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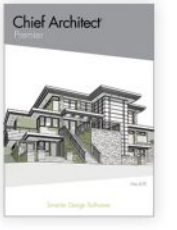

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On the cover: Tim Uhler, of Pioneer Builders in Port Orchard, Wash., makes a plumb cut on a rafter using Makita's cordless framing saw. See the story on page 37. Photo courtesy Tim Uhler.

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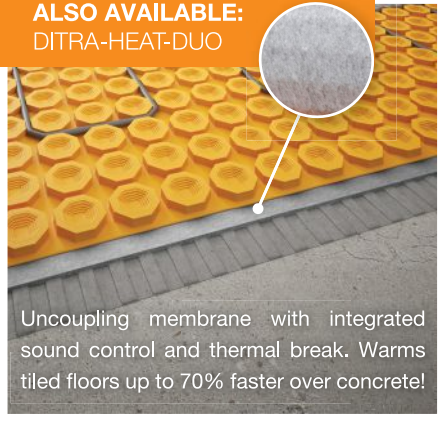

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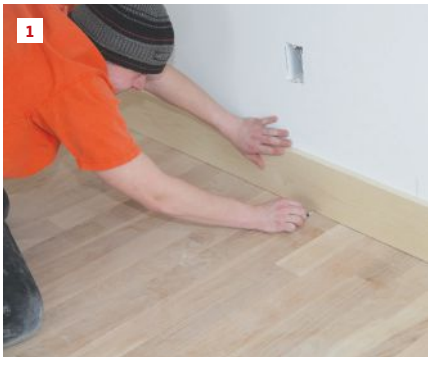
BY ROE OSBORN

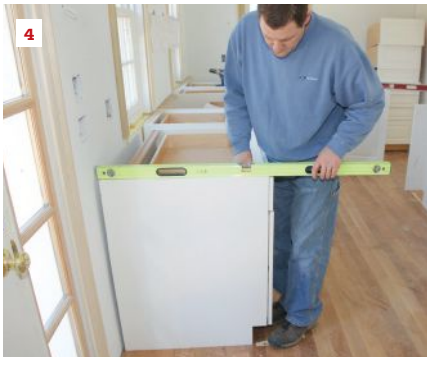
Scribing Basics

In a perfect world, every surface of a house is straight and either level or plumb, but in reality, that is seldom the case. Studs can twist, pushing drywall out of whack, and houses settle, leaving walls out of plumb and floors out of level. Even new work, such as hardwood flooring, isn't always straight and flat. Yet finish carpenters are expected to install their work straight, level, and plumb. The key to doing this successfully is scribing, or transferring any unevenness to the finished material so that it fits perfectly.

For most finish carpenters, scribing is something that they do as a matter of course—often several times a day. Examples of tasks where scribing is often needed include fitting baseboard to an uneven floor **(1)**, fitting the bottom of a door to an uneven or out-of-square sill, and fitting a cabinet against a wall **(2)**. Scribing trim to a beachstone fireplace or to round pebble floor tile can be challenging, but it's also a way to showcase your talents as a craftsperson **(3)**.

Tolerances. The guiding premise for scribing is how close the fit has to be. With paint-grade trim work I've done, 1/16 inch or less was fine. Once the wood is primed, a bead of painter's caulk can make a joint disappear. But I've also worked in boat shops where the tolerances were less than the thickness of paper.





Photos by Roe Osborn

Common scribes are fitting baseboard to a floor **(1)**, scribing a cabinet to a wall **(2)**, and scribing to an irregular surface **(3)**. Shim cabinets level before scribing **(4)**.

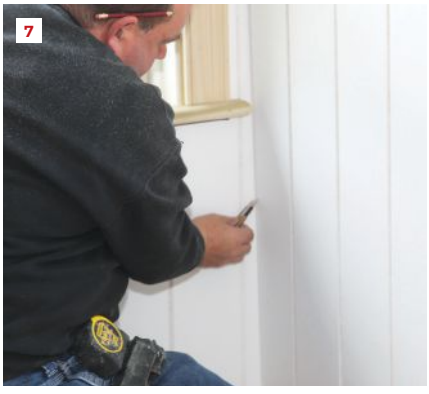
Location is another factor for tolerances. A baseboard that is scribed to a hardwood floor might be visible only to the clients' dogs and cats, while a cap rail on wall paneling that is closer to eye level might require a much tighter fit.

When working with a crew, be sure that the manager has made it clear what tolerances are expected—and be aware that those tolerances may vary depending on the client or where in a house you are working. Your boss may be OK with you spending an hour to scribe cherry baseboard in a formal dining room, but the baseboard in the closet of a child's room is probably not as critical and should be installed more quickly. If you are working for yourself, working to acceptable tolerances can be the difference between a profitable or unprofitable project.

Setting up the scribe. There are many variables when deciding how much material to remove and from where. The first is whether the object being scribed needs to be level or plumb. A good example of this is an end cabinet where it returns into a wall. Except in rare cases, kitchen cabinets are always installed with the faces of the cabinets plumb and the tops of the cabinets level side-to-side, and with the faces and tops in plane with those of the other cabinets in the same row. After the rest of the cabinets in the line are installed, the end cabinet is leveled in place, with the top in plane with the others **(4)**.

With the cabinet as close as possible to its final position, set the scribe to the amount that you have to remove so the cabinet face will line up with the other cabinets. That is the amount you need to mark along the back edge of the filler piece of the cabinet.

When baseboard is scribed to a floor, it usually looks better if the baseboard is kept generally parallel to the flooring surface rather than perfectly level. If there is a hump in one spot, raise an end to make the gaps on either side of the hump roughly equal before scribing. Otherwise, you may end up



For small, straight line gaps, scribe with a pencil **(5)**, and remove waste with a belt sander **(6)**. Use a compass scribe for wider gaps **(7)** or for more finicky profiles **(8)**.

taking too much off of one end, making the baseboard look tapered. Keeping baseboard generally parallel with the floor will make it easier to keep adjacent sections aligned.

Horizontal pieces like a cap rail on wall paneling should be set up so that the overhang is close to even. If the paneling is relatively straight but the wall is not, set the rail stock on top of the paneling with a consistent overhang. When you scribe the cap to the wall, the overhang or reveal along the edge will be even and consistent.

Pencil scribing. When scribing, I try to remove as little material as possible, and there are usually sections of the board from which I don't remove any material. After setting up the scribe, I find the largest gap that needs to be bridged to create a tight fit. If that gap is less than 1/4 inch, and I am scribing to a flat surface such as a floor or a wall, the quickest and easiest way to scribe is to place a sharp pencil on the flat surface and let the point of the pencil ride on the material **(5)**. Keep the pencil square to the work, and mark the entire length of the board being fit. Avoid pressing too hard on the pencil; the point can dig in and follow the grain rather than drawing a line parallel to the surface irregularity.

Removing the waste from a pencil scribe can be done with whatever tool you are most comfortable using. A common way of removing waste for a small scribe is using a belt sander **(6)**. Clamp the board to a workbench and lightly sand the edge, taking care to keep the sander moving side-to-side to avoid gouging the edge. To remove material from a straight edge such as a baseboard, I prefer to use a sharp block plane, which is easier for me to control.

Compass scribing. When I'm scribing gaps larger than 1/4 inch, such as where sections of paneling meet in a corner, my tool of choice is a compass scribe—basically a compass with a hard point on one side and a place to insert a sharp pencil on the other **(7)**. You can find one at just about any hardware store or lumberyard for under $5. Before I begin to scribe, I slide the pencil into the sleeve so that the pencil point is even with the hard point on the other side.

To set the compass width, put the hard point against the irregular surface, and close the pencil side to the largest gap. Then run the compass down the entire length of the board. For an accurate scribe, be sure to keep the open compass scribe perpendicular to the irregular surface, while keeping the points of the compass in line with the surface you are scribing.

Advanced scribing. Many times I need to scribe to a very uneven or irregular surface. A common example is scribing the end of base-cap trim to blend seamlessly into the profile of door trim **(8)**.

Another example, mentioned earlier, is scribing trim to a stone fireplace or to a pebble floor. For those cases, the hard point of the compass scribe lets you precisely follow the contours of the irregular surface.

In the photo sequence on the facing page, I show how I scribed a length of baseboard to a natural stone accent section of a tile entry. After cutting the baseboard to length, I set it in place and checked it for level, just letting the bottom edge touch the highest stone **(9)**. Next, I set my compass scribe to the maximum distance that the baseboard needed to drop once it was scribed to fit, and I marked the profile of the stone **(10)**. Because the scribe has to match the profile of the stone directly below the visible edge of the baseboard, I angled the compass to the face of the baseboard so that the hard point followed the stones and the spaces below **(11)**.

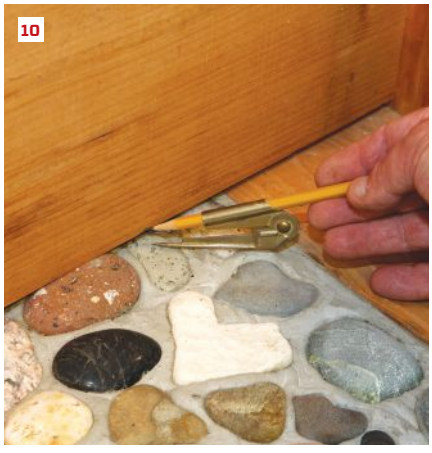
When I had finished marking my initial scribe, I rough cut close to the line with a jigsaw **(12)**, following up with a coarse rasp **(13)**. Part of the baseboard rested on wood flooring, and I used a block plane to cut that section to the scribe line **(14)**.

Scribe in degrees. As I cut to the line with the rasp and the plane, I angled the tools to create a back bevel (only the outside edge of the wood needs to contact the stone). I also make a habit of erasing any leftover pencil lines **(15)**. I am rarely lucky enough that the piece fits perfectly on the first try,

and erasing the lines gives me a fresh surface to fine-tune the scribe. For this particular scribe, I went back twice to tweak the fit, each time using a smaller scribe gap.

When I was happy with the fit, I set the piece in place and gave it a gentle tap down to let it nestle against the stones before fastening the baseboard **(16)**. For this project, I left the wood natural and unfinished with exposed fasteners. If the piece was to be painted, I would have applied a primer coat and at least one finish coat before installing it.

Roe Osborn, author of Framing a House *and* Finishing a House, *is a senior editor at* JLC.



The photos above illustrate the process of scribing a baseboard section to the irregular surface of randomly shaped pebbles (see photo 3 on page 7 for the finished scribe). The steps are described starting on page 8.

For a more detailed discussion of scribing, go to **www.jlconline.com/training-the-trades/scribing-basics**.

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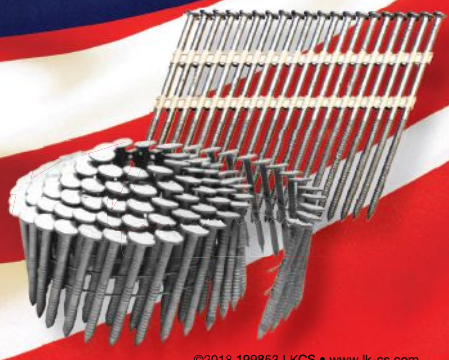

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Q A client has hired me to build a large outbuilding with a single-plane shed roof. How do I weatherproof the uppermost edge?

A Mike Guertin (on Instagram @mike_guertin), a builder and remodeler in East Greenwich, R.I., and a presenter at JLC Live, responds: We framed and roofed a number of contemporary homes in the 1970s and 1980s with mono-slope (aka mono-pitch) roofs. Back then, local lumberyards stocked mono-slope ridge flashing that looked like oversized drip edge. But instead of being installed before the roofing (in the usual drip-edge fashion), mono-slope flashing is installed with the roof leg on top of the roofing and the vertical leg extending down over the fascia.

Mono-slope ridge cap flashings are still fabricated by flashing manufacturers and can be found online, but the lumberyards in my area no longer stock those flashings. Rather than wait for a special order, I make my own—mono-slope ridge flashing is easy to make on a sheet metal break (see "Using a Sheet Metal Brake," May/17).

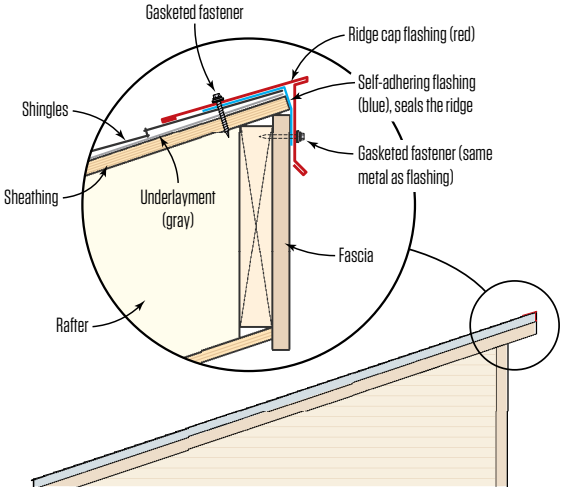
I start with regular colored aluminum coil stock 0.019 inch thick or thicker (galvanized, copper, or stainless steel can also be used). Standard sizing calls for a 6-inch-wide roof leg and a 4-inch drop leg with a 1/2-inch drip bend at the bottom. I hem the 6-inch edge and the 1/2-inch drip bend to stiffen the flashing and minimize oil-canning when it expands. I adjust the angle between the roof and drop legs to match the slope of the roof.

I often form an extended edge of the roof leg of the flashing (similar to the projection found on most drip edges). The projection is mainly cosmetic, creating a shadow line along the ridge, and doesn't improve the water resistance of the flashing.

I install the flashing over the roofing (such as asphalt shingles) along the ridge, with the roof leg face-nailed or screwed down. Ideally, you should use the same metal for the fasteners and the flashing—aluminum fasteners with aluminum flashing, galvanized steel with galvanized steel—to avoid corrosion due to galvanic reaction. If you're concerned about the flashing leaking at the fastener penetrations, you can use gasketed fasteners commonly used to fasten metal roofing.

If you're in a high-wind area, I recommend applying a 4-inch strip of self-adhering flashing (SAF) tape to help seal the roofing to the fascia. The ridge flashing then goes over the SAF. In the event that wind-blown rain makes its way under the drop leg of the ridge flashing, the flashing tape will block the water. You can also nail the drop leg to the fascia board for extra hold-down.

Mono-Slope Ridge Cap



Custom-bent flashing (photo) and self-adhering flashing weatherproof the top edge of a mono-slope roof. Gasketed fasteners hold the flashing in place.

Photo: Mike Guertin; Illustration: Tim Healey

Q My tile installer recently told me that he wanted to use caulk in the corners of a tiled shower instead of grout. Is that necessary?

A Tom Meehan, a second-generation tile installer and co-author of *Working with Tile* who lives and works in Harwich, Mass., responds: The vast majority of showers that I've tiled have had no problems when I use grout in the corners. But on that subject, the Tile Council of North America (TCNA) offers the following recommendation: "Technically, anywhere there is a change in substrate or backing surface such as the joint between walks and floor and wall joint, caulk should be used in place of grout since these surfaces move independently of each other." But the TCNA then goes on to list five reasons that installers use grout instead of caulk. Matching the grout color—both when the caulk is new and as it changes over time—are major reasons. Caulk's tendency to support mold growth as well as its greater need for maintenance are others.

The key word in this recommendation is "technically." Clearly, the TCNA recognizes that many tile installers use grout alone to seal shower corners. But the point of allowing surfaces to move independently of each other is an important one. To that end, I am very careful when prepping the backerboard in a shower. I finish all backerboard corners and seams using a special moisture-resistant mesh tape bedded in latex-modified thinset mortar. I never use the standard mesh tape used for regular drywall. Before applying the tape, I put a layer of thinset on both mating surfaces without filling up or "packing" the joint. This joint space allows for slight movement, which helps to keep the grout from cracking, in most cases.

In those extremely rare cases where cracks develop in the grout in a corner, I thoroughly scrape out the old grout and completely clean the joint. Then I run a bead of caulk in the corner. To minimize the chances for mold, I use nothing except 100% silicone caulk. In addition to silicone, the TCNA recommends urethane or multi-polymer caulks. It cautions against acrylic caulk, which it says can break down in horizontal wet applications.

As the TCNA recommendation notes, it can be difficult to match the color of the caulk with the color of the grout used in the rest of the shower. I've found that caulk manufacturers always seem to be expanding the color choices for their caulk to meet this challenge. As a word of caution, however, note that some caulks change color in the process of curing, becoming opaque or turning clear. So it's always a good idea to test a small area before caulking the entire seam. If I can't find a close color match, I often resort to using clear silicone.

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Rafter Framing for a Conical Roof

BY NATHANIEL ELDON

Last year, I completed a project that incorporated a half-round turret-like porch. In the article "Framing a Two-Story Half Round Porch" (Apr/19), I discussed the curved framing—mainly the semicircular steel assembly and integrating it with the wood-frame house—but I stopped short of discussing the semicircular conical roof that capped off the porch.

Hip beginnings. The roof rafters for the half-cone rested on a curved 2-by plate that we attached to the uppermost curved steel beam with powder-actuated fasteners and 1/2-inch-diameter carriage bolts. The conical roof was actually the end of a gabled roof volume that extended from the house out over the porch. We started by cutting the common rafters for the gable roof. The rafters for the conical section would have the same tail details as the commons, but the top cuts (for the point of the cone) would have to be measured and cut later, so we set the pattern rafter aside.

We ran a 2x10 ridge from the house over to where the semicircular framing of the porch began. In hip-roof fashion, we installed three king commons. The first ran in a straight line from the end of the ridge to the midpoint of the curved plate **(1)**. The next two king commons opposed each other at the end of the ridge **(2)**. These two rafters were perpendicular to the ridge and ran down to the beginning of the semicircle on either side.

A tight intersection. With a hip roof, a hip rafter would extend 45 degrees out from the king-common intersection to the corner of the building. Because there was no corner, the rafters for this roof simply fanned out around the semicircle. I was concerned about the intersection where seventeen 2x8 rafters were all supposed to meet. I considered installing headers to catch some of the intermediate rafters, but a header would be a straight line between the radial rafters, with the top edge below the curved plane of the roof. In situations such as this, I find that the best strategy is making a full-size plan drawing of the roof to visualize the framing.

Full-scale drawing. With the house still in its early framing stages, we picked out a large open floor area for the drawing. After

Like framing a hip roof, framing a cone begins with three common rafters. The first comes off the end of the ridge **(1)**, and the other two support the ridge from the sides **(2)**.

A full-scale drawing allowed the crew to visualize the intersection of the radial rafters. After swinging a semicircle to represent the top plate **(3)**, they used a ripping to trace the rafters one by one **(4)**. Darkening the lines let them see the end cut details **(5)**.

Photos by Nathaniel Eldon


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7


8


9

The crew found the midpoint of a 2-by spanning between the common rafters and transferred that point to the plate to mark the positions of the "eighth" rafters **(6)**. Midway between those points and the common rafters **(7)**, they marked the positions of the "sixteenth" rafters **(8)**. After laying out the rafters, the crew measured from the plate to the shoulder of the angled cut to find the length of each rafter **(9)**.


10


11

The rafter tails were identical to the commons, so the crew used the pattern rafter to trace the tail, and then cut the details **(10)**. After measuring and marking the shoulders of the plumb cut, they took the saw angle from the floor drawing and cut the top **(11)**.

picking a center point for the semicircle (the center point of the end of the ridge), we drew its outer circumference **(3)** and snapped centerlines for the three king common rafters. Using a straight ripping of 2-by material, we drew the outlines of the kings **(4)**, which divided the half circle into two quarters of a circle. Next, we found the center point between the kings and drew in the rafters that broke the semicircle into eighths of a circle, then sixteenths, and finally thirty-seconds. That layout put the rafter tails just under 16 inches apart.

So far, we'd let all the lines intersect at the top, but now I darkened in the ends of the rafters starting with the kings **(5)**. The "eighth" rafters were followed by the "sixteenth" rafters. The acute angle at the end of the "sixteenth" rafters would be greater than 45 degrees, but we could still cut it with a circular saw. I decided just to butt the "thirty-second" rafters into the available spaces rather than trying to cut long tapered ends. Darkening in the ends of the rafters at the intersection also allowed us to take the cut angles directly from the full-scale drawing.

Plate layout. The tail ends of all the rafters in the semicircle would be identical, but before cutting, we needed to lay out the rafter positions on the plate. Typically, rafter layout on a straight plate

The arcs between the king commons were each a fourth of a circle's circumference. The first two rafters installed split those arcs into eighths **(12)**. Starting at one end of the semicircle, the crew then installed the four rafters that created sixteenths along with the eight "thirty-second" rafters **(13, 14)**. They nailed the rafters together at the peak **(15)** and tapped down any uneven ones **(16)**.

means pulling a tape down the length, marking the rafter positions, and squaring the marks by holding the edge of the square against the plate. But with the curved plate, we couldn't just "pull" the layout, and we couldn't hold a square to the edge of the plate to mark the positions. Instead, we kept dividing the space between the king commons in half until we got the layout we needed.

We cut a 2-by to exactly span the quarter circle between the king commons, marked the midpoint on the 2-by, and squared over from that point onto the plate for the "eighth" rafters **(6)**. After laying out their positions, we measured between that layout and the king common **(7)** and transferred the measurement to the 2-by. Then we used the 2-by to measure and mark the positions of "sixteenth" rafters **(8)**. Those rafters were close enough together that we just measured to the midpoint for the position of the "thirty-second" rafters.

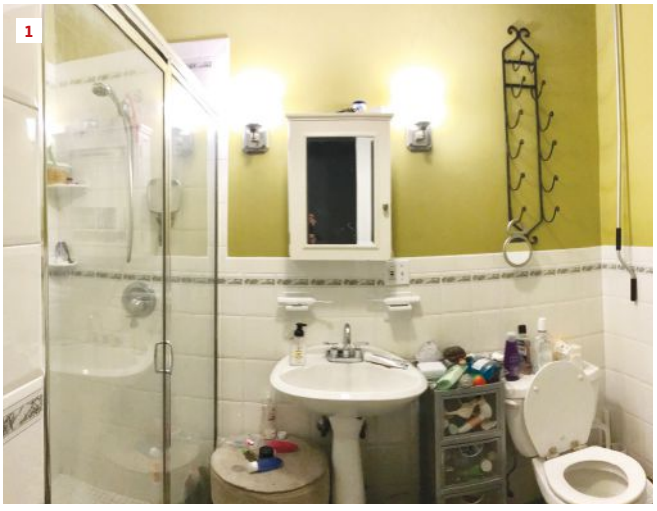
Rafters in the round. With the plates laid out, it was time to cut and fit the rafters. We measured from the outside edge of the plate to the shoulder position of the "eighth" rafters **(9)**. We laid out and cut the rafter tails using the pattern rafter set aside earlier to mark the eaves overhang and the birdsmouth **(10)**. Then we measured up for the plumb cut. Taking the angle from the floor layout, we set the saw blade angle and made the plumb cut at the top ends of the rafters **(11)**.

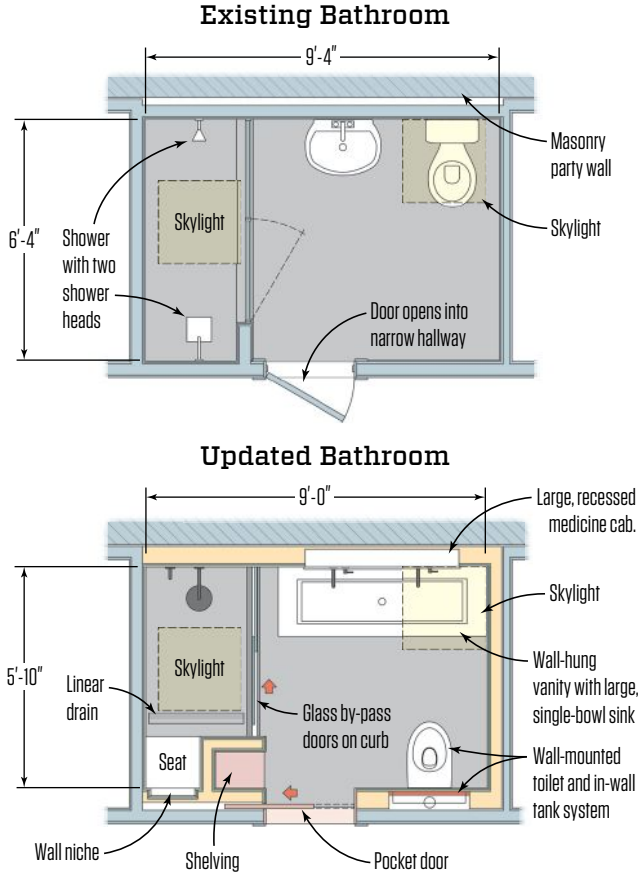
After cutting and installing the "eighth" rafters **(12)**, we turned to the "sixteenth" rafters. We measured and cut them in the same fashion **(13)**, but this time the acute angle made the cut a bit more challenging.

Instead of installing all of the "sixteenth" rafters, we started at one side of the semicircle, installing the "sixteenth" rafters and filling in the "thirty-second" rafters while we were still in position **(14)**.

To join the rafters at the top of the cone, we toenailed or face-nailed wherever possible **(15)**. When all the radial rafters were installed, I went around and made sure they were all in plane for the sheathing and trim, tapping them down where necessary **(16)**.

Nathaniel Eldon owns Eldon Builders (eldonbuilders.com), a custom home building and remodeling company in Cape May, N.J.





The original 20-year-old bathroom **(1)** felt dated to the homeowners, who preferred a more contemporary look. Moving the toilet to the opposite wall and installing built-in shelving and a pocket-style entry door maximized the available space in the bathroom's modest footprint.

Updating a Row House Bathroom

BY ROB CORBO

I always like getting a call from these particular clients. They've been periodically updating their Hoboken, N.J., row house (see "Retrofitting an Oversize Door in Structural Brick," Oct/14) and have been contracting with our remodeling company to do most of the work. Their design preference is for contemporary rather than period fixtures and finishes, which can be tricky when working with an older brownstone building with a deep and narrow layout and oftentimes unique construction details. A case in point was the recent renovation of their 20-year-old third-floor bathroom, which our clients wanted to transform into a more luxurious space suitable for a master bedroom suite **(1)**.

Demo. Though we weren't changing the bathroom's roughly 9-foot-by-6-foot footprint, we did need to remove the existing finishes. Because the work was to be done on the row house's third floor, protecting the two flights of finished stairs leading up there was a priority, as was fast and efficient removal of the construction debris. So we hired a demo crew to remove the old finishes down to the studs and joists, safely transport the debris down the stairs without damaging them, remove the debris from the building, and dispose of it.

Framing. Besides the masonry party wall between buildings, the existing wall construction consisted of a blend of original plaster-and-lath walls over wood framing and more recent drywall over steel studs. In some places, the wood framing was installed on the flat to gain valuable floor space—in a 16-foot-wide building, every inch counts. Once the demo crew had removed the wall finishes and much of the framing and chipped away the tile floor, mud bed underneath, and wood plank subflooring, we started reframing the space.

To strengthen the floor system for the new tile, we sistered new joists onto the existing 2x8 floor framing, straightening and leveling the floor in the process. After the plumber made needed modifications to the underfloor shower and toilet drain lines, we laid down a new plywood subfloor, gluing and screwing the plywood to the framing (see before and after floor plans, left).

We reframed the walls using a combination of 2x4s and 2x6s, installing the wider studs where necessary to create extra depth for routing hot and cold supplies and DWV lines for the toilet, which was relocated to the opposite wall. We were also replacing the existing hinged door, which opened awkwardly into a narrow hallway, with a pocket door. Here, we left the existing hallway

Photos: David White Studio NYC; Illustration: Tim Healey

New 2x6 wall framing and solid blocking were needed for the wall-hung vanity and recessed cabinet above **(2)** and for the toilet's in-wall tank and mounting system **(3)**. The two wall-tile selections were slightly different sizes **(4)**, requiring different-sized grout joints to ensure that they lined up in the corners where they met **(5, 6)**.

wall framing intact and framed the interior wall with 2x4s on the flat, leaving a 2-inch-wide space for the pocket door.

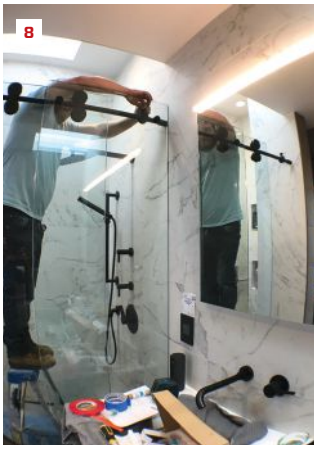
The Toto Aquia wall-hung toilet that our clients had selected required 2x6 framing. The unit has an in-wall tank system that requires a minimum 5 1/8 inches of clearance and has a steel support frame with specific rough-opening requirements **(3)**. Because the walls would be clad with large-format porcelain tile, it was critical to use straight framing and install it so that it was perfectly plumb.

The "attic" in a typical row house is really just a narrow gap between the ceiling joists and the roof framing, which varies in height depending on whether the roof drains toward the center of the building (as is common) or toward the back. In this case, the rafters and joists were fairly close together, which simplified the framing of the wells for the room's two skylights, a fixed one over the sink and an operating one over the shower. Thankfully, ventilation ductwork and electrical wiring were already in place, so no one had to crawl up there to install a new roof cap or pull new cable.

Once the walls were framed, our plumbing sub roughed in new copper supply lines and PVC DWV pipe for the shower, vanity, and relocated toilet.

Tile details. In preparation for the tile, we installed cement backerboard in the shower area, taping the joints with mesh tape embedded in thinset, and installed moisture-resistant drywall in the rest of the room. Over the plywood subfloor, the tile sub installed a Schluter Kerdi membrane. In the shower, we installed Noble's Pro-Slope preformed composite shower base, over which our tile sub installed a waterproof sheet membrane liner followed by a mortar bed. Before installing the tile, he applied a liquid waterproofing membrane to the walls.

When clients make their own selections and buy tile and other finishes online rather than through a showroom with professional guidance, the results can be mixed. In this case, they chose two contrasting porcelain tiles for the walls: matte-gray tile and white tile with a marble-like pattern. But when our tile subcontractor did



The clients selected all of the finishes and fixtures, including the recessed cabinet **(7)** and barn door–style shower-door hardware **(8)**. Skylights over the shower and sink **(9)** make up for the room's lack of windows, while the wall-hung toilet lends the new bathroom a contemporary look **(10)**. The frameless bypass door provides easy access to the shower **(11)**.

a test layout with the two nominally sized 12-by-24-inch tiles, we discovered that they were slightly different heights **(4)**. To accommodate the size difference between the two tiles so they would still be aligned at the corners where they met, he installed the white tile with wider grout joints **(5, 6)**.

Finishing up. To prepare for the installation of the room's large recessed medicine cabinet, we had framed a rough opening in the wall and roughed in wiring for its integral lighting. After the tile was grouted, we installed the cabinet **(7)**, along with the wall-hung vanity beneath it.

To maximize the small room's volume, our clients opted for a bypass-style shower door sourced from a local supplier, Glasscrafters **(8)**. The shower features a built-in seat topped by a solid black granite slab that matches the stone used to cap the shower curb. Recessed niches above the seat provide plenty of shelf space for shower accessories. We also replaced a pair of skylights, one in the shower, and one over the vanity **(9)**.

Our clients chose the wall-hung toilet because of its contemporary, easy-to-clean style, but it also offers another benefit: It occupies slightly less floor space than a standard toilet, projecting out from the wall only 21 inches, compared with 26 inches or more for a standard toilet. The few extra inches—along with the relatively narrow, 22-inch-deep wall-hung vanity—make a difference in a bathroom that is less than 6 feet wide. This particular model has a dual 1.6/0.9 gallons per flush feature, with controls mounted on a panel above the toilet **(10)**.

To supplement the storage under the vanity, we built a niche next to the entry door. The cherry shelving in the niche matches the vanity **(11)** and adds a warm touch to the hard surfaces in the room. Pleased, our clients next focused their sights on their second-floor bath.

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

Photos by Tim Healey, except photo 1 by Andrew Martin of the *Vermont Community Newspaper Group*

The fire started in an attached carriage barn **(1)**, destroying stored family belongings **(2)**. Abutting the barn, a butler's pantry was severely damaged as well **(3)**. Smoke found its way into the main home via wall framing cavities **(4)**.

Lessons From Restoring a Fire-Damaged Home

BY TUCKER FOSSIANO

Last January, I was contacted by homeowners whose house had caught fire a few weeks earlier, just before Christmas. Before calling me, they had reached out to a number of other builders, but none wanted to do the job. They sounded a little desperate, so I agreed to meet them at their home—an old, three-story Victorian built in the late 1890s.

Surveying the site, I saw that the fire had been largely contained to the home's attached carriage barn. A one-story section of the home (connecting the carriage barn to the main house) and the main house itself were mostly smoke-damaged. The couple told me that they had recently moved from out of state and had lived in the home only a few months. Compounding their problems, a lot of their belongings were still boxed up from the move and stored in the carriage barn when the fire occurred, which resulted in significant property loss. The displaced homeowners were living in a rental house.

Standing in their burned-out barn, I knew this wasn't an ideal job for us. Fire remediation work is messy, hazardous, and specialized—my company focuses on high-end remodeling and custom home construction. Also, years earlier, I had a bad experience doing remediation work through a franchised company specializing in emergency fire restoration. It was a nightmare dealing with the added levels of decision-making and an insurance company that battled us on pricing. But I felt bad for these homeowners—they were in a tough spot and new to the community—so I said I'd help them.

Within weeks of the fire. An emergency restoration contractor that had a working relationship with the homeowner's insurance company secured the site. It did some demolition work, installed a lockable temporary plywood door over the fire-damaged barn door, and dealt with the utilities (because the fire occurred in the unheated carriage barn, the home's heating system was not shut off). It also boxed up the homeowner's salvageable belongings in order to move them off site to have the acrid smoky smell removed from the items.

The insurance adjuster visited the site and determined that repairing the home was too big of a job for the restoration company. That prompted opening an insurance claim, which allowed the homeowners to hire a contractor to help them rebuild their home. The claim would be open for only a year, so the clock was ticking even before we were officially on board.

The demo work was completed within a week, with an excavator doing the bulk of the work in one morning **(5)**. After gutting the home's one-story connector and sealing the framing with primer **(6)**, the crew poured a new garage foundation.

THE PAPER CHASE

Before we could start construction, the insurance company had to develop a work scope. Its purpose was to define what was to be removed, what could be salvaged, and what new items would be needed to restore the fire-damaged home as close as possible to its pre-fire condition. What the company eventually produced was an 85-page report that was broken down so minutely that it was confusing and difficult to price out. The process of reconciling its budget pricing with what it would actually cost me to restore the home was much harder than I anticipated. Arriving at an agreed-upon project cost took nearly four months.

Work scope. The insurer wanted us to gut the smoke-damaged one-story connector, which contained the kitchen and a bathroom. The fire-damaged butler's pantry, which extended into the footprint of the barn, also needed to be removed. In the main house, plaster, lath, and insulation from the walls facing the fire-damaged barn needed to be removed on all three floors. Once the existing framing was exposed in these areas, it would need to be sealed with multiple coats of primer.

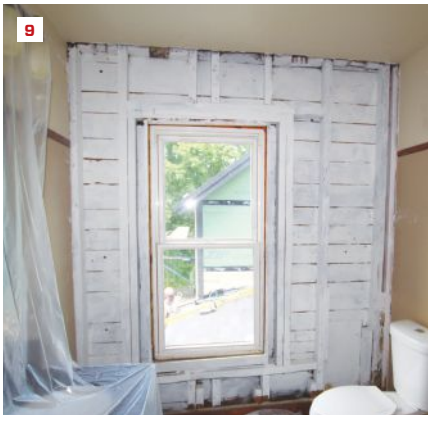
The fire-charred carriage barn had been built on an old fieldstone foundation and had a wooden first floor with a crawlspace below it. The insurance company wanted us to tear it down and rebuild it on the existing cobbled-together stone foundation (the company was in full "replace-as-it-was" mode), while our clients wanted to use the rebuilt barn as a garage. There was no way I was going to build on an insufficient foundation. We had to prove that the woefully under-designed foundation and wood floor were structurally inadequate.

To do so, the insurance company wanted to use an out-of-state engineer with whom it had a working relationship (it wouldn't allow us to use a local structural engineer). It took a couple of weeks for the engineer to schedule and visit the site, another two weeks for him to write his report, and a few more weeks for the engineering report to be processed by the insurance company. This process was a major factor in delaying the project.

Pricing. The insurance company's estimating is compiled from national data with percentage factors to account for regional cost differences. Some of its pricing is actually pretty good, but more often I found its work scope confusing and felt its formulas did not properly account for labor on a lot of the line items. Take, for example, the line item "10 lineal-feet of trim, reinstall." The $0.87-per-lineal-foot allowance to install it doesn't account for the time required to go to the lumberyard and get the material, bring it the jobsite, set up a saw, set up a compressor, and cut it. In general, the company's pricing didn't seem to account for site visits, construction management services, or any intangibles that commonly occur during construction.

Having been low-balled on costs on the previous fire mitigation job (and a few flood-damage projects over the years as well), I was prepared to dig my heels in and not get bullied into doing the project for less money than it was going to cost. After trying to decipher the insurance report, I decided to price out the job like one of my typical proposals, then reconcile the project cost with the insurer later on. Doing this allowed me to wrap my head around the project's true cost, but also contributed to the project's delay.

When estimating a project, I typically take the job cost and calculate our O&P percentage on top of that to cover our project management services. But the insurance company calculated O&P into its individual line items. After battling with the company on this point, we relented and backed out our O&P percentage from our pricing and tried to make our profit margins through labor efficiencies and budget shuffling.



The existing ceiling and hardwood floors were removed in the connector's kitchen area. Wall, ceiling, and roof framing was primed and left "open" for three months to air out **(7)**. The first-floor framing in the connector was primed approximately 8 feet back from the abutting fire-damaged barn location **(8)**. In the main house, plaster, lath, and insulation from the walls facing the fire-damaged barn were removed. Here, the existing framing is primed in a second-story bathroom **(9)**. Cabinets are being installed in the new kitchen **(10)**.

REPAIRING THE HOME

After months of negotiating back and forth, we finally began demolition. We walled off the main house from the demo area with plastic and ran an XPower HEPA air scrubber (xpower.com). Wearing respirators and heavy-duty gloves and clothing, our crew gutted the one-story connector, bagging up the existing insulation and any painted materials. An excavator made quick work of the charred remains of the barn, compacting it into multiple dumpsters in one morning. We then masked off the upper two floors and removed the existing plaster, lath, and insulation from the walls adjacent to the carriage barn, all the while continuously running the air scrubber. The demo work was completed within a week.

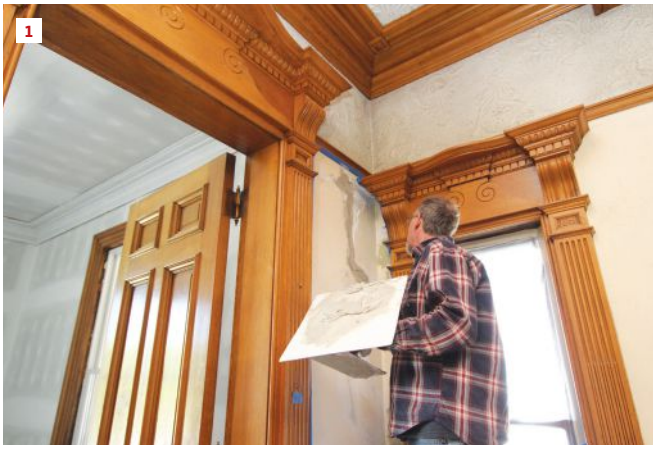
Smoke mitigation. Priming the existing framing was pretty much the extent of our smoke-mitigation work. We left it open as long as possible to air it out, periodically sniff-testing the sealed framing at various temperatures and humidity levels. We primed the worst smoke-damaged areas with three coats of Bin Advanced Synthetic Shellac Sealer and spot-primed where we smelled hints of smoke. We then drywalled at the end of summer.

Changes. The main budget hiccup was with the electrical. The insurance company's work scope covering the electrical was more broadly defined. Once we started demoing, the electricians found that a lot of the electrical wiring throughout the home was not up to code. The electricians were obligated to upgrade the service in order for the homeowners to safely re-occupy their house. I sent the insurance company an invoice from the electrician summarizing what was outside of their work scope, and the insurance company stepped up and agreed to pay for it.

Finishing up. After the drywall installation, finishing up the home was standard. We installed a new kitchen and bath in the salvaged connector, closed up the main home's walls with drywall and Roxul batt insulation, and built the new garage with generous second-story storage. A new mudroom, pantry, and stairwell extended into the footprint of the garage, similar to home's original floor plan. We also installed a one-hour firewall between the living space and unheated garage.

The homeowners moved back into their home in October; we are still trying to close out the project before the insurance claim deadline in late December. They are grateful for our work and are looking forward to a more peaceful holiday season this year.

Tucker Fossiano owns and operates Beacon Hill Builders, a high-end remodeling and custom home building company in Stowe, Vt.



Built in 1884, the mansion had a number of different plaster finishes. Here, Ron Bisson applies brown coat to a textured wall using a putty knife **(1)** and a trowel **(2)**. Pushing the brown coat hard against the old plaster helps key it in along the edge **(3)**. On large repairs, a 42-inch-long slicker is used to flatten the brown coat using a sawing motion **(4)**.

Repairing Traditional Wall Plaster

BY RON AND WILLIAM BISSON

Last fall, we wrote about a plaster ceiling restoration project we worked on along with helper Derek Dawson in St. Johnsbury, Vt. (see "Repairing Ornamental Plaster," Nov/18). In addition to doing the ceiling restoration, we repaired numerous textured plaster walls and polished flat plaster walls in the historic 135-year-old mansion. The wall repairs varied from small cracks to a roughly 7-by-10-foot replacement section of polished wall. In this story, we'll focus on repairing the textured plaster walls (located in the same space as the ornamental ceiling) and give a glimpse into plaster wall restoration work using traditional materials and techniques.

LIME PLASTER VS. GYPSUM PLASTER

There are basically two kinds of interior plaster used for walls and ceilings: lime-base coat and gypsum-base coat. Lime plaster is a much older interior finish, with a history stretching back more than a thousand years. Gypsum was very expensive to refine until the mid-1800s, so gypsum plaster was used only in the ornamental trade before that time, and only started to appear in northern New England around 1900.

Lime-base coat. Traditional lime-base plaster is composed of two coats: a base coat consisting of water, sand, lime, and either wood fiber or animal hair; and a finish coat made of water, lime, and sand. The first coat is scratched in onto wooden lath and allowed to set for seven days, followed by the second coat, which also is allowed to set for seven days. Plasterers would then come back a third time to water trowel the plaster down and polish the finish wall or ceiling smooth. Lime-base plaster takes much longer to dry than gypsum-base plaster and is less durable.

Gypsum-base coat. The walls we repaired on this project were gypsum-base plaster (which encompasses both scratch and brown coats) with a lime-putty finish coat. The scratch coat consists of water, gypsum, and wood fiber, while the brown coat consists of water, gypsum, and sand. The finish coat is made from water, lime, gauging (highly refined gypsum), and a retarder (which keeps the plaster from prematurely setting). The scratch coat is applied over the wood lath. Then, the next day, the brown coat is applied over the scratch. The two-coat base is allowed to set two or three days before the lime-putty finish coat is applied. The resulting finish coat is either polished flat or textured while still wet.

On our initial walk-through, we tested the walls by pushing a putty knife into them (if the knife goes through to the lath, it's lime-base coat; if it doesn't, it's gypsum-base coat—gypsum is much harder than lime). A few of the home's original lime-base-coat walls remained, while most had been redone over the years with gypsum. The remaining few lime-base walls were in good shape and did not need to be repaired.

Photos by Tim Healey and William Bisson

REPAIRING THE WALLS

Working on historic buildings, we're obligated to save as much of the existing plaster as possible and don't remove stable plaster unless told otherwise. On this project, the architect mandated that we preserve as much of the existing swirled textured wall as we could. For us, the skill is knowing what plaster to remove and what to leave in place.

Starting out, we scraped out damaged areas until we reached sound plaster. Any plaster that had come loose from the lath or "lost its key" was removed. We then meticulously scraped out the gaps between the existing lath in order to key in the new plaster. Next, we cleaned the lath with a stiff brush and then vacuumed it off (vacuuming helps with the bonding agent application).

Wood lath repair. In restoration work, it's common to come across damaged lath that needs to be replaced. We mostly encounter sawed lath on our projects (which was the case here), and occasionally split lath. Sawed lath is readily available at most lumberyards, while split lath needs to be custom-sawn at a mill. Typically found in older buildings, it is made from thin, 3/8-to-1/2-inch-thick boards and is generally 6 feet long and between 6 and 14 inches wide. A board is tacked in place, then split and pried apart with a plasterer's hatchet every couple of inches. The resulting split-up board is nailed off with 4- or 6-penny nails. Split lath is not as good as sawn, but on historical work, we always try to match the materials we replace, if possible. This includes whether or not we can use a bonding agent.

Bonding agent. Prior to mixing the scratch coat, we wet down the existing wood lath with a pump sprayer and brushed on the bonding agent. A bonding agent is used to help adhere new plaster to old, dusty lath. It's basically made out of alum and it holds in moisture; we typically use USG's Plaster Bonder. On older historical work, a bonding agent was often not used. On those projects, we're therefore obligated not to use one. That means we have to be more conscious of dampening the lath—wetting it more frequently—which adds time to the plaster installation.

Scratch coat. One hour after wetting down the lath and brushing on the bonding agent, we applied the scratch coat. The scratch coat is made of water, gypsum, and wood fiber, which helps to stop the plaster from falling through the gaps in the lath when being applied, while also strengthening the base coat.

Using a 14-inch trowel, we applied the plaster perpendicular to the lath to a 1/4-inch thickness, using just enough pressure to force it to "key" into the gaps in the lath. We then raked the plaster with a plaster rake in one, smooth motion with a gentle touch (raking helps create a mechanical bond between the scratch and the brown coats). The scratch coat doesn't have to fully set before the brown coat is applied, which we typically do the next day.

Brown coat. The brown coat is composed of water, gypsum, and sand. On this project, the plaster walls generally ranged from 7/8 inch to 1 1/8 inches thick. Plaster finish is usually fairly flat, but the underlying framing is typically not—plaster can therefore be very thick or thin in different locations on a wall. The brown coat helps to compensate for the variation in thickness and is applied to accommodate a 1/8-inch-thick lime-putty finish coat—the new

William Bisson applies brown coat to the damaged textured walls **(5)** and uses a slicker to gauge the straightness of the brown coat at corners **(6)**. He dampens the walls **(7)**, then mixes the finish coat **(8)**. The finish coat is applied to the repaired area with a 14-inch trowel **(9)** and slicker **(10)**, then the texture is combed in.

On this small crack, helper Derek Dawson uses a putty knife to flatten the new plaster and push it in along the edges **(11)**. The electrical box is set at the proper depth to avoid interfering with the new finish **(12)**. The lime-putty coat is applied in two passes; here, the first pass is made **(13)**. Ron Bisson uses a texture comb to mimic an existing swirl pattern **(14, 15)**.

finish is applied flush with the existing plaster finish.

We applied the brown coat with a 14-inch trowel and firmly pressed it into the scratch coat to flatten it out. Depending on the size of the repair area, we flattened and smoothed out the brown coat with darbies, slickers, trowels, or putty knives. We then allowed the two-coat base to set two or three days before applying the lime-putty finish coat.

Quick primer on plastering tools. On large repairs, we need to use a darby or a slicker to help flatten out the brown and finish coats. A darby is a 4-foot-long piece of metal that has two handles, one at each end. You hold one handle while you swing it around in an arc against the wall to flatten it. A slicker (or feathered edge) is a 42-inch-long metal straightedge that's used to plane the brown and finish coats and square up corners. On mid-size repairs, we typically use 14-inch trowels to flatten out the base and finish coats. On cracks less than 2 inches wide, we use 6-inch broad putty knifes to flatten and smooth the plaster. We also use the knives to push the new plaster hard against the old plaster and help key it in along the edges of the repair, regardless of the repair size.

Finish coat. The lime-putty coat consists of water, "slacked" lime, gauging, and a retarder—the lime being the bulk of the mix. On textured finishes, as was the case here, we add sand to the putty to texture it. "Slacked" lime is lime that has been soaked for a few days. Slacked lime is more pliable, and it blends into itself better. We store the wet lime in buckets and use it as needed. Plaster retarder is added to control how long you want a batch to last. But getting the mix right is tricky: Too much will weaken the plaster and it'll crack; too little, and it'll prematurely harden. Once we mix in the retarder, we add gauging to the lime. The gauging is highly refined gypsum and it serves as the hardener. We have about a 40-minute window to use the batch.

With the lime putty mixed and the two-coat base coat wetted down, we applied the finish coat. Working in concert, William and I applied the textured finish coat. William put the putty coat on in two passes; the first pass was applied with pressure, the second, with little to no pressure. The second pass was loose enough for me to texture the wall with a plastic texture comb to match the wall's existing swirl pattern. We needed to work fast, as we had only a five-to-10-minute window to start texturing the wall. The texture was fairly simple but difficult to mimic.

Feathering. Because the existing wall was painted and lime putty cannot adhere to paint, we had to feather our new finish coat right up to the edge of the painted surface. As we textured to match the existing wall, we wiped the plaster off the paint. After the lime putty dried, we applied parging (spackle) over the hairline seam between the new plaster and the existing painted surface and sanded it smooth to cover the seam.

The cure time on a traditional gypsum-base wall on wood framing is 30 days. Before the cured walls were painted, their moisture content was tested with a moisture meter.

Master plasterers Ron and William Bisson own and operate Bisson Plastering, in Craftsbury, Vt.

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BY IAN SCHWANDT

Building a Worker-Centered Crew

Part 2: The Framework

When we watch experts ply their trade, whether they are carpenters, NFL quarterbacks, painters, chefs, or plumbers, we often marvel at how effortlessly they achieve a high-level product. Look behind the scenes, however, and you will find the framework that provides the support for the skills needed to produce at such a high level. Scholars have attempted to quantify this in terms of hours worked—I've frequently seen 10,000 hours cited. Coaches push drills that enforce an order of execution. Practice, practice, practice. But we share one thing in common with these experts—at one point, on day zero, we all knew nothing about our trades.

It is here that lead carpenters find themselves in the center of another triangle—this time, of influences instead of obligations: the strength of the employer's business systems, the quality of the communication between all parties to the work, and the needs of the worker. If the training needs of the worker are high, the lead carpenter can meet those needs effectively only if backed by clearly defined scopes of work and project objectives, strong project management and company financials, and a clearly expressed commitment from the employer to develop young tradespeople. In my career, I have frequently encountered business systems that ran in conflict with one another. There are a range of challenges that flow from poorly defined and executed business systems, including difficulty retaining workers and poor productivity as the crew struggles to understand what's expected. One of the biggest culprits is an opaque or conceptual scope of work that leads to inaccurate labor estimates; if forced to work with those, no lead carpenters can be effective in moving a young worker's career forward from day zero.

REMEMBER DAY ZERO

Rather than blame the business, though, we often blame workers. Sit around a table or a bar with veteran tradespeople and you will undoubtedly hear stories of "young people these days." They cannot read a tape measure. They don't own tools. They disappear at lunch on their first day and never come back—not even for their check! The lead carpenters who will be effective at passing the trade to the workers of tomorrow will be the ones who can hear these complaints, step back, and think critically about why these are common themes and what they can do to provide the neck-up training needed for novices to grow into productive crew members.

Many of us fall into the "this is the only thing I've ever done" camp, and it is not easy to remember back to day zero and how little we knew at the time. No one is born knowing how to read a tape measure, much less what tape measures are better suited for framing than for cabinetmaking. By the time we have reached the level of lead carpenter, we have performed the tasks so many times, it becomes robotic. Getting in touch with your own "inner robot" is important for understanding how to quickly elevate the novices on your crew.

Neuroscientists believe that as our brains learn new skills, the storage of those skills is sourced to different parts of the brain. Over time and in the right environment, the skills that young tradespeople learn will move across the brain and end up stored in the same area as skills like riding a bike. This is the robot part of the brain. Just as we likely don't remember individual bike-riding lessons, we also no longer remember what it was like to not know how to read a tape measure. Experiments by neuroscientists at the University of California at Berkeley have also shown how stress affects the passage of new skills and information to the robot part of the brain, with moderate levels of stress being more conducive to learning than low and high levels.

No one is born knowing how to read a tape measure, much less what tape measures are better suited for framing than for cabinetmaking.

SEE CLEARLY HOW CREW MEMBERS LEARN

Understanding how to apply these concepts to our crews can boost our ability to develop young tradespeople. Not everyone learns the same way and one person's moderate stress level is another's mental breakdown. Most lead carpenters I know have a "go to" crew member who they routinely trust with important tasks. Oftentimes, I have found my "go to" in unexpected places. A lead carpenter who is aware of his crew is able to see what a novice tradesperson may have a knack for. When we look deeper into what makes a person the "go to" for a task, it will tell us a lot about how that person learns. And when we know how that crew member learns, we as lead carpenters can create optimal situations tailored to the individual.

We have to see where the novice is at. Knowing nothing in the presence of experts is an unsettling place to be, especially in an age when we can access all of the world's knowledge via the devices we keep in our pockets. Lead carpenters need to understand how this environment plays into the psyche of the novice and set our expectations accordingly. In most of the day-to-day work performed in the building trades, expert-level talent is not required and much can

When we know how a crew member learns, we can create optimal situations tailored to that individual.

be achieved with basic competency and confidence. This first step is the largest and most difficult one to take.

New crew members, especially green ones, are typically a resource drain. That's why once we have gained some experience, we tend to place a high value on others with the same level of experience, and a low value on novices (just like the seasoned carpenters lamenting the kids these days). To succeed in creating a strong neck-up environment, you don't have to remember what it was like not to know what "the little line" on a tape measure meant, only that at one point you didn't know that it was 1/16 inch. It's from this point of view that you'll be able to build a list of the important baseline skills needed for a new hire to contribute to the job at hand in a meaningful way.

By now you may be thinking, "I have a job to run. I don't have time for all this head-shrinking stuff." I argue that for the lead carpenter, this requires only a subtle, but necessary, change in your awareness of your crew and of your employer. Viewed from within the triangle of responsibilities—to owner, employer, and crew—the lead is the most direct conduit for change within a company. We have our boots not only in the jobsite mud but also on the hardwood floor of the company HQ. This perspective is our greatest asset to our employers, to our crew, and, most important, to ourselves. In the next article in the series, I'll break down the skills, both neck up and neck down, that I have found to be most impactful in creating value for the company and in building basic competency and meaning for the worker.

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Ian Schwandt is a lead carpenter from central Wisconsin with experience leading commercial and residential projects in the Midwest and Northeast.

BY TED CUSHMAN

The Solar-Ready Rooftop

As solar panels continue to drop in cost, integrating photovoltaics into a house roof continues to be a more and more attractive option. For homeowners who want net-zero or nearly net-zero performance, the question of whether a house is suitable for solar becomes particularly important.

There are two components to the net-zero house energy equation. On the one hand, there's conservation: The house needs to be designed and built to require minimal inputs of energy for heating, cooling, lighting, and plug loads. On the other hand, there's on-site power generation: No house uses zero power, so to reach net zero, the house has to generate some of its own juice using photovoltaics.

In practice, net-zero houses generate surplus energy during summer months when days are long and the sun is high in the sky, and they consume power from off site during winter months (and, of course, at night). To reach a good balance requires thoughtful consideration of house siting, roof slope, roof orientation, and shading—the key factors that determine a home's suitability for on-site generation of power.

Photos by Ted Cushman/JLC

ReVision Energy's Thomas Tutor demonstrates use of the Solmetric SunEye for determining solar exposure.

ROOF ORIENTATION

Solar panels produce the most power when they're pointed directly at the sun. But since the sun moves across the sky from sunrise to sunset, the typical solution is to split the difference. To maximize production, an ideal solar rooftop in the northern hemisphere, including the United States, will face dead south—solar south, that is, not magnetic south. There's a difference. The magnetic north pole isn't at the earth's geographic north pole, so to find solar south, you apply a correction factor to the compass reading. The factor varies by geographic location; local solar installers are familiar with the required correction to compass readings in their areas.

ROOF SLOPE

The cheapest and the simplest way to mount solar panels is on a rack in plane with the roof. In that case, the angle of the solar panels to the sun is the same as the roof's angle. The panels will be directly perpendicular to the rays of the sun—their highest-output condition—when the roof is. So ideally, the roof will be framed at that pitch. The highest solar output for the year will happen on the days when the sun is shining directly down on the face of the solar panels. The roof angle determines which days that will be.

WHAT'S GOOD ENOUGH?

In practice, however, solar orientation doesn't have to be perfect, says Connecticut builder Nick Lehto. Lehto specializes in net-zero construction, building airtight, double-wall wood-frame homes in the New England-farmhouse style. "I try to get to a HERS rating of about forty before PV, and then at that point I implement a PV system to bring the house down to zero," says Lehto.

But given the real constraints of home building, Lehto can't always orient his roofs due south, or frame roofs to a solar-optimized pitch. Roof angles and house orientation are important, he says, but not always under the builder's full control.

"I try to maximize it the best I can given the lot," says Lehto, "but it doesn't always work out. The lot is what the lot is. Sometimes you have to accept that solar doesn't make sense on a project. But in a wide-open field, we always try to orient the roofline, as well as a lot of the windows, towards the south, and I shoot for roof pitch of 8/12 to 10/12."

Low-pitched roofs such as this one are less sensitive to compass orientation than steeper roofs.

What about the difference between magnetic south and true south? Lehto says, "To be honest, I don't pay too much attention to that. From what my solar installer tells me, if you're off a few degrees, the penalty isn't all that significant."

Thomas Tutor, a solar design specialist with ReVision Energy in Maine, confirms the point. "One of the common misconceptions is that a solar roof has to face due south. Of course, if you're building new, and you have a choice, orienting it due south is ideal. But anywhere within 45 degrees east or west of that is very good." A house facing 45 degrees off of due south still produces 90% of its potential power, says Tutor.

Charlie Morgan, of Eastern CT Solar in North Stonington, Conn., handles Nick Lehto's solar panel installs. Morgan says, "Most of the houses I do are retrofit projects. I think the same is true of most solar installers. So you have to work with what you've got. A lot of times that roof is not oriented toward perfect south. That doesn't mean it's not a good roof for solar. Solar south is ideal; once you start moving east and west of south, you start losing some production and some efficiency in the system."

But non-south-facing roofs can still produce a lot of power. Says Morgan: "If you had an optimum south-facing roof, you'd be at 98% production; if you had an east-facing roof at a 35-degree pitch, you'd be at 80% production. And if you were east at a 21-degree pitch, you'd have about 84% because there's less shading by the roof. So that flatter roof helps you out a bit."

Thomas Tutor points out, "With a zero-degree pitch—so, a flat roof—it doesn't matter which angle it's facing. That's sort of obvious, but you get the idea: At a flatter pitch, the home's orientation angle is less important." For houses that don't face due south, a flatter roof can be an advantage, Tutor explains: "For example, if you have a 20-degree pitched roof, and you are facing true south, you are at 96% solar tilt orientation factor. If you went down to a west roof, you are at 80%. But that 80% is better than a 40-degree pitched roof that is also due west. Because that flatter angle can still catch a little bit more of the sun's rays when it is to the south."

Given the declining cost of solar panels, builders may find it practical to make up for imperfections in roof slope or orientation by simply adding more panels where space allows. Says Morgan, "We often do that. It makes the project more expensive, because you're trying to make up for lower efficiency by throwing more money at it, but it's doable. And with the price of solar panels not the limiting factor that it was, adding a few solar panels doesn't generally break the bank anymore."

THE SHADING PROBLEM

Shade on the roof, on the other hand, can be a significant issue. "The big bugaboo now when you're trying to design a system and optimize production is less the orientation and more making sure that you're not encumbering yourself with any shading from trees," says Morgan. "You want at least six hours of open sky. We kind of use the window between 9 a.m. and 3 p.m. on a south-facing roof. You don't want any shading on the array, because that will really reduce your production."

Advancing technology has reduced the shading penalty. Explains Morgan, "Back when we were using string inverters, you would wire up a string of 6 to 12 modules in series, and if you had another dozen panels, that would be another string. But that way, if one panel in a string was impacted by shade or being dirtier than the other panels or something, it would bring down the production of that whole string of panels. But with the new generation

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of micro-inverters, each solar panel acts independently. If one solar panel is impacted by shade, it's only impacting that one solar panel and not the rest of them. So that's made a big difference in being able to mitigate for some shady situations. But regardless, if you're impacting one solar panel with shade, you are still losing some production. Keeping the shade off the array is important."

A newer innovation is the "DC optimizer." Says Tutor, "These are little pieces of electronics that go on the back of each panel and they help regulate the voltage so that they don't cause one panel having shade to affect the output of panels beside it. DC optimizers are similar to micro-inverters, where you do have individual panel-level electronics, but the DC optimizer isn't actually inverting the power there on the roof, so it keeps that more sensitive piece of electronics in the basement (the inverter), which we find is more effective and has a lot fewer service calls and issues than with the older micro-inverters that we used to install."

There are a couple of ways to evaluate a building site's shading situation, says Morgan. "We have a tool that we can go up on the roof with, called a Solmetric SunEye (solmetric.com). It takes a fisheye view of the sky, and you can calculate the amount of shading potential for different times of the year. But even easier than that now is a software that is available that allows you through satellite imagery to model the irradiance on a given site remotely using Google Earth. So I can take a Google Earth picture, draw my array on it on the computer, and then add in the trees, and the software will calculate the shading and the production for me. That's called Aurora (aurorasolar.com)."

BUILDING WITH SOLAR IN MIND

With the cost of solar panels continuing to drop, some home buyers are deferring solar purchases. As a solar installer, Morgan has a few other words of advice for builders who are building with solar in mind, either now or in the future.

"Keep in mind the structural capacity of the roof," Morgan advises. "One of the things we have to do is provide a structural review as we go through the permitting process—basically, a letter signed and stamped by an engineer saying that the roof can accommodate the additional loading of the solar."

Wiring connections are another consideration. Morgan says, "It's really nice to provide a wiring chase down from the attic to wherever the load center or interconnection point is going to be. There is always going to be some ancillary equipment, such as the inverter, that goes along with your stuff on the roof. It's nice to have room to put that. If you put your electrical panel in a tiny little closet, that might make it tough."

ReVision Energy likes to be involved in the project from the beginning, says Tutor. This ensures that conduit runs are suitable for the purpose. He explains, "We run into issues where contractors have put in non-electrically-rated conduit, or it's got multiple bends and there are not the pull points that it needs, or it terminates in the wrong spot, or it's inside a wall where we can't find it." ReVision typically installs 1-inch-diameter EMT conduit, says Tutor. Code requires 3 feet of space on either side of the electrical panel and in front of it, he notes; the same requirement applies to the inverter for the solar system, so that additional space needs to be provided.

It's also wise to eliminate obstructions on the roof. "Make sure your vent pipes for the plumbing in the house are on the non-south side of the roof," advises Morgan. "Limit the number of skylights where you're planning to maybe put in your solar panels. And avoid putting dormers on the south side of the roof."

Ted Cushman is a senior editor at JLC.

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Cordless Rear-Handle Saws

Battery-powered framing saws have come of age

BY TIM UHLER

A couple of years ago, I wrote about how my company used primarily cordless tools when framing our houses ("The Cordless Framing Site," Dec/17). In fact, the only saws we used with cords were beam saws. At the time, only Makita and DeWalt offered cordless versions of rear-handle, worm-drive-style saws, our preference. Since then, Hilti, Skilsaw, and Milwaukee have released cordless rear-handle saws, creating a perfect opportunity to test and compare them.

It seems that west of the Mississippi, rear-handle worm drives, like the Skil 77, have been the preference and staple for many decades. I like the rear-handle design because I find it to be more natural to push the saw from behind, and as a right-handed person, it's easier to see the blade when it is on the left. These saws are known for their power, but the downside, of course, is their weight.

The five saws I reviewed for this article have many features in common. They share a rear-handle, blade-left design and have brakes—a safety feature I love—and rafter hooks. They all bevel to 53° and take 7 1/4-inch blades. And, of course, they're all battery powered.

The high-amp batteries that drive these cordless saws come in a range of shapes and sizes. From left to right: Bosch; DeWalt; Skilsaw; Hilti; and Makita.

Photos by Tim Uhler

MAKITA XSR01PT

Makita has done a great job of making this saw feel compact while providing enough power that I haven't regretted going cordless. The hook is large and will fit over 2 1/2-inch I-joists. While the saw bevels to 53°, it has stops at 22.5° and 45°. It runs off a pair of 18-volt batteries that slide under the saw behind the motor.

The Makita isn't the most powerful saw of this group, but it's still easily capable of cutting compound miters on 2x12 jacks or 1 3/4-inch LVL. As one guy on my crew said, this saw feels like "finesse" and not brutish like some other saws (including corded ones). With a depth of cut of 2 9/16 inches, it can cut through a 3-by in a single pass. The saw spins the blade at 5,100 rpm and weighs in at 12.14 pounds with the batteries attached.

I found this kit online for $350, but if you time it right, you can get an additional two batteries included as a promotion. We found that we never outran the batteries that were on the charger. By the time the batteries in the saw were dead, the batteries in the charger were ready to go.

MAKITA XSR01PT

Total weight	12.14 lb.
Battery weight (both)	2.14 lb.
Amp hours	5 Ah x 2
Rpm	5,100
Max. cutting depth at 90°	2 9/16 in.
Max. cutting depth at 45°	1 3/4 in.

HILTI SC 60W-A36

The Hilti saw felt very well-balanced. It is the only saw that doesn't have a safety button to push before pulling the trigger and spinning the blade, though it does have the ability to lock out the trigger. The rafter hook, which is made of plastic and sits on top of the saw, doesn't fit over 2 1/2-inch material. It also tended to pinch when it was hanging off a 2-by rafter or joist, requiring a little extra effort to remove it. My saw didn't ship with a hook, but others have told me their saws did.

The saw is powered by a single 36-volt battery, which slides in from the right but sits just behind the motor, contributing to the saw's nice balance. In order to check the charge, you have to pop out the battery by hitting a button on the back of the saw.

The blade in the Hilti spins at 4,000 rpm, so the saw does cut a little slower than the saws with faster-spinning blades, but not enough for me to care. Cutting depth is 2 3/8 inches. This saw weighs in at 12.32 pounds with the battery attached. It also has a work light that is handy now that the days are shorter and darker.

This saw had enough power for us when we were hand-cutting 2x12 Doug fir rafters. Online through Hilti, this saw kit with one battery runs about $600.

HILTI SC 60W-A36

Total weight	12.32 lb.
Battery weight	3 lb.
Amp hours	5.2 Ah
Rpm	4,000
Max. cutting depth at 90°	2 3/8 in.
Max. cutting depth at 45°	1 15/16 in.

MILWAUKEE 2830-21HD

The Milwaukee M18 Fuel saw ships with an 18-volt 12-Ah high-output battery that slides in from the top between the motor and handle. The handle sits back from the battery and is nice and large, which I feel helps contribute to the saw's balance. And I like the side-mounted rafter hook, which is large enough to fit over 2 1/2-inch material. Like the Hilti, this saw also has an LED work light.

One feature on the Milwaukee worth noting is a dust port built into the upper guard that can be hooked up to a vacuum. Since we don't use a vac, we found that this port shoots dust all over the material being cut, so we taped it off. Like all of the other saws in our testing, it has an electric blade brake.

The blade on the saw spins at 5,800 rpm, and has a cutting depth of 2 1/2 inches. The saw weighs in at 13.13 pounds with the battery attached.

Online, this kit sells for $450. To run it as a framer, you need another battery, so watch for deals in which you can get a battery thrown in. Another strategy that works well is to charge the battery at lunch regardless of the charge, which will allow you to cut all day long.

MILWAUKEE 2830-21HD

Total weight	13.13 lb.
Battery weight	3.66 lb.
Amp hours	12 Ah
Rpm	5,800
Max. cutting depth at 90°	2 1/2 in.
Max. cutting depth at 45°	1 7/8 in.

DEWALT DCS577X1

This 60-volt saw from DeWalt uses the company's FlexVolt battery platform and ships with a 9-Ah battery. The motor spins the blade at 5,800 rpm, and the depth of cut is 2 7/16 inches.

While the side-mounted rafter hook will fit over 2 1/2-inch stock, I had a little trouble with the hook getting caught on the material I was cutting. I think this problem is caused by the fact that the hook on my test saw will pivot 180°. When I mentioned this problem on Instagram, a number of guys shared videos that show the same thing, but an equal number say their hooks don't rotate past 90° and so don't get hung up. What is unclear is if the hook mechanism breaks somehow after use, or if there was a manufacturing change. To me, it isn't a deal breaker, but it's worth mentioning.

Like the Milwaukee, the DeWalt has a sawdust port, which we likewise covered with tape, built into the upper guard. The saw also has an integrated dust blower to clear the cut line, but I didn't notice it until I read about it in the manual. The bevel gauge has stops at 22.5° and 45°; like the other saws, maximum bevel capacity is 53°.

Online, this kit sells for $400.

DEWALT DCS577X1

Total weight	14.37 lb.
Battery weight	3.35 lb.
Amp hours	9 Ah
Rpm	5,800
Max. cutting depth at 90°	2 7/16 in.
Max. cutting depth at 45°	1 7/8 in.

SKILSAW TRUEHVL CORDLESS WORM DRIVE

The only true worm drive in this group, the Skilsaw TrueHVL is exactly like the company's corded Mag77LT but with a giant battery mounted to the underside of the rear handle. This is a 48-volt 5.0-Ah battery, and while the location looks awkward, it actually helps to balance out the saw. The saw's maximum cutting depth at 90° is 2 3/8 inches, and the blade spins at 5,800 rpm.

While the rafter hook will fit over 2 1/2-inch material, I wish it were a little longer. Another thing to be aware of is that the top handle of the saw is designed to hook up to a vacuum. The tool ships with an adapter that is supposed to help direct the dust away from the user, but I found when cutting jacks that it shot dust right into my face.

And about that battery: It is by far the largest of the bunch and made the saw feel cumbersome. It tended to get in the way while the saw was in use and prevented the saw from hanging out of the way from our sawhorses when they were loaded with material. The battery is also designed specifically for this saw, so you won't be able to use it with other cordless tools from the company.

Skilsaw says that this saw is available in a number of different kits, but as of the writing of this review, I could only find the kit with one battery and a retail price of $400.

SKILSAW TRUEHVL

Total weight	15.14 lb.
Battery weight	4.3 lb.
Amp hours	5 Ah
Rpm	5,800
Max. cutting depth at 90°	2 3/8 in.
Max. cutting depth at 45°	1 15/16 in.

CONCLUSIONS

None of these impressive saws had any trouble ripping LVL or cutting steep compound miters on 2x12 stock, and any would be a no-compromise replacement for a corded saw. But as I get older, I look for lighter-weight tools as much as possible. Therefore, my first choice is the Makita, because it is the lightest and most compact saw of the bunch. It is also the least powerful, but that hasn't bothered me one bit; it still has plenty of power for my needs.

Tied for second are the saws from Milwaukee and DeWalt. The Milwaukee is only a little heavier than the Makita, but is more powerful and fast. And while it feels like the handle on the DeWalt is too close to the saw, making it squirrelly while ripping ply, it is crazy fast and powerful; in fact, it's the most powerful saw of the bunch. It has a great line of sight when it's beveled, and the sheer amount of power makes it a pleasure to cut compound miters with this saw. If your primary goal is power, pick this one.

Fourth, I would pick the Skilsaw. On the plus side, it is very powerful, nearly as strong as the DeWalt, and is a genuine worm drive, with its well-deserved reputation for durability. But the battery is just too large, making this saw the heaviest of the bunch. That's a deal breaker for me, but it might not be for you.

There's a lot to like about Hilti's saw. It was close to the Makita in terms of balance and nearly as light; in fact, I really like the saw except for the higher price. If someone wants to pay $600 for the kit, I think they'd be happy with it too.

Tim Uhler is a lead carpenter for Pioneer Builders in Port Orchard, Wash., and a JLC contributing editor. Follow him on Instagram @awesomeframers.

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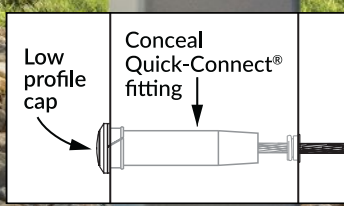

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Photos by Matthew Carroll Navey

Mixing Your Own Concrete

Save time and money with a small mixer and some elbow grease

BY JOHN CARROLL

Recently, I mixed and poured a yard of concrete for the footing of a small addition with the help of a friend, who made it a point to remind me that there were big, clunky trucks that will bring concrete to you all mixed and ready to go. Of course, I was well aware of that fact, but as I pointed out to him, those big, clunky trucks cost close to a quarter of a million dollars apiece, and the people who invest in them are not all that interested in selling their concrete a yard at a time.

Most ready-mix concrete companies don't want their expensive trucks tied up on what they consider tiny pours. Usually, they won't make the trip for less than a yard, and to make money on these so-called "short loads" (one to seven yards), they apply a minimum load charge of around $100. In addition, many concrete companies have time limits of seven to 10 minutes per yard for unloading the concrete.

The extra charges for the concrete are not as bad as they may seem. For example, on a two-yard pour, who wouldn't pay an extra $100 to avoid mixing up four tons of concrete? The time limits are another matter. Unless the truck can pull up very close to the pour, it can be difficult to unload a yard of concrete—which weighs 4,000 pounds—in less than 10 minutes.

You can line up extra help to unload the concrete, but lining up good help for a backbreaking job like that isn't always easy, and it can be expensive if the truck doesn't show up on time. Like any supplier of building materials, ready-mix concrete companies face numerous

Mixing concrete from scratch involves the combination of portland cement, sand, coarse aggregate (crushed and graded stone), and water. The industry standard uses a 1-2-3 formula with one part portland cement, two parts sand, and three parts aggregate for a 4,500-psi mix **(1)**. Adding 50% more portland cement increases the strength to more than 5,000 psi **(2)**.

Bagged premixed concrete has many advantages and is convenient. The 80-pound bags can be arduous to handle all at once, so the author cuts the bags in half. First, he places the bag over a pipe and slits the top paper **(3)**. Lifting the pipe splits the contents in half **(4)** and then tears through the rest of the bag, leaving two 40-pound bags **(5)**.

variables that make it difficult to stay on schedule. And the customer who buys hundreds of yards per month takes precedence over guys like me, who buy only five or six yards every two months. Unfortunately, when the truck is late, I still have to pay my help for the time they're on the job.

In my world of remodeling and custom masonry work, most pours are inaccessible to a concrete truck. Some pours are also several feet above the ground. The good news is that the majority of my pours are fairly small and I can mix the concrete myself. With my concrete mixer, I can mix up about a half yard per hour, so I don't think twice about mixing my own concrete for up to one-and-a-half yards.

WORKING STEADILY

While mixing concrete on site is physically demanding, the time pressures are considerably more relaxed compared with those of a pour using ready-mixed concrete. For the footing pour mentioned above, I started by putting a plastic sheet on the ground at the edge of the property. While I dug the footing, I had 41 bags of concrete—at 80 pounds apiece—delivered and stacked neatly on the plastic. At the end of the day, I carefully covered the concrete with a tarp to protect the bags from getting wet.

The next day, I set up my mixer near the concrete stack, and, with everything already set up, I was able to start mixing and pouring just minutes after the inspector approved the footing. With no time constraints, there was no urgency to move the concrete from the truck and into the forms. Instead, my sole employee and I mixed and placed the concrete over the course of a couple of hours in a calm and controlled fashion.

Had we gone the ready-mix route, I would have needed to schedule the delivery after the inspection, and delivery might have been a

day or two later. I also would have needed to round up another worker to help unload the concrete in the time allowed, and the three of us might have had to wait an hour or two for the truck to arrive. If it happened to rain between the inspector's approval and the arrival of the truck, I would have had to pump the water out of the footing, remove the rebar, and scoop up the wet muck at the bottom of the footing before the pour. So while those big, clunky trucks do offer the initial convenience of bringing ready-to-pour concrete to you, they can sometimes bring some big, clunky problems as well.

MATERIALS FOR MIXING ON SITE

Basic concrete consists of four ingredients: portland cement, sand, coarse aggregate (usually crushed and graded stone), and water. There are two ways to assemble materials for making concrete on site. The traditional way is to buy the stone, sand, and portland cement separately, measure them on site, and mix them with water. The second way is to buy premixed dry concrete by the bag and add water. Both methods work well.

Mixing concrete is actually as easy as 1-2-3. In the industry, there is an oft-quoted 1-2-3 formula for mixing concrete, where one part portland cement is combined with two parts sand and three parts stone **(1)**. In his article "As Simple as 1-2-3" (*Concrete Construction*, Jun/10), Allen Face reports that the 1-2-3 formula delivers concrete with a compressive strength of 4,500 pounds per square inch (psi)—fine for standard residential work, which typically calls for concrete in the range of 2,500 to 3,000 psi.

If I need stronger concrete, I increase the proportion of portland cement. On a recent project, the client requested that I beef up the mixture to produce high-strength concrete that exceeded 5,000 psi. I achieved this number by mixing the materials in a 1.5:2:3 ratio **(2)**.

CONCRETE BY THE BAG

For most of my pours, I buy concrete premixed in 80-pound bags, rather than mixing the materials from scratch. The cost for both approaches is roughly the same, but premixed bags have three advantages. First, the bags take up less space (there is often no place for me to put piles of sand and stone on my client's property). Second, with bagged concrete, I can buy the exact amount that I need. (I typically buy a few extra bags to make sure I don't end up short, then return any unused bags after the pour). Third, mixing concrete by the bag is easier and faster than making it from scratch. And when I'm finished with the concrete work, I don't have to deal with leftover materials.

The big-box stores in my area sell bagged concrete that is rated at 4,000 psi, but local suppliers also offer high-strength concrete in bags rated at 5,000 psi. They also offer concrete with additives to make the concrete cure more quickly and with fibers in the mix to increase crack resistance.

ESTIMATING MATERIALS

Sand, gravel, and concrete are usually sold by the cubic yard, which can be confusing because just about everything else in the building industry is measured in feet and inches or just straight


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Mechanical mixers are a great way to mix small batches of concrete **(6)**. The author pours water into the drum up to the inner ring **(7)** and then adds premixed concrete **(8)**.


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Choose concrete with a 4-inch slump for flatwork **(9)**. Use a stiffer mix of 2 to 3 inches for deeper work such as this footing **(10)**, then consolidate the mix with a vibrator **(11)**.

inches. In lieu of a calculator or jobsite computer, I usually resort to basic math, which to me is far simpler than trying to use any of those gadgets.

Basic geometry teaches us that to determine volume, multiply the length times the width times the thickness. The confusion begins when you have to convert from feet and inches to yards.

As an example for calculating amounts, let's take a U-shaped concrete footing for an addition that will be 12 feet long and 10 feet wide. The footing is specified to be 16 inches wide and 8 inches thick. After accounting for the corner overlaps, the total length of the footing is 30 feet 8 inches (368 inches). So, now we just need to calculate the volume and convert those numbers into cubic yards.

For me, the simplest approach is to measure the length in straight inches, then multiply the result by the width and the depth. The math looks like this: 368 x 16 x 8 = 47,104. Then I divide 47,101 (the total number of cubic inches in the footing) by 46,656 (the number of cubic inches in a cubic yard), which gives me the volume of the footing in cubic yards. These calculations indicate that the exact amount of concrete needed would be 1.01 cubic yards. By the way, you don't need to carry the 46,656 dimension around in your head; any time you need to use it, just multiply 36 x 36 x 36.

When estimating materials for the 1-2-3 method, I don't figure in the volume of the portland cement. For the most part, the cement fills in the spaces between the grains of sand and the stones. So applying the formula to this footing, I'd need a bare minimum of a half yard (two parts) of sand and three-quarters of a yard (three parts) of stone. To estimate the amount of portland cement needed, I use the figure of six 94-pound bags per yard. Because I've established that I'll need approximately one yard total, I know that I'll need six bags of portland cement.

When estimating the number of 80-pound bags of premixed concrete needed, I divide the number of cubic inches needed—in this case 47,104—by 1,150 to determine the number of 80-pound bags needed. The result is 41 bags. So where did I come up with the number 1,150? According to manufacturers, each 80-pound bag produces $^2/_3$ cubic foot of concrete. A cubic foot (12x12x12 inches) is equal to 1,728 cubic inches. Multiplying that number by .667, or $^2/_3$, yields 1,152 inches, which I rounded down to 1,150.

MEASURING THE DRY INGREDIENTS

When mixing 1-2-3 concrete, many masons count shovel loads of each ingredient to make up the recipe. But because I consider a shovelful to be an inaccurate measure and because I find it easy to lose count, I prefer to fill six buckets of equal size with the ingredients. To make a batch of 4,500-psi concrete, I fill one bucket with portland cement, two buckets with sand and three buckets with stone (see photo 1). If I want stronger concrete, I increase the amount of portland by 50%.

If I'm using premixed concrete, following a recipe isn't necessary. I can load my mixer with three 80-pound bags, which produces about two-thirds of a wheelbarrow worth of concrete. To save my back, I don't try to empty a full bag into the machine in one shot. Instead, I cut the bags in half and dump them 40 pounds at a time.

To cut a full bag in half, I place it over a length of pipe and slit the bag down the middle **(3)**. Lifting up the pipe lifts the bag and breaks through the underside of the bag **(4)**, leaving two half bags ready to dump into the mixer **(5)**.

MIXING THE CONCRETE

There's no escaping the fact that mixing and placing concrete is heavy work. For this reason, I always try to set up the job and use techniques that minimize the grunt force required. With all the masonry work I do, one key to saving my back is the aforementioned mechanical concrete mixer **(6)**. If you find that you're mixing concrete on site every couple of weeks or even every couple of months, a mechanical mixer can pay for itself quickly with the work that it saves. Mixers can be gas-powered or electric, and they vary in their capacity or volume. Mine is a 115-volt electric mixer. New professional-grade mixers can cost up to $3,000, and new light-duty mixers can cost about the same as a miter saw. With a little shopping, you may be able to find a less expensive, used mixer.

I begin by setting up my mixer on concrete blocks 8 inches high. That height lets me dump the concrete easily into the wheelbarrow. Next, I set up a hose with a pistol-grip nozzle that allows me to control the water flow with one hand. The nozzle can also be hooked on the side of the mixer, so I don't have to bend down to pick the hose up off the ground every time I need it.

Whether I'm mixing concrete from scratch (using the 1-2-3 formula or a slight variation of it) or from premixed bags, I always start with the water. Inside the drum of my mixer, there is a raised section in the center that forms a ring. I've found that filling the drum with water up to the bottom edge of this ring is a good starting point for one load **(7)**.

It's important to realize that water is in the mix to cause a chemical reaction called "hydration," which in turn creates the hardened concrete. The amount of water needed to achieve hydration is surprisingly small—the dry ingredients have to be thoroughly moistened but they don't need to be saturated with water. Excessive water substantially weakens concrete (see sidebar, page 50), so as I mix the concrete, I try to add just enough water to make the mixture workable.

After putting water in the drum of the mixer, I add the dry ingredients. If I'm using the 1-2-3 method, I put the stone in first, followed by the sand. These abrasive materials help clean the inside of the mixer drum. After these ingredients are thoroughly blended, I add a little more water, which turns the mix into a fairly thick, wet slurry. Then I add the portland cement and monitor the batch as the mixer churns, adding a little water at a time until the mixture has the consistency, or slump, I'm looking for.

If I'm using premixed concrete, I also start with the water filled to the ring. Then I add the dry ingredients a half-bag at a time **(8)**. As with 1-2-3 concrete, I add small quantities of water as the ingredients mix until the mixture has the slump I want.

The term "slump" refers to the fluidity or consistency of the concrete mix. The higher the number, the more fluid the mix is. For flatwork, I aim for a slump of 4 inches. At this slump, the concrete is thick but plastic enough to spread and cut even with the form

For wheelbarrow mixing, measure water more precisely **(12)**. Mix all the water with half the dry mix **(13)**, then add the second half of the dry mix for the proper consistency **(14)**.

For mixing concrete in a wheelbarrow, a conventional hoe doesn't work well, because its square corners don't fit into the corners of the tub **(15)**. A mortar hoe has rounded corners and holes in the blade for easier and more thorough mixing **(16)**.

with a straightedge screed **(9)**. On deeper pours, I use a slump of 2 or 3 inches, which is much stiffer **(10)**. After placing this stiffer mix, I use a vibrator that consolidates the mix and brings the finer particles in the mix to the surface **(11)**.

KEEPING THE MIXER CLEAN

After mixing each batch of concrete and dumping it into my wheelbarrow, I leave the drum turning and again add water up to the ring inside the drum. The water washes off the inside surface of the drum as well as the paddles as it turns. The mixer continues to turn while I wheel the concrete over to the site of the pour. In the meantime, the water thoroughly cleans and rinses the inside of the drum.

When I mix the next batch of concrete, the cleaning water in the drum provides the initial water for that batch. The mixer stays running throughout the pour, and at the end of the day, I just give the drum a final rinse and dump that small amount of water.

THINGS TO KNOW WHEN MIXING YOUR OWN CONCRETE

It takes eight to 10 wheelbarrow loads (3/4 full) to move a cubic yard of concrete. A contractor's wheelbarrow loaded with concrete weighs more than 400 pounds.

Adding one gallon of water to a yard of concrete:

- Increases the slump about 1 inch
- Decreases the compressive strength 200 to 330 psi
- Increases the amount of shrinkage up to 10%

Cost comparison of a single yard of concrete in the author's area:

• Ready-mix concrete delivered by truck	$285 (w/min. load fee)
• Bagged concrete mixed on site (add $80 for delivery)	$140
• 1-2-3 concrete mixed on site (add $80 for delivery)	$170

Helpful hints: Always wear eye protection when mixing concrete. Avoid standing in front of the drum looking directly at the concrete as it churns. The drum can spit out gobs of wet cement as it turns, so always stand to one side while mixing.

MIXING CONCRETE IN A WHEELBARROW

It's not always worth the time and effort to tow my mixer to the site and set it up. On very small pours, it's often easier to mix the concrete by hand in a wheelbarrow. Mixing by hand is hard work, but there are a couple of things that make the job easier and also help produce high-quality concrete.

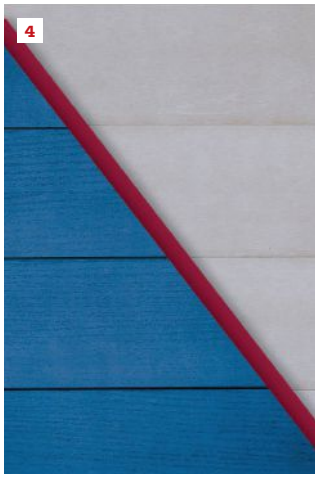
The first thing I do is to measure the water more carefully than I do with the mixer. For an 80-pound bag of concrete, manufacturers recommend using three-and-three-quarters quarts of water per bag **(12)**. But I've found that this ratio makes very stiff, zero-slump concrete, which can be difficult to place and finish. Instead, I use four quarts (a full gallon), which makes very good concrete that is easy to work with.

To mix the concrete, I cut a bag in half as before and dump a half-bag in a wheelbarrow. I add the entire gallon of water and mix the dry concrete into it, creating a soupy and fluid mix **(13)**. Then I add the second half-bag to the soupy mixture and mix it thoroughly with my hoe **(14)**. The result is an excellent low-slump concrete. If I need to increase the slump, I can add water sparingly. But I'm careful not to overdo it; too much water weakens the concrete.

The second thing I do is to mix the concrete with a hoe called a "short-handled mortar hoe," which has rounded corners. A regular hoe has trouble getting into the corners of the wheelbarrow, where dry or unmixed concrete tends to accumulate **(15)**. Because of its rounded corners, the mortar-hoe blade fits much better **(16)**. The holes in the hoe let some of the mix pass through for less resistance as you stir the mix, and the short handle makes it much easier to handle the hoe while mixing concrete at wheelbarrow height.

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

BY SYMONE GARVETT



1. Wide-Plank Flooring
Made from North American hickory, Next Frontier engineered-hardwood flooring from Bruce updates a traditional favorite with wider-width planks, a matte finish, a hand-scraped texture, and 10 new color options. Pricing ranges from $4 to $6 per square foot. Other new engineered-hardwood collections from Bruce include American Honor (oak), Early Canterbury (maple), and Blacksmith's Forge (birch). According to the manufacturer, planks for all four styles can be stapled, floated, or glued down. bruce.com

2. Kitchen Sink Selections
Ruvati's Gravena Series of kitchen sinks now has new size options. From a generous 33-inch model to handle large pots to a compact 13-inch unit for wet bars, the sinks include standard features such as a stainless-steel drain cover, a deep basket strainer that traps waste, a bottom rinse grid that protects the sink from scratches, an undermount installation, and curved inside corners. Pricing ranges from $400 to $610. ruvati.com

3. Classic Door Knobs
The Circulaire Collection, Grandeur Hardware's newest set of modular hardware knobs and rosettes, is patterned after the look of classic colonial style but with clean, round details more closely associated with modern design. The knobs and rosettes are constructed from forged brass and may be mixed and matched with any other Grandeur knobs, levers, or plates. The Circulaire components are available in a variety of exterior and interior door configurations, including deadbolt sets and "thick door kits." Pricing ranges from $130 to $225. grandeurhardware.com

4. Reversible Siding Profile
Boral Building Products has added a reversible siding profile to its TruExterior line of poly-ash siding and trim. The new profile comes in two configurations: with smooth nickel gap on one side and wood-grain shiplap on the other, or with wood-grain nickel gap on one side and smooth shiplap on the other. Each siding profile is available in 4-, 6-, 8-, and 10-inch widths and 12- and 16-foot lengths and is made from Boral's standard TruExterior siding blend of polymers and fly ash. Contact a local distributor for pricing. boralbuildingproducts.com

5. Unique Subway Tiles

Sculpted with an angled surface that creates shadows, the tiles in Island Stone's Dunes series form a pattern when installed that is meant to evoke wind-swept sand dunes. Each 7 1/2-by-11 3/4-inch tile measures from 1/4 to 5/8 inch thick and is available in four colors: crystal white, typhoon grey, sandstone mint, or sandstone ocean. The tumbled natural stone is ideally installed with grout but can be installed dry stacked, the manufacturer says. Pricing was unavailable. islandstone.com

6. Upgraded Pocket Door Frame

Johnson Hardware's 1500SC Series Pocket Door Frame now has all-steel split studs. The switch to galvanized steel from steel-wrapped wood makes the frame's walls stronger, more rigid, and more resistant to doors flexing or bowing in and out, according to the manufacturer. The narrower studs allow for an additional 1/4 inch of pocket clearance, providing a larger, 2 1/4-inch pocket that will hold doors up to 60 inches wide and 108 inches high, with a maximum weight of 200 pounds. Pricing starts around $187. johnsonhardware.com

7. Steel Dryer Wall Vent

InOvate Dryer Products has redesigned its DryerWallVent to improve its durability, reliability, and resistance to the elements. The "next generation" DryerWallVent is made from heavy-gauge galvanized steel in three powder-coat colors—brown, tan, or white—with upgrades including integrated magnets, a built-in drip edge, and an integrated secondary backing plate. Pricing starts around $48. dryerwallvent.com

8. Non-Condensing Tankless Water Heater

Navien has entered the non-condensing market with its new Navien Premium Non-Condensing (NPN) tankless water heaters. The units will be offered in two series: the NPN-U (universal) for both interior and exterior operation and the NPN-E for exteriors only. Both will be available in 160,000 Btu/h, 180,000 Btu/h, and 199,900 Btu/h models for use with either natural gas or liquid propane. These models incorporate NaviTech technology, which includes a stainless steel heat exchanger and a stainless steel burner with "lean/rich stable cleaner burning technology." Contact a local distributor for pricing. navieninc.com

9. Solar Swing-Gate Operator
LiftMaster has introduced the 12V DC Solar Residential Linear Actuator Package, a swing-gate operator optimized for a solar-panel power source. The gate operators are available in single- or double-swing gate applications, and the full kit includes the operator, control box, and a 12-volt solar panel, which provides up to 126 days of standby power to the gate operator and minimizes power consumption when it is not in use. The system is rated for gates up to 16 feet or 850 pounds and meets UL 325 safety standards. The suggested retail price is $2,388. liftmaster.com

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10. LED Cabinet Lighting
Ideal for under or over cabinets, a new line of Honeywell-branded cabinet lighting from lighting manufacturer Jasco uses long-lasting, energy-efficient LED technology to eliminate the need for replacement bulbs, says the company. The 40 new lighting options range from plug-in or direct-wire LED strips to recessed puck lights. The Linkable Recess-Mountable Pucks (pictured at right) are dimmable and provide a soft white light at 150 lumens per puck. Pricing for the pieces ranges from $12 to $66. byjasco.com

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11. Wood-Framed Windows
Pella's new Lifestyle Series of wood windows and patio doors incorporates the company's patented glass, which Pella says is designed to reduce outside noise and improve energy efficiency. The new series also features customizations such as accessible blinds-between-the-glass and shades, Rolscreen retractable screens, and integrated security sensors. A variety of interior and exterior finishes, grille patterns, and hardware finishes are available. Contact a local distributor for pricing. pella.com

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12. UV-Resistant Flashing
Tamko Building Products' newly upgraded TW-105 Flashing Membrane can remain exposed to UV for three times as long as the original product, says the manufacturer. The redesigned membrane, traditionally used for balcony and breezeway details, includes a white polymer surface film that triples the 60-day UV resistance of the original product to 180 days. TW-105 Flashing is available in 12-inch-by-40-foot rolls; each carton contains two rolls for a total of 80 linear feet. Pricing varies by region. tamkowaterproofing.com

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December Advertising Index

*Advertising appears in regional editions

Classifieds

BY CLAYTON DEKORNE

Mind and Hand

Charles H. Ham, an appointed appraiser in Chicago, one-time editor of the *Chicago Tribune*, and an outspoken advocate for education reform, founded in Chicago a School of Manual Training. It wasn't the only school of its kind. The Manual Training movement had a strong foothold throughout the U.S. The North Bennet Street School in Boston is one example that survives today, though not as a public school for general education as some 300 manual training schools across the U.S. once were. Charles Ham stands out in the movement for his book, *Mind and Hand*, in which he presented the Ideal School founded on learning industrial arts not as a vocational preparation, per se, but as the foundation for the intellectual and moral development of children. Here are some excerpts in which he sets out to prove that work with the hands is a necessary foundation for a sound education:

Education and civilization are convertible terms; for civilization is the art of rendering life agreeable; and things—art products—constitute the basis of all the comforts and elegancies of civilized life. The great gulf between the savage and the civilized human is spanned by the seven hand tools [the ax, the saw, the hammer, the file, the drill, the lathe and the plane]; and the modern machine shop is a powered aggregation of these tools ... Tools, then, constitute the great civilizing agency of the world. Carlyle well said of humans: Without tools he is nothing, with tools he is all!"

...The training of the hand reacts upon the mind, inciting it to excursions into the realm of science in search of the hidden laws and principles governing materials and methods to be utilized through the arts in useful and beautiful things.

... The error in prevailing methods of education consists in striving to reach the concrete by way of the abstract, whereas we should pursue a diametrically opposite course.

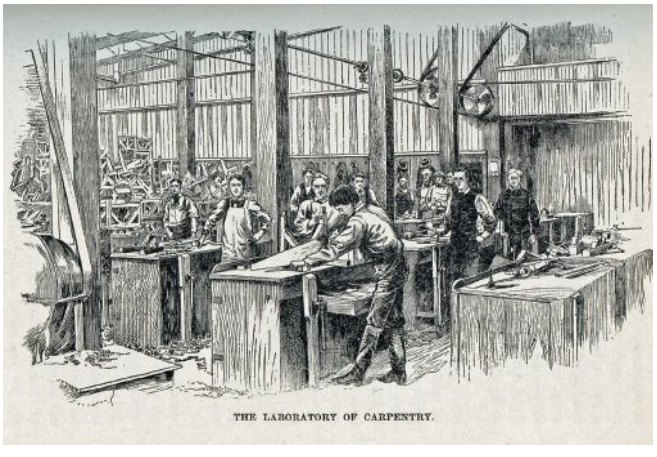
... The philosophy of manual training, the rationale of the new education, is the union of thought and action. Theoretical knowledge is incomplete. An exclusively mental exercise merely teaches the pupil how to think, while the essential complement of thought is action ... Like thought and action, the mind and hand complement each other. They are natural allies; the mind speculates, the hand tests the speculations of the mind by experiment. The hand thus explodes the errors of the mind ... It is easy to juggle with words—to make the worse appear the better reason—but a lie in the concrete is always hideous!

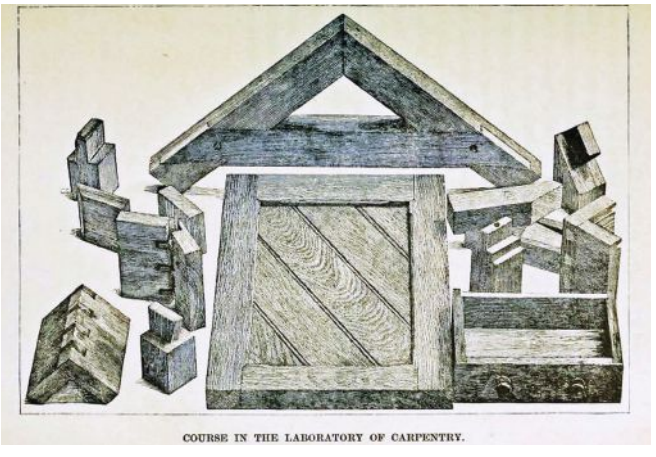
... The hand becomes the guide as well as the agent of the mind; it constantly appeals to the mind, by its acts, to hew to the line and let the chips fly where they may.

... It will be a great day for man—the day that ushers in the dawn of a more sober view of life, the day that inaugurates the era of mastership of things in place of mastership of words.

... The scientist and the artisan are the twin ministers of human progress. It is in the works of their hands that human history is found. All other records are inaccurate; in all other accounts there is room for deception; but the thing made is the truth.

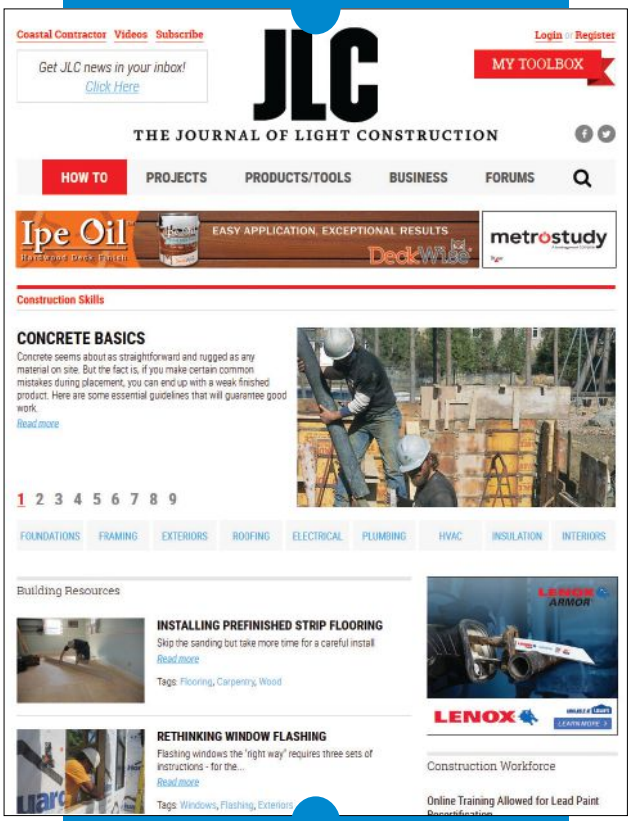
Mind and Hand is available free online in the National Archives of the Library of Congress.


THE LABORATORY OF CARPENTRY.


COURSE IN THE LABORATORY OF CARPENTRY.

Among the many laboratories in Charles Ham's Ideal School, the Laboratory of Carpentry is one of several classrooms students attend each day to learn "through things instead of through signs of things." The lesson, which starts with the student's shop drawings of the object to be made, brings together the "three great powers"—observation, reflection, and action.

JLC



JLConline.com
offers sound technical advice, practical how-to articles, expert hosted forums, as well as networking opportunities.

hanleywood

Every project deserves a signature.

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