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Retrofitting Air-to-Water
Heat Pumps

Architectural Lighting



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On the cover: Rudolph Waros of Specialty Glass Services installs one of his custom stained-glass sidelights at the Queen of Zero project—the 2024 *JLC* case-study home—in Maryland. See the story on page 24. Photo by Jennifer Chase.

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BY MARC FORGET

Building a Career in Carpentry



Level 1 students practice introductory hand-tool skills at Algonquin College, in Ottawa, Ontario (top). Above, a shop station is set up for trim work and tool familiarization.

Each of us has a unique path into the trades. It could be that summer job that never ended, a high school course that grabbed our interest, or a family connection that brought us in. On that path, we received training on the job and perhaps some instruction in a school setting. Here, I share some details about the program that provided me with training in my career and encourage you to seek out opportunities that will help you grow your own.

In Canada, we have more than 400 professions open to apprenticeship programs that are under the jurisdiction of each province or territory, while for 54 of those trades, the federal government provides an added framework that ensures that training standards are met across the country, with final certifications being nationally recognized under the Red Seal program. Those Red Seal trades include electrician, gas fitter, and carpenter, the latter being the program that I'll discuss here. Apprenticeship in a trade has a long history, going back to the 12th century with craft guilds in Europe. In much the same way, that system of learning skills under a master carpenter to become a journeyman, with some instruction or examination in the guild house along with on-site tutelage, continues today in Canada. To earn a journeyman certification, individuals can choose among three paths, the most important being apprenticeship.

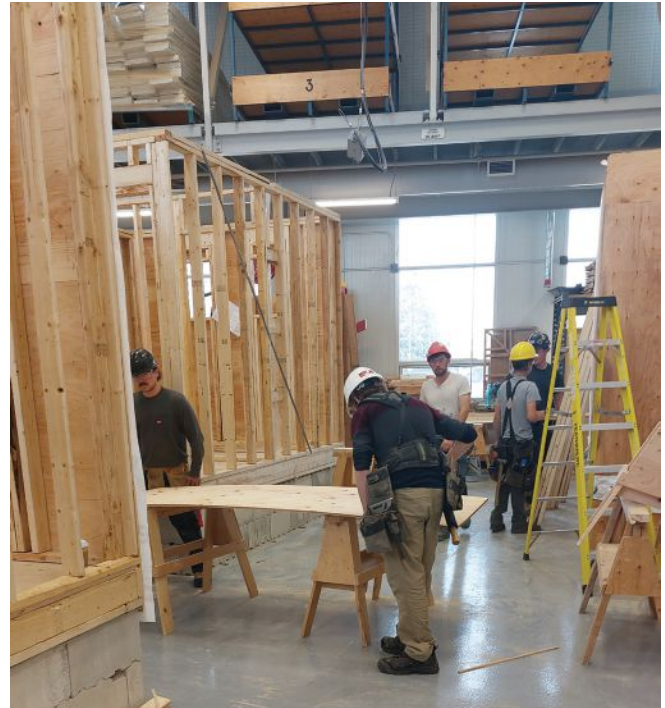
In the first option, a prospective apprentice finds a licensed employer to sponsor them, and the two sign an agreement with the provincial government. The individual will then be added to a list to be called for school training when a spot opens. Usually, an apprentice will work for a year or so, then take a level of training, then go back to work for another year and do the next level of training until they are finished. An apprentice can have multiple employers over the time needed to acquire the necessary hours, as long as each agrees to be a sponsor.

A second route is to take a related post-secondary technician or technologist course that equates to one or two levels of the apprenticeship program and then find an employment sponsor to begin the path of apprenticeship for further training.

The final option is for workers who have been in a trade for many years and may not have had the finances or educational background for the in-school training. These candidates provide proof of the hours spent on the job and then challenge the final Certificate of Qualification (C of Q) exam that completes the apprenticeship. With preparation in building codes, calculations, and safety, many workers have been able to receive certificates later in their careers.

The apprenticeship program in carpentry requires 7,200 hours

Photos by Marc Forget



Starting with hand tools and bench skills, students work up to larger projects as the levels progress. Here, the students are making miter boxes (above left). Wall layout and framing is being practiced by the level 2 students in their teams (above right).

combined on the job and in school training—generally, a little more than 6,000 hours on the job and more than 1,000 hours in class. Most candidates take four years or so to complete the requirements. The in-class portions are four intakes, each seven weeks in duration. This training occurs at local colleges or at a union training center, with the curriculum being the same wherever it's taught. During the apprenticeship period, the individual carries a logbook that must be signed by a licensed or competent worker to certify that the apprentice has reached a level of knowledge on different aspects of the job—framing, finishing carpentry, form work, and site safety, to name a few. Once the apprentice has completed the in-school training with passing grades at each level, reached the required on-the-job hours with proof from their employers, and acquired the logbook signatures, they can sign up to write the Certificate of Qualification. This exam is created with input from colleges and tradespeople from across the country and administered by the province.

The exam consists of questions on many aspects of carpentry. Sections on framing, concrete work, interior and exterior finishing, planning and layout, common occupational skills (safety, rigging, site management, etc.), and renovations are all included. The exam has a time limit of four hours and a pass score is 70%, with a cost that varies by province (in Ontario, it is \$150 (Canadian) plus tax). With successful completion of the exam, the individual will have

an Interprovincial Certificate of Qualification Red Seal in carpentry.

To reach this point, an applicant will encounter some costs, although some support is provided. The schooling itself may be fully paid by the province or, at minimum, heavily subsidized by the government, but in some jurisdictions, the apprentices must pay a fee of a few hundred dollars for each or some of the training intakes. While training in school, apprentices are eligible for unemployment insurance, with possible added allowances for travel to the training facility and childcare subsidies. At present, grants of \$1,000 and \$2,000 are available upon successful completion of each level for completing the Red Seal exam, up to a maximum of \$4,000. Apprentices can also apply for loans and grants for tools and business expenses. These payouts have ebbed and flowed over the years depending on government policy.

While I followed the path outlined above, most carpenters don't. Unlike certain designated trades—for example, electricians or plumbers must be either an apprentice or licensed to perform the work—carpenters do not need certification to work. Most who have an interest in carpentry get a job and start earning and learning on the job without going through the apprenticeship system.

Because the apprenticeship program is so comprehensive, apprentices are required to learn skills that they may never directly use in their career. In a conversation I had recently with



The apprentices practice large-scale projects in an open shop. Not being subject to the weather is a nice change for them. While not quite the same as being on site, working in a controlled environment allows for mistakes (learning opportunities) to happen under supervision. Similar setups to this exist in colleges and union training centers across Canada.



The Red Seal indicates that an individual has spent the time and effort to meet a nationally recognized standard. While going through the various levels of the program, the apprentice can experience many different aspects of the trade they have chosen and then build on what they learned to further their career.

an accomplished carpenter who is not licensed, he bemoaned the training in stair building and calculations in the Red Seal. Most stairs are built in specialized shops and then brought to site, so why train for what most don't do, he said. In my case, I had to train in concrete formwork, which I never touched again in 20 years (mostly by choice). Instead of creating a generalist jack of all trades within carpentry, some argue, the program should be separated into sections like trim or forming. After all, that is often the way it happens for those in the work force. They start with a company, roofing, for instance, and then work and learn to be a roofer.

Outside of the apprenticeship, shorter courses do exist that specialize in specific parts of the trade, like framing and flooring. If such a program offers a quicker path to training in a specific area, usually with an opportunity for a job right away, why should a person dedicate time and money for training in all aspects of carpentry like the Red Seal provides? In large centers particularly, the trend is to have narrowly trained "installers" perform the work on site. The problem with this is that when that narrow skill is not in demand, the worker is not able to pivot to work that is available. While some of these specific training offerings can be useful and a start, they should be the beginning of your path, not the end. The



It was all about framing in the main shop during this visit by the author at his former school. Formwork, roofing, scaffolding, and more all happen hands-on throughout the program. A combination of practical training and in-class instruction fills the seven weeks of each level.

carpenters whose work I most respected over the years tried their hand at many different parts of the trade.

Here lies the point I would like to make to those who are starting out in construction: If you want to build a career and not just start a job, you need to seek out varied knowledge and experience. The broader skill set provided by the apprenticeship program allowed me to be nimble early in my career and, when the economy cycled, I most often stayed employed.

Other post-secondary courses exist outside of apprenticeship programs. If school isn't an option, then invest in yourself by searching out different job opportunities early in your career to broaden your knowledge. Most people specialize as time goes by; if you spend time working on flooring or framing, for example, you will discover whether it suits you. Some tasks you will enjoy more and will therefore want to do more of and get better at. Others you will find that you would rather avoid. The knowledge gained in the task—even just discovering that you don't like it—will turn out to be useful in situations that you may not anticipate now. Roofing, concrete forming, and stair calculations didn't turn into the focus of my career but learning about them did help me when I was running jobsites and then my own business later in my career.

For a ground level example—say, hanging a door—you will be better able to deal with any issues that come up if you know what is going on with the framing. That holds true for hanging board, laying hardwood, or installing cabinets. The projects you will work on are a series of parts, like foundation, drywall, and so forth, but all trades are about problem solving—it is the aspect that I enjoyed the most—and with more understanding of how each part affects the other, you will be more successful at solving the puzzles that come. As my grandmother would say, all knowledge is useful; you just don't know when you'll use it.

While this article provides an introduction to a program, along with its opportunities and process, that you may not have known about, more importantly, I hope it has also given you a better understanding that training in school or on the job is about building a base of experience. The wider and more varied that base is, the greater your ability will be to take advantage of opportunities you come across. That in turn should lead to more pay, more job satisfaction, and a better career. The quip “A jack of all trades is a master of none” is used as an insult against a person who has more than one focus to their work. What is forgotten is that the whole quote is “A jack of all trades is a master of none but oftentimes better than a master of one.”



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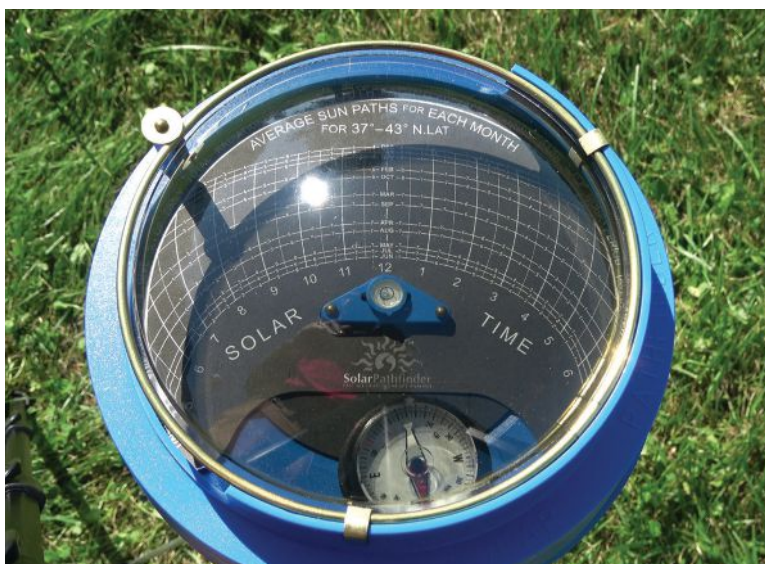
Q We are doing a whole-house remodel for a client who wants to add rooftop solar. There are a couple of places on the house facing west and south where it seems like solar panels would work well, but there are also quite a few trees on the site. We would like to advise our clients on the best location for the panels. How does one go about evaluating a site for placing photovoltaics?

A *Drew Schiavone, energy conservation and technology specialist at the University of Maryland, responds:* South-facing rooftops are ideal for solar installations in the northern hemisphere as they receive the most sunlight throughout the day, maximizing energy production and efficiency. The sun rises in the east and sets in the west, reaching its highest point in the southern sky around noon. South-facing panels are oriented to capture this path, ensuring they receive direct sunlight for the longest period each day. West-facing rooftops can be suitable in some cases, particularly if your energy consumption peaks in the late afternoon and early evening. Although west-facing systems generate less power overall compared with south-facing panels, they can help meet peak demand times.

You're right to consider the impact of trees on the efficiency of the solar panels. Panels should be placed in areas with minimal shading, and any trees that cause significant shading (often referred to as nuisance trees) should be removed or regularly trimmed to prevent shadows. By doing a solar assessment using tools like a Solar Pathfinder (which helps identify shading patterns), drone surveys, and/or lidar (light detection and ranging), you can get an accurate picture of what can be produced from solar panels in a specific location. These tracking methods will show you what energy you will be able to capture throughout the year. With that information, you can begin to design the size of the solar system needed to meet the clients' goals.

I tend to look at this with a holistic approach, however. If the shading from trees is going to reduce the efficiency of the solar system, clear-cutting a bunch of trees from the property may not be the route you want to go. A balance needs to be found to maintain both the efficiency of the solar system and the environmental benefits of the trees. So, perhaps looking at adding panels on the west side also may be a better overall option. If you discuss with the clients upfront what their goals are and maximize efficiency throughout the home, then the capacity of the system will be easier to manage. Perhaps shading will be less of a problem.

One of the issues I run into is that expectations of the system are not always thought out. Many people will look at the maximum output of the system as what they should expect every day, but that won't be the case; factors like weather conditions, seasonal changes, and shading can all affect the system's efficiency. Solar is not a silver bullet but a part of meeting the client's goals, such as cost savings, energy efficiency, carbon footprint, and so forth. Also think about possible future needs. Will there be a heat pump or vehicle charging in the coming years? Before you even start designing the system, it's important to have these conversations to establish realistic expectations.



The Solar Pathfinder houses a sun-path diagram within a plastic dome. For a detailed description of its use, go to @EnergyUME on YouTube.

Photo by Drew Schiavone

Scribing Inlays for Wood Floors

BY TOM OURADA

I am a hardwood installer who specializes in creating intricate images and patterns in my clients' flooring projects. To demonstrate the techniques I've developed through trial and error (a lot of both) to achieve fillerless results in $\frac{3}{4}$ -inch hard-

wood, I'm going to use a project I created for this article—a multicolored ball made from wenge, maple, Brazilian cherry, and white oak. Like any other learned skill, these techniques take practice and patience to execute. You can use the tools

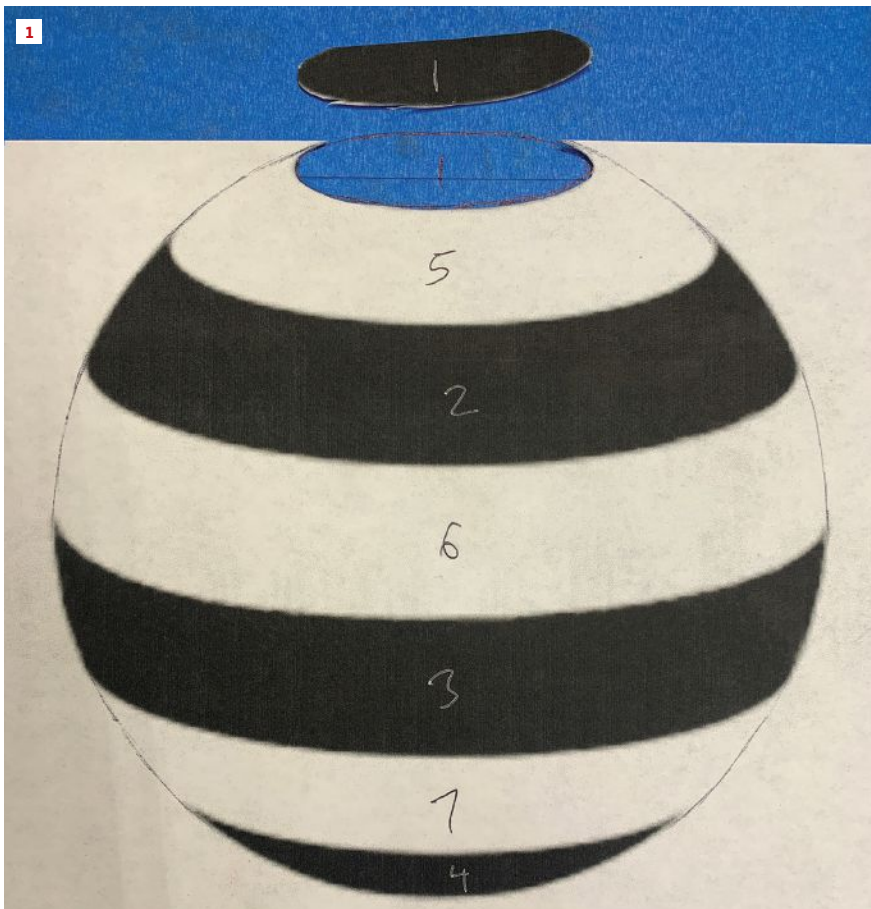
you have, of course, but I generally use a 4-foot-by-24-inch oscillating belt sander, a 1-inch-by-42-inch vertical belt sander, an oscillating spindle sander with spindles of various diameters, and a band saw with a $\frac{3}{16}$ -inch blade. With these four tools, I have created many intricate, nonlinear inlays in flooring.

Projects all start with a design penciled out and separated into pieces (1). Depth and definition of the design are then created by using different colors of wood like paint. A basic color palette can be started with maple for white and wenge for black and then expanded with as many different species as needed (2).

Some basics. A clear line is key to accurately mating inlays. I prefer using a pen because the ink lays down a dark (or white) line that stays a consistent width, whereas a traditional pencil point changes dimension as it wears (3). Mechanical pencils are consistent in width, but the graphite doesn't show up well on some woods. My definition of a line for these techniques is a mark that has two edges (one on either side) and a middle, which are all important to recognize when I cut.

I distinguish two types of cuts: a side-cut and a through-cut. For a side-cut, a blade cuts with its kerf just to the edge of the line but never touching it. I use this cut when the line is on a part of the wood piece to be saved. A through-cut has the kerf of the blade cutting through the middle of the line but always leaving just a bit of the line showing so as not to cut into the piece of wood to be saved (4). I use a through-cut when one edge of the line is at the edge of the piece of wood being saved, but the line itself is not being saved.

Only the edges—the set edge and the



The author uses this ball design, which he drew up for this article, to template pieces of $\frac{3}{4}$ -inch-thick pieces of maple and wenge (1).

Photos by Tom Ourada

mating edge—of two pieces of wood are paired together at a time. For example, in photo 6, the darker wenge marked “4” is the set piece, and the lighter maple with a “7” is the mating piece. The set edge is to be cut to the desired shape with only the kerf cuts sanded smooth. No further work needs to be done to its edge; think of this as set in stone. The mating-edge piece is then cut to fit to the set edge by scribing.

The through- and side-cuts work in tandem with the lines created by scribing nonlinear shapes from a set edge. Scribing the nonlinear shape onto the mating piece from the set-edge piece can be done with the following four techniques: Paper scribe, top scribe, rough parallel scribe, and high side scribe.

Paper scribe. I use paper to copy the shape of the set edge and transpose that edge to another piece of wood (the mating piece). I put the paper atop the workpiece to be copied and secure it with two points of contact (I use two fingers; tape is too slow and messy. Remember, it is important that the paper doesn’t move). Holding the paper firmly over the set edge with at least two points of contact, I lightly run a finger on the paper along the edge of the wood underneath, creating a slight crease (5). Coating the finger with pencil graphite first defines the crease with a darkened line, making it easier to see where to cut. Using a sharp utility knife and the darkened crease as a guide, I smoothly cut the paper along the edge of the wood, making sure to cut right to the edge of the wood (I am still holding the paper with at least two points of contact).

I remove any excess paper and place the resulting pattern onto the piece to be mated (I use the grain as another design

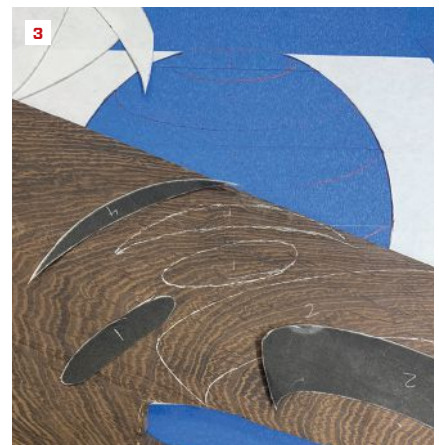
feature, so it may determine where on the mating piece I place the scribe paper). Again maintaining two points of contact, I use the thickness of the paper’s edge as a guide for the pen tip to draw a line. I make sure not to apply too much pressure against the paper’s lip so I don’t draw under the paper’s edge. Three points of contact work best here, as two fingers walk along the edge to hold the paper down firmly while the third repositions.

A top scribe is similar to the paper scribe in that the set-edge piece (like the piece of paper) is placed atop the mating piece (6). I follow the same procedures as before, with care taken to keep two points of pressure on the set edge to prevent movement when tracing the set edge on to the mating piece.

The rough parallel scribe is used when the two workpieces are already similar enough that they can be placed closely together. This closeness allows the scribe line to be hand-drawn parallel from the set-edge piece onto the piece being mated. I do this first to get close and then transition to my high-side-scribe technique.

For the high side scribe, I hold the set edge slightly higher against the mating piece but not on top of it. Depending on the size of the gap between the set edge and the mating edge, I either hold the tip of the pen (when the gap is tight) against the set edge to make the mark or use the outer diameter of the pen to distance the tip away from the set edge (with a larger gap).

Once the line is established by any of the methods above, I determine if the line should be cut with a through-cut (the line is not part of the piece you’re saving; see photo 4) or a side-cut (the line is part of the piece you’re saving; see photo 7). After I cut



With the first cuts the author makes, you can see the illusion of depth created by the contrasting colors and attention to grain orientation (2). The white pen leaves a consistent and easily seen line on the dark wenge (3).



Here is an example of a through-cut in a section of maple. A slight back bevel allows for easier fine-tuning later (4). A darkened finger tip run along the edge of the wood on the paper creates a crease and an easy-to-see line. Cutting along this line will make a template (5).



Here, the author is top scribing. The part marked with a “4” is the set edge and the one marked with a “7” is the mating edge (6). The author makes a side-cut in the Brazilian cherry that will have the bottom part of the ball set into it (7).

the mating piece and it appears to fit closely, I lightly sand off the kerf marks before moving along to fine-tuning.

Sanding is a more precise means of removing material at this point. Using an oscillating belt sander or other sanding device, I carefully sand almost all of the line off and check to see how the pieces fit together. Marking two lines as “anchors” on both pieces of wood (the mating piece and the set piece) maintains their collaborative orientation throughout the fine-tuning process. The anchor lines (8) are needed because as the fit between the two pieces tightens, any shift errantly in either direction can create new gaps or high spots and can lead to removal of more material than needed.

Fine-tuning. As the pieces fit more tightly together, fine adjustments are required to get the final tight fit. High spots are the single areas on the mating edge that touch the set edge first, preventing the rest of the mating edge from coupling tightly together. The three principle kinds of notations I created for marking areas to sand are anchor hash marks, apex hash marks, and transitional arcs. Anchor marks designate both starting and stopping points of material removal and serve as positioning points common to the set and mating pieces across the edge where they meet. Apex hash marks are perpendicular to the anchors and indicate the point where the mating piece is the farthest away from the set edge. Transitional arcs with anchors are the combination of two anchors and an apex, with the arc representing the amount of material that needs to be sanded off the mating piece.

Using this marking system helps me further refine the fit but, depending on how much I still need to work the edge, I use a second simple marking system. This is for my final fine-tuning. The first of these marks are just half-circles that mark where a bump to be removed starts and stops. The type of marks you use are up to you; the

important thing is to keep organized as you work the pieces closer together. There can be multiple bumps on an edge, and I find noting as many of them as possible at a time reduces the number of trips to the sander and helps keep them highlighted for the long trip to the tool (8).

I keep my sander right next to me, but that's still far enough away for my brain that I often forget what needs to be sanded. Most edges require multiple sets of notations and with that comes notation congestion. So to keep track, the marks I make have an order to them. The first ones are the half-circles mentioned above, next are "V's," then a "V" with a dot. The point is I can tell how far along I have come and what I've worked on already. You can get creative to differentiate the marks; when there are too many notations, I sand them off with sandpaper that I have handy, and start fresh.

Using a hot glue gun, once the set edge and the mating piece are as tight as you want them, dab a few drops on one of the edges and quickly smash them together with the anchor marks aligned. The hot glue is forgivable in this situation; if the two pieces need to be separated, for whatever reason, they can be easily pulled apart and the glue scraped off without too much worry about damage. I have found the hot glue essential for keeping hundreds of pieces together and organized while I'm constructing very intricate inlays.

I use the grain and color of the wood pieces to accentuate the design. I also try to forecast how the wood color will change with time so that the pattern will maintain its look. I've found that the most important tool I have, however, is patience, so be sure to give yourself plenty of time and find the process that works for you.

Tom Ourada is a flooring installer and craftsman in Nine Mile Falls, Wash. Check out his work at ouradadesigns.com.



The author makes anchor marks to keep the pieces in alignment as he refines the fit (8). With the various marks the author uses, he is able to highlight points of reference and areas to be removed (9).



The project is sanded and finish coated (10).

Adding a Fire Escape

BY ROB CORBO

When I review a set of plans that includes a type of construction we have never attempted before, my emotions run the gamut from the excitement of a new challenge to the anxiousness of an uncertain outcome. The latter feeling prevailed when I reviewed a three-story fire escape for a recent job in Hoboken, N.J. We had never erected a fire escape before, and increasing my anxiety was its location—it was to land on a concrete roof/patio above the homeowner's bedroom expansion. My concerns were eased by a couple of things: A professional engineer designed the fire-escape patio landing, and we had a structural-steel sub that could do the work.

The architectural plans reflected the homeowner's goal of expanding his daughter's bedroom at the garden level and expanding the two apartments above by squaring the back of the building, which stepped back from the first floor at each of the floors above; the project would add 8 feet to the second-floor apartment and 16 feet to the third-floor unit. When the architect presented the plan to the city, the building authority informed the architect and

homeowner that to meet code, the upgrade required installing a fire escape to service the two apartments and provide roof access. While that added to the budget, the homeowner was willing to move forward.

Our construction plan was to build the garden-level bedroom expansion first and once finished, use the bedroom's roof/patio to erect scaffolding for construction of the upper levels. The footprint of the garden-level expansion measured 14 feet by 18 feet. It would be built where an existing patio and retaining walls had been constructed years before. The retaining walls were constructed with a future expansion in mind, but to make sure we could build off them, we dug three exploratory holes to check their existing footings. The architect joined us on site for the examination. She cleared the retaining walls for construction, and we started the block work. Once that was finished, things got interesting.

The engineer's structural plan for the roof, designed to support the future fire escape, called for two W12x26 I-beams running parallel across the addition block walls in a north to south direction, 4½ feet apart,

and 18½ feet in length. In the southeastern quadrant of the addition, W8x18 I-beams were to be welded between the W12x26 I-beams, creating a 4-by-9-foot rectangle that reflected the fire-escape footprint. Equally spaced and welded across the top of the I-beam rectangle, six 18-inch-high HSS (hollow structural section) 4-by-4-by-5/16-inch steel tubes were placed to receive the fire escape posts.

There was one aspect of the structural plan I couldn't shake. A 20-foot W12x26 beam would be 12 inches high and weigh 26 pounds per foot, or 520 pounds per piece. In Hoboken, a community of mostly attached housing, there is no access to a backyard via a driveway or side yard. Therefore, we couldn't use any machines to carry the steel to the backyard or lift it to the top of the block wall; we'd have to carry every piece of steel by hand through the front window, through the house, and out the back door. To lighten the load, I asked the engineer if we might substitute two C-channels bolted together on site to create an acceptable I-beam. One C-channel would weigh less than the beam and would be less of a danger



Before work began, the building stepped back on the second and third levels. Additions on the two levels will align with the brick wall of the main level (1). With the back patio demolished, block work begins (2), and an extension of the basement-level slab is prepped for the pour (3).

Photos by Rob Corbo



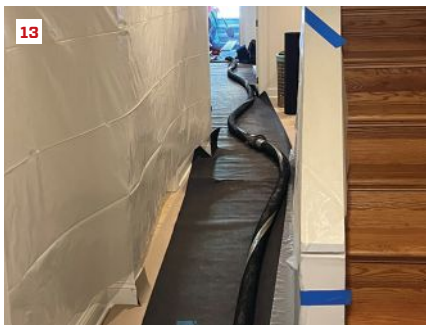
With the basement-level block walls up, the crew receives the individual pieces of steel C-channel for the beams, threading them through a front window (4) and carrying them through the house (5). The lengths of C-channel are placed atop the block walls to be fabricated into beams (6).



To create the beams, the steel fabricator spot-welded and bolted the C-channel together (7). Angle iron to support the corrugated steel decking was bolted to the C-channel, and the completed beams were painted with red oxide primer (8, 9).



Blocks are fitted around the beam ends to form pockets (10), and short, intersecting I-beams are added between the main beams (11). These short beams will support the square tubing stub-outs that will connect to the fire escape. The deck, which will support the fire escape and serve as a patio, is ready to be poured (12).



With no access to the backyard, the hose from the pumper truck has to run through the basement (13). Yellow string lines guide the placement (14, 15) and finishing (16) of the slab, which slopes to a center drain. The new basement area was insulated (17) and finished while the second- and third-level additions were built out and the fire escape was erected (18).

to the crew. I kept imagining a slip, a drop, and a crushed foot. The downside was two-fold: We'd have to carry two C-channels for each beam, and we'd need to drill and bolt the channels together. The engineer agreed and specified C10x20 channels. These were lighter by 6 pounds per foot—120 pounds lighter per 20-foot length—so each piece would be 400 pounds instead of 520 pounds. I discussed the option with the sub doing the work, and he opted for the C-channels. He drilled, bolted, and spot-welded the channel for no extra charge.

Once the C10x20s and W8x18s were bolted and welded and all in place, we welded 4x4 angle iron to the beam webs. The angle iron was set to carry 20-gauge galvanized metal decking and metal mesh for the concrete pour to follow. The metal decking was spot-welded to the angle iron.

It's Hoboken, so for the pour, we had to orchestrate a pumper truck, a concrete truck, no parking at the site, and a police officer to open and close the street as re-

quired during the pour. The concrete truck had to back down a one-way street to align with the back end of the pumper. We ran the pumper hose through the garden-level hallway to the backyard, pouring 6 inches of concrete at the perimeter and pitching it to 4½ inches at a center drain. I am happy to say the concrete flowed nicely throughout the pour. No hose clogs, no machinery breakdowns, no traffic accidents, no pedestrian injuries, and no blowouts. We let the slab cure for a few days and then set scaffolding up to build out the upper levels.

The mason constructed the upper-level additions with block, steel, and a brick veneer. Once the veneer was completed, Flores Welders, the iron guy, came by to take his measurements for the fire escape. During our meeting, the homeowner requested all platforms be curved on the outside and have a curved handrail to make the unit a bit more attractive. While the platform end frames and handrails were being bent, Flores' guys started extending the 4x4 square tubing

stub-outs that were welded on the roof/patio steel infrastructure before the concrete pad was poured. The 4x4 extensions are done in sections: Extend the tubing 10 feet, install the first set of stairs, the first platform, and the next set of stairs; then, extend the tubing for the next level and continue up. The building extension took longer than I had hoped, which kept Flores off site.

As of this writing, the fire escape is taking longer than I had hoped, but everyone is busy juggling jobs trying to make everyone happy, while not making anyone happy. So it goes in construction. Until the fire escape is finished, the HVAC and roofer subs will not have roof access to finish their work. I tell myself, no worries, the last 40 years have passed in a heartbeat; another week or two for completion of the fire escape will be piece of cake.

Rob Corbo is a building contractor based in Elizabeth, N.J., specializing in high-quality gut rehabs and renovations of inner-city residences.



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BY IAN SCHWANDT

Transitioning to Hybrid Production Management

During its life cycle, a residential remodeling company faces several moments when it must change if it is to grow and stay profitable. The most obvious moment is when a company founder recognizes they can no longer keep up with the needs of the business while also working in the field. This is when they trade in their toolbelt for sales training and spreadsheets.

The lead carpenter system was born out of the baby boomer generation as it aged into prime earning years. Company founders faced this transition by coaching their high-performing employees to run projects with their toolbelts on, just as they had done, and the resulting lead carpenter system has proven to be a more scalable alternative to a founder leading one or two project crews at once. However, as project size and complexity increase, some companies are beginning to shift toward a project manager-based system or a hybrid system with both lead carpenters and project managers, in hopes of maintaining scalability and profitability.

TDS Custom Construction, where I am the production manager, began the shift to a hybrid lead-carpenter and project-manager system about two years ago, and we see our ability to create project teams with both lead carpenters and project managers as vital to executing a higher number of complex projects each year. We moved in this direction in reaction to ever-increasing administrative requirements during the contract and preconstruction phases. Pulling lead carpenters out of the field or having upper management execute administrative and planning tasks did not prove to be as scalable as adding a layer of project managers to the team.

HOW IT WORKS

Our project teams—made up of in-house design staff, project managers, lead carpenters, and our production coordinator—form after the design team signs off on the schematic design. Each team member has a repeatable set of responsibilities; using JobTread construction management software, we track these and create a project package for the lead carpenter.

The project manager is the first production team member to get involved while a project is still in the design phase. They conduct site walk-throughs, take the lead in developing trade-partner and vendor scopes of work, and solicit pricing for the subcontracted portions of the project. This early involvement gives the project manager time to develop a deep understanding of the project goals, the client, and the design intent, which in turn provides a strong foundation for carrying the project from design through to completion with the lead carpenter.

Post contract, the project manager teams up with our production coordinator to “buy out” the project by issuing purchase orders

Creating project teams with both lead carpenters and project managers is vital to executing a higher number of complex projects each year.

to the selected vendors and trade partners with whom the project manager worked during the design phase.

The production coordinator sets up the project in JobTread by building the baseline schedule, uploading important project documents, ordering items with long lead times, and setting up the budget for job costing. During this preconstruction phase, the project manager focuses on building a field team that meets the needs of the project and prepping the client and their home for the work ahead. The lead carpenter typically gets their first look at the drawings and specs of the project during this phase by attending meetings with the project manager and the design team.

Armed with an understanding of the design intent and the project goals, the lead carpenter works with the project manager to source non-purchase-order materials and set up the site requirements—dumpsters, construction toilets, and rented equipment—for the project start. During the build phase, the lead carpenter directs all work on the site, schedules deliveries and trade partners, orders materials, and manages the client’s day-to-day needs. Project managers focus on job costing and managing the overall schedule using JobTread, in addition to leading a weekly meeting with the client. Our project managers also participate in weekly tactical planning meetings at our office where I work with them to build three-week and quarterly look-aheads to manage our labor pool and the start-date expectations of future clients.

This division of labor enables our project managers to serve as the bridge between the office-based employees and the field-based build team, while maximizing the number of projects that our teams can run concurrently. Each project manager handles four to six remodeling projects at once, depending on job size, and each lead carpenter runs the sites for one to three projects, based on their level of experience. Like the move to the lead carpenter system before it, the transition to a hybrid or project-manager-based system is an important step in the evolution of remodeling companies aimed at increased profitability and efficiency.

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

What Is Leadership?

They say there are no stupid questions, but “What is a leader?” may qualify. Still, not having a great answer to that question for most of my adult life was the most significant impediment I faced in embracing the idea of being a leader.

When I was young, I was a Boy Scout. Though people say that scouting is a good way to learn leadership skills, I was mostly in it to get out of the house. Most of what I understood to be leadership fell on the shoulders of the adults in our troop: “Set up your tent.” “Go to sleep.” “Stop throwing that!” During my college years, I took outdoorsy summer jobs that also purported to build leadership skills. Again, it didn’t seem that there was a lot to this leadership thing. Make a menu, organize some outdoorsy work, and tell other outdoorsy kids where to set up their tents and who is cooking dinner and breakfast. I could do all of that, but did that make me a leader?

Years later, after learning construction, co-founding a remodeling business, and hearing about leadership this and that, I was suffering from a mild yet persistent case of what we now call impostor syndrome—the fear of being discovered as a fraud. As a business owner, I was supposed to be good at leadership, but what was leadership?

Leaders are loud, leaders are born. Leaders have been through Navy Seals BUD/S training. Leaders have a particular DISC profile, Kolbe A Index, Myers-Briggs profile, or Dungeons & Dragons character and alignment (Chaotic Neutral Druid here). I’ve never been the square-jawed, loud person who walks in and dominates a room. Natural-born leaders can be heard outside over the din of battle. I’m quiet and avoid loud noises. When I try to shout over noise, my voice cracks like a 13-year-old’s—not the same impact as, say, someone like Jocko Willink, the exemplary square-jawed author of *Extreme Ownership: How U.S. Navy Seals Lead and Win*. Not identifying with any of those leadership models contributed to my impostor syndrome; as far as I could tell, I didn’t have the stuff that leaders have.

Clearly, that changed. Several years ago, I got involved with a group of guys who were mostly exercising together and goofing off in the early hours of the morning as part of a loosely organized national group called F3. Its stated mission is to “plant, grow, and serve small men’s workout groups for the invigoration of male community leadership.” I was all-in on the exercise, and meeting some new guys sounded great. The idea of discussing and practicing leadership was intriguing. I didn’t know how jumping jacks, burpees, and push-ups at 5:30 a.m. would contribute to my growth as a leader, but as a lifelong leadership impostor looking for answers, I decided to attend the group’s weekly evening leadership discussions. At one of the initial meetings, a definition of leadership was offered: A leader is a person who influences the movement of a group toward a position of advantage.

Some people might be born with a square jaw and a loud voice, but nobody is born a leader.

Oh. That’s it? All this time, and the answer is that simple. So, when I told those outdoorsy kids to set up the tents over there because they wouldn’t flood if it rained, I was being a leader? And I did that without having graduated from West Point? This was a light-bulb moment. Not only did the concept of leadership suddenly become more relatable, but I also realized that the reason it hadn’t been was that I didn’t have a definition of leadership. With that simple, single-sentence definition, I knew that leadership was not only something that I could do but also something that I had been doing for much of my life.

Of course, owning and managing a business presents more complex challenges than siting tents, and the position of advantage that we need to move toward is not always clear, but the fundamentals are similar. A leader needs to have the vision to see the position of advantage and clearly articulate how to get there. And a leader needs to embrace the fact that movement will cause disruption of the status quo. Seeing the good spot for the tents, telling people where to set them up, and understanding the extra effort it might take is easier than, say, restructuring the roles and responsibilities of the members of your production department, but here is the fantastic other thing I realized about leadership after learning this definition: Anyone can practice the required skills and get better at them. The notion of a “born leader” is baloney. Some people might be born with a square jaw and a loud voice, but nobody is born a leader.

In the exercise group, everyone shares in leading workouts. Every week, anyone can plan a workout and lead a small group for an hour. It’s good practice in a safe space where failure will not cost anyone anything. Similarly, there are plenty of other low-pressure opportunities for anyone to practice leadership by moving any group they are associated with to a position of advantage. Planning a family vacation with my wife is an opportunity to practice leadership. So is planning with friends to go camping or meet up for a mountain bike ride. Grocery shopping with my kids might be the most challenging leadership practice. Understanding what leadership is helps me find opportunities to practice and continually polish leadership skills for more significant tasks; without a good definition and lots of practice, I would still be floundering as a leadership impostor.

Zach Snider is principal of Alloy Architecture + Construction based in Charlottesville, Va.

BY MARK PARLEE

Tracing a Troublesome Window Leak

Last fall, I was hired by a builder to consult about a window leak on a home he had completed only two years earlier. The owner of this home, in Slater, Iowa, had called him back because a small section of the interior MDF trim had swollen, and the paint cracked just below one of the mullions (1, 2). When I inserted a moisture-meter probe just below the mullion, it registered an elevated moisture content. Taking things slowly, so as not to create too much of a mess for the homeowner all at once, I asked the builder to start by removing the exterior trim. I returned later to investigate.

On my return visit, we observed a slight opening on top of the window at the mullion where two windows joined—a clear point of water entry (3). The other mullion in the three-window array had been sealed all the way to the nail fin, and there was no visible swelling on the interior.

The exact path of the leak to the interior still wasn't clear until the builder removed the interior trim. On a third visit, I conducted a light water-spray test with a simple pump sprayer and observed water dripping at the base of the window almost immediately. During the test, I directed the spray at the mullions, starting

about 6 inches above the sill, moving about halfway up the window, and then proceeding to the top—at all three locations, water leaks became evident.

Working from the interior after spraying the mullions, I used a moisture meter to map the moisture content along the entire base of the window. The moisture content was highest at the location of the failing interior trim (44% MC) and was elevated (around 24% MC) at locations at or near shims. Between shims along the sill, the moisture content remained within the range of normal (below 16% MC). Clearly, the shims were part of the problem, but that was not all.

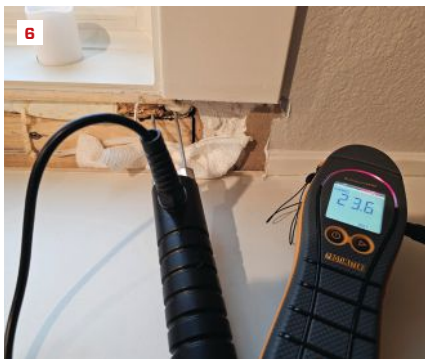
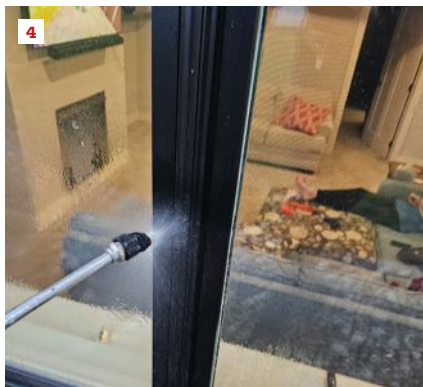
The builder told me that Pella service had looked at the window and reported everything was fine. I had a different outlook. The following is my assessment of the window installation:

Sill flashing. Pella allows use of DuPont flashing tapes, and the builder had used DuPont StraightFlash to form a sill pan. This was not an outright failure, but I recommend using DuPont's FlexWrap tape at the sill because I believe the channels in the flexible tape help to direct water to the exterior (in addition to FlexWrap's being easier to form a tight seal at corners).



The author was called to investigate what the builder believed was a window leak that caused the interior MDF sill trim to expand and the paint to crack near one mullion (1). From the exterior, there were no apparent leaks (2). It's worth noting that splash back from roof runoff was an unlikely contributor to the problem, as this house has a functional gutter system.

Photos by Mark Parlee



Once the exterior window trim was removed, the author observed a slight gap above one mullion (3). Some silicone sealant had been used here, but it did not fully seal the gap. With the interior trim removed, the author conducted a light water test (4). Then, using a moisture meter, he mapped the moisture content (MC) along the bottom of the window. The MC was highest (44%) below the gap in the mullion (5) and was elevated wherever there were wood shims (6). The author used a flat bar to push a folded piece of paper towel to the exterior (7) during the water test, and it came out sopping (8).

Fin flashing. Pella specifies that the window flashing tape should cover the nail fin and bend at a right angle onto the edge of the window frame. That was not done on this window.

Sealed trim. The exterior trim is supposed to be installed with a 3/8-inch gap around the window frame for backer rod and sealant. Instead, the trim was installed tight to the window frame without sealant.

Interior seal. The interior gap between the window frame and rough opening should be sealed with expanding foam or backer rod and sealant. When expanding foam is used, the window manufacturer does not want the installer to fill the entire jamb space. Instead, space should be left open to provide a path for incidental moisture to drain to the exterior. This window was not sealed with foam, leaving the gap, which performed appropriately.

Window shims. The window was set on wood shims, as it should be. However, the shims were pushed out all the way to the metal nail fin. During the water test, we could see water running down the interior side of the nail fin, and it was evident that the shims were wicking moisture along their length to the interior,

and this water saturated the interior trim. The shims effectively compromised the drainage gap around the window and interrupted the path for water to drain to the exterior. Instead of draining down and out, as it should, the water was able to flow to the interior by wicking through the wood shims.

For preventing the shims from short-circuiting the water drainage, I recommend using composite shims, which are impervious to water. Make sure they are installed so they do not touch the window's nail fin. In addition, it's important to hold the shims back from the interior. This will maintain an even space around the entire window perimeter so the window installer can include continuous backer rod and sealant. This tight seal is important as both a water seal and an air seal; neither function can be realized when the seal is interrupted by shims.

Mark Parlee started as a siding contractor, and grew Parlee Builders into a remodeling and new home construction firm in Urbandale, Iowa. He has parlayed his expertise into building-envelope consulting. Learn more about him at thebuildingconsultant.com.

BUILDING PERFORMANCE



Queen of Zero: Lessons Learned An Overview of the 2024 *JLC* Case-Study Home

BY NICOLE TYSVAER

In a story of rebirth, a 1901 Queen Anne Victorian-style house that was destroyed by a tragic fire has become the Queen of Zero—a phoenix of a house rising from the ashes with its architecture true to the original’s turn-of-the-century aesthetic but its performance aligned with the U.S. Department of Energy’s Zero Energy Ready Home (ZERH) standard.

The site is located in a historical district of suburban Maryland just outside Washington, D.C. Though the area was once full

of stately Victorians, the stock of these centenarian balloon-framed antiques has dwindled significantly. The neighborhood is now predominantly a mix of mid-century bungalows and newer, production-built craftsman-style houses.

Queen of Zero’s owner, a longtime Maryland resident with a deep appreciation for historical preservation, explained that after the fire, “it was never a question of whether we would rebuild” the original home. Yet, recognizing the demands of a changing

climate and rising utility costs, the owner sought to modernize the functional aspects of his new home with advancements in energy efficiency, resiliency, and comfort. To achieve net-zero performance, Queen of Zero incorporated a host of innovative products and materials, such as solar shingles and an exterior shell made of structural insulated panels (SIPs).

As the CEO of Symbi Homes, a green-build developer and consulting service, I have worked for more than a decade at the

Photo: Unik Creative Studio

forefront of high-performance homebuilding, seeking to forge new pathways for sustainability in residential construction. At the Queen of Zero project, I served as director of sustainability, working to ensure that the project aligned with our zero-energy goals, while maintaining the integrity of its Victorian aesthetic.

I worked alongside an all-star team of veteran sustainable-homebuilding professionals including architect Michael Romero, Matt Kulp and Keyur Shah of Daks Builders, Kelly Gillespie of Kelly Green Energy Raters, and Daniel Santaella of Unik Creative Studio.

The home was completed in about 13 months, achieving everything we set out to do and then some, as the project evolved over time both at the homeowner's direction and as a result of our net-zero requirements. In this article, I highlight many of the unique and challenging aspects of this build, discussing lessons learned along the way. The article concludes with my reflections on how this case study can inform a larger effort for advancing high-performance homebuilding.

WHAT IS ZERH?

Launched in 2012, the U.S. Department of Energy's Zero Energy Ready Home (ZERH) certification program provides standards for the design and construction of single-family and multifamily properties that achieve a level of performance whereby the home's energy consumption could be offset almost entirely by renewable sources. In addition to the exceptional level of energy efficiency they promote, ZERH standards boost the durability and resiliency of buildings, while lowering maintenance costs and increasing occupant comfort and well-being.

I think of ZERH as the Energy Star program "on steroids." To meet the ZERH standard, a home must comply with the requirements for Energy Star Version 3.1, EPA Indoor AirPlus, EPA WaterSense, EPA

Renewable Energy Ready Home, and the Energy Star Water Management Checklist. And that's just the beginning!

ZERH homes are designed to achieve a HERS (Home Energy Rating System) score of 50 or less, which is at least 50% more efficient than a standard reference home, and about 25% more efficient than the average Energy Star-certified home. The Queen achieved a HERS score of 15 when modeled with the 12.3kW solar roof capacity. The Queen's HERS model estimates utility cost savings of about \$6,000 per year compared with a conventionally built reference home (equivalent to the 2006 IECC).

ZERH IMPLEMENTATION

Achieving ZERH certification requires assembling a team of high-performance-homebuilding experts and gathering their input early in the project's preconstruction design phase. Team members include a third-party green rater with the credentials for certifying ZERH homes who can review architectural drawings for program compliance. In addition, the HVAC contractor and/or mechanical engineer should be engaged early to begin modeling the mechanical systems via the ACCA Manual J, D and S. The builder also needs to complete the Department of Energy's ZERH training and registration process.

During construction, the green rater will want to stay updated on the progress at each stage of construction. Although ZERH requires only two on-site inspections (pre-drywall and final), there are several requirements that will need to be verified via photo documentation. For this reason, I recommend creating a shared drive of construction progress photos accessible to the green rater in real time.

A VICTORIAN ZERH

Traditional Victorians are fanciful and embellished—reflective of a moment in



Structure. The Queen of Zero framing crew installs one of 90 structural insulated panels (SIPs) for the home's walls.

history when homes served as artistic expressions and status symbols made possible by the invention of power tools and a growing middle class during the Industrial Revolution. This architectural vernacular of elaborate trim details and intricate brass fixtures may seem at odds with the concept of a newly built net-zero home, which often conjures the image of a minimalist contemporary house or off-grid cabin.

However, from a theoretical perspective, the high-performance features of a net-zero build exist primarily outside the realm of embellishments, focusing on the mechanicals, wall systems, windows, insulation, and air-sealing (the "guts" of the home). For this reason, much of the Queen of



Exterior performance. The crew installs low-E, argon-filled double-pane windows (2) that meet Energy Star Version 3.1 standards for solar heat gain and insulation value in climate zone 4. On the exterior (3), they created a rainscreen with 1x4 pressure-treated wood furring strips installed 16 inches on-center.

Zero project followed a typical playbook for constructing a ZERH-certified home, with some exceptions when the aesthetics and performance seemed to duel. For example:

Rooftop renewables. The complicated roof structure with its many pitches, hips, and valleys meant that installing solar panels would be virtually impossible and practically useless, especially considering the county’s setback requirements. Thus, the decision was made to source a Tesla Solar Roof with the added bonus of the material’s low-tech look resembling historical slate shingles. The Tesla solar installers recommended a naturally vented roof, which proved challenging due to the complicated roof design and the fully unvented third-floor attic space. To solve for this, the team opted to install the roof sheathing on 1-by purlins, holding these a couple of inches back from the hip and valley rafters

to provide a channel for air to flow past the purlins at these locations.

Air-sealing and insulation details. To be sure, a nice, flat, continuous wall is much easier to air-seal and insulate than one with a variety of projections, curves, or funky angles. Yet, Victorians favor dormers and bay windows, which are notoriously leaky. And the rafters of a turret roof contain dozens of nonperpendicular angles. With each architectural detail in the Queen’s structure, our crew had to pay particular attention to how these spaces would be properly insulated and air-sealed, using a variety of products (spray foam, cellulose, caulk, rigid insulation, etc.) to get the job done.

Low-emission finishes. The tighter the home, the more critical it is to avoid adding materials that emit indoor air pollutants such as VOCs. However, when

it comes to wood finishes, low-emission products are typically lighter in color and sometimes difficult to apply. The hardwood flooring installers refused to use a water-based product, for example, because of the challenges in covering a large room without areas of patchiness or uneven finish. Fortunately, we found a great product—ProCoat UnoCoat Hardwax Uroil, a no-VOC stain that provides consistent coverage in a variety of dark, rich colors that perfectly matched the wood trim.

LED lighting. ZERH homes reduce energy costs in part by requiring LED bulbs in all lighting fixtures. When the design calls for period lighting (as in, the period when electricity was invented), LED fixtures can be scarce, but many antiques can be retrofitted with LED bulbs that mimic the original look. At the Queen of Zero, the homeowner purchased several decorative



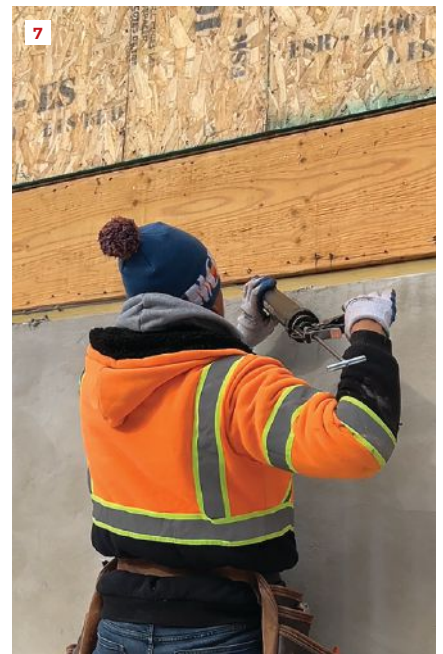
Rooftop solar. The complex roof plane left little room for conventional photovoltaic panels but worked well for Tesla Solar Roof shingles, which mimic the look of historical slate shingles. However, the Tesla shingles require a naturally vented roof, which proved challenging with all the hips and valleys that block airflow through many rafter bays.

antique lights that were expertly and beautifully retrofitted for efficiency.

Cozy fireplaces. Ideally, a well-sealed ZERH home would not include any combustible gas appliances or equipment that might introduce toxins into the indoor air. Victorians are known for their multiple fireplaces with decadent mantels and hearths, cherished family gathering spots. I asked the homeowner to consider a variety of electrical inserts—typically LED-glowing fake logs with a background video playing flickering flames—for the home’s two prominent fireplaces. He understandably turned me down and instead opted for direct-vent gas inserts with fixed, flush glass fronts.

MECHANICALS FIT FOR A QUEEN

Designing an optimal heating, cooling and ventilation system for the Queen of Zero was no easy feat, especially considering its location in Maryland (zone 4A), a mixed climate with high humidity levels. Our



Attention to air-sealing. Crew members work on air-sealing the foundation walls. Tape, caulk, and foam sealant were used throughout the Queen of Zero home to air-seal it and achieve 1.7 ACH50 at the final blower door test.

team of mechanical experts needed to address both comfort and efficiency in a tight home conditioning all four floors with a segmented layout typical of Victorians.

Now that the home is near completion and the system is operational, I can attest to the superior level of comfort (thus far) throughout all four levels of this 4,800-square-foot home. In September with outdoor temps near 80°F and humidity an average 74%, the Queen's interior achieved a consistent 72° and 45% humidity, even in the finished attic space on the third floor. Most notably, the home stayed relatively comfortable during workdays when a constant stream of crew members entered and exited the property's seven exterior doors.

SYSTEM COMPONENTS

The Queen of Zero is heated and cooled via four high-performance cold-climate heat pumps manufactured by Mitsubishi Electric HVAC US. With the exception of the basement music room, the house is conditioned via three ducted air handlers serving 1) first floor and partial basement; 2) second floor; and 3) third-floor finished attic. The basement music room, built with extensive sound-attenuation materials in the walls and ceiling, has a dedicated wall-mounted mini-split for heating and cooling—a ductless system designed to reduce sound-wave transmission to adjacent areas of the home.

At the jobsite, we have a saying, “This is not your grandmother’s Victorian,” and the final mechanical design is a perfect example. Despite the home’s conventional turn-of-the-century layout with its many segmented rooms and despite the central staircase that encourages the stack effect of warm air rising to the upper floors, the compartmentalization of the Queen’s HVAC into four distinct systems, each with its own thermostat and controls, ensures optimal comfort in all areas of the home. Gone are the days of sweltering attic spaces and chilly, damp basements.

As per ASHRAE 62.2 ventilation standards, the tight envelope of this high-performance home (less than 2.0 ACH50) requires a whole-house mechanical system to help circulate fresh air. We selected an AprilAire V22BEC Energy Recovery Ventilator (ERV), which transfers much of the energy used to heat or cool the indoor air from the exhaust air to the intake stream as it dumps fresh, filtered air into the supply side of the Mitsubishi Electric SVZ-KP24NA air handler. The V22BEC ERV also pairs with AprilAire’s 8120X Ventilation Controller, which monitors outdoor temperatures and will adjust its schedule to avoid bringing in fresh air during the hottest, most humid times of day.

To control humidity in the house, we added an AprilAire whole-home dehumidifier to each heating and cooling system. Importantly, these units can monitor indoor humidity levels and operate independently from heating and cooling demands. In other words, even in conditions where the thermostat is not calling for cooling, the dehumidifiers will run to remove excess humidity from the conditioned space. Similarly, a whole-home AprilAire 800 Steam Humidifier connected to the first-floor air handler will add humidity to the home during dry winter months—even when the thermostats are not calling for heat.

ADDRESSING DUCT LEAKAGE

The ZERH program follows Energy Star standards for maximum allowable duct leakage. For this project, duct testing measurements could not exceed 6% air leakage (≤ 6 CFM25 per 100 square feet of conditioned space). Increasingly, local municipalities are also requiring duct tests to pass final residential building inspections. The requirement makes a lot of sense—leaky ducts reduce thermal comfort, decrease the efficiency of mechanical systems, and increase the cost of utility bills. Such rigorous duct leakage testing is a significant shift in the work

processes for many residential HVAC professionals, who may not be accustomed to such scrutiny. I have yet to find a system that passes on the first manometer reading.

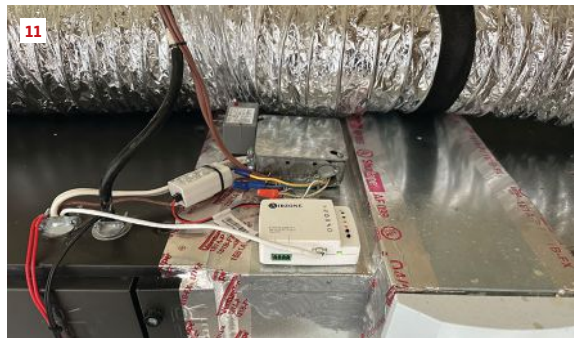
Retrotec’s Noah Lawrence assisted with pre-drywall duct testing. His initial tests did not go as planned—results showed approximately 12% duct leakage, which is double the allowable amount for ZERH certification, on all three ducted systems. We worked with the HVAC contractors over several days chasing theatrical-smoke trails to find and plug the leaks before we finally managed to get the duct leakage below 6% at pre-drywall. One lesson learned: We should have tested the attic systems prior to spray-foam installation, as it was difficult to reach some leaks in the tight cavities behind the knee walls.

Because this process of sealing the ducts can be labor-intensive, it is important to include the standard for maximum allowable duct leakage in the HVAC subcontract so expectations are clear up front. Also, it helps to clarify who will be responsible for additional consulting fees if the green rater needs to make multiple trips for testing and diagnostics.

HUMIDITY CONTROL

High-performance building standards tighten and fortify a house’s exterior shell to keep the outdoor elements at bay, while maintaining more consistent, comfortable conditions within the house. In theory, this beefing up of the shell means that the mechanical systems will work less to heat and cool the indoor space. However, in many climates, less conditioning and less natural airflow will necessitate whole-home humidity control mechanisms that operate independently from heating and cooling equipment.

Over the years, I have learned that a standard Energy Recovery Ventilator (ERV) does not provide adequate dehumidification of indoor air in our humid climate zone. In



Mechanicals fit for a Queen. One of four air handlers in the house fits in an attic knee wall (8). Retrotec’s Noah Lawrence assists with pre-drywall duct testing (9). This initial test proved the ducts were too leaky, prompting the crew to chase down more leaks to meet the ZERH standard. Above (10) is one of four AprilAire ducted dehumidifiers. The Airzone Aidoo Pro module (11) functions as an intermediary communication device to integrate the heat pumps with the thermostats and dehumidifiers.

fact, even though ERVs remove some of the humidity from the incoming ventilation air, they do not remove all of it and can still make indoor humidity levels rise on days when the outdoor environment is particularly moist. For this reason, we installed an ERV at Queen of Zero that includes an outdoor climate sensor to limit the ventilation intake when outdoor relative humidity levels rise.

In addition, it is important to note that adding a dehumidifier in the basement, the most common location for homes in our area, would not be sufficient for this project. According to Doug Horgan, vice president of best practices at BOWA, a Washington, D.C.-area custom homebuilding and remodeling firm, “Humid

air is lighter than dry air. So everything else being equal, if your house is closed, your upper levels will end up with more humidity.” In other words, a dehumidifier in the basement will do nothing to solve humidity problems on the upper floors of the home, which is why the Queen has a ducted, whole-home dehumidifier attached to each heating and cooling system.

Horgan also points out that dehumidifying equipment inherently adds heat to the treated air and therefore recommends that ducted units operate on the supply side of the air handler. At the Queen, the HVAC contractor, Ridgchi Appadoo, found that the warm air emitted from the dehumidifiers was causing the Mitsubishi Electric

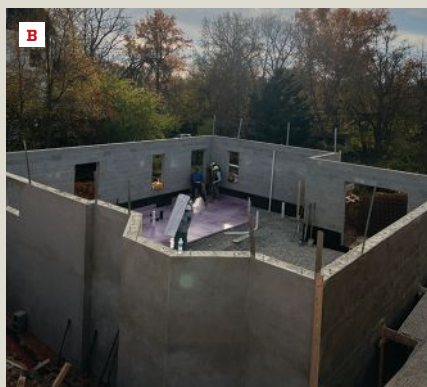
air handlers to operate less efficiently. The solution was to alter the settings on the AprilAire equipment to reduce its operation slightly—more specifically, the dehumidifier was programmed to operate only when the thermostat was not calling for cooling.

EQUIPMENT INTEGRATION

In total, 14 pieces of mechanical equipment regulate the Queen’s indoor air and operate in harmony to ensure optimal comfort for her occupants. To help manage the system from a user perspective, Appadoo opted for Ecobee Premium Pro Wi-Fi-enabled thermostats, which allow the homeowner to control the complex system from one app on his cellphone.

QUEEN OF ZERO: LESSONS LEARNED

QUEEN OF ZERO PROGRESSION



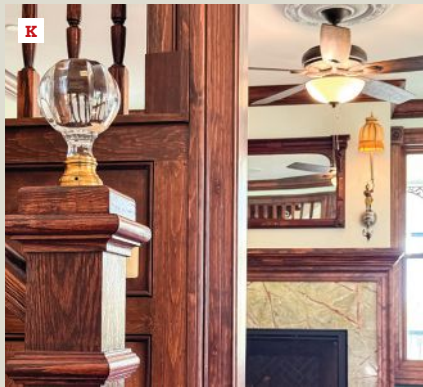
Rising from the ashes after the original house burnt down (A), the block walk-out foundation was the first part of the new structure to be built on the sloped site (B), followed by the walls, which were framed with structural insulated panels (C).



A combination of scissor trusses (D) and stick framing (E) was used to re-create the complex roof geometry that is an important design feature of a Queen Anne Victorian. The turned porch posts—another distinctive architectural element—were fabricated by Resin Art and secured with continuous threaded rod from the concrete piers to the roof framing (F).



As the building is enclosed, its Queen Anne persona begins to take shape (G). Once the home is dried-in, attention shifts to air-sealing and insulation. Site supervisor Matt Kulp of Daks Builders seals the gaps between the SIPs (H); netting on the top-floor ceilings will be used to contain dense-packed Greenfiber Sanctuary cellulose for sound attenuation (I).



The living room (J), foyer (K), and library (L) feature hardwood floors, trim work, and lighting details that capture the interior details of the original house. One difference in the lighting, however, is that the period fixtures were updated to include more energy-efficient LED lamps.



The kitchen blended modern, energy-efficient appliances with Victorian-inspired finishes and colors (M). The second-floor bath features dramatic wallpaper that offers a fun, modern take on ornate Victorian style (N). Similarly, the expressive stone and tile patterns in both the second-floor bath and the primary bath (O) are in keeping with Victorian sensibilities.



The re-created house features a finished attic (P) that elegantly incorporates the rooftop turret (Q). The turret is roofed with laminated shingles that blend well with the Tesla Solar Shingles. True to its Victorian roots, the exterior is given a “painted lady” treatment of vibrant colors (R).

However, because there are some limitations of the Ecobee thermostats pairing with Mitsubishi Electric air handlers, Appadoo used an Airzone Aidoo Pro module to integrate the Mitsubishi system with the Ecobee Premium Pro thermostats and AprilAire dehumidifiers. According to Appadoo, “This setup allows all parts to work together seamlessly, providing optimal temperature and humidity control tailored to the home’s needs.”

TWEAKS TO THE SYSTEM

Despite our concerted efforts to model the mechanical loads and duct design, the system has still required some adjustment. For example, we found that the system sometimes struggled to keep up with afternoon solar heat gain in the kitchen from a 2-by-4-foot skylight. Fortunately, the homeowner had the foresight to purchase a solar shade with his Velux FCM 2246 skylight, which solves this problem.

We anticipate adjustments to the system will continue through four seasons of occupancy. Joseph Hillenmeyer, AprilAire senior product manager, explains that many factors can impact how mechanicals function—from number of occupants, to opening windows, to cooking and showering habits. “As people live in the house, they probably will end up tweaking the equipment to an extent. But if you don’t include [the equipment] on the front end, then they’re calling someone to [install] it later, and it’s always going [to] be more difficult to retrofit those things. At least now we know everything’s designed for the size of the house and the operation of the house, and the tweaks they want to make will all be possible.”

Another significant factor impacting performance will be equipment maintenance. The Queen’s HVAC system has at least 11 air filters throughout the house that will require regular cleaning or changing, with schedules varying based on manufac-

turer specifications, filter type, and degree of use. The upside to all this housekeeping is incredibly pristine indoor air, as the filters are designed to remove a plethora of airborne toxins and pollutants such as dust, mold, and viruses.

Of course, none of this innovative work would be possible without a highly competent and dedicated team of HVAC professionals willing to go above and beyond business-as-usual. Appadoo and his staff at Thermal Plus participate in advanced training and professional development opportunities as an integral part of their business model, which means they are uniquely prepared for increasingly stringent building energy codes on the horizon. Our team has also benefited from direct communication with the manufacturers, which offered valuable advice and technical assistance throughout the project.

SCALING SUSTAINABILITY

In conclusion, I turn to a question posed at the outset of this case study: What do our lessons learned from Queen of Zero teach us about scaling sustainable homebuilding across the country? Less than 1% of all homes built in the U.S. achieve the Zero Energy Ready Home standard. What will it take to increase that number to even 5% or 10%? What barriers exist to more widespread adoption of high-performance homebuilding practices?

The Queen of Zero case study demonstrates that it is possible to build to a higher standard of performance while also tackling the complexity of an embellished architectural vernacular. Net-zero homes do not need to look like square boxes. Given a generous budget, performance and Victorian aesthetics can coexist.

I have also built ZERH homes without a generous budget. I have found that the efficiency upgrades of a net-zero build may add 5% to 10% to the construction costs but that those expenses can be offset by value



A REVIVAL OF CRAFT— THE QUEEN’S ART GLASS

When presented with the task of designing the Queen of Zero, architect Michael Romero knew that it would not be possible to build an exact replica of the original 1901 Victorian home primarily due to budget constraints, availability of materials, and technological enhancements. Rather, Romero explained, his job was to use “elements of the language and traditions that we call Victorian” to create a home inspired by the original. Romero knew that compromises would need to be made and suggested that the team carefully choose “our moments of craft” that would pay homage to the past.

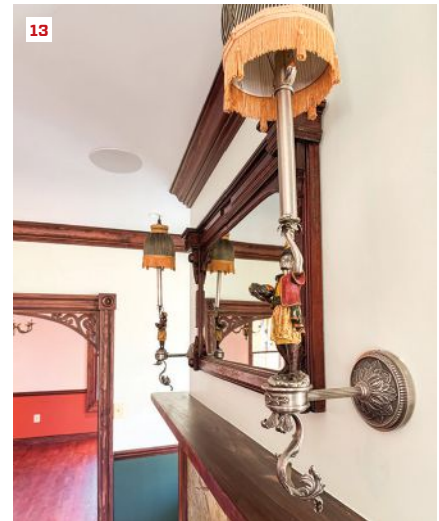
Perhaps no other element in the home celebrates its Victorian heritage more than the stained glass windows at the Queen’s front-door sidelights and transom. Designed, fabricated, and installed by Rudolph Waros of Specialty Glass Services, the final customized double-paned panels were inspired by the great blue herons on the original front door that burned—a scene familiar along the waterways in the area. —N.T.

engineering other parts of the project. Budgets aside, there are some significant gaps that I believe need to be addressed to scale sustainable homebuilding in the U.S., including:

The workforce gap. Although the project benefited from a leadership team experienced in building sustainable homes, the vast majority of crew members were learning on the job how to adapt to high-performance standards. The first framing crew, unfamiliar with how to install SIPs, complained that site supervisor Matt Kulp was being “too picky” and walked off the job after their first day. Thus, builders should be prepared for some growing pains as they work to assemble a competent and willing team, one that may have had a limited history of training opportunities. The challenge is not only to fill gaps in knowledge but also to encourage a growth mindset that welcomes the learning process.

The incentive gap. Building to a net-zero standard requires more planning time, a longer production calendar, and more resources for project management and oversight than building a similar conventional, code-built home. At the Queen of Zero, we had five conference calls to finalize the design of the naturally ventilated roof—just one detail out of many that required special care and attention. Builders who complete a for-sale ZERH-certified project are eligible for the 45L federal tax credit up to \$5,000. Homeowners who build a ZERH are eligible for additional federal tax credits (for example, the renewable energy tax credit) through the Inflation Reduction Act. These benefits are helpful, but I don’t believe they’re sufficient to encourage more widespread adoption of the program. The trades, for example, should also be incentivized to stretch their knowledge and techniques to adapt to the standards.

The ecosystem gap. It’s one thing to specify a bunch of “high performance” equipment and materials, and quite another



The high-performance features of a net-zero build largely exist outside the realm of Victorian embellishments, including the dark-stained trim (12) and period lighting (13) that grace the interior of the Queen of Zero home.

er to expertly assemble all the components of a house into one integrated system that optimizes comfort, resiliency, and efficiency. This ecosystem approach requires that the design and construction of the house considers the climate, inhabitants, and uses of the property. A well-balanced ecosystem incorporates the underlying principles of building science and can adapt to a changing environment. Collaboration is key, and all contributors must be on board with the sustainability program.

The testing gap. High-performance houses are subjected to more rigorous testing and inspections than typical builds. A ZERH house has a required pre-drywall inspection that includes duct testing for air leakage and a detailed quality check for insulation installation. At Queen of Zero, we added a pre-drywall blower door test to identify any unplugged exterior penetrations. In my experience, many of these pre-drywall energy inspections happen after the county’s building official has already inspected and approved the project

for close-in. Yet, the little gaps and cracks identified by energy auditors at pre-dry-wall can have a tremendous impact on the performance of the house.

In the pursuit of building better houses, working to fill these gaps and make the leap to high-performance homebuilding may seem overwhelming or otherwise unattainable. Yet, at the moment I am writing this conclusion, I am also wrapping up participation in a local workgroup gathering industry input on code changes for residential construction in the District of Columbia. Similar to other jurisdictions around the country, D.C. will soon be requiring net-zero standards for all new homes and substantial renovations. It’s hard to believe but, in the coming years, building homes that produce as much energy as they consume will likely become the norm, not the exception.

Contributing editor Nicole Tysvaer is CEO of Symbi Homes, a residential builder and developer based in Bethesda, Md.

HVAC



Retrofitting Air-to-Water Heat Pumps Adding upgraded functionality to an existing boiler system

BY JOHN SIEGENTHALER

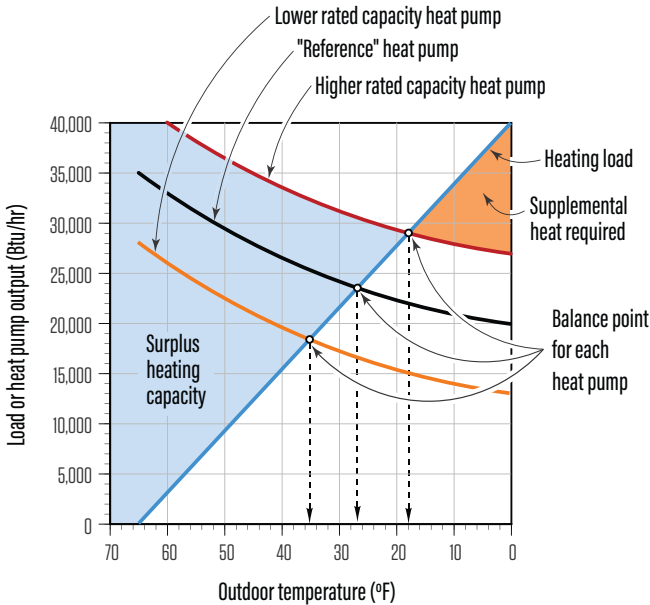
In some European countries, hydronic heat pump sales have exceeded boiler sales for several years running. The North American market is not there yet, but many signs point to a promising future, especially for air-to-water heat pumps.

This trend is reshaping the hydronic heating and cooling markets in significant ways. It's creating unrivaled opportunities compared with previous advancements in hydronics technology. One

example is adding cooling to a hydronic heating offering. That in itself, is a really big deal! It provides an answer for clients who want hydronic heating but ask the inevitable question: "What should I do about cooling?" It also appeals to those who are highly motivated to reduce carbon emissions but still want a system that provides superior comfort—something that properly installed hydronic heating systems have a track record of delivering.

Photo courtesy: EnerTech Global

When Supplemental Heat Is Needed



HEAT PUMP HELPER

It is estimated that there are more than 6 million hydronic heating systems currently installed in the U.S. The vast majority use boilers operating on fossil fuels as their heat source. This established base sets the stage for how air-to-water heat pumps will initially gain market share. Many will be integrated into existing boiler-based systems.

Note that I did not say that most air-to-water heat pumps will replace existing boilers.

While it's true that clients wanting to eliminate fossil fuels from their heating system can have their existing boiler removed as part of an air-to-water heat pump installation, it's also true that retaining an existing boiler that has remaining service life offers several benefits.

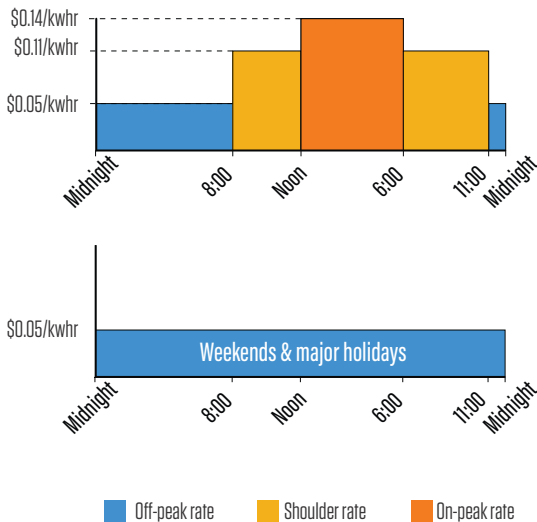
The heating load of any building increases as the outdoor temperature drops. Unfortunately, the heat output of any air-source heat pump *decreases* as the outdoor temperature drops. This effect is illustrated in the chart at top left. The heating-load line crosses the heat pump's heating-capacity line at a "balance point." This is where the building's heat loss is the same as the heat pump's output. At warmer outdoor temperatures, the heat pump has more than sufficient capacity to heat the building. At outdoor temperatures below the balance point, some type of supplemental heat input is needed to maintain the desired comfort temperature in the building. This is where that existing boiler comes in. It can operate along with the heat pump to ensure sufficient heat delivery to the building.

Assuming that the boiler is sized to the building's design heating load—and most are significantly oversized—it can provide 100% backup heat if the heat pump is down for service.

Another benefit is that most gas- or oil-fired boilers used in residential and light commercial buildings have low electrical power demands compared with a heat pump or electric resistance heating elements. This allows a small portable generator to keep the boiler and a few circulators or zone valves operating during a prolonged power outage. The system can be easily wired to allow the owner to switch between utility and generator power.

Using the existing fossil fuel boiler as the supplemental and backup heat source might also eliminate the need for an electrical service upgrade, which can be necessary, especially in older homes, if any form of electric resistance heating were used for these purposes.

Sample Electricity Rate Structure

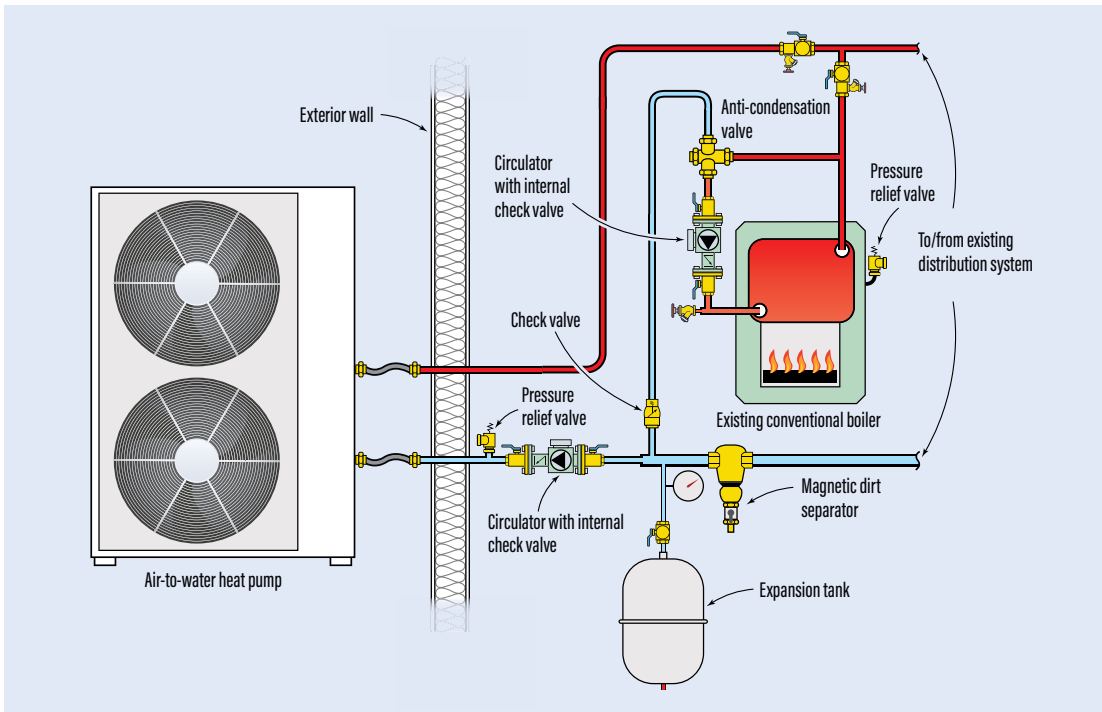
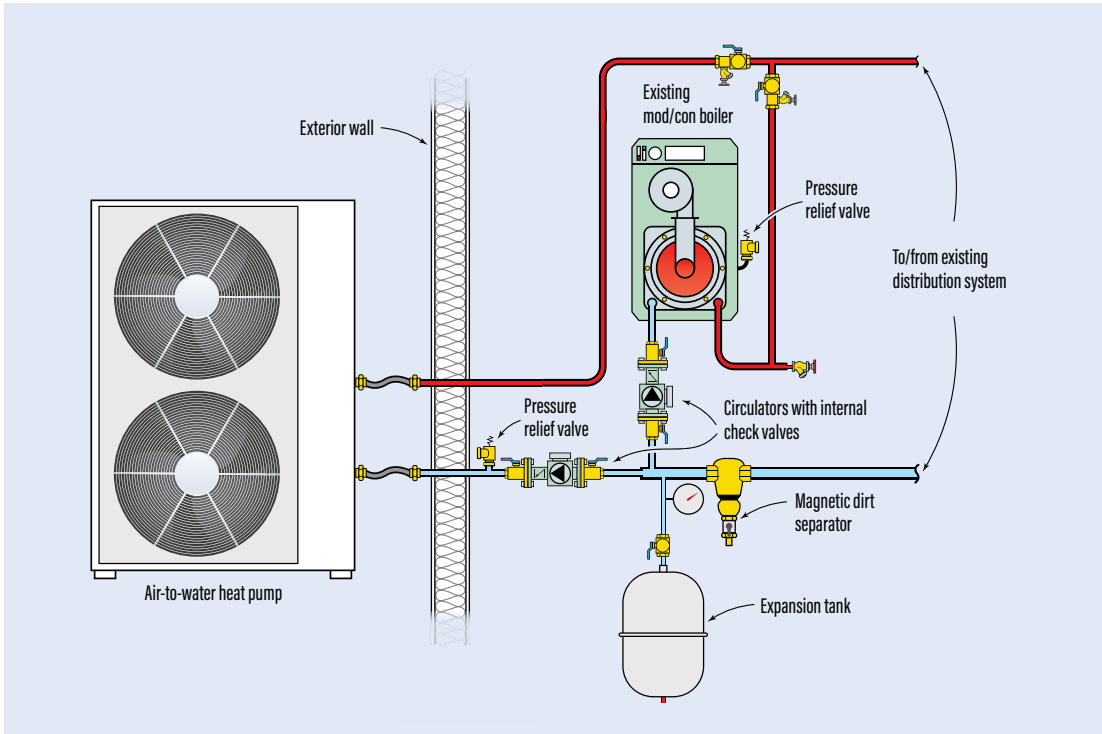


All illustrations by Ola Kwiatkowska

WHEN THE PRICE IS RIGHT

The rapid shift toward electrification in the HVAC market as well as the growing electric vehicle market continues to strain existing

Two Parallel Piping Options





This vent connector had been installed only months before sustained flue-gas condensation caused this corrosion.

such a rate structure. Depending on the time-of-use rate structure available, it might make sense to use the existing boiler for heat needed during peak periods. Likewise, operating the heat pump during off-peak periods ensures the lowest price for electrically sourced heat.

Air-to-water heat pumps can also be combined with water-based thermal storage to leverage the lower off-peak electrical rates.

I've worked on research projects based on this concept, and the results to date have been encouraging. An air-to-water heat pump combined with thermal storage has been able to maintain stable comfort in a home in a cold northern climate while operating only during off-peak hours. The combination of air-to-water heat pumps and thermal storage will likely see wider implementation in the future, especially when heat pumps operating on R-290 refrigerant, which allows discharge water temperatures up to about 170°F, become available in North America.

MAKING CONNECTIONS

The general concept that applies to situations where multiple hydronic heat sources are used is to connect them in parallel not in series. This allows any heat source to be the sole heat provider. It also allows simultaneous operation if and when necessary. It prevents needless heat loss that occurs when heated fluid flows

utility grids, especially during periods of peak demand.

Time-of-use electrical rates are one demand-side management tool used by utilities to encourage electrical usage during low-demand periods and discourage use during high-demand periods. The concept is simple: Price electricity low during periods of low demand and significantly higher during periods of high demand.

The chart at the bottom of page 35 shows an example of

through inactive heat sources. Finally, it allows any of the heat sources to be serviced or even temporarily removed if necessary, without curtailing operation of the remaining heat sources.

The illustrations on the facing page show two ways to connect an air-to-water heat pump in parallel with an existing boiler.

The lower piping diagram shows a “conventional” boiler. This classification includes cast-iron, steel-fire-tube, and copper-water-tube boilers. These boilers are not intended to operate at low water temperatures that allow sustained condensation of flue gases produced during combustion. If allowed to form, the acidic condensate can eat through a typical 26-gauge-galvanized vent connector pipe in a matter of months. The photo at left shows a vent connector that's only 6 months old and has failed due to corrosion from sustained flue gas condensation.

Anti-condensation valve. The common way to prevent sustained flue gas condensation is to install an “anti-condensation” thermostatic mixing valve in the near boiler piping. This valve is shown in the lower schematic on the facing page. It's also shown installed in the photo on the next page. An anti-condensation valve mixes higher temperature water leaving the boiler with cooler water returning from the heat emitters so that the water entering the boiler is nominally 130°F or higher, which prevents sustained flue gas condensation. It's an important detail that helps prolong the life of a conventional boiler and its venting system.

The upper piping diagram on the facing page shows a “mod/con” boiler, which is designed to operate with sustained flue gas condensation and, as such, doesn't require an anti-condensation mixing valve.

Circulator with internal check valve. In each diagram, the boiler and heat pump have an associated circulator equipped with an internal check valve. The heat pump circulator operates only when the heat pump is active. The boiler circulator operates only when the boiler is active. The check valves prevent flow reversal through an inactive heat source when the other heat source is operating.

Magnetic dirt separator. Both diagrams also show a magnetic dirt separator. It captures dirt or other debris in the system, and its strong internal magnet captures iron oxide particles. The latter are typically present in existing hydronic systems that have cast-iron or steel components. If not captured and periodically drained from the system, these particles can accumulate on the heat transfer surfaces inside the heat pump. The resulting “fouling” will reduce the heat pump's heating capacity and efficiency. Iron oxide can also collect within the rotor can of ECM circulators. I strongly recommend installing a magnetic dirt separator as part of the “surgery” undertaken when adding the heat pump.

THE BRAINS

There are several ways to control a heat pump and boiler in the same system. The most common is to treat the heat pump as the primary heat source, favoring its operation over the boiler whenever it can maintain comfort in the building. The boiler would operate only as a supplemental, or backup, heat source if and when the heat pump's output is inadequate.

This type of control is easily handled by a two-stage boiler controller. The controller's first stage contacts turn on the heat pump and its associated circulator whenever the system needs heat. The controller monitors the temperature change that occurs with the heat pump operating. If it "judges" that the required water temperature will not be met by the heat pump after a few minutes of operation, it closes another set of contacts, turning on the boiler and its circulator.

Staging controllers have adjustable settings for water temperature set points, differentials, inter-stage time delays, and other options. They are widely available from several sources.

FREEZE PROTECTION

Air-to-water heat pumps are available in "monobloc" and "DX split" configurations.

A monobloc heat pump is completely self-contained and installed outside. It's factory-charged with refrigerant and requires

only water piping and electrical connections.

Most manufacturers of monobloc heat pumps require the use of antifreeze in their units to provide freeze protection during potentially long power outages in subfreezing weather. A 30% solution of nontoxic propylene glycol is adequate in most areas of the U.S. Extremely cold locations may require 40% to 50% solutions.

Although it's possible to configure systems with heat exchangers that separate the antifreeze solution in the heat pump from water in the remainder of the system, doing so reduces thermal performance and can add significant expense. The more common approach is to fill the entire system with the antifreeze solution and sell the owner on the benefit of equipping the system to survive a long-term winter power outage.

Air-to-water heat pumps designed as "DX split" configurations (see photos and illustration on facing page) have outdoor and indoor modules connected by a copper refrigerant line set. One benefit of these units is that there is no water outside and thus antifreeze is not required. One constraint is that basic refrigerant skills and tooling are required to commission the system. Installers need to make proper flare connections, pressure test and evacuate the line set, and open the service valves in the outdoor unit to release the refrigerant into the line set. They may also have to add refrigerant if the line set is longer than the allowance set by the manufacturer.

To prevent sustained flue-gas condensation, an "anti-condensation valve" installed near the boiler mixes higher temperature water with cooler water so that the water entering the boiler is nominally 130°F or higher.

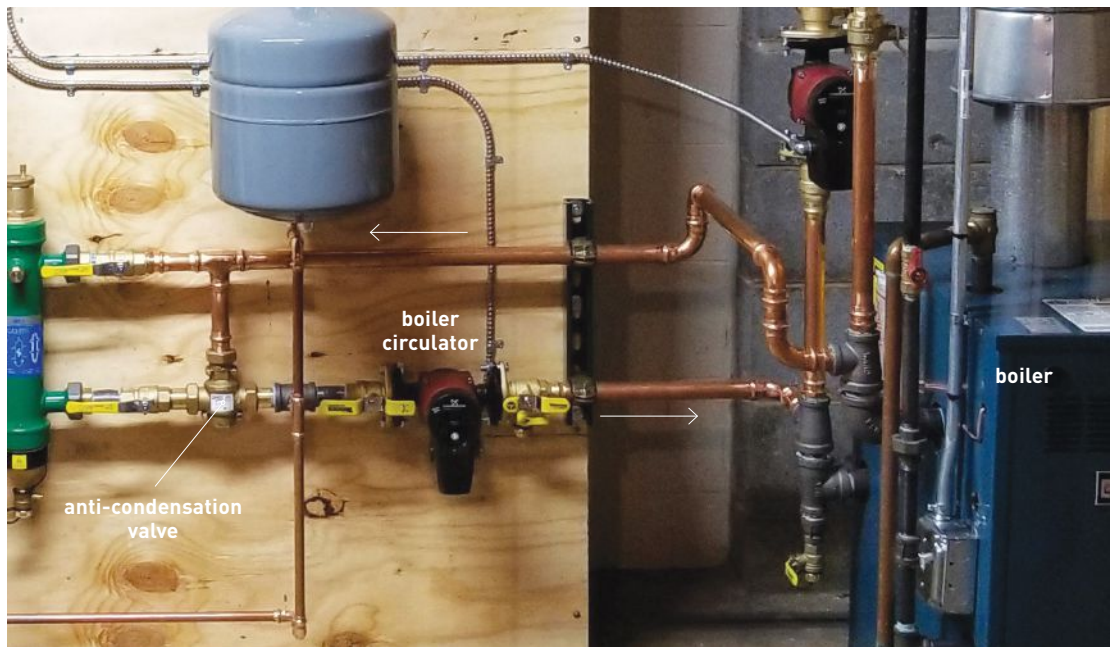
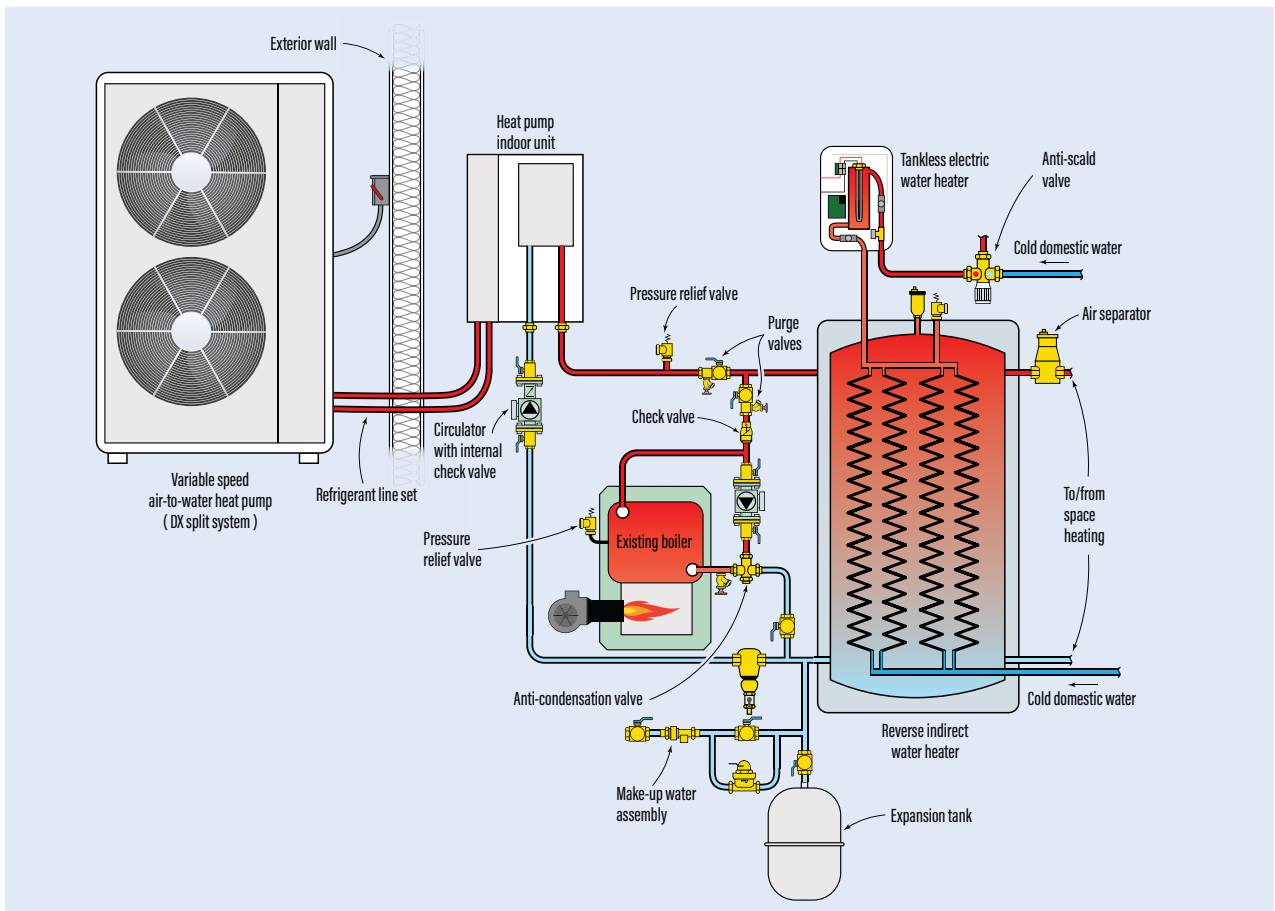


Photo courtesy Cody Mack



Shown here is an example of the outdoor (far left) and indoor (left) units for a DX split air-to-water heat pump. Copper refrigerant tubing, covered with white insulation, connects these two units.

Dual-Fuel System With 'Reverse Indirect' Tank



Photos: John Siegenhafer

EXPANDABILITY

Systems with air-to-water heat pumps can be configured to include domestic water heating. The illustration below shows a system that uses a “reverse indirect” tank as both a buffer and a domestic water heater. That tank can accept heat from the heat pump’s indoor unit or the existing boiler.

The heat pump or the boiler heats the water in the shell of this tank. Cold domestic water passes through multiple copper heat exchanger coils whenever hot water is drawn from a fixture.

The temperature of the domestic water leaving the tank coils depends on the temperature maintained in the tank shell. It also depends on the draw rate for domestic hot water. If the heat pump maintains the water in the tank shell at 5°F to 10°F above the expected domestic hot-water delivery temperature, and reasonable draw rates are sufficient, the tank can often fully heat the water as it passes through the coils. If these conditions are not present, the tank can

still preheat the domestic water. That water then passes through some type of “booster” heater, such as an electric tankless unit, to bring it to the required delivery temperature. Be sure to check the thermal rating data of the reverse indirect tank to determine if a booster heater is needed.

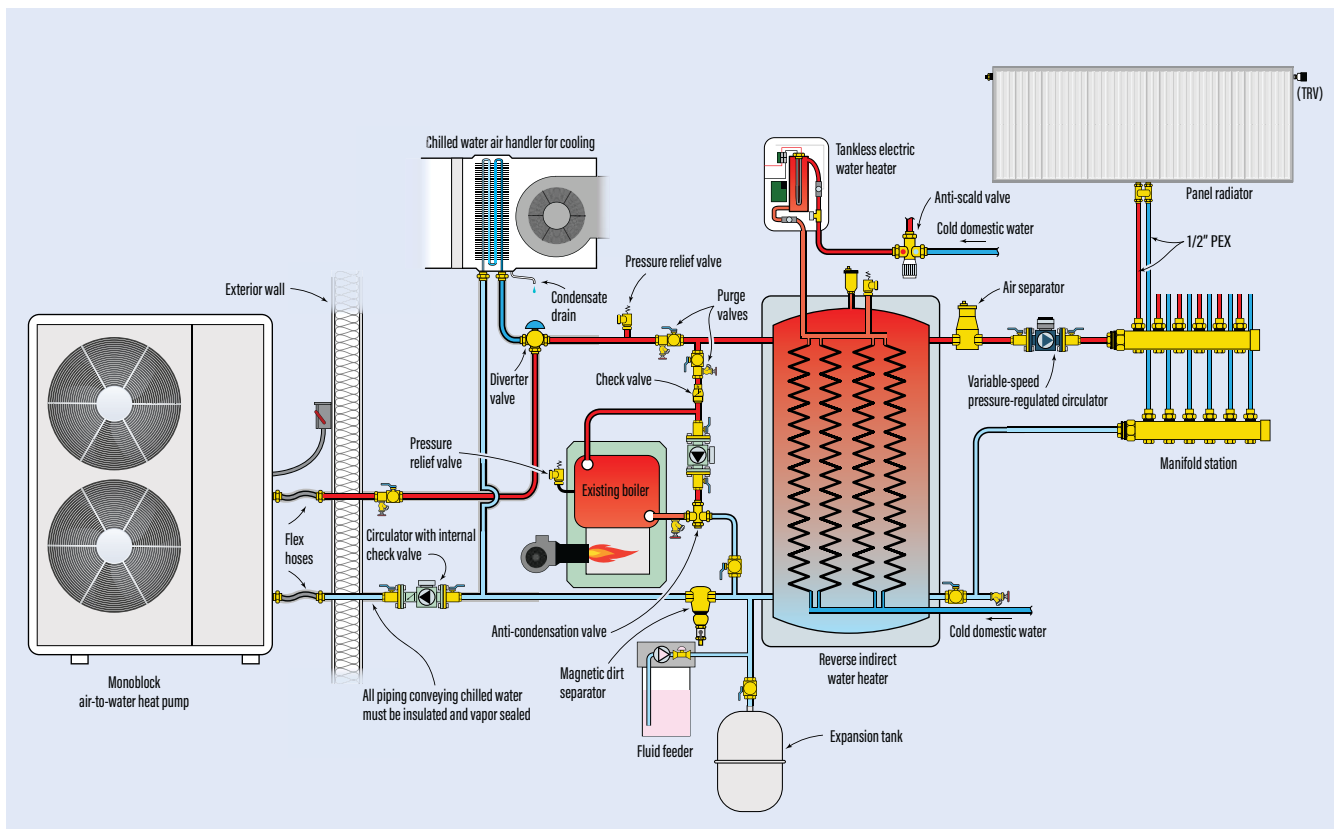
CHILLING OUT

When someone buys an air-to-water heat pump for hydronic heating, they’re also buying a machine capable of producing chilled water for cooling.

Although there are systems where the heat pump provides only space heating and perhaps domestic water heating, the ability to add cooling opens up opportunities that were not in the residential or light-commercial hydronics “wheelhouse” in decades past.

If you compare the illustration below with the illustration on the previous page, you’ll see overlap. The parallel arrangement of

Dual-Fuel System With ‘Reverse Indirect’ Tank and Cooling





A big advantage of integrating a heat pump with a hydronic system is the option to add cooling with a chilled water unit on an air handler, as was done above.

the heat pump and existing boiler remains, but instead of a DX split system heat pump, the second illustration shows a monobloc. This implies that the system will operate with an antifreeze solution. An air handler equipped with a cooling coil has been added to the system. The piping supplying chilled fluid from the heat pump passes through an electrically operated diverting valve on its way to the air handler. This valve allows the heat pump to switch between cooling and maintaining a suitable “hot” temperature in the reverse indirect for domestic hot-water production. Controls allow one of these loads to be prioritized over the other.

Photo: John Siegenthaler

The air handler must be equipped with a condensate drip pan that connects to a suitable drain. During humid weather, several gallons of condensate can form each day. It is typically drained outside the building or, where codes allow, tied to the building’s DWV piping.

All piping conveying chilled water must be insulated and vapor sealed. I cannot overstate how important this is. The surfaces of the piping and components conveying chilled fluid at 45°F to 55°F are well below the dew point of surrounding air. If that air contacts these surfaces, condensate will form in a matter of minutes. Eventually, it will drip onto whatever is beneath it. You can probably imagine where this scenario will lead as far as callbacks and customer relationships are concerned.

I prefer elastomeric foam insulation such as Armaflex. It is readily available, comes pre-split to fit over pipes, and has strong, pressure-sensitive tape on its longitudinal seams to bond them together after the insulation is fit to the piping. All butt joints need to be bonded using a rubber-based contact cement. Elastomeric foam insulation also has low vapor permeability, eliminating the need for a separate vapor-barrier wrapping. This type of insulation can be easily and accurately cut using an electric carving knife. Unless codes require otherwise, 1/2-inch wall thickness is generally adequate to prevent condensation.

The piping for the air handler shown at left is wrapped with elastomeric foam insulation. The circulator volute and isolation valves are wrapped with elastomeric foam tape, which is easier to fit to complicated surfaces. There was no floor drain in this installation, so a condensate pump was used to collect and eject the condensate outside the basement.

The reverse indirect tank in the illustration on the facing page serves as both a buffer and a domestic water heater. A very simple “home-run” heating distribution system, in which several panel radiators are connected to a manifold station, connects to the right side of the tank. Each radiator is equipped with a thermostatic radiator valve, allowing it to operate independently of the others. The variable-speed, pressure-regulated circulator automatically changes speed as the radiator valves open, close, or vary flow through their associated radiator.

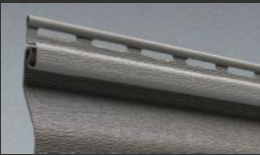
WHAT'S AHEAD

Air-to-water heat pumps will have increasingly profound impacts on hydronic heating and cooling. They’re an ideal way to significantly “electrify” existing hydronic systems supplied by boilers and do so without foregoing the benefits of a “dual fuel” approach.

John Siegenthaler, P.E., operates Appropriate Designs, a building systems engineering firm in Holland Patent, N.Y.



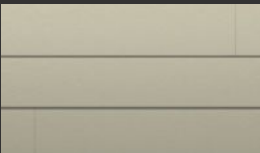
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INTERIORS



Architectural Lighting for Homes Using LED strip lighting to transform interior spaces

BY RICK MILLS

LED lighting has come a long way in the past 10 to 15 years. It is now found in commercial spaces, high-powered stadium lighting, automobiles, and, of course, homes. Back in 2013, I remember exploring LED tape lighting for a project, but it was extremely expensive, making it impractical.

Now, however, you can find a vast array of LED tape lighting at the big box stores and big online retailers at extremely reasonable prices. Like everything, you get what you pay for, and pricing can vary greatly depending on which product you select.

We have found great versatility with LED tape lighting on our projects over the past few years and have been able to explore some fun and creative options with adventurous clients. In this article, I will touch on some of the ways tape lighting can be used to high-

light different architectural elements of a home. Called “architectural lighting” in the industry, it is typically installed so the light source is not visible but is hidden by a valance and positioned so the light washes over the intended architectural feature.

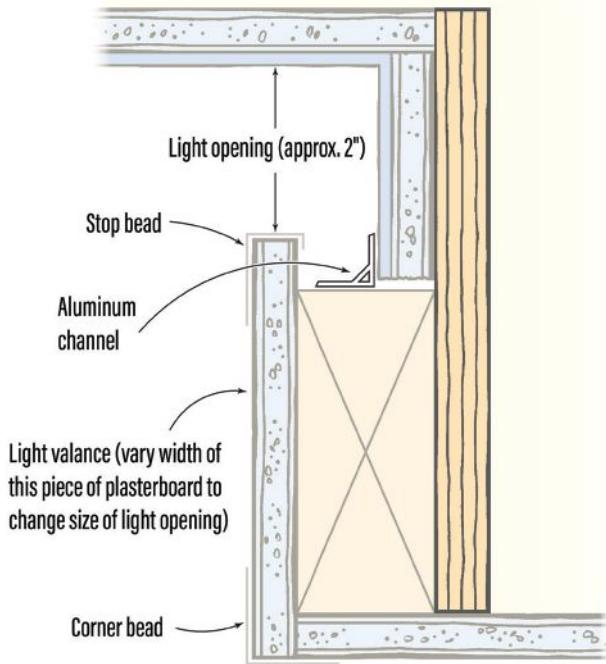
In all the applications we executed, our clients brought us inspiration photos they had collected online. Though they didn’t have any information on how these details were achieved, that wasn’t a problem for us; one of the things we enjoy in the custom-building world is figuring out how to do something we’ve never done before.

FIRST TRAY CEILING

The tray ceiling in one bedroom was the first architectural lighting detail we tackled on this particular project. You can see in

Photos by Rick Mills; illustration by Ola Kwiatkowska

Cove for Perimeter Ceiling Light



At the perimeter of the ceiling, the author and his crew built a cove to hide recessed LED tape. The 2x4 supports an angled aluminum track that holds the LED tape. On the front face, a ripped piece of plasterboard acts as a valance to hide the LED tape from sight.

photos 5 and 6 (see page 45) that the amount of open space from which the light emits at the perimeter of the tray ceiling is very small; figuring out the ideal opening size for the valance proved to be a key detail.

Whenever we have a building detail that we're unsure of how to execute, we will connect with each trade involved. In this case, that would be the framer/carpenter, electrician, and plaster crew. The framing contractor and I sketched out some ideas on how the detail could be done and quickly realized this was going to be a multistep process. The plasterer confirmed our concept. We would need to plaster the ceiling and down the wall behind the valance before we completed the framing for the face of the cove element that would support the valance (see illustration, above). To make it simple for the crew hanging the plasterboard, we installed temporary strips of 3/4-inch plywood to define where the plasterboard needed to stop. We then had the plasterers plaster

the upper ceiling and sides above the temporary plywood strips.

Once the plasterwork had been done, we removed the strips and exchanged them for a 2-by ripped to a custom dimension. With this work done, it was time for the electricians to step in and complete the tape light installation.

The tape light would be installed on top of the 2-by in an aluminum channel. There are various channel styles, depending on how you want the light to be cast. For this application, we selected an angled channel that would help push the light outward, toward the center of the room. We used construction adhesive to stick the track to the 2-by, allowing a day for it to dry before installing the LED strip in the channel.

During the electrical rough-in, we planned for a low-voltage wire to be installed in one corner of the ceiling to power the tape. Sticking the tape to the track is simple, but there are some connectors to manage where the low-voltage "lead" (power supply) attaches to the lead on the tape. We used an American Lighting product, which comes in 16-foot lengths. Since in most of the rooms, we needed two rolls, we had to plan for a splice. Keeping the distances between lighting elements even so the light wash would be consistent proved challenging. We managed this by drilling a hole through the 2-by and into the wall where we could tuck the small amount of excess wire out of the way.

Once all the LED tape was in place, the electricians energized the transformer with a temporary cord to make sure everything was working properly and the light was cast evenly. The last step was to install the acrylic lens over the track. This lens, which is frosted, obscures the individual diodes and helps spread the light evenly.

On a side note, it's important to intentionally plan for the placement of transformers with your electrician. The transformers need to remain accessible and be within a maximum distance of the lighting (typically, around 15 feet) to avoid a voltage drop. Good options include the inside of cabinets, closets, and other easy-to-access, out-of-sight locations. For the tray ceiling, we placed the transformers in the attic that backed up next to this space.

With the lighting installed, we could then install the plasterboard on the lower ceiling area. This "rip" of plasterboard capped the edge of the 2-by, and another rip wrapped up the short face of the tray ceiling. The drywall hangers cut these small pieces, and our carpenters and plaster crew installed them along with the corner beads at the outside corner that defined the perimeter of the tray ceiling and the stop bead (a type of J-bead for plaster) that terminated the edge of the short vertical rise that created the light valance. With crews working side by side, we were able to fine-tune the details of the board, corner bead, and stop bead that capped off the open end of the plasterboard.

To simplify installation of the stop bead, the guys made some gauge blocks at the desired light opening. The blocks allowed them to quickly tack the stop bead in place. From there, we installed the corner bead parallel to the stop bead. As most of you know, nothing is perfect in construction, especially in framing. We found locations where we may have had some dips in the upper and lower ceiling. We had to finesse some areas to find that sweet spot that



The first step was to plaster the ceiling, including turning the plaster down the inside corners at the perimeter (1). The author's crew ripped plywood to form a screed (2), which was replaced by a 2x4 for mounting the lighting track (3).



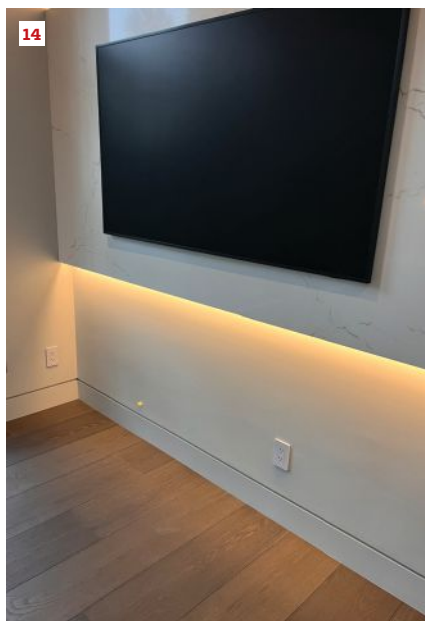
The strip lighting clips to the track with the emitters projecting upward at an angle (4). The bottom corner of the ceiling and the 2x4 are covered with plasterboard (5, 6). The width of the valance plasterboard defines the opening for the light.



The valance plasterboard is finished off with corner bead on the outside and a stop bead at the top of the valance (7). The plasterers returned to finish plastering the ceiling and walls before paint (8). The result nicely defines the perimeter of the ceiling (9).



Initially, the clients asked the author to add concealed LED lighting to one ceiling. They were so pleased with the result that they asked the author's company to include it throughout the house. Shown above are some of the ways it was used in the main kitchen (10) and behind the mirrors and under the floating vanities in two bathrooms (11, 12).



The homeowners chose to make architectural lighting a signature of their new home. LED strip lighting was also incorporated into exterior steps (13), installed to offset a stone television panel (14), and even used to outline wall panels beneath the tray ceiling in this bedroom (15).



Concealed LED strip lighting was used to accentuate the high, vaulted ceiling planes in the main living room (16). The finished rec room ceiling included coffers (17).

looked straight in both directions (in and out and up and down) and parallel to the ceiling above. Some of these came down to judgment calls in the field; we had some good eyes looking at it, and we were all able to agree on what looked best. We kept the light on to help us see how any adjustment affected the “cast lines”—the way the light was cast across the ceiling.

Before any new plaster work started, we made sure to protect the light lens with painter’s tape. Once the plaster crew wrapped up, some curing time was needed before paint. During this time, we removed the protective tape from the lens. Our painters preferred to lay down their own tape on the lens to ensure a good cut-in and, since they had to take responsibility for the quality of the work, we obliged.

Once the paint work was underway, we discovered a new challenge with washing wall and ceiling surfaces with light: The dry-wall/plaster and paint all need to be as close to perfect as possible. The wall wash shows any and all imperfections; as little as a brush stroke out of place can be seen at a close distance.

THE IDEA CATCHES ON

Once that first tray ceiling was completed, the client and design team were thrilled with the results and opted to seek out new opportunities to use architectural lighting on the project.

By taking the basic concept of what we learned with the tray ceilings, we were able to extrapolate the details in a variety of ways. Some of the other areas we were able to add lighting to were backlit mirrors, under exterior step treads, and toe kicks. Some other cool and unique areas included a backlit headboard as well as a top- and bottom-lit bump-out for a TV.

In all these applications, one of the most challenging aspects proved to be determining how much “coverage” was needed for the valance that hid the strip light from view. We wanted to allow enough light to escape to wash the walls but not so much that the source of the light could be seen. With the mirrors, we installed the plywood backer that the tape was attached to, turned on the light, and then tinkered with some scrap plywood to find the amount of coverage that looked best. We did this “mock-up” prior to ordering the mirror.

As a builder, we truly love challenges on a job. Finding new elements to include on our projects is fun and rewarding. It helped that we had adventurous clients who trusted us to work through these amazing details.

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

BY VINCENT SALANDRO



1. Versatile Workstation Sink

For its Quartz Classic Undermount Workstation sink, Zurn Elkay Water Solutions combined natural quartz and high-performance acrylic resin to create a nonporous sink surface that the firm says can stand up to daily use. The workstation, including an acacia wood cutting board, colander, drying rack, roll-up drying rack, bottom grid, and color-matching drain, costs \$880. There is also a four-piece workstation kit for \$640. elkay.com/us/en.html



2. Solar-Charging Hearing Protection

3M touts its WorkTunes Connect + Solar Hearing Protector as the first solar-charging wireless Bluetooth hearing protector for the consumer market. The headset integrates innovative solar cell technology, developed by Powerfoyle for electronics, that continuously charges with both outdoor and indoor light. Like other WorkTunes models, it has a noise reduction rating of 26 dB, and its built-in microphone allows users to make and take phone calls, while background noise reduction enhances call clarity. It sells for \$170. 3M.com/worktunes



3. PVC-Free Corner Bead

Designed with a memory-free hinge that adjusts to any angle on inside and outside corners, Pro-Flex300 from ClarkDietrich is a muddable, PVC-free, flexible corner bead with a reinforced paper backing. According to the manufacturer, the product installs with less compound than standard corner beads do; because the paper surface is pretreated to accept paint, finishing compound is not required over the laminated area. The 3-inch corner bead is packaged in 100-foot rolls. clarkdietrich.com



4. Clear Flashing Tape

Most flashing tapes obscure nail and screw fin patterns on windows, but Typar's Clear Acrylic Flashing tape allows better visibility during installations and inspections. The tape's transparency is achieved with the manufacturer's waterproof, self-healing acrylic adhesive, which can be applied in temperatures down to 20°F. The tape has a split-release liner for simpler film removal. It comes in 75-foot rolls in 4-, 6-, 9-, and 12-inch widths. typar.com

5. Cold Climate Heat Pump

Bosch Home Comfort's IDS Ultra ColdClimate Heat Pump reportedly operates in climates reaching temperatures as low as -13°F, with 100% heating capacity down to 5°F. The unit's Enhanced Vapor Injection (EVI) compressor borrows extra heat from the hot side of the refrigerant cycle, redirecting it to warm the home. Additionally, the pump features demand response capability, allowing utilities to manage electrical loads prior to peak usage time, and it complies with new low global warming potential A2L refrigerant requirements. bosch-homecomfort.us/ultra

6. Push-to-Connect Pipe Fitting

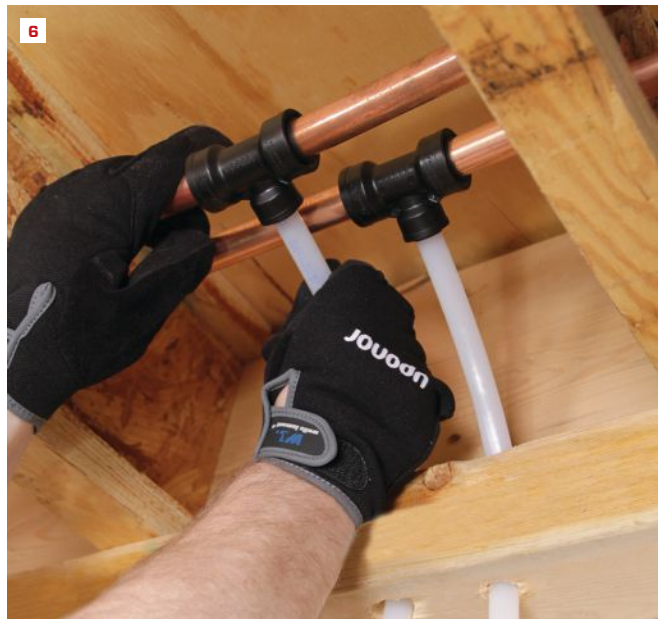
A professional-grade engineered polymer push-to-connect fitting, TotalFit from Uponor works with PEX, PE-RT, CPVC, and copper piping systems. The fittings can be used to repair potable hot-water and cold-water distribution piping systems in single-family homes, townhomes, apartments, and condos. TotalFit is approved by the Uniform Plumbing Code and International Plumbing Code for installation in a concrete slab, direct burial in the soil, and behind walls without access panels. uponor.com

7. Rod Coupler Anchor

Designed to be used with a single-story or multistory rod tie-down system, the Titen HD Rod Coupler anchor from Simpson Strong-Tie is now available in a 1/2-inch-by-9 3/4-inch size with a head style that accepts 3/8-inch-diameter threaded rod. The manufacturer says the anchor is a fast and simple way to attach threaded rod to a concrete stem wall or thickened slab footing; installation requires no special tools, cure time, or a secondary setting process. It's code listed in ESR-2713 for both wind and seismic loading. strongtie.com

8. Combi Gas Boiler

Weil-McLain's Simplicity high-efficiency (95% AFUE) combination gas boiler is designed to provide both hydronic space heating and domestic hot water (though it can also be installed as a heat-only unit). The boiler has an insulated stainless-steel firetube heat exchanger with a vertical "self-rinsing" orientation for easier maintenance, and the touchscreen display reportedly simplifies setup and troubleshooting for service technicians. It's available in sizes of 110, 150, and 199 MBH. weil-mclain.com



Products

9. High-Efficiency Ventilation Timer

Deako's Simple Ventilation Timer can improve the efficiency of bathroom exhaust fans used to meet continuous ventilation requirements. When connected to an exhaust fan, the timer can be set to automatically run the fan for 0 to 60 minutes every hour. It also has 10-, 30-, and 60-minute timer buttons for manual operation—which the unit “counts” toward any ventilation scheduled in the same hour. The timer—with an MSRP of \$75—is sold separately from Deako's backplates. deako.com



10. Diffusive Floor Heating System

Laticrete's Strata_Heat Radiant Floor Heating system includes Spliceless Wire, a high-performance floor heating wire; an uncoupling mat; a Wi-Fi-enabled thermostat; and Thermal Pack, a heat-conductive thin-set additive. According to the company, when added to Laticrete modified thinset, the Thermal Pack enables diffusion of heat throughout the thinset from the heating wire, thereby eliminating cold spots. A Wi-Fi-enabled thermostat allows users to control and monitor temperature. laticrete.com



11. Yakisugi Siding

Yakisugi, a traditional Japanese siding from Nakamoto Forestry, is a maintenance-optional building material hardened and preserved through a charring process. Made from cypress, Yakisugi is intensely burned as a preservative heat treatment. Nakamoto Forestry manufactures three variations of yakisugi in 35 finish options: suyaki, the original charred surface; gendai, a surface wire-brushed only once to removed the charred textures; and pika-pika (pictured), a surface wire-brushed twice to achieve a topographic texture that is lighter in color. nakamotoforestry.com

12. Mortarless Column Wrap

Ply Gem's column wrap product, now under the ClipStone brand name, can be installed in approximately 30 minutes with everyday tools and no masonry skills required. The mortarless stone veneer wraps around existing 4-, 6-, or 8-inch pressure-treated posts, providing the look of a 14-inch-by-14-inch natural stone column. The veneer is available in the ProStack (four color options) and Northern Ledge (five color options) styles of stone. plygem.com





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Flex Power 8 1/4-Inch and 10-Inch Table Saws

BY MARK CLEMENT

Flex has been on the ground—as Lowe’s house brand (available at other tool retailers, too)—for nearly three years, a century or so less than the brands it competes with. Every Flex tool I’ve reviewed has made an effort to be different with some best-in-class results. Here, I do a side-by-side review of the Flex 8 1/4-inch and 10-inch cordless table saws. I can’t help but also compare the two units against their sister table saw (same parent company, Chervon), the Skil TS6307-00 15-amp saw, the best saw (in my opinion and for the work I do) in the category. By far.

I looked at portability, power, controls, squareness, dust management, and “storability” and used the saws to cut pressure-treated 2-by, composite trim material, typical framing, 1-by trim, and super-knotty spruce furring strip. I looked at special features, too, and thought about users whose daily tasks differ from mine.

OUT OF THE BOX

The first thing to check is that the blade is parallel to the fence and set square to the table at 0 degrees. Both saws’ blades were 90 degrees and 45 degrees to the table out of the box. The 10-inch unit needed the fence adjusted only a hair.

The 10-inch saw kit comes with a monster 10-Ah battery and the 8 1/4-inch with a 6-Ah battery, both on the company’s new (read: more energy, faster charging, longer lasting than Gen 1—which I found accurate) Stacked Lithium power plants. I’m not a lab, so I didn’t run boards for hours testing numbers of cuts. I did forget that both saws were cordless. On projects like a basement remodel where

ripping isn’t a full-time job, battery life is measured in days. If you deal mostly with composite materials—low load—the battery life may still be days. I ripped oodles of Acre by Modern Mill for column wraps, and the battery had plenty of power.

Both saws have an LED strip in the fence (charged separately). I build a number of decks and, when it’s dark at 4:30, I’ll take any light source I can get.

The 8 1/4-inch saw is compact with a folding, extra table section to the left of the blade that claims best-cut capacity in its class for ripping sheet goods. I’m not a big ripper of sheet goods with table saws, but I hoped the fold-out section would be a good base on which to store the saw in my service body truck. It wasn’t. The saw tipped easily off its side. I don’t use the fold-out much, but it’s there if you need it and out of the way if you don’t. Hardware works well, but it adds weight to the 50-pound unit. For the material I rip, the cut capacity of the 8 1/4-inch saw works on 95% of what I need ripped with less blade plate resistance.

The 10-inch saw has a feature called CutSense, a Flex innovation in which pressing a button before activating the saw will shut it off after a rip is made. The blade senses pressure and, when it doesn’t, it shuts the saw off. The intention is to save battery life. However, it requires the extra step of pressing a switch near the start button before each use. If you make a rip and leave the saw long enough to install the item and want CutSense to be active on the next rip, it isn’t.

Fence locks. I need to give a shout out to the fence lock on the 8 1/4-inch saw. I’m not saying I like it; my years-long muscle memory



The Flex cordless table saw is available in 8 1/4-inch (on stand, at left in photo) and 10-inch (on table, at right in photo) models (1). The stand can be configured for either model. The author operates the fold-out support of the 8 1/4-inch saw (2).

Photos by Mark Clement

Weigh In!

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

of reaching under the table doesn't like it. But mechanically, it is an easier reach. The 10-inch tool has the comfort-food edition of an under-table fence lock. Both saws lock hard and snap into place. Engaging the locks does take some oomph; the lock on the 10-inch is actually loud.

Power. There are two ways I "measure" power: Everyday stuff—2-by, 1-by, composite-by—and the oddball we all run into. On this job, I had to thin 2x3, very knotty, spruce furring strips (strapping), and I'll be darned: The saws weren't happy.

I can feel the saws plowing through a KD fir 2x4. This is true of all saws, to a degree. However, with the blades all the way up into this material, the battery electronics shut both saws down as (I suspect) they heated up—and the batteries were bottoming out their electron exchange. With fresh batteries, the units were fine.

I didn't notice anything atypical in the materials I sent through the saws. Both saws cut smoothly, and the battery life on a cordless table saw still surprises me. That said, I ran out of juice with no real warning. The saws either start struggling or stop altogether, depending on the load, and I had to go to my battery farm to get back in the game. Should that be a chafe for you, like it is for me, you can buy the company's AC/DC adapter. It's unwieldy-ish (as is every other one I've seen) and takes up truck space. With its (sometimes maddening) fan-whirring transformer one-third of the way along, its otherwise generous 20-foot lead cord provides ample reach.

Dust. The Flex 10-inch saw includes a 22.5-degree angled chute that channels sawdust down. Genius. It should be tool building code. It rarely clogs. Instead of exiting the unit in a plume, most tailings "chute" down into a drywall bucket or empty box.

Switch. The 8 1/4-inch unit has a pull-tab type switch I really like. Flick on, bump off. The 10-inch has the same switch as the Skil, adapted from more stationary saws. It works, but it is just a hair more work. Press on, paddle off.

Stand. Both units use the same folding X-stand, which has one configuration for the 10-inch saw and another for the 8 1/4-inch saw. Assembly is required. Dragging from truck is also required. Both saws weigh about 50 pounds but feel way heavier than the Skil unit I have (also about 50 pounds), which has its stand built in. The Skil is *much* easier to set up, store, and manage.

Storability and portability. While I have a bowling alley in the back of my e350 service body, that room is not infinite, and I need to travel through it. Both saws must be stored on their bases—not on their sides like their sister Skil can be—and, being separate, the stand takes up more room. The Flex saws also require two extra trips to and from the truck for setup and break down compared with the Skil. On the plus side, unlike saws tangled up in fancy collapsible stands and wheel kits, the Flex saws can be moved in and out of a jobsite, through a door, and upstairs by one person.

CONCLUSIONS

Both saws perform as promised. Neither, other than their cordlessness, lived up to my simple Skil. They share some features: switches, fences, likely motors.

The batteries alone are impressive in delivering giant energy. The saws that are built around them (Flex isn't sure if it is a battery company that builds tools or the other way around) do the work we need done well and hold their own on jobsites from decks to new homes and basement remodels, where running cords isn't convenient.

The Flex table saw kit (saw, battery, and charger) costs \$800 for the 10-inch saw and \$600 for the 8 1/4-inch saw; the stand (\$100) and the AC adapter (\$200) are sold separately.

Mark Clement is a deck builder and remodeler in Ambler, Pa., and the author of The Carpenter's Notebook. Find him at @myfixituplife.



Both saws have a lighted fence (3). Shown in photo (4) are a 10-Ah battery (foreground, at left), included with the 10-inch saw; a 6-Ah battery (foreground, at right), included with the 8 1/4-inch saw; and an adapter (behind), sold separately.

Festool Systainer ToolBag

BY TOM O'BRIEN

When I'm working in occupied houses, my Festool dust extractor follows me from room to room like a puppy on a leash. By the end of the day, its top will be littered with loose tools and fasteners. It was always my intention to build a toolbox that could empower me to use the vac as a mobile tool cart, but now maybe I won't have to. Festool's new Systainer³ ToolBag (1) is a soft-sided tote with a hard plastic base that mates with all the company's mobile dust extractors and both generations of Systainers.

The toolbag features two full-length tool trays on the interior, a zippered pocket on each exterior side, and a few open pockets of various sizes on the ends. Otherwise, the interior is a blank slate, with only a pair of Velcro strips to which interchangeable, pocketed inserts can be affixed. Included with the bag are two T1 inserts, which have four large and eight small, soft-sided, bottomless pockets; one T2, which has four large, soft-sided, bottomless pockets; and one T3, which has three tight, hard-plastic-lined pockets (2). The T3 insert is designed to provide safe storage for sharp tools such as chisels. A small, T4 individual toolbag and a padded shoulder strap are also included. Additional inserts can be purchased separately.

For testing, Festool provided me with four samples of each of the inserts, which allowed me to experiment with layout. For the carpentry work that I do, the winning setup proved to be a T1 and a T2 on each side of the divider and a pair of T3s, one on each sidewall. The T1 offers the most storage options, while the T2's low profile affords more open space for hammers and saws. What impressed me about the T3 was the tight fit that kept my short screwdrivers and

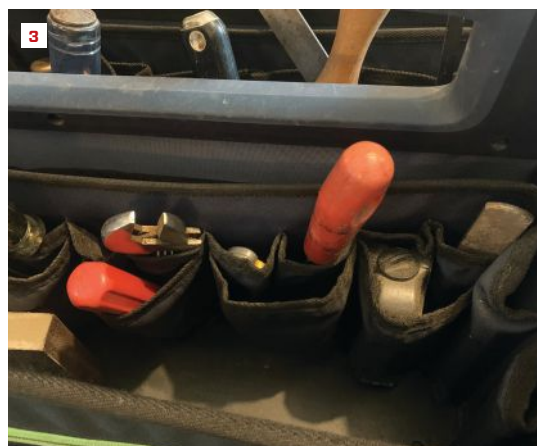
utility knives from dropping to the bottom of the pocket (more on that later). It's nice to have the option to shuffle the inserts around, remove them completely, or outfit spare inserts with tools for specific tasks and swap one for another, depending on the job.

One thing I'm not entirely sold on is the bottomless "pocket" concept. Essentially, what the T1 and T2 inserts have for tool holders are not pockets but sleeves. The manufacturer touts this feature as an advantage because sharp objects simply drop in and sawdust is easily sucked up. In my experience, long tools and those that were widest on top were a good fit for the bottomless pockets. But short, skinny tools fell down the well and had to be rescued (3). Although my ability to employ an extra T3 insert made this a non-issue for me, I wonder if it might have been possible to taper the small pockets.

My other concern was that the toolbag's dark blue interior sometimes made it difficult for my aging eyes to find what I was looking for. But that was solved by clipping a flashlight to the handle.

Despite these minor quibbles, I would gladly put up real money for the Systainer³ ToolBag and pay extra for another T3 insert. As someone who struggles with organization, I appreciate the ability to strap this toolbox on top of a dust extractor or another Systainer and move about the jobsite, knowing that everything I need is within arm's reach when I need it, and that I can return it to its rightful place when I'm done. Cost is \$200. festoolusa.com

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

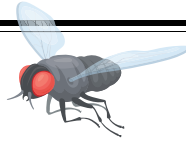


Photos by Tom O'Brien



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BY MARC FORGET



Salute to Bob



We've all met or worked with that one person who, through no fault of their own, is stalked by misadventure like a hunter after a prize buck. I have Bob (not his real name), who has dealt me many an ace card for break-time conversations with fellow tradespeople. Bob is a good man and friend and a solid worker but, when the fates were spinning the thread of his life, they put in some knots and tangles for variety. Moments of laughter are important, even vital, to get you through a day's work. Bob would be the first to share these and other stories; there is no filter or unnecessary pride with Bob, a true open book.

One day, while we were leaving a jobsite for lunch, Bob realized that he had not put the spare key back in its spot in the garage. I quickly turned around in the cul-de-sac, and he hopped out to square the key away. Looking through the passenger window of the truck, I watched Bob open the garage's side door and recoil in terror. Then he began maniacally dancing and flaying about, but as if I were watching a silent horror/comedy, I couldn't hear the squeals or stream of profanity. By Bob's telling, legions of flies had gathered at the garage door's window and, when the door opened, they all flew to freedom, directly into Bob's unsuspecting face. It took some time before I could catch my breath after watching him perform his interpretive dance. I paid for lunch that day; it seemed fair.

Among our crew, friendly wagers and competition were always part of the workday. At one point, Bob and another co-worker came to a bet about who could find the cheapest tin of smoked oysters for lunch. This went back and forth for weeks until Bob found the golden ticket with a tin for 17 cents. The co-worker conceded defeat and paid out the promised donut. Victory was short-lived, however, as later that day, Bob's digestive system took to violent revolution. When the carnage of revolt eventually subsided, casualties included three days' wages, a lost weekend, a set of work clothes, and 8 pounds of body weight. As part of the peace treaty, eating contests in general—and tinned shellfish, specifically—were banned from the jobsite. Legend has it that the cursed portable toilet of that day is still in service, and you can still hear Bob's cries from its blue walls.

For the final story, we need to go to a hot, summer day a number of years ago, when Bob and another worker were gutting out an old home for renovation. Old lath and plaster create an evil kind of dust. The base coat of this plaster was mixed with horsehair and

By Bob's telling, legions of flies had gathered at the garage door's window and, when the door opened, they all flew to freedom, directly into Bob's unsuspecting face.

ash along with what was suspected to be asbestos. (This happened before stringent regulations and testing, so safety ranked third after production and awesomeness.) Precautions were taken, though: full Tyvek suits, cartridge masks, goggles, and gloves, along with pump sprayers containing a mixture of water and PVA glue for spraying the walls to keep the dust down as work proceeded.

Bob began working at a fast pace, but then his sprayer started to clog up. Getting frustrated, he secured the sprayer between his feet and furiously worked the pump handle to clear the blockage. The built-up pressure was too much for the unit, and the release valve shot away into Bob's below-belt area. Bob's yelp of pain was followed by a torrent of glue and water that covered him from stem to stern. The co-worker fell to the floor to dodge the spray and try to catch a breath from laughing, while, with muffled profanity, Bob frantically grabbed the unit to staunch the spray, only making it worse.

After the pressure finally subsided, Bob—now in a wet, sticky cocoon—gathered himself and helped clean the area before trying to remove his now-adhered suit. Working in a Tyvek suit is like boil-in-the-bag cooking, so Bob was down to his skivvies underneath. His barely recovered co-worker had to help cut him free. Now, Bob is a furry fellow, and some of him peeled off with the suit, to add real pain to the hurt pride. He did not want to put clean clothes over his gooey self, so we silently watched a mostly naked Bob march with surprising dignity through the site in his matted shorts, down the street to his car, then home for a shower.

Part of what makes a good crew is getting along well, not just being technically proficient. A good story well told or a shared laugh on site always makes a day run smoother. So here's to Bob and all the Bobs out there who inspire the stories that brighten our days.

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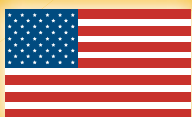
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