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JEREMY BITTERMANN/COURTESY LEVER ARCHITECTURE

The State of the Art of Timber

CROSS-LAMINATED TIMBER SHIFTS FROM SPOTLIGHT TO STANDARD.

Engineers specializing in cross-laminated timber (CLT) see its future less in boutique prototype towers, requiring case-by-case demonstrations for approval, than in a meat-and-potatoes midrise market. While, according to Colorado State University's John van de Lindt, "some of those pioneering early CLT buildings are really almost like a partial R&D project in disguise," he and colleagues predict that the field's maturation **continued on page 11**

TONY HISGETT/FLICKR

A Growing Industry

THE LUMBER INDUSTRY LOOKS TO THE FUTURE OF CONSTRUCTION WHILE MAINTAINING THE WORLD'S FORESTS.

North America's lumber industry helped define what it means to build in the modern era. With the invention of the light balloon–frame, lumber became an indispensable resource to the quickly expanding United States **continued on page 9**

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COURTESY STUDIO MA

Zeroing In

ARIZONA STATE REVEALS PLANS FOR A STUDIO MA–DESIGNED TIMBER NET-ZERO BUILDING.

Los Angeles–based Studio Ma has unveiled a radically sustainable master plan and conceptual design for Arizona State University's Interdisciplinary Science & Technology Building—a science and research complex that will be centered around a vast atrium filled with plants and water. **continued on page 12**

Carbon, Copied

IS MASS TIMBER THE SUSTAINABLE SOLUTION ENVIRONMENTALISTS CLAIM IT IS?

We like to blame a lot of things for climate change—namely coal and cow farts—but if we were to search for a worthy scapegoat, architects might end up looking in the mirror. The building sector is responsible for 44.6 percent of U.S. carbon dioxide (CO_2) emissions. And, with an estimated 1.9 trillion billion square feet to be built in the next 33 years, those emissions will not subside without significant intervention. On the flip side, for architects anyway, **continued on page 5**

What Wood You Do?

A FIGHT IS BREWING OVER FEDERAL LEGISLATION THAT COULD GIVE THE TIMBER INDUSTRY A JOLT.

The battle over the 2017 Timber Innovation Act is gaining momentum in Washington, D.C., where two new Senate sponsors and four new Congress members have signed on to it since this past May. The pending legislation would provide funding for research into innovative wood materials and mass timber structures above 85 feet. The bill's proponents are hoping that it will be an impetus for transforming cities and towns across the country with a **continued on page 5**

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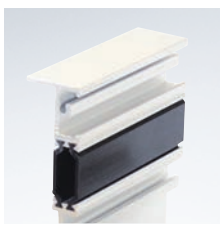

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Cover image, top left: A custom connection at LEVER Architecture's Albina Yard (see page 14).

IT'S GOING DOWN, I'M YELLING "TIMBER!"

Mass timber is having its Masion Dom-i-no moment.

At the 2014 Venice Architecture Biennale, a curious structure sat on the grass near the international pavilion in the Giardini. It was an engineered timber version of Le Corbusier's Maison Dom-Ino, the seminal, prototypical reinforced concrete project, which was celebrating its 100th birthday.

As a manifesto of sort for modernism, the original Maison Dom-Ino sent shockwaves through the architecture world and the built environment at large. It was a replicable, scalable building system made from simple columns and floor slabs, which could be stacked vertically and horizontally like dominoes.

The 2014 version was commissioned by Brett Steele, then dean at the Architectural Association School of Architecture in London. He described the "afterlife" of the 1914 Dom-Ino as "a set of guiding, abstract, and idealized principles" that have shaped the world as we know it today.

The choice of timber in this case is an interesting one, as mass timber seems to be today's material that looks promising for the future, much like steel and concrete did in the 20th century. As outlined in this issue, timber has a litany of benefits including carbon sequestration, lower embodied energy than steel and concrete, psychological benefits for inhabitants, less construction noise in tight urban sites, easier on-site construction in general, and many other positive aspects. It would reorient wood from light-frame suburban development toward mid-rise dense urban development.

Taller and taller timber towers serve as the "Eiffel Tower" moments for the rapidly expanding timber industry, as pointed out by Jimmy Stamp in the *Smithsonian Magazine* article, "Is Timber the Future of Urban Construction?" And these important projects have brough attention to an otherwise niche building trade. Alongside these "Wow!" projects, there is another, less sexy side of the timber revolution that could help to change the way we build in America. New technologies abroad are already making midrise construction cheaper and more viable at larger scales. This incremental progress is taking place among manufacturers, architects, engineers, and designers as we speak in places like the nearly 600,000-square-foot Arbora complex in Montreal, Quebec (page 10). And companies, such as Nordic Engineered Wood, are expanding in the U.S. market, a place known for innovation that makes things cheaper and more market-ready.

Once the market can produce mass timber structures cheaper than steel and concrete, there could be a seismic shift. And as timber becomes more viable for safety concerns, and more legal through local codes adapting ("The State of the Art of Timber," front page), we could see timber proliferate at the same rate as the early-20th century saw the Maison Dom-Ino's system spread across the world over the next 100 years.

But of course we are speculating a bit in this issue. The future is not so clear. A fight is brewing in Congress ("What Wood You Do?" front page) over the bipartisan Timber Innovation Act (and along with it, lobbying antics from the steel, concrete, and sand industries). If U.S. governmental agencies and private companies—namely manufacturers—come together, the costs could come down. It is possible that architectural knowledge-research and development could bend the markets so as to impact both economic and environmental resource allocation networks toward a lower-carbon future, as architect and timber expert Alan Organschi told *AN* in a conversation.

The arms race is already on, and the National Forest Service has awarded $250,000 to Boston-based IKD to develop a hardwood-based CLT (page 15), which is an important incremental step in the process.

This issue speculates on a future where entire blocks might be built with green technologies including mass timber, and whole cites could be filled with beautiful wood buildings layered onto stone, brick, steel, glass, and concrete urban fabric.

How this revolution might play out is unclear, but we are seeing glimpses of what might be to come, such as Framework by LEVER Architecture in Portland (facing page), which will be the tallest building in the U.S., or the work of Michael Green Architecture in Vancouver (page 20), or Gray Organschi Architecture out of New Haven, Connecticut (page 22), which has been researching mass timber at the Yale School of Architecture. We also look to Europe and Canada for success stories that might be examples for the future of mass timber in the U.S. (page 28).

As Steele said of his 2014 Maison Dom-Ino, "This initial installation will remind visitors not only of modern architecture's most foundational project, but of an architectural instinct made even more apparent today than it was at the time of its original conception; namely that architecture always operates in the space created by a contrast between architecture as already known, and what it might yet become."

Can we imagine a partially wooden future? **Matt Shaw**

The Oregon Forest Science Complex at Oregon State University by Michael Green Architects.

COURTESY OREGON STATE UNIVERSITY COLLEGE OF FORESTRY

Visiting Paul Bunyan

2018 INTERNATIONAL MASS TIMBER CONFERENCE TO BE HELD IN PORTLAND, OREGON.

March 20–28, 2018
Oregon Convention Center
Portland, Oregon

The third annual International Mass Timber Conference will be held next spring in Portland, Oregon.

Since its first iteration in 2016, the conference has become one of the largest gatherings of experts and stakeholders specializing in cross-laminated timber (CLT) and related products. In 2017 alone, over 800 experts from 22 countries attended.

The programming focuses on CLT, nail-laminated timber, glulam beams and panels, mass plywood panels, dowel-laminated timber, and laminated veneer lumber, exploring the supply chain of these products as well as the pros and cons of their implementation.

The presenters are yet to be determined, but the tracks are pointed at different audiences: developers and builders, architects and engineers, and manufacturers. There will also be two building tours. The first will be of mass timber construction in the city of Portland, including a visit to the World Forestry Center. The second will head to Freres Lumber Co., Inc.'s mass plywood panel (MPP) plant, the first facility in the world to focus on the production of veneer-based mass timber panels. The second tour will visit the Oregon Forest Science Complex at Oregon State University, a $65 million building made largely of laminated timber products and designed by Vancouver-based studio Michael Green Architects. The complex will contain a dedicated research facility for prototyping wood technologies, dubbed the National Center for Advanced Wood Products Manufacturing and Design.

As part of the overall conference, an exhibition hall will be set up at the Oregon Convention Center, with spaces still for sale on a first-come, first-served basis. At the convention center (the largest in the Pacific Northwest), exhibitors will be able to interact with professionals from a range of backgrounds, from the design field to government agencies, as well as supply-side experts drawn to cutting-edge research on timber.

Jackson Rollings

COURTESY PFLY/FLICKR

Carbon, Copied **continued from front page**

this means the power to reduce carbon emissions is quite literally in your hands. "No designer—I think—wakes up and says, 'I want to make the world worse today,'" William McDonough, architect, designer, and sustainable development leader said. "To make the world better, that's our job."

Identifying successful ways to build sustainably can be difficult in a haze of green washing and checklist-style certifications, but many environmental experts, architects, and scientists are looking to mass-built timber as a reliable way to reduce carbon and fossil fuel output. A recent study, "Carbon, Fossil Fuel, and Biodiversity Mitigation with Wood and Forests," stated that using wood as a building-material substitute could save "14 to 31 percent of global CO_2 emissions and 12 to 19 percent of global FF [fossil fuel] consumption by using 34 to 100 percent of the world's sustainable wood growth."

Building with timber reduces the overall carbon footprint in several ways. First, wood is a renewable resource, and growing a tree is a low-impact method of production (i.e. it uses photosynthesis rather than a plethora of machines). Second, trees are grown in abundance all over the United States and don't need to be imported from abroad, reducing the amount of energy expended on shipping. "Right now we harvest less than half of what we could and still be well within the threshold of sustainability," Kathryn Fernholz, the executive director at Dovetail Partners, an environmental nonprofit, explained. "That's not the same in every single scenario, but in general in the U.S., we have an abundance of wood."

Third, and perhaps counterintuitively, many environmentalists believe that harvesting trees allows forests to become more efficient at carbon sequestration. The logic is simple: When a tree is harvested, it stores carbon, then when another tree is planted in its place, it also will store carbon, making that plot of land's carbon sequestration infinitely multipliable as trees are planted, grown, and harvested. "There is a widely held belief that cutting down trees is bad and causes loss of forest, but a strong market for wood products would cause us to grow more forests," Fernholz said. "The vast majority of deforestation is land conversion, using the land for something else like development or agriculture. We know what resources we have and we monitor them and adjust. Forestry is not in the same place it was a hundred or even fifty years ago when deforestation was an issue."

The United States has an abundance of wood in our forests, which can be sustainably harvested to build timber structures, saving 14 to 31 percent of carbon dioxide emissions.

While that stance of de- and reforestation is under debate among environmental experts, across the board, timber is generally a more sustainable building material because it is a renewable resource (provided that responsible forest practices are used). This includes the energy consumed to produce cross-laminated timber (CLT) in factories, which have a carbon emissions advantage over steel because the wood does not need to be heated over 2,700 degrees Fahrenheit like steel or concrete—in fact, unless the wood is kiln dried, heat isn't need at all. Although embodied carbon is typically measured per building, because different amounts of each material are used in different scenarios, Wood for Good, a campaign by the timber industry to promote the material, claims that a ton of bricks requires four times the amount of energy to produce as a ton of sawn softwood (wood used for CLT); concrete requires five times, steel 24 times, and aluminum 126 times.

"Reporting carbon emissions for wood includes a range of different assumptions and methods," explained Kathrina Simonen, an associate professor of architecture at the University of Washington and director of the Carbon Leadership Forum. "So sometimes it ends up negative and sometimes it ends up positive. It can be confusing." She is optimistic, however, that research is close to resolving the differences. Responsible **continued on page 19**

COURTESY LEVER ARCHITECTURE

What Wood You Do? **continued from front page**

bevy of midrise and high-rise mass timber buildings.

"I am very impressed with the large cross-aisle support," Chadwick Oliver, director of Yale University's Global Institute of Sustainable Forestry, said. "You have Bruce Westerman, a Republican congressman from Arkansas and Peter DeFazio, a Democrat from Oregon who has been on the side of environmental groups. This looks like a bill that is quite serious about moving forward."

However, the concrete and steel industries are vigorously lobbying to derail the legislation, and have established a website called Build with Strength that contains a detailed critique of the new generation of wood buildings. "It is a piece of legislation that props up one industry over another and we think that it is misguided and dangerous," Kevin Lawlor, a spokesperson from Build with Strength, said. "We don't think that it is safe in three-to-five story buildings, and we don't think that it is safer in taller buildings."

The wood products industry, the U.S. Forest Service, and other advocates claim that technological advances make the new generation of tall timber buildings more fire resistant. In fact, According to Dr. Patricia A. Layton, director of the Wood Utilization + Design Institute at Clemson University, that is because of the way it chars in a fire: By insulating its interior, an exposed wood beam can actually be structurally stronger than a steel one. "Steel loses its strength at a lower temperature than does wood," she explained. "If you expose concrete or steel it is combustible, and it does feel the effects of fire."

Framework by LEVER Architecture was funded in part by a $1.5 million U.S. Tall Wood Building award sponsored by the United States Department of Agriculture.

Many of the act's supporters say that allowing buildings to be built from wood technologies such as cross-laminated timber (CLT) will result in a host of economic and environmental benefits. Most of the Timber Innovation Act's sponsors hail from states where the wood industry is struggling to recoup from the recent housing downturn and also suffering from the decrease in demand for paper that is a result of the increasing digitalization of the economy.

"A big part of the innovation act is having the U.S. Forest Service work to expand markets and attract business to heavily forested states, particularly those that have a major timber industry," said Andrew Dodson, vice president of the American Wood Council, who notes that the U.S. Timber Innovation Act is a way to help jump-start a sagging wood-products industry. "Mills are running at much lower capacity," he said, "two shifts versus three or four—we want to put more mill jobs back in place."

However, some in the mass timber industry say that the Timber Innovation Act will be of limited **continued on page 19**

OPEN> STORE

COURTESY ADIDAS

adidas Originals
1532 N. Milwaukee Ave., Chicago

773-772-0043
Designer: adidas/Latitude

Wicker Park, Chicago, has become a mecca for brand flagships and one-off retail spaces. The latest to join the fray is adidas Originals, with a 5,000-square-foot flagship store selling all of adidas's classic footwear. Built in the former space of a now-relocated record store, adidas exposed the 100-plus-year-old building's normally hidden heavy timber bow-truss roof structure. As an homage to the store's surrounding neighborhood, the changing room is modeled after the L line's train cars, which rumble just feet outside the back of the building, and benches and signage are reminiscent of those found at each of the train's stations. A large "Community Wall" maps the neighborhood in etched metal and provides a place to announce local events, concerts, and upcoming store exclusives, as well as act as a display for locally focused books, magazines, and postcards. Throughout the space, adidas commissioned permanent and temporary artworks by local street artists, including POSE and TUBSZ. All together, the adidas Originals flagship has a palette that is all Chicago. **Matthew Messner**

OPEN> DINING HALL

LEONID FURMANSKY

Vassar College
124 Raymond Avenue
Poughkeepsie, New York

845-437-7400
Architect: Lewis.Tsurumaki.Lewis

Burly, thick cross-laminated timber islands make up a curving landscape of tables in the new All Campus Dining Center in the Students' Building at Vassar College. In a renovation of a renovation of a renovation of a 1913 McKim, Mead & White building, Lewis.Tsurumaki.Lewis (LTL Architects) redesigned the dining hall (previously a three-story auditorium and dance hall) by unifying 28,000 square feet into an open space with serveries distributed across the plan, elevated ceilings, and a new stair linking the two floors (located where the staircase was in the original building).

Made in a manufacturing process usually reserved for structural application, the CNC-cut typography tables answer the project's aim to foster social exchange among students. The scale and unusual curvilinear form of the tables activates the space for groups and solitary diners to share a collective surface. LTL worked closely with SmartLam to design and efficiently fabricate the components with custom CNC milling. All the parts were flat-packed, shipped, and assembled on-site. Effectively, the custom tables accommodate a seating count of around 800 and were less expensive than generic commercially available ones. **Gabrielle Golenda**

OPEN> AIRPORT

MATTHEW MILLMAN

Jackson Hole Airport
1250 East Airport Road
Jackson, Wyoming

307-733-5454
Architect: Gensler

What's old is new again at Jackson Hole Airport, where Gensler has transformed an aging airport complex into a glulam gateway for the Grand Teton and Yellowstone National Parks. The 16,000-square-foot complex was originally designed in 1950 as a single-terminal facility; uncoordinated expansions occurred over the ensuing decades, leaving a jumbled and inefficient layout.

Gensler sought to "tie in to regional history without going into cliché," according to Brent Mather, design director at the firm's Denver offices. Hybrid mass wood structural systems pay homage to the region's timber heritage while also supporting the airport's new large-span flat roof. Across the terminals and ticketing areas, large-span roof elements and steel truss connections create a "modern interpretation of western regional architecture." By integrating structural and finish materials into multifunctional elements, the designers subverted prototypical airport design and instead delivered a warm, inviting space. **AP**

EAVESDROP

Frisky Rick

During a recent talk in New York, Richard Rogers proffered a less than glowing review of Venturi, Scott Brown and Associates' Sainsbury Wing in the National Gallery. "I don't understand it, I never have," the architect mused. "Plus they picked someone from another country (which is not very English) to do a very national building. When I look at it, I don't understand where the links are between it and the National Gallery... You can't change it on either side, and you just wonder what you gain from it."

Strong Words

On Facebook, Minneapolis Ward 10 City Councilmember Lisa Bender recently posted images of a ridiculous protest against bike lanes being painted on streets. It was led by the former Ward 10 councilmember and one of her current opponents. Handmade and printed signs bore slogans such as "Cars First," "Suck It Lane," "Mafia Lane," and oddly "Nazi Lane." Her post prompted a long string of comments arguing the merits and apparent tax burden of bike lanes, but that generally remained civil. Bender pointed out in the comments that her original post was not meant to be specifically about bike lanes as much as the act of equating genocide with anything that is not genocide, in this case, city planning.

Paper Plans

After much commotion about the possibility of a wooden skyscraper in Manhattan, the developer behind the project, Sy Ghassemi, called everything off in February. Designed by SHoP Architects, 475 West 18th Street would have been the city's largest wood-frame structure at ten stories, supported by columns of mass timber. Engineers from Arup and environmental design consultants from Atelier Ten also participated in the design, which won a $1.5 million grant from the U.S. Department of Agriculture dubbed the U.S. Tall Wood Building Prize to research and develop the project further. Ghassemi said the plyscraper became unfeasible due to a recent downturn in the market—garnering the support of lenders proved too difficult—in spite of the design's originality.

Send blueprints and protest signs to eavesdrop@archpaper.com.

UNVEILED> TERRACE HOUSE

COURTESY PORTLIVING

Design Architect: Shigeru Ban Architects
Local Architect: Francl Architects
Developer: PortLiving
Structural Engineer: Read Jones Christoffersen
Timber Design Engineer: Création Holz
Timber Consultant: Equilibrium Consulting
Landscape Architects: Cornelia Oberlander and Enns Gauthier

Designs for a timber addition by Shigeru Ban were recently revealed for Arthur Erickson's 1978 Evergreen Building. The original structure features a staggered array of triangular concrete terraces planted with greenery (to which PLOT's Mountain Dwellings outside Copenhagen share an undeniable likeness).

Called the Terrace House, Ban's upward addition will extend into more all-timber terraces planted with lush vegetation, with a glass-clad rectangular tower with a triangle cut off its sloped peak, a nod to the concrete structure below. Landscape architect Cornelia Oberlander will collaborate with Ban, having participated in the design of the original Erickson building.

Ban's addition will reportedly make Terrace House the tallest hybrid timber structure in the world, supported by Vancouver-based developer PortLiving. **JR**

UNVEILED> 711 BROADWAY

COURTESY LAKEIFLATO ARCHITECTS

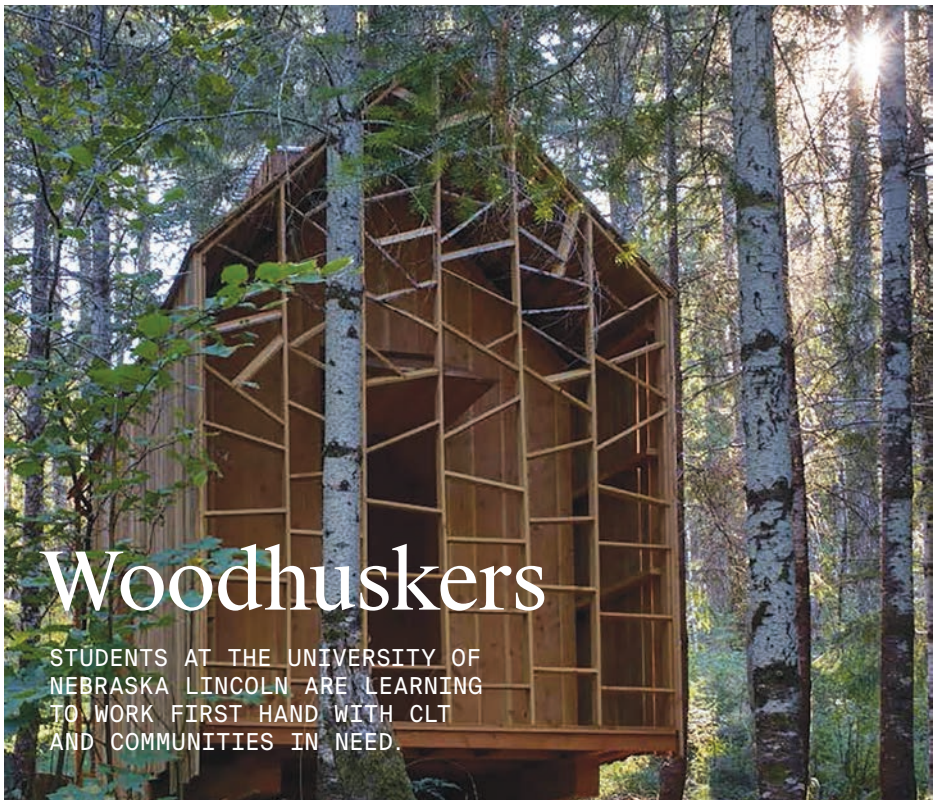
Owner: CBMB Properties
Design Architect: Lake|Flato Architects
Architect of Record: BOKA Powell
Contractor-Structural Engineer: StructureCraft
Landscape Architect: Hocker Design Group
Client-Developer: Hixon Properties and Cavender Brothers Management
Completion Date: 2018 (expected)

Lake|Flato Architects has designed a new mass timber office building set to take over the lower Broadway corridor of San Antonio, Texas, on the site of an old Cadillac dealership. The project proposal details a six-story structure with ground-floor retail space and subgrade parking.

The structural timber system (in lieu of concrete or steel) will be clad in glass, masonry, and metal panels—all of which are supported by an exposed wooden framework that spans the interconnected volumes and visually ties together the mixed-material palette. This is fully articulated by the north glass canopy that culminates with an exposed timber shed roof that dramatically slopes toward the street.

The entire lumber skeleton will be built in British Columbia by design-build firm StructureCraft in just two months and then assembled in place. As one of many projects under development in what has come to be known as "dealership row," it will occupy one of the area's eyesore parking lots that have been that empty for years. The revitalization of the River North district aims to improve walkability and reduce traffic along a three-mile stretch of Broadway a move that has spurred growth of comparable commercial spaces in the district.

Permitting the conceptual approval from the Historic Design Review Commission, the project is expected break ground in spring 2018. **GG**



JASON GRIFFITHS

Woodhuskers

STUDENTS AT THE UNIVERSITY OF NEBRASKA LINCOLN ARE LEARNING TO WORK FIRST HAND WITH CLT AND COMMUNITIES IN NEED.

As part of the University of Nebraska Lincoln summer design-build elective, students learn the ins and outs of "file to factory" production by designing and detailing a small cabin.

Mass timber may not be the first thing that comes to mind when one thinks of Nebraska, but that does not mean that the ever-growing field of advanced wood construction is not alive and well there. Not only are projects being built with cross-laminated timber (CLT), but the University of Nebraska Lincoln (UNL) is exploring exactly how to teach students how to work with the relatively new material. Led by Professor Jason Griffiths, PLAIN is a design-build collective of students specializing in working with CLT and nonprofit organizations throughout the Midwest.

Despite being based in a region specifically known for its lack of forests (the first white settlers built their homes out of clumps of sod), PLAIN has found success working closely with local and national governments to bring CLT technology to the Great Plains. With funding from the university and the U.S. Forest Service, Griffiths has been able to craft a curriculum which see students designing prefabricated mass timber structures, working closely with fabricators and directing on-site construction. For sourcing the wood, PLAIN has worked with townships struggling to control the spread of emerald ash borer beetles, which have begun to destroy ash tree populations across the Midwest.

"In some ways, we have a little space where we can try things, while also getting students up to speed on what it means to work with CLT as it becomes more popular in the Midwest." Jason Griffiths said. "One thing about working in the Midwest, there are many interesting contemporary vernacular forms. There is a relevance there, which links CLT to the northern Midwestern states and the Scandinavian use of heavy timber. They are very place-driven, pragmatic ideas that people just get here."

PLAIN has found clients in community organizations and local governments with multiple projects funded, under construction, and finished. These include a community orchard facility, a few small cabins, and a child resource center for the Santee Sioux Reservation. In each project, the work of the students ranges from the harvesting of the timber and specifying CLT manufacturing, through developing details and finishes for the projects. Notably, for the community orchard facility, students are harvesting wood blighted by emerald ash borers.

The Santee Sioux Reservation child services building will serve families affected by domestic violence. Working with the tribal council and a number of child and family services organizations students developed a design based on the delicate needs of the project, which would frequently be used for forensic investigations of child abuse victims. The sensitive nature of the program has added complexity to the project, while helping justify the use of wood for the construction.

"This is the trickiest of all of the projects, it involves some very intense issues," explained Griffiths. "What are trying to do, working with SmartLam and the community, is to deliver a very strong, solid, building. We're making a fully CLT interior and a brick exterior, which may end up being one of the first of its kind composites in the United States."

With the help of communities open to using the atypical materials and technology, Griffiths and the students at UNL are working toward a way of thinking and teaching mass timber which has yet to be codified. While the technological and professional sides of the material quickly move forward, gaining popularity, the pedagogy may now need to play catch up. Ironically, with a few semesters successfully complete, it may soon be the Great Plains where the field will be looking for the next generation of mass timber designers. **MM**

GRÅSMARK/WIKIMEDIA COMMONS

With their highly articulated arms and cutting heads, harvesters provide a safe and efficient means for a single person to do work that once took many.

A Growing Industry continued from front page in the 19th century. Over the past 150 years, the process and politics of wood have shaped a highly efficient industry that still provides the vast majority of the U.S.'s house-building material. With new technology, wood is pushing into new territories, and the lumber industry is bracing to respond to these demands.

The process of harvesting lumber has dramatically changed since the industry began to standardize and organize in the late 1800s. No longer will you find any teams of two-person saws felling ancient trees or a Paul Bunyan-esque worker swinging an axe. Most of the industry became highly mechanized in the 1970s with the invention of the harvester. Harvesters, invented in Scandinavia, are tree cutting, moving, and trimming vehicles that have drastically reduced the danger and time involved in lumber work. Crawling through the forest, harvesters reach out with an articulated arm, grab a tree by the base with its nimble claw, then cut, trim, and lift the bare log onto the back of a transport vehicle. This can all be done by one operator, and during the process the tree is measured and catalogued. This entire process has added efficiency and sustainability to an industry that carefully balances a fine line of production and conservation.

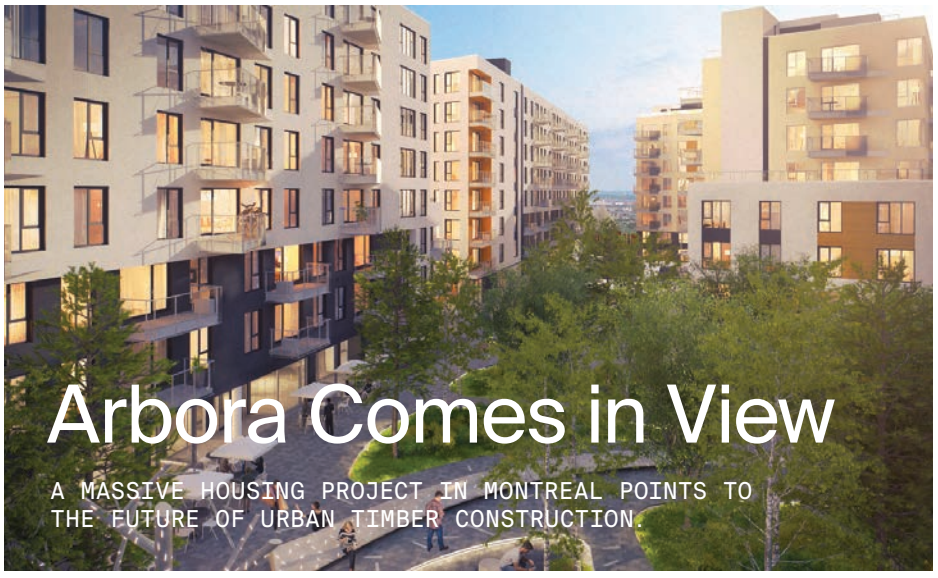
In North America and Europe, long gone are the days of clear-cutting forests and destroying an entire region's ecology. While clear-cutting "slash and burn" operations still happen in parts of South America and Africa, they are due to the expanding, unregulated livestock and agriculture industries, not the timber industry. The careful regulation and scientific study of the lumber industry in the United States and Canada have led to a net increase of 1 percent of forested land over the last 50 years. That means the forests of North America are stable, with a slight increase, even as roughly 45.5 billion board feet of lumber are harvested in the United States in a single year. This is thanks to precise tree selection, sometimes using satellite imagery and GPS, and aggressive tree-growing programs.

While much of the harvesting techniques have been streamlined, the politics behind harvesting have been anything but. Most notably, the Canada-U.S. softwood lumber dispute is considered one of the greatest points of trade tension between the two countries. The disagreement is directly linked to how and where lumber is coming from. In the United States, most lumber comes from the property of 11 million private U.S. landowners. In Canada, most land dedicated to lumber harvesting is owned by the government. In the interest of maintaining a healthy economy, Canadian provincial governments subsidize the industry, effectively keeping the price of lumber low and stable. This is in direct conflict with the private-market-driven prices U.S. companies charge. Over the past 40 years, a number of lawsuits and agreements have been filed and disputed between the two countries over Canada's subsidies and the movement of lumber over the border. While this dispute is currently at an uneasy truce, the potential of new wood technologies is promising to drive the demand for lumber to new heights.

Roughly 80 percent of all lumber harvested in the world is softwood. Despite its name, softwood, as opposed to hardwood, is not defined by its softness, but rather by the species of tree it comes from. Softwoods are generally conifers, such as pines, firs, and cedars, while hardwoods come from broad-leaved trees, such as oaks, maples, and hickories. Softwoods have long been used for light-frame construction, while hardwoods have been traditionally used for heavy timber construction, as well as fine woodworking due to its often-fine grain.

Although the lumber industry is confident it can handle an increase in demand, there are factors that will need to be addressed. As of yet, there are few standards for producing heavy timber, CLT in particular, and legal definitions are also lacking. The industry is developing so fast that local fire codes ("State of the Art of Timber?" front page) have not been established for the material. At the same time, architects, lumber producers, and manufacturers across North America are looking to Canada and Europe for a way forward (page 28), while innovating in their own right.

MM



COURTESY ARBORA

Arbora Comes in View

A MASSIVE HOUSING PROJECT IN MONTREAL POINTS TO THE FUTURE OF URBAN TIMBER CONSTRUCTION.

Arbora is a 600,00-square-foot complex that is at the leading edge of mass timber technology and market feasibility.

Comprising three eight-story buildings totaling just shy of 600,000 square feet, the Arbora Complex near downtown Montreal is one of the largest mass timber projects in the world.

The notability of this project is not just its size, but its ability to be a competitive, marketable, environmentally responsible alternative to increasingly affordable steel and concrete construction—an ability we might not associate with mass timber structures. The $130 million project offers 434 units, 130 of which are rental.

According to U.S. Market Development Manager Jean-Marc Dubois at Nordic, a Quebec-based company that, among other services, supplied wood for the project, "The market in Montreal is more suppressed than Vancouver and Toronto. To be able to build means you must have a design that is viable and efficient—something that brings value to the developer. There's a lot of press surrounding high-rise wood construction, but Arbora shows there's a place for affordable, viable mid-rise construction."

Arbora involves cross-laminated timber (CLT), composed of layers of dimensional lumber stacked perpendicularly and glued together to create structural panels. CLT panels are typically made of layers of three, five, or seven, and, because they offer two-way span capabilities, can be used for floors, walls, and roofs. The result is a material that is lightweight, strong (up to seven times the strength of concrete), efficiently shipped, and less labor-intensive than its steel and concrete counterparts.

"With mass timber structures, you can use less employees and get more work done," said Dubois. "There's a shortage of skilled labor across North America, so the fact that you can raise structures with considerably less skilled employees is very critical. Typically we operate with as few as four to six tradespeople on a jobsite. The output per person is much greater."

These benefits come with a cost, however: increased upfront coordination and design time. Engineered wood components are designed, optimized, cut to millimeter precision, and then shipped to site for assembly. Dubois reports that Nordic is involved on multiple fronts of mass timber projects like Arbora, coordinating design, engineering, fabrication, construction sequencing, and regulatory parameters. "This is one of the things that distinguishes Nordic," he said. "There's a tremendous amount of involvement and engagement with our team that you don't necessarily see as you're looking at the construction process. We're taking an active role in the design process, in addition to sitting in meetings with local authorities."

The key to Arbora's commercial success in a competitive housing market is design efficiency, and an acknowledgement of the inherent structural properties of CLT from the outset of a project."There are efficiency gains in replication," Dubois said. The project was organized around a 20-foot grid, an ideal structural span and shipping dimension for the beams and panels. The consistency of the grid allowed an efficient manufacturing process, and abbreviated on-site assembly time.

Early adopters of CLT in North America have tended to be more-custom projects like schools and sports venues, but Dubois sees demand for mass timber shifting into commercial real estate, namely office workplace typologies, where the unique look of a wood structure can offer differentiation in the marketplace.

Mass timber adoption in the United States has lagged behind that in Canadian markets. Dubois attributes this to a number of factors including the litigious nature of the United States, and the tendency of Canadian authorities to be receptive to performance-based design. "In Quebec, we don't promote one building material over another, so we have to make a market against steel and concrete, which is exceedingly inexpensive," he said. "We have to be economically viable and prove we are meeting the same structural and safety requirements that other systems must abide by.

"Performance-based design typically runs into more red tape in the United States," he continued. "I think it's a fear of the unknown. This has led the American Wood Council, the U.S. Department of Agriculture, and the wood industry to promote the tall wood agenda, to try and get coded options so that it is prescriptive as opposed to alternative means and methods."

John Stoughton

COURTESY NEHRI

A two-story prototype is tested on the world's largest shake table at the University of California San Diego.

The State of the Art of Timber **continued from front page** depends on the incorporation of research-driven CLT standards into building codes.

"If you're going to just do a two-story residential home, you have a perfect design code pathway to do it," said Shiling Pei of the Colorado School of Mines, chief investigator on a National Science Foundation (NSF)-supported study of seismic design methods. "But if you want to go taller, especially [if] you want to go above 85 feet—that is currently IBC [International Building Code] for Type IV, heavy timber—then you have to do something else...a lot of testing to try to convince the local building-code officials." He views CLT beyond about 20 stories skeptically, on economic grounds: "In my projects, I say it's tall wood; it's not high-rise wood."

Pei cites the 2011 CLT Handbook by Canadian nonprofit FPInnovations as a pivotal document, republished in a 2013 U.S. edition with input from the American Wood Council (AWC), Forest Products Laboratory, WoodWorks, and APA: The Engineered Wood Association (formerly the American Plywood Association). In 2011, APA and the American National Standards Institute developed a performance-based standard, PRG 320, updating it in 2012 and 2017; it offers detailed specifications on CLT products' composition, dimensions, shear strength, stiffness, and other properties. The AWC's National Design Specifications for Wood Construction and the IBC include basic CLT sections in their 2015 editions.

Since seismic risks in Europe (Italy excepted) are milder, the transfer of CLT technology to Canada and the U.S., particularly for larger scales and open plans, requires standards addressing lateral forces. The next hurdle is for the American Society of Civil Engineers' influential code book, *ASCE 7: Minimum Design Loads for Buildings and Other Structures* to address CLT, particularly its response-modification coefficient or R factor (not to be confused with R values for thermal resistance) in its seismic design provisions. "To make [CLT] economically competitive," van de Lindt said, "it really needs to have these seismic performance coefficients (essentially an R factor) in the code, so that people don't have to get special permission every time they want to use it," incurring engineers' reviewing costs. Results of van de Lindt's R-factor studies are expected next year, and the code-revision cycle takes about five years; if a proposal based on the findings passes review by Building Seismic Safety Council committees and a public-comment period, it should enter the 2022 edition of ASCE 7, then IBC.

"With CLT, everything rotates like a rigid body under seismic stresses," van de Lindt said. "Panels do not deform enough to dissipate energy and suck load right into them.... For a steel special moment frame that's detailed for seismic, it can be an R of 8, [which has] a lot of ductility." Yet adding concrete or steel lateral systems, as in Brock Commons (Acton Ostry Architects, Vancouver, page 12) and Carbon12 (PATH Architecture, Portland), respectively, requires multiple trades on-site and squanders CLT's construction speed. Advanced "disruptive technologies" common in Japan (base or inter-story isolation using sliders, rockers, or damping devices) require special review. Very tall wood, 20 stories and above, he believes, calls for performance-based modeling rather than prescriptive tables and "will always require review, at least in our lifetime."

Andre Barbosa of Oregon State University's School of Civil and Construction Engineering and Tallwood Design Institute concurred, noting that CLT projects above about ten stories are often hybrids with concrete cores or steel for lateral resistance. "You get the best out of both materials. You have the CLT that's lighter; [its] strength-to-weight ratio is very, very good. You get the concrete that allows you to go to longer spans, but also it creates that natural barrier for smoke and essentially for fire across floors." Current methods of addressing timber's susceptibility to moisture and insects are generally adequate, he says, adding that long-term deflection (creep) in CLT buildings tall enough for large loads needs further study.

Supported by the NSF's Natural Hazards Engineering Research Infrastructure Tall Wood program, Pei and colleagues recently built a two-story prototype for testing on the world's largest shake table at the University of California San Diego. Simulating 14 quakes of varying severity up through a "maximum credible earthquake," a once in 2,500-years event, "the building essentially received no damage, and we don't need to repair anything," Pei reported, noting that CLT rocking walls actually outperformed their concrete and steel counterparts in resilience. His next studies will test a ten-story building under **continued on page 15**

Architect: Rossetti
Structural Engineer: WSP Parsons Brinckerhoff
Photograph: Rafael Gamo

Top Seed

Arthur Ashe Stadium at **USTA's Billie Jean King National Tennis Center** is one of sport's most beloved venues. But its roofless design meant rain often stopped play. To keep tournaments on schedule, the stadium's original designers, architect **Rossetti** and engineer **WSP Parsons Brinckerhoff**, proposed the tennis world's largest long-span retractable roof. With a 7-minute opening time and a design that keeps sightlines unobstructed, the new lightweight fabric and steel canopy is favored to win over athletes and fans alike. Read more about it in **Metals in Construction** online.

Zeroing In continued from front page

The scheme will literally embody what its professors will be teaching—achieving triple net-zero performance by consuming zero net energy, and producing zero waste and zero net greenhouse gas emissions.

"Beyond the field of architecture we need to be working with scientists," said Studio Ma principal Christiana Moss. Much of the technology for the building was, in fact, developed by ASU scientists.

The green elements inside and out are many. A light-rail station will run right up to the edge of the structure, offsetting carbon usage, while wetlands and bioswales along the periphery will absorb and clean runoff. Not only will the complex's cross-laminated timber (CLT) frame sequester carbon much more effectively than steel, ASU developed carbon-collection panels that will trap carbon dioxide, which can then be employed to enrich the soil. Sun shades will keep the interiors cool; and rooftop solar photovoltaics will help power the building.

"This represents a closing of the energy loop," said Moss. "We're collecting as much as we use. The building, in a way, becomes living."

Inside the massive daylit atrium, the biome's thick diversity of plants will purify waste air, while its wetlands landscape will recycle rainwater, which will be stored in tanks under the biome. An adjacent water-treatment portion of the complex will also treat and recycle sewage (perhaps for the entire campus) for use as gray water using low-energy, bio-based systems. The final phase of that treatment will be moving the water through a hydroponic reactor inside the atrium. The interior will also be a centerpiece for farming, with grassy areas and even a canal entering the heart of the building.

"These things have been done," said Moss. "But they haven't been done at this scale, in the same place."

The project's delivery date is fall 2020. ASU recently issued an RFP, and another architect (still to be selected) will be brought in to oversee the design. But whatever happens, "the function needs to drive the form; and it will require a much broader team of researchers to pull off," said Moss.

"There's a whole field of research that needs to be opened up to what this is proposing," Moss added. "This is the beginning of a whole future I see for architecture. This is where we all need to go." **Sam Lubell**

COURTESY STUDIO MA

Top: Arizona State University's Interdisciplinary Science & Technology Building. **Right:** The building is intended to be as green as possible, and it features a mass timber structure that frames a massive atrium.

Tonal Paper Terrazzo. One of 32 new designs.

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Fir & Above

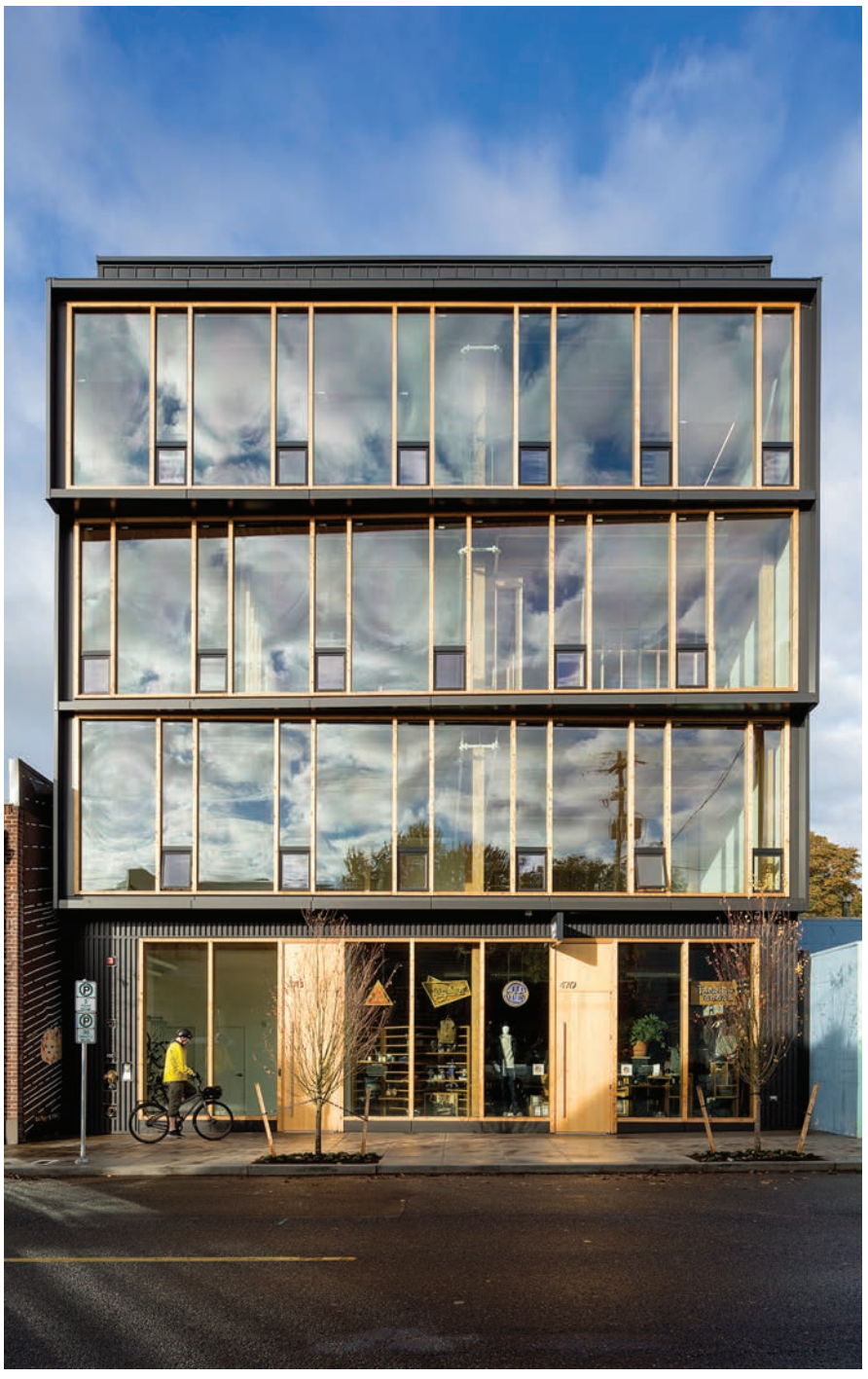
LEVER ARCHITECTURE CRAFTS AN OFFICE BUILDING OUT OF TIMBER IN NORTH PORTLAND.

In Portland, Oregon, even the buildings are bespoke and locally sourced. At least, that's the case with LEVER Architecture's Albina Yard project, where the developer, Portland-based Reworks, tasked the architects with creating a marquee structure that could be used as a testing site and showroom for emerging mass timber systems built from locally sourced lumber.

The 16,000-square-foot speculative office building is a love letter to mass timber construction, proudly utilizing prefabricated elements as finishing materials and leaving raw Douglas fir cross-laminated timber (CLT) panels and glulam beams rough and unadorned.

The speculative nature of the four-story office building forced the designers to be "very, very deliberate about architectural moves," said Thomas Robinson, founding principal at LEVER Architecture. The mind-set resulted in a rather straightforward approach: A centrally located plywood shear wall–wrapped elevator core anchors the rectangular office block along one of its long sides, leaving open spans elsewhere. The core contains bathrooms, a lift, egress stairs, and an accent stair made entirely of CLT panels. The building's U-shaped open plan features large-span offices topped by glulam beams with columns spaced farther apart than would be allowed under less rigid structural systems. Both of the short ends of the building are studded with windows. The principal facade contains ground-floor retail that hugs the street, while the back face overlooks a modest courtyard containing a small shipping container that houses a separate office.

The building's 8 ¾-inch-by-12-inch structural glulam columns are spaced 15 feet apart and support 18-to-24-inch deep girders that are laid out 10 feet on-center. At the start of the project, LEVER studied mass timber and conventional tongue-and-groove decking strategies in tandem and found that CLT's superior spanning capabilities would ultimately require fewer costly overhead beams, saving time and money on finishes and structure alike. The building's timber elements were digitally fabricated off-site to tolerances approaching ⅛ of an inch, just enough to account for the small amount of swelling that can occur in building elements during open-air construction in Portland's soggy climate. Custom-fabricated, powder-coated steel connections hold the wood assemblies together, their engineered bolts embedded deep within the mass of each glulam beam. "We wanted to find a way to embed steel in the wood to protect it from fire," Robinson explained in reference to the buried bolts. He added, "The powder coat finish prevents the connections from rusting and staining the wood as well." Like the structural members, the connections were digitally fabricated to order for the project and designed to "drift" in either direction by as much as 2 percent in the event of an earthquake, providing just enough dexterity for the building to sway but not shatter.



JEREMY BITTERMANN

The crisp structural connections and exposed fire-suppression and HVAC systems lend the structure the type of elemental clarity usually reserved for utilitarian warehouse spaces, right on brand for the creative office–seeking clientele. The building's main facade is clad in a custom window assembly made up of large floor-to-ceiling spans of plate glass interrupted by narrower expanses containing operable windows. "We were excited to express wood on the exterior of the building," Robinson said, highlighting the rot-resistant Port Orford cedar wood mullions and window frames along the gradually cantilevering facade. The window wall is an indication, Robinson said, of the building's innovative structural system. The face of the building steps out little by little as it climbs, with the second and third floors together projecting four feet out and the fourth floor above cantilevering just a few more feet over the street. The depth of these cantilevers is directly related to the spanning capabilities of the three-ply CLT panels used to structure the building.

Ultimately, the project—now fully leased—seems to pull off its intended showroom purpose, showcasing glulam beams that were machined in Portland and CLT panels manufactured in southern Oregon, with everything made from Oregon-harvested lumber. **AP**

Resources

General Contractor and Developer
Reworks
reworksinc.com

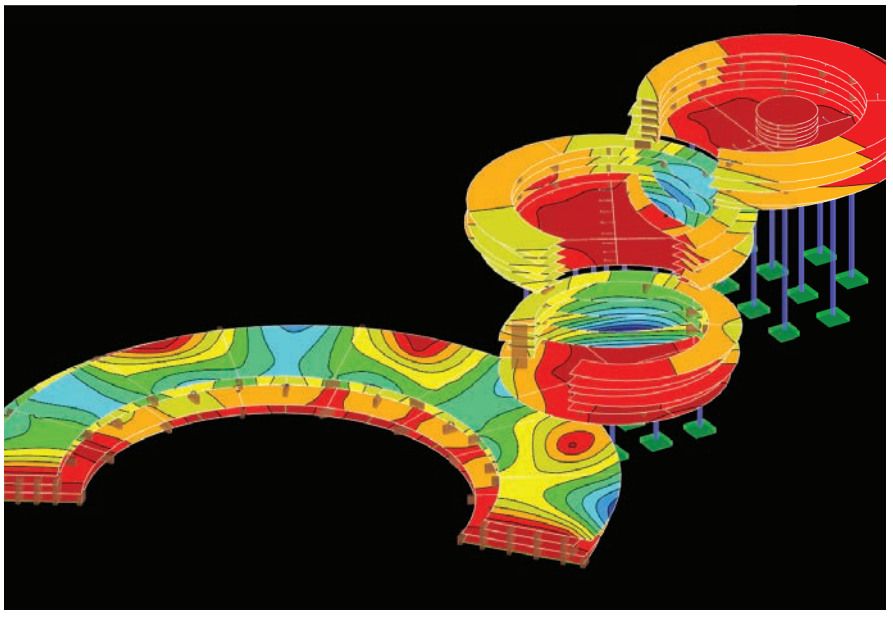
Structural Engineer
KPFF Consulting Engineers
kpff.com

CLT Supplier
D.R. Johnson Lumber Company
drjlumber.com

CNC Routing
Cut My Timber
cutmytimber.com

Cover image (front page, top left): A detail of the custom connection. **Top:** Facade modulation on LEVER Architecture's Albina Yard project is a direct result of the structural capabilities of the building's CLT construction. **Bottom:** The building's mass timber construction was left exposed for people to enjoy.

IN DETAIL



COURTESY IKD

With few precedents to follow, the hardwood CLT Conversation Plinth in Columbus, Indiana, needed to be engineered from the ground up using the latest digital stress models.

Hard Lessons

BOSTON-BASED IKD HAS DEDICATED MUCH OF ITS ENERGY TO USING HARDWOOD IN CROSS-LAMINATED TIMBER.

Thanks to a two-year, $250,000 Wood Innovations Grant from the United States Forest Service, and with further support from the National Hardwood Lumber Association, Indiana Hardwood Lumberman's Association, and the Indiana Department of Natural Resources, IKD is currently working on an advancement that may completely change the cross-laminated timber (CLT) market. Currently, CLT is made primarily of softwoods, which have the advantage of being fast-growing and inexpensive. IKD believes the future of CLT should also include hardwood, and now it just might.

As a proof of concept, IKD has constructed a large installation, which stands as the first hardwood CLT structure in the United States. The project was built with an experimental CLT material made from low-value hardwood sawn logs for Exhibit Columbus, the new architectural exhibition in the modernist mecca of Columbus, Indiana. A reference to the conversation pit in the Eero Saarinen–designed Miller House, the IKD's Conversation Plinth is a multilevel occupiable installation in the plaza in front of the I.M. Pei–designed Cleo Rogers Memorial Library.

The motivations behind using hardwood are two-fold. Currently, over 50 percent of the 80 million cubic feet of hardwood harvested in Indiana each year is used for low-value industrial products. By integrating this wood into the higher-value CLT, it raises the value of what is already Indiana's largest cash crop. And from the perspective of designers and engineers, hardwood CLT provides the possibility of a more fire-resistant panel and a form-factor advantage.

"We are currently exploring a number of applications that could have larger-scale building applications," IKD partner Yugon Kim said. "Since hardwood has superior mechanical properties, we believe we can achieve a panel that could be thinner to meet the same structural capacity of an equivalent softwood CLT panel."

The Conversation Plinth is not simply an exhibition piece for IKD. It is a test of the hardwood CLT the firm developed with SmartLam, the first CLT manufacturer in the United States. Over the months, the project will be subjected to the varied and sometimes-extreme weather of south-central Indiana, providing firsthand data that IKD and SmartLam can use to advance their research on the material. From the beating sun of late summer through the sleet, snow, and ice of winter, the project will be monitored for durability as well as aesthetic and structural changes.

"We are closely observing the mix-species panels and seeing how they react in the extreme temperature and moisture fluctuations so that we can continue to refine the species mix within the panel, the adhesion process, and the finish application and approach," Kim explained. "It is really interesting to see how differently hardwood moves from softwood when the moisture content varies, and we are looking deeper at the fiber structures and unique characters of species themselves as well to create a superior CLT panel."

The project continues much of the timber research IKD has been doing, including its design for the Timber City at the National Building Museum in Washington, D.C., and work on timber modular waste units, a timber version of CMU made from timber waste that has won numerous awards. **MM**

Resources

Project Lead and Designer
IKD
i-k-design.com

CLT Fabrication
SmartLam
smartlam.com

Timber Engineering
Bensonwood
bensonwood.com

Phase One Hardwood Testing Material Supplier
Pike Lumber Company
pikelumber.com

Phase Two Conversation Plinth Hardwood Material Supplier
Koetter Woodworking
koetterwoodworking.com

General Contractor
Taylor Brothers Construction Co.
tbcci.com

Softwood Material Supplier And Fabricator
Sauter Timber
sautertimber.com

The State of the Art of Timber continued from page 11 combined seismic stress and fire; the experiment has earned the inevitable nickname "shake and bake."

Flammability is "a concern very often expressed, but an easy one to dismiss," said Lech Muszynski, associate professor of wood science and engineering at Oregon State University's College of Forestry. Studies support the counterintuitive idea that charring produces an insulating layer that actually slows pyrolysis, making it advance predictably and sparing enough wood to pass two-hour fire-resistance tests. "I've done some testing on unprotected CLT assemblies here in the states, large-scale floor and wall assemblies; there is a large library of similar tests being done in Europe in the past," Muszynski reported, crediting Ario Ceccotti of the Istituto per la Valorizzazione del Legno e delle Specie Arboree (Trees and Timber Institute) for similar research in Italy and Japan. These tests have largely involved exposed CLT, though in practice the material is commonly encapsulated in gypsum board, adding another hour or so to its fire-resistance rating. Two commercial CLT manufacturers in the U.S., Muszynski noted, Oregon's D.R. Johnson (which he advises) and Montana's SmartLam, have their products fire-certified.

Steel components within joints, Muszynski added, are more vulnerable than the wood. He uses a photo from the 1906 San Francisco fire to illustrate "the difference between flammable and fire-safe": A severely burnt wooden beam shows charring and exposed nails, indicating deep fire penetration, but remains rigid, while two heat-weakened steel beams flop across the wooden member, resembling soggy pasta. Adhesives also require attention: Some bonded timber products use melamine urea-formaldehyde resins, which harden under heat, but the more common adhesive is polyurethane, which softens if the char reaches bond lines. Moisture can be more hazardous when worksite protections are lacking: Muszynski recalls an Italian project where financial delays left a site idle for several months, exposing CLT to rain—and underscoring the importance of using contractors familiar with the material. **Bill Millard**

What Goes Around

CHICAGO'S DUSABLE MUSEUM OF AFRICAN AMERICAN HISTORY CONVERTS ONE OF DANIEL BURNHAM'S MOST UTILITARIAN BUILDINGS INTO A POWERFUL EXHIBITION SPACE.

COURTESY EXPO CHICAGO

Unable to convert the Roundhouse into whitewall gallery space, DuSable opted to leave the interior in its original timber and iron form.

Situated just one block west of the architecturally rich University of Chicago, the DuSable Museum of African American History is undertaking a major preservation effort. Located directly across from the Daniel Burnham–designed DuSable, the Roundhouse, a former horse stable also designed by Burnham, has laid vacant for over 40 years. Yet over the past decade, the DuSable Museum has worked to convert the heavy timber and stone structure into additional exhibition space.

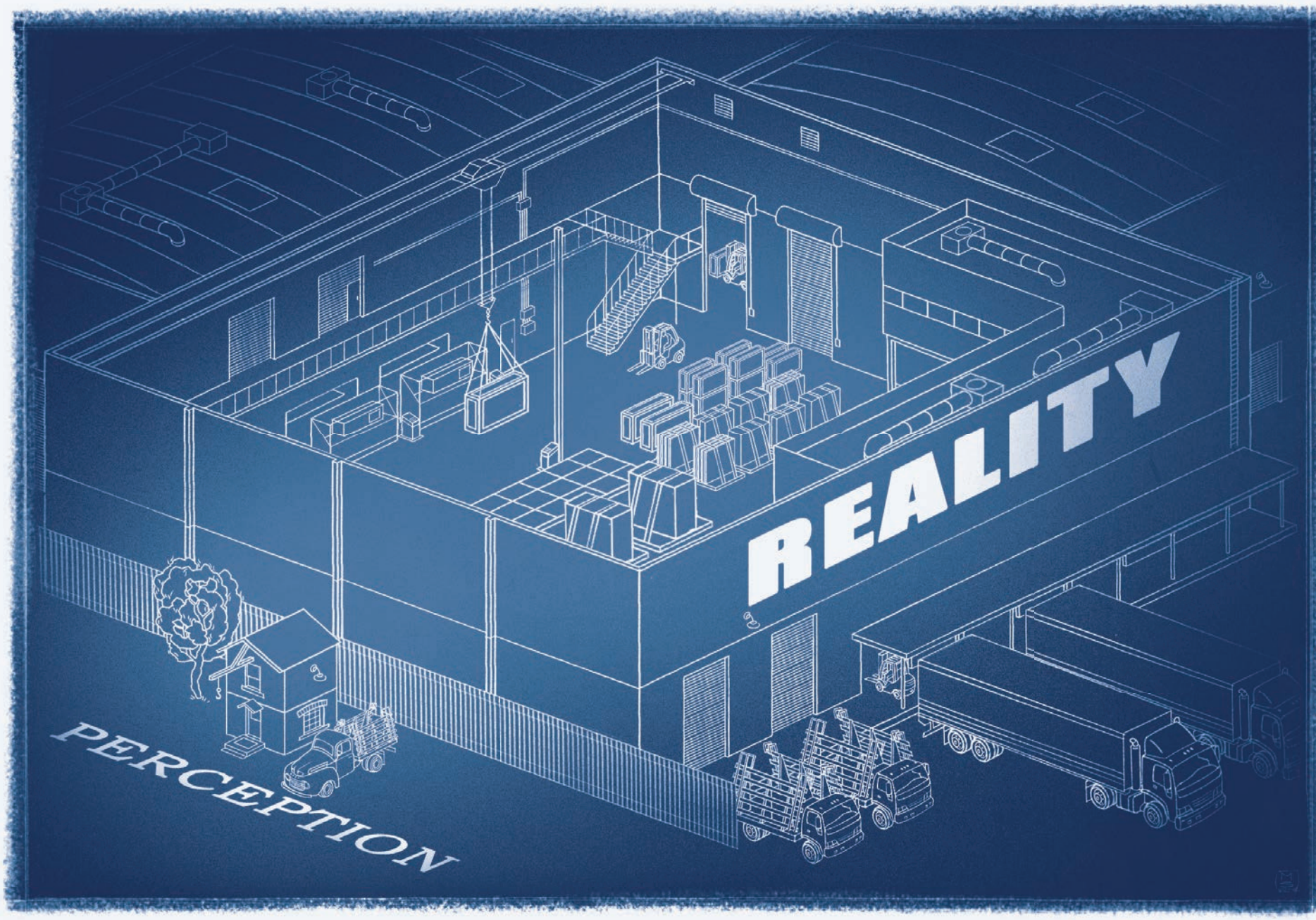
The DuSable Museum began working on converting the Roundhouse in the mid-2000s only to have the project stall thanks to the economic recession in 2008. By 2009, a renovation of the building's exterior was complete, but the interior was left far from the museum-quality space the DuSable was hoping to achieve. To bring the 61,000-square-foot space up to museum standards, it would cost upward of $35 million. Unable to raise those funds, the project has taken a new direction, which will see scaled-back goals completed in the coming years.

Starting with a $582,000 outdoor space, the Roundhouse is now able to host events and exhibitions for the first time. Designed by Chicago-based Site Design Group, the outdoor area is the first step in connecting the Roundhouse to the museum's main building with a pedestrian-friendly landscape. At the same time, the interior of the building has been cleaned, and has already hosted its first major art event. Though the original plan to convert the interior into white-wall galleries has been put on hold, crowds happily flocked to catch a glimpse of one of Burnham's most utilitarian projects.

Much to the joy of architects and preservationists alike, the soaring heavy timber dome has survived in excellent condition. The web of large pine timbers is supported by the limestone walls and cast-iron columns, which all look as though they were recently constructed. At 150 feet across, the space is a welcome addition to Chicago's catalogue of impressive civic interiors.

The Roundhouse was the site of this year's edition of EXPO CHICAGO, which hosted large-scale installations curated by Paris's Palais de Tokyo. Coinciding with the opening of the Chicago Architecture Biennial, the Singing Stones exhibition commissioned Chicago- and Paris-based artists to create massive works. The height of the space allowed for tall hanging pieces, while the round walls intensified another work, which utilized ambient sound. Yet another installation addressed the few windows, a clerestory near the dome's pinnacle, with colored films, filling the room with rainbow light during the day.

While the Roundhouse may never reach the level of museum refinement and environmental control previously planned, it will continue to be updated and made ready for more exhibitions and events. It is currently scheduled to be complete by the time the Barack Obama Presidential Center opens on the other end of the University of Chicago's campus in 2021. The DuSable has already begun conversations with the center to ensure exhibitions in both institutions are complementary. Until that time, architects can only hope the museum will occasionally open as it has for EXPO, letting the world in to see just how architectural a horse stable can be. **MM**



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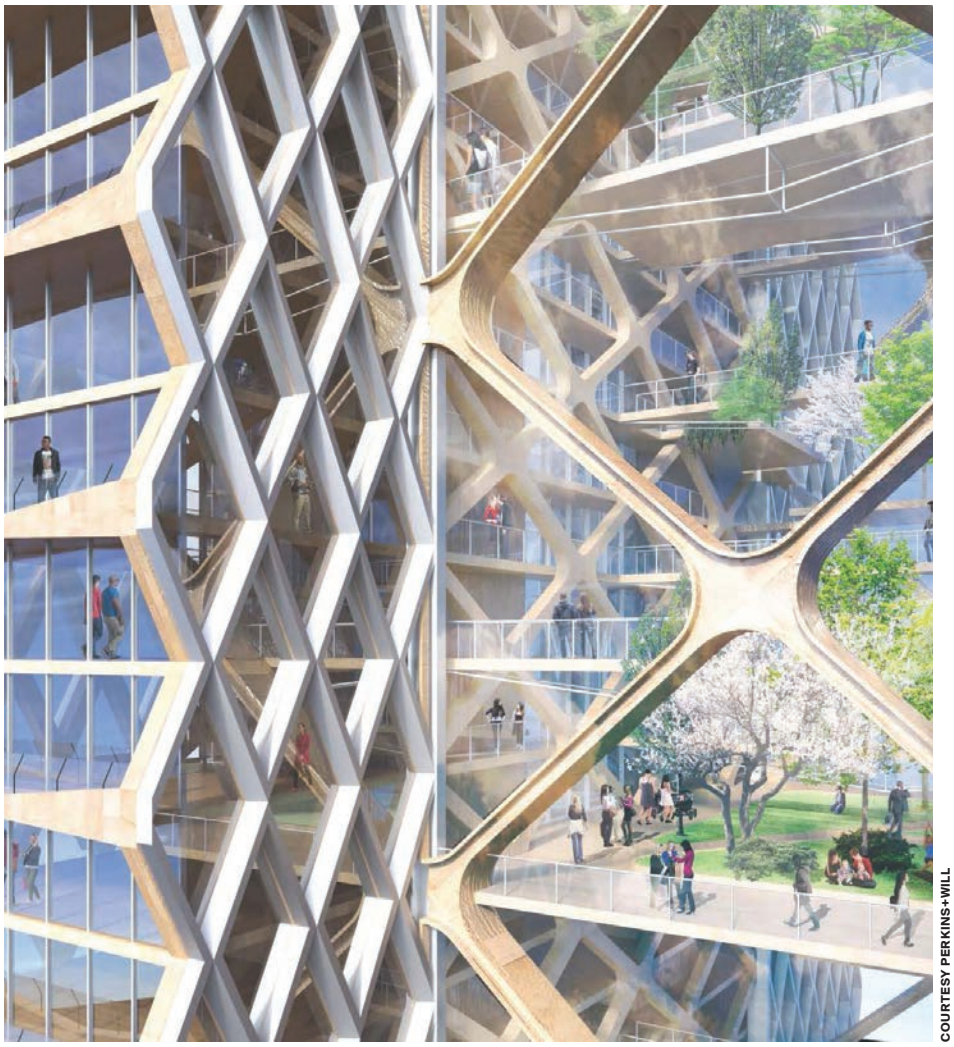


COURTESY PERKINS+WILL

The proposed Perkins+Will–designed River Beech Tower, if built, would be the tallest wood structure at 80 stories. Currently in a conceptual phase, the design calls for the use of easily available commercial wood products.

Up for the Count

AN INTERVIEWS THE COUNCIL ON TALL BUILDINGS AND URBAN HABITAT ABOUT ITS 2017 AUDIT OF WOOD TOWERS AROUND THE WORLD.

AN Midwest Editor Matthew Messner spoke with Daniel Safarik, editor for the Council on Tall Buildings and Urban Habitat (CTBUH), about its "Tall Timber: A Global Audit." The audit documented proposed, under-construction, and built tall buildings that use mass timber as their primary structural materials.

***The Architect's Newspaper*: What Prompted the CTBUH to conduct an audit of timber projects around the world?**

Daniel Safarik: We track all kinds of tall building construction routinely for the Skyscraper Center database and for our Global News feed on our website. The first well-publicized tall timber building was Stadthaus in London, which was completed in 2009. We noticed what seemed like a spike in announcements of tall timber buildings being proposed and constructed about four years ago [2013], and everything that has happened since has reaffirmed this impression. When we saw the buy-in from the U.S. government represented by the U.S. Tall Wood Building Competition, in October 2014, that confirmed the impression that this really had momentum behind it, so we committed to tracking the two resultant projects through to completion. Unfortunately, the New York project was canceled due to market feasibility concerns, but the Portland project is now under construction (page 14). So the momentum began to build from that point, and we formed a Tall Timber working group in late 2014. The group started working on a design manual in mid-2015, and that effort has now gotten a turbo boost with the audit and the upcoming workshop at our 2017 conference, which is bringing together a lot of the key participants.

Were there any surprises once the information was gathered?

The most striking thing was the diversity of construction methods that are being used to create these buildings, which are specific to local jurisdiction and the nature of the timber supply in each region. Of course, herein lies the difficulty of generalizing about what's going on in tall timber worldwide, as well as coming to a consensus about classification and best practices—that is our challenge.

What are some of the interesting discussions happening around mass timber?

It's encouraging to see the range of proposals, from both a stylistic and construction standpoint. The primary discussions revolve around fire safety and code, sustainability, and the feasibility of modifying fabrication techniques from mass production of stick-built single-family and platform-framed low-rise buildings to something that is workable for high-rise.

What do you think the next steps are for mass timber to become a common building method?

The foremost obstacle is local fire codes. Most fire codes prohibit wood structures from rising above five or six stories. Many codes stipulate that a building of this height must also have a concrete base, particularly if there are commercial uses on the ground floor, such as restaurants, or if there is vehicle parking, to give one to three hours of fire protection that would allow safe exiting before structural collapse. This is predicated on the assumption that wood high-rises would use platform construction, with dimensional lumber such as two by fours, beams, and joists, similar to those currently permitted.

The key to mass timber's viability as a structural material for tall buildings lies in its name. Massive wood walls and structural beams and columns comprised of engineered panels have demonstrated fire performance equal to concrete and, in some cases, superior to steel. Wood unquestionably burns, so there would be smoke issues, as with any fire, which would require proper sprinklering, pressurization, and other tactics used in tall buildings today. But mass timber has to burn through many layers before it is structurally compromised—basically it "chars" long before it collapses. As more jurisdictions come to appreciate the aesthetic, economic, and environmental advantages of tall timber, fire codes are expected to change.

The second-biggest obstacle is a lack of standardization of construction materials, methods, and definitions. There are many forms of mass timber, and a wide degree of variance in approach when it comes to supporting tall timber structures. Thus, there is a range of techniques, from assemblages of highly similar panels for both floors and walls, to complex column/beam/outrigger combinations, such as are found in high-rises of steel and concrete. There are numerous proprietary systems, and the connections between elements also vary widely—often it is the location and orientation of the steel connectors between wood elements that can make all the difference in how long a structure can withstand fire or seismic action, and thus determine its feasibility under local code.

Are there any proposals, speculative or real, that you are particularly excited about?

I like the one we published in the CTBUH Journal for Chicago: the River Beech Tower. It would be great to see that go up in our home city.

Carbon, Copied **continued from page 5** forestry practices are already underway, with harvest occurring on long rotations so that the forest has time to regenerate itself and care can be taken to avoid removing other plants, roots, and branches in the process.

Lastly, "Wood can be a durable good, as we've seen in ancient wooden buildings like the Temple at Nara, Japan [originally built in 745 AD and rebuilt in 1709]," McDonough said. "In [wood's] history, it is often put into a cycle of use and reuse that can take it from large numbers to smaller and smaller [components]." Its ability to withstand centuries and to be disassembled and then reassembled into other buildings and furnishings keeps it out of the landfill and in a perpetual cycle of use until it can ultimately be returned to the environment in some form.

Although well over 90 percent of one-to-three-story residential buildings are already wood-built, there are only a handful of midrise and tall timber buildings across the United States, a result of building codes that often prohibit timber-built structures larger than four to six stories. However, thanks in part to innovative wood products, including CLT, nail laminated timber (NLT), and glue laminated timber (glulam), wood construction can be used in buildings as tall as 40 stories. A study by consulting and engineering company Poyry and the New England Forestry Foundation shows that the greatest potential for timber-built is in midrise (six to 14 story) buildings, as it also tends to be more economical to build with timber at that scale. According to the Softwood Lumber Board, over two-thirds of the square footage in the midrise sector could be made with mass timber. These statistics combined, in addition to the taller structures that mass timber can create, have the potential to make a sizable dent in our CO_2 and fossil fuel emissions.

Like virtually everything in architecture, though, it is all in the details; for timber to be sustainable it has to be done correctly, from responsible forestry practices to environmentally safe glues and binders to craftsmanship and the design itself. "It is tremendously exciting. Building with wood creates diverse opportunities—there are different species and materials that all can work," Fernholz said. "However, it is important to recognize that some things can come from wood, but nothing replaces good design and planning."

Olivia Martin

What Wood You Do? **continued from page 5** utility until building codes are changed to allow for the use of CLT. "The code issue is more critical than the Timber Innovation Act," Jean-Marc Dubois, director of business development for the Montreal-based Nordic Structures, said. He believes that New York City's restrictive building codes have helped stall progress on tall timber, pointing to the wooden skyscraper designed by SHoP architects (page 7) that was killed earlier this year as an example.

Even though the 2015 International Building Code (IBC), which New York City has not adopted, allows for the use of CLT, Dubois said that building departments throughout the country haven't updated their codes to allow for the use of CLT. Having the SHoP project, which received a lot of publicity, fail to get built was a major setback for the industry, according to Dubois. "New York City had the ability to be a real-world leader with timber innovation," he said. "It was disappointing."

A $250,000 grant from the U.S. Forest Service's Wood Innovations Grant program helped Yugon Kim of Boston-based IKD develop what he believes is the first hardwood CLT structure in the U.S.: An outdoor sculpture in Columbus, Indiana, which consists of a series of ascending arcing forms (page 15).

Congress is not the only place in Washington where the merits of tall mass timber are being explored. Steve Marshall, assistant director at the U.S. Forest Service, has been working with the International Code Council to develop standards for the use of CLT. In addition, the U.S. Department of Defense has been conducting blast tests with CLT to determine whether it is an appropriate material to use on its bases.

Marshall said there are other potential sources for government support for CLT projects aside from direct funding from the Timber Innovation Act. In the third week of October, his agency will be releasing a new round of grants of up to $250,000 under its Wood Innovations Grants program. Next year, the Forest Service is planning on making $8 million available under the same program, and applications will be due by mid-January.

One of the most notable examples of how government funding can play a difference is with LEVER Architecture's innovative design of the 12-story (148-foot-tall) Framework building (page 5) under construction in Portland, Oregon, which will be the first wood high-rise in the U.S. A $1.5 million U.S. Tall Building Award sponsored by the U.S. Department of Agriculture helped fund the seismic and fire-safety tests that enabled it to pass muster with Portland building department officials.

Thomas Robinson, principal of LEVER Architecture said that the concrete and steel industries shouldn't be worried about losing market share because in the future most tall timber structures will be hybrids that include concrete and steel as well as wood. "We need to look at each material for its appropriate purpose," he said.

Alex Ulam

STUDIO VISIT

MICHAEL GREEN ARCHITECTURE

Réinventer Paris/Baobab Tower

COURTESY MICHAEL GREEN ARCHITECTURE

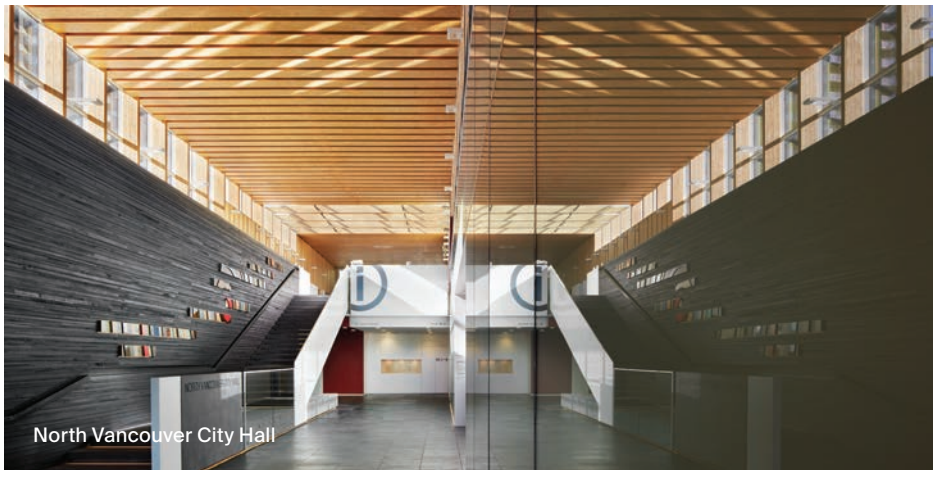
A wood-centered practice reengages with natural materials.

Michael Green Architecture (MGA) is a leader in the design of mass timber structures. The firm, jointly based in Portland, Oregon, and British Columbia, Canada, has been a pioneer in mass timber construction since the early days of glulam. Now, as mass timber technologies proliferate and gain wider acceptance, MGA is poised to make the next great leap in mass timber construction: full-fledged mass timber automation and prefabrication.

"All of our projects are made from wood," Michael Green explained over telephone, before adding that 95 percent of the firm's work is specifically built using mass timber. The approach is due mostly to preference, as Green is a trained millworker who began his career decades ago working for renowned architect César Pelli designing "big buildings in steel and concrete around the world." Those whirlwind experiences left the architect starved for ways to reengage with natural materials and craft, so after returning to his native Canada, Green opened his own wood-focused office.

Throughout the early mass timber era, the architect was among the first to consider its widespread use and architectural potential. Today, the office focuses on utilizing mass timber elements in a variety of building types—for example, when tight urban conditions call for compact and efficient structures. The firm also works with institutional clients seeking long-term facilities and "100-year" buildings, which mass timber can easily provide. Green sees working in mass timber as "an opportunity to insert a lot of passion" into building projects that work as explorations in industrial design and are planned with a keen understanding of how they will be put together.

This industrialized construction process suits Green, who explained that construction remains the last "major industry left on Earth that is still craft-oriented," meaning that every building is built essentially as a one-off, custom prototype with none of the cost-saving benefits of industrialized factory production. That's where mass timber comes in—building components are produced to order in controlled factory settings, where weather, temperature, and other variables are tightly relegated. The firm is currently working with technology start up Katerra, which is looking to utilize the potentials of mass timber to automate and integrate the construction process nationwide. **AP**


North Vancouver City Hall


North Vancouver City Hall


Wood Innovation and Design Centre

CLOCKWISE FROM THE TOP LEFT: MARTIN TESSLER; EMA PETER; COURTESY MICHAEL GREEN ARCHITECTURE; MARTIN TESSLER


Empire State of Wood

Wood Innovation and Design Centre

MGA recently completed work on the Wood Innovation and Design Centre in Prince George, British Columbia. At the time of its completion, the nearly 97-foot-tall, six-story structure was the tallest all-timber structure in the world. The lower three floors of the project contain facilities for students pursuing wood-focused engineering degrees while the upper floors house governmental and wood industry–related office spaces. The building is clad in an elaborate system of louvered wood shutters that are optimized by exposure to mitigate solar glare. Aside from the structure's mechanical penthouse, there is no concrete used in the building. Instead, the "dry" structure integrates CLT floor panels, glulam columns and beams, and mass timber walls into a complex design that conceals electrical and plumbing services within its relatively thin floor panels.

North Vancouver City Hall

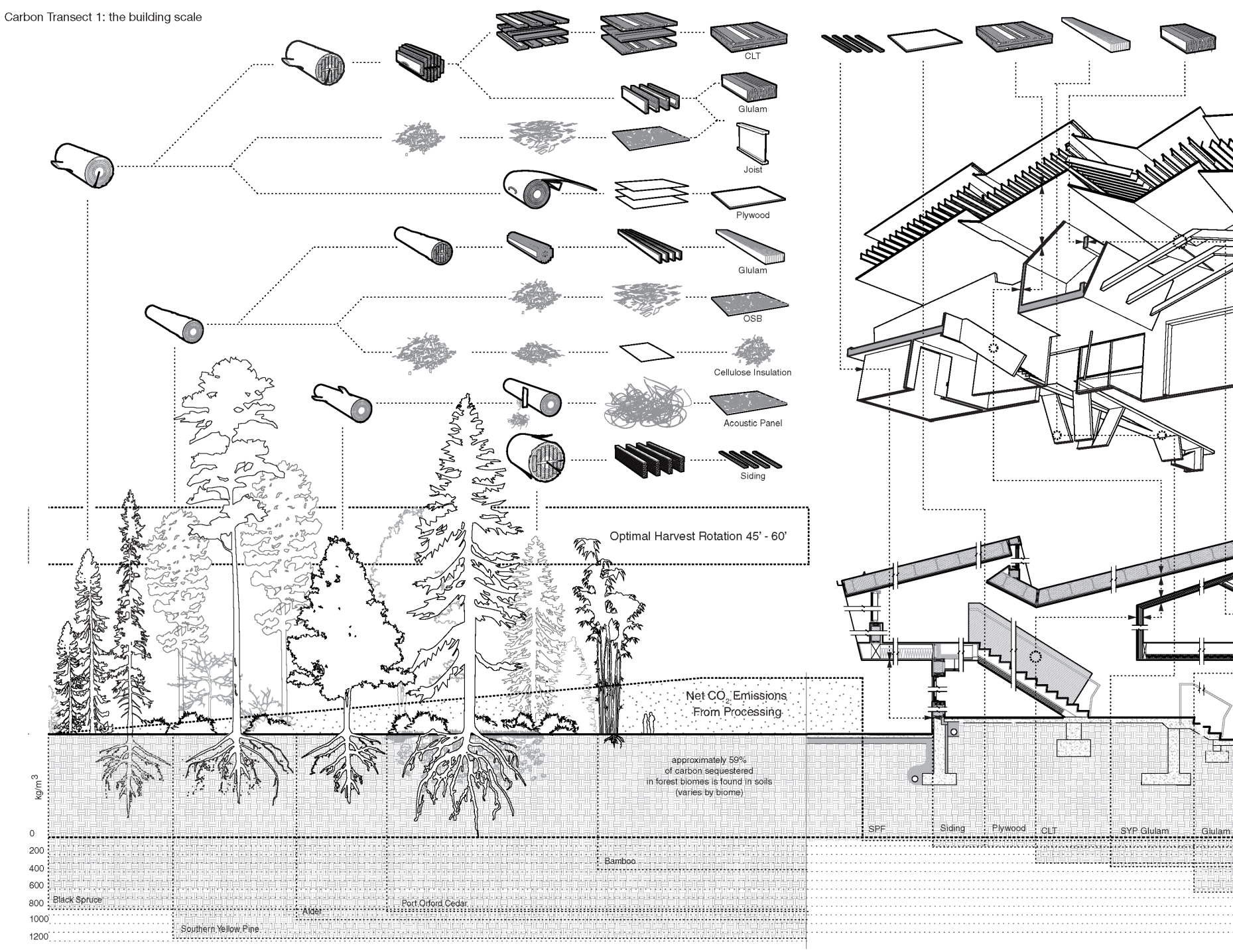
The renovation and expansion of a municipal City Hall structure in North Vancouver, British Columbia, is one of the firm's earliest mass timber projects. The 36,000-square-foot renovation bridges a repurposed 1970s-era structure and an existing library building with a new double-height mass timber and glass atrium. The 220-foot-long space is topped with CLT roof joists propped up on large CLT columns. Where the atrium meets the existing offices, clerestory windows provide views between public and business areas. The exterior of the long and narrow addition is clad in charred wood—a material that also wraps the exterior surfaces of other building elements—creating a new and dramatic exterior courtyard.

Empire State of Wood

As part of MGA's early mass wood experiments, the firm worked with Finnish wood and paper group Metsä Wood on their speculative wood initiative. For the project, the firm was tasked with redesigning an iconic steel structure using mass timber elements. Naturally, MGA chose to envision the Empire State building as a mass timber tower, replacing steel girders and beams with glulam structures joined by metal plates. With slight modifications to the existing tower's structural design, MGA was able to pull off a mass timber replica that matched the Empire State Building's height inch for inch.

Réinventer Paris/ Baobab Tower

The firm's Réinventer Paris project proposes a large-scale, 35-story mass timber tower complex that would span over Paris's Peripherique highway belt. The innovative and speculative proposal attempts to explore a new model for high-density housing that encompasses a variety of functional uses—market-rate and social housing, a student-oriented hotel, and a bus depot—dispersed throughout a series of high- and midrise timber structures. The timber towers feature CLT columns that frame indoor-outdoor verandas, with lower buildings clad in wood louver assemblies.



Services and Systems Boundaries

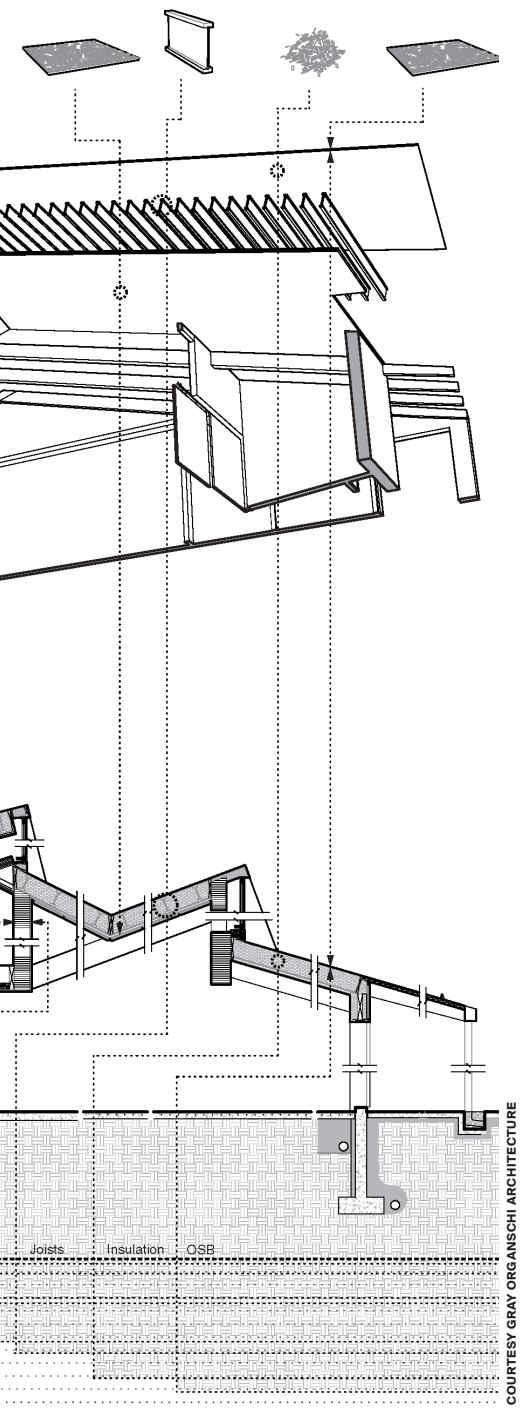
The topic this week in my practice class is "Scope of Services," where we examine the architect's relationship to the client's work, to wit: What, exactly, does she have to do to deliver the project? The idea of "Basic Services" is central to explaining traditional practice, in that it's the way we routinize our efforts through standard stages of effort (schematic design, design development, and so forth), structure decision-making, and, almost as important, create a basis for protecting our limited fees and invoicing the client.

The idea of basic services or even "phases of design" has been under pressure for some time, mostly under the delaminating influence of technology. Long gone are the hand-drawn, single-line diagrams that once comprised the end product of schematics, just as transferring design intent to a builder may include BIM data or digital geometry in addition to traditional two-dimensional construction documents. The fluidity of digital data, and the purported insight that accompanies it, has blurred and expanded the system boundaries of services themselves.

Nowhere is this more apparent than in the latest thinking about the use of mass timber as a fundamental building material for cities, work pioneered by my faculty colleague Alan Organschi of Gray Organschi Architecture. Alan argues persuasively that there is an opportunity to rethink the systems of carbon, energy, material production, design, and construction by the thoughtful and systematic use of engineered lumber—a renewable resource—in urban construction, where the forest is not just another source of raw material but also a place to store carbon. His thinking is not unlike Kiel Moe's at Harvard, who posits that buildings aren't independent objects that merely coexist with the systems that produce and sustain them, but rather are integral parts of those systems. Architects should ignore the resulting system boundaries created by constructs like, for example, the idea that our work be something called "Basic Services."

Both Organschi and Moe believe that architects must change the scale of their influence beyond the materialization of form by understanding, incorporating, and (dare I say it) controlling the flows of capital, energy, materials, and production. We need to replace our understanding of the supply chain with an overt ability to create and optimize it. This idea is immediately appealing, harkening back to the original assertions of modernism and its putative benefits for production and society, but equally daunting and intractable. This is precisely why Organschi's claims about mass timber are so important: They represent a clear "through-line" from the means of making to the creation of form that is at the heart of the architect's design proposition.

Architects have always been part of a systems-design problem, and today's digital tools that allow the representation, analysis, and optimization of systems fit perfectly into these new responsibilities. The digitization of design has blurred the traditional boundaries of our "systems of service," but there are new opportunities emerging as design is informed by new technologies like systems engineering, big data analysis, and optimization, machine learning, and integrated network design. These tools will wend their way into innovative practices like Organschi's, necessary to increase the architect's un-



COURTESY GRAY ORGANSCHI ARCHITECTURE

on Ground High School

An image from the forthcoming book *Wood Urbanism: From the Molecular to the Territorial* (Actar, 2018). A diagram explaining the systems and processes that go into wood products and the Common Ground High School by Gray Organschi Architecture.

derstanding of and span of control over the supply chain.

Organschi's work thus challenges the entire idea of "Basic Services" as it currently drives practice—calling into question the roles of technology, research, professional certification, even the compensation to the architect for taking on such responsibilities. A "net zero" building means nothing if the systems that delivered it generate huge amounts of unaccounted carbon. We'll need to reconsider and remediate all the systems boundaries of design—our internal protocols and processes and our relationship to the supply chain—to have true influence on the implications of our buildings. The efforts around mass timber described in this issue are some of the best thinking on this front so far. **Phil Bernstein**

String Tied, This Year's Holiday Gift Guide

We asked our editors, architects, and fellow design aficionados what they are putting at the top of their wish lists this year. The result is a compilation of rarities, outrageous objects, curiosities, and other items that you would want but would never buy for yourself.

CHEESE GRATER FORMA
Zaha Hadid for Alessi

Zaha Hadid Architects designed a cheese grater that follows the same aesthetic of her most iconic works: organic shapes derived from natural forms. Composed of a sculptural black base that holds a punctured, mirror-polished stainless-steel grater, the ergonomic shape is designed to fit comfortably in the palm of the user's hand.

alessi.com | $80

FRANK TRAY
Good Thing

Purveyor of all things mundane and manufacturer of everyday objects, Good Thing made something that is especially banal into something quite useful and amusing. Using an industrial metal-forming technique to shape siding into a hotdog wrapper–like detail, this handsome catchall is a useful tool for storing a sausage, as well as loose change, keys, makeup, etc.

supergoodthing.com | $24

1ST FLOOR BLUE MUG
Adam Nathaniel Furman
Sir John Soane's Museum Shop

London-based designer Adam Nathaniel Furman designed this ceramic mug elevated on vaulted arches, fusing contemporary design with historic architectural motifs: "Elevated above the common detritus of your breakfast table, this dining item elegantly maintains the dignified sanctity of your morning brew."

soane.org | $32

ZEILMAKER CHAIR
Gerrit Thomas Rietveld
MoMA Store

This subdued dark-green iteration of Rietveld's iconic 1918 Red and Blue Chair features the same architectural lines inspired by the philosophy of "well-being and comfort of the spirit." Later versions of the chair incorporate various colors depending on the client—in this case, a green, black, and white motif was created for a schoolteacher.

store.moma.org | $4,215

JULIET VESSELS
Anna Karlin

Made of borosilicate glass, these tabletop vessels reference science lab beakers but are finished with hand-turned solid brass stoppers for a new and unfamiliar feel. Each stopper is unique to the different glass shapes.

annakarlin.com | $110

A PIECE OF KAHN - TRAVERTINE CUFF AND EARRINGS
Pico Design for the Yale Center for British Art

Inspired by the architecture of Louis Kahn, these pieces are part of the Moth/Butterfly Collection, a collaboration between Yale Center for British Art (YCBA) and Pico Design. Geometric in form, the sterling-silver jewelry has brushed and oxidized finishes that envelop a travertine cuboid recovered from the recent renovation of the Kahn-designed YCBA.

picomeanslittle.com | cuff $250, earrings $125

GUATEMALA THROW
CoopDPS for ZigZagZurich

This brightly patterned woolen Nordic blanket is the work of Nathalie Du Pasquier and George Sowden—the founding members of the Memphis Group. Part of the Post Crisis Collection, referencing the aftermath of the 2008 financial crash, the blanket features geometries mingling with abstract organics in a wash of the iconic duo's famously bright, bold primaries.

zigzagzurich.com | $203

OD-11
Teenage Engineering

This rectangular volume houses a wireless multi-room loudspeaker that plays your music from any device. The new OD-11 is a carefully re-engineered version of the original OD-11 ortho-directional loudspeaker, made in 1974 by the Swedish sound genius Stig Carlsson. It can be paired with the ortho remote, which allows for wireless control.

teenage.engineering | $999

ALVAR AALTO SERVING PLATTERS
The Glass House Design Store

These serving platters integrate the undulating lines of the iconic glass Alvar Aalto vase into wood. Fashioned in birch with an oak veneer, the material palette pays tribute to the designer's love of the Finnish landscape.

designstore.theglasshouse.org | $60

SPIRIT LEVEL CUFFS
The Cufflink Store

These cuff links capture a real "working spirit" with a design that incorporates a leveling tool. The cuff fastener is outfitted with a real bridged center vial that will level up any shirt.

thecufflinkstore.co.uk | $21

CLICK-CLOCK
Ayako Aratani

Sculpted in porcelain, these wall-hanging timepieces were formed with biomorphic, rounded edges that visually denote the time of day by the spine-like hour markers. Effectively, they gently hint at the time of day and dissolve any time-related anxiety.

ayakodesignstudio.com | small $75, medium $95

HALF TIMBERED T-SHIRT
Sam Jacob Studio

Sam Jacob Studio devised this T-shirt with an edge-to-edge silk-screened Pugin-esque black and white motif. Like "architecture for your body," the graphic pattern is a tribute to the op art effect of buildings like the Elizabethan manor Little Moreton Hall, and is also a twist on the artifice of mock-Tudor suburban buildings.

samjacobstudio.com | $40

ARC DE TRIOMPHE
LEGO

Create a four-inch-tall model of Paris's iconic landmark with 382 LEGO bricks. Once built, the iconic reproduction features statue-adorned pillars, sculptural reliefs, and stone-like coloring.

shop.lego.com | $40

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How can the United States timber industry get a head start by looking to successful projects and leading university researchers in Europe and Canada?

C.F. Møller's Hagastaden apartment building in Stockholm was designed in collaboration with Dinelljohansson; it is part of a Swedish research project on tall timber.

COURTESY C.F. MØLLER

Mass Timber Scales Up. Nail-Laminated Timber (NLT). Glue-Laminated Timber (Glulam). Dowel-Laminated Timber (DLT). Carbon Sequestration. Lower Embodied Energy. Sustainable Forestry. Market-Driven Innovation. Hardwood versus Softwood. Lumber Mills. Supply Chains. Mid-Rise. High-Density. Urban Housing. Psychological Benefits of Wood Interiors. Quieter Construction Sites. Seismic Testing. Fire Safety. University of British Columbia Campus. Alvar Aalto University. Federal Institute of Technology of Lausanne. Norwegian Institute of Wood Technology. Technical University of Munich.

LEARNING FROM EUROPE (AND CANADA)

By Antonio Pacheco

DANIEL SHEARING

Waugh Thistleton Architects utilized cross-laminated timber construction for their Dalston Lane project in order to lighten the overall weight of the complex, allowing the architects to build taller while also increasing the number of units in the development.

The United States-Europe-Canada Axis

What can American architects learn from Canadian and European practical experiments in mass timber?

If the steady stream of newly announced mass wood projects is any indication, mass timber building technologies are poised to take the American construction and design industries by storm over the next few years. As products like cross-laminated timber (CLT), nail-laminated timber (NLT), glue-laminated timber (glulam), and dowel-laminated timber (DLT) begin to make their way into widespread use, designers, engineers, and builders alike are searching for the best—and sometimes, most extreme—applications for mass timber technologies. But rather than reinvent the wheel, American designers can look to experienced mass timber designers in Europe and Canada for key lessons as they begin to test the limits of these materials in the United States.

European and Canadian architects and researchers have long been at the forefront of mass timber design, starting with early experiments in the 1970s. By the 1990s, researchers like Julius K. Natterer at the Federal Institute of Technology in Lausanne, Switzerland, were developing initial CLT prototypes. Natterer's work has been buttressed by that of many others, including research performed at the Norwegian Institute of Wood Technology under Thomas Orskaug and experiments conducted at the Technical University of Munich under Stefan Winter.

Studying Wood

European university research institutes are leading the way in normalizing mass wood construction.

Today's tall mass timber race owes a hefty debt to decades' worth of European experimentation that established mass timber technologies as low-carbon, high-impact building materials. Rather than focusing on building the largest timber structures, many ongoing research efforts are centered on the nuts-and-bolts aspects of mass timber design, such as developing material longevity, studying building demolition and deconstruction, and improving and standardizing fire and safety code acceptance of timber structures. Experiments around the continent abound, but much of the impactful research is taking place at a handful of universities and research institutions. On the following pages, *AN* takes a look at some of the top programs.

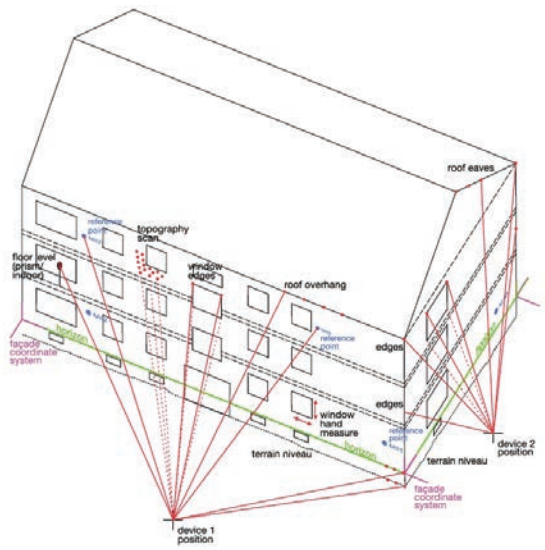
Alvar Aalto University

The Department of Architecture at Alvar Aalto University in Helsinki, Finland, offers a one-year intensive wood-focused study program that explores the ecological, technical, and architectural properties of wood and mass timber technologies.

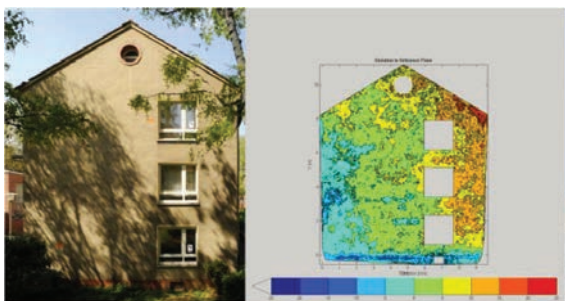
The Wood Program, currently led by professor Pekka Heikkinen, is responsible for an annual design-build studio that has consistently pushed architectural boundaries surrounding the application of wood construction methods. The studio has been running for 20 years, an effort that recently resulted in a retrospective exhibition at the Museum of Finnish Architecture.

The Wood Program has been around long enough to have produced ongoing and complete research projects, including the E2ReBuild project, a European Union–backed initiative aimed at retrofitting residential buildings for a low-carbon future. The project utilizes EU funding to promote and implement cost-effective, energy-efficient retrofitting strategies at the industry level for existing multifamily structures.

The program has also birthed TES Energy Facade, a facade modernization project that utilizes mass timber infill panels as a cost-effective approach to retrofitting outdated building facades for existing structures.



Timber manufacturer Gumpp & Maier utilized tachymetry-based surveying systems to gather data on existing conditions for a detailed 3-D model.



COURTESY E2REBUILD

Research efforts utilized thermal imaging to help find specific areas along building facade that needed extra attention.

COURTESY ACTON OSTRY ARCHITECTS/UNIVERSITY OF BRITISH COLUMBIA

With their 18-story Brock Commons project, Acton Ostry Architects supplemented the mass timber walls, columns, and floors with a concrete core in order to allow for a taller, more rigid structure.

One key lesson European timber projects teach is that when it comes to structural systems, weight matters. On average, mass timber assemblies weigh between one-third and one-fifth as much as concrete structures, despite equivalent structural capacities. As a result, mass timber buildings are much lighter than concrete ones, a positive for building in tricky urban situations, for example—where underground rail yards, subway tunnels, and municipal utilities place limits on how heavy and tall buildings can be.

London-based Waugh Thistleton Architects (WTA), for example, recently completed work on Dalston Lane, a 121-unit CLT midrise complex located above a tunnel serving the Eurostar train line in the city's Hackney neighborhood.

For the project, the architects worked with timber-engineering specialists Ramboll to develop a stepped tower cluster rising between five and ten stories tall. CLT panels are used for the external, party, and core walls of the building, as well as the stairs and the building's floors. The variegated massing is due directly to the architect's use of CLT construction, which resulted in a lighter building that allowed the designers to build taller without more extensive foundations. The resulting building, with its staggered massing, better maximizes daylight infiltration into apartment units. The added height allowed the architects to add 50 more units to the project than originally permitted, a testament to just how light CLT can be.

Andrew Waugh of WTA said, "Timber buildings are just simpler, cheaper, and nicer [than concrete ones]. High-density urban housing should be built using mass timber."

Lighter mass timber buildings also perform better in seismic zones. Since the lighter buildings carry less inertia, the potential for catastrophic swaying goes down. The strategy was applied this year with the Brock Commons tower, an 18-story, 400-bed college dormitory designed by Vancouver-based Acton Ostry Architects for the University of British Columbia Point Grey campus. The tower is made up of a hybrid structural system that includes CLT floor slabs, glulam columns, steel connectors, and dual concrete cores. The concrete cores anchor the light mass wood structure in place, helping to counteract seismic and wind-generated forces. The 173-foot-tall structure is currently considered the tallest mass timber building in the world, and the construction is particularly multifaceted, utilizing a specifically fabri-

COURTESY C.F. MØLLER

A new 23-story housing tower by C.F. Møller features seven levels of mass timber construction and a roof terrace. The mass timber floors sit above 15 levels of traditional concrete construction.

cated set of interdependent building materials and finishes to meet structural and fire-safety regulations.

The Brock Commons tower's hybrid structural system brings to light another valuable lesson: that above certain heights—ten to twelve stories—the lightness of mass timber construction becomes a liability with regard to wind loads. The lack of physical mass at the highest parts of a prototypical timber tower results in increased deflection from wind loads. Ola Jonsson, partner architect at Swedish architecture firm C.F. Møller, recommended architects "go back to thinking about construction when designing mass timber structures," as a way of rethinking approaches to dealing with difficult-to-manage structural conditions. He added, "It's so early [in the adoption of mass timber technologies] that few really know how to do it well." The architect said that with certain tall timber tower projects the office is working on, designers had to develop new massing strategies to limit wind loads. Jonsson continued, "Many engineers lack experience in mass timber, so architects have to become central figures in construction and design during this early phase of adoption."

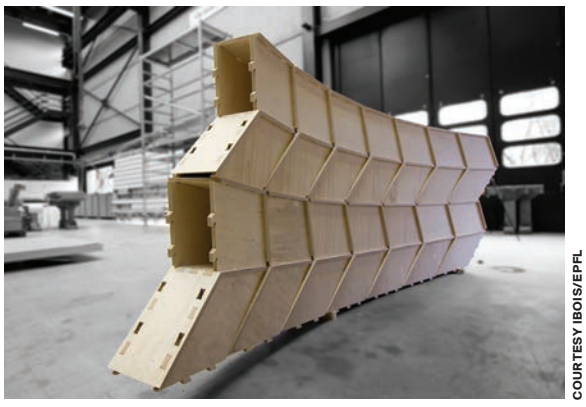
Federal Institute of Technology of Lausanne

IBOIS, a laboratory for timber construction housed in the School of Architecture, Civil, and Environmental Engineering at the Federal Institute of Technology of Lausanne in Switzerland, has pursued wood-focused research under the directorship of professor Yves Weinand since 2004. Weinand's study focuses on developing new technological approaches to mass timber construction from an architectural and engineering perspective.

Ongoing projects include developing "wood welding" technologies, experimenting with artificially densified wood materials, and exploring novel uses for panelized mass timber systems. The laboratory has also partnered with ETH Zurich on digital fabrication and construction initiatives.

Yves Weinand 's work at the IBOIS lab focuses on finding new uses for mass timber, including experiments with long-span structures.

A recent IBOIS pavilion sought to create a continuous, long-span volume utilizing differently sized mass timber arches.



COURTESY IBOIS/EPFL

The pavilion's spanning arches are built from piecemeal CLT elements that snap together.

Norwegian Institute of Wood Technology

The Norwegian Institute of Wood Technology (NIWT) is the official research and design center for the Norwegian sawmill and timber industry. The institute researches new wood applications and materials, provides various types of lumber certification, and performs inspections of timber structures. Importantly, the institute, run by Thomas Orskaug, certifies European-produced wood products according to the standards of the Japanese Ministry of Agriculture, Forestry, and Fisheries for sale in Japan, a major market for the European wood industry.

NIWT publishes research and industry reports widely, including the journal *Wood Technology Information*, a biannual publication that reports on wood-construction innovation.

COURTESY TRETEKNISK

NIWT promotes mass timber industry research and provides certification for mass timber products and assemblies.

The firm is currently developing over ten mass timber projects, an emerging body of work that came out of earlier mass timber competition entries developed by C.F. Møller that took the world by storm. C.F. Møller recently entered into a partnership with HSB Stockholm—Sweden's largest housing association—to design a series of new mass timber housing towers, including the 34-story Västerbroplan tower designed with concrete cores and wraparound terraces. The tower's columns and beams will consist of a blend of CLT and solid timber. The building's terraces will come with integrated exterior curtains and will be fully enclosed by a steel superstructure containing glass panels. The tip of the building is designed to dematerialize as it steps back along two facades, creating a series of exposed terraces and planted areas. Like Brock Commons, Västerbroplan tower features a hybrid structural system that is "resource-effective," according to Jonsson, meaning both lightweight and rigid.

The firm is also at work on a 20-story bundled housing tower called Hagastaden for HSB Stockholm, this one designed as part of a new quarter of the city that will contain mixed uses and generous pedestrian areas. The tower features varied floor heights designed to accommodate divergent uses like student flats, penthouse apartments, and typical family-occupied units.

Aside from the firm's multiple mass timber projects, C.F. Møller is working as part of an interdisciplinary research team that is developing new strategies around mass timber towers rising 20 stories or more. The group—backed by SP Technical Research Institute of Sweden, Växjö Municipality, and Linnaeus University, among others—will investigate mass timber construction from a fire-safety, life cycle, and construction technology perspective.

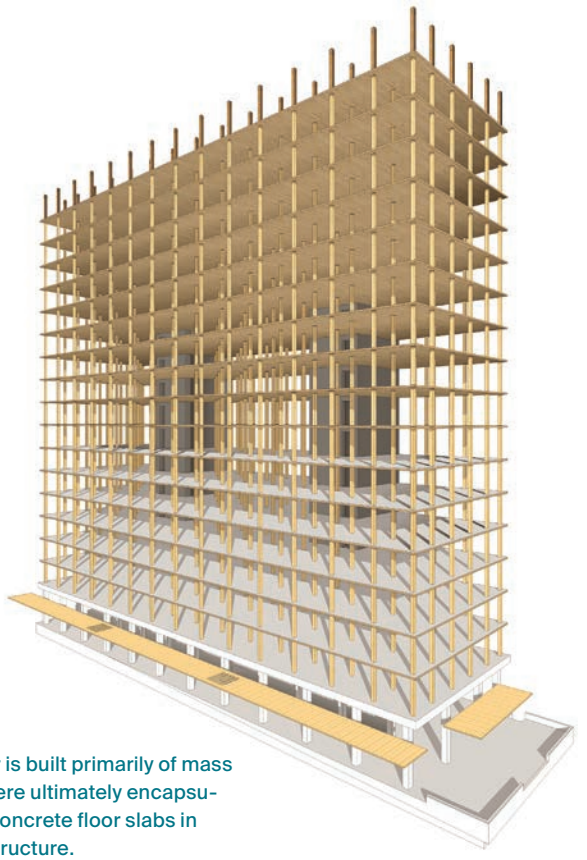
Regarding the research project, Jonsson explained, "Massive wood constructions give urban planners, architects, and designers great possibilities to develop innovative and sustainable architecture," adding, "but a broader knowledge and more practical experience in the industry is needed."

Another paradigm-shifting impact mass timber construction has had on European building methods relates directly to the construction process.

Because mass timber elements are factory-produced to order, the relationship between engineer, builder, and architect is extremely integrated. Cory Scrivner, mass timber specialist with Canadian mass timber manufacturer Structurlam, said, "For us, it's all about the 3-D model. [Digital modeling and coordination] are all done before we go into production in the factory: Everything has already been approved by the architect, engineer, and our team." Scrivner explained further that the intense coordination was necessary, as "we are designing a building made from components that are accurate within one to two millimeters of the digital model."

The designers behind Brock Commons utilized Structurlam as the mass timber manufacturer for the project. The advanced level of project coordination and off-site fabrication meant that project was finished roughly four months ahead of schedule, with a time-lapse video on a project website showing construction crews erecting upward of two floors per day. The first story for the project was built from cast-in-place concrete, while the remaining 17 stories are built in mass wood. The structural system utilizes glulam columns, steel connectors, and a two-way spanning CLT flat-slab. The design creates a floor beam–free structure that could be erected start-to-finish in nine and a half weeks.

The rapid-fire construction time line, however, comes at the expense of longer planning and design phases prior to any work boots hitting the job site, as the teams must become absolutely synced prior to fabrication. Waugh of WTA explained that often with timber buildings, the firm asks its clients to "give us more time now [in the planning stages of construction] and we'll save you even more time on the back end." Waugh added, "The better programmed the construction process, the faster



COURTESY ACTON OSTRY ARCHITECTS*

Though the Brock Commons tower is built primarily of mass timber systems, those elements were ultimately encapsulated by layers of drywall and thin concrete floor slabs in order to completely fireproof the structure.

and more accurately the buildings come out." Waugh said that after erecting several mass timber structures, the firm had "gotten so much better at it" than when they first started. One area of improvement has been material usage, which decreased with each project as the structural capabilities of mass timber have been further explored, tested, and certified. The Dalston Station project mentioned earlier, for example, utilized about two-thirds as much timber as the firm's first mass timber project erected a decade ago.

Part of the reason for the improvements, Waugh and Jonsson agreed, results from designers' greater awareness of and comfort with the construction process. "To design well in mass timber, you need an architect who wants to understand that the nature of [the architect] is one of a 'master builder' as well as one of a 'master designer,'" Waugh explained.

Since mass timber construction methodologies are based on kit-of-parts assembly systems of mass-produced panel types and structural elements, there has been increased interest among European and Canadian firms in building high-density mass timber housing.

These experiments have positive implications for the many American cities burdened with housing shortages and long project-approval times. Waugh explained that WTA's focus rests on expanding the abundance of available housing through mass timber construction. He said, "We design everything in our office now as if it was a mass timber project. Concrete projects are becoming more and more rare."

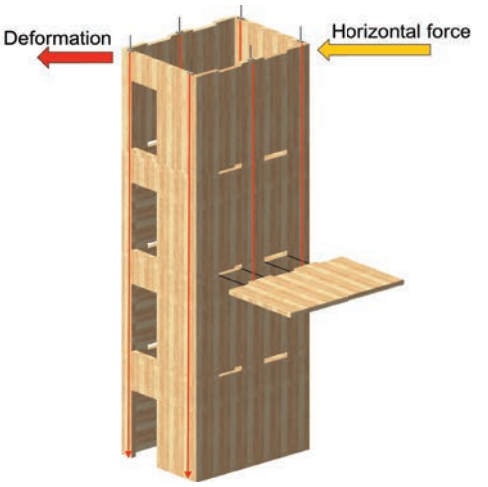
Several projects in the works, like Shigeru Ban's recently proposed 19-story Terrace House in Vancouver (page 7), Michael Green Architecture's 35-story Baobab building in Paris (page 20), and PLP Architecture's 80-story addition to the Barbican housing estate in London, point toward a wider adoption of tall and supertall mass timber housing towers. With faster construction times and fabrication that can occur in tandem with permitting, mass timber has the potential to help cities add housing rapidly, safely, and efficiently.

Waugh added, "Humanity is becoming more urban, so the principal job of an architect in the 21st century is to develop high-density urban housing. In an era of climate change, it behooves you [as a designer] to reduce the amount of carbon emitted. Again, for us, mass timber is a way to do that."

Technical University of Munich

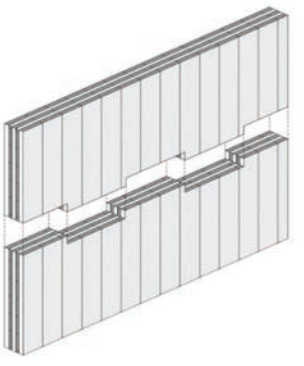
At the Technical University of Munich, professor Stefan Winter chairs the Timber Construction and Structural Design department. The department focuses on studying the fire-safety, energy-efficiency, and building-modernization aspects of mass timber design. The department is responsible for new experiments aimed at standardizing the fire-safety and performance standards of timber frame elements in order to promote their widespread use.

A recent research project on the topic hopes to make plant-based insulation materials more accessible to the building industry by standardizing fire ratings for these materials into European fire standards. Another research topic at the university involves making mass timber buildings more moisture-safe, a growing concern for tall mass timber structures in particular. The research team is dedicated to studying the water-absorptive qualities of mass timber products both on the construction site and over the lifespan of completed structures, with the goal of minimizing and stabilizing water-infiltration of mass timber elements and structures.



COURTESY STEFAN WINTER/MARTIN GRAFE/PHILIPP DIETSCH

Researchers at TUM are also developing approaches for prestressing CLT structures in an effort to make more rigid forms that will allow for taller timber buildings.



The researchers are looking to form-fitting, tongue-and-groove–style connections and complex anchorage assemblies to decrease structural creeping in CLT structures.

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22

Opera Cake

RENOVATIONS TO THE SANTA FE OPERA HOUSE ENHANCE THE SOUTHWEST DESERT ICON.

In 1957, the open-air Santa Fe Opera House was built with lofty ambitions to blend opera and the outdoors, but it only provided basic amenities. In 1997, James Stewart Polshek and Partners tore down the old auditorium and built Crosby Theatre: an iconic suspended-roof structure that greatly enhanced the theater experience. But structural relics from the 1957 version—including the cramped wing space, small bathrooms, and limited front- and back-of-house amenities—kept both attendees and staff on their toes. Now, Matiz Architecture & Design has completed a renovation of the iconic complex. **continued on page 14**

Arch-etyp

THE ST. LOUIS ARCH'S SA
AND KILEY-DESIGNED LAND
GETS A REVAMP.

"Our project is at the end of a seve
project," said Gullivar Shepard, p
at Brooklyn-based Michael Van
burgh **continued on page 14**

I Like Pike

SEATTLE'S MILLER HULL REVAMPS AND EXPANDS THE CITY'S HISTORIC MARKET.

As a core segment of the millennial generation reaches adulthood, a renewed entrepreneurial spirit has enveloped much of popular culture.

In Seattle, this experimentation is on display at various levels of the food chain— from the opening of the latest vegan ice cream shop to one of the largest online retailers in the world acquiring Whole Foods. Yet some old standbys remain as beloved as ever. Such is Pike Place Market, the Emerald City's **continued on page 20**

Back to S

PRESTON SCOTT COHEN COMPLETES A NEW WING FO
THE TAUBMAN COLLEGE AT
UNIVERSITY OF MICHIGAN.

Architecture and urban planning
at the University of Michigan's
College are in for a rare treat: a n
While not a complete teardown-r
school has added 36,000 squar

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AN INTERIOR 8

Westport Presbyterian Church
Exhibit Columbus
Chicago Architecture Biennial
Adam Nathaniel Furman

Fall 2017

archpaper.com/subscribe

NOVEMBER/DECEMBER 2017

WEST

NOVEMBER

SATURDAY 4
SYMPOSIUM
Landscape as Catalyst: Lawrence Halprin's Legacy and Los Angeles
9:30 a.m.
A+D Museum
900 E 4th St.
Los Angeles
aplusd.org

FRIDAY 10
EVENT
Mike Brinck: All About Automated Parking Systems
12:00 p.m.
AIA San Francisco
130 Sutter St.
aiasf.org

SUNDAY 12
WORKSHOP
Marina Magalhães: Decolonizing the Body Through Dance: River Edition
10:00 a.m.
Beta Main
114 W. 4th St.
Los Angeles
themainmuseum.org

DECEMBER

FRIDAY 8
EVENT
Thomas L. Safran: City Leaders Breakfast Reception
8:00 a.m.
Moore Ruble Yudell Architects
933 Pico Blvd.
Santa Monica
aialosangeles.org

SOUTHWEST

NOVEMBER

THURSDAY 9
CONVENTION
TxA Annual Convention and Design Exposition Texas Society of Architects
8:00 a.m.
Austin Convention Center
500 E. Cesar Chavez St.
texasarchitects.org

SATURDAY 11
EVENT
East Austin Studio Tour
11:00 a.m.
Austin, TX
east.bigmedium.org

DECEMBER

THURSDAY 7
EVENT
AIA Annual Holiday Party
6:00 p.m.
AIA New Orleans Center for Design
1000 St. Charles Ave.
New Orleans
aianeworleans.org

ONGOING
EXHIBITION
Alexander Calder An Outburst of Color
Orientation Gallery
Phoenix Art Museum
1625 N. Central Ave.
Phoenix
phxart.org

MIDWEST

NOVEMBER

THURSDAY 9
BOOK LAUNCH
UrbanLab Bowling
6:00 p.m.
Madlener House
4 West Burton Pl.
Chicago
grahamfoundation.org

FRIDAY 10
LECTURE
Nick Gelpi: Mockups and Other Strange Constructions
4:30 p.m.
University of Wisconsin-Milwaukee
2131 East Hartford Ave.
Milwaukee
uwm.edu

THURSDAY 30
TALK
Allan Wexler: Absurd Thinking: Between Art and Design
6:00 p.m.
Madlener House
4 West Burton Pl.
Chicago
grahamfoundation.org

ONGOING
Chicago Architecture Biennial
Chicago
chicagoarchitecturebiennial.org

EAST

NOVEMBER

SUNDAY 5
PERFORMANCE
Eiko Otake: A Body in Places
10:00 a.m.
The Met Cloisters
99 Margaret Corbin Dr.
New York
metmuseum.org

FRIDAY 10
PERFORMANCE
Alex Schweder and Ward Shelley: The Newcomers
28 Liberty St.
New York
17.performa-arts.org

SATURDAY 11
CONFERENCE
Circulations Conference
2:00 p.m.
Performa 17 Biennial Hub
427 Broadway
New York
17.performa-arts.org

SUNDAY 12
PERFORMANCE
Eiko Otake: A Body in Places
10:00 a.m.
The Met Breuer
945 Madison Ave.
New York
metmuseum.org

SUNDAY 19
PERFORMANCE
Eiko Otake: A Body in Places
10:00 a.m.
Metropolitan Museum of Art
1000 5th Ave.
New York
metmuseum.org

CHUNE YE CHOU

Midwest
SOM: Engineering x [Art + Architecture]
345 North Morgan Street, Chicago
Through January 7, 2018

Several exhibitions are running concurrently to the Chicago Architectural Biennial throughout the city. Just west of downtown, SOM has filled a converted industrial space with eight decades of examples of its practice. Revolving around a series of over thirty 1:500 scale models of SOM's most notable tower projects, the show delves into the firm's long history of expressive structural solutions and innovative engineering feats. Along with buildings, it also highlights SOM's many collaborations with famous artists to produce some of Chicago's most iconic public sculptures. Numerous models and drawings pulled from the firm's archive explore work with the likes of Pablo Picasso, James Turrell, Jaume Plensa, and Janet Echelman, to name a few. Many will find this practical, yet exuberant, show a welcome counterpoint to the more esoteric exhibition showing in the Cultural Center.

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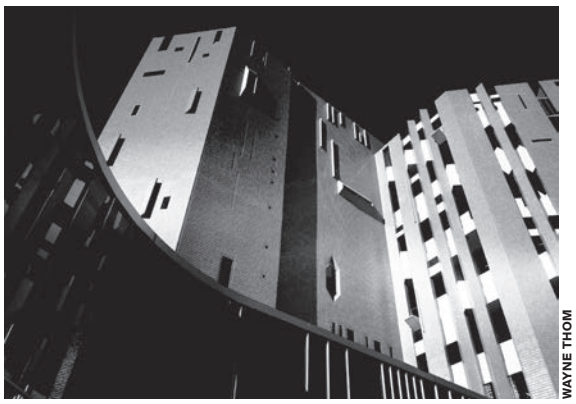

WAYNE THOM

Southwest
Then, Now, Next: Evolution of an Architectural Icon
Denver Art Museum
100 West 14th Parkway
Denver
Through February 25, 2018

In line with the renovation of the Gio Ponti–designed North Building at the Denver Art Museum, the museum is featuring an exhibit on the history and future of the famed modernist building, which opened in 1971.

The exhibit's title makes reference to the time line of the structure, featuring early historical documentation, models, sketches, and ephemera from its early days, to renderings and plans for its current redevelopment. According to the curator Darrin Alfred, the show's historiography will allow visitors to better understand "how the need for such a structure arose and...how innovative a museum building it was for the late 1960s."

The renovation, being completed by Fentress Architects and Machado Silvetti, is projected for completion in 2021.

COURTESY SEATTLE ARCHITECTURE FOUNDATION

West
Architectural Model Exhibit: Resurgence at Seattle Architecture Foundation
Seattle Architecture Foundation
1010 Western Avenue
Seattle
Through November 18

The Seattle Architecture Foundation is presenting the *Architectural Model Exhibit: Resurgence*, the 20th annual run of the architectural model showcase. The exhibition features wooden architectural models from Berger Partnership, Bohlin Cywinski Jackson, CallisonRTKL, Kejia Zhang & Xiaoxi Jiao, LMN Architects, Schemata Workshop, SOM, and ZGF Architects, among others.

Resurgence postulates new ways of utilizing architectural practice to interact between community movements and changing notions of contemporary urbanism. Roundtables on the subjects of green building and historic properties accompany the show.

FRANÇOIS DALLEGRET, DIMITRI CHAMBLAS, AND FRANÇOIS PERRIN

East
The Environment Bubble at 7th Performa Biennial
Central Park
Mineral Springs
West 70th Street, New York
November 8

Like past installments, Performa 17's seventh biennial—Circulations—explores movement through space with a multilayered program comprised of over 60 site-specific live performances and architectural experiments in over 45 architectural venues throughout New York City and region.

The headlining performance resurrects a novel blueprint by the Montreal-based architect François Dallegret. Dallegret worked with architect François Perrin and Dimitri Chamblas to actualize the inflatable structure in Central Park. There, dance workshops at 12 p.m. and 2 p.m. will draw visitors together in the activated site to rethink public and private space.

The inflatable installation will move to DUMBO the following day, November 9. Once again, Chamblas's choreographed performances will take place at 12 p.m., 2 p.m., and 4 p.m. on the Empire Fulton Ferry Lawn.

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Sofa Composition/ Albert Frey, 1949/ Courtesy of CONVERSO and Andrew Nemiroski

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APRIL 19 + 20

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JULY 19

CHICAGO
SEPTEMBER 21

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OCTOBER 4

LOS ANGELES
OCTOBER 25 + 26

BOSTON
NOVEMBER 9

SEATTLE
DECEMBER 7

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Robert Venturi's Rome

By Stephen Harby and Frederick Fisher
ORO Editions, $19.65

Complexity and Contradiction in Architecture is not an easy book, or so we were told by Vincent Scully in the introduction to Robert Venturi's seminal 1966 publication.

The book's release is the stuff of modern architectural mythology. When initially published, Venturi's text signified a daring step away from modern orthodoxy. It encouraged the design community to actively participate in broad architectural discourse, to treat the past as prologue rather than discarding it as merely vestigial.

The book was loathed by many. Treated as critical contraband, it was seen as incendiary and vulgar, and was perceived to be a jab to the prevailing momentum of Western architectural progress.

However, to a small fraction of midcentury architects, the book was a welcome embrace of architectural inheritance. It was a permissive, if soft, manifesto allowing designers to stretch out, to embrace a messy and nonlinear practice, to get a little weird.

Frederick Fisher and Stephen Harby proudly identify with Team Venturi. The first pages of *Robert Venturi's Rome*, to which both contribute text and watercolor illustration, celebrate the profound influence *Complexity and Contradiction* had on the way they practice, teach, and understand the built environment.

Reading the book as students proved to be a shared watershed moment. Fisher immediately shifted focus from art and art history to architecture, and has worked in Rome as both an architect and Rome Prize Fellow. Harby received the book from Vincent Scully in a fateful transaction that lead to a Rome Prize Fellowship and a recurring teaching position in the Eternal City.

Robert Venturi's Rome is ostensibly a travel book for the architecturally inclined, exploring some, though not all, of the Roman sites referenced in *Complexity and Contradiction*. Fisher and Harby "propose to take the reader on a journey through time and ideas by visiting and discussing nearly thirty Roman places that exemplify Venturi's revolutionary ideas," and they use the *Complexity and Contradiction* table of contents, and supplemental quotes from the original text, as a framework for ten short tours.

Unsurprisingly, by pairing buildings and urban spaces with the tenets of Venturi's work, including "ambiguity," "contradiction" (both "adapted" and "juxtaposed"), and the "double-functioning element," *Robert Venturi's Rome* is quickly revealed to be more complex, and yes, more contradictory, than a standard travel guide of the Fodor's or Rick Steves variety.

Fisher and Harby pragmatically outline locations and hours of operation, but eschew detailed photography for their own watercolor illustrations. The images of buildings, architectural elements, and plans are gorgeous, lovingly rendered and evocative, but leave details to be examined solely by text. Accordingly, the text often carries an unevenly distributed burden.

Venturi populated *Complexity and Contradiction in Architecture* with more than 250 images, mixing architectural photographs and drawings with mannerist and abstract paintings, an approach that buttressed his criticism and apologia. Conversely, Fisher and Harby are successful when describing formally familiar work, like the Pantheon or Casa Girasole, but struggle when examining complicated baroque spaces, like Francesco Borromini's San Carlo alle Quattro Fontane.

Vacillating between highlight reel and inside baseball, the tone of the book is inconsistent. It is simultaneously a travelogue for the architecturally curious and a series of esoteric incantations relying on the erudition of the reader to spot the sly relationship between Fisher and Harby's text and Venturi's design exegesis.

The esteem in which the authors hold Venturi—and his work—and their admiration for Roman architecture is evident. Venerating both theorist and city, Fisher and Harby note, "it is possible that, without acknowledging it, Venturi…is celebrating the fact that in the hands of Borromini and many other architects, classical language is a living, fluid thing, and not the dead language that Venturi's modernist contemporaries would have considered it."

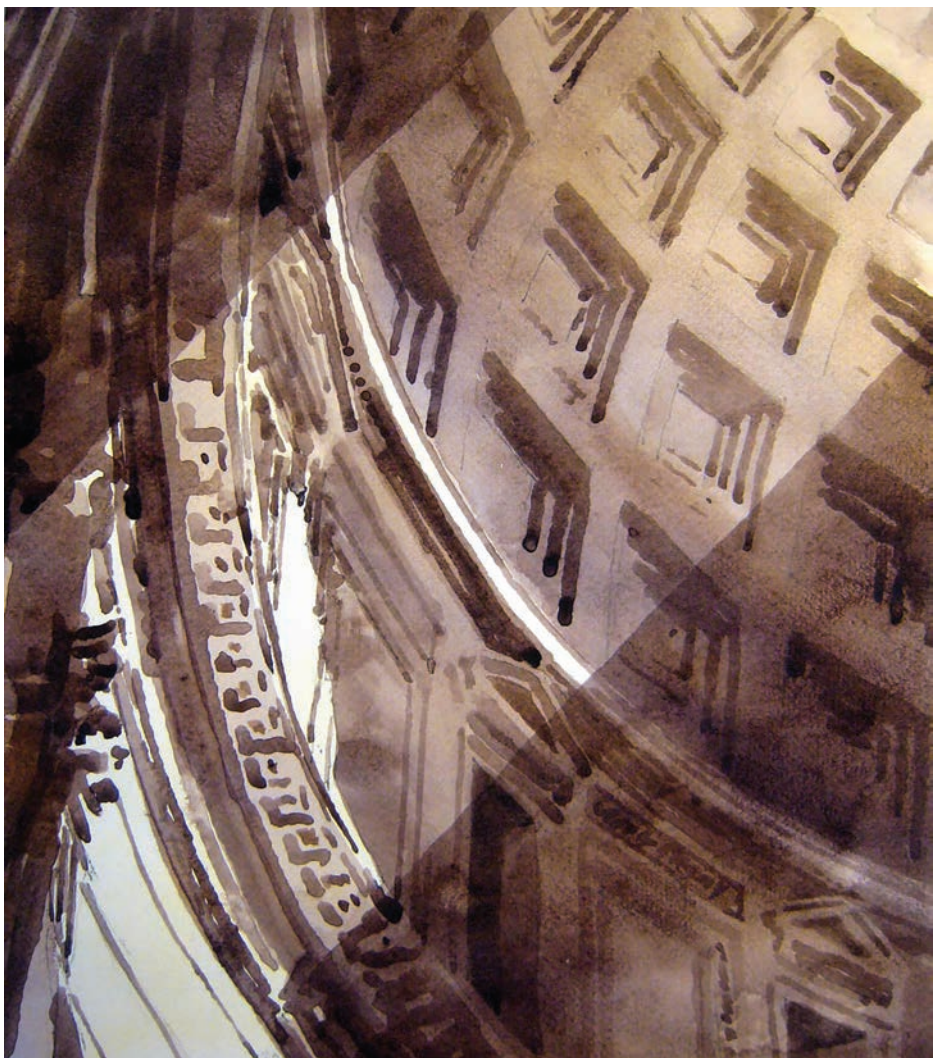
By design or otherwise, the publication of *Robert Venturi's Rome* feels timely and in keeping with a broader revivalist spirit currently underway. It fits easily with the recent Ettore Sottsass show at the Met Breuer, the successful effort to designate Kevin Roche and John Dinkeloo's Ambassador Grill as a New York City landmark, and the recognition of the glass pyramid–topped Musée Louvre renovation with an AIA 25-year award.

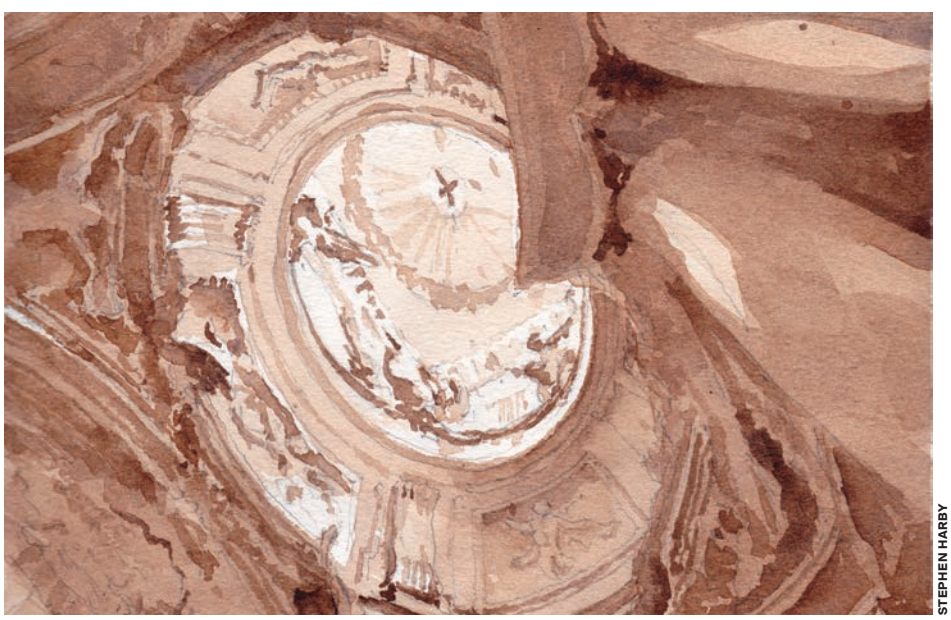
Still, it takes a unique kind of architectural navel gazer to appreciate the meta-narrative of a book about a book by an architect designing buildings about architecture.

Scully suggested that *Complexity and Contradiction* might shift our professional perspective from the Champs d'Elysées to Main Street. Through thoughtful analysis and vivid illustration, Fisher and Harby remind us that Rome is a complex city of interwoven Main Streets populated by both historic exemplars and idiosyncratic oddities.

Robert Venturi's Rome "evokes many levels of meaning and combinations of focus," write the authors. "Its space and its elements become readable and workable in several ways at once." Coincidentally, so does *Robert Venturi's Rome*.

Brian Newman is an architect and university campus planner and has taught at Washington University in St. Louis.





STEPHEN HARBY

Stephen Harby and Frederick Fisher visited many of the Roman sites referred to in Robert Venturi's *Complexity and Contradiction*, and produced watercolor paintings to illustrate this architectural travel guide.

Advancing Wood Architecture: A Computational Approach

Edited by Achim Menges, Tobias Schwinn, and Oliver David Krieg, Routledge, $54.95

Wood

William Hall, Phaidon, $49.95

FRANÇOIS DALLEGRET, DIMITRI CHAMBLAS, AND FRANÇOIS PERRIN

Wood by William Hall, published by Phaidon. This spread shows Evolver in Zermatt, Switzerland, 2009.

Renewed interest in wood building is emerging with mass timber construction, glued-laminated timber and cross-laminated timber, as well as potential policy incentives. While the material is used throughout the world, it is finding a renaissance, and for good reason, as two new books show. The material is renewable and sustainable when harvested correctly. It is, compared to steel and masonry, relatively lightweight. It is pliable. The books highlight these advantages; one focuses on advancements in the construction process, the other examines use.

Wood is a primeval construction material—Marc-Antoine Laugier's primitive hut—and only advancements in technology and process have altered the way we use it, from steam molding and lamination to computer numerical control (CNC). *Advancing Wood Architecture* is a compilation of essays and projects about the application of computational experiments in wood structure for both conceptualization and construction.

Academic in its approach, the book is for the truly interested reader—not someone browsing contemporary wood architecture. Leaving casual interest aside, the book provides fascinating insight to current computer-aided practices and possibilities from four of Europe's leading universities. The section from ETH Zurich focuses on CNC-related fabrication and extending digital processes into construction. While the multilayered roof system of the Arc_Tec_Lab building results from their study, the experimental project's diagrams and process photos far outweigh finished photography. Further sections feature projects culminating in complete pavilions. École Polytechnique Fédérale de Lausanne and the University of Stuttgart examine weaving and shell structures, and particularly joint systems that maximize material use and strength. The Architectural Association uses its recently inherited forested Hooke Park to continue studies in localized, experimental processes via 3-D scanning, natural tree forms in construction and practical innovations.

The final section compiles discussions by some of Germany's leading timber manufacturers and engineers, as well as proceedings at the Advancing Wood Architecture symposium held in 2015. All agree that new technologies enable better economies, sustainability, and collaboration depending on the applications. Scale and location are still key determinants, but the ability to collaborate from the initial design stages through construction, rather than a design-bid-build process, has been providing the most innovative developments and better value.

A counterpoint to the technical is a volume decidedly more pictorial. Having already produced a volume on brick in Phaidon's series on building materials, William Hall returns with *Wood*. As with others in the series, this volume categorizes projects by themes: form, texture, juxtaposition, landscape, light, mass, presence, and scale. Each project receives space for one image, which often leaves details noted in captions absent in favor of an overall photo. This is especially a liability where structural details play an important role but aren't as apparent. While each example could easily fit in multiple sections, Sandworm, a project by Casagrande Laboratory, is one of the few projects that actually does, appearing in both landscape and light. And the light section might be the most problematic, as many photos show the whole project rather than the structures' play of light. However, the design and layout of the book provide the impact that allows readers to see the forest for the trees.

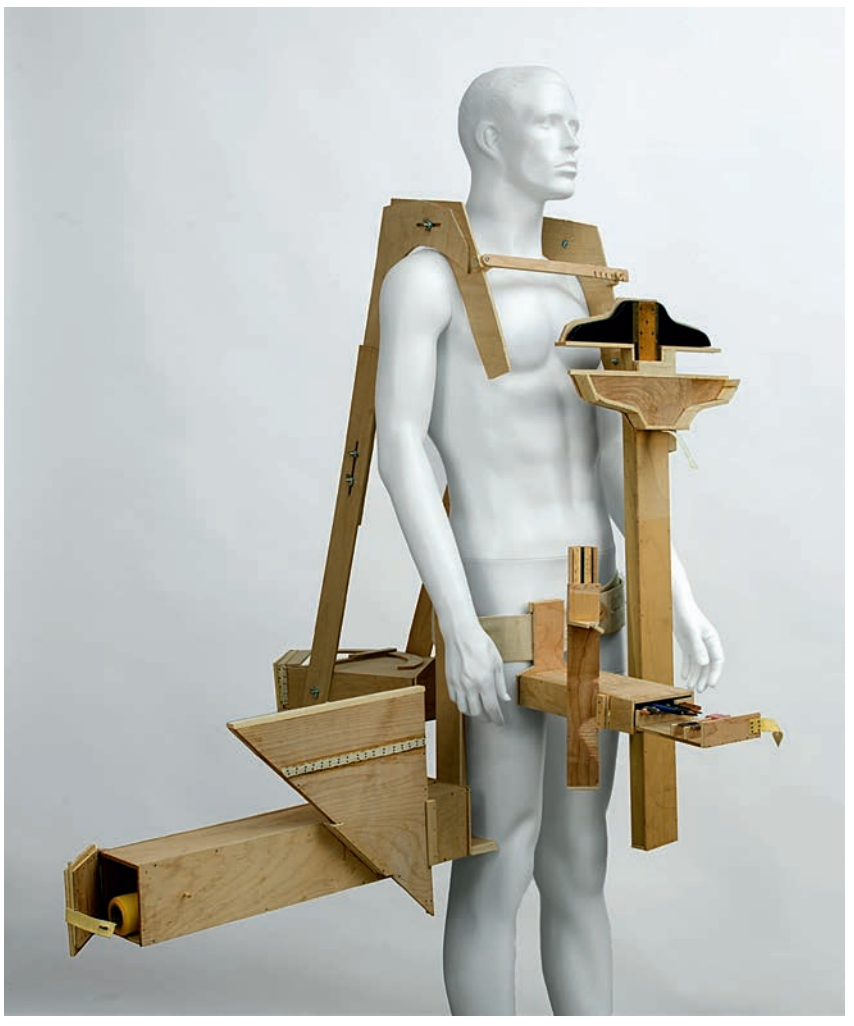
Avoiding a nostalgic reverie of the past, or a blind adoration of the contemporary, Hall presents a balanced view that reminds readers that today's wonders have equally amazing counterparts from centuries past. This appears strongest when projects are paired to show precedence and evolution, such as Sir Robert Seppings's covered slipway from 1838 paired with Taira Nishizawa's Forestry Hall from 2004. Le Chêne Millénaire, both historical and unsurpassed in creative imagination, is a literal tree house from 1696. Centuries later, Terunobu Fujimori built his teahouse Takasugi-an atop two tree trunks in a clearing. And this is where Hall's book thrives—as a source of material inspiration.

The introductory essay, "Trees as Architecture" by Richard Mabey, provides an accessible overview of wood and its uses for the layperson, but enough nuance for those familiar with timber construction; for example, he compares columnar trees to excurrent—the trunk is dominant to the branches—and decurrent—which has diverse branching. Hall's captions equally range from the cursory to the clinical.

Advancing Wood Architecture explicates the latest research and developments in wood construction, while Hall's *Wood* provides inspiration for design, and for touring.

James Way is a Portland-based writer and frequent contributor to *AN*.

COURTESY ALLAN WEXLER



Top: Sheathing the Rift, 2014, hand-worked ink-jet on panel. **Left:** Plien Air Studio, 2016.

Sheathing the Rift (2014) is from a series of hand-worked multimedia images that incorporate the practices of photography, sculpture, and drawing. Rather than depict functional space, they envisage the human spirit and depict the deep-seated origins of the search for shelter. Each work is constructed like a builder constructs a building: Beginning with a plaster model and paper props, it is photographed, printed in sections, tiled together, glued to a wood panel, drawn into, and finally waxed and buffed.

Allan Wexler: Absurd Thinking: Between Art and Design, published by Lars Müller, is a recent survey of the work by Allan Wexler. The book features projects developed across the artist's career that mediate the gap between fine and applied art, using the mediums of architecture, sculpture, photography, painting and drawing. Wexler's work is sometimes functional, sometimes theoretical, and often performative. In all cases, it demonstrates a commitment to reevaluating basic assumptions about the human relationship to the built and natural environments.

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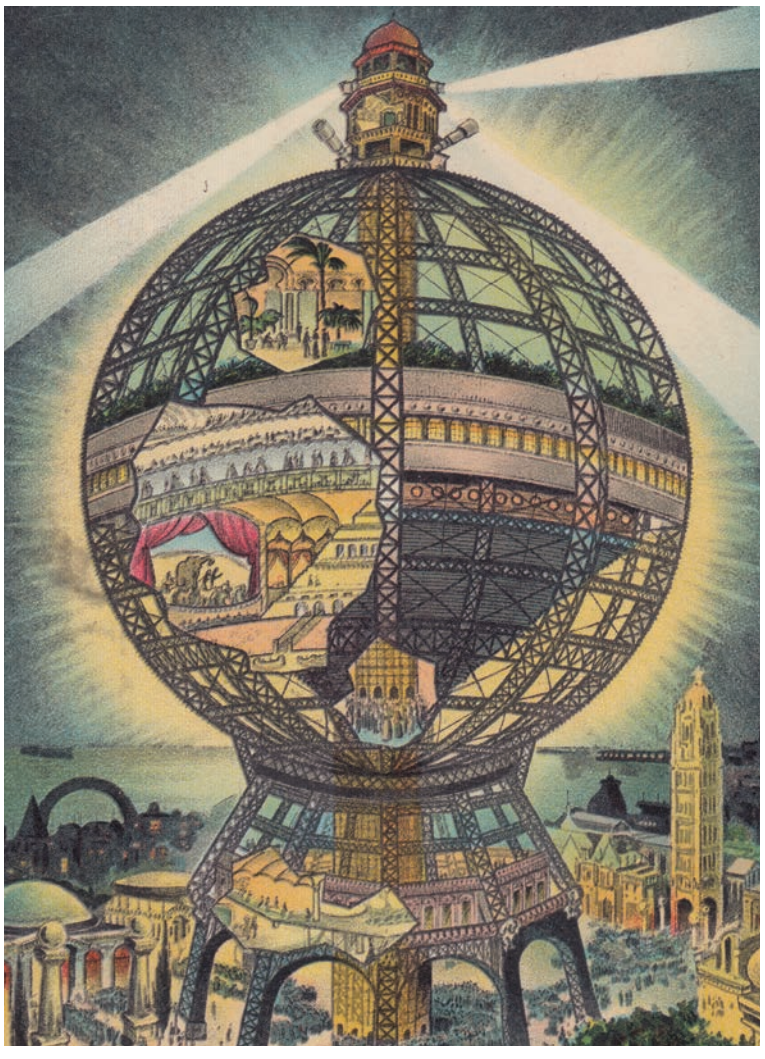

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Samuel Friede, *Coney Island Globe Tower*, 1906. Postcard, 3.81in x 5.86in. Courtesy Queens Museum

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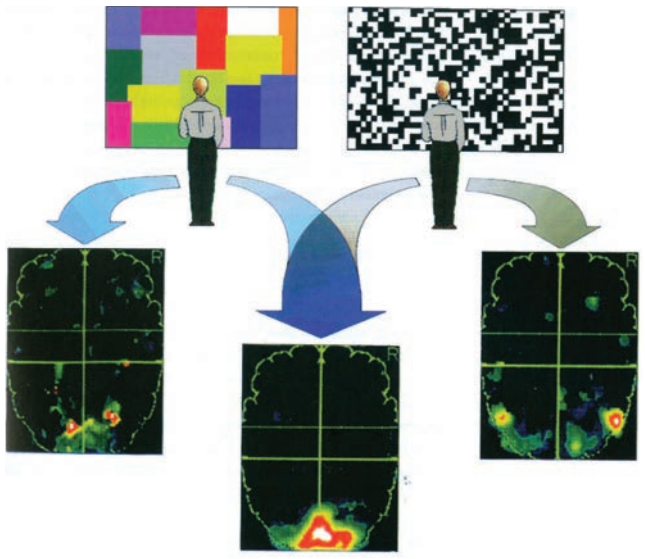
OPINION

How Neuroscience Can Help Architects



COURTESY SAMIR ZEKI, A VISION OF THE BRAIN, LONDON, BLACKWELL, 1993.

An experiment demonstrates functional specialization of the brain. MRI scans of the visual cortex in the occipital lobes show different areas of the brain activated for colored panels (lower left) and a moving scene (lower right).

More than a decade ago, the American Institute of Architects founded ANFA—the Academy for Neuroscience in Architecture—to foster research on aspects of brain science that might pertain to design and the built environment. Though the group has sponsored three conferences and provided research support for several collaborative studies, relatively few architects are aware of its existence. There is a significant gulf between the design and neuroscience communities that has discouraged joint research and teaching at major universities, especially in the United States.

One of the reasons for this divide is rooted in decades of poststructuralist philosophy concerning texts, linguistics, symbolism, and modernist aesthetics. Architectural theory, as taught in most design schools, has little use for brain science, or indeed any hard science. Few architecture degree programs offer courses in cognitive psychology or neuroscience to students, undergraduate or graduate. Further, the kind of biometric design hotly pursued by high-tech companies isn't being promoted in architecture because it might challenge our romantic notion of "artistic genius."

This year is a propitious moment to correct this myopia, because brain scientists are becoming interested in architecture as they recognize that aesthetic preferences, emotional responses to places, and various kinds of haptic awareness can be measured experimentally. A recent article by Anjan Chatterjee and his colleagues at the University of Pennsylvania identified several areas for study, predicting that scientists might investigate the "neuroscience of architectural experience" using a range of existing methods as well as new techniques. I joined colleagues from Boston, New York, and the Salk Institute to form a research group on "measuring the experience of place" at the Ax:son Johnson Foundation in Stockholm in September 2017. An October symposium sponsored by the Richard H. Driehaus Foundation in Chicago also recently addressed new discoveries on how perception and cognition interact when humans experience the built environment. Most importantly, the Johns Hopkins School of Medicine now has an "Institute for Neuroaesthetics" with significant funding from several public health organizations within the U.S. government.

If either practicing architects or academic faculty want a place at the table, ample opportunities now exist for getting into neuroaesthetics, biometrics, and cognitive science, among several other research fields. But why should architects care about obscure brain experiments when facing the myriad challenges of global warming, energy conservation, unchecked urban growth, and housing shortages?

Here are a few compelling reasons why our profession should pursue alliances with people who research thinking about, acting in, and perceiving, our changing environment.

First, we are stewards of public health. Our buildings not only foster healthy social interaction among users, they can cause illnesses or promote wellness; affect moods and generate feelings of wellbeing; even promote healing in therapeutic settings. Brain science and evolutionary psychology offer knowledge about how we as designers can positively affect changes in the built environment. As professionals face challenges to their authority, additional expertise in critical areas of health science give us more room to increase our market share, and our profits, notwithstanding the altruistic contributions we make to society as a whole.

Second, we help make cities and other environments safe, enjoyable, stimulating, and aesthetically pleasing places for people and other animals. We are largely responsible for creating beauty in the world. We often direct governments and organizations in their efforts to build or repair infrastructure. We are more than just conceptual artists, because we provide real, tangible places for civic engagement and pleasurable social activities. We quite literally use our knowledge of the brain, the body, and the environment to solve problems, and we are virtually unique in this regard among professionals. Unless we understand the important theory of grounded cognition, we won't fully utilize our talents and experience.

Third, we are the creators, and protectors, of the most precious places on our planet—places like the Piazza San Marco in Venice, Central Park in New York, and Machu Picchu in Peru. We understand the historical, cultural, social, and aesthetic significance of places. We have the capacity to restore, conserve, repair, and rebuild places that have been damaged in some way—by war, weather, neglect, and poverty. Like shamans in traditional societies, we use "magic" to create the most dramatic experiences in our familiar environments, and expose people to strange and unfamiliar settings. Without us, life would lose some of its most spiritual, most psychologically rich moments and events. Yet we are losing our credibility and power as information overload, political chaos, and fake expertise cloud the social spaces we inhabit.

There are additional ways in which discoveries about brain-body-environment interactions can help designers confront a more complex professional habitus. However, the three above should motivate all of us to look beyond our comfortable design habits and predilections in the years to come. There is a growing crisis, evident in the economics of practice, that is threatening to sever the tenuous bonds linking the building trades, financial system, university programs, engineering and technology communities, and design professionals. Increasing our knowledge in a critical area such as cognitive science will help to put us back in the conversation about how to reform our building and urban planning systems. We can again become leaders in the struggle to improve the planet.

The most significant discoveries in neuroscience and cognition since the 1990s, the "decade of the brain," don't just affect doctors, philosophers, and biologists. Aspects of the visual system that were virtually unknown when I was a graduate student in the 1970s, such as precognitive fixations in certain illusions such as the Necker cube, will change the way architects represent space. Research on visual thinking and problem solving indicate significant deficits in judgment, memory retention, deep feedback, and motor learning when students are taught with digital tools rather than with pencils, paper, or stylus-based media. The more humans employ multiple sensory-motor modalities, the better their capacity to learn, create, and think critically.

Moreover, the direct experience of great places will implant indelible memories in any designer; and experiments prove that these are necessary for stocking the mental scrapbooks we use on a daily basis. Photographs, videos, and images on an iPad won't supply the same stimuli or learning potential, yet most design schools rely on these things when teaching. How many recent graduates of architectural schools have stood inside the nave of the Chiesa del Redentore, ridden the funicular to the top of the Superga, or been cooled by the fountains of the Villa Lante at Bagnaia?

Laboratories using various kinds of biometric tracking and analysis have sprung up around the world. Companies such as Google, Apple, and Tesla have been using both data and the technology for eye tracking, body mapping, touch-sensitive controls, and face recognition for years. A few research labs exist in academia and AE corporations, but architects have lagged significantly behind other industries.

Embodiment, the theory sweeping the brain-science community (yet still contested by some scientists), will influence nearly all aspects of intellectual life, but especially work in creative disciplines. If we think with not only our brains but with our bodies, using the objects around us instrumentally, then the built environment becomes an adjunct in all of our biological functions. Some philosophers, such as Andy Clark of the University of Edinburgh, believe that the computational theory of mind should be abandoned by cognitive science and replaced with situated or embodied cognition. All the foundations of continental philosophy are under review, including most of what architectural theorists consider fundamental. Authorities such as Alberto Pérez-Gómez, Harry Francis Mallgrave, and Thomas Fisher have called for sweeping changes in the way we teach history, environmental science, and design, but little has changed in either practice or the academy in recent years.

If brain scientists are studying aesthetics in music, painting, and poetry, and finding universal principles that appear to be "hardwired," then why aren't architects pushing for similar research in our discipline? Perhaps because some of their preliminary findings don't jibe with what we believe: Originality is the true measure of genius; new forms are better than old ones; beauty is in the eye of the beholder; symmetry is boring; space needn't be defined by walls or rooms; and transparency is phenomenal. It turns out that our brains prefer symmetry and predictable forms; nothing we invent hasn't been seen before; many kinds of beauty are universal (such as pleasing facial features); our bodies respond better to symmetry because we are bilateral creatures; we require edges in order to assess depth; and transparency can be unsettling, even dangerous. Modernist design principles were derived from Gestalt psychology, now almost a century out of date. Hegelian historicism influences neither historians nor philosophers, but architects cling to the zeitgeist as if it were sacrament.

If architectural design was grounded in the latest scientific research, as measured experimentally and published in peer-reviewed journals, perhaps designers would not be perceived as disconnected narcissists eager to curry favor in the realms of art and fashion, unconcerned with the price or practicality of their creations. The American Institute of Architects used a recent television advertising campaign to disabuse the public of such widespread negative stereotypes, but it will take more than public relations to bring lost credibility back to the profession. I believe that neuroscience offers a clear path to relevant knowledge about how our users—organisms with brains and perceptual systems—respond to the built environment, and hence a way to enhance the artistic and technical quality of everything we design.

Mark Alan Hewitt, FAIA is an architect and author based in New Jersey.

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