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ON THE COVER: Dwight Hoilman, a plaster trade partner of Jackson Andrews Building+Design of Virginia Beach, Va., screeds the brown coat on a plaster range hood. See the story on page 19. Photo by Rick Mills.

TOP: MARC FORGET; BOTTOM: NATHANIEL CARLSEN

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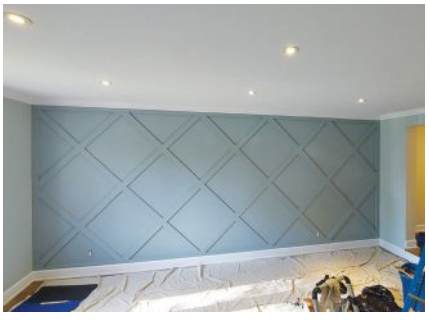
Laying Out a Feature Wall

by **MARC FORGET**

While the speed with which we produce a product determines whether we turn a profit and keep a client happy, it will never make up for poor execution. Most of the jobs you will do will involve careful planning. And for some tasks, planning makes up the bulk of the work. Our attention to careful layout and allowing enough time for it is the focus of this article. A fair portion of the field work I did involved cutting various moldings or bits of wood, then attaching them to walls to create patterns matching inspirational photos or sketches from designers or homeowners. The actual installation was not usually the challenging part. The cuts were often simple miters, and the fastening did not require overly specialized tools or skills. The work was in making the idea fit the space that it was going into.

I made the example shown here using 1x4 flat MDF stock to create a straightforward lattice pattern on a wall that does not have many features (switches, outlets, art, wall sconces, etc.) to work around or emphasize. The design is based on a picture that my boss of 24 years had seen on Pinterest and requested be roughly duplicated in her living room. Since she was unable to find a cheaper contractor than her husband, I got the job.

Finding center. The first step was to create a plumb and parallel frame in which the lattice would sit. I removed the existing crown molding and with the baseboard already removed for floor refinishing, I began the frame. For the ceiling and floor, I ran 1x8s level and parallel to each other to provide backing for the base and crown while allowing enough material to be exposed. Then I scribed a strip of 1x4 and ran it plumb at each end of the wall. Within that box, I found center both vertically and horizontally and drew lines up and across the wall. The pattern would radiate out from these anchor points. They were also my reference for all the steps that follow (see "Measurements," page 10).



Before and after. The majority of time spent on a decorative project like this is in the layout. With intersecting lines, it is easy to lose the pattern if you do not have set points to follow.

Defining pattern size. Next, I needed to determine how big each diamond would be and how the diamonds would merge with each of the four sides. I knew from the inspiration photo that a diamond would be centered on the wall, but not how big it would be. In much the same way as I would lay out panels for wainscoting, I took the total wall length and divided it by the number of boxes I thought might work, subtracting the width of the grid work between each diamond.

My first thought was one diamond in the middle with two on each side for a total of five diamonds. There would then be four spaces (grid material) between the diamonds. Each of those spaces measured 4⅞ inches, which equals the horizontal length of travel of a 1x4 as it passes through the horizontal center line at a 45-degree angle.

Here is the math. The total width of grid material across the wall is:

4⅞ x 4 = 19.5

Subtract that from the wall length:

221.625 - 19.5 = 202.125

Divide that by the five diamonds:

202.125 ÷ 5 = 40.425

Converted to fractions, the interior dimension of each diamond would be about 40 7/16 inches. That may need to be adjusted, but it's a starting point for laying out lines on the wall.

Laying out. Just above the horizontal center line and next to the vertical one, I ran a strip of masking tape on which to draw my first pencil marks. I used tape so I could easily remove the first marks without taking out my center lines. I measured out from the dead center 20 7/32 inches (half of the

PHOTOS AND ILLUSTRATIONS BY MARC FORGET

diamond) vertically and horizontally along my center lines and then placed a scrap piece of 1x4 cut at 45 degrees to make a mark where the next diamond would begin. Having done this in both axes, I could see if I needed to change the diamond size so the partial diamonds at the walls, floor, and ceiling would look balanced.

In a perfect world these partial diamonds would be exactly half, but a perfect world does not exist in carpentry. It was close but not the same measurement at the ceiling as at the walls. Running the layout again, I settled on 40⅜ inches for the inside dimension of each full diamond. Next, I ran the full pattern on the wall to be sure.

So far, I had representations of the lattice just in one strip vertically and horizontally. To be sure that my pattern would not wander, I then drew two more horizontal lines across the wall where the middle points of the diamonds in the next rows would land above and below the center one. Using these three lines, I drew out how my first run of 1x4s would look. Then, I drew in the rest of the lattice pattern on the wall (see illustrations, facing page).

To incorporate this outlet, I added material to fill the space below it.

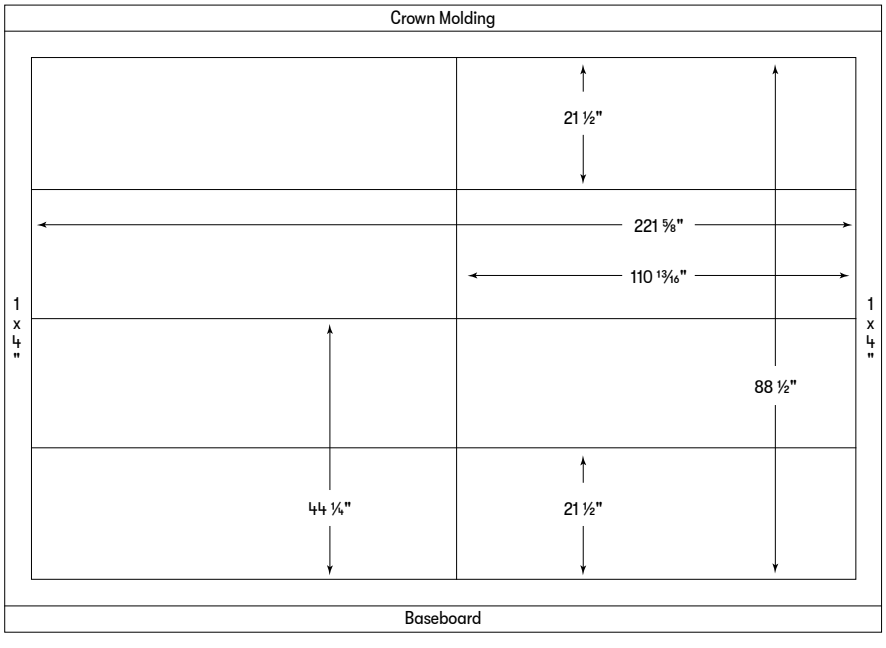
A note on professionalism. Other than installing the border, I had not installed any other material at this point. There are three main reasons for taking this much time to create a layout. First, I want to make sure that the layout will work visually. By drawing it out, I can see if any adjustments are needed. Second, while the math may say it works, I check to see if the layout reflects the intention of the original inspirational sketch or photo. It's easy to start plowing ahead with the first marks and lines and then realize that, in your hyperfocus on the measurements, you missed on the impression you were trying to make.

The third point is getting consent. With the pattern drawn out, the client or designer can see close to what the layout looks like on the wall. I have done layouts in the past and been told that they didn't work and weren't what the clients expected, and to not go ahead. It's better to find that out before you put the material on the walls. To this last point, clients and designers have also made adjustments on site that ended up looking different from what we had started with. Be sure to get signatures every time a change is made to the original plan.

Decorative projects are not the same as framing a wall or laying shingles, where the layout must be technically correct. The priority in projects like a feature wall, wainscoting, and other ornamental details is the visual appearance. Those who are going to live with it (and pay for it) or who have designed it often have their own ideas of what looks good. It's important to compromise and let go of your opinions (unless the client or designer asks for them). If the sketch says the element should be a certain size, and you start cutting and installing right away, you leave yourself in danger of doing the job three times: once how you thought it should be done, a second time tearing it out, and a third when you do it so it fits the space and client's expectations. Take the time a professional should to have a fully worked out plan before you start.

Installing. Once the layout was complete and approved, I cut the parts,

Measurements



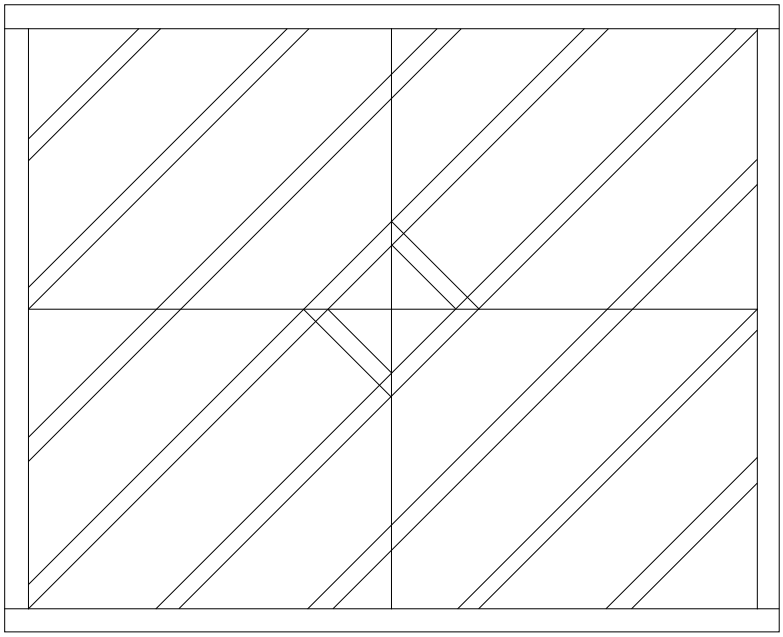
Gather the measurements, double-check those numbers, and then form the plan. Starting with accurate information and a square frame to work in will give the project the best chance of success.

glued them to the wall with adhesive caulking, and fastened them with an 18-gauge nailer, hitting studs where I could. With this being an exterior wall, I was not worried about hitting plumbing but still used 1½-inch nails. For these jobs, the glue is doing the heavy lifting so I prefer to save the steel and not fill my work with holes. (I'll get a better finish later.) Because of how the parts fit together, I did not bother using a biscuit joiner. After three years, no cracks have shown at the joints. I did apply PVA glue where the 1x4 grid work connects and applied Bondo over those joints. I could have used Dyna patch or spackle, but I have found Bondo gives a better paint finish and is less prone to cracking.

All the edges were caulked to the wall, joints sanded, and surfaces primed before I applied two coats of finish paint. For the color, we went two shades darker than the surrounding walls from the same paint color swatch.

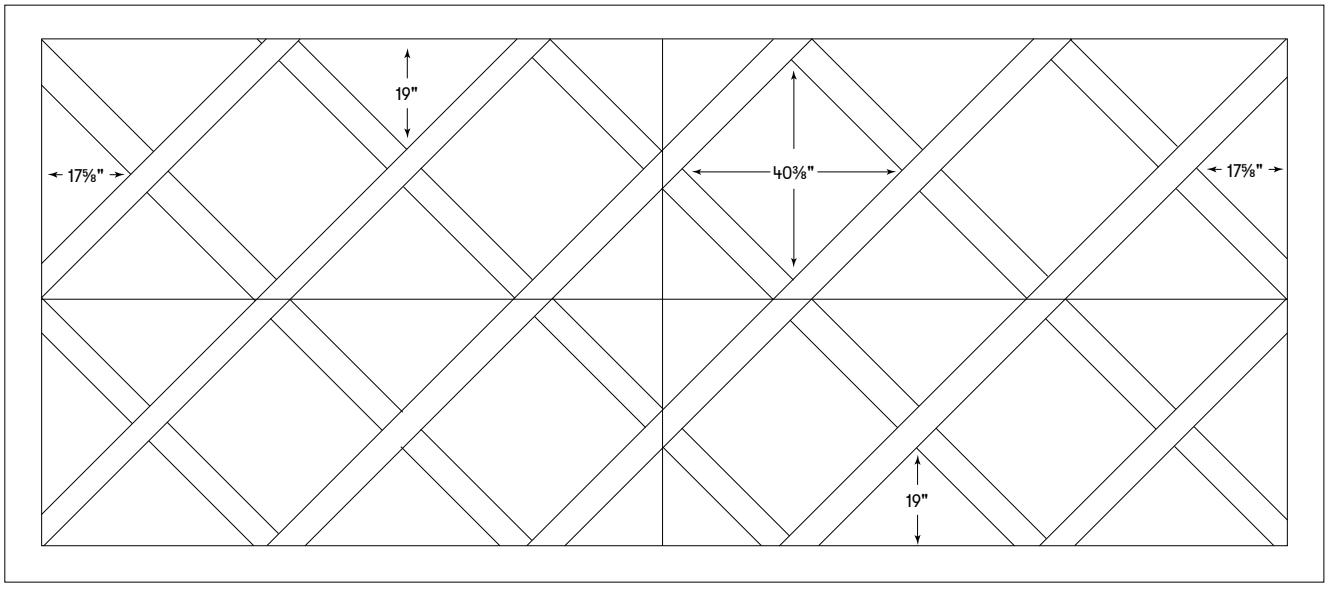
Marc Forget is an associate editor at JLC.

First Lines of the Pattern



Starting from the center lines, mark out the long lines of the grid. Double-check them each time for spacing so they remain parallel to each other (above).

Full Pattern Drawn



After the long lines are drawn, fill in the rest of the grid. A full-scale representation of the design allows for solving problems early and facilitates final approval. With everything laid out this way, the install goes quickly with less waste. Measurements for parts and angles for cuts are all easy to determine.

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Q Do vaulted ceilings need to be vented? What is the most practical way to detail the roof ventilation for a cold climate, and how are other builders maintaining an air barrier with can lights and other ceiling penetrations?

A *Ben Bogie, director of outreach and education and the production manager for Connecticut-based BPC Green Builders, responds:* By far the easiest way to vent a vaulted ceiling, and the one people have the most success with, is to run vent chutes continuously from the soffit to the ridge in each rafter bay. The only two locations where that gets a little dicey are in wildfire territory—a Wildland Urban Interface (WUI) zone—where embers can be pulled into soffit vents, and in a coastal environment with high wind speeds, where soffit vents can increase uplift pressures on the roof assembly. Once you install the vent chutes, pack as much fluffy insulation as you can below them.

If you want to go one better, put a continuous air barrier, typically a membrane, taped OSB, taped plywood, taped cardboard, or similar—on the bottom side of the roof framing. This air barrier will cut down on the majority of any moisture load that might get into that assembly.

The vent chutes are there to help mitigate moisture collecting on the back surface of the sheathing; the air barrier stops airflow into the cavity, reducing the moisture load there. I don't care about the permeability of this control layer on the lower side of the roof, unless the area below the roof has something like an indoor pool or serious aquatic fish tanks. I don't mean a small aquarium, but like a fish-tank business or something similar. For that kind of scenario, we'd go to a Class 2, or even a Class 1, vapor retarder, and pay attention to mechanical ventilation. But this is a whole different topic.

Following the requirements listed in R806.5 of the IRC, you *can* build an unvented, enclosed roof assembly. To do this, a lot of the industry has turned to flashing the bottom side of the roof deck with closed-cell spray foam followed by fluffy insulation in the rest of the roof cavity. This can work, but you need to know the correct ratio of impermeable insulation (spray foam) to permeable insulation (fluffy stuff). Building Science Corp. (buildingscience.com) is a great resource for this information. On the next page is a simple table BSC adapted from Table R 806.5 of the 2018 IRC that lists these ratios.

Theoretically, spray foam works, but I have seen many spray-foam failures on roofs, and I don't have much confidence in it for my clients unless it's unavoidable. Over time, with the intense thermal cycling (changes in temperature) and the accompanying moisture fluctuations that a roof experiences over the course of a year, the bond starts to degrade, and the foam pulls away from the framing. When that happens, we no longer have a continuous air barrier or a vapor barrier, and moisture can now get to the sheathing. But since we have no ventilation to dissipate that moisture, the roof deck rots. Also, with spray foam on the bottom side of the roof deck, we need to ask: What do we do if there's a roof leak? The foam keeps the leak from running to the interior, and you don't know you have a problem until a substantial chunk of the OSB on the deck turns to what Joe Lstiburek (of BSC) calls "beaver barf." The deck essentially turns to oatmeal.

With both approaches, we're trying to avoid the sheathing getting cold and moisture adsorbing (accumulating on the surface of the sheathing). I vastly prefer a vented assembly, but we could go a third route: We can keep the sheathing warm and avoid adsorption by stacking a bunch of exterior insulation on the outside of the structural roof deck. This works great, aside from the fact that it's expensive. Theoretically, I'm agnostic to the kind of insulation you put up there. Any insulation that gets you to the ratio you need for your climate zone and that traps enough heat to keep the sheathing warm will work.

In our own practice with these assemblies, we lean toward vapor-permeable insulation. I think that assemblies that have some drying potential built into them are going to end up more resilient,

Insulation for Climate Control			
Climate Zone	Rigid Board or Air Impermeable Insulation	Code-Required R-Value	Ratio of Rigid Board or Air Impermeable Insulation R-Value to Total Insulation R-Value
1,2,3	R-5	R-38	10%
4C	R-10	R-49	20%
4A, 4B	R-15	R-49	30%
5	R-20	R-49	40%
6	R-25	R-49	50%
7	R-30	R-49	60%
8	R-35	R-49	70%

Adapted from Table R 806.5 2018 International Residential Code. Source: Building Science Corp.

especially in cold climates. Eventually, the insulation and air-sealing materials are going to break down, and the chances that an assembly will begin to collect moisture will increase. The more permeable the materials in an assembly are, the more drying potential the assembly will have.

We've often used nailbase panels for this third approach. These are essentially a single-sided SIP. People in the residential world aren't terribly familiar with them, but they're used all over the commercial realm, and they're reasonably low-cost. Some examples are ACFoam, Insulspan, Insulfoam, ThermaCal, and Thermapan. We typically use ones with a 6-inch piece of expanded polystyrene (EPS) foam adhered to ½-inch OSB on the top side. You screw down through the OSB into the roof structure below and then apply your finished roofing on top of that.

The alternative is to stack layers of foam with staggered seams to get to whatever R-value you need, lay 2-bys over the top, and screw those down through the foam. You then install a roof deck on top and apply the finished roofing. I've recently learned this is good for anything above about a 3:12 roof.

Below 3:12, it's better to put the OSB or plywood directly onto the foam and screw down through that. At this low slope, the roof will essentially act like a flat roof and the air space created by the furring won't vent well—there's not enough convective airflow. And then there's a weird thing that happens: The moisture in the air of enclosed, still air spaces exposed to outdoor temperatures will regularly ratchet up to 100% relative humidity, which is kind of scary. At those moisture levels, the wood gets wet enough to begin to decay.

If you're working with vapor-open insulation, like rigid mineral wool or rigid wood fiber, on top of the roof framing, I like the strapped version because it creates a vent space and any moisture that makes its way through the insulation will vent out. To me, that's a super-resilient assembly.

Our go-to roof assembly on projects now is a roof framed either with a TJI or a parallel-chord truss, typically about 18 inches deep. We sheathe the top side of those structural members with ½-inch CDX plywood and tape it as our air barrier. We tape from the wall right onto the roof; any eaves are added afterward, over the air barrier.

The taped plywood is the continuous air barrier, and then we fur on top of that with 2-bys on the flat covered with a layer of Zip System sheathing. We prefer an integrated sheathing like Zip because we can dry-in the building quickly. And it's nice that we now have two air barriers at the top of the structural roof. It's vapor permeable because CDX plywood allows moisture to pass through and dry into that vent channel.

The big advantage of this roof assembly is that we can do almost anything we want on the inside. Often we build houses with light fixtures all over the place and in-wall speakers and other electronics. Sometimes, we also need to sneak ductwork and plumbing through the roof assembly. With the air barrier up above, we don't have to try to neurotically detail every little penetration, which ends up soaking up a ton of time.

One important caveat: This is not a particularly well-documented roof assembly as far as moisture performance goes. The calculations say it's safe (usually; it depends on who runs them). We have embedded monitors in all our assemblies; we're in our second year of measuring cyclical moisture loads in this type of assembly.

The assembly functions similarly to a double-stud-wall assembly: That first layer of plywood is going to get a little wet and adsorb moisture, but that happens when it's cold, and then it dries out. So far, what we've observed is working; it's safe. That being said, I don't know if this is the best roof assembly for somebody who is not going all-in with air control and mechanical ventilation as part of their building practice. If you're paying attention to all the variables, it works great. If not, you might end up in a lawsuit. So, I'm a little hesitant to full-boat recommend this strategy until we have completed monitoring this type of assembly for a substantial time and have formulated a detailed set of guidelines for building it.

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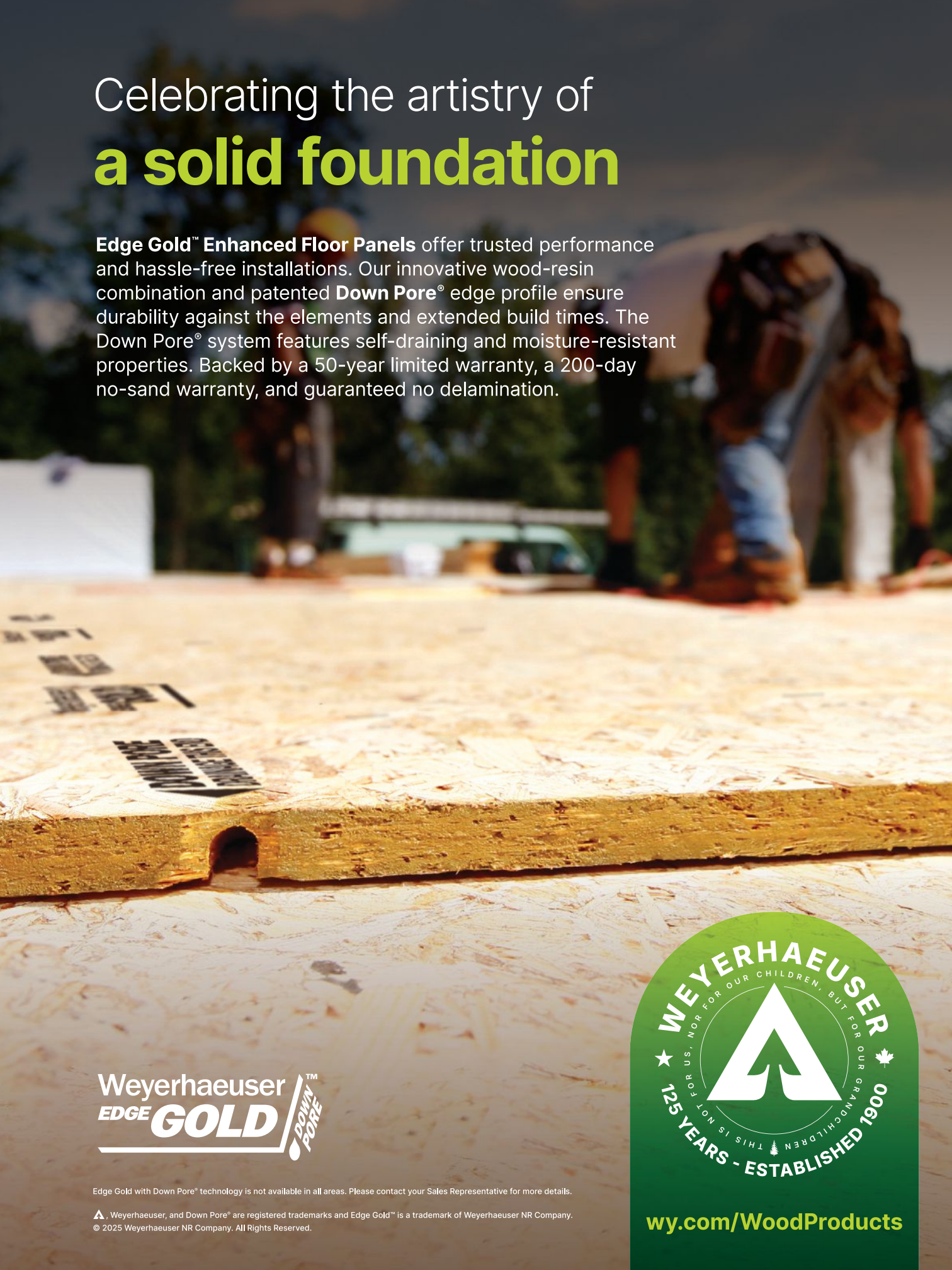

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Building a Plaster Range Hood

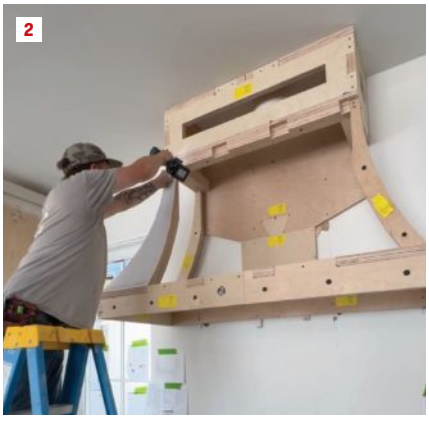
by **RICK MILLS**

Plastered kitchen range hoods have become increasingly popular on our projects. The first time we tackled one of these was probably 10 years ago and, since then, we have honed our process for building them.

On past projects, we framed the structure of the hood ourselves, but it proved time-consuming, and it was often hard to cut an accurate curve across multiple members. For this reason, on a recent project, we worked with Archways and Ceilings, a company that produces custom CNC parts for arches, ceilings, and hoods, and pretty much anything you can think of that has a radius (archwaysandceilings.com). You tell the company what you want, and it comes back in kit form with labeled parts and a set of plans.

The hood in this project (for a new home in Virginia Beach) needed to fit between the 10-foot-high ceiling and a tile backsplash accent. The design called for a traditional "Tuscan" shape with a band of white oak around the bottom. Our in-house lead designer created an initial shop drawing that we submitted to Archways and Ceilings. When filling out the order form, we specified the hood-liner model (a 60-inch Trade-Wind) that the client selected. After a few days lead time, the company sent us final shop drawings for approval. Once we signed off on them, the project moved into production.

Assembling the kit proved extremely easy. It was almost like building one of those old-school Balsa-wood plane kits. Once it was screwed into studs on the wall, we installed the hood liner (in this case, we chose to install an in-line blower in the attic to cut down on noise at the range but the same basic steps apply for any hood liner). Then our HVAC contractor connected the duct work and the electrician hardwired the unit.



A crew member positions the back plate and top frame of the Archways and Ceilings hood kit with a laser level and checks it for flat (1). He secures the curved ribs (2) once the lower frame is assembled.

PHOTOS BY RICK MILLS

Prep Work

Next, we called in the plaster crew.

Primer. The plasterers prepped the framing by priming the wood. The primer protects the framework and helps prevent it from absorbing moisture that might cause swelling and crack the plaster.

Critical separation. The plasterwork began with the underside of the hood. Though that area is the least glamorous, it still needs close attention. Here, the plaster crew installed a metal stop bead against the hood liner and corner bead on the outside edges of the hood base, using a strip of hardboard and drywall to pack out the bottom of the frame and bring the beads to the right level in relation to the hood liner. They needed to create a separation between the metal hood liner and the narrow plaster band. This would provide a clean visual break between the two dissimilar materials and prevent any hairline cracks that might otherwise occur if we installed plaster directly to the hood liner. Keeping a small but consistent break line is quite tedious, because the narrow strip of plaster that spans from the outside edge (corner bead) to the inside edge (stop bead) needs to plane out with the edge of the hood liner. But once this detail was complete, the rest of the plaster work went quickly and efficiently.

Simulator. Before the guys started "running mud," we needed to nail

With the hood kit and the fan insert installed, the plaster crew began work on the fussy part where the plaster would meet the metal fan grille. Step one was to pack out the lower edges with hardboard and drywall **(3)**. Care was required to create a separation between the plaster stop bead and fan insert **(4)**. With the stop bead complete on the inside edge and corner bead installed on the outer edge, a plasterer applies the scratch coat to the lower face of the hood **(5)**.

down the transition from the base of the plastered curve to the band of white oak that would be installed after the plaster was complete. For a clean transition, we would have to back bevel the top edge of the white oak to mesh with the plaster at an obtuse angle. A corner bead of some type at this junction would then allow us to stop the plaster on an acute angle. In the past, we've used a Schluter transition piece, which leaves a nice, ⅛-inch-wide metal accent, but it wouldn't work at the steep angle we had here. Instead, we used a sacrificial piece of poplar to simulate the white oak. The plasterers could plaster to this, leaving an acute angle once the poplar was removed.

We've found this method, which we call using a "simulator," extremely helpful on many projects, especially when the process is messy, and we don't want to spoil the finish piece.

Poly and lath. Metal lath would cover the framing, but first the crew covered the frame with poly sheeting. This sheeting serves double duty: It provides protection from the moisture in the plaster, and it prevents any clumps or crumbs of plaster from falling into the hood.

With the poly in place, the crew fastened the wire lath to the framing. If you've ever worked with this material, you know it is sharp along the edges; using gloves is highly recommended.

Our plasterers typically use lath screws or drywall screws to affix the lath. A lath screw looks similar to a gutter screw with a Phillips head, but its flat head is wide and thin to hold the lath securely without creating a bump when plaster is troweled over it. Drywall screws also work, but you have to drive them in the corners of the diamond spaces in the lath and set the head carefully—too proud, and they'll create a bump; too deep, and the bugle head can drive past the metal and won't hold the lath down.

Grounds and rod. Next up were the "grounds," which is a traditional term for the strips installed over the lath to act as guides for screeding off excess plaster. These take away a lot of the error that can occur by freehand-troweling the plaster over the form. Of course, it helps to have a good frame to screw the grounds onto; otherwise, every error in the frame would telegraph onto the surface. The screeding is performed with a "rod"—a straight, flat piece of metal long enough to project past the corners so the plaster is smoothed across each surface plane.

Plastering the Hood

Over metal lath, plastering needs to be a three-coat process.

Scratch coat. The scratch coat has a high sand content. This layer is troweled on heavy enough to cover the lath, and it can be freehand-troweled to sit down slightly below the grounds.

Once the scratch coat starts to set up and becomes stiff, the plasterers rake grooves in the surface (hence the name "scratch coat"). These grooves allow the next layer of plaster to mechanically bond to the scratch coat, preventing any possible separation in the future.

With the lower face complete and the boards to simulate the finish trim in place, a plasterer applies poly to protect the fan insert (6), then applies the metal lath (7, 8). Note the lath detail at the "hips" that prevents the cut edge of the lath from poking through the scratch coat (9). A plasterer then applies a scratch coat of plaster between the "ground" strips (10, 11).

Brown coat, aka base coat. The brown coat is also a heavy-duty, high-sand plaster mix that the plasterers apply with a trowel. Once enough plaster is in place, they rod it off. This is my favorite part of the process; whenever I get a chance to catch this step in action, I have to stop and watch. The plasterers make numerous passes with the rod across the grounds until they get a consistently smooth, flat surface, filling in any voids or imperfections as needed.

Once the brown coat has cured enough to be stiff, the plasterers remove the grounds and fill in the spaces left by the grounds to the level of the surrounding base coat. The brown coat is then left to cure for a full day, allowing the plaster to dry and the moisture to dissipate.

White coat, aka final coat. The final coat is a smooth, sand-free mix with a small amount of lime for workability. Our plaster crew likes to use USG's Diamond product for this.

At this point, the process is basically the same as plastering over any wall surface or substrate. The white coat is applied and troweled until smooth. The crew still had to carefully work both sides of the "hip" on the hood to create a crisp transition.

In my opinion, this step, working the plaster smooth and flat, takes the most skill. When the plaster is done, we all like to say it's "slick as glass." It almost has a marble look to it. I feel like it's a shame to paint it, considering its raw beauty and the fact that it is one of the oldest building crafts in the world.

Finishing Touch

The final step was to wrap the perimeter of the base with the band of white oak. We replicated the back bevel from the simulator boards on the top of the three oak boards that form the band.

One detail that added a particularly elegant flare, while also giving us tolerance for slight imperfections, was a small, ⅛-inch shadow line separating the top of the white oak and the base of the plaster curve. We also held the oak down about ¼ inch on the lower edge, again giving us a little flexibility to overcome any slight ups and downs in the corner bead. The client opted to finish the white oak with an ultra-matte clear finish, resulting in a clean, organic look that tied in with several white-oak beams and columns in the surrounding spaces.

Rick Mills is a senior project manager for Jackson Andrews Building + Design, in Virginia Beach, Va. You can follow Rick and company on Instagram at @rick.jacksonandrewsbuilding and @jacksonandrewsbuilding.

The plasterer trowels on the brown coat and then screeds it flush to the "grounds" with a "rod" **(12)**. When the brown coat has stiffened, the grounds are removed and the gaps filled in with the brown-coat mix **(13)**. After the brown coat cures for a full day, he applies the white coat **(14)**. Once the finish coat cures, the project moves to the finishing stage for paint, tile, and trim. To complete the hood, a carpenter installs a band of white oak to its base **(15, 16)**.

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5 Reasons to Partner with ProVia for Stone

Custom Tool Storage

by **NATHANIEL CARLSEN**

By making all the boxes the same size, the author saved on materials and construction time. This uniformity means an accessory built for one will fit all. The boxes can also be stacked to create level worktops (1, 2). The author can easily adjust the drawer dividers as his needs change (3).

While it's a stretch to say that every element of construction is downstream from organization, it's not much of one. Gone are the days of building a wooden tool tote at the start of an apprenticeship and filling it with all the handsaws and chisels needed to build a house. Instead, the range of tools and supplies has burgeoned over time, placing an increasing importance on our capacity to keep the jobsite organized.

The market's solution to this problem is the modular, stackable toolbox, Packout and Systainer being standouts in this category. Walk onto any jobsite, and it's an easy bet that someone has their tools organized in a big red box or its market alternatives. These systems are durable and convenient, but they do not come cheap. When I priced out a comprehensive organization of my tools, the sum was well beyond my budget, and the merchandise left several of my key demands unsatisfied. The obvious solution was to build my own modular toolbox system.

Design

Ron Paulk's torsion-box workbench inspired my design. Paulk's designs are a modern classic, using a plywood torsion box to create a strong and portable bench. This construction was perfect for my idea of creating "blocks" that I could bring on site and stack, Lego style, in any configuration I needed. The resulting blocks, made with ¾- and ½-inch plywood, are lightweight enough to be easily carried up a ladder and durable enough to support several hundred pounds.

One of the issues I have with plastic toolboxes is that they're not designed for standing on. Also, their uneven surfaces can't take a hammer blow or function well as worktops. My blocks are solid and flat enough to serve both these functions. When doing interior trim work, I like to use two blocks as step stools to access each corner of the casing and, with their open, lipped interiors, I can easily grab them with my boots and slide them along the floor as I work along the head casing. I find these blocks much more comfortable to work from than any step stool.

This comfort comes, chiefly, from their size. The blocks are 20 inches square and 12 inches tall. I based these measurements on the totes used in lobster fishing and commonly used by carpenters on the Maine coast. This size is the perfect intersection between capacity and portability, with a 20-inch worktop just fitting under my arm, and a 12-inch height easily supported by my hip in transport.

A benefit of the torsion-box design is that the side panel makes an excellent handle and, while I can't carry a full load of tools with one arm as I can with a Packout, I can use two hands to carry more weight with greater comfort. The lower lip keeps loose tools from sliding out of the block, so I can securely keep and carry tools in blocks without drawers. Pattern routing and mass producing the components let me efficiently create 10 identical blocks.

PHOTOS BY NATHANIEL CARLSEN

Creating identical blocks was important because I wanted to fit some blocks out with interchangeable drawers. Using the quarter-quarter-quarter drawer construction (search online for "QQQ drawer system" for more information) and wooden slides, I built short and tall drawers, sized and installed so that each block can take two short drawers or one tall drawer. The drawers glide well on the wooden slides, which provide enough resistance to keep the drawers from easily opening on their own. Without metal hardware, the drawers easily slide in and out of different blocks and also open from both sides of a block. This means that if I set up my system in the middle of a room, my tools are accessible from both sides.

I fitted out the drawers with a tackle-box-style divider system, allowing me to customize the drawer organization to my needs. Between the blocks with drawers and the blocks that serve as open shelves, I can easily access all my tools without having to unstack anything.

Because of this ease of access, the blocks can serve as organizers not only on the jobsite but also in the van. I set up my van in part around these blocks. They support a shelf for my miter saw and, by positioning my hand-tool and fastener blocks next to each door with open blocks stacked above, I have the essentials easily on hand while also having flexible shelf space to hold whatever tools I need for the current job. When that job is completed, those tools migrate back into the drawers deeper in the van, and the shelf space is freed up for whatever the next job requires.

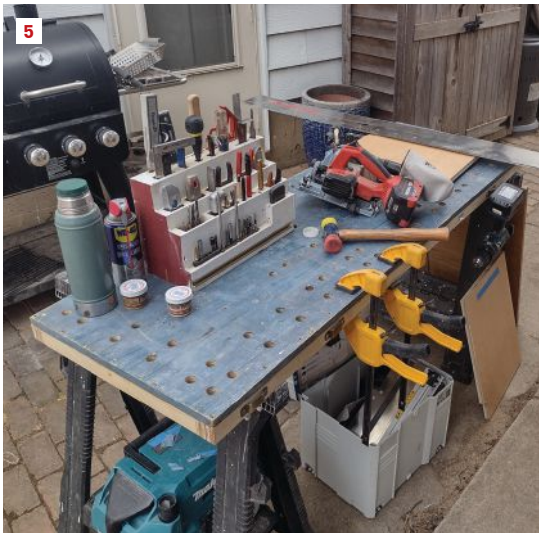
The best part is that when I want to reorganize my van, the blocks are easy to reconfigure and, when I have to haul a bunch of material, the van is easy to empty. They even function as a ladder to help me climb onto my roof rack.

In addition to blocks, I also built a series of worktops and rolling bases, 20 inches wide and varying between 40 and 60 inches long. The tops are drilled out with 20mm bench dog holes to allow for MFT (multifunction table) style clamping, and my two smaller worktops are fitted out with a woodworking vise and a router table insert, respectively. These worktops, bases, and blocks all clip together with toggle clamps to form a robust, easily movable unit.

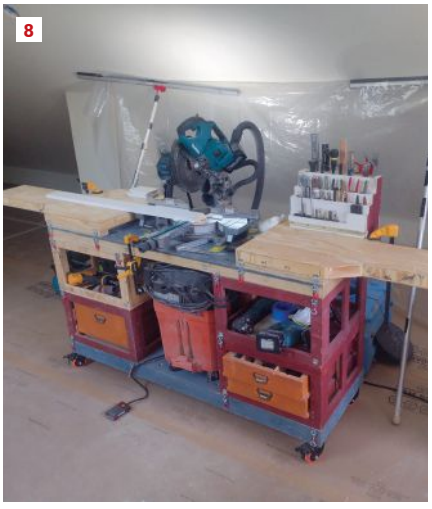
Because my system is modular and uniformly sized, I'm able to build new work surfaces that can clip on to my existing system. The other day, I diced up a few premade torsion boxes I had lying around, attached hardware and, just like that, I had the wings for my new miter-saw station. The capacity for iteration has become one of the most useful elements of this system.

In Operation

I came to the realization at the start of this process that I hate working on the ground, and I don't even like having my tools on the ground. I find it to be both less efficient and less comfortable, so I wanted to create a system that would facilitate elevated and organized work equally well for jobs of different sizes. The modular nature



The holddowns on the boxes enable clamping them together as a unit for secure stacking in the author's van (4). The worktops provide a flat work surface for many tasks. Note the drilled holes for clamps as well as the clips on the edges for hanging tools within easy reach (5).



The author says the boxes are easy to carry and provide a sturdy platform to stand on (6, 7). With the system set up as a miter station, the holddown clamps keep everything secure, including tall and short drawers, open storage, and dust collection, all in a single mobile unit (8).

of my block system has allowed me to experiment with many variations over the last year, falling into three general configurations depending on the size of the job.

For small, in-and-out work, I usually use blocks alone, without bases and worktops. When I rebuilt a deck, I loaded up a rolling dolly with two blocks (with drawers) and a trash can. This provided a small, flat work surface—helpful for changing blades and other smaller, fiddly tasks—and kept my tools organized and mobile. Nowadays, I use blocks without drawers for these smaller tasks, especially for punch-list work.

The other day, I went to a jobsite to adjust some doors, dial in some cabinet drawers, and do some caulking and touch-up, the usual punch-list smorgasbord. After arriving on site, I gathered all the tools I anticipated needing into two open blocks, which I then stacked inside the house close to where I was working. While this didn't create a large working surface, it did keep my tools together and close at hand rather than spread out over the floor.

When I need a more substantial work surface but will be somewhere for only a day or two, I usually set up a worktop on sawhorses. While I have stacked blocks on top of this surface, I recently started hanging an open block from the worktop, clipping it securely in place. This allows me to use the same load and stack technique I mentioned before. With some tape-measure clips on the worktop to hang my drills from and my pyramid organizer for all my essential hand tools, this setup provides adequate storage for most medium-scale work I do.

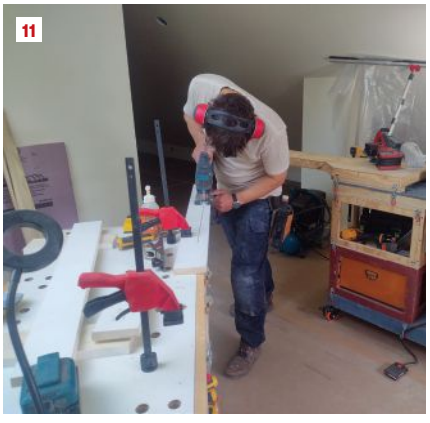
Adding miter-saw wings to the worktop yields a fairly substantial, lightweight, and economical setup. A cheap pair of plastic sawhorses usually does the trick, but I keep a pair of leveling sawhorses in my van to create a stable workbench on uneven ground. If I want a bit more space, I can augment this setup with a pair of stacked blocks to form a lower working surface, or I can use two blocks on edge with a piece of plywood to form a long, low shelf to hold other tools at a convenient height.

These capabilities are handy, but the system offers the most benefits when it's time to move in somewhere for longer than a week, especially for interior trim jobs. Using my rolling bases, I can set up multiple workbenches that are level with one another and that I can roll around into whatever orientation best suits each task. This was especially useful for preassembling large casing on the bench.

If I am doing shop work, I can set up my workbenches with all my material and tools immediately at hand. I built the benches to line up perfectly with our shop table saw and outfeed table, allowing me to easily transport components around the shop. With so much mobility and capacity for improvisation, I have found that my ideal setup is to make a U-shaped pocket for myself, with all my tools and working space within easy reach. However, if I think an L-shape would be better for the task, the rolling bases make this shift incredibly easy.

I can roll a small workshop from room to room, then take it apart, move it one floor up, and restack to continue

Mobile bases enable the system to be moved to fit the task or the space as needs change **(9, 10)**. Here, the author uses the holes in the worktop for his holddown clamps **(11)**.



working. If I were setting up for a job that would take months, I would likely empty my entire van and use the blocks to build a complete workshop on site, with a stationary wall of tools and a full set of rolling workbenches.

Having used this system for the better part of a year, it's hard to overstate its flexibility and efficiency. I sometimes joke that all I'm doing is fulfilling a childhood fantasy of having a giant Lego set, but the possibilities stemming from this metaphor are profound. If I want to prebuild a porch roof or other similar structure at a comfortable working height, I can use the blocks to support the structure. If I am going to cut irritatingly large closet shelves, I can use a block to elevate them off the ground to make the cut. If I need to assemble post wraps, I can use my blocks as a reliably square and flat clamping surface. I can stack a staircase, build staging, and perform many more iterations that I have yet to discover. My limitation is my imagination.

There is no denying the usefulness of the modular toolboxes on sale at the hardware store, and I need to be upfront: The time cost of building out my entire system was considerable. I spent many, many late nights in the TDS shop, and there were times I wondered whether I should have just bought some toolboxes and moved on with my life. However, the square, flat, stackable wooden blocks have considerable advantages over plastic boxes on the jobsite and perform functions no plastic box ever could.

Moreover, these blocks are tuned to me, sized to me, individualized to how I want to work. The worktops fit precisely under my arm, not under what someone decided was the average-sized arm. The openings and drawers are sized to fit the tools I own and use the most, not what some product designer decided was reasonable.

Walk onto any jobsite, and you will encounter the same conversation over and over: "Well, I love X about this toolbox, but Y just won't fit," or "If I could use the toolbox in Z way, it would be so much more useful." It is the rare product that fully satisfies the demands of every tradesperson, and we accept trade-offs when it comes to power tools and hand tools because, realistically, most of us won't build our own circular saws or forge our own chisels. But there was a day, not all that long ago, when carpenters did make their own toolboxes, sized to fit their tools exactly, with a handle shaved to fit comfortably in their grip. Though we are living in the modern world, with new tools and new ways of working, the homemade wooden toolbox still has its place.

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

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From Jobsite to Office: Why Financial Metrics Matter

by **IAN SCHWANDT**

Editor's note: In this issue, Ian Schwandt kicks off a new JLC *business series concurrent with the launch of his Substack, "Nails to Numbers." This first installment begins with an overview of his career, which is essential to understanding his perspective as a tradesperson who acquired his business acumen by living the numbers while wearing a tool belt.*

Looking back 20 years to my carpentry apprenticeship, I can easily see how the skills I learned on the jobsite and at the Southeast Wisconsin Carpentry Training Center (see "A Union Apprenticeship: Training Suited to a Sustainable Industry," Nov/19) set me up for a great career in the building trades. What was not obvious at the time was that those instructors and mentors were planting seeds for lifelong learning.

Concrete led to framing, framing led to walls, and walls led to finishes. Each challenge built on the last: stair building, roof framing, complex remodels. Yesterday's advanced techniques became tomorrow's basics. It wasn't just a linear path from apprentice to journeyman to lead; it was a mindset of constant improvement.

That mindset stuck with me and, as my career progressed, I wanted more than trade skills. I wanted to understand how the business worked.

This desire for knowledge was shaped by mentors like Jim Rhynders of Idema General Contractors, in Poughkeepsie, N.Y., and Mason Lord of Hudson Valley Preservation, in Kent, Conn. Both brought me into the inner workings of their businesses and shared openly how their wins and missteps shaped their strategies. They gave me the opportunity to work on estimates, participate in project planning, and ask questions about the financial side of the business. Still, the numbers felt abstract. I knew what a well-run job looked like in the field but not if that job was supporting the company's financial health.

That changed in 2022, when I became the production manager at TDS Custom Construction after serving 18 months as an estimator and project developer for the company. In this new role, I worked closely with the owner, Ben Blodgett, who, like me and my past mentors, came up through the field. Ben had moved from laborer to GM before buying the company in 2021, and he had a clear vision that in my role as production manager, I should act as "the CFO of the production department."

Being the "CFO of production" means understanding that every project has a direct line to the company's financial health. The position is not just about estimating and job costing—it's about forecasting, cash flow, labor capacity, and sustainable growth. The CFO mentality blends accounting discipline with forward-looking operational strategy.

In this article series, and in my Substack, "Nails to Numbers," I draw on my journey from lead carpenter to estimator to CFO of production as I focus on the data-driven metrics that I've learned about from building industry mentors and finance professionals. The data-to-build metrics, like gross profit per day, volume per week, and over/underbilling and labor efficiency ratios already exist inside your company. Whether they are handwritten notes, spreadsheets, or QuickBooks files, the data is there to be leveraged.

Using this data and the accompanying metrics as forecasting tools, I can see the whole field of play and lead more effectively. My team sees why a job could be "on schedule or on budget" and still underperform. They build schedules that meet deadlines without burning out our crew. We learned how real-time job costing connects to the current month's profit and loss. We are forecasting workload and revenue with a degree of accuracy that opens new growth opportunities.

Leveraging your own data through clear metrics and planning models, you can help your team connect the dots between their day-to-day decisions and the long-term health of the business. That shared understanding builds shared responsibility. And shared responsibility creates the accountability that leaders need when building businesses that not only survive but thrive.

This series isn't about becoming an accountant. It's about building your financial fluency as a builder and giving you and your team a new set of tools to lead with confidence. With that, let's kick off with the first metric aimed at helping us accurately price jobs.

Gross Profit Per Day

One of the oldest questions in building must be, "What should I charge for my work?" Many of my colleagues focus on setting a flat gross margin percentage in hopes of delivering reliable gross profit. This technique can work well when a company performs a narrow range of project offerings, such as kitchens, baths, or decks—projects that have similar durations and cost-of-goods profiles. Design-build and custom contractors, however, perform work that is often a

one of a kind. This one-off custom work can vary wildly in cost of goods, turning the flat gross margin percentage into a liability. After all, you can't spend a percentage, so let's talk dollars.

Talking and thinking in dollars rather than percentages brings me to an essential document: the company budget. Whether you bristle at the thought of sticking to a budget or consider it a license to spend, I believe this document is where you need to start to answer the age-old question mentioned above. A budget is a planning tool. The data it contains can tell you the kind of jobs you need and how to produce the cash flow to support your team and your future. Done right, your budget becomes the framework for your estimating process.

You might be tempted to start your budgeting exercise by throwing out a revenue goal, but let's define gross profit first. I build our company budget starting with two things: *operating expenses* and *net profit*. Added together, they tell me how much gross profit we need to generate in a year. This gives us a clear definition for gross profit that can be expressed in dollars:

Gross Profit =
Operating Expenses + Net Profit Target

I think of this as a bottom-up approach to budget building. A company's net profit is the quintessential bottom line, while its operating expenses fall in the middle of a typical budget document and encompass company overhead costs, or the "keeping the lights on" part of running a business. Operating expenses can be further divided into overhead operating expenses and indirect expenses. Indirect expenses include production manager and administrative salaries, vehicle and tool expenses, training, and so forth. These expenses support business operations but are not easy to job-cost directly to a project. Indirect expenses are typically allocated "above the line" into COGS (cost of goods sold) through an indirect allocation shown on the budget and on future P&L statements. We can use this to further define gross profit:

Gross Profit = Overhead Operating Expenses + Net Profit Target

Determining a net profit target can feel challenging if you don't have any historical data to review. An often-repeated industry standard is 10%, but since we can't spend a percentage, and we are using a bottom-up budgeting approach, we need more data. Your target should reflect the return on the capital that you have invested in the business. A simplified formula for determining invested capital is

Total Equity + Total Debt + Non-Operating Cash (such as savings or retained earnings) = Invested Capital

If you are going to risk your capital and your free time to make only 5% net, why not just invest in a mutual fund and make 6%? Beyond providing a return on invested capital, your net profit target also needs to fund planned growth and the day-to-day cash flow needs of the business.

This deeper understanding of gross profit creates the foundation for understanding your budget as

Net Profit Target + Overhead Operating Expenses + Cost of Goods Sold (COGS) = Revenue

My colleague Zach Snider, principal of ALLOY Architecture + Construction, in Charlottesville, Va., refers to seeing your revenue goal through this lens as a planning tool that creates a deeper understanding of gross profit as real money that fuels the company's operations. This bottom-up approach forces you to know your true cost of doing business instead of relying on a revenue-first, top-down model and its rule-of-thumb percentages that too often leave profit as, at best, a happy accident and, at worst, a net loss.

Armed with gross profit in dollars, you can develop a metric to serve as your north star in deciding what to charge: gross profit per day. A company that needs $1M gross profit per year to be successful needs to bring in $2,740 ($1M/365) gross profit every day to meet that goal. This can be further refined by the number of projects you can operate at one time. If your team can produce four jobs at once, then each job needs to contribute $685 in gross profit per day of project duration.

The magic in using gross profit per day as a tool is that it directs attention to how you as a manager apply your labor resources to a group of projects. A huge project that requires more labor reduces capacity, and it will need to bring in a higher gross profit per day. If a smaller job allows for extra capacity, then you can take on a smaller project at a lower gross profit per day. Whether your company self-performs carpentry labor or is project management only, your labor output is the true limiting factor in how much work you can perform each year.

Gross profit per day is grounded in the reality of remodeling work. Revenue is unpredictable. COGS will shift based on design, specs, and subcontractor mix. If a project ties up your team for six weeks, it needs to pay for that time. When I build a project budget, I start with COGS, determine the duration using the volume-per-week metric (to be discussed in my next article) and, finally, add the gross profit per day adjusted for labor capacity and the risk profile of the project.

Gross profit per day puts your labor at the center of your business model. It's how you translate hours into dollars and avoid thinking like a salesperson who's just selling projects like a basket of goods. Instead, you're selling production capacity—your team's ability to deliver value each day they're on the clock. Gross profit per day is how you price that capacity, track it, and improve it.

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

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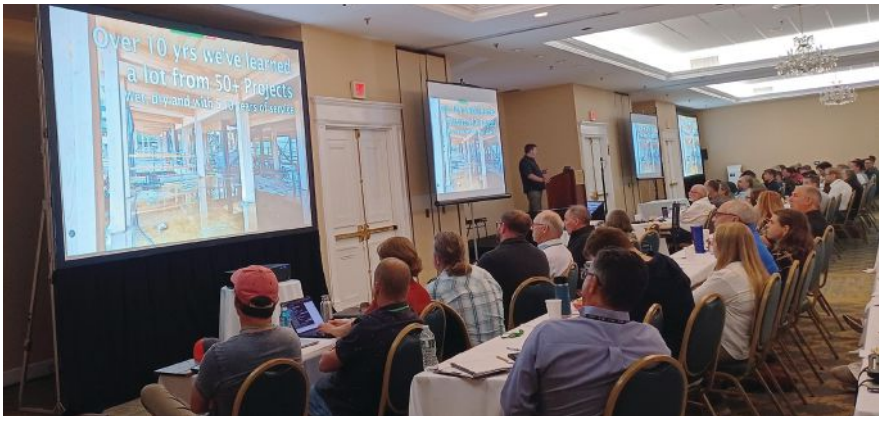
Notes From Summer Camp: Low-Carbon Building

by **CLAYTON DEKORNE**

I had the good fortune this year to attend "Summer Camp," aka The Westford Symposium on Building Science, which has been held the first week of August (more or less) for the past 27 years. I feel fortunate because work and family demands don't always allow me to attend, and because it's so much fun. The conference sessions, organized by Joe Lstiburek, fully immerse attendees in the experience and collective knowledge of the brightest minds in building science, engineering, and practical building design in North America (and sometimes beyond). The notably fun part takes place after hours, when the conference adjourns and everyone retires to the BSC campus (and home of Joe and his wife, Betsy Petitt, whom Joe credits with organizing everything but the conference sessions, though she probably has some say in those, too). The hospitality is generous and the conversations with guests unusually inspiring.

The conference part is fun, too, if you lean toward building better, but it's also a lot of work. The flow of information is incessant; some of it eludes my grasp, and all of it is advanced.

The following are notes from just one of the presentations. They are impressions, a riff, not a full summary or the melody itself. Any attempt to recap a presentation inevitably falls short of the live event.



About 500 attendees participated in the 27th Westford Symposium on Building Science (affectionately know as "Summer Camp"), in Massachusetts from August 4 to 6 this year.

PHOTOS (INCLUDING PHOTOS OF PRESENTATION SLIDES AT CONFERENCE) BY CLAY DEKORNE

Should Low Carbon Take the Lead?

John Straube opened the conference by asking: How much focus should we put on low-embodied-carbon building materials? Straight off, he acknowledged he's new to this study and has questions around this fresh frame of reference for building science. Straube is known for his work on the design of moisture-tolerant building enclosures. (A second edition of *Building Science for Building Enclosures*, the seminal book he co-wrote with Eric Burnett, was recently released; the first edition, which was given out at Summer Camp circa 2005, has become my go-to resource for sorting out questions about moisture moving through building assemblies.) On this new topic, he brought an admirably open viewpoint that refreshingly didn't feel like preaching of a true believer. Nevertheless, I left the session convinced that carbon reduction is the inevitable next step in the evolution of building better.

Here's a brief recap, inspired by Straube, of this evolution to date: The energy crisis in the 1970s ushered in a new age of making buildings more energy efficient. This movement led to a raft of moisture-related disasters, like rotting structures and unhealthy, mold-ridden indoor environments, which have been the impetus for the work of many of the Summer Camp attendees (including much of *JLC*'s coverage of building failures since its beginning in the 1980s). Efforts to reduce energy consumption have gradually made progress, largely driven by codes, though codes, Straube noted, are based more on theory than reality due to low compliance (even in Canada). Still, the U.S. has seen a 30% reduction in household energy use since 1980. But our industry is not making much progress in reducing carbon emissions.

Operational vs. embodied. The energy consumed by a building over its lifetime is, in the new vernacular,

"operational carbon," and it's still of critical importance for reducing carbon emissions. But the main reason our industry has made few gains in reducing greenhouse gas emissions is "embodied" carbon. Straube zeros in on the portion emitted when building materials are mined, processed, and transported, and when building products are manufactured from those materials, stored, and transported.

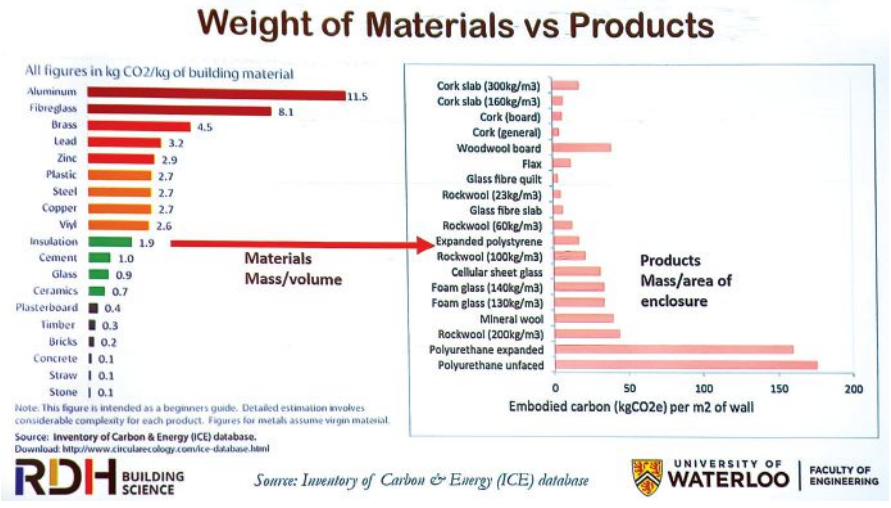
An attendee at the conference commented that "embodied" is somewhat of a misnomer and that a more appropriate term might be "upfront carbon." That attendee attributed this term to Lloyd Alter, the Toronto-based sustainability enthusiast who helped popularize the term on Twitter in 2019 and whose upcoming book is titled *The Story of Upfront Carbon*. According to promotional materials, this book is intended to focus consumers on the "astonishing" amount of carbon used to produce everyday goods, and it explains "why we are fixated on energy efficiency, not carbon, and why this needs to change." While the first part of that statement may be true of many of us, the second part seems dangerously close to throwing the champagne out with the cork. This opinion is mine, but I think it reflects the healthy critique of the low-carbon movement that Straube wants Summer Camp attendees to consider. To be fair to Alter and his publicists, it's probably true we shouldn't be "fixated," but Straube's presentation underscored the importance of staying rational as we move toward low carbon. Forgetting about operational carbon is not the way to do that.

Project-specific products and assemblies. When designers and builders select low-carbon materials, Straube urges them to evaluate specific products and assemblies, not just material types. The embodied carbon of ready-mix concrete, he explains, is more meaningful than the carbon emitted from cement; counting the carbon released making a wood I-joist is a more accurate tally than the carbon from wood.

Counting carbon. Different building materials and products emit different greenhouse gases, each with its own potency. This potency is expressed as a global warming potential, or GWP. To compare the emissions from different products, GWPs are converted to an equivalent of just one gas, carbon dioxide, or CO_2e. The CO_2e of products is reported by the manufacturer in a standardized format called an Environmental Product Declaration. EPDs serve as a nutrition label, so to speak, for construction materials. And while EPDs may be the most reliable documents available for evaluating the life-cycle carbon of materials, they are constantly changing as new data and new assumptions are sifted into these reports. They have an expiration date, and Straube advises specifiers to regularly check that they are consulting up-to-date data.

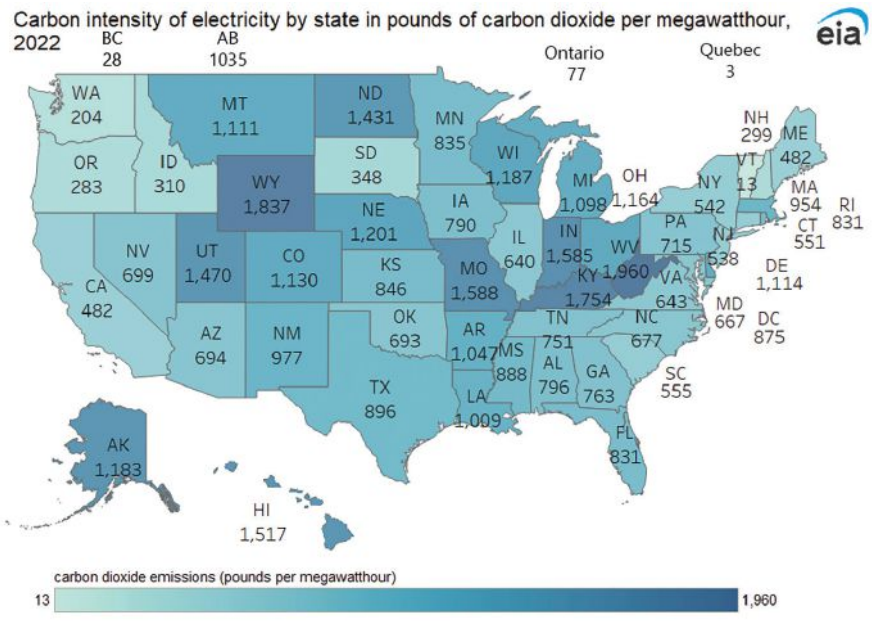
It's also important to accurately parse the data in the EPDs. For example, the carbon emissions from raw materials are typically expressed as a function of weight as CO_2e/lb or CO_2e/kg. But this measure does not accurately reflect how the materials are incorporated into buildings. A better, and certainly easier, accounting for specifiers and designers is to evaluate the amount of product used in an area of an assembly, such as wall area. This is typically expressed as $lbCO_2e$ per ft^2 or $kgCO_2e$ per m^2. This difference is particularly evident when evaluating insulation and varies widely depending on the type (see image, below). In particular, Straube emphasized, any attempts to reduce the amount of insulation as a category in buildings is a fool's quest (my term); insulation is the material that most contributes to reducing the operational carbon expended. The echoing refrain is "don't forget operational carbon."

Building lifespan. A full accounting of carbon reduction necessarily encompasses the whole life cycle of the building, which I find an especially refreshing reset in the building-better



The embodied carbon in a product like Rockwool, even high-density compressed Rockwool boards, is significantly lower than in closed-cell spray foam insulation (a type of expanded polyurethane foam) or polyisocyanurate foam boards (also derived from polyurethane). The CO_2e/kg of insulation as a category doesn't provide this critical detail.

This map shows the carbon by weight emitted from every megawatt-hour of electricity generated in all U.S. states and four Canadian provinces, highlighting where efforts to decarbonize the grid are needed most.



evolution. Focusing on low-carbon forces us to think more holistically about buildings in a way that energy efficiency often doesn't. As an industry, or perhaps a society, we are obsessed with the dollar payback on energy efficiency—a payback measured in years, and the fewer the better. No one ever accounts for the payback on granite countertops and open floor plans, but we insist that we account for the payback on high-performance windows and increased insulation and air sealing. This pushes us to think in short bursts of time about a critical dimension of building performance. The focus on embodied carbon ropes in the entire life of the building, and the longer the better.

Decarbonizing the Grid

The biggest "aha" moments I had listening to Straube underscored the links between decarbonizing buildings and decarbonizing the grid.

The map above, which is based on figures from the U.S. Energy Information Administration's Power Plant Operations Report, shows the carbon intensity—the amount of CO_2 emitted to produce a megawatt hour of electricity—for all U.S. states and the most populous provinces in Canada. Carbon intensity varies depending on how the electricity is generated. California, for example, generates about 53% of its electricity using renewable sources of energy, while Massachusetts generates less than 2.1% from hydro and renewables. Quebec's carbon intensity of just 3 stands out; this is the lowest in North America owing to Quebec's vast hydropower resources.

Concern over a carbonized grid comes into sharp focus when states and municipalities propose policies for banning fossil-fuel-burning equipment in new buildings. Pointing to a headline in the popular press, Straube referred to this as part of the "electrify everything" movement. My state, New York, has such a "gas ban" policy, which is due to take effect for new buildings seven stories and under starting December 31, 2025, and in all new buildings starting January 1, 2029. Such policies make no sense if the replacement equipment relies on carbon-intensive electricity. To be fair, it's coupled with a New York law that requires the state to generate 70% of its electricity from renewable resources by 2030. About 38% of its electricity currently comes from renewables (22% from in-state hydropower and 16% from wind and solar) so it seems fairly obvious that the "gas ban" is wildly premature.

Straube also noted that the link between decarbonizing the grid (or its opposite) and buildings goes much further than converting to heat pumps. Where building products are made has a profound impact on how we count their embodied carbon. For example, drywall made in Quebec with its electricity's ultralow carbon intensity of 3 would have a significantly lower CO_2e than drywall made in, say, Texas, where the carbon intensity is almost 900.

Last word. While I've only touched on part of Straube's arguments here, I hope two things are clear: Low-carbon building is only a logical next step to building better if it's done logically, and key to that logic is not turning our backs on energy efficiency. True, it's going to be a steep climb before our industry makes much of a difference, but we can get started right away, even if we have to bide time until the grid improves. As a parting gift, Straube left us with some super-simple ways to begin: Don't build if you can renovate; build smaller; build simpler; use materials and products efficiently; use materials and products with lower carbon. This last item will require care.

Clay DeKorne is chief editor of JLC.

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Troubleshooting Zone Damper Systems

Solutions for the general contractor to vexing problems

by **DOUG HORGAN**

A zone damper system is a set of mechanized dampers added to a ducted HVAC system to direct all the air to only some areas of the house while shutting off the rest. This improves control and comfort, as each zone has its own thermostat telling the system when it needs heating or cooling, instead of being on a ride with one thermostat for the entire house.

Marketing by companies that sell controls can make it seem like you can deliver perfect comfort to a dozen rooms, but, in my experience, that is overselling. We have found zoned systems particularly helpful where one or two reasonably large areas, such as a south-facing great room with lots of glass or a first-floor vs. second-floor area, behave differently from the rest of a house. Setups with two to four zones, new ductwork, and thorough "commissioning" (checking that everything is working at the end of install) can improve on single-zone setups. However, it's unlikely you can deliver significantly different temperatures in different zones, and when you have more than a few zones, operational problems tend to occur. We've also found that these complex systems are susceptible to problems on installation, not to mention the numerous new electronic and mechanical parts, each of which can fail. After a decade or two, several broken dampers like the one in the photo above are usually lying around the attics of houses with zone damper systems.

In this article, I'll cover some issues our company has had with zone damper systems, and I'll offer some general recommendations based on our experience installing several dozen systems over the years.

PHOTOS BY DOUG HORGAN

Anatomy of a Zone Damper System

The main parts of a zone damper system are a main control panel with its

own little computer and connections for all the other parts, motorized dampers in each branch duct, and individual thermostats (or sensors) for each zone.

Some systems have additional pieces, such as a "bypass duct" whose damper allows air to blow directly from the supply ductwork back to the return ducts (so system airflow stays high enough even with some zones closed off) or a "supply air sensor," which signals the system if the air is getting too hot or too cold (which can happen when enough dampers close and airflow is restricted).

The best damper systems can communicate with the HVAC system control and ramp fan speed and compressor settings up or down as needed to meet different zone demands.

Each thermostat is wired to its own connector on the main zone control board (zone 1, 2, 3, etc.), and the corresponding zone damper is wired to its respective damper connector. The main computer reads each thermostat and sends heating or cooling to the appropriate zones. Different zone damper controls have various setups to help manage this. Simple controls just send air out when triggered by the thermostat; more sophisticated ones can interface with variable-speed systems to ramp down the airflow based on how many zones are open, or run the system fan to move cool or warm air around the zones without wasting energy using the furnace or A/C compressor.

Case of an Ineffective Pressure Switch

The first system with zone dampers I worked on had problems the client's HVAC contractor seemed unable to fix. These included noise and repeated coil freeze-ups. This was a while back and the system was a simple one made by a third-party company and bolted on to a regular heat pump system.

I downloaded the manual and headed into the attic. The system was straightforward, with two dampers on the two main supply trunks. Since this third-party brand couldn't talk to the machine and turn down the system airflow when only one zone was calling, a large bypass duct had been installed.

As I sat in the hot attic, I heard loud airflow noise. Then, the bypass damper opened, and the noise quieted down as the air had a place to go. When the damper opened up completely, a switch clicked, and the damper started closing again. The noise would then ramp back up, the switch would click again, the damper would start to open, and so on.

The manual revealed that this bypass was controlled by a pressure switch that opened the damper when pressure in the ducts was high and closed it when pressure was low. On this system, the bypass damper was cycling back and forth, leaving the system starved for air much of the time and leading to coil freeze-ups on hot days and a lot of unnecessary noise. The main zone controller did not have a direct connection to the damper or sensor, so the system couldn't manage the cycle. Ultimately, we replaced the motorized damper with a "barometric" damper, which is a free-swinging damper with an arm sticking out with an adjustable weight on it; the higher the air pressure, the more the damper is pushed open, with some adjustability based on where the weight is installed on the arm.

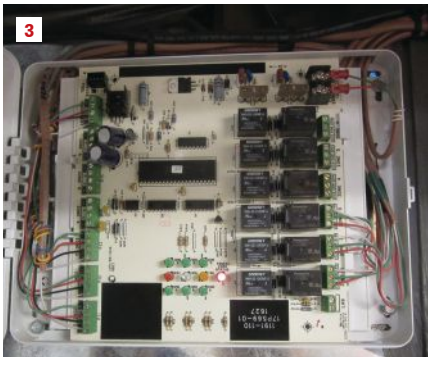
While that type of damper locks in inefficiency with some level of air always recirculating, at least it didn't cause problems with cycling like the original switched one did. These days, we avoid bypass setups altogether when possible. We favor sophisticated zone controllers that ramp down multispeed machines to adapt to the number of open zones (see "Bypass Duct Dilemma" on the facing page). When we have to install a bypass damper, we use barometric ones, rather than relying on pressure sensors.

Cases of Miswired Dampers

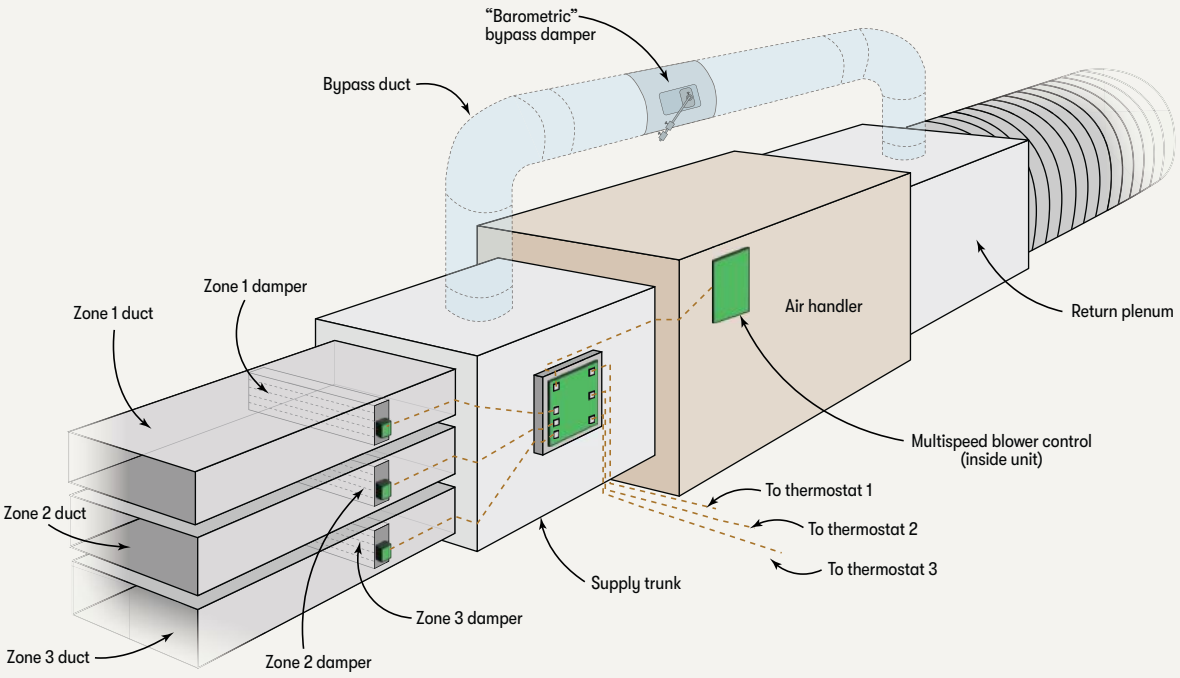
On a different system another contractor had installed, the problem was that a basement area was freezing cold all summer while some areas upstairs were not as cool as desired.

In one case of a miswired damper, the basement AC was running at 60°F in summer, much colder than the set point, and the clients kept lowering the set point because that helped keep the upstairs more comfortable.

A Carrier zone damper system has a useful diagnostic mode that includes a zone test that opens each zone individually. This allows you to see whether each zone damper was correctly wired to the corresponding connector on the zone control panel.



This zone control panel, which is wired for a three-zone system, has seven identical wires pulled to the central control. It's easy to mix them up.



Bypass Duct Dilemma

When one or more zone dampers close, static pressure can build up in the remaining supply trunk, increasing the velocity of air in any open branch ducts. This can create noticeable noise, strain fan motors, and lower the system's efficiency. Many HVAC installers add a bypass duct to reduce these problems. A damper in the duct—operated by a pressure sensor in the supply trunk or via a counterbalance mechanism that responds to difference in pressure (on a barometric damper, as shown in the bypass duct, above)—opens when static pressure increases, providing an escape route for air back to the return plenum.

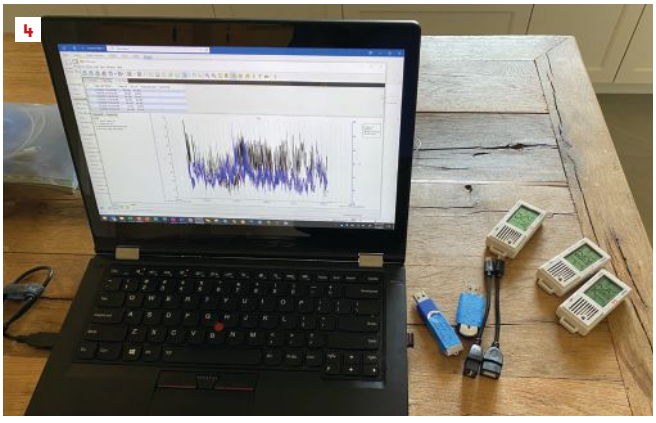
While common, this practice reduces the system's efficiency because it sends conditioned air back into the system to be reconditioned rather than delivering it to rooms. This recirculation lowers the evaporator coil temperature, which reduces the unit's capacity and efficiency. For these reasons, some building codes limit use of bypass ducts, forcing system designers to use variable-speed blowers and better duct sizing to control pressure variations instead.

We prefer more efficient HVAC designs. But we also contend with existing systems, and converting one to a functional system without bypass sometimes exceeds the budget, so we have to make the existing system work with the bypass duct included. —D.H.

This HVAC setup used a Carrier zone damper system that has some useful features, including a diagnostic mode with system tests. We first ran a zone test, in which each zone was opened in turn, and we could see whether the "zone one" damper was wired to the "zone one" connectors.

None of the zones were opening correctly per the numbering on the thermostats. It turned out that all the dampers were wired backward: They opened when directed to close and closed when they were supposed to open. When the basement system called for heat or air conditioning, the basement damper would close, and the air would go upstairs; when the upstairs areas needed cooling or heating, the air would go only to the basement. Once summer rolled around, when the system tried to cool upstairs, it froze out the basement instead. This was a simple and quick fix. We just switched the "open" and "close" wires on each damper.

Another house where one zone was always too cold and another too warm seemed to have a similar problem. Diagnostics revealed that zone 2 would start blowing when zone 3 called for cooling, and vice versa. When the sunny side of the house, zone 3, asked for



The author used a set of data loggers to record temperatures at short, two-minute intervals all around the system—at the main air handler, in the ducts in several zones, and at select thermostats.

When clients set their thermostats to automatically switch from cool to heat, a heating set point of only 3°F below the cooling set point can exacerbate problems.

cold air, it would all blow into zone 2. Zone 2 was always cold from all this air conditioning mistakenly blowing into it, so its thermostat never called for cooling, which prevented zone 3 from getting any air conditioning. Again, we simply swapped the damper wiring to fix the problem.

Wiring has been at the root of the majority of zone-damper problems I've been involved with. It's understandable when you think about the installation process. Techs run wires from the control panel to each thermostat location and to each zone damper, all off the same spools of thermostat wire typical of smart thermostats and standard dampers. Then they wire up each thermostat and damper. Last, they connect all the thermostat and damper wires to the correct locations on the board.

Usually, a minimum of six, and as many as 12, identical wires stick out of the wall, and it's surprising if no mistakes are made. Taking another hour or two to fully check these systems is important.

When Blow-by Airflow Triggers Heating

In one case, the house had temperature problems during moderately hot days but was better on hotter days. The zone damper system was made by a zoning company, not the HVAC system company, and as this was a while ago, it did not feature any logging or recording ability. The photos the client sent showing crazy thermostat readings left little doubt there was a problem. We used a set of data loggers to record temperatures at short, two-minute intervals all around the system—at the main air handler, in the ducts in several zones and at select thermostats. The results and a close read of the installation manual revealed the problem.

The 27 incandescent recessed lights in the clients' large kitchen were on all day, while an employee cooked (very delicious-smelling food) for most of the day, so the kitchen thermostat was almost always calling for air conditioning. Typical dampers on residential systems block most airflow, but not quite all, when closed. So, when the system ran cold air for hours on end on moderate days, it ended up cooling the other zones in the house even though their dampers were shut. Exacerbating matters, the clients had set their thermostats to automatically switch from cool to heat, with the heating set point only 3°F below the cooling set point.

The temperature data we reviewed showed the system switching to heating when a zone or two outside the kitchen dropped below the heating set point because they were overcooled by damper blow-by on moderate days. This brand of board had a three-minute purge cycle (that is, running the fan to clear out cooled air) between switching from cool to heat, a 20-minute-minimum cycle of heating (or cooling), and a three-minute purge cycle before switching back to cooling, so the air conditioning was turning off for nearly half an hour in the middle of peak cooling time, leaving the kitchen hot.

In this case, the damper blow-by and control timers could not be changed. We convinced the clients to lower the heating set point for the summer to create a wider "deadband" (the temperature range in which the system calls for neither heating nor cooling), change out the incandescent bulbs for LEDs, and fix the broken range hood to lower the heat load in the kitchen. These steps were enough to bring the system under much better control.

Disparate Zone Sizing

On a different job, we added a zone for a 500-square-foot newly finished basement exercise room, tied into a large system serving the main level and the rest of the basement, about 2,000 square feet. The system was very noisy in the exercise room and repeatedly

shut itself down with lockout errors, especially on colder days.

We tried running the system with one zone calling at a time and found the exercise room registers blasting air and the furnace clicking off on overheat after a few minutes of operation. When we clicked through the many setup screens on the sophisticated zone thermostat, we learned that it required manual setup of zone sizes so the system would know how much air to send to each zone. In this case, the default 50%/50% had never been updated.

Once we changed the percentages to 20%/80%, the system behaved well.

Dehumidifier Discharge and Air-Starved Zones

In one large house, there were several temperature complaints: The gym was too hot, the theater room was stuffy, and the primary bedroom and closets were too warm and humid. The house was large and complex with multiple machines, each with zone dampers, and it had 32 thermostats when we started working.

In this case, the thermostats were able to log system state. When I plugged a USB thumb drive into the thermostat and set logging to "on," every five seconds, the thermostat recorded 60(!) parameters, including thermostat settings, temperature and humidity at each thermostat, damper settings, and system operation settings and temperatures.

In the theater and gym area, the clients had set the gym set point at 65°F, which was much lower than in the rest of the house. This zone often called for cool air. The sophisticated zone system would run the geothermal air handler at a low speed to satisfy this one zone when it was the only one calling.

We inadvertently created a problem by adding a ducted dehumidifier with its outlet duct connected to the supply-side ductwork for the system, which is the recommended installation setup for a dehumidifier. But on this zone-damper system, blowing 75 cfm of hot dehumidifier discharge air into the ductwork while running low-speed air conditioning in only one zone warmed up the gym zone when it called for cooling. This led to the gym calling for more cooling but heating up considerably from the hot dehumidifier air! We fixed that by moving the dehumidifier outlet duct.

When this zone damper closed, a low whistle sounded. The problem was solved by adjusting the stop on the damper motor to keep it open a little, and then monitoring temperatures to be sure that solution didn't cause a new problem.

Meanwhile, the theater room, which was tied into the same system, got warm and stuffy when the family had movie night. We adjusted the humidity control on the thermostat and used the thermostat setup software to correctly set the zone size (some zone systems require manual setup of zone size so they run fans and compressors at the correct speeds for the ductwork and load in each zone). These adjustments both helped, as did some client education about engaging the "fan on" setting when using the theater room.

However, the job wasn't finished. We noticed other potential issues with cooling the space. It had only three supply registers and one small return; also, an adjacent A/V equipment closet always felt warm despite its one A/C outlet.

We used a Retrotec Acin FlowFinder MK2 flow hood to measure the airflow in the theater and discovered that decisions made during construction to minimize obtrusive ductwork had choked off airflow to the space.

We solved the comfort issues by adding outlets on the existing ductwork to maximize available airflow; combining an adjacent zone with the theater and connecting the ducts to bring more air into the theater; adding a return to the hot equipment closet to take away much of the heat so it no longer affected the theater room; and boosting the "fan on" fan speed setting in the system software.

Further adjustments. In the primary suite, our monitoring revealed that a thermostat in a closet was calling for cooling but the temperature didn't change no matter what the setting was. We could measure very low airflow from the registers and crawled around the attic looking for any obvious issues with the ductwork. When we climbed over the main trunk lines into a smaller attic space, we

found an easy-to-fix problem: On the same zone, a second damper that was needed for the convoluted duct system had never been wired up, so it stayed closed. Fixing that solved the temperature issues.

A physical adjustment to one damper solved the final problem. When this zone closed, a low whistle would sound. We adjusted the stop on the damper motor to keep it open a little rather than shutting all the way, then monitored temperatures in the area to be sure we hadn't caused a new problem.

Problematic Systems

After installing several dozen zoned systems and encountering problems like the case studies described above, we've come to some general conclusions about what works and what doesn't.

To begin with, we've learned to be wary of the following problematic system types:

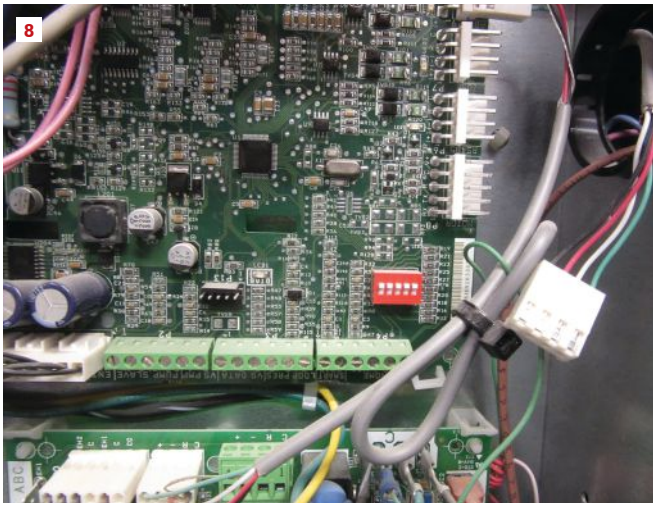
Single-speed units and third-party controls. When zone controls are installed on a single-speed HVAC system, they are always susceptible to restricting the airflow enough to cause the system to work harder, potentially overheat, and cause premature wear on electronic fan controls. As mentioned, bypass ducts relieve the pressure buildup that causes the airflow restrictions, but the recirculation of freshly heated or cooled air back into the return causes temperatures at the furnace or A/C to run much hotter or colder, again making the system work harder or even experience premature problems. While in theory, larger ducts could minimize these issues, in many cases, the zone system is added to existing ductwork where that isn't an option, and in others, the clients object to the space needed for large ducts (objections are common on standard-size ducts, let alone oversized ones).

Variable or multispeed HVAC systems, in theory, can operate at lower air volumes and should be better under part-load conditions that happen most of the time when some zone dampers are closed. However, when zone controls can't talk to the HVAC machine, that doesn't happen. For the most part, third-party zone controls don't reach into the speed controls for variable-speed furnaces or heat pumps. For this reason, we much prefer same-brand damper systems, despite their steep prices.

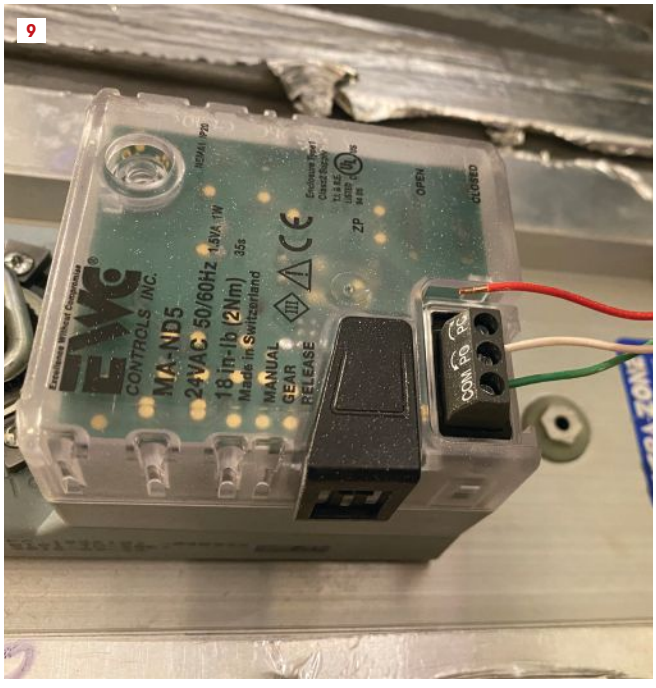
Complex systems. It's fair to budget significant time to start up and verify these systems. The complexity invariably leads to problems (such as miswired zones or forgotten dampers), and installers are often unfamiliar with setup steps such as setting zone-size percentages based on Manual J Btu loads or typing in the clients' preferred labels for each zone so they easily understand what's happening. We've found that many HVAC contractors, even well-above-average ones, need extra help with verification. Not to mention that when problems are revealed, it's often during the first heat wave or cold snap when no HVAC contractor has an extra four hours for complicated troubleshooting, so it can be helpful for GCs to be familiar with diagnostic steps.

Let's not forget that modern HVAC machines themselves are already complicated. The many options and parameters we can set allow maximum flexibility in installation and sophisticated comfort, but they take longer to set up as well as troubleshoot. On the house with 32 zones, we had to acquire a special tool to talk to the machines, and we spent hours reviewing DIP switch settings, programming zone sizes, and calling tech support.

In addition, the same ordinary problems happen with these systems—wires mysteriously not being connected, digital thermostats reading a few



For a complex system with 32 zones, the author's company bought a $250 tool to talk to the equipment **(7)**. They spent hours reviewing DIP switch settings and calling tech support for help reprogramming zone settings before resolving all the problems. The red block **(8)** on one of the control panels shows an example of the DIP switches involved.



The red wire on this zone damper motor is disconnected—a problem that occurs often and is one of the first things to look for when clients report uncomfortable zone conditions.

Thermostats can vary from actual temperature and humidity conditions. Here, the thermostat is overstating the temperature by about 4°F and the humidity by about 14%. On most thermostats, the readings can be recalibrated to match a more accurate device.

degrees off (or over 10% off relative humidity), and so on—but the number of problems is multiplied by the number of connections and devices.

Final Recommendations

Use as few zones as possible. One of my HVAC friends says never puts in more than four, and he prefers two. Another says three or four is the right number, that two aren't enough and five are too many.

If you can, avoid setting thermostats to switch from heat to cool automatically. This can lead systems to overcool some zones and trip them into heat mode. Then you get no cooling for like 25 minutes as it switches over and then back to cooling.

Proprietary systems that can modulate heating/cooling based on demand usually work much better than the ones with a bypass damper, which are noisy and inefficient and can cause overheating or overcooling.

We've found the systems that work with variable speed equipment work best and are quiet and efficient. There are even more advanced systems with dampers that don't just fully open or fully close; they have steps between as well, and their sophisticated controls attempt to send the right amount of air to each zone to keep the temperatures even all the time. We haven't had the opportunity to work with these, but the idea is intriguing.

Read the manual. It usually wants ductwork oversized (beyond what you need to condition the spaces) and the smallest zone to be of a certain size, sometimes as big as 25% or more of total system airflow, which would be way more air than a single room would normally need. Follow all the setup steps, and manually run through all the zones to be sure they're hooked up correctly.

Almost all the serious problems I've been involved with were caused by miswired zone dampers; that is, the Zone X thermostat is tied into the Zone Y damper and vice versa, resulting in air continually blowing into Zone Y because the Zone X thermostat is never satisfied. Or one of two dampers on one zone wasn't hooked up, or the dampers were all wired backward.

I've been impressed with Carrier and WaterFurnace units when wired correctly. EWC and Honeywell are a mixed bag. There's less room for error if the zone board can't turn down the system when demand is low.

Most systems seem to struggle with managing significantly different set points. If clients want the gym at 65°F and the rest of the house at 75°F, the gym should have its own system. Just like the number of zones, this becomes much harder to manage after the fact. For this reason, it's now part of our normal client discussions during planning.

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

VELUX®
Skylight System

INSTALLING VENTING SKYLIGHTS WITHOUT THE HEADACHES

What Pros Need to Know

Skylights used to have a reputation among some builders as a risky detail, fearing too many callbacks, too much potential for leaks. However, the truth is that modern venting skylights have come a long way, and today's systems are easier to install, more reliable and far more efficient than many realize.

For remodelers and builders looking to add ventilation and natural light without increasing the mechanical load, venting skylights are one of the most effective passive solutions available. They allow warm, stale air to rise and exit the home naturally, pulling in cooler air through lower openings in a classic stack-effect setup. And when installed correctly with today's flashing kits and curb systems, they're every bit as durable and watertight as a standard roof penetration.

SAME FRAMING, MORE FUNCTION

One of the biggest misconceptions in the field is that venting skylights require special framing or added labor. In reality, most modern models are designed to install just as easily as their fixed counterparts. The rough opening is the same, and the installation process follows familiar steps without a learning curve. With pre-flashed curbs or step flashing kits now standard on many models, weatherproofing is also faster and more foolproof than it used to be.

NO ELECTRICIAN NEEDED

Wiring has traditionally been the holdup for some builders considering venting models. Running electrical lines, opening up walls and coordinating with a sub can make what should be a one-day job drag into a longer process. But there's good

news: Solar-powered units are making electric-free operation a standard feature. These skylights use a small, integrated solar panel and rechargeable battery to power the venting motor and remote-controlled functions, eliminating the need for wiring, an electrician and workflow disruptions. Simply mount the solar panel to a pre-mounted bracket, connect the wire cables together and turn it on. That's it.

DON'T OVERLOOK THE SHADE

Shades are one feature that homeowners often overlook before installation. In fact, many builders report that clients come back wishing they'd included them from the start. For that reason, the leading skylight company in the world recently made shades standard in almost every model. VELUX's Skylight System includes a pre-installed, solar-powered shade that operates by remote control. These shades not only give users total light control, but they also significantly improve thermal performance. Research shows that when the double-pleated, room-darkening solar shade is in the down position, it enhances the already industry-leading thermal performance by up to 45% and blocks up to 19% more of the sun's radiation.

WHAT IT MEANS FOR YOUR NEXT JOB

If you haven't installed a skylight recently, it might be time to revisit your assumptions. With improved installation systems, solar-powered operation and integrated shade options, headaches are a thing of the past. The VELUX Skylight System packages all of these features into a single, streamlined unit that installs cleanly and operates independently from the home's wiring.

For remodelers and builders seeking to incorporate natural light, passive ventilation and long-term client satisfaction with minimal fuss, venting skylights are worth a second look.

Visit veluxusa.com/remodeler for more information

Produced by Zonda Media, a Delaware corporation
marketing.zondahome.com

PHOTOS BY ERNEST MUELLER

Efficient Outdoor Lighting

An innovative solution to overcome unexpected price increases for private utility pole lights

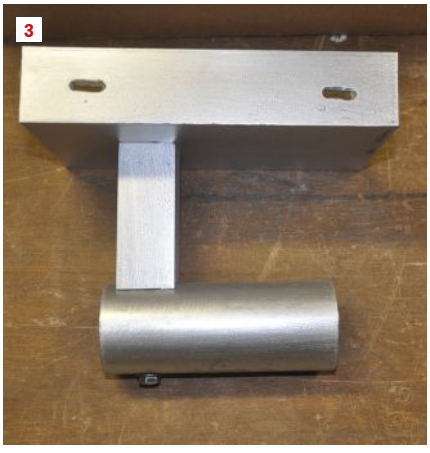
by **ERNEST MUELLER**

Along a 250-foot driveway through a heavily wooded area are two utility poles that led to one of my recent projects. These poles support overhead service lines for power, telephone, and cable and connect to the house basement through underground cables. PSE&G, the electric utility company, offered unmetered service for light fixtures mounted to the poles. In 1982, two 100-watt MV (mercury vapor) pole light fixtures were installed with photocells for dusk to dawn illumination. Service was billed monthly with a fixed charge for the light fixtures plus electric energy and delivery charges, which varied from month to month based on estimated kWh consumption.

The original two-fixture charge was $12.90 per month and had increased to a modest $14.88 by 2024. Then, the fixture charge jumped to $41.32 without any notification or explanation. The cost for estimated 1,010-kWh annual energy consumption was $98.80. The total annual operating cost was now $594 ($297 per light) for the original lighting.

I investigated alternative lighting with one energy-efficient LED luminaire near the house. I liked the downlight distribution of pole lights and searched for streetlight fixtures. To match the brightness of the existing pole lights, I needed only 25 watts for LED lighting. The electrical energy

Before. Utility service runs underground from a utility pole near the end of the driveway to the house, and a light was mounted on this pole **(1)**. The author pulled cable from the basement breaker panel through an existing conduit **(2)** to feed a light mounted on a pine tree 12 feet away.



Mounting brackets. The author fabricated aluminum mounting brackets for the light **(3)** and the motion detector **(4)**. Slots in the bases allow for securing the brackets to the tree with stainless steel strapping.

consumption would be a quarter of what it had been and even less with timed operation.

Site Conditions

Underground service runs from the utility pole to a meter outside the west side of the house. Also, two 1-inch poly tubes run from the pole location to the basement. One houses cable service. The other was intended for future landscape lighting. The dusk-to-dawn PSE&G 100-watt MV pole lights illuminated the driveway near the street connection and in front of the garage. The light output of such lamps is typically about 4,000 lumens at 4000K (Kelvin refers to the color temperature).

A large pine tree 12 feet from the second utility pole turned out to be a suitable mount for a streetlight-type luminaire directed toward the house and away from neighboring houses. To replace the pole light, we could simply pull a new cable into the existing conduit and connect it to the breaker panel to feed an LED luminaire equipped with a photocell.

Planning and Design

To keep the provision for landscape lighting, I decided to install a splice box at the utility pole and a GFI outlet at that location. The cable to the luminaire would rise along the pole and drape to the light fixture mounted with a custom-made bracket to the tree. The first design for the support called for welding the aluminum parts, but the cost was too high. I changed the design to a bolted version, obtained the parts for less than $50, and did the simple fabrication.

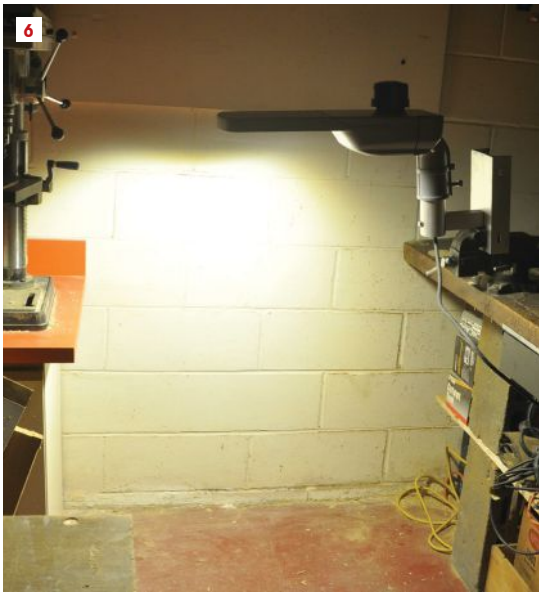
To replicate the 100-watt MV pole light, a 25-watt LED streetlight would do. Such luminaires are readily available with lenses for various light distribution patterns and optional add-on shields. The area to be illuminated is some 40 by 40 feet, and the mounting location required a “forward” light direction. After evaluating several options, we chose a ZGSM-ST17-25S model with 3,875-lumen output from Hangzhou ZGSM Technology and a shield to limit backlight. I specified 3000K, an optic to suit the area of illumination, and a three-pin photocell.

LED streetlight fixtures have a driver to power the light and allow dimming with remote control. However, such controls are designed for utility applications with sophisticated control devices, not for residential use. For solar-type LED, I found a company offering a smartphone app to set times and dimming levels, coupled with a motion sensor. It represented my preferred control mode, but solar powering was not practical for the tree-shaded site,

and I could not find a similar system for 120-volt applications.

ZGSM can factory-set a dimming program, but changing it on site requires a utility-type control device. ZGSM also offers a control with a motion sensor, but a combination of dimming and motion control was not available. Another company offers an eight-position selector switch at the light fixtures to set the lumen output, which could be helpful to tune the lighting application. However, I decided to build my own add-on control feature for the ZGSM fixture we chose, using a timer to shut the light off at a certain time and a motion sensor to turn the light back on as needed. The luminaire's photocell turns the light on at dusk, the timer shuts it off at a set time, and the motion sensor control takes over. This control mode is mindful of neighbors and follows the "dark-night" initiative.

For simplicity, I selected a mechanical 24-hour timer switch (TB 388) with battery backup. It has a control selector switch: Auto (timed operating mode, photo cell turns the light on during the set time allowed), On (dusk-to-dawn lighting controlled by the photo cell), and Off. For motion detection, I selected an RAB Lighting Stealth STL200-LED. It offers a 200-degree, 50-foot detection pattern and comes with add-on shields to restrict the angle. It also has a built-in photocell. The sensitivity, photocell operating mode, and the off-delay after motion detection ceases are all adjustable.



Testing. In the shop, the author tested the light before installing it: He first connected a power cord and installed the photocell **(5)**. Then, with the fixture mounted in the bracket he'd fabricated, he plugged in the power cord and turned off the shop lights **(6)**. The light functioned as intended.

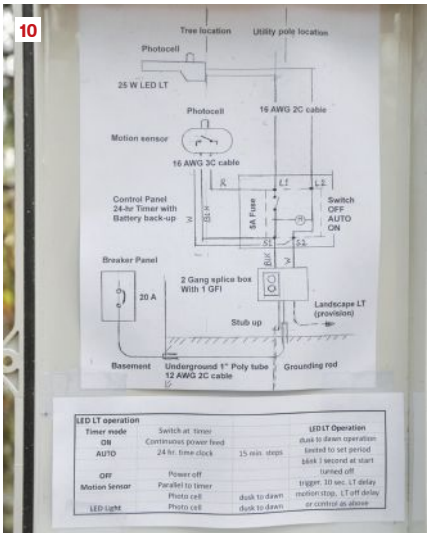
Power. To power the new light, the author pulled new 12-gauge UF-B wire through the existing black poly conduit **(7)**, then through flex conduit, which fit snug inside the poly tube **(8)**. This wire runs to a splice/outlet box with a GFI double outlet **(9)**.

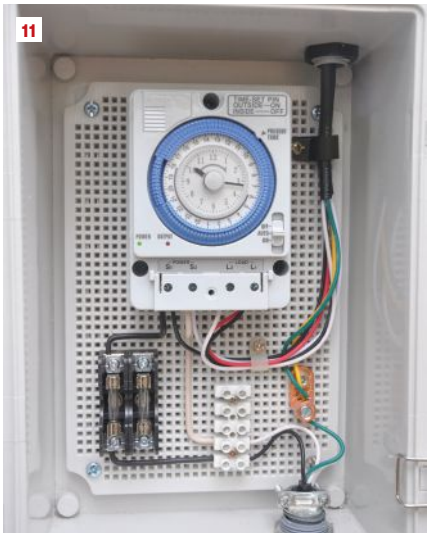
Prep Work

I fabricated a support to mount the light fixture to a 20-inch-diameter tree. The bracket consists of three aluminum parts—a 5-inch channel, a 1½-inch-square tube, and a 2-inch Schedule-40 pipe—held together with a ⅜-inch bolt. I cut slots in the legs of the channel for stainless-steel mounting straps and drilled the bolt hole. I shaped one end of the square tube to match the pipe diameter and inserted a wood pin to locate the position of the bolt that would hold the channel, tube, and pipe together. After drilling the bolt holes and cleaning and sanding with 150 grit, I bolted the parts together. I primed and spray-painted the assembly metallic gray.

Likewise, to fabricate a base for installing the motion detector to the tree, I drilled and tapped holes in 5-inch channel and fastened a 4-inch outdoor-type metal box to it.

I set up the LED light fixture with the fabricated support in the workshop for testing, connected a power cord,





Control box. The wiring schematic **(10)** details the wiring that ties in the photo cell, motion sensor, and timer controls, as well as the power circuit for the tree-mounted light. The author mounted the timer control on a mounting plate inside a lockable ABS box and added a 5-amp fuse that allowed him to step down to 16-gauge wire for the control circuit **(11)**. He mounted this box on the old utility pole above the GFI outlet and power junction **(12)**.

installed the photocell, and plugged the cord into an outlet. The LED light blinked for a second. I turned off the shop light and the LED turned on after a 10-second delay. With the shop light turned back on, the LED turned off after a three-second delay. In dusk-to-dawn operation, such delays will not be noticed; however, for triggering with a motion sensor, the 10-second delay before turning on is longer than I had hoped, but acceptable.

Mounting the back shield to the fixture required some modifications. The hole diameter at the fixture was 4mm and not tapped. The supplied M5 socket cap screws have a 4.8mm diameter. I drilled the hole to 4.3mm and cut #8-32 threads for standard stainless-steel screws.

Installation

I pulled a 12 AWG 2C cable (Southwire copper UF-B) through the 95-foot-long, 1-inch-diameter poly tube. At the pole, I mounted a two-gang metallic outdoor box and installed one GFI double outlet. The larger box provides extra space for cable splicing. I installed a ⅝-inch-by-8-foot-long copper-clad-steel ground rod and connected it with 6 AWG bare copper to the splice/outlet box. There seems to be no special fitting for a poly-tube-to-flexible-conduit connection. Luckily, the flex conduit fit snug inside the poly tube. I added a hose clamp and taped the joint for a watertight connection.

I installed the timer switch on the back board inside an 11-by-7.5-by-5-inch waterproof IP67 ABS plastic box with a hinged cover and lock provision. I added a fuse holder and a 5-amp fuse to use 16 AWG wiring for the light fixture (2C) and the motion sensor (3C). I mounted the control box 56 inches above ground at the pole and connected it with liquid-tight flexible conduit to the splice/outlet box below. I affixed the control schematic and LED operating mode on the inside of the control box cover (see photos 10 and 12, above).

The height of the light installation needed serious consideration. Interpreting photometric test reports and diagrams for a specific lighting application may require help from experts. I submitted an area arrangement sketch to ZGSM, and an agent helped guide me for the lens selection and mounting height range. I chose 14 feet for the fixture mounting height. Stainless-steel bands strap the support bracket to the tree, and the mounting height can be adjusted by moving them up or down, if required. The supplied luminaire attachment fitting allows for +/-15 degrees adjustment from level and sideways swivel on the support pin.

The manual for the motion sensor suggests a mounting height of 6 to 12 feet for optimum range and detection. A diagram shows a 50-foot-distance by 100-foot-wide detection range at a 10-foot mounting height. I selected an 8-foot height for this installation. I mounted the bracket with stainless-steel straps as I did with the light, so it can be moved, if required. Upon energizing, the motion sensor starts with a 15-minute test period, which allows for making adjustments and tuning.

Controls and Adjustments

I set the light timer window from 6 to 9 p.m. During that time, the photocell located on top of the light fixture turns on the light depending on the natural light level. At 9 p.m., the timer shuts off the light, and the motion sensor control, which is connected in parallel, takes over. When motion is sensed within its detection range, the sensor

Light and motion sensor. The author mounted the brackets holding the LED light fixture **(13)** and motion sensor **(14)** on the tree with stainless-steel straps. The motion sensor is positioned lower on the trunk, which stands about 12 feet from the old utility pole on which the control box is mounted.

turns on the light with a 10-second delay (I kept the factory settings for the motion sensor).

The selected mounting height for the light fixture and motion sensor proved correct. After some operating time, I adjusted the luminaire angle to +15 degrees from level, to increase the forward light projection toward the garage front. I did not mount the back shield, since the lighting effect on the surrounding trees is pleasing.

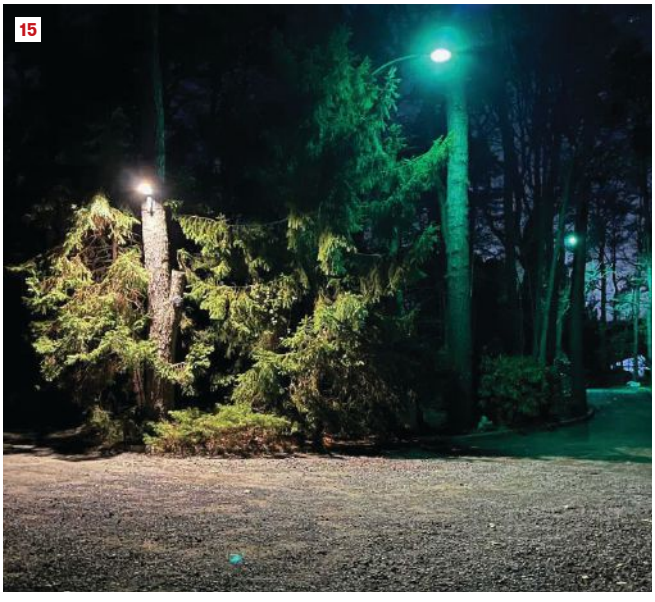
Bottom Line

After we installed the new LED light, the old MV lights remained operational until PSE&G finally removed them, some time later. This afforded a comparison of the two lights, and it was clear that the warmer, 3000K LED light is more pleasing than the 4000K utility light.

The two utility pole lights along the driveway were eliminated. The one near the street was never necessary. The one near the house was replaced with a tree-mounted, high-efficiency LED luminaire. Timed operation drastically reduces electrical energy consumption and "light pollution."

The total material cost for the installed system with one luminaire and controls is less than the previous annual fixture utility charge for two pole lights. The annual electrical consumption with timed operation is less than 30 kWh from metered service, compared with 500 kWh for estimated unmetered service (at a lower rate) for each dusk-to-dawn utility light.

Ernest Mueller renovates homes in East Brunswick, N.J.



Results. Before the utility company took down the old mercury vapor lamp, the author had a chance to compare the light output of the old and new lights (at right and left in the photo, respectively) **(15).** The new LED successfully illuminated the area in front of the garage as well as the head of the driveway **(16).**

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Products

by **VINCENT SALANDRO**

1. Double-Duty Wall Membrane

For starters, the vapor permeability of Benjamin Obdyke's VaporWise interior membrane changes along with seasonal changes in humidity levels. When humidity is low, the vapor-variable membrane acts as a Class II vapor retarder. As humidity increases, the membrane's permeability increases, allowing moisture to escape, helping to dry the wall cavity. Additionally, a layer of reinforced mesh adds strength, and a translucent outer layer enables installers to monitor insulation blown into the cavities. A 59-inch-by-164-foot roll covers 806 square feet. We found prices that vary from around $380 to $430. ***benjaminobdyke.com***

2. Low-Profile Floating Shelf Bracket

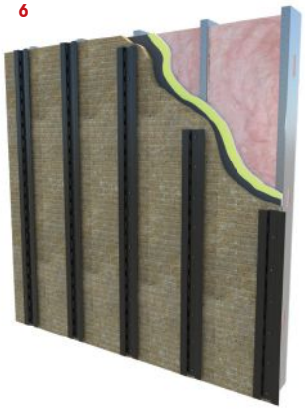
Made with American steel, the Thin Floating Shelf Bracket from Federal Brace has a minimal profile. When you attach the brackets directly to wall studs before installing drywall, their bases are completely hidden, making the shelf appear to float. Though the bases are visible if you attach them to studs through drywall, the slim profile remains unobtrusive. Brackets support up to 50 pounds and hold shelves up to 10 inches deep. Brackets cost $25 each. ***federalbrace.com***

3. Smart Light Dimmer

Leviton's Decora Smart Wi-Fi 0-10V Dimmer adds smart control to 0-10V dimmable LED drivers and electronic fluorescent ballasts. It features an adjustable soft fade; dimming range can be adjusted on either the device or the My Leviton app. With the app, users can also set the dimmer to always come on at a certain light level as well as control the dimmer remotely. Installers can choose 0-10V linear or logarithmic dimming modes. It costs about $90 online. ***leviton.com***

4. Eco-Friendly, Design-Forward Surfaces

Caesarstone Icon surfaces contain approximately 80% recycled materials and almost no crystalline silica. According to the company, the product's design and eco-friendly manufacturing practices reduce waste. Though the surfaces contain less than 1% crystalline silica, the company advises installers to follow safety protocols for stone, including working with wet tools, wearing a protective mask, and ensuring proper ventilation. ***caesarstoneus.com***



5. Adjustable Sliding Door Hardware

Ideal for bedrooms, hallways, and guest rooms, 1138 Series Sliding Bypass Door Hardware from Johnson Hardware features a top-hung, rolled steel track with a convex rail that the manufacturer says ensures smooth, quiet gliding. The adjustable side-mount hanger plates and door guides help eliminate installation guesswork and the need to relocate screws when fine-tuning. The hardware is compatible with 1⅜-inch-thick doors. Sets include all hardware for two- or four-door installations. ***johnsonhardware.com***

6. Vertical Rainscreen and Cladding Support

Designed for use over exterior continuous insulation, ProChannel Ci-Vertical steel rails from ClarkDietrich support exterior wall cladding and create a ⅞-inch rainscreen. The hat-channel-type rails come with preassembled (screw and sleeve) Trufast Grip-Deck TubeSeal fasteners; lengths depend on the combined thickness of the insulation, WRB, and sheathing they need to penetrate. Rails are also available in a black finish for open-joint cladding. ***clarkdietrich.com***

7. Stainless-Steel Linear Drains

Slot Drains from Landscape Drains are linear, stainless-steel, in-ground drains designed to drain paved and hardscaped areas without unsightly grates or landscape swales. Made of T304 or T316 stainless steel, the drains have a ½-inch slot that is nearly invisible when installed. The 4000 Series (shown) features one flat side for installation against walls. Other models for high-volume drainage (6000 Series) and less-costly PVC bodies below grade (3000 Series) are available. ***landscapedrains.com***

8. Gun-Grade Liquid Flashing

Typar's Liquid Flashing is a gun-grade elastomeric liquid flashing designed for air- and water-sealing window and door sills and bottom wall plates, air-barrier joint details, and other challenging applications in both new and existing wall assemblies. It is a hybrid STPE/SMP formulation and reportedly stretches 325% before breaking. Rated at 14 perms, the flashing has a 50°F to 180°F application range and bonds to most surfaces without primer, according to Typar. It is tack-free in 20 minutes and paintable within 48 to 72 hours. It is available in 20-ounce sausages and 2-gallon buckets for bulk loading guns. ***typar.com***

9. Stainless-Steel Outdoor Cabinetry

The Trex Ready series of outdoor, stainless-steel cabinetry offers seven predesigned layouts in six UV-resistant powder coat finishes. The Veranda model (shown) features a grill with a side-burner cabinet to the left of the grill cabinet. The model also provides a space for undercounter refrigeration and a pull-out cabinet for trash. All models come standard at a 30-inch height and 27-inch depth, with 4-inch leveler legs and 24-inch depths available. ***trex-outdoorkitchens.com***

10. Self-Adhered Air and Water Barrier

Sto Corp.'s StoShield SA high-performance, self-adhered air- and water-resistive barrier is available in two configurations. The StoShield SA VP is a vapor-permeable barrier that resists air leakage and water intrusion, while allowing water vapor to escape and the assembly to dry. A non-permeable version—StoShield SA NP—resists air, water, and vapor movement and is designed to protect above-grade concrete and masonry walls in commercial applications. Both membranes adhere without primer to most substrates in temperatures down to 20°F. ***stocorp.com***

11. Pivot Roof Pipe Boot

A ball-and-socket component that adjusts for roof pitch (from 3:12 to 12:12) helps Master Flow's Pivot Pipe Boot Flashing protect against leaks at plumbing vent pipe penetrations, according to GAF. Designed with an all-metal exterior body, the boot is available in 1½-, 2-, 3-, and 4-inch sizes, as well as in several colors to better match roofing materials. The manufacturer claims the boot eliminates the need for gaskets, caulks, or rubber seals. We found them for about $50 to $60 online. ***gaf.com***

12. Adjustable Deck Pedestal System

The Bison Level.Up Adjustable Deck Pedestal System replaces concrete footers and posts for decks up to 20 inches high (including the surface) with telescoping pedestals that the company says allow for fast, precise height adjustments. Each pedestal reportedly can support up to 750 pounds and accommodate grades up to an 8% slope. Bison reports that the pedestals are manufactured in the U.S. with 20% post-consumer recycled materials and are weather-, freeze-, and mold-resistant. We found a kit with 12 pedestals for about $280 online. ***level-updecking.com***

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

Vampire Tools Scissors and Screw Extractor Pliers

by **JAKE LEWANDOWSKI**

For several weeks, I've been using Vampire Tools' Super Combo Scissors and Brute Screw Extractor pliers to see how well they worked on the job. Vampire sells a variety of specialty shears and pliers for different applications. My first impression was that the tools seem well-made and geared toward professionals at a competitive price point.

Super Combo Scissors

We use scissors frequently for site protection, specifically for cutting finish floor guard for hardwood floors, rosin paper, Ram Board, heavy-duty 4- and 6-mil plastic, and light painters' plastic. We also use scissors for cutting rope like 550 paracord. We tested the Super Combo Scissors (VT-011) on all those materials.

Several features separate these scissors from most construction-grade scissors I have found at big box stores. The 4-in-1 multifunction tool has a flat blade for smooth cutting of cloth and paper and a lower, serrated blade to hold the material without slipping; a wire cutter close to the handle for copper or steel wire; and a built-in safety box opener for cartons.

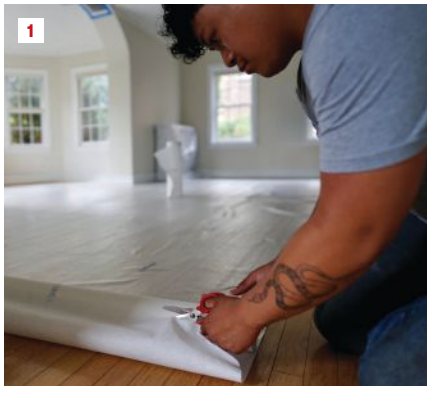
One feature we had mixed feelings about was the serrated blade. On one hand, it cut through heavy rope and 550 paracord easily and excelled at any chopping activity. On the flip side, when using the scissors to slice or push through 6-mil plastic, we had to be aware of how open the blades were. Because of this, some of the guys found using the scissors awkward for setting dust barrier walls. I liked the heavy-duty plastic sheath that came with the scissors came; it would be even better if it had a belt clip.

Brute 6.25-Inch Screw Extractor Pliers

After having the Brute Screw Extractor Pliers (VT-002-6) in my bag for a number of weeks, I can say I like them. They're smaller than lineman's pliers and similar to needle-nose pliers in size and feel, but with a clipped nose. Among other stand-out features, the black oxide coating seems extremely durable, and the thermoplastic rubber grips have a slight give and feel more slip-resistant than those on other pliers I've used. For pliers of this size, they have aggressive teeth, which, according to Vampire Tools, can bite onto stripped fasteners. I had limited success when I tried this.

My final take is that both tools are a solid value, and I am confident they'll perform as needed. I would struggle to find a better pair of scissors ($30) and pliers ($36) at these prices.

Jake Lewandowski is a construction manager with Chicago-based Great Lakes Builders.



PHOTOS THIS PAGE: JAKE LEWANDOWSKI

The author and his crew found Vampire Tools' Super Combo Scissors—priced at $30—to be useful for many tasks on site **(1)**. The Brute Screw Extractor pliers proved to be well made. They cost $36 **(2)**. You can find the full lineup at vampiretools.com.

Brunt Perkins Boot

by **JOHN CARROLL**

In my long career as a hands-on builder, I have spent more hours than I care to think about working on my knees. My 75-year-old knees have held up well, but I can't say the same about my work boots. The toes of my boots have always been the problem. They have quickly worn through as I've worked on hard, abrasive surfaces such as roofs, concrete slabs, and masonry paving.

The Brunt Perkins boot has solved this problem for me by adding a robust rubber toe cap in this vulnerable spot. After a year of use, the toes show no sign of wear. The rest of the boots, including the soles, have proven to be durable too (see photo, below).

Like all work boots, the Perkins comp toe work boot is built more for durability and safety than comfort. I didn't expect them to feel like track shoes or hiking boots, but I found them tolerably comfortable right out of the box. They have an OSHA-accepted safety toe, which is made of a composite rather than steel. They are also water-resistant. These are excellent work boots that are built to last. Unlike other high-quality work boots, they come with a moderate price tag of $160. All in all, a very good deal. bruntworkwear.com

John Carroll, author of Working Alone*, is a builder who lives and works in Durham, N.C.*

BOOTS: MATT NAVEY; CHALK: ARON JONES

Tajima Compact Chalk Line

by **ARON JONES**

As a carpenter, I appreciate it when a company does something that improves my day. This time, it was Tajima. I've been a fan of its chalk lines for a few decades. They are durable and reliable, and the new Chalk-Rite Compact is everything I would expect. It has the same rugged, jobsite-ready construction Tajima is known for: compact, heavy-duty aluminum case, collapsible metal handle, wear-resistant metal tip on the cap, and smooth-running five-gear winding mechanism. Plus, all those features now fit in a smaller package.

Tajima trimmed the fat without sacrificing performance. The new tool's slim body easily fits in small bags or pouches and clips to a belt, making it an exceptional line for anyone who does renovations or remodeling. How often do you need more than 50 feet of chalk line on a bathroom or kitchen renovation? With its smaller footprint and lighter weight, the Chalk-Rite Compact (CR701SFR) has secured a spot in my toolbox. It costs $50 at tajimatool.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.

The Chalk-Rite Compact chalk line performs as well as its larger cousins from Tajima without taking up as much space **(1)**. It is compatible with the company's clip-n-hold system for secure storage and convenience **(2)**.

A Letter of Appreciation to the Trades

by **MARC FORGET**

It has been a year since I hung up my hammer above the mantel and exchanged the tool belt and jobsite for a laptop and a home office. The learning curve has been vertical, and the work set very different from what I had relied on for the previous 20 years. In this change, I have been fortunate that my colleagues have been supportive and a pleasure to work with. This career transition came as a surprise to my friends and acquaintances and brings out a couple of consistent responses from them and me when I share the news.

Most people immediately say, "That should be easier on the body." I find that both an interesting first response and not necessarily the case, given the desk pounds I've acquired. The comment that always seems to follow is, "Do you miss it?" My answer is always "yes," but the why behind the "yes" is what I want to share with you today in the hope that you will discover (or re-discover?) what you find valuable in your own work.

The first point, as I can best describe it, is the "Doing." People in the trades use a novel combination of both physical and mental exertion that produces an irrefutable result. Some days, we just follow a script, and the work slips into a flow where the task is completed without our appearing to exert any thought. Think of the steady rhythm of laying a floor or shingling a roof. Other times, we spend most of the day grappling with math and angles, putting our effort into forming the plan before the stairs or intersecting roof lines or intricate flashing details take shape.

In either case, falling into production or solving the puzzle, we get satisfaction from creating something substantial that was not there before. The result of what we do is tangible and will be used by our customers and by others we will never know. In a world where so much feels temporary, doing something that results in a firm and lasting product is novel.

The other part of the job I miss is the people. The cast of characters in the trades is difficult to describe to outsiders. Good, bad, and many shades between, these personalities color our days and our stories long after they have moved on. When my old business partner and I meet up, the conversation will often turn to former subs and workmates. Since we are both terrible with names, these individuals are usually reduced to nicknames or anecdotes, not always complimentary. Even nameless, they are still remembered and continue to provide humor or instruction, and mark milestones in our careers.

PHOTO BY MARC FORGET

Even more important than the cut scenes that the bit players provide are the main characters that we work with as a crew. I have heard that many people find this kind of shared experience in sports or the military, but I found mine in construction. Working with other professionals to complete a task fulfills me, and then seeing the physical result at the end of the project enhances that gratification. The on-site banter and workflow shorthand, along with the shared obstacles overcome, are not easily replicated in a Zoom meeting.

Please don't mistake my observations for some romantic view of being on the tools. The jingoism about the trades that you see printed on shirts or bumper stickers has never held weight with me. The glossy view of working in construction quickly tarnishes when a 2x6 shatters in your hand from the cold or when you visit the ER after having a violent disagreement with a table saw.

There must be something, though, that keeps you going beyond a paycheck or a clever quote on a hat. I certainly don't miss some parts—the commute, the dust, the uncomfortable temperatures, and many other dimensions. My career change has already given me new ways to measure accomplishment and has provided space to think through what parts of my old one kept me motivated. Go find yours.

Marc Forget is an associate editor with JLC.

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