingly, little of the indigenous knowledge endured. Radio brought some ability to track storms, but only early on in a storm's development, as the reports were relayed by ships that alerted other ships that moved out of the way, making forecasting of where a storm might land more difficult as the storms grew. Airplanes that could fly into storms helped, though not without great peril to pilots and navigators. It wasn't until the development

of weather satellites and radar improved efforts to monitor the progress of storms in real time that predictions improved.

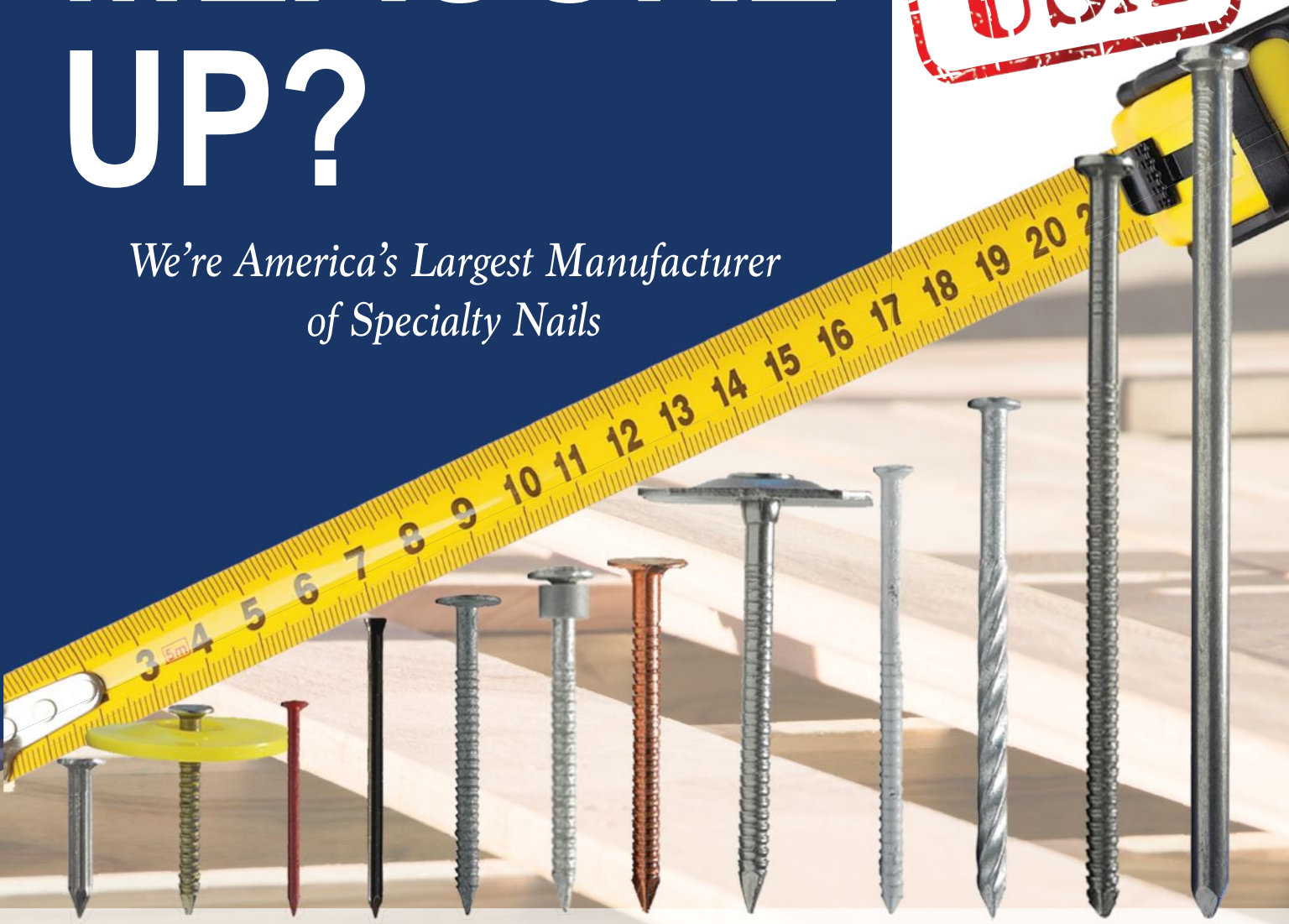
Convincing the public to take storm warnings seriously took a little longer, as predictions had previously been so unreliable. It wasn't until 1961 that a local TV news director from Houston named Dan Rather decided to superimpose the map of Texas over a radar image of Hurricane Carla that the public got a visual on the magnitude of a Category 5 hurricane. His reporting, and subsequent mass evacuation of Galveston, is credited for saving countless lives. Thereafter, weather reporting was transformed, and with that came another problem: sensationalism and overreporting. E.B. White summed up the problem best in 1954, Dolin reports: "... we are still trying to balance the role of media in informing us about impending hurricanes, while simultaneously not allowing their reports to become so over the top that we start ignoring them altogether, by virtue of their repetitive and alarmist nature. It is a fine line that separates effective reporting from hype that numbs the senses."



Brace yourself: Eric Dolin's brutal history presages more storms to come, bringing the further dissolution of all we hold most dear.

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