

WOOD DESIGN & BUILDING®

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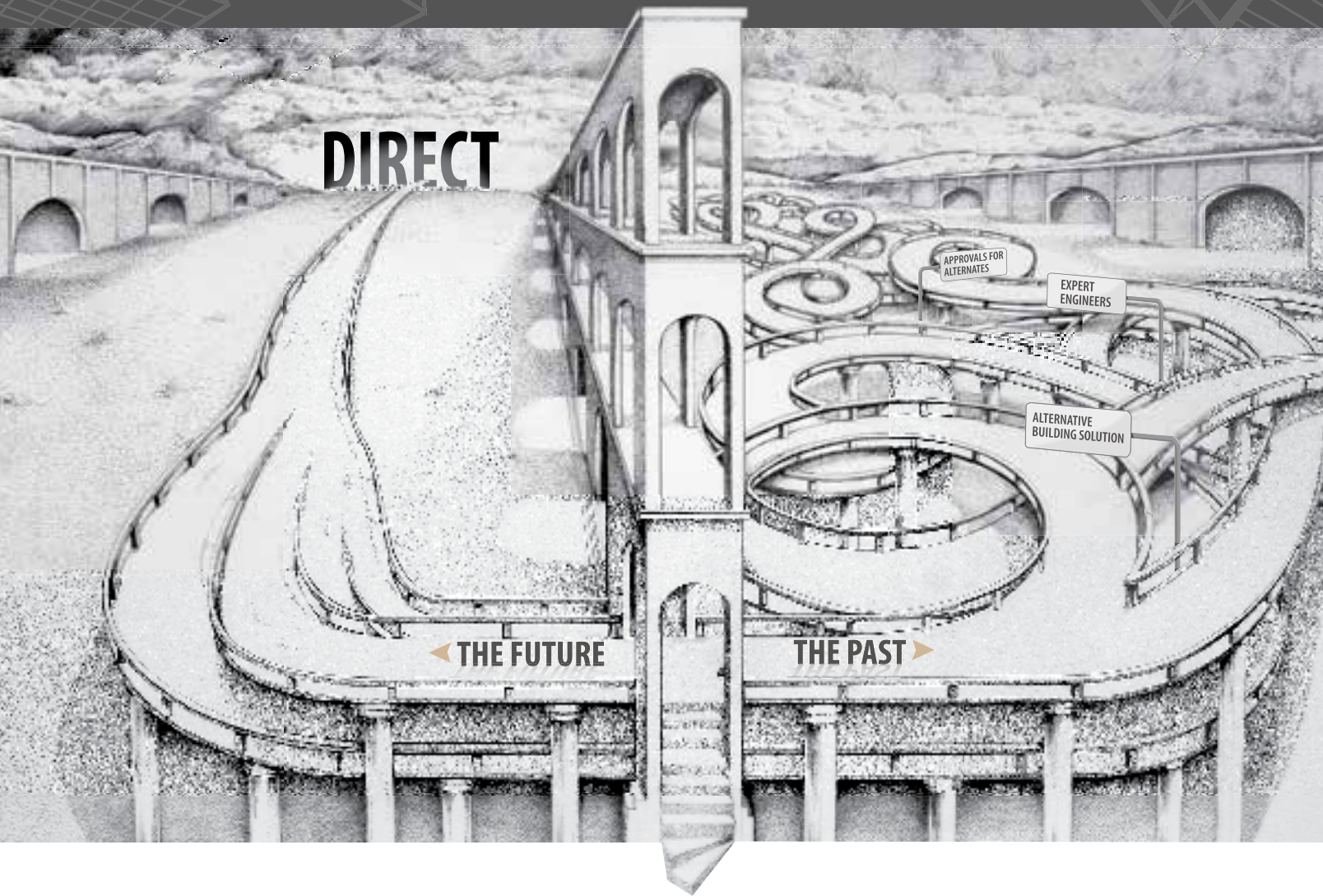
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c o n t e n t s



Above and on the cover: LIVE OAK BANK HEADQUARTERS, WILMINGTON, NC
PHOTO CREDIT: Mark Herboth Photography

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Mass timber offers opportunities to push the limits of wood construction. Whatever it lacks in romance, success with fabricating and installing it requires skills and techniques taken directly from the timber frame workshop.

Traditional craft values of visualization, anticipation, accuracy, and precision apply to timberwork regardless of the specifics of the timber employed.

PHOTO CREDIT: Fraserwood





Tasteful Architecture

I have a special affinity for one of the projects in this issue: the Curtiss and Vickers Kitchen and Dining Facilities, commissioned by the Department of National Defence for the Canadian Forces Base in Borden, ON. These two buildings have replaced four old “mess halls” which dated back to the ’50s.

I first saw these projects last December in Ottawa as we gathered with the judges of our *Wood Design & Building* Awards program to review the submissions. The projects had been announced back in 2011 by then Minister of Defence, Peter MacKay. The \$77-million announcement drew criticism from many as it came at a time when the government was cutting spending in other areas.

I liked the project immediately but I am biased; I grew up in a military family. My father was a member of the Canadian Armed Forces and I know the kind of building these gorgeous timber facilities would have replaced; likely drab, institutional, utilitarian boxes.

I certainly never thought I’d have the opportunity to profile military facilities like these in our magazine, but as I do every year, I’d taken notes throughout the judging process and I was happy when the judges identified these projects as worthy of a profile in our pages. Though the projects did not win an award, the judges noted the beauty and attention to detail in the projects, and were pleased by the departure from military vernacular. What a difference these structures must make in the lives of the men and women who work and eat there every day. Isn’t that what architecture is all about?

And speaking of awards, *Wood Design & Building* recently received its own accolades. In February, Trade, Association and Business Publications International (TABPI) released its first-ever “Big 95” list, highlighting its 95 most acclaimed business-to-business/trade publications. The Big 95 list includes titles from all over the world. This magazine placed 55th.

Paul J. Heney, President, says TABPI looked at the number of Gold, Silver, Bronze, and Honorable Mention wins each publication received in the Tabbies, its annual editorial and design awards competition, between 2004 and 2015.

“Honoring excellent design and editorial work is what the Tabbies is all about,” says Heney. “But we felt that it was also important to recognize consistency. There are many publications that excel year after year, and The Big 95 honors those editors and art directors who have taken pride in what they do on a continual basis.”

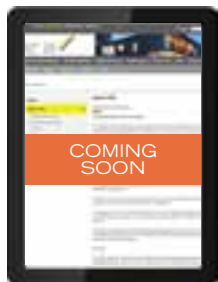
We hope you agree. 🍷

Theresa Rogers
Executive Editor
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Wood Design & Building magazine invites you to submit your project for consideration and possible publication. We welcome contributed projects, bylined articles and letters to the editor, as well as comments or suggestions for improving our magazine. Please send your submissions to Theresa Rogers at trogers@dvtail.com.

inspiration BOARD

WHAT I'VE FALLEN FOR THIS MONTH...



Wood Design & Building Online
We're working hard to build a stronger online presence.
We're beefing up our web and social media channels.
Stay tuned!



AIA Convention 2016
We're headed to AIA in Philadelphia in May! Come and visit us at booth 860.
Bring your business cards, projects and ideas!
<https://convention.aia.org/Attendee/Home>



PHOTO CREDIT: Peter Larsson/Lars Berglund

Transparent Wood

You're reading right; windows and solar panels in the future could be made from wood. Researchers in Sweden have developed a transparent wood material suitable for mass production. The process involves chemically and then heat-treating wood for a transparent, though hazy, structurally sound product.

Researchers next want to enhance the transparency of the material, scale up the manufacturing process and work with different types of wood.

www.kth.se/en/che/divisions/biocomposites/welcome-to-the-division-of-biocomposites-1.18856



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Boathouses

Kelly Townsend

To take something old and make it new again is fundamental to modern architecture. This mix of nostalgic old world forms and contemporary functionality is perfectly matched in recent examples of boathouse designs all over the world.

On the Chicago River, in Chicago's Clark Park, sits the visually striking WMS Boathouse. The slanted roofs and trusses are designed to represent a rhythmic rowing movement and allow natural lighting. The interior is lined with timber planks that extend to the exterior balconies. The boathouse is a recreational center for the Chicago Rowing Foundation and is part of an ecological movement to revitalize the river.

Boathouses are a common sight along Norwegian coasts, but as the fishery has declined, some of these former boat storage units have been transformed for leisurely pursuits. Naust V is a picturesque boathouse found in the small village of Vikebygd. Constructed from locally produced heartwood pine and plywood, it enhances the water's serenity with its warm, orange evening glow.

A privately owned boathouse and docking facility in Canada's Georgian Bay employs a modern design inspired by rustic building materials. The boathouse sits on a large cedar dock, with a timber structure sturdy enough to withstand a Canadian winter, since this boathouse was built as a year-round family getaway. The black-stained, resawn, horizontal cedar recedes into the landscape.

Amsterdam's Restaurant Het Bosch exemplifies the marriage between classic and modern with this lakeside eatery. To cut construction time, the designers used prefabricated laminated timber panels for the roof and walls, with wooden columns for the frame. The elevated structure sits on a steel base to provide a memorable view of the marina and Nieuwe Meer Lake.

The use of wood presented here shows how looking for a new perspective on an old concept, from a private family escape to a new community hotspot, can create astounding results. 🌲

1. WMS Boathouse (2013)
Architect: Studio Gang Architects
Location: Chicago, IL
PHOTO CREDIT: Hedrich Blessing

2. Naust V (2015)
Architect: Koreo Arkitekter and Kolab Arkitekter
Location: Vikebygd, Norway
PHOTO CREDIT: Mattias Josefsson

3. Boat House (2014)
Architect: Weiss Architecture & Urbanism Limited
Location: Georgian Bay, ON
PHOTO CREDIT: Arnaud Marthouret

4. Restaurant Het Bosch (2010)
Architect: DREISSEN architects & JagerJanssen architects BNA
Location: Amsterdam, Netherlands
PHOTO CREDIT: John Lewis Marshal



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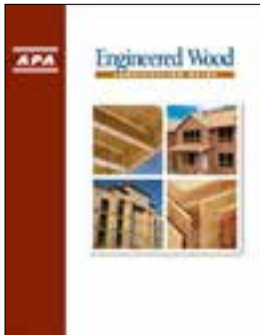
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► New U.S. and Canadian Engineering Guides Available

Engineering guides for wood construction in the U.S. and Canada have recently been updated. The Canadian Wood Council (CWC) released its 2014 edition of the Engineering Guide for Wood Frame Construction, which has been revised to conform to the 2015 edition of the National Building Code of Canada. This is the fourth edition of the Canadian Engineering Guide. In the U.S., APA – The Engineered Wood Association revised its Engineered Wood Construction Guide in February of 2016. This is the 33rd edition of the 92-page guide that was first published in 1962. The Canadian and U.S. engineering guides are available for download at the CWC and APA websites, respectively.

www.cwc.ca

www.apawood.org



► Derek Nighbor Becomes CEO of FPAC

The Forest Products Association of Canada (FPAC) announced that Derek Nighbor is the association's new CEO as of March 7, 2016. Nighbor is the former Senior Vice-President of Food and Consumer Products of Canada where he oversaw federal, provincial and ter-

ritorial government relations, community and corporate partnerships, and membership development. Prior to that, he was Senior Vice-President with the Retail Council of Canada and Chief of Staff to the Ontario's Consumer and Business Services Minister. "[Derek's] years of government and association experience will serve us well as FPAC continues to highlight our global leadership in sustainable forest management," says Curt Stevens, Chair of the FPAC Board of Directors, who announced the news in February. "From coast-to-coast the forestry industry is quintessentially Canadian," Nighbor says. "As a native of the Ottawa Valley, I have seen first-hand how important the sector is to local communities. It's about sustainable growth, good jobs, thoughtful partnerships, and expanding export markets."

www.fpac.ca

► New Annual Report on Canada's Forests

The 2015 report on The State of Canada's Forests is now available for download from Natural Resources Canada. The annual report contains reliable statistics on Canada's forests and important science-based information about the country's sustainable forest management practices.

This is the 25th edition of the report, which has been published every year since 1990. The purpose of the report is to support sound decision-making and informed public discussion concerning national forests and the forest sector. According to Natural Resources Canada, the forest industry accounted for almost 6 per cent of all Canadian exports in 2014, or \$31 billion. Canada is the world's largest producer of newsprint and northern bleached softwood kraft pulp and the second largest producer of softwood lumber.

www.nrcan.gc.ca/forests/report/16496



► Formation of Ad Hoc Tall Wood Committee

The International Code Council (ICC) Board of Directors has approved the formation of a Tall Wood Ad Hoc Committee. Tall wood is an industry term for buildings taller than six stories that use cross-laminated timber (CLT) and other heavy timber manufactured wood products for the structure.

The committee will be made up of stakeholders, code officials and other interested parties. Its purpose will be to study tall wood construction and possibly develop code changes to be submitted for the 2021 International Building Code. "Other nations have already seen the benefits of tall wood construction, from the low carbon footprint, ease of construction and reduced construction time," says Kenneth Bland, Vice-President, American Wood Council (AWC). AWC petitioned ICC to create the committee to research the building science of tall wood buildings, and is pleased that it is moving forward. This is an important step toward the advancement of tall wood in the United States, a carbon-sequestering alternative form of construction."

www.awc.org

► Green Building's LEED Credit Promotes Sustainable Forestry

The green building movement – from architects and builders to specifiers and planners – can now benefit from an expanded range of responsibly sourced timber and forest products eligible for Leadership in Energy and Environmental Design (LEED). The U.S. Green Building Council (USGBC) recently issued an Alternative Compliance Path (ACP). The ACP rewards building projects that use “wood products from certified sources as defined by ASTM D7612-10”, which includes internationally recognized voluntary forest certification standards such as PEFC (Programme for the Endorsement of Forest Certification) and FSC. PEFC's North American-based members include ATFS, CSA and SFI. The ACP will apply to all LEED v4 rating systems including Homes v4 and to all LEED 2009 rating systems. Sustainable, PEFC-certified timber provides architects and the construction industry with great opportunities, says Ben Gunneberg, CEO of PEFC International. With LEED now including PEFC, construction projects can in the future obtain both LEED and PEFC Project Chain of Custody certification. The construction industry is one of the largest buyers of timber products, meaning the sector has a huge influence on the type of timber in demand, Gunneberg says. With PEFC-certified timber offering the widest choice of sustainable timber available to architects, specifiers and designers, Gunneberg says we are poised to see an increase of wood used in construction.

www.pefc.org

► New Innovation Gallery for Canadian Forest Industry

A new branded online marketplace is being established to help Canada's forest industry become more economically competitive and environmentally sustainable. Known as the Investments in Forest Industry (IFIT) Gallery, this online marketplace will be managed by NineSigma and sponsored by Natural Resources Canada. The IFIT Gallery is seeking new markets for a variety of innovative products made from renewable materials sourced from sustainably managed forests. One such example is a new strong, lightweight composite core material that can achieve the look and feel of wood on metal or plastic surfaces. The collaboration aims to foster commercial relationships by showcasing the capabilities of IFIT-supported companies, and others seeking to further strengthen new products, markets and new partnerships. NineSigma's Innovation Galleries are branded online marketplaces where companies, associations and government groups can post their technology needs and showcase technology offers.

www.ninesights.ninesigma.com/web/ifit



► Trees Are Good For Groundwater in Tropical Drylands

According to a recent Swedish study, trees can improve the groundwater recharge in conditions that are common across much of the seasonally dry tropics. The study, published in Scientific Reports journal, was based on field measurements taken by a team of researchers in a cultivated woodland in Burkina Faso. What they discovered settles a longstanding debate about whether trees are beneficial to water availability or whether they consume more water in transpiration and interception (evaporation on leaf surfaces) than other vegetation. It turns out both are somewhat true. Without trees, tropical soils lose their larger pores and much of the water is not able to enter deep into the soil. Instead, water is lost through overland flow and evaporation on the soil's surface. But with overly high tree cover, the trees use more water than is gained by the improved soil properties. “The results offer opportunities for renewed environmental restoration and carbon sequestration in degraded lands,” says research leader Ulrik Ilstedt.

www.slu.se/en



Curtiss Dining Hall

Curtiss and Vickers Kitchen and Dining Facilities

Timber design, natural light and outdoor views distinguish new commercial kitchens and dining halls

CFB Borden, ON



The Curtiss and Vickers Kitchen and Dining Facilities were commissioned by the Department of National Defence for the Canadian Forces Base in Borden, ON, and were built to replace four aging and inadequate dining facilities that dated back to the 1950s – two Junior Ranks dining halls, the Officers’ Mess, and the Senior Non-Commissioned Officers’ (NCO) Mess.

Designed for 750 people, each of these two new “all ranks” dining halls is able to serve 1,500 people per meal in two seatings. Since the kitchens serve thousands of meals each day, the design team focused on providing efficient and robust buildings, optimized interior traffic flow, and pleasant, relaxing dining areas flooded with natural light.



As components of CFB Borden’s Master Real Property Development Plan, the buildings are strategically placed on the redesigned pedestrian campus where every facility is within walking distance. These sister projects share a similar language and footprint, though each has its own unique color scheme and timber structure.

Viewed from the exterior, the two buildings are indeed very much alike and the crisp, deliberately understated glazed forms blend in effortlessly with the existing buildings on the base. On the interior, however, the delightful versatility of wood construction enabled the designers to distinguish one hall from the other with expressive and unique timber structures. Vickers





Dining Hall features glulam columns that branch out from the column bases in graceful tree-like structures, while Curtiss Dining Hall uses a system of columns with dramatic oblique arches to support the roof.

The thermal properties of wood, along with its ability to withstand high humidity, allowed a large number of roof members to extend beyond the building envelope to support the exterior perimeter canopy. This feature gives the design a sense of natural continuity, reinforcing the link between interior and exterior spaces established by the floor to ceiling glass curtain walls in the main dining areas.

The acoustic properties of the exposed wood surfaces are perfectly suited to the buildings' function as a dining hall. The wood offers much-needed sound dampening in a large, open space with periods of high occupancy and elevated noise levels.

The use of timber also supports the LEED Silver certification these buildings targeted. Each single-story facility (plus basement and mechanical mezzanine) used certified glulam beams and boasts a high-efficiency building envelope. Additional sustainability features include an aggressive construction waste management strategy, increased energy and water efficiencies, and site strategies which reduce the heat island effect and promote walking or cycling in lieu of driving. Indoor environmental quality was also a priority and was managed through the selection of materials and methods which reduced or eliminated potentially harmful toxins. Large and complex mechanical equipment seamlessly integrates itself into the architecture providing comfort and fresh air for building occupants.

The new dining halls are inviting, exceptionally functional and easy to maintain. The spaces are easy to navigate, providing user-friendly circulation to and from all serving areas and dining zones. The timber design, natural light and views to the outside from virtually all spaces are features seldom found in large, commercial kitchens and make Vickers Dining Hall and Curtiss Dining Hall real successes and excellent prototypes for future projects. 🌲

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Department of National Defence

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STRUCTURAL ENGINEER
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Vickers Dining Hall: Aquicon Construction Co Ltd.
Brampton, ON

TIMBER SUPPLIERS
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Penticton, BC

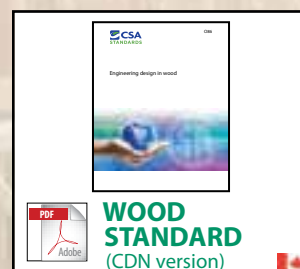
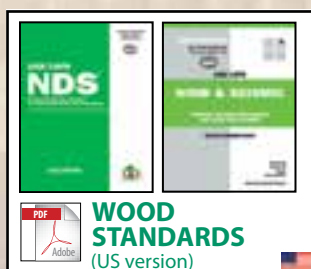
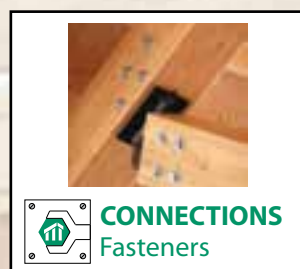
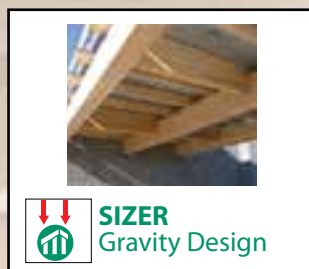
Vickers Dining Hall: Timber Systems Limited
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PHOTOGRAPHY
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Martis Camp 141

Interplay of natural
materials mimics
pattern of the forest

Truckee, CA





The Martis Valley, at the foot of Northstar California ski resort, provides the site for this family ski residence. The community's aggressive protection of the landscape has preserved a semi-rural/alpine forest environment of second growth pine and fir trees. An undisturbed landscape of 36-inch diameter pine and fir trees forms Martis Camp 141's entry court. A private terrace floats above the south courtyard and extends the major public space to the distant view. The two territories are bridged and connected by full-height glazed screens. Two-story sheds oriented south shield the main living areas and exterior patio space from adjacent properties and western storms. The built structure repeats in form the stepped and diffused light of the trees resulting in a feel of landscape intensification.





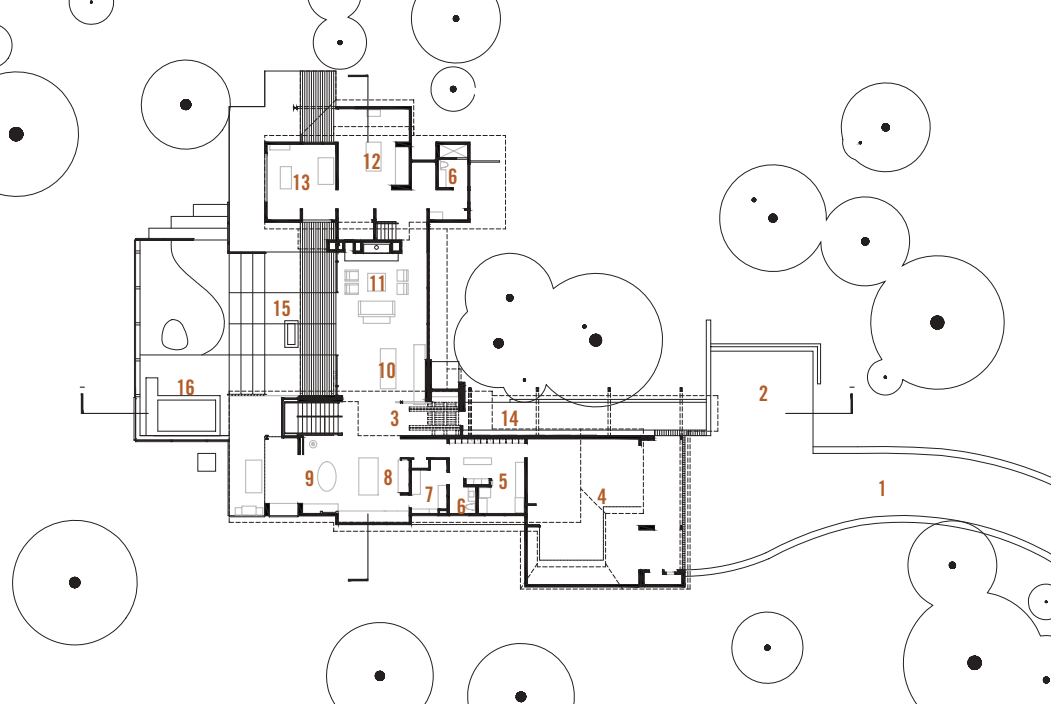




Douglas fir provides the residence framework. Advanced framing techniques and engineered open web joist floor and roof framing diaphragms provide space for mechanical and electrical routing. Natural cedar, charred cedar (an ancient Japanese preservation technique called Shou Sugi Ban), black steel panels and extensive glazing sheath the built form. Floors are covered in California walnut and concrete. A travertine marble slab fireplace anchors the open space and screens the access to the master loft. Interior cabinetry is detailed in a simple overlay design and utilizes ebonyized quarter-sawn oak with travertine work surfaces.

The house contains six private sleeping areas. The clients, with grown children, requested privacy for family and friends. Additional sleeping accommodations were





⊕ GROUND FLOOR PLAN

- | | | | |
|-----------|----------------|----------------|--------------------|
| 1. drive | 5. mud/laundry | 9. eating | 13. office/bedroom |
| 2. park | 6. washroom | 10. dining | 14. entry terrace |
| 3. entry | 7. pantry | 11. living | 15. sun terrace |
| 4. garage | 8. kitchen | 12. art studio | 16. pool |

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required for holiday gatherings. Two spaces serve secondary purposes; one doubles as an office and the other as a family media room. Five-and-a-half baths serve the sleeping areas. Additional requirements include a studio space, ski and mud room, and a butler pantry connected to a three-car garage.

Vertical continuity is created with open stairs at each side of the public space and a loft that overlooks the living area below. Interplay between solid and glazed areas is used to suggest abstraction between public and private and triggers friendly association with the light-dark pattern of the natural forest. Material selection and deployment reinforce this three-dimensional quiltwork of space. The blackened cedar, steel panels and glazing all claim kinship to the blacks and grays of the evergreen tree trunks of the surrounding woods. 🌲

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PHOTOGRAPHY
 Joe Fletcher Photography
 Oakland, CA

GOING UP WITH MASS TIMBER



T3 Office Building - six stories, 180,000 sqft prefabricated mass timber panels on glulam beams and columns - Minneapolis, MN

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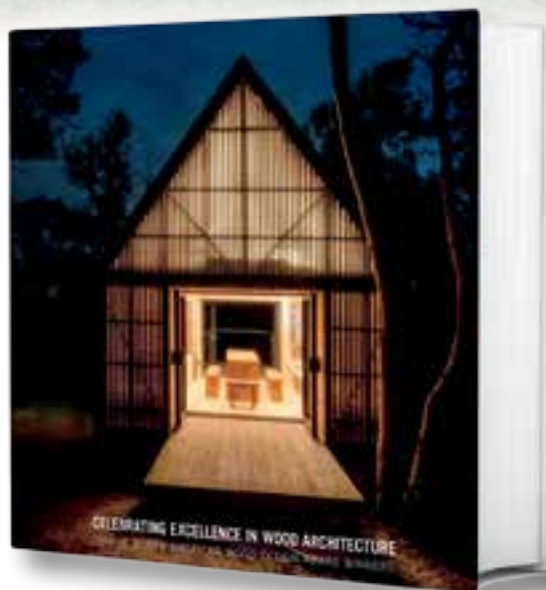


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Live Oak Bank Headquarters

Bank's beautiful yet unassuming wood headquarters sits lightly on the land

Wilmington, NC

Live Oak Bank, a privately held bank headquartered in Wilmington, NC, made it a mission to create the best workplace environment for its employees. This led to the decision to construct a new office building customized to its specific needs. The client found a piece of unused land in the heart of Wilmington and challenged the architect to create a design that disturbed the site as little as possible. Great lengths were taken to preserve trees and natural features of the site and to maximize the view connection from the offices and workspaces to the exterior courtyard and grove of live oak trees.

The owners of Live Oak Bank wanted their new headquarters to appear as natural as possible on the heavily wooded site – as if it had been there for years and grew from the ground itself. Great care was taken to preserve the existing trees and find wood siding to blend with the natural environment. To maintain the true southern feel of the building and of Live Oak Bank, cypress was selected for the exterior siding, interior ceilings and custom millwork. As the years go by, it will weather and turn a silvery gray, further camouflaging the building. Oak flooring is used throughout the interior, stained a medium color to contrast with the light cypress. The building structure is predominantly Southern yellow pine glulam beams, columns and king post trusses. The glulam is exposed throughout to showcase the structural elements and the natural beauty of the pine.

The 36,500-sq.ft. office building captures views from every workspace. Because natural light and views were critical goals, the office wings are long and slender, with interior glass walls for transparency throughout the building. These workspaces are anchored by an informal employee lounge with a double-height window wall, which offers a view of the central courtyard and the live oak grove beyond. The distinction between inside and outside is further softened by shaded terraces, active walkways, decks through the courtyard, and a second-floor balcony. Other features include a 50-seat tiered digital conference room, a fitness center and an on-site dog park.





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Treet

World's tallest timber building
extends Norwegian timber tradition

Bergen, Norway





The world's tallest timber building is an ambitious project realized by a developer who wanted to demonstrate it's possible to build high-density urban housing using environmentally friendly materials.

Norway has a long tradition of building in wood and it seemed only natural to continue and further develop this tradition. Timber construction materials have developed remarkably over the past few decades and new mass timber products offer new possibilities.

This project consists of a laminated timber structure and apartments made in modules. Everything was prefabricated, brought to the site and put together in a short period of time. The structural concept for Treet consists of four self-supporting modules, then a "power floor" as support for the next four modules, then another power floor and four new modules on top. The entire load-bearing structure is timber.

The initial concept involved leaving the exterior construction fully exposed, however, due to the extremely humid climate, the project team decided to protect the construction with glass facades on the two fronts and cladding on the two other sides. Glass hangs on two laminated timber beams which are supported by a CLT frame that forms the walls and floors of balconies. The double facade provides a glassed in balcony for each apartment, also resulting in improved insulation and sound protection from nearby bridge traffic.


One of the design challenges was to prevent the timber building from swaying excessively in strong winds. Engineers determined module construction would reduce this motion and recommended a load on top of the building, such as a swimming pool, to add weight. The idea didn't make sense given the climate, so a concrete deck was chosen as the right load.

Fireproofing of the entire construction was also carefully planned, with solutions specific to the project. All exposed wood, both interior and exterior, was fire-treated. All gaps and open areas were closed to prevent fire from spreading. The entire building is sprinkled including the CLT walls and floors/ceilings of the balconies. Treet was originally planned with wooden cladding on the west and east facades, however, steel cladding was installed to minimize maintenance requirements since the building's height and placement made some areas difficult to access. There is wooden cladding on parts of the facade where access for maintenance is considered good. These areas must be fire-treated regularly.





The building contains 62 apartments. Each apartment has a private balcony and the building offers common roof terraces and a gym. Parking is located in the concrete basement under the entrance level. A waterfront promenade and small marina are located directly outside the building.

The developer believes this project can be recreated almost anywhere and perhaps built even taller using the same system of four-on-four modules. Several instruments were built into the structure for performance monitoring by the research and university institutions which contributed expertise in the development of the project. 

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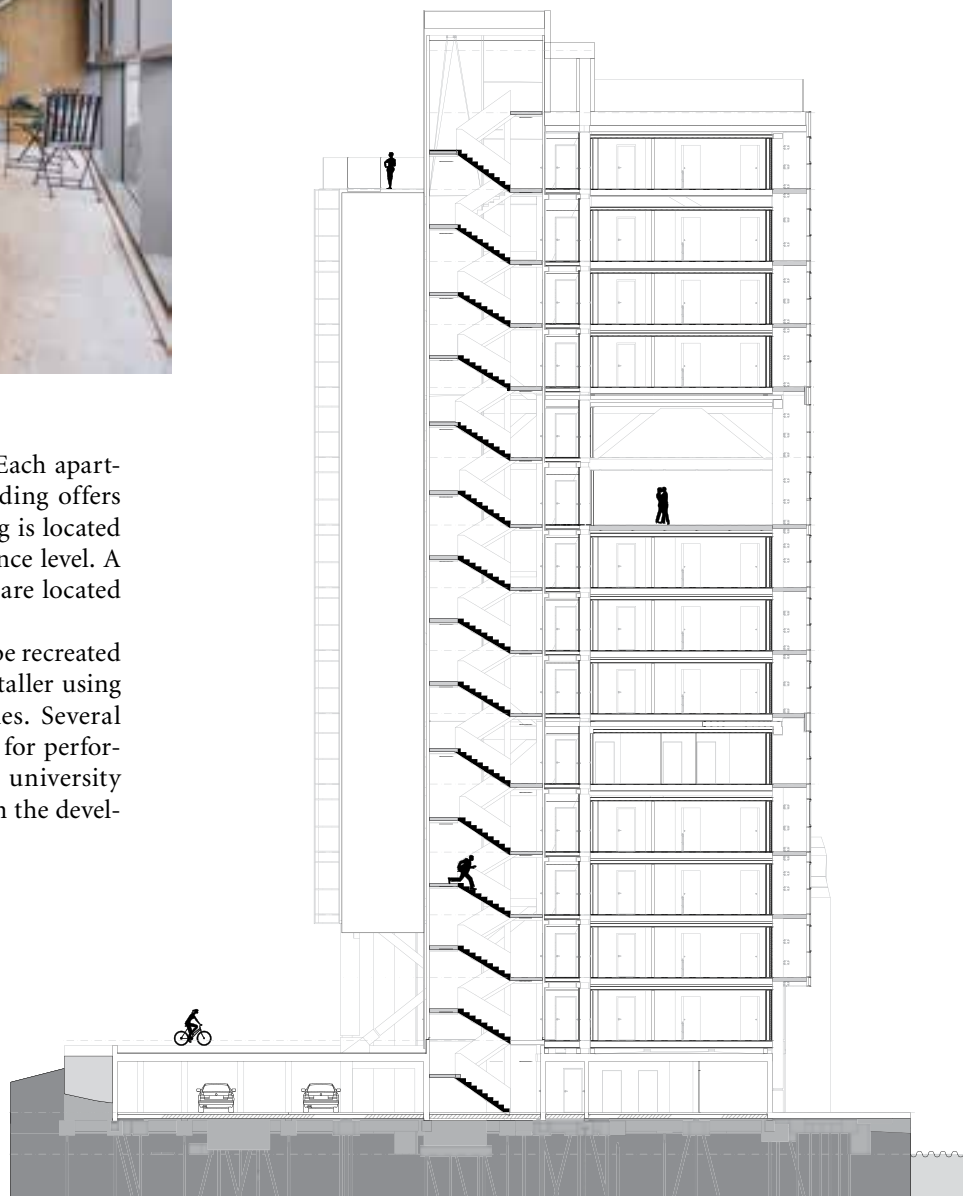
TIMBER SUPPLIERS

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Tartu, Estonia

Moelven
Moelv, Norway

PHOTOGRAPHY

JC PhotoMorten
Pedersen, Inviso



PROJECT FACTS

Internal area including basement

63,000 sq.ft.

Total area

78,576 sq.ft.,

14-story timber structure atop a concrete base

Height

162 ft. from entrance level

(173 ft. from lowest point of wooden structure)

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Site installation of prefabricated roof (courtesy of H+ME Technology).

Prefabrication for Mid-rise

Mark Kaustinen and Kenneth Koo

With ever-increasing pressure on project schedules, and economic factors including rising land and construction costs, there has been a desire to use more off-site constructed elements. Historically, prefabrication in North America began with the construction of panelized kit houses. Today, the industry has grown and systems include components, panelized elements or modular units that are built and/or assembled in a factory and integrated with the works on-site. This is done for many different types of building projects, including mid-rise (up to six stories) projects.

The Canadian Manufactured Housing Institute's (CMHI) 2014 Annual Report indicated a factory-built market share of 15% of single family homes in Canada. However, in northern Europe, the dominant approach to wood frame construction is prefabrication, with more than 80% of the market share. Presently, panelization leads the way in Europe and has captured the attention of builders and designers in both Canada and United States.

Since 2009, the province of British Columbia has permitted mid-rise wood frame construction for residential occupancies up to six stories. The 2015 *National Building Code of Canada* (NBCC) now also permits wood construction up to six stories with mixed occupancies and is an excellent opportunity for developers to increase the sellable area. The higher building heights increase the vertical and lateral demands, and require increased attention to design and construction details.

To support the use of the new provisions in the 2015 NBCC, FPInnovations published the "Mid-Rise Wood-Frame

Construction Handbook," a resource guide packed with information and guidance for construction professionals across Canada. In Canada, Wood *WORKS!* noted there are more than 250 mid-rise wood buildings either completed or in planning or design/construction stage.

For building owners or developers planning to construct a mid-rise building, it would be worthwhile to consider if prefabrication would shorten the project schedule, meet quality needs, reduce construction costs, reduce material waste, or meet other material requirements.

Types of prefabricated systems

Components

These include trusses, including engineered wood products, glulam post and beam, mass timber, and precut systems.

In North America, the common prefabricated component is the metal plate connected wood truss. Though other components are emerging, these are not included in this article.

Panelized Building Elements

Panelized elements are walls, floors, ceilings and wall systems that are either open type framed or closed (that include building paper, windows, doors, insulation, electrical chases, vapour barrier and interior gypsum and could include exterior insulation and cladding).

Prefabricated elements provide a flexible building system that improves the speed of construction and can be adapted to a wide variety of building forms. There are numerous companies across Canada and the U.S. that can provide this level



Figure 1: Transportation of floor and wall panels (courtesy of ACQBUILT).



Figure 2: Site installation of prefabricated wall and floor (courtesy of H+ME Technology).

of prefabrication, including some local truss companies. Panelized assemblies are generally two-dimensional elements since they can be transported more easily, either horizontally (flat pack) or vertically, and are less prone to transportation and installation limitations.

The following construction sequence of a mid-rise 5+1 wood-frame project (Figure 3) demonstrates the effective and quick erection of the building with prefabricated panels.

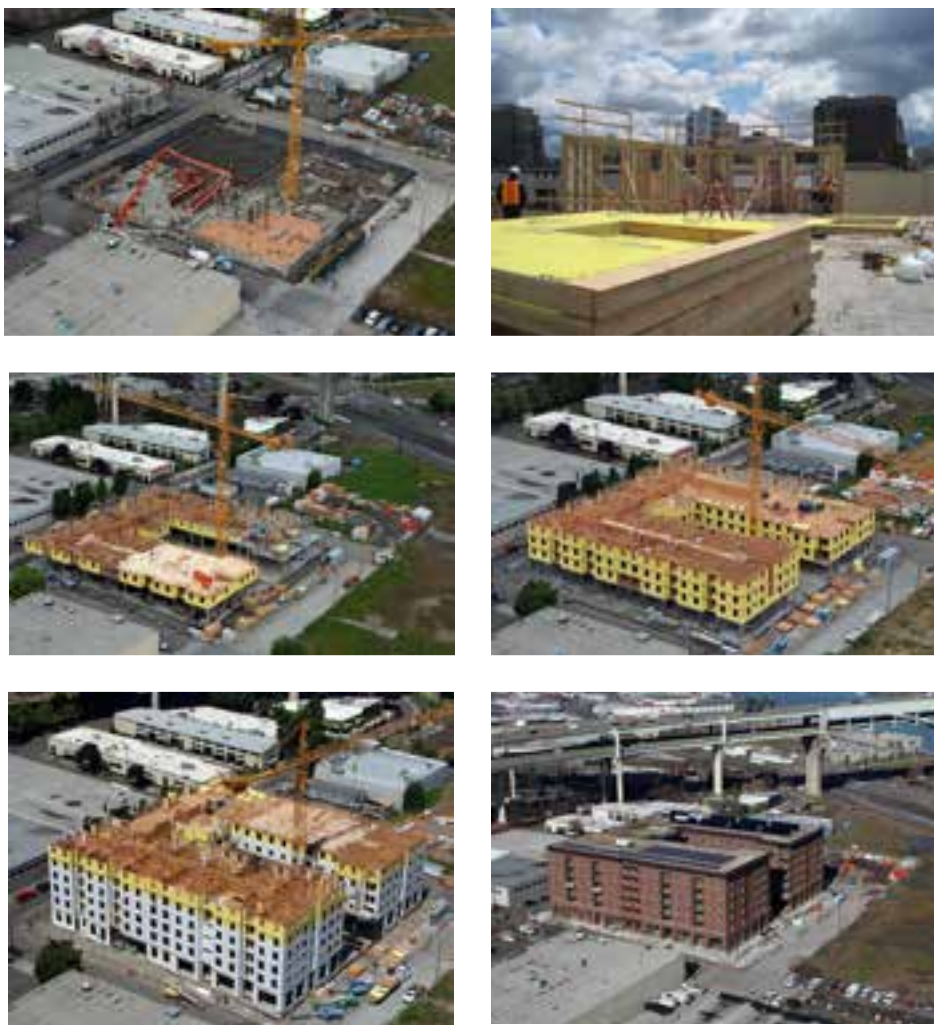


Figure 3: Construction phases of a panelized mid-rise wood-frame building (courtesy of Walsh Construction).

Modular building elements

Modular building elements are fully erected, three-dimensional modules that typically include a floor, walls (exterior and interior) and ceiling/roof. This is the most complete form of prefabrication as each module can include most of the interior finishes, insulation, plumbing, electrical, cabinets, appliances, windows, doors and in some cases, exterior finishes when delivered to the project site. Some manufacturers suggest modular building elements can arrive at the site up to 85% complete.

PRECONSTRUCTION PROCESS

Planning is the key to a well-executed mid-rise project that incorporates off-site construction. Some of the key items needed for success include:

- A project leader who will coordinate and integrate all site and off-site construction activities.
- A collaborative approach to design, a construction and manufacturing team approach to ensure a suitable, well-developed building program.
- A clear understanding of the items that need to be resolved and confirmed prior to the manufacturing start date so manufacturing flows smoothly. This is commonly referred to as the design freeze by manufacturers.

A design freeze requires many details to be resolved earlier in the project than site construction. This can dramatically reduce requests for information, site instructions and change orders because details are worked out in advance. The level of design freeze items requiring resolution prior to the design freeze is dependent on the prefabrication solution used but can include architectural, interior layout and detailing, mechanical (HVAC and plumbing), electrical, and structural design. In addition, the location and strategy for tie-ins, the exterior and interior finish strategy, and installation of all these items need to be worked out in advance of factory or site construction. Because the pace in a factory is much

quicker than site construction, interrupting the flow to change or reconsider items can cause major cost and scheduling issues that can compromise the project results.

Another critical step is to agree on a payment process that suits all parties and reflects the division of work between site and factory. The processes should be coordinated and agreed to by the project owner, the manufacturer, professionals involved with payment draws, lenders, and project insurers.

It is important to work with the relevant Authorities Having Jurisdiction (i.e. municipalities and building officials) where the building is to be located to ensure they understand the approach and are comfortable that the quality program (i.e. CSA) implemented by the prefabricator meets the AHJ's needs for review and inspections.

Architectural Design

The design team should involve the system manufacturer, general contractor and installer at the concept stage so they can devise an appropriate layout and built program that maximizes the benefits of the off-site construction system under consideration. During the design process, the team must have a clear understanding of the relevant site conditions and restraints (existing above-ground telephone and power lines, rail tracks, etc.) that may affect the shipping, transportation and installation of the building elements.

Structural Engineering

The project engineer will coordinate the complete engineering program including the off-site constructed elements, foundation design, and connection of the units or components into a cohesive system. Depending on the system, a specialized structural engineer may be involved to provide specific structural engineering design for the off-site constructed elements to ensure transportation, lifting and connection details are suitable.

Electrical Engineering

Factory-produced elements (in CSA-approved factories) with electrical components will require additional coordination for panel or module connections. Open panels should also be reviewed by the electrical team to ensure connection points are in locations that are suitable.


Mechanical Engineering (including plumbing)

Factory-produced elements with CSA-approved mechanical systems will also require detailed coordination for panel or module connections since they take up the largest amount of building space and the design of mechanical systems typically lags behind other disciplines.

Mid-rise buildings push the technical envelope of wood frame construction and require additional specialized

knowledge and expertise to ensure they perform. What is different for professionals when prefabrication is part of the construction approach is the need for greater coordination and collaboration at the front end of the project. This should be considered a shift of when the work occurs rather than an increase in effort, though for both mid-rise and prefabrication there is a learning curve to fully realize the benefits of higher quality and speed of construction.

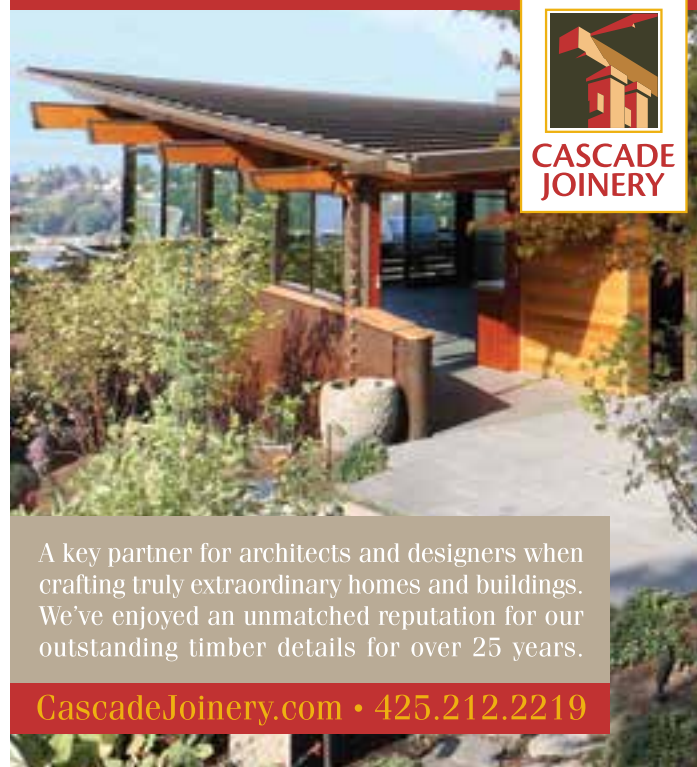
SUMMARY

Changes to the building codes to permit mid-rise wood frame construction have created new opportunities for developers which are also leading to greater technical challenges for design, engineering and construction professionals. Prefabrication is a method developers can employ to meet these requirements and capitalize on the scheduling and economic benefits this form of construction provides. Prefabrication can be a game changer for North American wood frame construction. 

For more information, contact Mark Kaustinen or Kenneth Koo at FPIinnovations.

Acknowledgement: The preparation of this article was financially supported by National Resources Canada (NRCan).

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What a Craft Tradition offers Modern Commercial Construction

Jeff Arvin with contributions from Mack Magee



This roof measures 56' x 56' and is comprised of 14 of CLT panels each measuring 8' x 56.' The panels were arranged in two perpendicular layers. The layers were stitched together with approximately 6,000 fully threaded screws.
PHOTO CREDIT: Trillium Dell Timberworks

Many of the tools and techniques used by modern timber framers today would be recognizable to 14th Century carpenters. Others, however, such as computer-aided manufacturing, would baffle and mystify the old guys even though many of the most advanced construction technologies are founded on basic principles that timber craftsmen of any era follow. In fact, these traditional principles are essential to success with many modern methods and materials.

When a craft like timber framing meets mainstream building practices, sparks can fly. For example, timber framers can drive designers crazy with their demands for a level of detail that is uncommon at the outset of a typical building project – drawings dimensioned to 1/32" are common in timber framing, but uncommon in conventional practice. While such demands may cause other professionals grief, they also produce exceptional results.

The ability to plan and visualize details before tools touch material is critical to success in timber framing, and is learned in the cradle. From their first mortise and tenon, timber crafters from any era learn to think in three dimensions and learn to anticipate the steps needed to convert raw timber into useful pieces. Given that specialized competency, it's not surprising that modern timber framers were among the early adopters of three-dimensional design software, and continue to quietly lead the building industry in its use. It was a natural transition based on long experience. From use of 3D drawing software, it's a short leap to the use of sophisticated CNC fabrication. Indeed, CNC fabrication is increasingly common in modern timber frame practice because the technology is based on the essential and traditional values of the craft: anticipation and visualization.

Next, consider mass timber. Mass timber offers designers and builders chances to push the limits of wood construction, even if, from a craft perspective, the material may be unappealing to some people. On the surface, mass timber appears to be antithetical to the timber frame aesthetic – a completely manufac-

tured product in which wood is pushed to shapes and dimensions well beyond natural limitations. The material is many steps away from the forest but, for whatever it lacks in romance, success with fabricating and installing it requires skills and techniques taken directly from the timber frame workshop.



An edge-halved and tabled scarf joint with under-squinted abutments and opposing wedges demonstrates the precision and accuracy in crafting of wood-to-wood connections typical of historic timber framing.
PHOTO CREDIT: Maine Post and Beam

Timber framers take great pride in fashioning timber joinery that requires nothing but thoughtful geometry and wooden pegs or wedges. Loads imposed on timber to timber connections in a six-story wooden structure, however, are likely to exceed the capacity of traditional wooden joinery so wood to steel to wood connections are needed. These also require high-level execution. Precision and accuracy are important, not only because it is difficult and costly to correct error in unforgiving materials like steel and mass timber, but also because the connections are likely to become a visible part of a finished environment and inaccurate work is not desirable or attractive. In all timber frame shops, it's common practice to strive for exceptional degrees of accuracy and precision. This is how a finely crafted environment is achieved; it's also how discouraging costs, such as those that might arise when an installation crew of four to six people and an expensive crane and operator are stopped by an inaccurately fabricated connection, are avoided. Those costs could be substantially mul-

PERSPECTIVE

Cross-laminated timber is often supported by and connected to glulam timbers of large dimension. Bringing these two large-format technologies together in commercial construction requires them to have consonance in their tolerance and manufacture. CLT panels, which have been manufactured for 30 years in Europe for a market that requires accuracy and precision in both residential and commercial timber construction, are measured in millimeters, even for massive panels that can be up to 10 feet in width and 260 feet in length. The same technology of very large and long CNC machines is employed to manufacture and fabricate glulam timbers which allows large-scale buildings in all three dimensions to be built to what we in North America would consider very close tolerances in spite of the deleterious potential of the additive nature of slight deviations.

Before the revival of timber framing in North America and the use of CLT for main structural elements, the lack of close tolerances was not an impediment to function or beauty in our built environment. Platform framing, whether in residential or commercial construction, allowed for necessary adjustments to be made as the structure is assembled on-site. In

Europe, the use of prefabricated structural elements which could not be easily adjusted on site (due to both technological and site constraints) drove the mass timber industry in Europe to increase manufacturing and fabrication accuracy to remain competitive with other structural systems. The building culture in North America has not had an impetus to develop this competency until now.

It is precisely this competency – which is essential to successful mass timber construction – that timber framers can bring to a project. It is a truism that it takes 30 years to integrate a new technology into the construction industry. There may be many causes for the innovation cycle to stretch this long, but it is sensible to suspect that at least one of the leading reasons is that builders cut their teeth on the technologies used early in their careers and these technologies become a part of their professional practice. Moving beyond an established norm, particularly when the innovation is more demanding, is almost always uncomfortable.

For timber framers, precision is a way of life, an established norm present in all their work, including commercial construction.

Mack Magee

tiplied on the urban site of a multi-story project and the cost of replacement materials makes errors even more expensive. Whether considering a 36-foot long 10" x 14" white oak timber, or an eight-foot by 40-foot cross-laminated timber panel, too short is too short, and these materials can't be replaced by running down to Lowes or RONA. The culture of accuracy and precision established and required by timber framers in the old days is equally important today in the use of modern manufactured materials.

The traditional craft values of anticipation, visualization, accuracy and precision lend themselves well to off-site construction and pre-fabrication, which is important for those wishing to employ mass timber since its size and weight makes on-site fabrication virtually impossible.

For timber framers, careful material


handling is second nature. The timbers have always been bigger than the framers so all shops are equipped to carefully handle big, expensive pieces of wood – not only in the shop but also at the building site. Protecting the edges and finishes of timbers until they are installed is a developed skill. Following industry best practices, almost all timber frame companies train and certify crew members in the use of forklifts and tele-handlers. Many shops also have overhead cranes or conveyor systems. Working on finished goods, even if they weigh hundreds of pounds, requires thought and care so shops make sure they have clean rigging and use edge protection to avoid stains and dinged edges.

Anticipation and pre-planning are essential for successfully installing heavy timber systems of all types. Modern timber framers are equipped with the specialty skills,



PHOTO CREDIT: Trillium Dell Timberworks

tools and techniques to install what they fabricate. It's one thing to wrestle heavy sticks with your feet on the ground, and quite another to assemble them high in the air. Modern installations are pre-planned, often complete with a set of schematic drawings depicting where to stage materials, locate the crane or other lifting devices and including diagrams (event animations!) for rigging and lifting complicated assemblies. Components are frequently indexed and bundled in order of use. Most experienced raising bosses plan and stage preassemblies to minimize crane time. An experienced timber frame installer combines the skills of carpenter, iron worker and rigging engineer. Pre-planning pays dividends in decreased costs and increased safety.

Modern timber framers aren't simply guys with beards and big chisels. They are participants in a living and evolving tradition, based on timeless principles, that has tremendous relevance for modern commercial construction. 

Jeff Arvin is Executive Director, Timber Framers Guild. He can be reached at jeff@tfguild.org. Mack Magee is President, Timber Framers Guild. He can be reached at m@tft.com.

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Demystifying the Acoustics of Wood-frame Buildings

Cathy Gagne

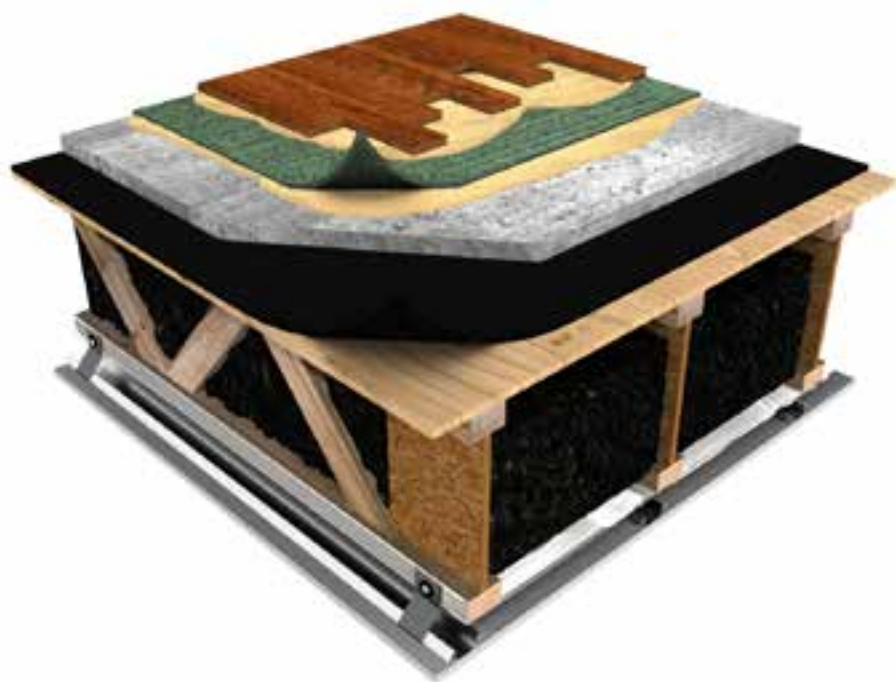


Figure 1 – Wood-frame structure, example assembly

Unwanted impact noises such as walking in high heels, dropping objects, moving furniture, and running children, or airborne noises such as loud music, television, and talking are a leading cause of lawsuits in multi-unit properties. Because of these noise concerns, owners are showing increased interest and expectations in the sound performance of their units.

Sound dampening in multi-unit buildings is essential for occupant comfort. The following information may be helpful when navigating through this complex, and often misunderstood field.

Four Factors to Consider

- **Mass & Density:** When it comes to sound transmission between floors, it's important to note that similarities do exist between airborne and impact noises. However, impact noises are far more complex to measure, classify and control. Because impact noises generate much more energy than airborne noises, they can travel more easily through a building's structure. Mass and density amplify impact noises while the transfer of airborne noises is decreased.

- **Resilience:** Essentially refers to decoupling dense materials with products that absorb vibrations.
- **Cavities:** Unsealed cavities (air space) in the structure, such as uninsulated spaces between joists, amplify the transmission of sound.
- **Seals:** Where air can pass, so can sound. Quality of the construction affects the overall acoustic performance of the building.

The Role of Each Component in an Assembly

Achieving acoustic efficiency depends on multiple factors. Meeting or exceeding occupant expectations depends on using the right “ingredients” (components/materials) in the right places to create the desired acoustical “recipe” (floor/ceiling assembly).

It is imperative to analyze the **type of building structure**. As an example, an eight to nine-inch concrete floor/ceiling slab between storeys, without a suspended ceiling, can achieve an average rating of FIIC 32 on its own (bare structure without floor covering). Adding a suspended ceiling to this same structure can increase the rating to FIIC 45. A wood-frame building will perform differently, depending on the materials in the floor/ceiling assembly (type of joist, insulation, acoustic suspension, number of gypsum board, etc.). Obviously, the nature of the construction will have a decisive impact on its acoustic potential, independently from the choice of floor covering.

To create the most effective acoustic assembly, it's important to know what **type of flooring** will be installed (glued or floating engineered wood, nailed hardwood flooring, vinyl flooring, ceramic tiles, etc.) since this information will guide you to the appropriate acoustical membrane category for your building. If the flooring type is not considered, the membrane's mechanical strength may not be sufficient enough to absorb the energy from the natural variations of the floor. For instance, vinyl flooring does not perform the same way as ceramic tile flooring. Ceramic tile, being a harder material, generally offers a lower performance for impact noises; however, when all details of the assembly are considered, it is possible to achieve excellent acoustic efficiency even with ceramic tile flooring.

In addition to the building structure and structural materials, the **type of acoustic membrane** chosen to go under the floors plays a significant role in the acoustic performance of the whole project. Mainly designed to mitigate the transfer of impact noises, the right acoustical membrane will effectively absorb vibrations as close to the source as possible, preventing these vibrations from gaining speed through the structure. It is important to understand that the "right" membrane can be completely different from one project to another. An efficient acoustic design is the result of the combination of different components in the assembly rather than individual elements.

Concrete is an excellent acoustic insulator for airborne noises, however, since it is a very hard material, it easily transfers vibrations therefore reducing the acoustic performance for impact noises. This means it is imperative to decouple the concrete topping from the rest of the structure with a resilient material. According to research by FPIInnovations that is borne out in multiple case studies, an acoustic membrane under a concrete topping over top of a CLT structure (cross-laminated timber) can add seven to 18 points on the FIIC rating of acoustic performance. A rating of FIIC 55 would become at least FIIC 62, for example. From the most effi-

cient to the least efficient, the materials most frequently used are rubber, felt and wood fiber ("Tentest"). A rubber underlay installed beneath a concrete topping can substantially increase the acoustic performance of a project.

From a sound transmission point of view, it is also essential to fill the **cavities between joists** as much as possible. Voids create resonance (the drum effect) so gaps must be filled with an insulating or absorbent material to improve a building's acoustic performance. Filling the joists with insulation from 50 per cent to 70 per cent of its height is considered best practice. Blown insulation should be installed to the full height (100 per cent) because it will eventually settle to about 65 per cent.



Figure 2 – drywall suspension



Figure 3 – resilient channel

Drywall suspension systems (figure 2) and **resilient channels** (figure 3) are used to optimize acoustics. Resilient channels (a means for attaching gypsum board to the supporting structure without allowing the two to touch. This de-coupling of the gypsum board from the framing reduces sound transmission) can add an average of six to seven points of acoustic performance

compared to simply attaching the drywall to the joist. Suspension clips (rather than attaching the metal furring (metal channel) directly to the wood beams or joists, they're suspended by insulators which have a rubber insert that absorbs shocks and vibrations, reducing the noise level to the floor above) can add an additional four to nine points of acoustic performance to a floor/ceiling assembly.

Gypsum boards (drywall) bring mass and density to a floor/ceiling assembly, helping reduce the transfer of airborne noises. Using two gypsum boards instead of one provides added acoustic performance of two to five points. A 5/8-inch thick gypsum board is preferable to a half-inch thick as the objective is to have as much mass as possible to avoid flanking (the lateral transmission of sound by the vibration of construction materials which constitute the supporting element of the floor (load-bearing walls)).

These same principles can be applied to structures built with different materials including concrete or steel.

Conclusion

Achieving acoustic performance depends on a combination of many complex factors. In addition to the building structure and materials, the type of acoustic membrane has a significant impact on the acoustical performance of a project, mainly in terms of mitigating impact noise.

Because each element of a construction envelope performs uniquely on its own, it makes accurately determining the acoustical performance of an unfinished building difficult. In order to make educated decisions, we must have a better understanding of acoustics and of evaluating the consequences of recommendations. There is no miracle product; a combination of solutions is the key to achieving optimal acoustic performance. Every project is unique and requires collaboration with professionals that can offer the proper guidance in this process. 📌

Cathy Gagne is Sales & Development Coordinator at AcoustiTECH. She can be reached at cagagne@acousti-tech.com or 1-888-838-4449, ext.235.

W o o d W A R E



Photo Credit: Tõnu Tunnel

Megaphones

Deep in the forest, on the edge of Estonia, three massive wooden megaphones lie scattered between dark-barked fir trees. This is Ruup, a philosophical apparatus designed and built by first-year interior design students from the Estonian Academy of Arts, which enables and encourages visitors to both notice and listen to the sounds of the forest. The story of Ruup began when students visited the forest looking for inspiration for a forest library

project. Rather than locating books in the forest, student Birgit Õigus was inspired to make the forest itself the book and fill its pages with the chirps of birds and the crunch of the leaves. Built out of larch, Ruup offers a place to rest your feet, as well as your thoughts. Sit, sleep, think, listen. Ruup is an open library with just one book: nature. 📖

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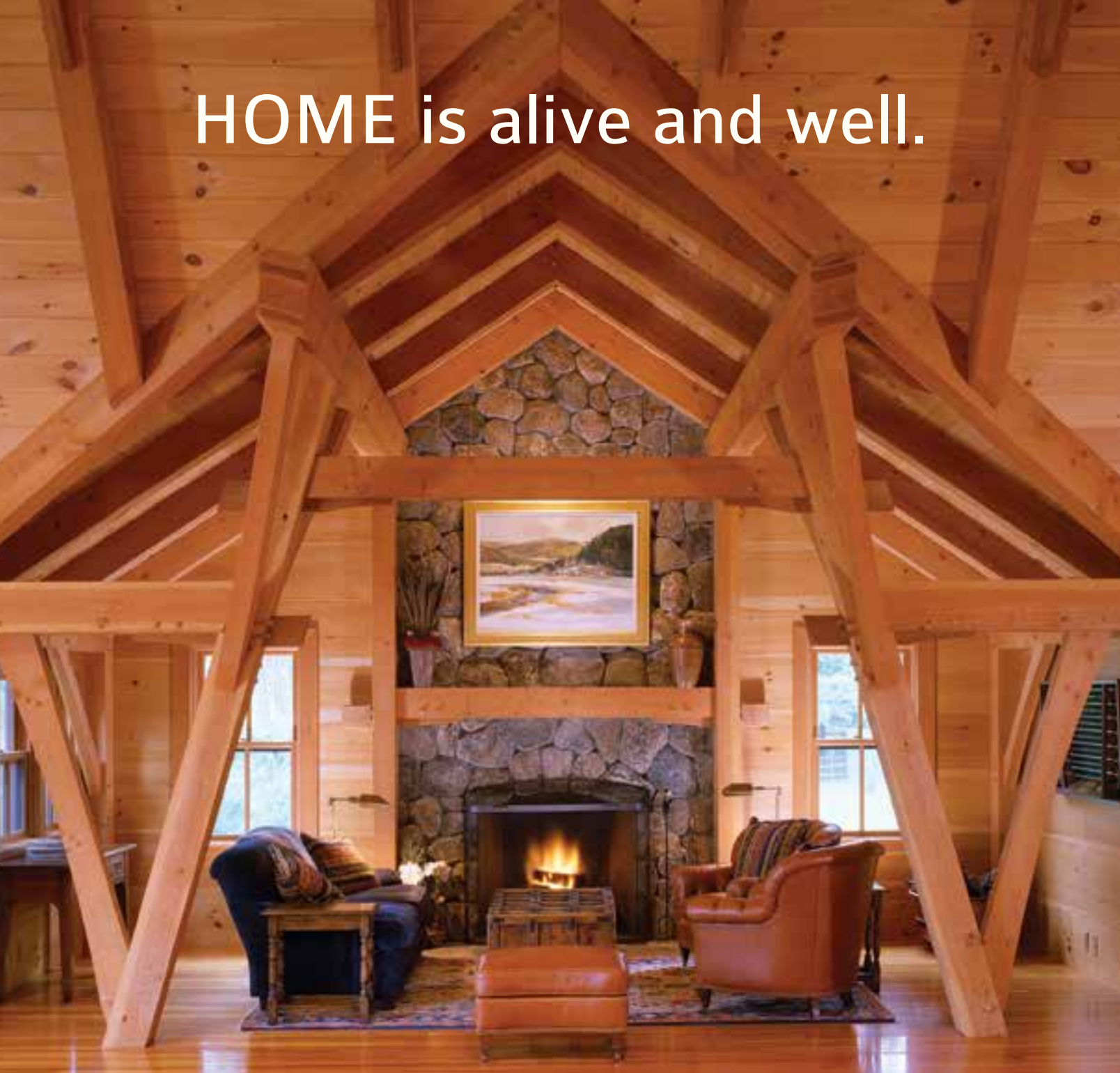
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