BY SLOAN RITCHIE

1. A CLT job is a logistics puzzle, and to do it profitably requires planning. At the start of the job, it took time to sort the panels with a crane, but stacking them in the order they would be used saved valuable crane time in the long run.

2. Panels were craned into place. Lifting straps were run through holes drilled near the tops of the wall panels.

Photos: atelierjones

Building With Cross Laminated Timber

In late 2014, my company had the opportunity to frame a 1,500-square-foot infill home in Seattle using a panelized building system called "cross laminated timber," or CLT. We were one of the first residential builders in the U.S. to use it. Although we were familiar with a panelized approach, having used structural insulated panels, we found that CLTs have their own learning curve.

CLT panels are solid, made from 2-by stock bonded together under pressure with a thermosetting adhesive. The layers are cross-laminated, like plywood, with the grain on each layer running 90 degrees to the adjacent layers. Panels for commercial construction (the biggest market worldwide) can have as many as seven layers, but the ones we used for this project had three or four, depending on whether they were for walls or floors.

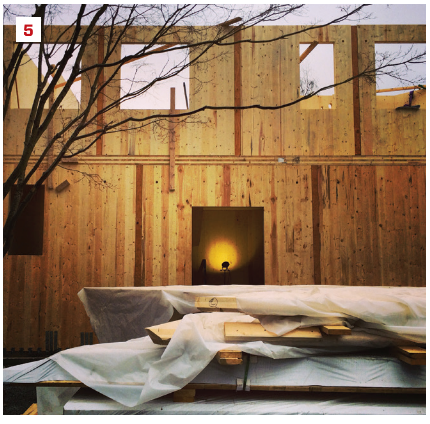
The panels were made by Structurlam, in British Columbia, from a combination of spruce, pine, and balsam fir, with blue-beetle-kill lodgepole pine in some of the interior laminations. The home required 67 panels, ranging in size from 2x10 feet to 8x35 feet and in weight from 200 to more than 2,800 pounds.

The architect and homeowner, Susan Jones of atelierjones in Seattle, chose my company because of its reputation for cutting-edge work, including the city's first Passive House. She had identified CLT as a sustainable material with a potential niche in the high-end green-home market.

The material is well-suited to an energy-efficient home. The solid panels simplify making the building envelope airtight, and they provide hygrothermal mass—they absorb and re-emit moisture as well as heat, helping to moderate fluctuations in both. Thermal bridging through the panels can be controlled with continuous exterior insulation.

FAST, BUT UNFORGIVING

As one would expect with a panelized system, the job went quickly. The complex floor plan—designed to fit a narrow, triangular lot—took just three weeks to frame, compared with the eight or 10 weeks that stick framing would have required. We based our labor estimate



3. The sill plate dimensions needed to be spot on, as panels can't be altered much. Metal hold-down straps anchored the panel to the plate.

4. Wall panels were stood in place on the sills and held plumb with diagonal bracing—just like a stick-framed wall.

5. The panel edges are notched at the factory to receive vertical splines (the darker boards) that hold adjacent panels together.

6. To maneuver floor panels into position, the crew attached the crane cables to threaded hardware embedded in the face of the panels.

on our experience with SIPs and ended up pretty close.

One caution: CLTs can be unforgiving. You can't adjust dimensions on the fly. The foundation dimensions must fit the plan exactly, and the panels must fit together perfectly. Small modifications can be made in the field, but that work wasn't part of our pricing, so we needed the panels to be the right sizes. The architect worked with Structurlam to create the panel order, then we reviewed the shop drawings before the panels were fabricated. This proved helpful, as we identified a couple of minor adjustments that needed to be made.

The ability to do that kind of review is crucial to success with this system. We have a lot of experience using CAD and reviewing shop drawings, but a builder without someone on staff with this experience may run into problems.

STAGING THE SITE

With CLTs, the job is a logistics puzzle, so good organization and planning are essential. We started by staging the panels. This was a small infill lot with room for just two stacks, so we arranged to have the first-floor wall and ceiling panels delivered first. After they were installed, we arranged delivery of the second-floor and roof panels.

Determining which panels go where isn't complicated: They're keyed to the plans and labeled 1a, 1b, 1c, and so on. Ideally, the panels would be stacked in order and oriented by the supplier in the position they'd be used. But that didn't happen here, so before work could begin, we needed to sort them using the crane, which ate up some time **(1)**.

ASSEMBLING THE PUZZLE

The wall panels had holes drilled through the upper portion. We put lifting straps through those holes, then had a worker or workers guide each panel into place **(2)**.

Like the foundation, the treated-wood sill plate must be perfect because of the fixed panel sizes. And of course bolts can't protrude above the surface of the sill plate. All connections in a CLT project must be specified by a structural engineer; in this case the panels were fastened to the sill plate with vertical straps **(3)**.

7. The engineer specified a series of closely spaced clips to secure the first- and second-floor wall panels to the intervening floor panel.

8. A worker applies a liquid-applied flashing product around a window opening. This material will be spread out to form a continuous film before the windows and insulation are installed.

9. The exterior was insulated with rigid mineral panels and covered with vertical wood siding. Any types of rigid insulation and siding could have been used, however.

10. Outdoor-rated wiring was attached to the panel exteriors, then drilled through to the inside at each fixture location. Plumbing was routed through interior framed partitions and chases.

Once a wall panel is in place, it's plumbed and braced the same as with any wall **(4)**, though the panels are a lot stiffer than a stick frame and tend to need fewer braces. As with SIPs, the CLT wall panels were joined to one another with vertical splines: The last few inches at the edge of the panel were notched to receive a 1-inch-thick plywood spline **(5)**.

The second-story floor panels included what Structurlam calls Rampa connectors: threaded sockets embedded in the panels at key lifting locations. A harness bolts to these connections and to the crane's lifting cable **(6)**. After lowering the floor panels into place, we set and braced the second-story wall panels. Small Simpson clips—which, like the hold-down straps at the base of the wall, were specified by the engineer—held the first- and second-story wall panels to the intervening floor panel **(7)**.

We flashed windows and doors with a fluid-applied flashing product called Prosoco FastFlash **(8)**, wrapped the home with VaproShield WrapShield housewrap, then insulated it with Roxul Rockboard 80 panels. A grid of 1x4 treated battens formed a rainscreen that we covered with vertical board siding **(9)**.

The roof was tricky. Although the home included roof panels, we framed over them with 2x8s so we could install polyisocyanurate insulation. We could have framed the roof without the panels, but the architect wanted the look of the CLTs on the inside.

Our subcontractors had never seen this system, so in order to get accurate estimates, we worked closely with them to plan electrical and mechanicals. You can't simply put pipes or wires inside the exterior walls. Our solution was to run outdoor-rated wire on the outside of the panels, then drill through the walls at each outlet location **(10)**. We ran most of the plumbing in stick-framed interior partitions. In some places, we built chases for plumbing drops.

The overall lesson here is that a builder who has the opportunity to use CLTs needs to systematically think through everything. Given enough upfront planning, it's a great system that creates a high-quality result. We would be happy to build with it again.

Sloan Ritchie owns Cascade Built, a Seattle custom builder that specializes in green construction.

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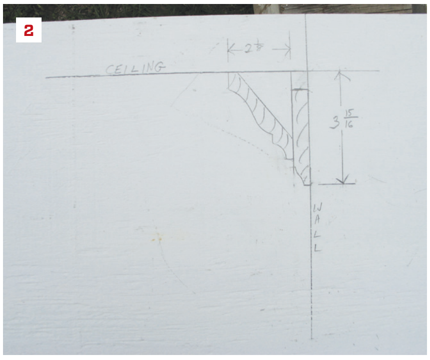

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Solo Installation of Crown Molding

BY JOHN CARROLL

Twenty-five years ago, I landed a job installing crown molding in a home. Thinking that I'd need a second pair of hands to handle the long, flimsy material, I hired a helper. But as the job progressed, I noticed that my helper spent much of his time watching me cut the material and fuss with each joint. After that I developed techniques to do the job by myself.

LAYING OUT THE JOB

Before I install crown molding, I take a few minutes to make a full-size cross-section drawing. This drawing lets me know how far down the wall to mark for the bottom of the molding, where to mark for any returns required, and how big to make back-up blocks, if needed, for fastening. Although I don't cut my crown in the "nested" position (tilted up against the fence at the 38-degree angle of the crown), a full-size drawing can also show you where to set up a block to hold the crown at the proper angle as you cut it.

To make the drawing, I clamp a framing square to a sheet of plywood and scribe along both legs of the square: one line for the ceiling and the other for the wall. I place a short piece of the crown molding against the legs of the square, making sure both edges are tight inside the square. Then I scribe all the way around the molding **(1)**. If you're cautious, as I am, you can check the angle of the back line with a Swanson Speed Square to make sure the crown is sitting at the desired 38-degree angle.

When I'm installing a single layer of molding, I'm done at this point. But for the project in the photos, I also needed to draw the upside-down base molding that expanded the profile, so I removed the square, held the base in place, and scribed around its profile as well.

After finishing the full-size drawing, I make some measurements. First, I find the distance from the bottom of the molding to the ceiling, in this case, $3\frac{15}{16}$ inches. Next, I determine the length of my returns. This project had three returns at $2\frac{1}{8}$ inches from the corner **(2)**.

With these measurements in hand, I mark the bottom of the crown profile on the wall using a scrap that I cut exactly $3\frac{15}{16}$ inches long **(3)**. I make marks at roughly 32-inch intervals, and at each of the return locations, I mark $2\frac{1}{8}$ inches in from the outside corners.

MEASUREMENTS WITHOUT A HELPER

A standard tape measure is just about useless for a

Photos: John Carroll

single person taking overhead measurements. Despite boasts of up to 11 feet of "stand-out," these tapes can be read only with the numbers facing up. Working at ceiling level, you need to turn the tape over to read the numbers, and when you do that, the tape inevitably collapses.

To overcome this problem, I use a different technique. For an outside corner, for instance, I mark the length of a piece in place. First I take a rough measurement while standing on the floor, then I cut the piece a few inches longer than I need. After cutting and fitting the inside corner, I hold the piece in place with one or two trim screws. On the back of the molding, I mark the outside edge of the wall. This mark represents the short point of the bottom of the cut for the outside corner.

When I need to measure from one inside corner to another, I use a measuring stick and rulers. For the measuring stick, I cut a strip of wood exactly 100 inches long. I butt this strip into one corner and mark the end **(4)**. Then I measure back from the other corner to the mark using an inexpensive metal ruler (I have several lengths) and add that dimension to 100 to find the total length.

If the wall is longer than the length of the material available (usually 196 inches, or 16 feet), I make up the length with two pieces so I don't need to measure corner-to-corner. Instead I usually install the first piece, then hold and mark the length of the second piece without measuring it.

If the wall is between 172 inches and 196 inches long, I first mark 100 inches as described above. Then I use my 72-inch ruler and mark 70 inches from the opposite corner. I am left with two marks a short distance apart. I measure that distance and add it to 170 to find the length I need.

Transferring measurements to a floppy piece of molding can be challenging, especially when measuring from an end that's cut at an angle. When measuring from the long point, I hold the tape in place with a spring clamp to make sure it stays put as I mark the measurement **(5)**. To measure from the short point of a cut, I clamp a Speed Square across the piece at that point and then hook the tape over the square **(6)**.

INSTALLING THE CROWN WITHOUT A HELPER

To hold up the far end of the material as I fuss with the joint and install the piece, I use a simple rig that I assemble on site. My support system starts with a horizontal 2x4 a couple of feet long clamped in a Rockwell JawHorse. To this 2x4, I attach a vertical strip of plywood about 8 inches wide and about 80 inches long. I slide the strip up to the correct height and clamp it to the 2x4 with a one-hand bar clamp **(7)**. This system sets up and moves easily, yet provides plenty of support for the material.

Although they aren't essential to working alone, I've found that work benches can speed up the installation and save trips up and down the ladder. I use a pair of benches that are 6 feet long and 22 inches high with

Photos: 4, Alan Culton; 5, Bill Phillips ; 6, John Carroll


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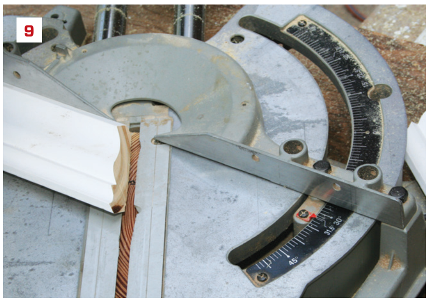
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2x12 tops. When I'm standing on them, my head is below the ceiling and I'm at a comfortable height for installing crown for an 8-foot ceiling. When they're combined, I can walk from one end of the piece to the other as I install the material.

SETTING UP THE WORKSTATION

As most carpenters know, taking a few minutes to set up a workstation at a job always pays dividends in safety, quality of work, and time. When you're working alone, a good workstation is a necessity.

My workstation isn't fancy—just a pair of saw horses with an old door placed across them. To set up my sliding compound miter saw (SCMS) for a job like this, I lay a piece of plywood over the door for a smooth surface. I position the saw all the way to the right of the table, and I set a simple, site-built support on the left side for the material **(8)**. My SCMS table swivels both left and right for miter cuts and tilts both left and right for bevel cuts, so I never need to flip the positions of the saw and the material support to make cuts.

Next to my workstation, I keep a bucket of clamps. You can quickly clamp material, and at times, tools, if you have the right clamps. For clamping small items, such as my tape measure to the molding, I use spring clamps. For stronger clamping, such as holding the crown in place while coping, I use one-hand bar clamps, which allow me to hold the jigsaw with two hands. I never use C-clamps at my workstation: They take way too much time.

TRICKS FOR MAKING COMPOUND CUTS

Working alone I find it easier to keep crown molding flat on the table of the saw instead of resting it at an angle against the fence. On most saws, the scales for both of these actions are clearly marked for the angles needed to make square corners with 38-degree crown molding: 31.6 degrees for the miter and 33.9 degrees for the bevel.

Even with these settings, it can be confusing to set the saw to the right combination of angles. So, to make it easier to visualize the orientation of the cuts, here are a few simple rules.

First keep in mind that the bottom of standard crown molding has the cove. For inside corners, the long point of the miter cut is always at the bottom, and the short point of the bevel cut is always at the front face of the molding **(9)**.

For outside corners, the short point of the miter cut is always at the bottom, and the long point of the bevel cut is always at the front face of the molding.

To see immediately if you're on the right track, look at the top of the cut. When you're making cuts for either inside or outside corners, the cut along the flat, vertical section at the top of the molding should always run perpendicular to the top edge **(10)**.

John Carroll, author of Working Alone *(Taunton Press, 1999), is a builder who lives and works in Durham, N.C.*

Photos: 7, AJ Culton; 8, Alan Culton; 9 and 10, Bill Phillips