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The Journal of Light Construction

January/February 2026
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ON THE COVER: Nathan Shirai seals the top plates and other penetrations in an attic to help control indoor comfort in a home in Chattanooga, Tenn. Photo by Patrick Dagnan. See the story on page 30.

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Working in Winter

by **MARC FORGET**

A constant in construction is adaptation. We must work with the materials, people, and locations we're given and "make it work" to complete our projects. One of those factors that we cannot control is the weather. While we have yet to figure out a way to bend the seasons to our will, we can control how we prepare for it. The city where I have worked during my career regularly dips below -20°C (-4°F) during winter and sometimes colder. The coldest I can think of was about -35°C (-31°F). Nothing has made me question my career choice like having a frozen 2x6 shatter in my hand or spending a morning shoveling a few feet of fluffy white stuff off a work site before I can start my day. As character building as working in the cold is, there are ways to make it manageable. First, I'll cover the body's responses to cold, the threats cold poses, and the ways the body loses heat. Then I'll share some of the methods I use to prevent that heat loss.

Physical Reactions to Cold

When you get cold, your body uses a couple of involuntary responses to try to warm itself up. It will start by shivering, as this movement creates heat. If the cold continues, then your body will start to pull blood to the core. This happens by constricting blood vessels at the extremities: fingers, toes, arms, legs, and skin. From there, if the situation does not improve, then body functions will slow down. Your thinking, muscle movements, and senses will be impeded. Even speech will become slurred. The longer the cold persists, the more dangerous it becomes for your health. Eventually, you enter stages of hypothermia.

Signs of hypothermia are uncontrollable shivering, slurred or confused speech, clumsy or awkward movements, and a withdrawn or confused mental state. If you see those signs in yourself or coworkers, you need to act immediately to get warm. (Yes, I know, we have all worked with someone whose baseline state looks like that, but if it is beyond the usual, then act accordingly.)

Hypothermia is a less common threat in our work, at least in my experience, as we usually have opportunities to get warm. Taking a break in a warm vehicle, getting access to food, being active, and being able to remove ourselves from the cold generally makes this outcome less likely. If you are thrown into an emergency (e.g., vehicle breakdown), though, then finding warmth is more difficult.

Many people I have worked with over the years carry a cold-weather emergency kit in their vehicles, particularly if they live outside an urban area. Even mild hypothermia on the construction site should still be watched for, and I recommend getting further first aid knowledge so you recognize the signs. When you think about the symptoms of hypothermia, you can see how any of them would be a danger on a construction site to the individual or coworkers.

A more common threat from the cold to those of us in the trades is frostnip or the more severe frostbite. Frostnip is when the outer layers of skin start to get white and waxy looking. There may be some pain in the area at first, followed by numbness, and the skin will feel firm to the touch at the surface but soft below. This is the

1

The author's impression of little Randy from the movie "A Christmas Story."

starting point for frostbite. Prevention is to keep exposed skin covered: gloves for the hands, warm head covering for the ears, thick socks and proper footwear for the feet, and a scarf or shield for the face.

All prevention methods need to be dry, as moisture will pull the heat from the body even quicker in cold weather. Also, wet clothing doesn't retain heat as well (if at all) as dry clothing. Frostnip does not cause permanent damage to the tissue on its own, but repeated instances of it can make you more susceptible and lead to more permanent damage of the skin and blood vessels.

PHOTOS BY RHIANNON FORGET

Base layers of synthetic material, wool socks with spares, and Merino wool long johns are the start **(2)**. Blanching of the skin is the start of frostnip **(3)**.

To treat this, warm the area with fresh clothing, warm hands, against warm skin, or in front of a heating source. It is important to take it seriously.

If the freezing continues, frostbite can result, and this can mean permanent damage to the area. Frostbite is when the lower layers of the skin also freeze and at that point you will need medical attention to recover the area. Warming a frostbitten body part should be done carefully and under medical supervision to prevent doing even more damage.

My experience with frostnip or frostbite is affected by the fact that I have Raynaud's. This is a condition in which circulation to the extremities is already poor. In my case, it affects my hands the most, and years of working in the cold have made me even more sensitive to it. Repeated damage has resulted in permanent numbness and lack of sensitivity. So, take care of those hands and toes—you only get one set.

Remember that you are creating the heat you need. The steps you take are generally to keep you warm not make you warm. (Exceptions are battery or chemically provided sources of heat, which I discuss later.) Your body loses heat in five ways. By knowing what they are, you can take steps to lessen the impact:

- **Radiation** occurs when your body creates heat, and this heat then passes through the skin and out into the environment.
- **Breathing** can make you cold by expelling warm air and bringing in cold air.
- **Evaporation** occurs when body heat turns moisture to a gas.
- **Conduction** is how heat moves from your body to a cold object.
- **Convection** (wind chill) occurs when the warm air around the body is replaced by cooler air.

Preventing Heat Loss

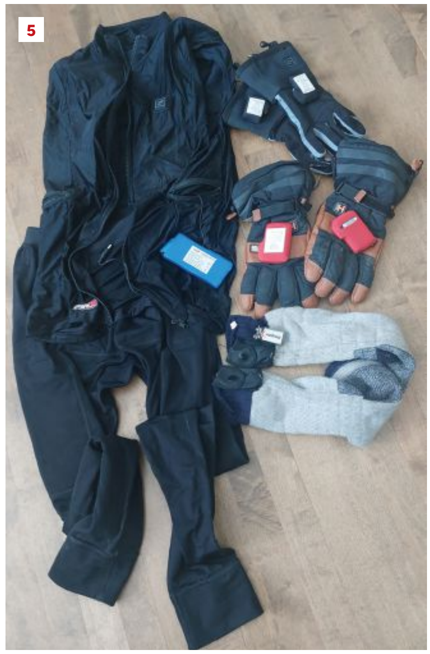
To prevent heat loss, you need a system that does several jobs: holds heat in, shields your breath from the cold (scarf, hood tunnel), wicks moisture away from the body, keeps moisture from getting in, and blocks the wind. Beyond the simplistic advice of "wear something warm" is that you need to think in layers that can handle all those requirements. A thick winter parka may keep you warm, but it is not a flexible solution.

Starting close to skin, have a base layer that "breathes" and wicks moisture away from the body. Synthetic fabric or a merino wool product should be

Combining inexpensive knit gloves and water-resistant work gloves works well **(4)**.

the choice, not cotton, as it will absorb sweat and make you feel cold. Then add an insulation layer or mid-layer that's not too thick but holds heat. A hoodie, wool sweater, fleece shirt, and work pants are examples. You want it to hold heat in while allowing moisture to move outward. Next comes a shell that could double as outerwear on warmer days. That could be a quilted vest, light jacket, or sweatshirt. The last piece is a winter work coat that allows movement, keeps rain and snow out, and protects against the wind. You could add snow pants to this last layer for those very cold or snowy days.

This stack of clothing allows you to peel off layers if you get too hot while keeping you protected. Think of it like a dimmer switch of warmth; you can change it as you need to, whereas a single warm layer gives you only the options of on and off. These layers also combat the many ways in which we lose heat.



Battery-assisted clothing and heating packs give a boost on cold days, but the author finds the workday often outlasts their heat output **(5, 6)**. Boot-drying "footballs" get the moisture out of footwear to promote warmer feet the next day **(7)**.

The best general advice I can give you about clothing is the same as I give for work boots or a mattress: Buy the best you can afford. Your ability to keep working relies on it. Beyond that, here are some specific recommendations that have worked for me.

Gloves. I go with a double layer of a thin knit glove and a water-resistant work glove. I wear a knit glove on the inside and an XL work glove on the outside. The combination gives me the most dexterity for handling material, pencils, or tools. It is also a cheap solution for an item that will see a lot of wear and need replacing. I have seen other carpenters (looking at you, Joe Canning) do the reverse, with the knit on the outside.

Experiment to see what is best for you. Just be sure that they are not too tight. You don't want to constrict blood flow, as that will make your hands cold, for sure. Also keep spares with you, tucked inside your jacket. When the first ones inevitably get wet, you can replace them with warm and dry ones.

Socks. Again, I wear two layers. First is a thin synthetic material that pulls moisture followed by a thick wool sock. Here, too, I keep extra pairs on hand—if not in my jacket, then in my insulated lunch box so they aren't cold when I put them on. Make a habit of changing your socks at lunch, at minimum, or sooner if your feet start to get cold.

Other foot-related gear. I coat my work boots with mink oil regularly to help keep out rain and snow. At the end of the day, I dry out the insides of the boots with plug-in dryers. I am also partial to chemical toe-warmer pouches. They come with an adhesive strip that allows you to stick them to the top of the toe inside of your boot; they will provide some heat for six or so hours until they need replacement.

Chemical heating pads or battery-powered clothing. I own a full selection of battery-powered clothing: long johns, gloves, socks, vest, and jacket. I also keep a stock of hand and foot warmers. However, these temporary sources of heat should only be supplements to your gear, because when the battery dies or the chemical reaction runs out, you still need to be warm. I mainly use them as a boost to get through a short period of extreme cold.

In addition to clothing, think about food. I make sure to have extra food on hand when I am working in the cold. When we work, our bodies burn calories to keep us moving. In the cold, our bodies are working much harder to generate heat. If I am running at a calorie deficit, I get cold quicker and have a harder time keeping warm. When I framed houses in the winter, my routine was breakfast, large snack at first break, lunch, and then another snack in the late afternoon. Once I got home, I was still starving for supper. The body is a furnace; keep it fueled up.

The cold season in Ottawa can vary, but the first hard frost historically hits mid-September and the last one in late April. Most times, it feels longer. January and February can be cruel with March acting as a tease. The reality is that if I didn't work in those months, I didn't get paid. So, I dressed for it.

There are, of course, regions where the cold season is longer and even more intense. My father spent six months of the year above the Arctic Circle when he was in the military. Vehicles would be kept running 24/7 because if you turned them off, they might not start again. It could be worse. Luckily, I haven't had to try and strip a form or raise a wall in that kind of cold. For the cold I have had to work through, I adapted. Wear layers, keep dry, avoid cotton base layers, have spares, and keep fed, and this too will pass. Stay toasty, my friends.

Marc Forget is a JLC *associate editor and often frozen licensed carpenter in Ottawa.*


Thermador

Q What's a safe way we can test to see if wires we find in walls during demolition are hot?

A *Chief Editor Clayton DeKorne responds:* I have always relied on a simple two-wire circuit tester like the one on the left in photo 1, below. You need to place the leads on bare wires (both hot and neutral legs); when a line is energized, the small bulb lights up. These are foolproof if you have good contact on bare wires.

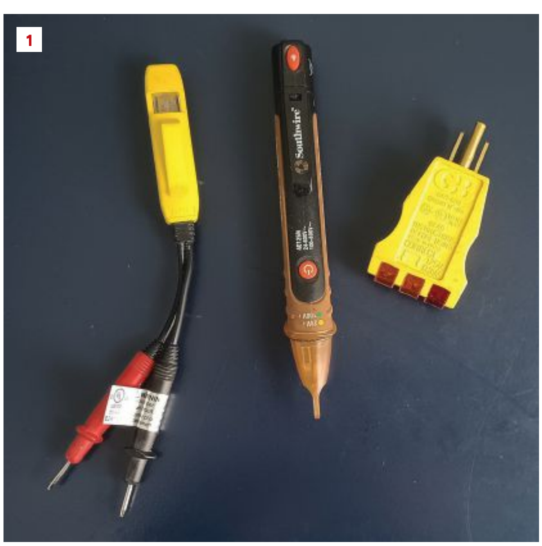
But I also always carry in my bags a non-contact voltage tester like the Southwire model in the center of photo 1 because it's fast, and you don't need a bare wire. (Often during demolition, you simply have a cable running through a framing bay with no end in sight.) The end of the voltage tester lights up green but turns red and chirps loudly when placed against the jacket of a hot wire. It's a fast check, but you should be very careful with these and still proceed with caution if you have a green light and think the wire is dead.

Some electricians call these non-contact testers "widowmakers" because you can get a false positive if the battery is low, the wire has extra-thick shielding, or conditions are wet. Even improper grounding can give a false positive, meaning the light will stay green even when the wire is hot. I always stick it in a known hot outlet or against a known hot wire of the same type to make sure it's working as intended. And even then, I don't assume it's correct until I can find an uninsulated end and test for certain with my two-wire tester.

I also carry a plug-in tester like the yellow one on the right in photo 1. These work only on outlets, but they're fast and sure and a terrific way to quality-check grounding conditions on new or existing wiring.

The tricky part of discovering wires during demolition is chasing down the circuit they're on so you can turn it off at the panel. Most of the time, I do this by trial and error via cellphone with another person turning off each circuit at the panel. Or you can test for continuity with a multimeter (and some long leads connected to the multimeter's leads with alligator clips). Travis Brungardt, a custom builder and remodeler who is also a licensed electrician, recommends using a two-button multimeter like the Klein ET-250 shown in photo 2, below. It functions as a voltage detector or a continuity tester but is vastly simplified compared with models with a dial.

1



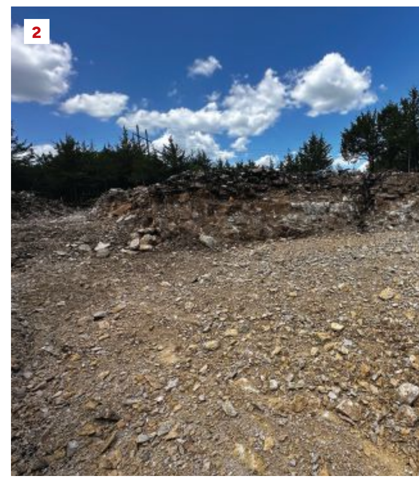
2

PHOTOS: 1, CLAY DEKORNE; 2, COURTESY KLEIN TOOLS

Flowable Fill

by **JAKE BRUTON**

Most sites in the Kansas City region lull you into thinking you know what you are getting: slightly expansive clays, pockets of topsoil thick enough to fool you into believing the job will be straightforward, and just enough stone to keep you honest. When we joined the project team for this custom home, design was nearly wrapped and no one had performed any soil testing. In other words, the house was happening regardless of what we found underground. A couple of exploratory holes were dug before our contract, but all they revealed was that excavation was going to be an expensive line item.



What should have been a one-day excavation with a minor 6-foot cut turned into several grueling weeks of work because of an excessive number of rocks on the site. Excavation, disposal, and backfilling all took more time and budget than expected **(1, 2)**.

Excavation

The house itself is a 3,700-square-foot slab on grade with a compact

Before the flowable fill, also known as controlled low strength material (CLSM), was placed, the author braced the foundation walls **(3)**. Because flowable fill is expensive, the author used it sparingly to fill the enlarged excavations around the foundation **(4)**.

PHOTOS BY JAKE BRUTON

A big advantage of flowable fill is speed. It comes out of the hose like a wet slurry, finds every void, levels itself, and requires essentially no manipulation **(6, 7)**.

150-square-foot basement space 9 feet deep that holds the mechanical systems and the lower section of a perpetual spa pool. The grade change across the footprint of the house is roughly 4 feet. At the garage, you walk in at natural grade, but at the far corner of the basement, the floor sits 4 feet above grade. That required a 6-foot cut. Normally, this is simple work for a good operator with a solid machine, one or two days, tops. But what should have been simple took multiple weeks and required more than one machine to keep things moving.

Roughly a foot below grade, the soils gave way to rock the size of a bowling ball. Not occasional rock, continuous rock. The excavation budget went up, the disposal budget went up, and the backfill plan had to be rewritten. The rocky conditions caused frequent collapses, which forced a much wider overdig than usual. We already dig wider than most builders in our area because we want working room for our team to feel safe to execute top-quality work. On this site, we were sloping far beyond even the OSHA expectations for Type C soils, simply to keep the sides of the excavation (rolling hills, really) standing.

Once excavation was finally complete, the question became how to backfill without blowing the budget or the schedule. We had a large pit, almost no usable material on site, and limited room to maneuver. Traditional backfill with clean material and compacted lifts was possible but would have meant a slow, equipment-heavy operation in a space that did not want to cooperate.

Flowable Fill Option

Flowable fill came up as an option. Controlled low strength material (CLSM) is essentially a cementitious backfill that behaves like water when placed and then hardens to a low-strength material. The American Concrete Institute (ACI) standard 229R 18 caps its compressive strength at 1,200 pounds per square inch (psi) to ensure it can be removed in the future if needed. (To me, psi is a misleading number. Porcelain tiles have upward of 20,000-psi ratings for compressive strength. EPS Type-IV foam is 20 psi. That same foam has a carrying capacity of 2,880 psf. Numbers get big fast, and our residential buildings are fairly light.)

It's important to note that the same standard doesn't set a low-side requirement for psi, so it can be spec'd very weak if needed. For this project, it made sense to combine CLSM with conventional compacted fill and take advantage of the strengths of each system.

Revised Backfill Plan

The goal was to get back to a workable elevation quickly without overspending on CLSM. We decided to place flowable fill only up to the level of the original undisturbed soil. This reduced the amount of CLSM required and brought our surface to a point where we could comfortably run a skid loader and compactor across the entire area. It gave us the result we needed while keeping the budget pointed in the right direction. It also meant we avoided burying any plumbing lines in the CLSM aside from a very short section of waste pipe at the foundation exit. Even at this elevation, we spent thousands of dollars on the CLSM.

The advantage of flowable fill is speed. CLSM comes out of the hose like a wet slurry, finds every void, levels itself, and requires essentially no manipulation. Our dozen-plus yards were placed in less than 45 minutes with one pump truck and one crew member. For any cementitious process, that is an incredibly efficient use of time and labor.

We braced the foundation walls prior to placement. With interior fill elevations higher than some of the exterior conditions and with the energetic nature of CLSM placement, bracing felt like the prudent choice. The walls did not move, the bracing came off easily, and everything performed as expected. We most likely would have executed this bracing with traditional fill as well.

A few takeaways are worth keeping in mind for anyone considering using CLSM. It does not need reinforcing. It is not a structural element. It is simply backfill made up of cementitious material.

Also, a pump truck is not always required. Access dictated that choice for us, but these mixes can arrive in standard concrete trucks and can even be delivered in dump trucks, depending on the proximity to the plant.

Finally, while ACI does not directly address plumbing embedment, I would avoid burying lines in CLSM unless it's necessary. It is low strength, but it still locks things in place a lot more than compacted soil does.

This was our first time using flowable fill. Everything went as planned. Performance so far is right in line with traditional backfill materials, and we gained days or even weeks in the schedule. Will we use it again? If the site conditions are right, absolutely. But those site conditions will need to be right because it isn't cheap.

Jake Bruton is the owner of Aarow Building in Columbia, Mo. Follow him at @jake.bruton on Instagram.

The American Concrete Institute does not directly address plumbing embedment. Playing it safe, the author kept all plumbing and perimeter drainage above the flowable fill (8).

Conventional crushed stone was used for the remainder of the foundation fill (9, 10).

Built-in Bookshelves, Built on Site

by **EMANUEL SILVA**

With the mockup approved **(1)**, the author cuts plywood sheets to size **(2, 3)** and rabbets them for the back panel **(4)**. He cuts and fastens the facing to the shelves **(5, 6)**.

PHOTOS BY EMANUEL SILVA

I am not a cabinet maker. I've always considered myself an all-around carpenter, and I take on all kinds of different jobs. My shop is the client's driveway or garage; for the job in this story, it was under the client's deck. With those limitations, I regularly provide cost-conscious custom work to my clients. On this job, the client wanted shelving for their many books in an unused space in their basement.

The space was a bump-out on the wall between two windows. As we went over options for height and depth, we narrowed it down to fixed shelves spaced at about 12 inches. To help her visualize it, I made a mockup that fit the space and put it where the finished bookcases would go. While this took extra time on my part, the client was able to set some books in the mockup and otherwise be sure it was what she wanted. It also gave me a plan to work from as I built the project. The client wanted the look of fixed shelves, so that spacing had to be right on.

Building the Shelves

For the shelves and boxes, my first thought was to use ¾-inch Baltic birch multi-ply. What I found was that the price had gone up and availability was a problem. I was able to find a ¾-inch poplar multi-ply that would give me the strength I needed and would fit the budget. I'd use ½-inch poplar plywood for the backs of the shelving units and clear pine that I cut to fit to face the front edges. For the face frames of each unit, I ripped poplar 1x4 to the widths needed.

Working outside, I cut down the plywood with a track saw to the sizes needed. I then cut a dado in the back edge of the bookshelf frames to recess the ½-inch plywood back into.

I cut all the shelves to size and banded the front of each shelf with strips of pine, fastening them with glue and 18-gauge brad nails. I also sanded all the parts before I went inside to start assembling them.

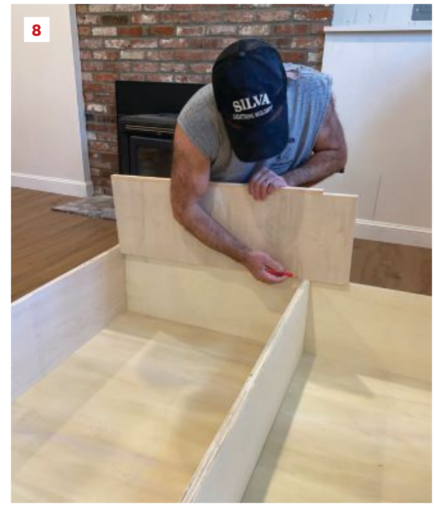
With all the parts cut, I moved into the basement to assemble the boxes. The frames of each box were glued, nailed, predrilled, and then screwed together. I glued and nailed the back in place, double-checking for square as I went. I then marked the oversized shelves to exact finished width and took them outside to cut. Screws driven through predrilled holes fastened each shelf in place to the sides of the boxes. Carefully running those screws through the middle of shelves prevented blow out or bulging in the plywood. I also attached each shelf from the back with screws. Having seen the books that the client wanted to store, I wanted to be sure the shelves would not bend.

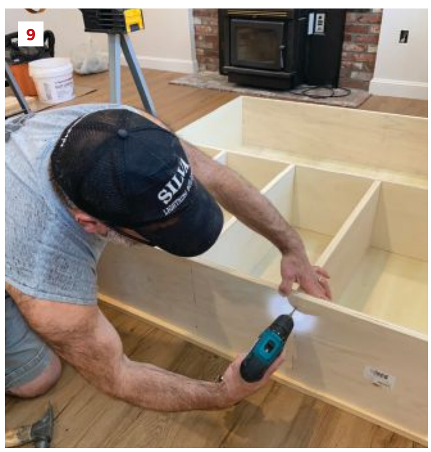
For the second set of shelves, I used pocket screws to attach them to the center divider, as I couldn't go straight through the divider because of the first set of shelves. Next, I placed each shelving unit onto an existing window ledge in the basement and screwed the units to it with pocket screws. I then screwed the units to the back wall through the ½-inch plywood backer.

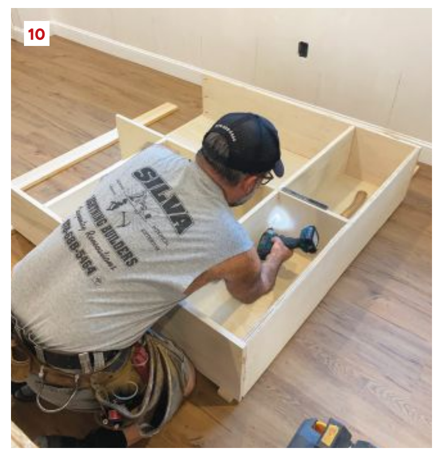
The face frames were next. Having cut the pieces, I glued and pocket-screwed these together outside before bringing them indoors. Each frame attached to the fronts of the bookshelves with glue and nails. Now, I could tie these units in with the rest of the basement.

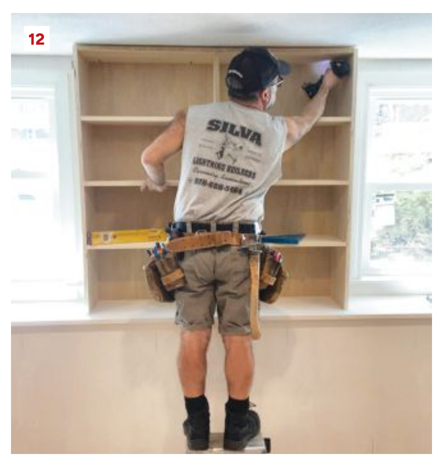
Finishing Up

I built a valance above each window that matched what I had done in the rest of the room. Everywhere else, the valance was used for a wiring chase, while above the windows, the valance was decorative and provided a reveal for the crown. I ran the same crown molding that was in the rest of the

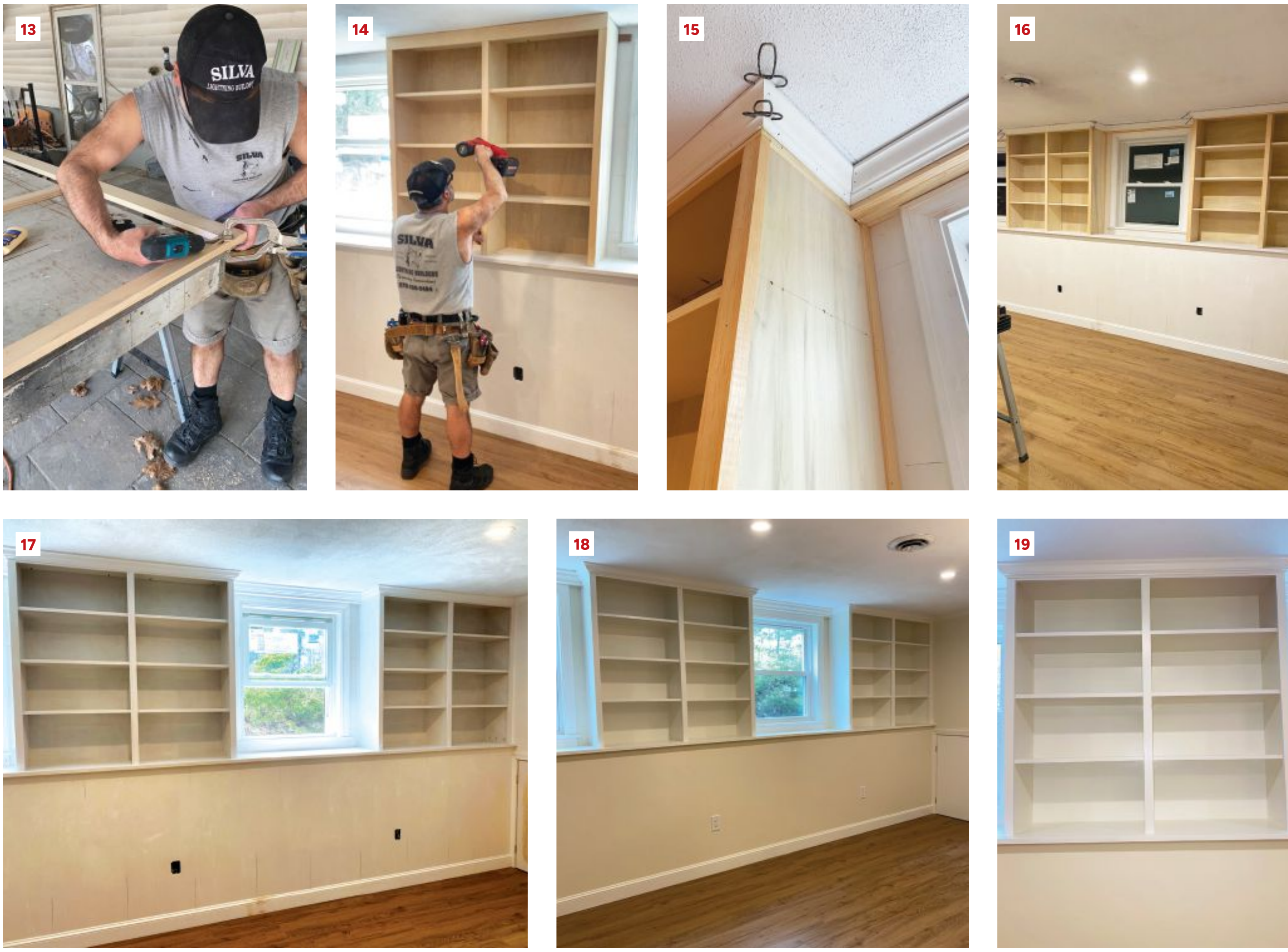








All parts are sanded before assembly moves inside **(7)**. Shelf width is confirmed before final cut **(8)**. Parts are predrilled to ensure alignment and to prevent screw blowout **(9, 10)**. The units fasten to both the ledge and the wall for stability **(11, 12)**.



The poplar face frames are cut, glued, and pocket-screwed together **(13)**. Then, they are mounted to the bookshelf units as one assembly with glue and nails **(14)**. The crown molding and valance above the windows tie the bookcases aesthetically into the rest of the room **(15, 16)**. An initial coat of primer **(17)** and a second coat after caulking and filling **(18)** ensure a clean finish product **(19)**.

basement onto the shelving units and above the windows.

I don't usually do the finish painting, and, for this job, the client had a painter lined up who did a good job. Still, since it's my name on the job more than the painter's, I like to do all the prep work myself.

With all the parts already sanded, I went over the screw holes with a sharp putty knife to remove any burrs. Then I applied a coat of primer, caulking, nail-hole filling, and a first coat of Red Devil One Time in the larger screw holes. After the One Time dried, I applied a second coat followed by a light sand and one last coat of primer. This might seem like a lot of work, but this way I can control what the finished job will look like no matter who does the final painting.

When the client first talked about wanting built-in shelves like her daughter had in her house, she thought a cabinet shop would have to be involved. She figured that would be more than she could afford, though. I told her that this was something I could do on site that would be custom fit but would also fit her budget. I turned out to be right on both counts and left her impressed with the results. I like projects like this where I get to be creative, solve a problem (storage in an otherwise dead space), and leave with a happy client. It's why I love what I do.

Emanuel Silva, a JLC *contributing editor, owns Silva Lightning Builder in North Andover, Mass. Reach him at silvalightningbuilders@gmail.com.*

When Honeybees Move In

Removal benefits the house and planet alike

by **FERNANDO PAGÉS RUIZ**

1

Meet Nanette Davis, the queen bee of Garden Variety Bees. In addition to moving bee hives, she teaches teens about beekeeping with the MoCo Beekeepers, mentors in the Hives to Heroes program, and serves as a behavior analyst helping families near Houston.

PHOTOS BY AUTHOR, EXCEPT 1 AND 8: COURTESY GARDEN VARIETY BEES

When a client asked me to rehab a hunting cabin deep in the woods, I didn't expect to step into a buzzing nightmare. After a long, dusty drive down a back road, I reached a small house near a lake, retrieved a key from the lockbox, and opened the front door—only to be greeted by a cloud of bees. I quickly slammed the door shut and called my client, explaining we couldn't start work until the bees were gone. Unfortunately, someone had already tried a DIY fix, unleashing an insect bomb. Bee carcasses covered the floor, a needless slaughter that was ineffective at getting rid of the bees.

Why Save Honeybees?

Many scientists consider the honeybee the most important species on Earth because of its vital role in pollinating plants, which is essential for the reproduction of many food crops and the health of ecosystems. A large part of our diet depends on crops that rely on bee pollination: no bees, no food.

Often regarded as simple insects, honeybees lead disciplined and diligent lives. Tens of thousands of female worker bees buzz in and out of a hive, foraging for food, feeding larvae, and building intricate combs of wax cells to store honey and protect the eggs as they develop into larvae and pupae, becoming fully grown bees in about two weeks. Their lifespan is brief, lasting only four to six weeks. To ensure the hive's survival, producing offspring and feeding everyone are endless tasks. We can all learn from their discipline and hard work as builders and members of a cooperative society.

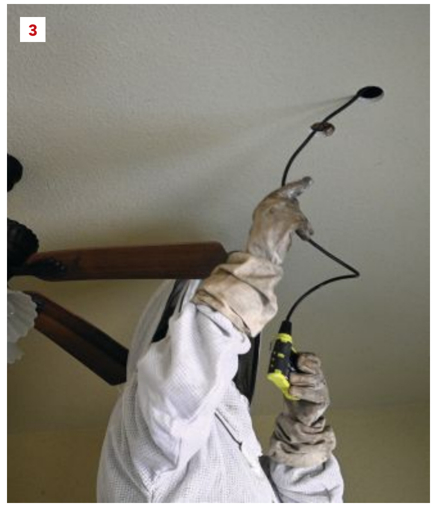
Unfortunately, honeybee populations are declining worldwide due to factors like pesticides and habitat loss, raising concerns about food security and our survival as a species. While killing honeybees isn't illegal, it is harmful to humans in the long run.

Not like termites. Honeybees may sometimes nest in walls or attics, but, because of their ecological importance and the temporary nature of their hives, relocating them is worthwhile. They differ markedly from other invasive insects like termites, which cause continuous damage by eating wood and spreading rapidly through buildings. Unlike honeybees, which are crucial for pollination and ecological health, termites are destructive pests that offer no benefit to human-made structures. Usually, extermination is the only practical option for termites.

Not like carpenter bees. While honeybees are highly social, living in large colonies that produce honey and support pollination, carpenter bees and other solitary species behave differently. Carpenter bees bore holes into wood for nesting, which can cause structural damage, though usually less severe than that caused by termites. Carpenter bees don't produce honey and are less vital to crop pollination, but all bees contribute to ecosystems through pollination. Green builders prioritize relocating beneficial bees, such as honeybees, while carefully addressing potential structural issues caused by carpenter bees.

The case for removal. Even if you don't care about bees, there's more to honeybee removal than just killing the invaders. A single colony can have up to 80,000 bees, making it tough to get rid of them all. They keep trying to find a way back, even chewing through wood and plaster if needed. Block one entrance, and they'll find another. In addition, robber bees may come to steal honey from a weakened hive. New swarms might move in, and dead bees will start to stink. If bees die in hidden spots, you'll have to deal with a strong smell for many months.

Besides the bees, honeycombs hidden inside walls or ceilings can cause structural problems. I knew honeycombs were probably hidden behind the drywall in my client's cabin. Unless we removed those, a sweet, sticky mess would remain in the walls, attracting other creatures as well as members of the original colony. Honey and wax



Arriving on site, the author found a killing field of bees perpetrated by a DIY attempt to rid the house of bees with an insect bomb **(2)**. Nanette Davis uses a fiberoptic inspection camera to locate the hive behind the drywall and between floor joists **(3)**.

Honey and wax can also seep into wooden framing, leading to potential mold growth, wood rot, or rodent or secondary insect infestations. Over time, the added weight and moisture inside walls can weaken the structure of insulation, drywall, and even electrical components.

The Proper Way to Evict Honeybees

After I made some inquiries, a friend of a friend recommended calling Nanette Davis at Garden Variety Bees. Nanette, a master beekeeper, agreed to examine our situation. We met a few days later, and she was shocked to see the area scattered with dead bees. "I've never seen so many dead bees," she said, with a hint of sadness. Still, many bees were still buzzing around, flying in and out of a small opening in the ceiling. "This was once a massive colony," she noted.

Nanette used a thermal imaging camera to detect a heat signature and determined the hive was in the ceiling. We decided to wait until the weather cooled so the bees would be calmer and the work less uncomfortable, since the house was in Houston and lacked air conditioning.

A few weeks later, Nanette came back with her assistant and life partner, Scott Davis. They showed up at the jobsite like any other subcontractor, unloading ladders and equipment. Their tools included hive boxes with frames for moving panels, bee vacuums to safely extract the insects, hive tools that look like paint scrapers, buckets, a bee smoker to calm the honeybees, and protective jumpsuits, gloves, and veils, with extras for me and my crew. Beekeepers aren't allowed to do demolition work in many areas, so I was responsible for cutting into the walls.

Beekeepers operate under numerous regulations and registrations to protect the safety of both the bees and the public. In Texas, pending legislation suggests mandatory training and licensure for a "Bee Removal Professional." It's a serious trade. I set up the ladders and drilled a few holes into the ceiling. Nanette used a fiber-optic inspection camera to confirm the hive's exact location. Fully suited, I climbed the ladder with jab saw and battery-powered Sawzall in hand and carefully started demolition.

Opening up a ceiling isn't difficult for a contractor like me. However, beekeepers, though they might know a lot about insects, don't necessarily know much about building hazards like electrical wiring or plumbing, and cutting into a house isn't part of their job. Laws differ across areas, so it's always best to hire a professional with the right equipment and knowledge to do the removal and follow any required protocols. A licensed professional should always handle opening building parts for hive access.

As the first sheet of drywall peeled off, I caught my first glimpse of the hive. It didn't look as I expected; I initially thought it was foam insulation. Honeycombs often hang vertically; in this case, they were suspended from under the subfloor of the second story. The combs resembled radiator panels designed for air circulation in summer and heat preservation in winter. Looking closer, I noticed the hexagonal structure of the individual cells. Bees build hexagons because they mesh together perfectly, like an endless puzzle, leaving no gaps between cells. It was time to let the expert take over.

Preparation

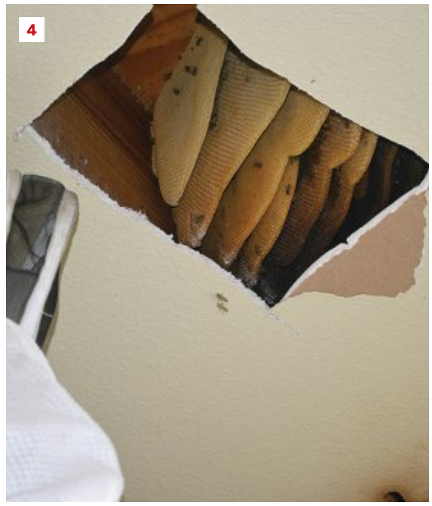
When preparing a site for hive removal, contractors should take proactive steps to protect the property and ensure crew safety. For example, block re-entry points to prevent bees from entering the interior and seal off surfaces prone to honey leakage. Lay down a drop cloth to prepare for a sticky mess. These steps are crucial to avoid staining, honey odors, and secondary damage that could require more extensive repairs. Also, be careful with ladders, as honey dripping on rungs can cause a fall.

The Gentle Art of Honeybee Removal

Though we exposed the hive and shook the structure while cutting, the bees remained surprisingly calm. While there are about 4,000 native bee species in the United States—800 of them in Texas—there was no doubt about the species here: the Western

Honeybee, Apis mellifera, the only bee in the country that produces honey. And there was plenty of it. As Nanette carefully scraped each panel from the subfloor, honey poured down her hands and arms onto the ladder rungs and the floor. It's a sweet but messy job.

Nanette removed her veil because the bees seemed unbothered. She complained about the heat and preferred the occasional sting over eight hours of sweating in a hood while carefully working overhead to remove each panel. At one point, she got stung. Some bees can become aggressive and swarm, but bees generally sting only as a last resort. After a worker bee stings a mammal, the barbed stinger can get stuck in the animal's skin, tearing loose from the bee's abdomen and leading to her death within minutes. It's a kamikaze mission. Bee venom contains histamines and proteins that can cause allergic reactions in some people, but, for most, a sting is just mild discomfort.



The bees occupied one joist bay (4). Made from wax flakes secreted by young worker bees after eating lots of honey, the combs are formed from top to bottom by thousands of worker bees gathering the flakes, chewing them up, and using their body heat to mold the honeycomb panels. As Nanette begins removing the combs, she feels at ease around the bees and takes off her protective veil (5).

Collaborating With Professionals

Working with licensed bee removal experts, such as master beekeepers, is essential for handling hive removal's structural and ecological challenges. These experts use tools like thermal cameras and fiber-optic scopes to safely locate hives without damaging other parts of the building. Beekeepers also help prevent DIY efforts that could worsen the problem and lead to unexpected repair expenses.

Smoke and Dance

When a bee stings, it releases alarm pheromones that attract other bees and prompt them to defend the hive. An angry swarm would have interrupted our work. To keep things peaceful, Nanette asked Scott to bring the smoker, a device that looks like an old oil can with a bellows attached. Smoke is produced in a fire chamber using wood chips, dried leaves, or grasses. Scott climbed the ladder and pumped the bellows, releasing smoke onto the hive. Soon, the bees' buzzing quieted, and the threat of an angry swarm diminished.

Bees communicate their locations and resources through what Nanette called the "waggle dance," an intricate movement that guides colony members to food sources. This behavior also helps beekeepers identify where bees are settling in human structures. Before deciding where to drill for the inspection camera, Nanette used a stethoscope to listen for buzzing. The rapid beating of the bees' wings generates the buzz and enough airflow to ventilate the hive and dehydrate the honey. Once the honey reaches a moisture content below 18.6%, it is "ripe" and stored in wax-sealed cells for long-term preservation. Bees live off their stored honey stock through the winter when the nectar of flowering plants is unavailable.

Although bees produce buzzing sounds, they don't communicate with them because they can't hear. Instead, they communicate through pheromones and dance. Different dances send different messages. A round dance indicates nearby nectar. A bee stamps her feet and wiggles her body when she needs grooming. There's even a "massage dance," where the bee moves her head to attract attention, and other bees respond by gently pulling her legs and rubbing her body. The alarm dance warns other bees of danger, and Nanette tried to calm this instinct with the smoker.

As Nanette continued removing honeycomb panels, she commented on their condition. She pointed out brood cells covered with a wax lid. Healthy broods are uniform, with brood cells lined up neatly, covering large sections of the comb. Queens are careful about how they lay eggs when everything is healthy. A scattered or "shotgun" pattern shows an unhealthy brood. Nanette shook her head, doubting the queen had survived the poisoning. She pointed to small peanut-shaped structures at the edges of some combs, explaining these are "practice queen chambers." The bees build these chambers to practice their skills, even if no queen will use them.

Scott Davis uses a smoker to calm the bees during removal **(6)**. The capped cells in this honeycomb panel **(7)** are brood pods where larvae develop. Unfortunately, the honeycomb the crew removed did not look healthy. A healthy comb **(8)** exhibits a solid pattern. The queen typically lays her eggs in a spiral, starting in the center. In this comb's center are bare spots where eggs have already hatched. Nanette and Scott cut and fit a honeycomb panel in a wood frame **(9)**. Nanette places a frame into a small hive box for transportation **(10)**.

Nanette asked us to step outside and look through a honeycomb into the sun to see the details of the symmetrical hexagonal pattern, which perfectly combines architectural form and function. Despite the honeycomb's fragile appearance, the interlocking hexagonal cells create a strong structure. It's surprisingly heavy. Charles Darwin once observed that bees' ability to build perfect honeycombs was "the most wonderful of all known instincts." Each hexagonal cell is so precisely made and neatly arranged that it's a visual delight.

Post-Removal Repairs and Restoration

After removing the panels, Nanette and Scott cut and placed them in wooden frames, securing each with rubber bands. These frames slipped into a slotted box for transport.

Once she placed all the panels safely in their frames, Nanette carefully scraped off all the wax and honey from the underside of the subfloor and joists. Any leftover residue could attract the bees that weren't in the hive; most were out foraging, so many would return looking for their home. With the hive gone, I could clearly see where the bees had entered through a gap between the cantilevered balcony joists and the floor framing. They had built their hive in the spot where the builder forgot to fill the joist bay with insulation. I sealed this crack with caulk and made a mental note: Always seal around joists and never forget to insulate.

Scott then brought out spray paint to seal the wax stain on the wood framing and kill any remaining odor. Odor-blocking paints, like Big D Odor Eliminator and Kilz, are also used in smoke-damage restoration and work better than standard sprays.

If the colony hadn't been poisoned, Nanette would have left a panel outside to attract foraging bees and prevent them from re-entering the house. But she was concerned the poison would harm other bees in the area. Likewise, the honey in the combs was inedible because of the poison. Uncontaminated honey, however, has extraordinary medicinal properties.

Scott uses a Colorado Bee Vac to gently round up the stragglers (11). The hose's smooth interior ensures the bees don't get banged up, while the adjustable valve keeps the suction just right. Nanette prepares to place the transported bees into their new-home hive (12). The queen cage (13) holds a queen bee and three "attendant bees" who tend to her needs, helping ensure she stays healthy while confined.

Honey has been a valued natural remedy for thousands of years. Ancient civilizations, such as those in Indian Vedic culture and China, appreciated honey for its antibacterial, anti-inflammatory, and antimicrobial properties. Honey has been used to heal wounds, digestive problems, and sore throats. Modern research shows that honey's antioxidant qualities help treat and prevent degenerative diseases. Honey is also a natural antiseptic that speeds up the healing of cuts, burns, and other injuries.

Limited Chance of Survival

To complete the extraction, Scott used a "Colorado Bee Vac" to gently suck the bees through a tube into a screened box with plenty of ventilation. It felt like an endless task; no matter how many bees Scott removed, new ones kept flying into the house through cracks. Eventually, nearly all the bees were gone, except for the thousands gathered outside, attracted by the smell of honey. Soon, the panel box and the bee-vac box were loaded onto the back of the beekeepers' pickup truck, along with the rest of the equipment, and we were ready to lock up and move the bees to their new home. Nanette and Scott took care that no bees got into the cab, as driving with a swarm could be dangerous.

After about a half-hour drive, we followed the beekeepers to a field where several hives were stacked on trailers, elevated above the ground to prevent flooding. The pair suited up again, as dropping bees into their new home can provoke anger and swarming. We kept a safe distance and observed.

When I asked Nanette about the bees' chances for survival, she wasn't optimistic. Because we had moved more than 4 miles away from their original hive, the bees wouldn't easily be able to find their way back, especially without a queen and with a weakened colony due to the insect bomb. The survival rate for relocated bees is very low. Our swarm had taken a serious hit from the poisoning and had lost its queen. Nanette would watch the bees and decide whether it made sense to introduce a new queen.

Introducing a new queen is delicate because the bees may kill her. The new queen is placed in a small cage with three worker bees as attendants. The cage protects her while the rest of the colony gets used to her pheromones. A small hole blocked with hard candy at one end of the queen's cage takes the bees about five days to chew through. This period allows the colony to accept her scent. Once the candy is gone, the queen is released to start laying eggs, and if everything goes smoothly, the colony is re-established.

Coexisting With Nature

Removing honeybees from the hunting cabin reminded us of how deeply connected we are to nature, even when it unexpectedly invades our spaces. Bees aren't just tiny pests to eliminate; they're vital for our ecosystems and food systems. Proper bee removal goes beyond solving a pest problem—it's about recognizing the important role pollinators play in supporting life on Earth.

When facing a similar situation, consider working with professionals who focus on safely relocating bees, ensuring their survival while protecting your property. This approach helps maintain ecological balance, one hive at a time.

Fernando Pagés Ruiz is the founder and owner of Building Affordable and a project manager at No-Nonsense Housing Co., based in Miami, Fla.

Ducts in Exterior Framing Cavities

by **DOUG HORGAN**

The first rule of ducts in roof and wall cavities is "don't." But, as remodelers, we don't always get our every wish.

We have found a couple of ways to install insulation above or behind the ducts when we are forced to put them in rafter or stud bays. These approaches are not rocket science, but if you discuss the options ahead of time with trade partners and crew members, you can get a much better result than if you just ignore it and hope for the best.

Avoid Exterior Framing

A bunch of savvy HVAC engineers have started using a technique that can make it possible to avoid running ducts in exterior framing altogether: Install supply registers closer to the middle of the house and rely on the "Coandă effect" to help deliver the air to an exterior wall across the room. The Coandă effect is the physical principle that moving air will "cling" to an adjacent surface like a ceiling or wall instead of dropping straight down.

In modern houses with today's excellent windows and wall insulation, it's nowhere near as important as it used to be to blow HVAC air directly on windows or exterior walls. Because a flow of air will follow a ceiling for many feet before dropping down into the room, a ceiling or high wall register 10 or 15 feet from the exterior can still deliver most of the same Btus to the exterior surfaces. In plenty of houses, an interior-area register near the ceiling can perform about as well as a duct near the window. In that case, no ductwork in rafter bays is even needed.

1

Rather than being run as one large rectangular duct, this line was split into two smaller round sections of flex duct that allowed ample closed-cell spray foam to be installed around them **(1)**.

When You Can't Avoid It

However, this approach doesn't always fit the project. For example, sometimes there are interior walls or other immovable elements that obstruct the flow of air. In these instances, we have two things to solve: 1) Make room for insulation outboard of the duct, and 2) figure out how to install it given that insulation crews normally do their work after the ductwork is installed.

To make room, we've used two general approaches: The first is to select shallow ducts that leave lots of room for insulation behind them. The second is to use round ducts, which allow us to install adequate insulation over most of the area.

Split 'em up. A complex but sensible method is to split ducts up into multiple smaller sections so they fit better. We sometimes have rooms like a bathroom or closets situated on the opposite side of an attic from the HVAC equipment and have been directed to run ductwork over a cathedral ceiling to get there. Instead of a

PHOTOS BY DOUG HORGAN

This flex duct **(2)** filled the whole cavity, leaving no room for condensation-controlling insulation above the duct and little room to install any insulation in the bay. The author's HVAC partner switched it out for a section of metal duct **(3)**. That made it possible to apply closed-cell spray foam between the duct and the sheathing and to fill the cavity, which provided condensation control on the duct.

single 6x12 trunk duct that almost completely fills a 2x8 rafter bay, we can branch off early and put in four 5-inch round ducts. These are much easier to insulate above and around.

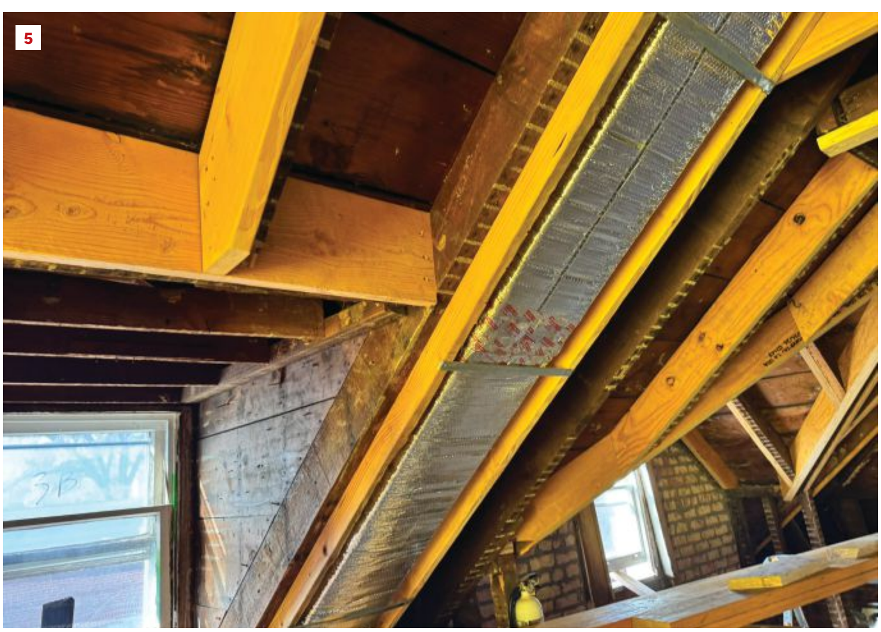
Round ducts. Even after a single round duct in a rafter bay is in place, we can usually insulate above and around it with spray foam or fibrous insulation. This simplifies scheduling and even allows more thickness of insulation above it compared with a larger rectangular duct. A competent designer needs to calculate the size of the new ducts, but that's usually straightforward. Since, as noted, a single round duct usually doesn't get in the way of installing insulation, it's an optimal solution from a scheduling standpoint.

We've found that flex duct can also make things even easier when we can use large enough sections; flex duct's pre-applied insulation makes easy work for all involved.

Spray foam. Or we can leave the ducts bare and spray them with closed-cell foam on all sides. This provides both condensation control on the duct as well as envelope insulation.

Let 'em hang. Another method we often use is to leave the ducts out of the cavities until insulation is placed. Our HVAC folks are usually open to the idea of leaving ducts hanging down and connecting them later. Sometimes, our carpenters attach the three or four pre-positioned straps after insulation without requiring the duct people to make an additional trip to the jobsite.

At left in the photo above, a section of flex duct and boot has pre-attached straps for final installation after insulation. At right, two rigid metal ducts are similarly set up with straps that will be used to attach the duct after the cavities have been insulated **(4)**.



This rectangular duct blocks access to the roof sheathing. Inaccessible elbows at each end mean it wouldn't be easy to make it removable. In cases like this, it's best to insulate the roof before the duct is placed **(5)**.

We can also avoid a special trip from the HVAC folks when we leave ducts disconnected in an accessible space and connect them later. Or the HVAC crew can make up some sections of hard pipe for us to place while we are insulating. Leaving ducts partially connected and hanging from the final straps makes it clear what will need to happen later. We haven't had issues with the insulation folks not understanding and accidentally overfilling bays or anything like that. We do depend on our full-time supervision to manage these steps, but it's simple enough that I would think it could work even without that.

Rigid foam. We've also installed foam board or spray foam before the HVAC rough-in even starts. A common situation is to have a couple of ducts running in rafter bays for less than 8 feet. It's not hard to fit a sheet of poiyiso or XPS foam board up against the roof sheathing and seal the perimeter with a can of sealing foam. Then ductwork can be installed in the normal timing, and the insulation crew can fill in around the sides during their normal visit.

Well-sealed foam board, with its high insulating value and moisture retarding qualities, is a good option above ductwork. We do make sure to avoid EPS foam in this application in our climate (Virginia), since EPS does allow moisture transmission, and we would prefer to block most of that.

Closed-cell spray foam can be used the same way, though it's an unusual project where we bring a spray rig in before HVAC ductwork is run. The way we more often use closed cell is to spray all the way around round ducts. Closed-cell foam can be used as duct insulation, so if we can size the duct right, we can make it possible to insulate above and all around it in one operation.

Best case, though, as mentioned at the beginning, is to never have ducts in exterior framing cavities.

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

Fixing Terrible Transitions

by **BRIAN CAMPBELL**

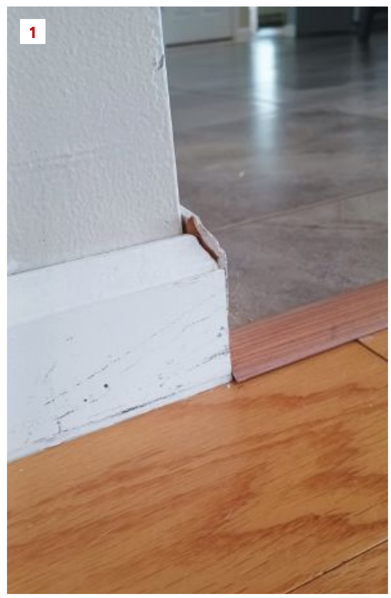
A big part of a trim carpenter's job is problem solving. A lot of DIY carpenters don't do this well, as evidenced when *JLC* editor Clayton DeKorne moved into a new house last April. The previous homeowner had opted to finish the house himself, and he did OK with ordinary casing and baseboard but left eyesores wherever floor height changed or moldings needed to terminate or change level.

What follows are a series of photos Clay took in his new house, along with photos I took in my shop after I dummied up scrap material to demonstrate the joints I would have used to resolve these transitions on one of my jobs. For some of these, I used a simple door stop to mimic the existing trim. But in other cases, the only scrap I had was leftover custom or salvaged trim, which is commentary in itself.

Modern trim hasn't done us any favors. Home centers and big box stores are full of wood, near wood, and plastic trim stock with shallow profiles. Good luck finding crown wider than 3 5⁄8 inches. Stock chair rail is 2 3⁄4 inches wide or less and rarely projects more than 3⁄4 inch off the wall. There's little sense of proportion in the ogees, coves, and beads that the new trim resembles. Of course, these shallow moldings are less expensive than solid, clear wood milled with deep profiles. But with care and skill, you can still produce handsome trim jobs using stock moldings. Good work doesn't have to look cheap.

Brian Campbell is a finish carpenter in the Twin Cities of Minn.

PHOTOS BY CLAY DEKORNE AND BRIAN CAMPBELL



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FLOOR CHANGES

This is one of the more egregious errors. The homeowner made no attempt whatsoever to resolve the change in floor height **(1)**. This occurred at every entrance to the kitchen (three of them), where the tile floor was 1⁄4 to 3⁄8 inch higher than the wood flooring.

With a shoe molding, you could cheat the elevation of the baseboard over the wood flooring to accommodate the change in floor height. The gap at the bottom of the baseboard would be covered by the shoe molding.

When I encounter this type of change in elevation, I prefer to miter the profiled edge, so it creates a step **(2)**. The small vertical piece then gets a reverse miter to return to horizontal. This results in a little parallelogram, with the short side equal to the change in floor height. The difference in floor thickness equals the drop at the top of baseboard. (Note: In my mockup above, the darker area on the bottom of the stepped baseboard represents the tile floor.)

I often encounter these steps in elevation with more elaborate base-cap and chair-rail moldings that wrap the outside wall corners on stairs, where this type of transition works well.

3

4

5

MOLDING TERMINATION

Any molding, such as this crown that ends where paneling in a bathroom meets the shower **(3)**, can be returned to the wall by cutting an outside miter. The small return piece then dies into the wall, covering the void behind the crown.

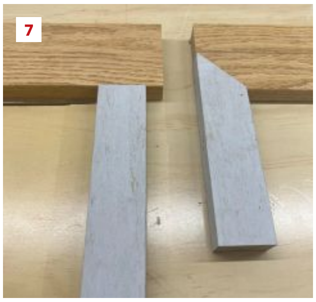
I cut in the vertical molding **(4, 5)** where its thickness matches the thickness on the bottom profile of the crown. By matching the thickness, the joining pieces will blend together seamlessly when painted.

HEAD CASING OPTIONS

The simplest solution for casing this floor-level window **(6)** would have been to use casing of the same width for the head and the sides. This would leave a small area of wall between the head casing and the window sill above. Yes, it's a fussy detail with respect to finishing the drywall and painting, but those are the type of interior details that look quite elegant.

Even if you wanted to avoid this fussy work and fill in the space with wood, the joint would look better cut square with the side casings butted underneath, either with an overhang (shown at left in photo **7**) or cut flush to the side casing. This is the correct way to case any window or door using square-edged trim. It mimics a post-and-beam connection, and it looks right because it looks structurally sound.

6



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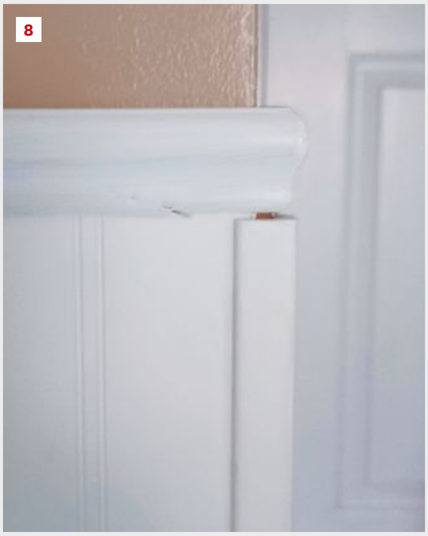

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PANEL CORNERS

Flimsy MDF paneling is tough to finish at an outside corner without corner molding **(8)**. A larger chair rail (one that projected further from the wall) would provide a large enough surface for the corner molding to die into. At the very least, this chair rail should have been packed out about ¼ inch to give the corner molding something to butt into.

For one of my jobs, I would have used solid-wood bead board for the wainscot to achieve this look. The best way I've found to finish the outside


9


11

corners of beadboard is with a dowel, as shown in photos **9** and **10**, above.

Clearly, cove molding makes for a cumbersome finish at inside corners, particularly where it meets a small chair rail **(11)**. Ideally, the inside corners of the paneling should have been butted together with no molding on the inside corners. Granted, this cheap grooved paneling can be hard to join cleanly if the walls aren't smooth and square. If I had to use a molding to clean up the joint, I would have just used a small quarter round.


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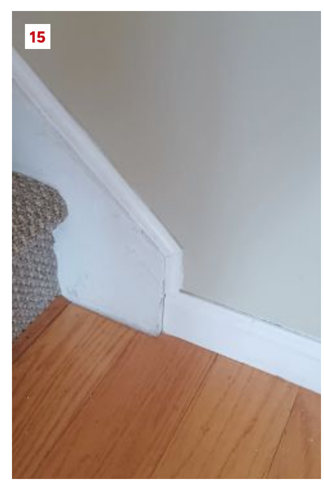
GENTLE OUTSIDE CORNER

I can understand wanting to cut a gentler outside corner, particularly for an outside corner where someone might run into it **(12)**. In such a case, I cut a couple of 22.5-degree miters, and use a small infill corner to maintain the molding profile wrapping around the corner, as shown in photo **13**.

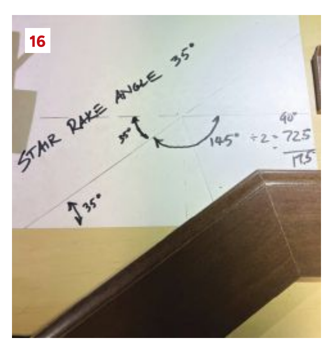
For assembling a small piece like this, many carpenters will use a cyanoacrylate glue, such as FastCap 2P-10, which sets up quickly and will hold the piece in place for assembly. But 2P-10 isn't a good long-term solution and can fail if the corner gets banged in the future. I will use 2P-10 for the assembly, along with wood glue for a more durable bond. I would also prefer a few brads in the joint to provide a strong mechanical connection.


14


15

STAIR TRANSITIONS

This is an especially terrible stair-to-base transition **(14, 15)**. The best solution is to extend the stair skirt up to the top of the baseboard and bisect the angle **(16)**. Ideally, the skirt and the baseboard are the same thickness and have the same molding profile. Sometimes with manufactured stairs, you don't have the chance to extend the skirt to the baseboard height. If this were the case, I would cut a triangle to infill the skirt and pack out the baseboard to match the skirt thickness.



16

Estimating Is More Than Just Pricing

by **IAN SCHWANDT**

Most remodelers treat estimating as a pricing exercise. Build the COGS (cost of goods sold) list, apply a margin, sell the job. However, this common approach sells the process short, and we miss out on the valuable financial data needed to run not just projects but the overall business.

When executed thoughtfully, an estimate is the blueprint for job costing, cost-to-complete tracking, and, ultimately, the accuracy of your monthly and quarterly financials. In this article, I'll walk through how I build estimates at TDS Design Build using the metrics of volume per week (VPW), gross profit per day (GP/day), and Direct Labor Efficiency Ratio (DLER). Then, in my next article, I'll explain how I use those same estimates as a basis for project job-costing and month-end accounting.

Coded COGS List

A clean COGS list is a prerequisite for clean job costing later. It should read like a ledger broken down by cost codes for your core project tasks. At TDS, we have 25 cost codes, seven of which focus on our self-perform work:

- 0300-General Requirements
- 0400-Demo
- 0700-Framing
- 1200-Decks and Porches
- 2100-Interior Trim
- 2200-Cabinetry
- 2300-Specialties

We break each cost code into four categories:

- .L — Self-performed labor
- .M — Materials
- .S — Trade partners/subs
- .O — Other costs (permits, rentals, testing, etc.)

This structure aligns our estimating spreadsheet with Job Tread's job-costing system, which means that once a project is sold:

- Labor flows into the Job Tread system from time cards.
- Materials and Other flow in from receipt and invoice uploads.
- Trade-partner costs automatically log from bills and purchase orders.

Volume per Week

Once the COGS list is complete, we finally look at the total with different durations and margins applied. This is where VPW enters the picture.

VPW is our historical throughput metric—the average revenue per week that our team produces on similar projects (see "How Long Will This Take? Leveraging Volume per Week," NovDec/2025). For certain scopes, we know our VPW range. For example, kitchens, baths, dormers, and small additions have a range of $13,000 to $18,000 VPW.

If the estimate produces a revenue total that results in a duration outside that range—say 35 to 40 weeks in a category where we typically run 12 to 18 weeks—then the estimate is wrong, the scope is wrong, or our plan for executing it is wrong.

Large gaps in VPW are not just scheduling concerns. They break:

Description	LHR	Labor Cost	Materials	Sales Tax	Other	Subcontract	Total						
Subtotal	1,041	88,427	38,230	2,103	4,174	155,415	288,349						
Contingency						1.000	-						
Total including contingency	1,041	88,427	38,230	2,103	4,174	155,415	288,349						
	52			Duration Wks	Multiplier	Margin	Price	GP$	VPW	GP/Day	CRI-GP	DLER	MSO%
				20	1.281	22.00%	369,375	81,026	18469	579	116893	3.26	54.12%
		35,867			1.299	23.00%	374,566	86,216	18728	616	122084	3.40	53.37%
					1.316	24.00%	379,410	91,061	18970	650	126928	3.54	52.69%
					1.330	25.00%	383,504	95,155	19175	680	131023	3.65	52.13%
		84	-		1.351	26.00%	389,560	101,211	19478	723	137078	3.82	51.32%
			-		1.370	27.00%	395,038	106,689	19752	762	142557	3.97	50.61%
			-		1.389	28.00%	400,517	112,168	20026	801	148035	4.13	49.92%
			-		1.408	29.00%	405,996	117,646	20300	840	153514	4.28	49.24%
			-		1.429	30.00%	412,051	123,702	20603	884	159569	4.45	48.52%
					1.449	31.00%	417,818	129,469	20891	925	165336	4.61	47.85%
					1.471	32.00%	424,162	135,812	21208	970	171680	4.79	47.13%

This summary of one of the author's estimates demonstrates how VPW, GP/day, and other metrics provide data to improve decision making when applying margins.

- Project management budgets.
- Overhead recovery.
- Labor utilization.
- Cash flow timing.
- Forecast accuracy.

VPW is the first check that the estimate reflects how the work will move through our system. If the VPW does not line up with our averages, we add or subtract weeks of duration. This action increases or decreases our duration-based 0300 General Requirements COGS—like project-management labor and equipment rentals—and updates the cost of the project. Only once the duration is set can the estimate move forward.

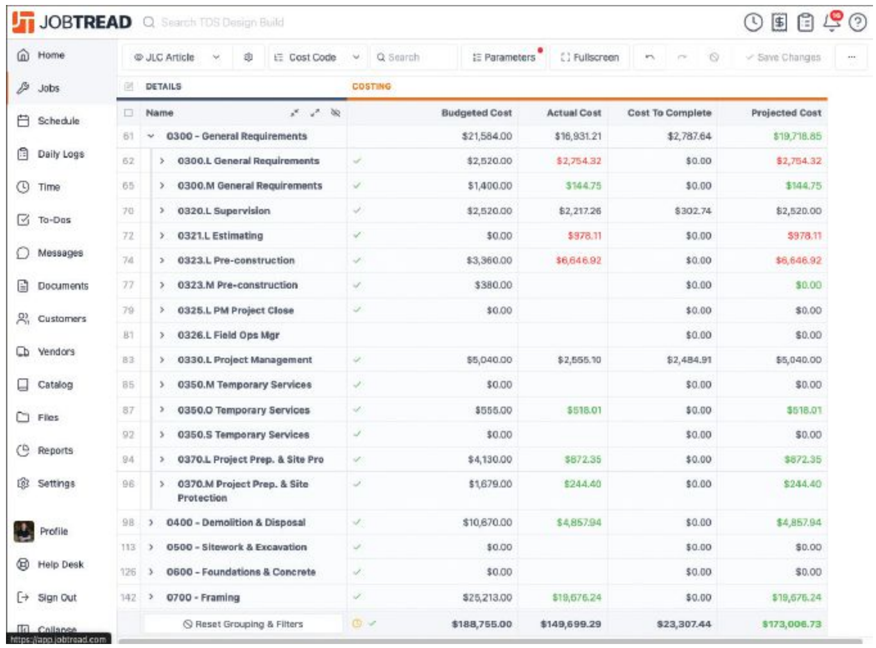
Gross Profit per Day

Next, we run the estimate through GP/day, the metric that ties revenue to the company budget. The formula is straightforward:

GP/day =
annual gross profit target ÷ 365
÷ number of concurrently
run projects

Applying this formula effectively requires an understanding of your company's capacity. While kitchens, baths, dormers, and small additions generate similar VPWs, their varying durations mean they realize different amounts of gross profit if a common gross profit percentage is used. For example, if the following are all priced at the same 32% margin:

- A $175,000, 12-week kitchen project yields $667 GP/day.
- A $110,000, 8-week bath project $628 GP/day.
- A $250,000, 16-week addition project yields $714 GP/day.
- A $125,000, 8-week dormer project yields $714 GP/day.



	Name	Budgeted Cost	Actual Cost	Cost To Complete	Projected Cost
61	0300 - General Requirements	$21,584.00	$16,931.21	$2,787.64	$19,718.85
62	0300.L General Requirements	$2,520.00	$2,754.32	$0.00	$2,754.32
65	0300.M General Requirements	$1,400.00	$144.75	$0.00	$144.75
70	0320.L Supervision	$2,520.00	$2,217.26	$302.74	$2,520.00
72	0321.L Estimating	$0.00	$978.11	$0.00	$978.11
74	0323.L Pre-construction	$3,360.00	$6,646.92	$0.00	$6,646.92
77	0323.M Pre-construction	$380.00		$0.00	$0.00
79	0325.L PM Project Close	$0.00		$0.00	$0.00
81	0326.L Field Ops Mgr			$0.00	$0.00
83	0330.L Project Management	$5,040.00	$2,555.10	$2,484.91	$5,040.00
85	0350.M Temporary Services	$0.00		$0.00	$0.00
87	0350.O Temporary Services	$555.00	$518.01	$0.00	$518.01
92	0350.S Temporary Services	$0.00		$0.00	$0.00
94	0370.L Project Prep. & Site Pro	$4,130.00	$872.35	$0.00	$872.35
96	0370.M Project Prep. & Site Protection	$1,679.00	$244.40	$0.00	$244.40
98	0400 - Demolition & Disposal	$10,670.00	$4,857.94	$0.00	$4,857.94
113	0500 - Sitework & Excavation	$0.00		$0.00	$0.00
126	0600 - Foundations & Concrete	$0.00		$0.00	$0.00
142	0700 - Framing	$25,213.00	$19,676.24	$0.00	$19,676.24
		$188,755.00	$149,699.29	$23,307.44	$173,006.73

This screen shot demonstrates how the author's cost-code structure for COGS aligns with Job Tread's job-cost system.

Running these jobs in a consistent loop could generate $2,723 in GP/day, but that requires always having a larger anchor project with a higher GP/day to offset the low GP/day of the smallest project. For us, GP/day is non-negotiable. If the projected duration and projected gross profit don't meet our GP/day target, the job will choke the business financially. Nine times out of 10, that means the margin needs to increase. Let's look at these examples again but with an equalized GP/day of $681:

- The 12-week kitchen project costs $176,183 at 32.5% margin.
- The 8-week bath project costs $112,936 at 33.8% margin.
- The 16-week addition project costs $246,272 at 31% margin.
- The 8-week dormer project costs $123,136 at 31% margin.

Bottom Line

This subtle change to margin application builds a system that supports your company's financial needs regardless of project type. It is easy to stop at "Does this price sound right?", but a better question is "Does this price support the company's financial engine at the pace required to run the business?"

Regardless of your pricing strategy, the foundation for accurate job costing and company financials is an organized estimate built on a trackable cost-code structure. In the next article, I will break down the steps that I take to use my estimates to track project performance and build month-end financials.

Ian Schwandt is the operations manager for TDS Design Build in Madison, Wis., and the author of Nails to Numbers *(nailstonumbers.substack.com).*

Solving Indoor Humidity Problems

Practical methods ensure comfort in a warm, humid climate

by **NATHAN SHIRAI**

As an insulation contractor operating in the Southeast, we frequently perform retrofit work for uncomfortable homeowners. For decades, the most common impetus for such work has been an air conditioner that struggles to keep up with the summer heat. This year, we've gotten calls arising from a new complaint: indoor humidity. While heat-related issues rarely impact more than comfort, humidity issues add the potential for biological growth and the hassle that comes with it.

This article details two projects my company undertook this year to control indoor humidity for homeowners who were sweating—literally and figuratively—their homes' performance. Each took a somewhat different path, but the overall theme is the same: Keep as much humidity out of the house as possible, then make sure the mechanicals can handle what's left. Solving elevated indoor humidity often involves multiple trades and, ideally, the effort is led by someone who approaches the home as a system and understands how each of its parts interacts with the others.

Keep in mind that the context I'm speaking from is that of warm-humid climate zone 3 during the humid season. We're often taught about building performance from a cold-climate perspective, as much of that knowledge in North America originates in New England and Canada. While the laws of physics don't change, a mental shift is required to translate those physics to southerly climes, where a long and humid air-conditioning season dominates. Northerners as well as Southerners can benefit from this understanding, especially with the increase of humidity and air conditioning loads moving north as climate trends shift.

PHOTOS BY NATHAN SHIRAI

Running a blower door while scanning with a thermal camera reveals where cooler, outdoor air is leaking through the structure. These examples show air leaks from the attic through top plates (1), through the basement ceiling (2), and around a recessed ceiling light (3).

Case 1: 1997 Suburban Single-Family

By the time I came onto the scene, four HVAC contractors, another insulation contractor, and a roofer had all tried and failed to control indoor humidity in this 4,000-square-foot, six-bedroom home that struggled to maintain indoor relative humidity under 70% despite the five (count 'em, five) dehumidifiers operating throughout the house. Two of those dehumidifiers were commercial-grade units, with one integrated into the main-level HVAC duct system. These accompanied other failed measures such as adding attic insulation (without air sealing), recommissioning an old, disconnected attic fan (which led to condensation on basement ductwork), removing that attic fan, installing a portable air conditioner in the pantry, messing with HVAC fan speed and filter configurations, and doing a bit of misguided air sealing in the garage.

One HVAC contractor told the owner that she would need to spend five figures replacing one of her duct systems. When I met her, the owner was near her wits' end, and nearly her bank account's as well, and was fatigued by the muggy indoor feel and the regular need to spray down little bits of biological growth emerging from behind switch plates in certain rooms. She was also understandably confused by the conflicting voices she had heard up to that point.

To borrow a maxim from the medical field: "Prescription without diagnosis is malpractice." Unfortunately, another maxim, "shoot first and ask questions later (or never)," summarizes the default approach for many in our industry. I knew that developing a solid plan would be critical to help this contractor-weary homeowner move forward, because she needed her next spend to be her last. Using a diagnostic process would cut through the noise and guide next steps based on data—the ingredient missing from everyone else's recipes.

With building forensic expert Corbett Lunsford acting remotely as a neutral third-party consultant, I spent a day inspecting and gathering relevant data about the home's envelope and mechanical systems. There are only so many sources of moisture inside a building. A thorough top-to-bottom inspection of the home quickly ruled out rain leaks, plumbing leaks, groundwater, and unusual occupant behavior, leaving outdoor humidity as the only possible source. Outdoor humidity's primary entry mode is air leakage, so we knew we were on the hunt for leakage pathways and pressures.

Leakage pathways. Using a blower door and thermal camera, we quickly verified the common leaks we expected to see. These mainly involved attic air leakage across the ceiling of the upper level through drywall and framing joints and penetrations.

This process also pinpointed some less obvious yet egregious sources of leaks. One was a bathroom exhaust fan that lacked a backdraft damper. The owner had been battling acute humidity buildup as well as an unusual number of oriental beetles in the bathroom that contained this fan, and she needed to empty the reservoir of a standalone dehumidifier in that room more frequently than the others in the house. This fan was the source of the humidity. Pulling the trim piece off revealed biological growth and insect bits on the back. Pulling the fan guts out of the housing revealed a discharge port completely open to the framing cavity, with a poorly installed insulation batt visible through the opening. Such a hole has the same effect as leaving a window cracked 24/7.

Another major source of leakage we discovered was along the rim of the daylight basement. This house has wood lap siding from the rim joist up, and brick veneer from the rim joist down. The two claddings are flush to each other—a condition allowed by the wood floor frame being built proud of the poured concrete foundation. This is a common configuration for daylight basements in our area. The sill plate rests on the foundation, but the joists cantilever a few inches past it, creating an air gap between the sill plate and the rim joist. This gap connects the entire floor diaphragm to a curtain of outdoor

Pulling the trim off a bathroom fan/light **(4)** revealed biological growth and insect bits on the back. After removing the fan motor **(5)**, the author discovered a discharge port completely open to the framing cavity **(6)**.

The author added Fantech RSK dampers to new Panasonic bath fans **(7)** to help reduce backdrafting. With the new fans and dampers in place, the crew sealed the fan units **(8)** by taping them to the drywall underneath and enclosing them in the attic with air-sealed boxes made from rigid foam board **(9)**.

air found between the foundation wall and the back of the brick veneer.

That outdoor air, along with the humidity it contains in the summer, provided the moisture source for the basement duct condensation that arose when the attic fan was recommissioned. Attic fans in leaky homes tend to create suction indoors. This house relieved that suction in part by pulling outdoor air in through this framing gap—enough to elevate the basement dew point above the surface temperature of the cold ductwork, resulting in condensation on the duct surfaces. A visual scan of the floor system above the finished basement's tile grid ceiling revealed other signs of air infiltration and elevated humidity, including the telltale dark discoloration on insulation batts close to the perimeter and a thin haze of biological growth widely distributed on the insulation and framing.

Pressures. Turning the blower door off and carrying the manometer around the house, we turned our attention to air pressure. Air leakage requires not only a pathway but also a pressure to act as a driving force. The air pressure we cared about was from outside to inside, and the manometer detected and verified that the house was frequently under suction due to several forces.

One was natural pressure created by the indoor-outdoor temperature difference. There was a light degree of air movement from the attic to the upper level due to the temperature difference between the cool air mass of the air-conditioned interior and the hot air mass outdoors. Cooler, denser air tends to sink and leak out through low places in the building, forcing the indoors to replace it by drawing outdoor air in through high places, like the upstairs ceiling. You probably know this as "stack effect."

We're often taught about stack effect as being primarily upward, which is the case during the heating season and the origin for the often repeated but inaccurate saying that "heat rises." During the cooling season, that dynamic reverses. Cold air draining out

To align the brick veneer with the lap siding (10), the floor joists cantilevered past the foundation a few inches, creating an air gap between the sill plate and the rim joist. This allowed humid outdoor air to leak into the floor cavity and a thin, white haze of biological growth to form on the framing and insulation (11). To access this leak, the crew opened the tray ceiling in the living room (12).

the bottom of the building pulls hot air in from the top, a process called the "reverse stack effect."

But stack pressure, though meaningful, is relatively weak and is easily overpowered when fans are turned on. The attic-mounted HVAC system serving the upper level created forced suction that outweighed natural stack pressure. This is because more air leaked out of the duct system's supply side into the unconditioned attic than leaked into the return side. This imbalance in leakage creates suction as the blower fan pulls more air out of the house at the return than it gives back through the supply. The house balances this deficit by sucking outdoor air in through the pathways outlined above.

The other primary offender was the portable AC unit in the pantry, which was required because the pantry lacked a duct from the central system. These appliances are effective at cooling small spaces. However, they also function as one-way air movers that exhaust air out of the house. This one-way exhaust was an important source of the negative pressure of the indoor space.

By turning various fan appliances on and off independently, we used the manometer to quantify and prioritize the sources of suction created in the house. Other sources included the clothes dryer and bathroom exhaust fans, but these were a lower priority because they operated only intermittently. The upstairs HVAC and portable air conditioner ran a lot and created the strongest pressures and so were the main reasons this house sucked humid air in from outdoors.

Mechanicals. On examining the mechanical systems, we noted that the home's two central air conditioners (one for the upstairs and another zoned system for both the main level and basement) were likely oversized at an average of around 533 square feet per ton of cooling capacity. Rather than calculating the load, many HVAC contractors use a guideline of 500 to 600 square feet per ton when selecting equipment, but this approach is coming to be considered out of date and usually results in oversized systems. One unintended consequence of too much cooling capacity is insufficient dehumidification. Such a system will satisfy the thermostat so quickly that it doesn't cycle air long enough to pull much moisture out.

We also discovered that the whole-home dehumidifier was not wired to call the blower fan when the air conditioner wasn't running. The dehumidifier's intake pulled from the HVAC return trunk, with its discharge ducted into the HVAC supply trunk. Without command of the blower fan, the dehumidifier's intake sucked its discharge air backward across the air handler, resulting in a short-circuit loop that prevented dehumidified air from being distributed to the rest of the house. Because the AC was oversized, the blower fan didn't operate as often as it needed to, so the dehumidifier mostly dehumidified about 10 linear feet of trunk line.

Recommendations. With Corbett's wisdom and experience, we interpreted these findings and came to some conclusions. In summary, this house sucked in humid outdoor air whenever the upstairs HVAC or pantry AC cycled on. And whenever they were off, natural pressure took over and brought attic air into the upstairs as conditioned air escaped out of the lowest level. The standalone dehumidifiers acted like overwhelmed bilge pumps in a leaky boat, diligently bailing the house out but not addressing the problem's source.

Armed with data proving the reasons for this home's high humidity, we could then confidently make the following recommendations to fix it:

- Air seal the attic floor.
- Air seal walls separating upstairs rooms from small side attics.
- Air seal floor-joist cavities open to side attics in plane with knee walls.
- Air seal the air gap along the perimeter of the basement rim joist.

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In the attic of the 1997 home, a small, open chase **(13)** created a leak equivalent to having a window open to the attic 24/7. The crew sealed this opening with rigid foam and canned spray foam **(14)**.

- Add upgraded backdraft dampers on all bathroom exhaust fans.
- Seal the upper-level duct system.
- Decommission the portable AC in the pantry and install a new branch from the central system to serve this room instead.
- Disconnect the whole-home dehumidifier from the main-level system and relocate it to serve the upper level instead.
- Verify the actual cooling load and replace HVAC units with right-sized equipment.

Air sealing the attic and the basement rim joist and upgrading bath-exhaust-fan dampers would prevent some humid outdoor air from entering the building in the first place, thereby lightening the dehumidification load at the source. Sealing the upper-level duct system and decommissioning the portable AC would reduce the amount of indoor suction pulling that outdoor air in. Finally, relocating the whole-home dehumidifier would place the paid-for appliance more appropriately upstream of the humidity's general top-down path through the building, and right-sizing the HVAC equipment would enable the mechanical systems to more thoroughly handle the building's latent load and create energy savings to boot.

Work performed. Ultimately, the homeowner had to draw a line with her budget. She wisely prioritized source control and elected to move forward with everything except relocating the whole-home dehumidifier and replacing the HVAC units. So, we got to work.

We tag-teamed this project with Springdale Heating and Air, a local HVAC contractor that understands the systemic dynamics in a building and the HVAC trade's impact on them. Its workers came in first to seal the ducts using the Aeroseal system, a highly efficient and effective method that pressurizes the duct system and forces an aerosolized sealant into leak points. This system is capable of duct sealing as close to perfection as anything in this world can be. By sealing from the inside, it can also reach joints that might otherwise be inaccessible to a worker sealing from the outside using mastic and tape.

Once that was complete, the HVAC crew wired the whole-home dehumidifier to run the air handler's blower fan when dehumidification is called for but air conditioning isn't. That way, dehumidified air would be mixed and distributed by the HVAC ductwork to the entire main level and basement of the house. The crew also added a backdraft damper where the dehumidifier's discharge entered the HVAC supply trunk. This prevents the backward looping of air across the dehumidifier when the air conditioning is running but the dehumidifier isn't.

Then it was our turn. The homeowner wanted to take advantage of this opportunity to update her upstairs bathroom exhaust fans, since they were nearly 30 years old and were about to be sealed into place and buried in fresh insulation. We installed new Panasonic units and added Fantech RSK backdraft dampers as well.

I like this damper style because it uses a light spring to hold butterfly flaps against a gasket. In my own testing, I've found that the factory dampers on most builder-grade bath fans are designed to stay slightly open until sufficient pressure makes them close. I've been able to backdraft such dampers with up to 2 pascals of pressure, at a flow rate of 10 to 11 cfm. For reference, the combined pressure effect from the HVAC and portable AC in this home was about -0.8 pascals, enough pressure to sneak air past these dampers without closing them.

The Fantech dampers don't allow any backdrafting at all and have become my go-to. Once the new fans and dampers were in place, we air sealed the bath-fan units by both taping them to the drywall underneath and enclosing them with air-sealed boxes made from rigid foam board on the attic side.

To maximize access to the attic floor for air sealing, we then had to take up several sheets of OSB that had been used as a storage platform. While we proposed removing all the existing attic insulation to fully expose all joints and penetrations, the cost of this combined with the amount of new insulation that would be required afterward exceeded the owner's budget. So, we dug and swam our way through the 20 inches plus of fiberglass insulation the previous insulator had blown to find and seal all the joints and penetrations we could physically touch. We discovered a small open chase about 2 feet square—functioning like a window open to the attic 24/7—as well as the "usual suspects" such as top-plate-to-drywall joints and electrical and plumbing penetrations through plates and drywall. All were sealed using canned foam.

The pull-down stair access had a zippered hood installed by the previous insulator. Though there are ways to construct a more airtight and better insulated cover over these notoriously leaky ladders, we kept the original one in place for budgetary reasons.

To access the side attics beside the upstairs rooms, we cut ports in the garage ceiling. We discovered what we expected: bare insulation batts in the walls adjacent to these attics. Some had a bit of sheathing, but most did not. We sealed the joints in the OSB where present and tied in an airtight housewrap detailed at the joints and edges for air barrier continuity. Rigid foam would have added some thermal resistance to these locations had the budget allowed.

We also discovered some joist cavities connecting these spaces to the floor diaphragm beneath the adjacent upstairs rooms. We sealed these cavities using blocks of rigid foam in line with the walls above.

The air gap along the basement perimeter was mostly accessible through a tile grid ceiling, but one large living room had a drywall tray ceiling detail that required some demolition. This demo and associated refinishing was deemed worthwhile because about 35% of the gap lay behind it, a big enough share of an important enough air leak. Access is tough in such locations, and the approach we landed on was to cut and cobble rigid foam blocks in such a way that we could reach their edges with canned foam guns.

Once we handled that detail, that room could be put back together. I usually advise clients that demoing finishes for the sake of insulation work is not cost effective, but, in this case, establishing control over indoor humidity justified it—though 90% of the time and cost of sealing this area went toward patching, finishing, and painting drywall.

We performed the diagnostic work at the end of last year's humid season and performed the remediation work in the following spring. I'm pleased to report that the owner was able to remove three of her standalone dehumidifiers, and the house maintained indoor relative humidity levels below

In the 2022 townhouse, the author's crew air sealed around the HVAC supply boots with canned foam **(15, 16)**. In addition, the ducts themselves were sealed by the HVAC contractor using the Aeroseal system.

70%—mostly around the high 50s with the occasional short spike into the 60s—all summer long. The whole-house dehumidifier on the main level remains, and she may have us relocate it next season. Another smaller, commercial-grade dehumidifier remains operational in the basement, though the client left it in place mainly because it was expensive and already paid for. Next season, we will experiment with turning it off. For now, the owner says she is "so happy, she could cry." We don't expect her tears to contribute enough moisture back to the home to warrant remediation.

Case 2: 2022 Townhouse

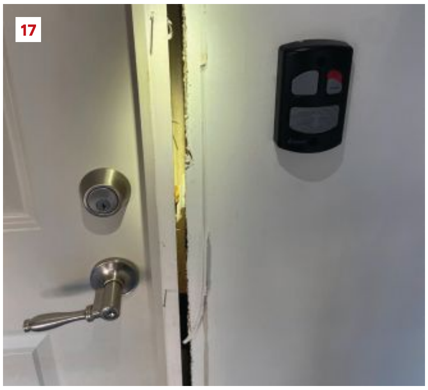
Not long after we completed the project above, another homeowner across town dealing with a similar problem called us. In her case, the first summer after occupying her 2022 attached townhouse, a rash of biological growth developed on indoor contents and surfaces and required extensive cleaning. The builder wasn't much help, and neither were other tradespeople she contacted. She was running a standalone dehumidifier and had placed desiccant bags throughout the home to get by until she could find a solution that didn't require constantly emptying reservoirs and replacing bags.

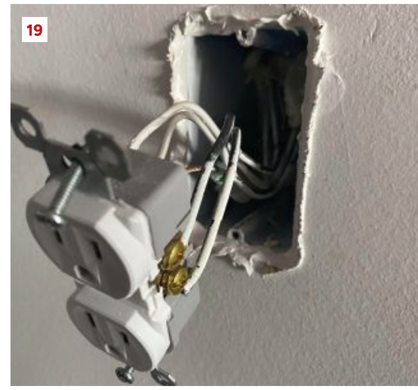
We followed the same diagnostic process as outlined in the previous case, though this 1,400-square-foot, single-level, two-bed townhouse on a slab was much simpler, with less to inspect. In this case, air leakage through the expected pathways was the main culprit.

Zonal pressure diagnostics (ZPD) clued us in to especially high air leakage in the rooms adjacent to the attached garage. ZPD uses a blower door and manometer to gauge the relative degree of leakiness to outdoors on a room-by-room basis (see "An Introduction to Zonal Pressure Diagnostics" by Randy Williams, May/23).

The mechanical system was grossly oversized at 3 tons of cooling capacity for this relatively small home, especially considering that the entire rear wall faced an adjoining unit, contained no glass, and accounted for almost zero load. That's even more capacity than the guideline of 500 to 600 square feet per ton would yield. What's more, duct leakage created 1.5 pascals of negative pressure indoors, enough to suck in a meaningful amount of outdoor air given an envelope not much tighter than the maximum of 7 ACH50 in force for new construction in our area.

For this owner, we recommended a similar, yet simpler, approach in a "good-better-best" presentation. The "good" approach simply proposed installing a whole-home dehumidifier.





Leaks through the garage separation wall are common: The door (17) is typically trimmed after the insulation crew has left, and the gap under the bottom plate (18) rarely gets sill seal. Outlets can be sealed to drywall with caulk (19); wires inside the box must also be sealed.

The "better" approach paired that with envelope and duct sealing. The "best" approach included envelope and duct sealing, and instead of a dehumidifier, we called for a full HVAC equipment replacement with right-sized indoor and outdoor units, with the caveat that we should then monitor conditions for a time to see whether adding a whole-home dehumidifier would be smart.

This owner selected the "best" approach, choosing to scrap her three-year-old HVAC equipment in favor of new. It's a bit daunting when someone takes your expensive advice, but we felt confident given the opportunity for improvement the data showed us.

Again, we tag-teamed the project with Springdale Heating and Air, which again sealed the ducts using the Aeroseal system and performed a careful room-by-room load calculation to size the new equipment. The company ended up replacing the old 3-ton, single-stage system with a 2-ton, two-stage system. Two-stage means that its maximum capacity is 2 tons, but it has a lower-capacity stage (closer to 1½ tons) that it can run when demand isn't at full extreme. In that stage, the unit will cool slower and run longer, which we like because longer run times mean more dehumidification. So, while the old single-stage system ran at 100% of its 3-ton capacity every time it turned on, the new system can more appropriately match its output to the requirements of the building by choosing between full capacity or reduced capacity. Notably, its high stage is two-thirds, and its low stage half, of the old system's capacity.

We followed up with the same attic air sealing work as in the first project, including upgraded backdraft dampers on bath fans. While there was no basement or side-attic work on this project, we did take special care to air seal the garage separation wall because of the higher degree of leakage we measured in the adjoining rooms.

You might be surprised by how much air can pass across a garage separation wall. In our area, this wall is typically no more than drywall on either side of 2x4 studs filled with fiberglass batts. Meaningful joints running all along the top and bottom of the drywall let garage air pass easily between the drywall and wall plates on its way in or out of the house. Usually, there's also a wavering gap under the bottom plate due to waves in the slab. (The owner shared an anecdote about one of her neighbors who cleaned his garage out with a leaf blower, only to discover garage dirt on indoor floors all along the base of the separation wall.) Finally, because the door unit for house entry is usually installed during trim-out, weeks after the insulation sub has already come and gone with their foam guns, it's almost never air sealed to the framing.

Sealing this wall involved first removing baseboard, door casing, and a receptacle plate from the garage side of the wall. Then we created an air barrier out of the drywall, using canned foam to seal it to the slab and door jamb and using caulk to seal the receptacle box knockouts and drywall cutout. We reinstalled the trim pieces into their original locations, and after a bit of cosmetic caulk, it was hard to tell that anything had happened.

After we sealed the envelope to prevent humid outdoor air infiltration, sealed the ductwork to reduce indoor suction, and right-sized the mechanicals to most appropriately handle the latent load, this townhouse maintained relative humidity below 60% for the second half of the summer without needing the standalone dehumidifier and desiccant bags. This meant the homeowner was able to take an extended, stress-free trip out of town without relying on a neighbor to empty the dehumidifier reservoir every day.

When I visited the home to take follow-up measurements after the end of this year's humid season, she gave me a big hug and said, "You have no idea how much taking care of this has helped my mental health." One's home should be a refuge, not a threat, and eliminating this humidity problem changed hers into the sanctuary it needed to be.

Nathan Shirai is principal of Insulation Unlimited, based in Chattanooga, Tenn. Follow him at @insulation_unlimited.

High-Performance Foundation Without Concrete

A passive-house builder's design for a low-carbon residential structure

by **DALE HULST**

PHOTOS BY DALE HULST EXCEPT 8 AND 9, COURTESY CLIMATE INC.

For our first "MiNet0" project in Grand Rapids, my goal was to build a comprehensively net-zero house. I started with a roof design that supported enough solar panels to power an all-electric home and charge a couple of electric vehicles. But beyond the roof and the energy systems, I wanted the entire structure to be optimized for low operational and embodied carbon. That meant building to passive house standards and rethinking the foundation to eliminate foam insulation and concrete.

I took inspiration from other successful "slabless slabs" that eliminate the slab portion of the foundation. The examples I've seen, however, typically still rely on concrete for the footings and stem walls. In addition, many slabless slabs use either foam board (XPS or EPS) or mineral-fiber boards for sub-slab insulation. To eliminate the remaining concrete and the foam, and to minimize the amount of mineral-wool insulation, I incorporated ultra-lightweight foamed-glass aggregate (UL-FGA) and ideas from two rare but code-based systems. Permanent wood foundation systems gave me the idea of using pressure-treated wood as the structural element, and frost-protected shallow foundation design principles enabled that structural element to be shorter than normal. The result was a short (less than 2 feet tall) wood-

The initial excavation (1) left the center area below the slab portion of the foundation elevated. Once the plumbing was roughed in (2), a fine geotextile was laid down, and the perimeter drains and a passive radon system were installed (3). Before placing the foamed-glass aggregate (4), the crew used plywood and stakes to define the outside edge of the geotextile and foamed-glass aggregate.

footing-and-stem-wall system sitting on compacted foamed-glass aggregate that extends 2 feet around the foundation perimeter and prevents the soil below the wood footing from freezing. The side of the footing is insulated with exterior mineral fiber board. The insulation exposed above grade is finished with cement board and capped with a metal flashing.

Site Prep

The excavation was shallow by Michigan standards. The excavator scraped off the topsoil and dug the perimeter about 2 ½ feet down for the frost protected shallow foundation. The soils on the site were sandy. I bored down about 7 feet with a hand corer and found clean, sugar sand all the way. It was beautiful material, but it didn't have great bearing capacity. Fill sand, which is coarser and more angular, would have been better. Still, I calculated the weight on the footing along the long bearing walls at 1,082 pounds per square foot (psf), which was reduced to 624 psf when distributed through the UL-FGA on the geotextile. Per Terzaghi's equation, the soil at excavation depth could handle 1,617 psf, so I had a workable safety margin, though I would have liked a bigger one.

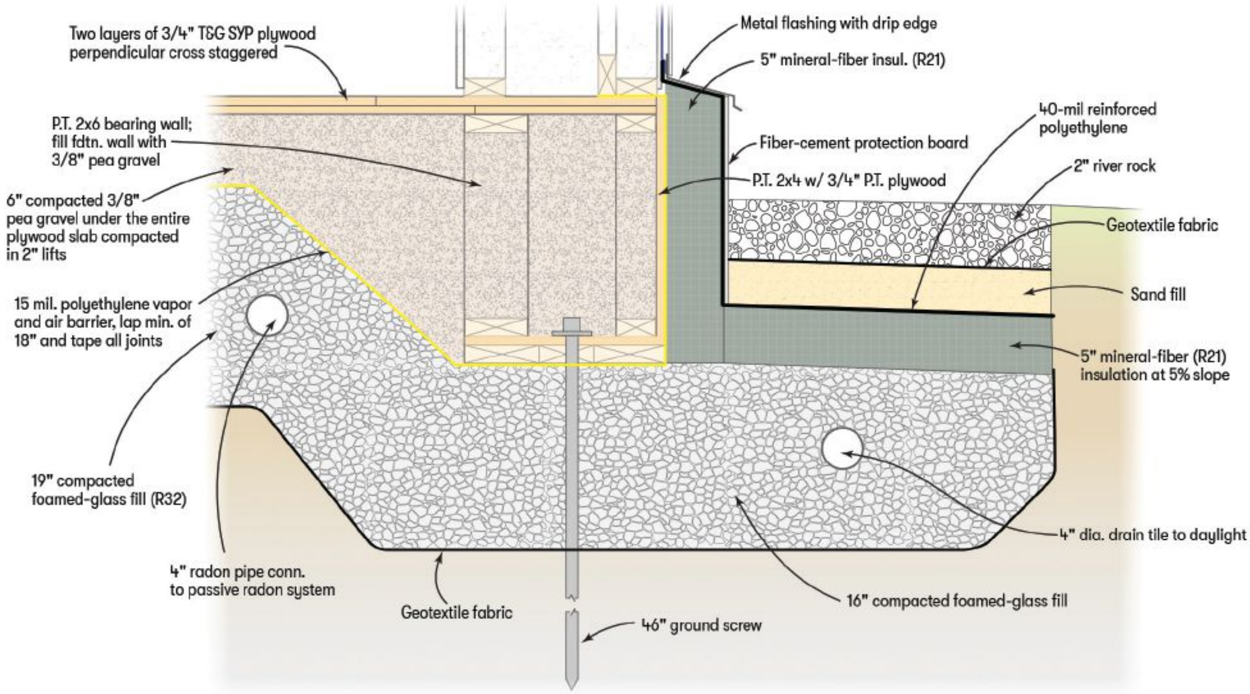
With the excavation roughed out, the plumbers roughed in the city drain and supply lines. Then, we covered the excavation with geotextile to stabilize the sandy soils and prevent the sand from working its way into the foamed-glass aggregate above it. Based on sieve analysis of the sand, I chose a heavy-duty (10 ounces/square foot), commercial-grade geotextile with a 100 U.S. sieve size. It was difficult to cut with a utility knife, so we bought heavy-duty scissors to cut it efficiently.

Final steps before placing the aggregate included placing 4-inch perforated drainpipe running to daylight to manage any groundwater and run-off that might seep under the house, placing 4-inch perforated pipe for passive radon venting, and setting temporary plywood edges in place to define the outside edge of the geotextile and foamed-glass aggregate.

Foamed-Glass Aggregate

For the deep bed of foamed-glass aggregate (UL-FGA), we opted for AeroAggregates, largely because the company has a division closer to Michigan, so shipping (which has

Low-Carbon Foundation Design (Section View)



its own carbon impact) was half the price. AeroAggregates' UL-FGA is a lightweight, closed-cell foamed-glass fill made from 100% recycled-glass containers. It has a high-friction surface, which helps the angular particles interlock when compacted, providing stability and a high compressive strength (approximately 2,500 psf for this material).

We placed about 16 inches of the fill in the footing area and 19 inches in the middle area under the slabless slab. Altogether, I ordered 105 yards of aggregate, delivered on a flatbed semi-truck in 3-yard super sacks. Unloading them was a lot of work. I climbed on the sacks, hooked a chain, and slung it over the bucket of the front-end loader, and we lifted each one.

To spread the fill, we got a little smarter and purchased a four-point sack lifter and brought in a small crane. We picked up each sack, swung it out over the area to be filled, cut the bottom open, and moved the opened sack around, working with shovels and spreaders to distribute the aggregate evenly, compacting as we went with a cordless Milwaukee MX Fuel plate compactor. Looking back, I should have had it delivered on a live-bottom truck and used a stone slinger to spread it. That would have saved a lot of work.

The coarse aggregate made it hard to achieve a smooth surface. I had ordered a finer grade but received only ½ yard, which was far too little. Next time, I'll order several yards of the finer material to create a flat, even layer. That should make it easier to set the footings and achieve a level surface.

On top of the UL-FGA, we installed Stego's 15-mil polyolefin vapor retarder. We taped the seams carefully, using a compatible tape (Compego), and repaired spots where tamping had torn holes. To protect the system from moisture, I bought a large, heavy-duty, scrim plastic sheet. We spent a lot of time covering and uncovering the foundation, then the framing as we went up, then the whole house before predicted storms. It kept things dry, but it was exhausting. Next time, we need to find a better strategy.

Wood Footings

Instead of pouring concrete footings, we built a footing system from kiln-dried after treatment (KDAT) lumber and plywood. I liked the kiln-dried material much better than typical PT lumber; it was lighter, truer, and less likely to warp. It also contained less moisture, which was important since I wanted minimal moisture in the system from the start.

For a footing base, we formed a sled using treated 2x8s capped with treated plywood and anchored it to the earth with 46-inch aluminum ground screws. We framed the double stem walls from treated 2x4s and 2x6s sheathed with treated plywood. We glued all the framing together with Climate Non-Slump (NS) Adhesive, a moisture-curing polyether structural adhesive. This adhesive was designed primarily for bonding framing to sheathing to increase the resilience of wood-framed structures against extreme winds and seismic events. While this type of resilience was not strictly needed at the foundation level, the adhesive is a nontoxic,

The double stem wall was built on a sled of treated 2x8s and treated plywood secured with ground screws **(5, 6)**. The author placed sensors to monitor temperature and humidity in the foundation **(7)**. Climate Adhesive was used to secure the treated plywood sheathing to the stem walls **(8, 9)**. A worker runs the remote-controlled rock slinger to fill the foundation with pea gravel **(10)**. Once filled, the foundation was covered with poly to keep it dry until the building could be weathered in **(11)**.

100% solids formulation, and we used it extensively wherever construction adhesive would normally be applied. We even used it around the heads of the earth anchors to air seal the Stego penetrations. (We also used Climate Adhesive NS as it was intended, to secure the rest of the framing to help the structure withstand the extreme forces of straight-line winds, which have become increasingly common in our region.)

To monitor the system's performance, I installed temperature and humidity sensors in the footing, walls, and roof. I can monitor these on my phone, and, so far, I haven't seen relative humidity rise above 80% anywhere in the envelope system. Some areas are surprisingly dry, almost like desert microclimates. That reassures me that the system is working as intended.

Pea Gravel and Plywood

Once the footing was in place, we filled the volume between the double stem walls with pea gravel and spread it to a minimum depth of 6 inches over the central slabless slab area, screeding it flat with a 2x4 aluminum tube across the top of the stem walls. This gravel would be covered with a double layer of ¾-inch T&G plywood. To prevent gravel from interfering with the tongue-and-groove, we laid fiberglass screen over it. That made laying the first layer of plywood easier and perhaps provided a little extra protection against insects. We glued the two layers of plywood together with Climate Adhesive.

We let some of the Stego vapor barrier stick out past the footing walls, thinking it might allow water to drain if it ever got in. In practice, it just got beat up and muddy. Next time, I would tape it up onto the footing walls and protect it from the start.

Frost and Moisture Protection

For our frost-protected design, we installed 5 inches of R21 mineral wool insulation (Powerwool 80, due to availability) on the vertical face of the foundation walls and extending 24 inches horizontally. Over this, we added a 40-mil reinforced polyethylene pond






The crew sheathed over the foundation with two layers of ¾-inch plywood (12), placing screen under the plywood to keep gravel out of the tongue-and-groove edges (13). The first-floor walls are framed and ready to stand (14). Above grade, the mineral-wool insulation on the stem wall was protected with 40-mil poly and cement board (15). The poly extends under a band of river rock (16). The garage foundation (17) was built with concrete; it served as a good test case for comparing the new foundation with conventional construction.

liner to keep bulk water out of the insulation, and we protected this membrane with cement board secured to the sheathing with long stainless-steel screws. Finding ground-contact-rated cement board proved difficult. The only source I found, Finex, shipped from California, and shipping was expensive, not to mention the carbon intensity this added. Despite these setbacks, it seemed to be the best material for this application, and I felt the ground-contact-rating was critical.

On top of the pond liner, we placed a layer of fill sand and some geotex and then finished to grade with an 8-inch-thick-by-24-inch-wide layer of river rock to keep vegetation away from the house and to help manage water. On the south side, I directed the downspouts off the large roof plane (with a 12.5-kWp PV array) into a rain garden planted with native species, combining water management with ecological landscaping.

Reflections and Lessons Learned

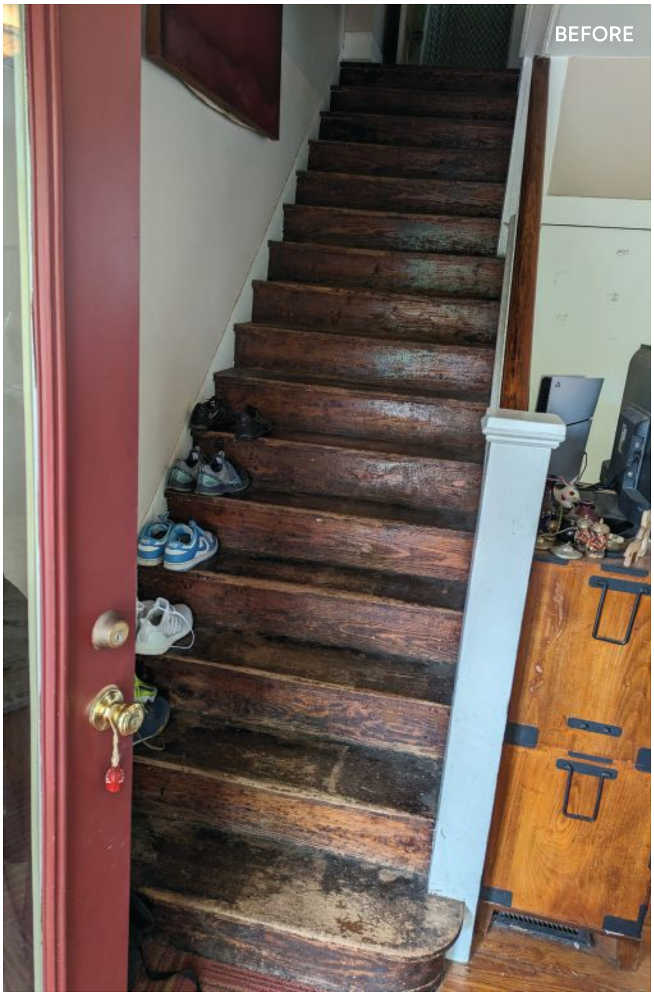
Looking back, I would do many things differently next time. Most importantly, I would excavate the foundation area flat rather than leaving the elevated area beneath the slabless slab. This would require more pea stone (or perhaps a crushed stone next time), but the labor savings from not fighting the slope would make up for it. In addition, I would order more of the fine-grade UL-FGA to make it easier to screed and smooth the surface of the aggregate. I would button up the vapor barrier earlier, as mentioned, and I would build the wood footing walls more like space frame trusses, so they could more easily be set level, regardless of the site surface.

Nevertheless, I'm proud of what we accomplished. Building a foundation without concrete and foam insulation is an important advancement in sustainable residential design.

It's also worth noting that the garage behind the house is on a steeper slope with a change in elevation of about 5 feet from the garage opening to the back nearest the house. This required pouring a 9-foot foundation wall to get below frost depth and support the backfill. I wasn't comfortable going without concrete for this structure, so we built the garage foundation conventionally.

The comparison with the house foundation proved to be a nice proof of concept. The concrete work for the garage cost about $40,000, and we often had to wait for the concrete contractor. There were scheduling conflicts and time spent waiting for the formwork and footing pour, then the wall formwork and pour, then curing time before backfill and flatwork, and then more curing time before we could start framing. Being able to self-perform the foundation work for the house kept us moving without delays and proved to be an efficient way to build. This gives me confidence that, with the changes mentioned above, this is a viable, cost-effective method for future projects in addition to the significant (~60%) embodied carbon reductions we achieved in the house.

Dale Hulst, a former engineering and operations manager in commercial HVAC, owns Michigan Net Zero Homes LLC, a design-build firm based in Grand Rapids, Mich.



Retreading Stairs

Brand-new treads and risers rejuvenate an old and tired staircase

by **NATHAN CLARK**

Retreading stairs is a great example of how carpenters often need to seamlessly blend the old with the new.

The old stairs I write about here were structurally sound but cosmetically worn and very squeaky. I shored them up and installed new stair components on top of the existing steps. Retreading the staircase with new red-oak tread and riser caps allowed me to leave the existing lead-painted woodwork and plaster undisturbed as well as reuse the original balustrade and newel post. I stained the new wood with General Finishes RTM color #76.

Curved Riser and Tread

A new curved riser consists of three rift and quarter-sawn ⅛-inch-thick solid wood laminations that I milled with a table saw and thickness planer. I built a bending form based on a tracing I took of the existing curved riser **(1, 3)**. To make bending the laminations

PHOTOS BY NATHAN CLARK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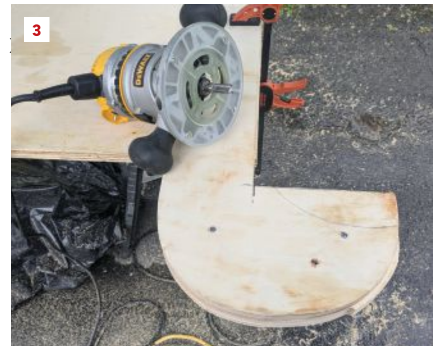
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easier, I soaked them in hot water for a few minutes **(2)**. Then, to preshape the parts before glue-up, I clamped the wet laminations around the form until they dried **(4)**. At that point, I glued the laminations together with Titebond and reclamped them to the form, leaving them for a few days while I focused on other projects **(5)**.

The curved tread is made from a wide, flat-sawn, red-oak board sourced from a local hardwood dealer. I made a template and used it to lay out the curve on the tread, then shaped the curve with a jigsaw. A disc sander worked well to square the edge and remove the saw marks. I made the final length and width cuts later, on site.

On a retreading job, the treads are typically thinner than usual and have a rabbeted nosing. I established the curved edge of the rabbet with a router and edge guide **(6)**. Several passes with a router thinned out all but the nosing of the tread. The router also rounded over the nosing.

Preparing the RetroTreads

I used RetroTreads for the straight treads on the rest of the stair. As with the milled-down curved tread above, the RetroTreads, at 5/8 inch thick, are thinner than a typical 1-inch-thick stair tread and so will have less impact on the unit rise of the first step to the floor. These RetroTreads had a built-in Scotia/cove molding, which I removed with a table saw and thickness planer **(7, 8)**.


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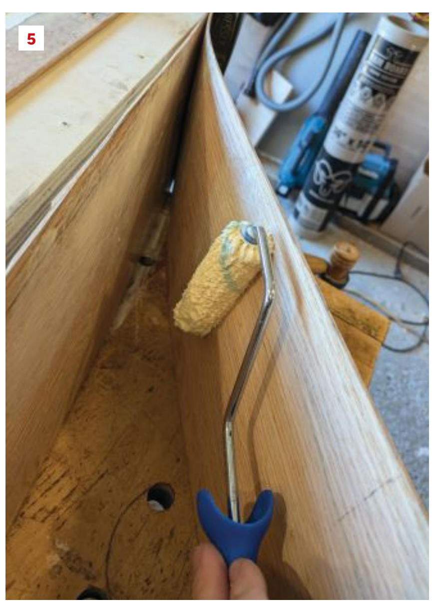
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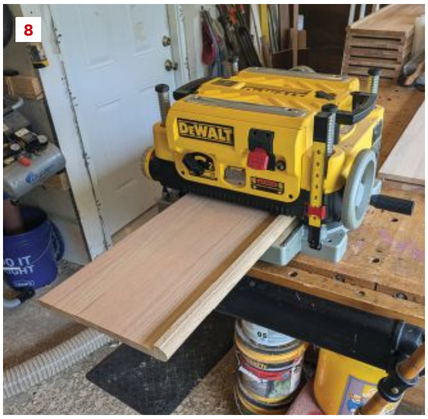

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I machine-sanded the treads and curved riser up to 150 grit with a large random orbital sander, then raised the grain with water followed by hand-sanding with 220 grit. I applied a water-based General Finishes RTM stain and brushed on three coats of polywhey floor polyurethane in satin.

Shoring Up the Existing Stairs

On site, I fastened through the backs of the existing risers into the treads with framing screws to tighten up the old stairs **(9)**, helping to reduce the squeaks.

I cut most of the nosing free from the original treads using a circular saw. A plywood spacer ensured that I consistently cut each nosing a whisker back over the riser below **(10)**. I then used an oscillating saw to flush-cut the nosing to the stringer on the balustrade side of the stairs. I pulled the nosing all the way out of the stringer; a new skirtboard will hide any gaps.

Working with a jigsaw and router, I also removed the existing curved tread's nosing. I predrilled and countersunk pilot holes in the treads and secured the treads to the risers below with some framing screws **(11, 12)**.

The balustrade-side stringer would remain visible at the end of the project, so I brad-nailed the remaining nub of nosing in place on that side. I followed up by filling the shallow voids with Zinsser MH Ready Patch and sanded the patches flush with the surrounding stringer surface **(13)**. I then primed and painted the balustrade-side stringer.

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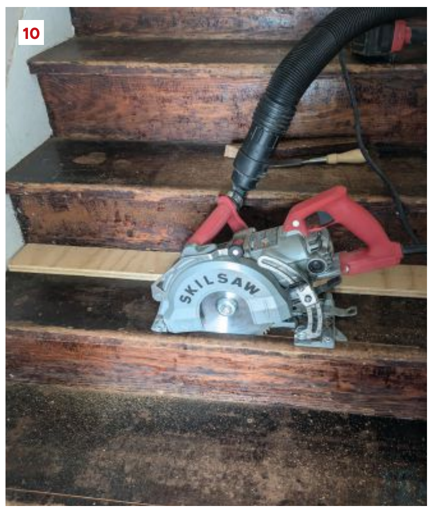

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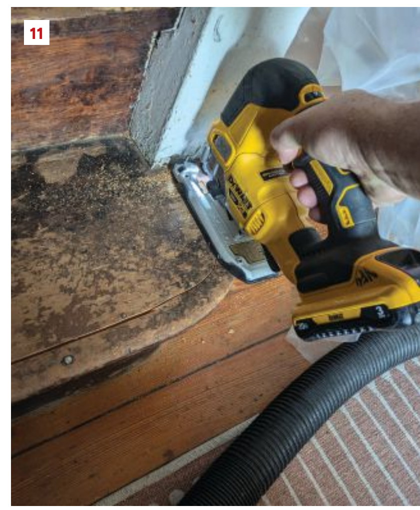

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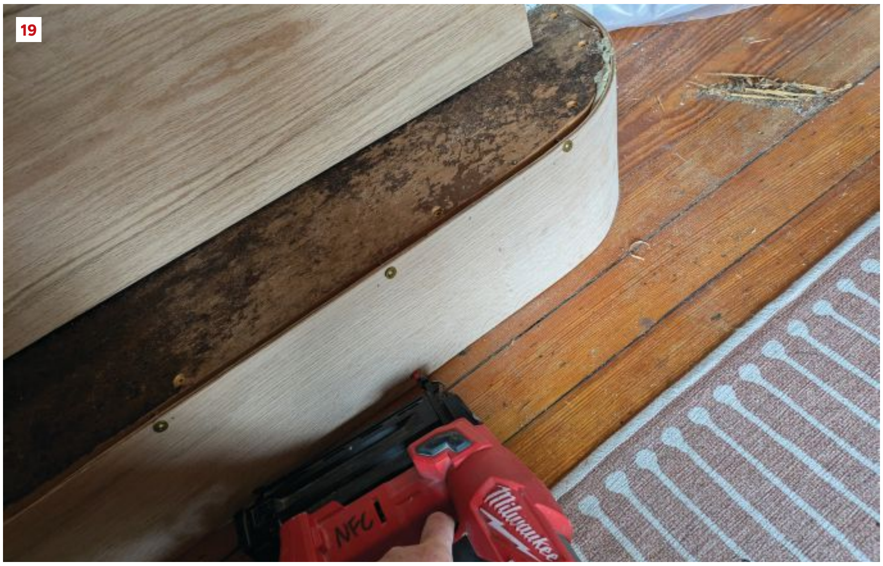

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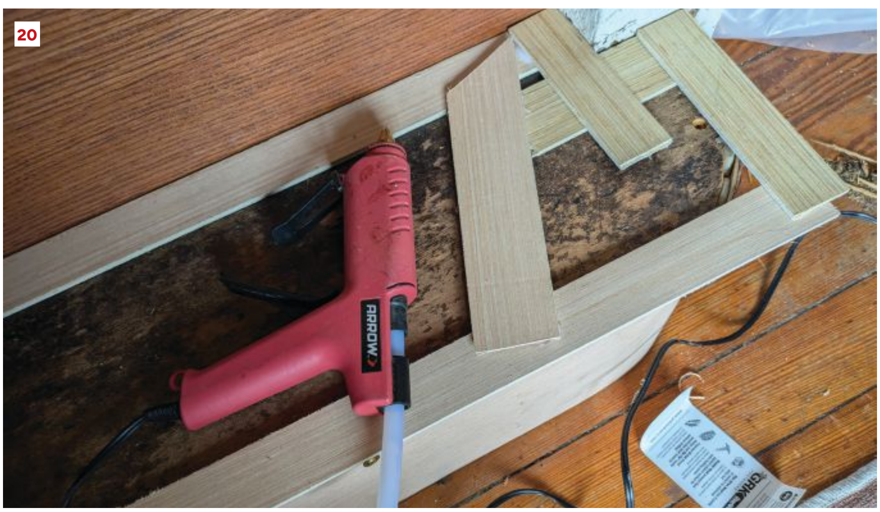

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Installing the Curved Riser and Curved Tread

I started installing the new treads and risers from the bottom of the staircase and worked my way up. So, first I installed the curved riser, then I fit the curved tread and preassembled it to the riser above. By preassembling the risers and treads in pairs like this, I can ensure that there are no gaps between the back of the treads and the riser above **(14, 15)**.

Before I installed the curved riser, I scribed it to the floor. Putting blue painter's tape along the bottom of the riser made it easier to see the scribed line as I rip cut the riser with a circular saw. I dialed in the final fit with a block plane **(16, 17)**.

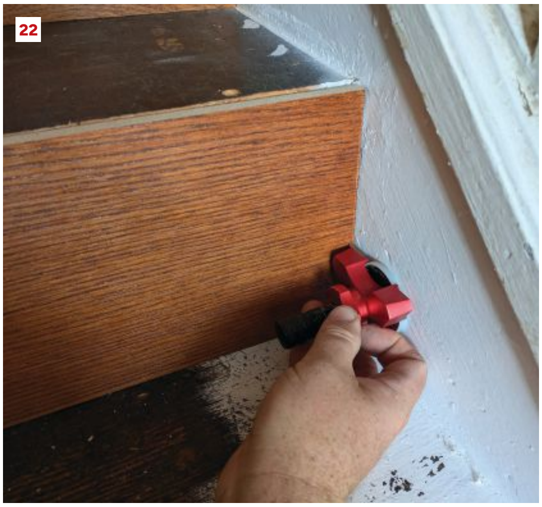
PL Premium construction adhesive has some elasticity once it cures, making it an excellent choice for stair parts **(18)**. I liberally applied the adhesive to the underside of the curved riser and tacked the riser in place with washer-head screws and brad nails **(19)**. The tread nosing would eventually hide the fastener holes along the top edge of the riser.

I assembled a template for each tread using strips of lauan and a hot glue gun **(20)**, then traced the rip cut line and the newel post cutout onto the bottom of the tread. I scribed the first straight riser to the right-side stringer and glued (using PL construction adhesive again) and screwed the riser to the back edge of the tread to create a "subassembly."

Four screws through the tread held the riser in place while the glue cured **(21)**. I also brad-nailed the top of the new riser to the old staircase; the next tread nosing would hide the nail holes.

Preassembling and Installing the Treads and Risers

After installing the curved step, I scribed each of the following risers and treads, bottom to top, to the balustrade-side stringer **(22)**. Crosscutting the treads and risers with a miter saw can chip the wood, so, instead, I deepened the scribe mark with a sharp utility blade to prevent chipping. A miter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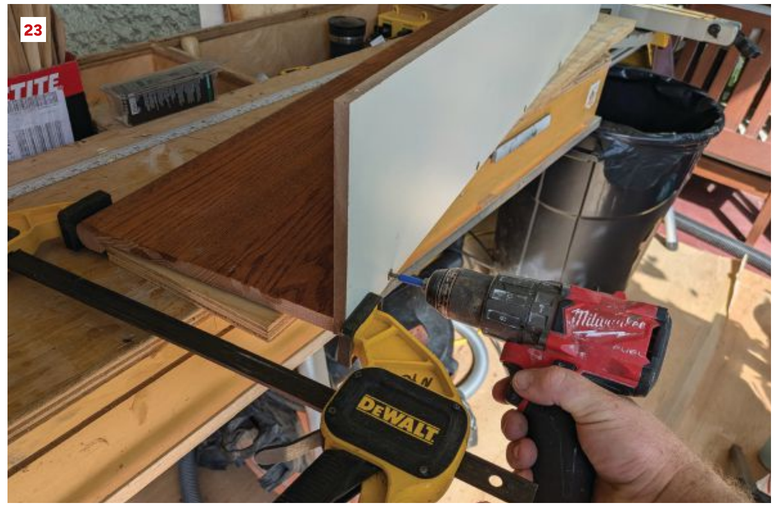

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plane cleaned up the saw marks and helped me dial in the fit.

I preassembled each tread to its riser above with PL Premium and some cabinet screws **(23, 24)**. I let any PL squeeze-out start to set up before I scraped it away with a sharp putty knife. Doing this results in fewer smears of the adhesive on the material.

I applied construction adhesive on the old treads and risers to make for a stiffer (and hopefully) squeak-free set of new stairs. I gave the new parts a few taps with a rubber mallet to fully seat them in the bed of adhesive. Then, I used a pry bar to hold the assembly tight to the stringer on the balustrade side as I set a couple of trim screws through the tread on the stringer side **(25)**. Three more trim screws across the front of the treads held them down **(26)**. I shot 15-gauge nails into the risers to hold them in place. Washer-head coarse-thread screws installed into the retro treads from below secured the old treads to the new ones **(27)**, resulting in minimal fasteners visible from above.

Landing Tread

Using a track saw followed by an oscillating saw, I cut the flooring back in preparation for a new landing tread. Slightly easing the leading edge of the existing flooring allowed for a smooth transition to the new tread.


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I cut a groove into the back of the landing tread as well as the existing flooring with a router bit **(28)**. This groove allowed me to attach the landing tread to the flooring with a spline, some PL construction adhesive, and a few screws **(29)**.

With all the parts installed, touched up, and cleaned, I stained everything followed by three coats of polyurethane. A light sanding was done between each coat.

Scribing a Skirtboard

A new skirtboard scribed to the treads would look better than the original stringer and result in fewer gaps over the years. The components of the staircase will expand and contract over time and this new skirtboard will allow that to happen while hiding any gaps. This method is also easier than scribing each tread and riser to the existing skirtboard **(30)**.

First, I scribed the tread lines of each step with a sharpened nail set into a piece of scrap wood at the height of the step rise **(31)**. Then I level-cut the bottom of the skirtboard to the floor and scribed each of the risers.

A scrap offcut of tread nosing is useful for tracing the nosing profile onto the skirtboard **(32)**. I used a circular saw, jigsaw, and block plane to cut to the scribed lines **(33)**. The scribed skirtboard usually needs to be dry-fit


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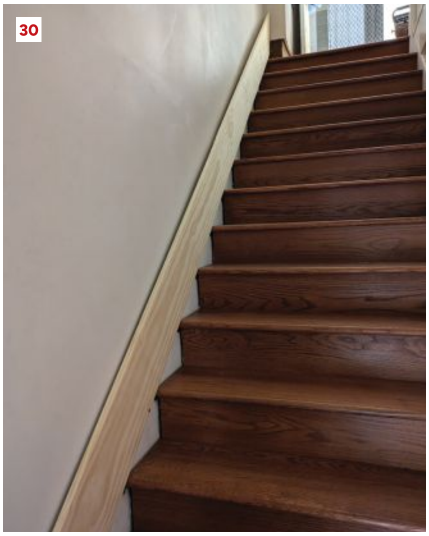
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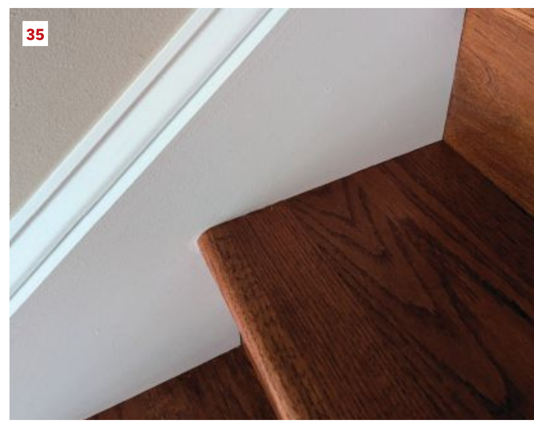
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first and potentially whittled a bit to achieve a tight fit.

I fastened the new skirtboard to the old stringer with two screws at each tread, then tied the baseboard into the skirtboard and added base cap molding run along the top **(34, 35)**.

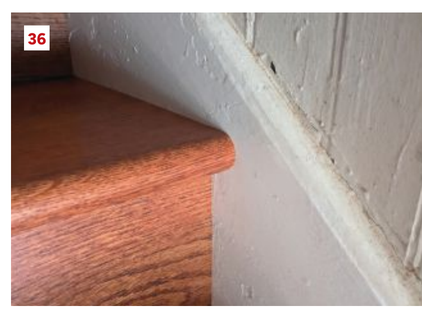
I filled the remaining exposed fastener holes in the treads with wood filler and stained them with the same stain I used on the raw oak. Then I lightly sanded all the stained stair components followed by a fourth and final coat of polyurethane. This will protect these stairs for years to come.

The Completed Stair

These new stairs look good and are nice and stiff (and quiet) to walk on compared with the original. The new treads and risers also fit tightly against the original stringer on the balustrade side. These joints may gap over time as the components expand and contract and the house continues to settle, but the careful use of glue and fasteners should minimize this effect.

As I had hoped, by repairing the original stairs and using them as subtreads and subrisers for new oak treads and risers, I was able to leave the old paint undisturbed and limit the scope of the project by keeping the balustrade intact. I also didn't have to damage and repair the plaster walls **(36, 37)**. The client was happy, mess was limited, and it was a fun and satisfying project.

Nathan Clark is a carpenter in Ithaca, N.Y. See his work at nateclarkbuilder.com.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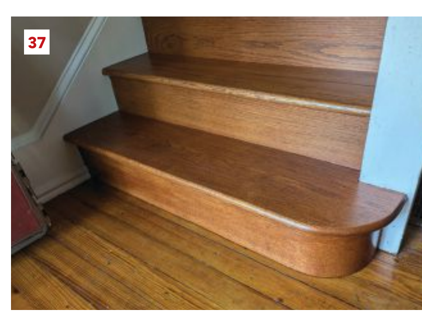
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Products

by **VINCENT SALANDRO**

1. Versatile Porcelain Tile Surfaces
Caesarstone has added eight new designs in a 12mm thickness to its Porcelain Collection and has also added a new 20mm-thickness option to seven existing designs. The slabs are recommended for applications including kitchen countertops and backsplashes, bathroom and shower walls, outdoor living areas, flooring, and fireplace surrounds. The company says the material is resistant to scratches, stains, and UV exposure and is nonporous, easy to clean, and easy to maintain. *caesarstoneus.com*

2. Seamless Insulation
The X-Bracket from InSoFast attaches to a wall or roof to fur it out for the installation of closed-cell spray foam or blown-in insulation without creating a thermal bridge between the wall or roof sheathing and the exterior cladding. Brackets are available in 2 ½-, 3 ¾-, 5 ½-, 7 ½-, and 9 ½-inch heights. The manufacturer claims the brackets provide cross-ventilated moisture control and can withstand extreme wind loads. *insofast.com*

3. Water-Based Vapor Barrier and Primer
Vapor Ban Primer W from Laticrete is a water-based, all-in-one vapor barrier and primer. According to Laticrete, the product offers a safer, faster, and more sustainable option without the required mixing of a two-part epoxy. The primer is moisture rated for 100% RH and an MVER up to 25 pounds per 1,000 square feet in 24 hours. The maker says the primer is hypoallergenic, low-odor, and low-VOC, making it ideal for installers sensitive to resin. The product's water-based formula avoids environmental concerns with traditional epoxies. *laticrete.com*

4. Aesthetic Pass-Through Window
The pass-through awning window from Windoor connects indoor and outdoor spaces with clean sight lines and simple operation. The window has a continuous top hinge and stainless steel concealed gas springs with an anti-drift feature that remains hidden when closed. Other features are a single-point locking mechanism, in-line ladder pull handles, and optional bottom sills. Window frames are available with impact- and non-impact-glass options and support sizes up to 32 square feet. *windoorinc.com*

5. Membrane for High-Performance Roofs

VaporDry SA from Benjamin Obdyke is a self-adhered, vapor-permeable roofing membrane. According to the manufacturer, a combination of a permeable trilaminate underlayment and acrylic adhesive helps maximize a roof's drying potential. The membrane is approved for use with all roofing types with a pitch 3:12 or greater, and the slip-resistant surface meets ASTM D1970 testing. The continuous acrylic adhesive reportedly self-seals around roofing fasteners, allowing the membrane to also serve as an air-control layer. *benjaminobdyke.com*

6. Water Source Geothermal Heat Pump

The Bosch RP Split is an Energy Star–certified water-to-air geothermal heat pump available in 2- to 5-ton capacities. The unit's two-stage scroll compressor adjusts output to demand for optimal efficiency while ½-inch closed-cell foam insulation combined with a floating compressor base allows for quieter operation. A low-profile, compact footprint fits in tight retrofit spaces. The model using R-454B refrigerant complies with criteria for lower global warming potential. The heat pump can be paired with the Bosch BV20 variable-speed air handler. *bosch-homecomfort.com*

7. Lightweight Insulated Concrete Panel System

HercuWall is an insulated concrete panel system that integrates structure, insulation, and a weather-resistant barrier in a single product. The R31 insulated panels are fabricated off site and delivered numbered and ready to install. According to the manufacturer, the lightweight design and numbered panels reduce labor requirements and improve installation efficiency. Rated for wind speeds up to 235 mph, the panels are suitable for high-velocity hurricane zones and are Miami-Dade code compliant. *nudura.com*

8. Treated Deck Framing Solution

ProWood treats TrueFrame Joist with MCA and a proprietary additive, promising less checking, greater stability, and straighter boards. According to the manufacturer, each joist is factory-planed to within 1⁄16 inch for flat edges and uniform sizing. Color infusion improves their appearance for projects with visible framing. Treated to UC4A Ground Contact, the joists are available as 2x8s, 2x10s, and 2x12s in 12-, 14-, 16-, and 20-foot lengths. *prowood.com*

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Tools of the Trade

Weigh In! Want to test a new tool or share a tool-related testimonial, gripe, or technique? Contact us at jlctools@zondahome.com.

Festool ETSC 2 150 Cordless Sander

by **TOM O'BRIEN**

I was helping a young tradesman load in his power tools recently when I noticed that not even one was of the plug-in variety. I bought my first cordless drill (Skil 9.6V) in 1985, and I've steadily built up a significant arsenal of battery-powered devices. But I never considered cutting the cord for operations that demand long runtime or generate significant amounts of dust, especially power sanding.

The ETSC 2 150 cordless sander kit comes in Festool's Systainer SYS3 M box.

When Festool announced the release of the first cordless model in its highly regarded line of random orbit (RO) sanders, I was eager to find out if it could change my mind.

Options

The ETSC 2 features a brushless motor with a 3.5mm orbit. It's available as model ETSC 2 125, which comes outfitted with a 125mm (5-inch) sanding pad, or as ETSC 2 150, which features a 150mm (6-inch) pad. Each can be purchased in kit form or as a bare tool without batteries or charger. As I'm not invested in Festool's cordless platform, I requested a full kit, with the 150mm pad since my corded RO sanders are that size.

In addition to the sander, the kit included a TCL 6 charger, two 18-volt, 4.0-amp/hr, Bluetooth-enabled batteries, dust bag, plastic pad protector, 5mm Allen wrench, and a bit of sandpaper (see photo, left). For testing purposes, Festool sent along its Granat D150 starter set of six 10-packs of grit sizes ranging from P60 to P320.

Positive Vibes

As I was unpacking the kit, several impressive features leaped out at me. What struck me first was how light and well-balanced the machine felt in my hand. The 4-Ah battery provided a perfect counterweight to the business end of the tool. And when I turned it on, I was surprised by the lack of vibration.

If one feature stood out—truly deserving the cliched title "Game-Changer"—it would be the LED ring light (see photo, opposite page). Unlike the tiny spots that most cordless tools feature nowadays, this one is a flood. I fell in love with it while I was scrambling to finish an exterior paint prep job before nightfall, only to discover with the push of a button that nothing could stop me now. That wasn't even the best part; when I turned the sander loose on shop work, the shallow angle of light served to highlight the slightest swirl mark or imperfection. No longer would I have to reach for a flashlight to make sure I didn't miss anything.

At full power, this light was blindingly bright. By pushing the on/off switch twice, I was able to cut the intensity in half. Once I became familiar with Festool's smartphone

PHOTOS BY TOM O'BRIEN

The author found the built-in light a stand-out feature. Note the removable edge guard.

app, I discovered that I could control a large number of options—including the length of time the light remains on after the tool shuts off—using the touchscreen.

As someone who has frequently complained (in print) about Festool's skimpy paper operating instructions, I was delighted to find a wealth of information on how to operate and maintain this tool readily available on the app and in an easy-to-follow visual format. The video tutorial on how to pair the batteries with a dust extractor via Bluetooth was especially helpful (users who exclusively work outdoors or on new construction might never have to worry about being tethered to an extractor).

Little or No Dust

In terms of dust collection, the sander impressed me with two significant innovations. Most obvious was the dust bag, which proved surprisingly effective at preventing most debris from becoming airborne. Thanks to its quick-release connector, it never popped off during operation (unlike every other bag I've ever used). If not for the ring light's ability to highlight the thin but consistent plume wafting out around the edges of the spinning pad, I might have been tempted to forgo the dust extractor altogether.

When I needed to work completely dust-free, it was easy to connect a suction hose to the sander. That was thanks to the newly designed sculpted metal dust port that accepts a D27 hose like a plug in a socket and holds onto it just as securely. Even when tethered to a dust extractor, the tool was significantly easier to operate without the added weight and hassle of an electric cord.

Battery

With the battery, the ETSC 2 150 weighed 4 pounds 8 ounces, about ½ pound heavier than the corded Festool 150/3 EQ that's been my go-to finisher for almost 20 years. After just a few side-by-side comparison tests on rough hardwoods and softwoods, it was apparent that this cordless sander could hold its own and was ready for full-time professional use. The most noticeable difference was how much less vibration the cordless sander produced. Due to its low center of gravity, perfect balance, and the fact that it didn't make my hands buzz, the ETSC 2 150 proved less tiresome to use for extended periods (despite the weight penalty).

I often had to swap batteries during big finishing jobs but never ran out of power. I was able to get at least 30 minutes of continuous runtime on a full charge and recharge a dead battery to 90% in roughly the same amount of time. So, two batteries ought to be enough for most applications.

I found the Festool ETSC 2 150 4,0 I-Plus 6-Inch 18V Cordless Orbital Sander Kit online for $705. The bare tool costs about $530. festoolusa.com

Tom O'Brien is a carpenter and freelance writer in New Milford, Conn.

1620 Workwear Durastretch Cargo Pants

by **ARON JONES**

Durastretch Cargo Pants have front and back zippered pockets, cellphone storage, a reinforced area for a knife clip, and more.

PHOTO BY ARON JONES

1620 Workwear in Massachusetts is one of the hidden gems of the construction industry. While I could begin by talking about how comfortable and durable the company's pants are, I'd like to start with its warranty. The company backs its gear with a lifetime warranty. That tells me the company's not just confident in its craftsmanship—it's committed to standing behind it. This is also the first workwear company that ever repaired a pair of pants for me instead of replacing them, which speaks to sustainability practices.

These pants are entirely manufactured in the U.S.: The fabric is woven in the U.S., and the pants are sewn just outside of Boston. And 1620 is doubling down on its commitment to quality workwear made in the U.S. When many companies were looking abroad for cheaper manufacturing alternatives, 1620 bought a factory in Massachusetts, which I had the opportunity to tour. It enables the company to continue to deliver quality products made in the U.S. by a workforce who are paid a living wage.

As a carpenter, I have put these pants through the wringer over the past year. These pants have seen every phase of construction, from rebar and concrete to flying trusses. They have fought with gusset plates, the occasional nail snag, abrasive sheathing, and more. And after more than a year of service, they do not have a single hole. I have never experienced that type of durability in a pair of pants before.

If you are going to wear a pair of pants eight to 10 hours a day, five to six days a week, they need to be comfortable. 1620 nailed comfort with its Durastretch fabric. The stretch is perfect no matter the task; whether you are hand-bombing lumber or climbing staging, these pants will move with you. They are hands-down the most comfortable work pants I have ever worn.

Admittedly, these cargo pants are an investment at $300, but they've already proven they can handle the job better than most. If you're tired of burning through "work" pants that barely last a season, give the Durastretch Cargo Pants from 1620 a shot. I have tried several articles of clothing from this company and have not been disappointed yet. Check it out at 1620usa.com.

Aron Jones is co-founder and site supervisor of Big Dog Construction on Grand Manan Island, New Brunswick. Follow him on Instagram at @bigdogconstruction.gm.

Shark Nail Puller

by **NATHANIEL CARLSEN**

To keep my toolbelt lightweight, I pare it down to essential tools that are only as large as they need to be for the job. However, sometimes bigger is better. That is the case with the Shark Corp. 14⅛-inch nail puller—a tool that eclipses smaller cat's paws and has earned a permanent place in my demo and framing rig.

Much of the tool's utility comes from its shape. The sharp teeth and flat grind on the inside of the paw dig into wood with ease, and the tapered notch grips a slightly proud nail without needing to be set with a hammer. In addition, the acute angle on the notch lets the tool pull an entire spectrum of fasteners, from 18-gauge finish nails to 4-inch spikes. Finally, the curve along the head of the tool enables a smooth, easy pulling motion. All these details add up to suit the tool for a wide range of situations.

Then, these characteristics are supercharged by the tool's size. At 14⅛ inches, the Shark has all the leverage I need to pull or pry anything that doesn't require a wrecker bar. While this does result in a heavier tool, I have been able to leave my Wonderbar in my toolbox since acquiring the Shark, which frees me up to carry one tool to do what I previously needed several to accomplish. The thick handle is stiff and transmits force well. When in the past, for example, I might have struggled to pull apart a double top plate using smaller or flatter pry bars, I now simply drive the pointy end of the Shark between the plates, using its size and heft to wedge the plates open enough to cut the nails.

The nail puller's size is especially an advantage when I'm pulling a lot of nails. Its length allows me to pull them significantly faster because I don't need to switch to a hammer to deal with the stubborn ones. Rather than using a cat's paw to pull a nail up, then switching to a hammer claw for leverage, I can pull it in one swift sequence with the Shark.

Set, hit, pull, repeat speeds up the task. And the comfort of knowing my fingers are good and clear, far away from where the hammer hits the tool, lets me hit with force. Although, the Shark's shape means the weight of a falling hammer alone is often enough to capture a nail.

With the set, hit, pull rhythm, I can pull nails out of a subfloor with speed and ease. I pulled a few hundred nails the other day, and I could barely count on two hands the number that needed another tap or pull. At around $25, this tool is a must-have. sharkcorp.com

Nathaniel Carlsen is a carpenter with TDS Custom Construction, in Madison, Wis. Follow his projects on Instagram at @nvcarlsen.

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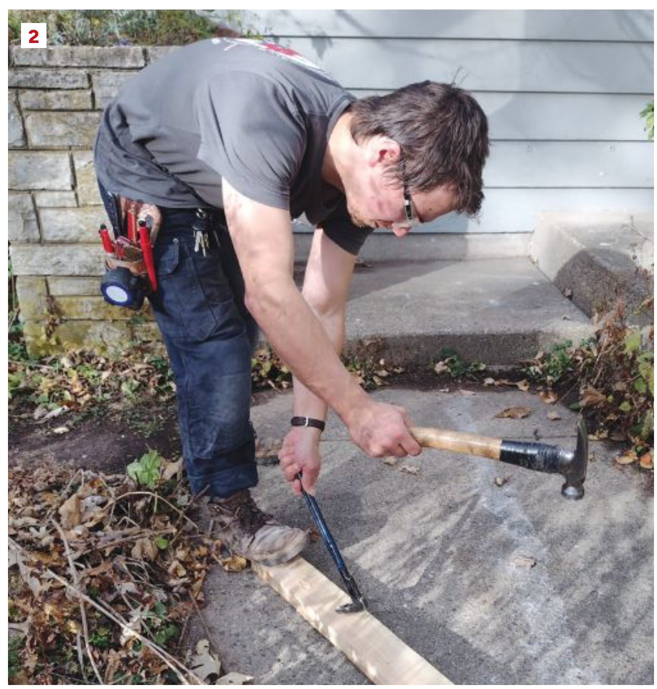

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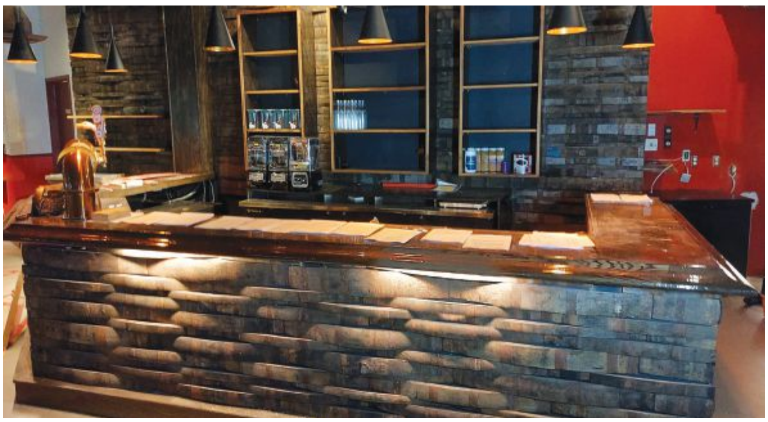
The "V" of the nail puller grabs the nail's shank, not its brittle head **(1, 2)**.

PHOTOS BY NATHANIEL CARLSEN

A Barrel of Fun

by **MARC FORGET**



The lighting highlights the varied texture of the barrel staves (above).

Occasionally, I build something out of the ordinary. A client may hand me a vague idea or rough sketch and ask me to make it work and look good. Or a client might want to repurpose materials into something that they were never intended for. Both applied to a project I did for friends at a restaurant they were opening.

One of the partners had another business selling small oak barrels for aging cocktails and other spirits at home (urbanbarrelcompany.com). Since he planned to sell the barrels at the restaurant, he wanted to incorporate their "spirit" into the space. So, through contacts in the distillery industry, he bought barrel staves from decommissioned whiskey, bourbon, and brandy casks for the cost of freight. He then tasked me with using these staves to cover the bar and some of the walls, leaving the details for how to go about it to me.

Repurposing a material always presents challenges, and using barrel staves as a cladding material is rife with them. Staves are not straight, flat, evenly sized boards. They curve (which can alter the length), taper at each end, and vary in width. In addition, they are made from well-seasoned white oak with a charred surface on one side, a very hard material that is tricky to cut and gifts you with a fine powder of soot each time you handle it.

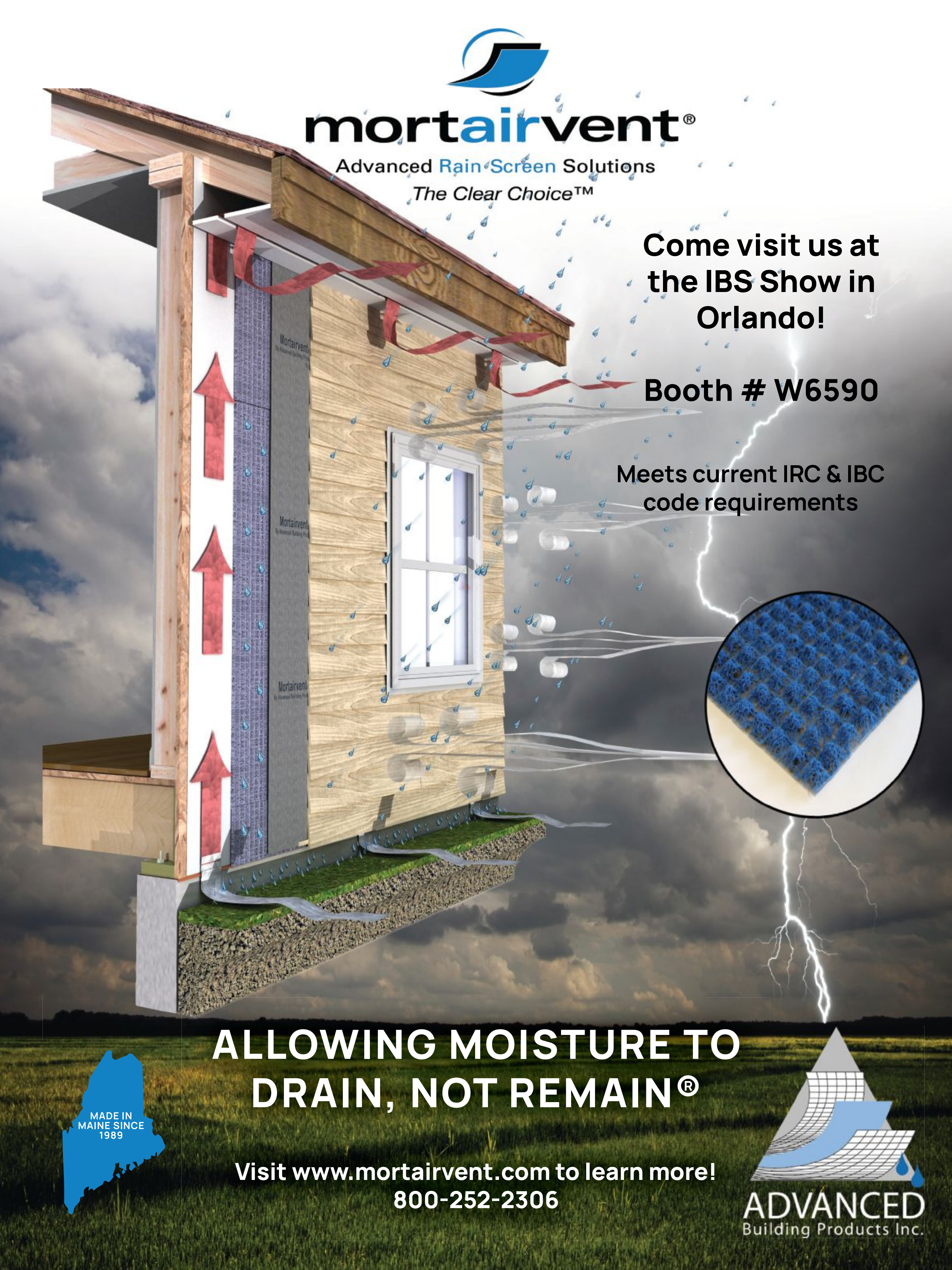
Assembling the staves was like putting together a puzzle of randomly sized pieces without a guide. I chose a horizontal weave pattern in which the end of each stave would land in the middle of the staves above and below. I drew vertical lines at the start and stop points for a guide. Then, I sorted the staves roughly by width into five groups. For each line of the weave, I used staves from only one of these groups, leveling each stave as I installed it. Though these steps took time, they prevented lines from dipping, rising, or ending short. They also helped me minimize the size of the gaps that the curved staves formed. To soften the contrast with the surface visible through the gaps, I painted the background a dark charcoal color. This seems to enhance the 3D character of the staves.

Cutting was, as mentioned, tricky. I had to ease the blade in and use clamps to hold the material to keep the blade from binding or the stave from jumping off the saw, even with a firm grip. For the soot, I ran a vacuum on the saw and an air cleaner in the room, but that dust still spread all over me and the work area. As a plus, an aroma of campfire, aged spirits, and oak filled the room.

The finished look is unique, as well as a one-off (hopefully) for me. The owners got the bold statement they wanted to distinguish their restaurant. The cladding starts conversations, links the different parts of the enterprise, and, with its weathered oak finish, has proved to be durable. As with other difficult flights of fancy I have built, I am both proud of the result and not keen to repeat what was a painstaking process. But you never know ...

Marc Forget is an associate editor at JLC *and licensed carpenter in Ottawa.*

PHOTOS BY MARC FORGET



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