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HOW WOMEN ARE TAKING ON THE 'BRO' CULTURE OF PROGRAMMING AND OPENING UP THE TECH SECTOR TO FRESH PERSPECTIVE.

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JUNE 2015 / VOLUME 26 / NUMBER 6 / SEATTLEBUSINESSMAG.COM

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WOOD YOU RATHER?

The Wood Innovation and Design Centre in British Columbia is meant to showcase the potential of building mid-rise and high-rise structures with engineered mass timber.



CRITICAL MASS

Cross-laminated timber: Is it strong enough to build high-rises — and revive a legacy Northwest industry?

by ANDREA WATTS
& LESLIE HELM

Before aerospace, software and coffee defined the Pacific Northwest, timber was the industry that fueled our economy. Now, a radical new approach toward sustainable construction — building high-rises from wood — could bring timber back into the spotlight, stimulating rural economies and promoting forest health in a way that architects, conservation groups and timber companies can get behind.

While the Pacific Northwest likes to boast of its many green buildings, they can't match wood high-rises in Europe and Australia that have carbon footprints a quarter that of similar-size buildings of steel and concrete. A 10-story wood apartment building called Forte was recently completed in Melbourne, Australia. The Tree is a 14-story luxury apartment building in Bergen, Norway, that will be the world's tallest wood building when it is completed this fall. Next year, builders will begin construction on HoHo, a 24-story hotel/office/apartment tower in Vienna composed of 76 percent wood.

With the Pacific Northwest's abundant forests, "we need to think of a Cascadia approach to developing this industry," says Michael Green, a Vancouver, British Columbia, architect whose TED Talk two years ago helped to spark local interest in high-rises of wood. Green built the six-story Wood Innovation and Design Centre, the largest wood building in

North America, in Prince George, British Columbia. He is now designing a 33-story wood tower for a location in Paris, France.

How can wood possibly replace steel and concrete in high-rise buildings? The answer is cross-laminated timber (CLT), a relatively new engineered wood product that is part of a broader category of products called "mass timber" that includes already popular products such as glulam beams. CLT panels can be made in dimensions up to 10 feet wide and 40 feet long and more than a foot thick.

The panels are composed of layers of individual pieces of lumber laminated together, with each layer arranged perpendicular to the next rather than longitudinally. An odd number of layers are bonded together by glue, dowels or nails. Once assembled, the panels form a box-like structure where the walls and floors provide both structural stability and lateral stiffness.

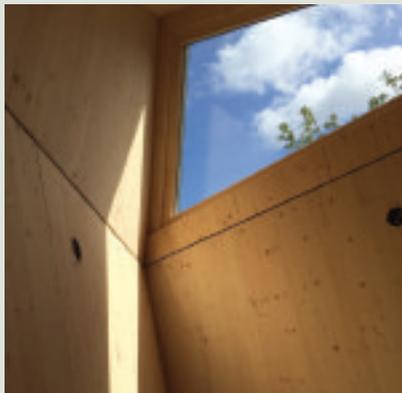
Architects love CLT because the beauty of the wood surface can be showcased with

no need for paint or drywall. Though the panels cost roughly the same as steel and concrete, they are far lighter and quicker to assemble on site. And lest you think that a wood building wouldn't be safe during a fire or an earthquake, full-scale tests show its fire resistance is comparable to steel and concrete. A seven-story CLT building tested in Japan showed no sign of damage in an earthquake the magnitude of the 1995 Kobe, Japan, event.

WHAT MAKES CLT so compelling is that it can be manufactured using "junk" trees with diameters as small as 4 inches, including many dead trees. National forests on either side of the Cascades are filled with "dog-hair thickets" of Western hemlock, Douglas fir and other trees that are conducive to wild-fires and pest outbreaks. Thin trees are uneconomical to harvest today because they have so little value, yet federal and state forest managers don't have the budget to clear them. When incorporated into CLT panels, that wood could provide the raw material to build many of the mid-rise buildings popping up in Seattle and other urban centers across the country.

"Everybody sees it coming," says Timothy Punke, senior vice president of corporate affairs and public policy at Plum Creek Timber Company, which owns vast forestlands in Washington state. "It's a huge opportunity to build environmentally friendly cities while helping rural economies that depend on timber and creating incentives for more people to plant more acres as trees."

Today, there are only 26 CLT manu-



▶ AT HOME IN SEATTLE

Susan Jones says building the first single-family residence in Seattle solely with CLT required a lot more planning because the CLT panels are prefabricated with windows and doorways already cut out. Her firm, atelierjones, spent three months working with computer numerical control (CNC) technicians at Structurlam Products, a CLT manufacturer in British Columbia, to produce the panels for her custom-built house. That advanced design planning paid off. When the panels were dropped into place, she says, "they fit like a glove."

Sloan Ritchie, the owner of Cascade Built, which built Jones' house, says working with CLT for the first time wasn't all that complicated. The crew did have to contend with windy November days that shut down use of the crane. But Ritchie says construction time was still faster than with a stick-frame project. The first floor of Jones' house was up in two days, and the entire structure was framed in two weeks. — A.W.



TIMBER TOWER.

The Wood Innovation and Design Centre in Prince George, British Columbia, uses no concrete above the ground-floor slab.

facturers worldwide. Most are clustered around Austria, which gave birth to the industry. Analysts estimate the market potential in the United States is \$4 billion, but sales could eventually grow far beyond that. Cees de Jager, chief marketing officer of the Softwood Lumber Board, an industry group, says 77 percent of the square footage built each year in the United States is less than 12 stories high and could be made with mass timber. Of nonresidential buildings under 12 stories, 90 percent today are made of steel and concrete. Replacing those with wood would sharply reduce the building sector's carbon footprints, but the United States is far behind Europe, Australia and Canada in building with mass timber. "It's not normal for the United States to be in fourth place," says de Jager. "We have to get to the gold level."

To be sure, it could be years before the notoriously conservative building sector takes to using CLT in construction in any major way. It's unclear whether sustainable forest practices can provide enough fiber at dependable levels over the long term. Building codes and the absence of local mills manufacturing CLT are also a problem. And while more jobs might eventually be added in the forests and mills, there could be fewer jobs at construction sites. CLT's construction technique, based on the lifting systems used for precast concrete construction, employs a crane to lower into place panels that are

then bolted together. This method requires a smaller crew at the building site.

Nevertheless, local leaders are moving forward to explore opportunities aggressively. "It's a potentially powerful way to monetize the ability to restore our forests, remove some of the fuel load and even start to create a more complex working forest," says Gene Duvernoy, who as CEO of Forterra (formerly the Cascade Land Conservancy) is known for bringing together divergent environmental and business groups behind common goals. If the industry can be developed sustainably, Duvernoy says, it should happen here. "We are a leader in technology, aerospace and coffee," he notes. "We have lots of forests. We deserve to be a leader in this world."

LAST SEPTEMBER, FORTERRA hosted a meeting that brought together an unlikely alliance of Pacific Northwest environmentalists, timber companies, politicians, architects and academics in the hope of jumpstarting an industry around CLT. The group continues to convene monthly to identify opportunities to demonstrate the value of CLT for communities, the environment and the economy.

"Having a conservation group like Forterra recognize this [CLT] opportunity changes the game completely," says Tom DeLuca, a professor in the School of Environmental and Forest Sciences at the

University of Washington. "They look at it from a whole systems approach and are effective at getting support for environmental groups. They bring credibility to the floor."

Washington Congressman Derek Kilmer, whose 6th District includes the entire Olympic Peninsula, which has been hit hard by the shuttering of sawmill operations, sees CLT as an important growth engine.

"New manufactured-wood products like cross-laminated timber are not only good for the environment," says Kilmer, "but they also have potential to create new manufacturing jobs in our rural communities." He recently added language to a defense authorization encouraging the Department of Defense to use CLT products in housing and other construction projects.

Timber companies like the idea that society might recognize forests as a source of sustainable resources.

"More uses for wood will drive up [timberland] prices," says Colin Moseley, chairman of Green Diamond Resource Company (formerly Simpson Resource Company), a fifth-generation, family-run business that owns 300,000 acres of forestland in Washington state and recently planted its 100 millionth tree. Higher-value timberland, in turn, creates incentives for land managers to buy more property that might otherwise be targeted for real estate development and convert it to timber production instead.

For the moment, Washington is well behind its Pacific Northwest neighbors

in embracing CLT. British Columbia's Structurlam Products was the first to build a CLT manufacturing facility in 2011. SmartLam Technologies operates a CLT-manufacturing plant in Montana and supplies panels that are used as skids at construction sites. And a government-industry collaboration helped launch a CLT manufacturing plant in Oregon this year. A Portland-based real estate development company is planning to break ground next year on a 12-story, mixed-use wood high-rise in Portland's Pearl District. And the city of Springfield, Oregon, is exploring the possibility of building the first mass-timber parking garage in the United States.

Washington architects see CLT as a perfect fit for the state. "The environmental story behind CLT is inspiring," says Joe Mayo, who traveled the world researching mass timber buildings and recently published *Solid Wood: Case Studies in Mass Timber Architecture, Technology and Design*. Architects like to use local materials, and "having a structural material that you can leave exposed gets at the heart of our regional architecture," Mayo adds.

Projects in Washington using CLT include the Brelford Washington State University Visitor Center in Pullman and the International Community Health Services' Shoreline Medical & Dental Clinic. Susan Jones, a Seattle architect, recently completed a two-story home made entirely of CLT, believed to be the first in the country.

THE TRUE BENEFIT OF CLT as a sustainable building product is only realized when it replaces steel and concrete in high-rise construction.

"For the first time, architects can push through the four-story limits of light-frame construction and design mid-rise buildings with wood," says Don Bender, director of the Composite Materials & Engineering Center at Washington State University. He sees more 8- to 12-story buildings being made from wood, as they are in Europe. Bender and his colleagues at WSU are studying ways of leapfrogging the existing technology to help build a more advanced CLT sector in Washington.

For all the advantages of CLT, getting the industry off the ground has proven difficult. It's the chicken-and-egg situation: Mill owners don't want to invest \$3 million to \$6 million to build automated production lines capable of manufacturing 10-foot-by-40-foot panels until there's a steady, reliable demand. Yet demand won't develop until a local supplier makes material costs more reasonable.

Another obstacle is American building codes that stifle innovation. European and Canadian codes are performance based, says Ethan Martin, Northwest regional director at WoodWorks, an industry group that supports wood construction. "[In Europe] you can say, 'I've run the calculations and I believe this material can support the load,'" he says. "The U.S. code is prescriptive: 'If you do A, then B, then C, you can use this product.' That's a challenge if a new material requires a new approach to building."

There has been some progress on this front. In 2012, the city of Seattle updated its building code to include CLT. The 2015 *International Building Code* includes more references to CLT construction and the next revision in 2018 will

► CREATING A MASS-TIMBER INDUSTRY HERE

Washington State University has received a \$250,000 grant from the U.S. Department of Agriculture for a joint effort with the private sector that it hopes will improve the functioning of an entire CLT supply chain. Architects, for example, might be able to send their CAD/CAM designs to a CLT manufacturer and have those designs seamlessly transferred into the software that tells numerically controlled machines where and how to cut the CLT panes.

Where today manufacturers use a subtracting process, first building the panels and then cutting out windows and doors, a process that wastes wood, an advanced manufacturing plant would use an additive process, like a 3-D printer, that puts wood only where it is needed, leaving voids for doors, windows, plumbing, mechanical and electrical lines. The machines could install various materials in LEGO-like fashion between the sheets to add soundproofing, fire resistance and other capabilities.

"It's about using advanced manufacturing to get beyond just thick, dumb panels and put in functionality," says Todd Beyreuther, an assistant research professor in WSU's Institute for Sustainable Design. "Architects would be able to use all the technology at their disposal to customize materials to their specific needs. It's about asking the wood [panel] to perform many functions with engineering and technology. The premise is that architects already think that way."

WSU is working with Vaagan Brothers Lumber, a technologically advanced Colville-based sawmill and logging company;

Spokane Valley's Berg Manufacturing, which has sophisticated capabilities for installing plumbing and electricity in containers used for camping; and SmartLam Technologies, a Montana-based CLT manufacturer. The goal is to build a pilot manufacturing facility to advance the state of the CLT manufacturing art.

"Ideally, you would put timber in one end and get [smart] panels with the plumbing and electricity already installed at the other end," says Andy Barrett, executive director at Berg Manufacturing. The electricity and plumbing would be connected at the same time the panels are bolted together at the construction site.

Although no company has yet committed to building a CLT manufacturing plant in Washington state, Beyreuther notes more and more people are asking how to get into the business. "In the next three to five years, we might see quite a jump in manufacturing," he says.

He believes it would make sense to have two CLT manufacturers in eastern Washington and two more in western Washington so that architects who want to control everything down to the species of wood used in the panels can collaborate closely with the manufacturer.

Beyreuther hopes to construct a large commercial building of CLT in the next two to three years, and he says building codes are not a barrier. "There is a green light on everything," he declares. "We could build a 10-story building today. It's just not yet cost effective." — L.H.

include even more. Though Susan Jones says it took four months to obtain the permits for her CLT-built home in Seattle, she praised the city for granting the permits and visiting the site to see the use of CLT firsthand. Several cities, including Minneapolis and Portland, have promised close cooperation with builders to grant variances allowing for 10-story wood buildings.

Cost is another barrier to more widespread use of CLT panels. Jones says building her house was twice as expensive as it would have been with traditional construction in large part because of the high cost of shipping the panels from the manufacturer in British Columbia. The lack of CLT manufacturers and the paucity of contractors familiar with the material's hidden cost benefits also contribute to higher costs.

FEDERAL SUPPORT MAY help close the gap. The U.S. Department of Agriculture is promoting the sector with grants and contests. Winners of the \$2 million Tall Wood Building Prize Competition, which has the goal of encouraging the construction of high-rise wood buildings, will be announced later this year. At least two groups in Washington and one in Oregon have entered. The Softwood Lumber Board is working with the USDA and with universities to



REACH FOR THE SKY.

Sky, the British broadcast and internet company, occupies the United Kingdom's first multistory timber commercial office structure. Sky calls it the Believe in Better Building.

create online courses and to explore the creation of skill development for workers who will eventually be working with CLT on the job site.

But one of the key drivers behind devel-

oping a CLT industry is the supply side. “[CLT] is not just about a new material that can be bought at Home Depot,” says Hans-Erik Blomgren, an associate at the Seattle office of Arup, a London-based company with extensive experience in building high-rises with CLT and which has partnered with Washington State University to enter the competition. “It’s a disruptive technology to the current state of the industry where panels are built in a factory and delivered in a lightweight, easy-to-transport way. Selling logs to China is not what we should be doing. We should be building high-value products.”

Though harvest levels on state and private lands have remained constant over the years, they have plummeted on federal lands because of pressure from environmentalists. This has forced sawmills to shut down, leaving many rural communities with high unemployment. And with federal forests too budget constrained,

they cannot engage in the selective thinning required to increase wildlife habitat, reduce fire danger and provide space for maturing trees.

CLT could fundamentally change the way forests are managed by creating demand for small-diameter trees. Support from environmentalists might also result in compromises that would stop court challenges that are now stalling harvesting in federal forests. Confidence that a steady supply of small-diameter wood would be available could encourage mill owners to consider investing in CLT manufacturing, although some subsidies might be required to encourage the first investments. There is discussion of state support for a CLT plant in Darrington, near the site of the 2014 Oso landslide. The city of Forks has offered land and is looking for a partner to build a CLT mill.

If handled right, the timber used in the manufacture of CLT “should be seen as renewable and green, not an extractive industry [like mining],” says DeLuca. “It’s about green building materials and more sustainable forest management.” And, presumably, a future of forestry that everyone can support. **SB**

➤ MEANWHILE, IN OREGON

While Washington tries to build momentum behind its CLT effort, Oregon is off and running. Oregon BEST, a state-funded nonprofit with the goal of leveraging clean-tech research, provided \$150,000 last year to D.R. Johnson Lumber Company and Riddle Laminators to help build and certify a Douglas fir CLT production line.

Valerie Johnson, president of D.R. Johnson Lumber, says the company expanded an existing building and installed new presses capable of producing the larger panels. “Because we have been manufacturing glulam beams for nearly 40 years, we have roughly one-fourth of the necessary equipment already,” says Johnson. “Once you’re used to resins, clamping and gluing, it’s not a process you’re afraid of.”

It took less than a year to design the presses; installation required less than two months. The plant can build panels up to 10 feet by 24 feet, but could add presses capable of producing 42-foot panels if the demand emerges.

Following certification by the Tacoma-based Engineered Wood Association, Johnson already has prospective customers lining up, including Oregon State University and the city of Springfield. — **A.W.**