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Summer 2015 — Number 70

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Aspen Art Museum
Wood screen and roof structure are signature of new gallery

Cost Analysis
Mass timber a competitive choice for low-rise commercial

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Above and **on the cover:** ASPEN ART MUSEUM, ASPEN, CO
PHOTO CREDIT: Michael Moran/OTTO

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BRINGING BACK *Play*

The recently released *ParticipACTION Report Card on Physical Activity for Children and Youth* in Canada is a dismal document. It asks, in an era of schoolyard ball bans, bylaws that restrict tobogganing and parents' frequent calls of "Be careful," are we limiting our children's ability to engage freely in active play outdoors? It's time to get out of kids' way, let them play outside and give them the freedom to occasionally scrape a knee. This is something I practice with my own family.

What many adults recall from their childhood as thrilling and exciting play that tested boundaries – such as exploring the woods, moving fast or playing at heights – is often called risky play these days. (While these activities could lead to injuries, the vast majority are minor. The fear of stranger abduction is also disproportionate to the risk, the report says, with the odds estimated to be about one in 14 million.)


Before


After

ParticipACTION is a national non-profit organization that works to make physical activity a vital part of everyday life. Though the organization was originally established in 1971, the idea of free outdoor play is a movement growing in popularity. A new campaign for Go RVing calls on parents to "Bring back wildhood" and shows families exploring, playing and getting dirty outside.

A Google search reveals a plethora of companies who build "natural playgrounds" which forgo plastic materials for wood structures children can manipulate in multiple ways.

I know of two local schools that are going natural in their playgrounds. Reesor Park Public School in Markham, ON, will use "rocks, logs and grasses that will integrate the playground with the adjoining forest" and "remain connected with nature." Fundraising is ongoing. At Elgin Court Public School in St. Thomas, ON, (left) students have a new outdoor classroom, quiet reading space and garden, thanks in part to a $20,000 "Sustainable Revitalization" prize which includes landscaping greenery and products made of recycled tires.

When you can't get outside, take the time to enjoy local museums and performing arts facilities. Many are wonderful examples of an architect's creative play with wood, like the Aspen Art Museum we've featured on p. 11. Shigeru Ban's long-span timber space frame roof structure forgoes metal joints in favor of long wood screws. The playful basketweave facade offers a glimpse of what is inside.

Young or old, make time this summer to let your feet and your mind wander freely. The world is your playground.

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...

In honor of "play" and the Pan Am/Parapan Am Games, taking place in Toronto beginning in July, I rounded up some of the new venues that play with the use of wood.

PHOTO CREDIT: James Lai

Cisco Milton Velodrome

The Cisco Milton Velodrome features a 250-meter timber track with two 42-degree banks for cyclists. The oval-shaped, three-storey velodrome is the first of its kind in Canada and only the second meeting top international standards in North America. The track is constructed of smooth, untreated Siberian spruce, renowned for its hardness, stability and long, straight lines. The track is rated for speeds of up to 85km/hr.

PHOTO CREDIT: Bondfield Construction

Markham Pan Am Centre

The Markham Pan Am Centre is a 147,000-sq.ft. multi-sport center and home of four Pan Am/Parapan Am competitions: badminton, table tennis, water polo and para table tennis. B+H Architects says wood, especially Douglas fir, plays an important role in the project as a signifier of warmth and natural materials. The project includes large glulam trusses spanning the pool, prominent use of wood as a finish in the primary feature stair and reception area, suspended ceilings throughout the Centre, and an engineered wood sport floor in solid maple for the field house.

PHOTO CREDIT: www.mottmac.com

Pan Am Shooting Centre

The venue has a distinctive profile inspired by the maple leaf, and incorporates green materials such as timber to blend harmoniously with its surroundings. Magma Architecture says the facade is constructed from low-priced and widely used H2 utility poles with an orange stain.

ABBIES 2014 Award Winner

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Treehouses

Lekha Kanagasabai

Treehouses have been reclaimed from childhood memory and reimagined as adult sanctuaries. Designers around the world have taken this childhood classic to new levels, creating unmatchable wooden structures for magical treetop escapes. Each of these structures aims to preserve nature while creating an extraordinary experience that will help people to understand and appreciate their surroundings.

In Japan, designers at Nendo have installed a sanctuary for birds and bird watchers alike. Designed for the Ando Momofuku Center, one side of Bird Apartment holds one person, giving him or her a close-up view of the other side of the house, which provides 78 nest spaces for birds.

Inspired by the enchanted forest that houses the structure, The Redwoods Treehouse restaurant in Auckland, New Zealand, is a venue for corporate events, intimate weddings and other celebrations. Designed by Peter Eising of Pacific Environment Architects, this elegant pod is constructed of vertical fins and slats built from sustainably grown pine and poplar, and can hold up to 50 guests.

The Free Spirit Spheres employ sailboat construction and rigging systems to create a floating spiritual haven in the trees. Tom Chudleigh is the genius behind the cozy spheres suspended within a west coast rainforest on Vancouver Island. Chudleigh's vision for the handcrafted structures was to provide a place for occupants to experience nature at its fullest without the concrete, foundation, or destruction that often results from the development of new man-made structures.

Built secretly in the backwoods of Whistler, The HemLoft was a four-year personal oeuvre for carpenter Joel Allen. The self-funded structure hovers above a small patch of federal government-owned land. The egg-like structure stands amongst a sea of green, deep in the forests of British Columbia.

1

2

3

4

1 The Redwoods Treehouse
Auckland, New Zealand
PHOTO CREDIT: LUCY G.

2 Bird Apartment
Komoro City, Japan
PHOTO CREDIT: DAICI ANO

3 The HemLoft
Whistler, BC
PHOTO CREDIT: JOEL ALLEN

4 Free Spirit Spheres
Qualicum Beach, BC
PHOTO CREDIT: TOM CHUDLEIGH

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Accsys Technologies Wins 2015 Engineering Innovation Award

The Forest Products Society (FPS), a non-profit technical association, recognized Accsys Technologies for excellence in the discipline of wood engineering, awarding the company the 2015 Engineering Innovation Award. Given to a company that has made a significant contribution to the field of wood engineering with a product that already has or will measurably impact the marketplace, the 2015 Engineering Innovation Award was granted to Accsys Technologies for its Accoya wood. Through a process called acetylation, Accoya is made unrecognizable as a food source to insects, protected from fungal decay, and made more resistant to swelling and shrinkage. Accsys Technologies requested that the $500 honorarium sponsored by the American Wood Council be donated to the Forest Products Society's Student Scholarship Fund.
www.forestprod.org/ic/awards.php

Tree Mapping Web Tool Proves Every Tree Counts

Toronto Parks and Trees Foundation, Ryerson University, and the City of Toronto have launched the Every Tree Counts campaign, an effort to bolster Toronto's tree population. As part of the initiative, participants are encouraged to use Citytrees, a tool that allows the tracking, mapping and counting of the trees being planted. Once a tree is uploaded into the app, its growth can be monitored and its health evaluated. The app includes the opportunity for the public to share their input. City of Toronto councillors, Michelle Berardinetti and Glenn De Baeremaeker, kicked off the event in June by planting the campaign's first two trees.
http://ryersonnc.ca

Engineered Wood Association's Safety and Health Awards Announced

APA – The Engineered Wood Association has announced the winners of its 2014 Safety and Health Awards. The annual awards program, which began in 1982, acknowledges the management and employees of companies and mills with achievements that include the lowest Weighted Incident Rate (WIR), Safety Innovation, Safety Improvement, Annual Safety and Health Honor Roll, Three-Year Safety Award, and Incident Free Honor Society, with certain awards further divided based on the type of product produced. In recognition of safety and operational excellence in the North American structural panel and engineered wood industry, awards were given to Anthony EACOM Inc., Boise Cascade Company, Louisiana-Pacific Canada Ltd., LP, Norbord, RoyOMartin, and Weyerhaeuser.
www.apawood.org/awards-program

Nominations Open for Forest Industry Aboriginal Business Award

The Forest Products Association of Canada (FPAC) and the Canadian Council for Aboriginal Business (CCAB) have begun receiving nominations for the 2015 Aboriginal Business Leadership Award. Now in its sixth year, the $5,000 annual award recognizes First Nations entrepreneurs that demonstrate outstanding leadership, environmental and safety performance, and delivery of high-quality products and services in the forest products sector. Nominees are judged against six criteria: business leadership, longevity, employment of Aboriginal peoples, safety and environmental performance, consistency of goods and services provided, and commitment to the Aboriginal community. With more than 1,400 Aboriginal-owned businesses and more than 17,000 Aboriginal workers in Canada, this award celebrates the contributions and accomplishments of Aboriginal Canadians in the forest products sector.
www.fpac.ca/index.php/en

Coalition to Promote Canada's Sustainable Forestry practices

Municipal officials and forest industry representatives from Quebec and Ontario met in Ottawa recently to ask the various levels of government to increase efforts promoting the sustainable forestry practices of Quebec, Ontario, and Canada on the international stage. The forest industry is Quebec's largest industry, and Ontario's second-largest, generating $15.8 billion and $11 billion respectively, in annual revenue. The Coalition noted that the industry follows some of the most stringent forest practices in the world, carries out its activities sustainably and responsibly, and provides quality jobs to thousands of workers in the two provinces. The Coalition wants the government to make it a priority to educate the rest of the world about Canadian forestry's sustainable and responsible practices, placing a focus on innovation and wealth-creation.
http://fqm.ca

Architect Ranks Set to Grow Faster than Ever

According to the National Council of Architectural Registration Board's (NCARB) *2015 NCARB By the Numbers* report, a record-high number of architectural candidates are working toward earning their architect license. In a preview of the report that will be released in July, numbers show that more than 37,000 candidates reported experience hours for the Intern Development Program (IDP) or were testing for the Architect Registration Examination (ARE) in 2014. The numbers also indicate increases over 2013 in the number of new candidates (4% increase), IDP completions (85% increase), ARE completions (17% increase), and total licensed architects. More detailed information, including demographic, gender and minority, accreditation, and year-over-year completion specifics, will be available when the full report is released by the NCARB in July.
www.ncarb.org/Publications.aspx

Spinnova Develops Wood Fiber Yarn

Spinnova Ltd., a research and product development company out of Finland, is developing fiber to yarn (F2Y) technology, an environmentally friendly technique that uses no dissolution chemicals to treat the pulp fibre. Marketed as sustainable and cost-effective, this technology is unique because it can manufacture yarn directly from wood fibers without the need for chemical processing. Spinnova's wood fiber yarn project is generating attention after winning the Ministry of Employment and the Economy's biorefinery competition in February 2015 and attracting approximately € million in investment. The inventor of the technique, Juha Salmela, the company's CTO, discovered the innovation in the VTT Technical Research Centre of Finland Ltd.'s pulp and paper sector research.
www.spinnova.fi

World Record Attempted for Most Trees Planted in One Hour

The Sustainable Forestry Initiative Inc. (SFI) recently organized an event to plant more than 200,000 trees in 28 different communities across North America during a one-hour period. With more than 1,100 participants in total, the event brought together teams of 25 to 100 people in locations from New York City to Vancouver Island, aiming to inspire responsible forest management and sustainable communities while also building up North America's tree canopy. The Sustainable Forestry Initiative Inc. is an independent, non-profit organization that promotes sustainable forest management through standards, research, conservation partnerships and community building. Official confirmation from Guinness World Records is expected in six to eight weeks from the May 20th world record attempt. Recent news reports say a team of 100 volunteers in Bhutan had set a new world record by planting 49,672 trees in one hour, 10,000 more trees than an Indian team three years ago.
www.sfiprogram.org/community-conservation/sfi-implementation-committees/guinness-world-record-attempt

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Aspen Art Museum

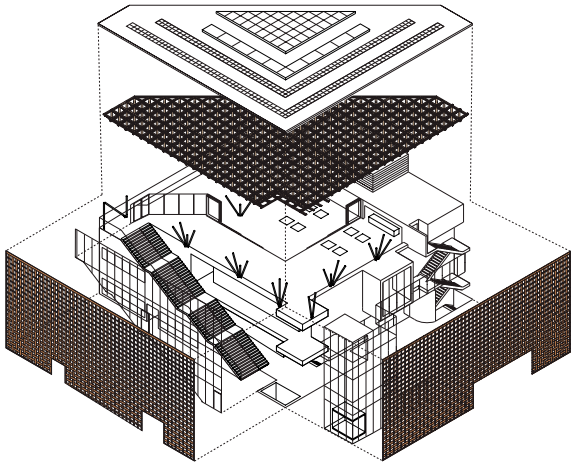
Prefabricated timber roof utilizes wood screws

Aspen, CO

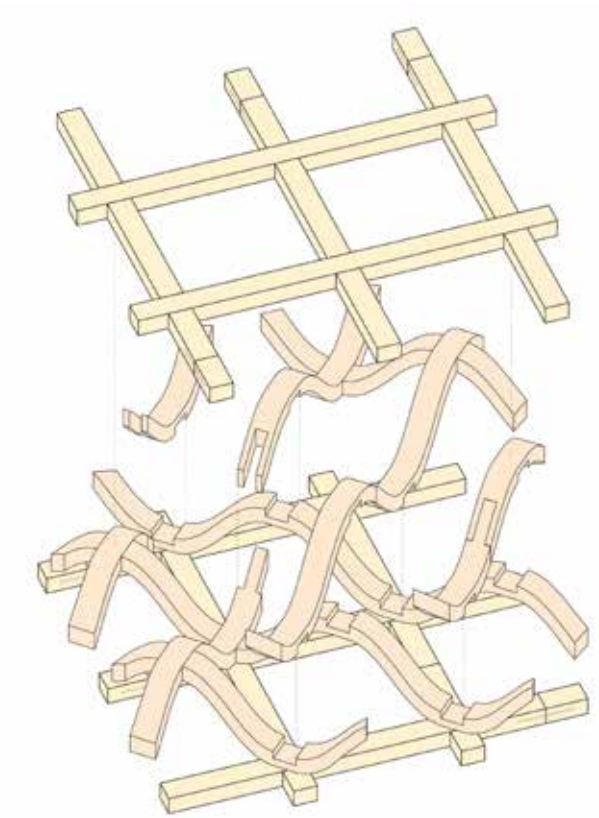
The New Aspen Art Museum is located in the center of the high mountain town of Aspen, CO on a prominent downtown corner site. The three-storey structure provides galleries on the first two floors above ground level and on one floor below. The third floor is a multi-function space and cafe. Half of the third floor area is given over to an outdoor terrace with views of the mountains. Design features include a long-span timber space frame roof structure, woven composite wood panel facade, structural glass floors for gallery daylighting, outdoor gallery staircase which connects the site plaza to the third floor roof level, and glass elevator.

Innovation

The timber space frame roof structure is an unprecedented prefabricated system that eliminates fabricated metal joints between truss chords and webs. The strength of the wood connections is the result of the geometry of the timber elements which are connected with long wood screws.



AXOMETRIC



The innovative climate design concept for the building relies on a "Thermos" principle, where spaces with a higher tolerance for climate variation are wrapped around the gallery spaces where climate variation must be minimized. The "wrapper" spaces support circulation and visual connections to the outdoors. The entire upper level of the building may be opened to the outdoors by retracting a large-scale wall system, further enhancing the connection between inside and outside. This is a very unique feature for an art museum.

Sustainability

In addition to the innovative climate design, the building maximizes opportunities for daylighting while mediating direct solar gain. The unique woven exterior screen and long-span timber space frame supporting the roof diffuse light entering through the extensive glass curtain wall and skylight system. Structural glass floors further enhance daylighting of gallery spaces.

PROJECT FACTS

Building Area
33,000 sq.ft.

Completion Date/Opening Date
August 2014

CLIENT
Aspen Art Museum
Aspen, CO

ARCHITECT
Shigeru Ban Architects
New, York, NY

EXECUTIVE ARCHITECT
Cottle Carr Yaw Architects
Basalt, CO

STRUCTURAL ENGINEER
KL&A, Inc.
Golden, CO

IN ASSOCIATION WITH
Hermann Blumer (Creation Holz GMBH)
Herisau, Switzerland

with SJB Kempter Fitze AG

GENERAL CONTRACTOR
Turner Construction in association with Summit Construction
Aspen, CO

SPECIALTY TIMBER FABRICATOR
Spearhead
Nelson, BC

PHOTOGRAPHY
Michael Moran/OTTO

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Architect: KMBR Client: Surrey Christian School Ed White Photographics

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Elizabeth II

Innovative clips hold wood against the house, still allowing natural movement

Amagansett, NY

Architecture is often about the visual sense, with less regard for the other faculties of perception. The location of this house, in the heart of a bustling resort town, demanded special consideration of the auditory sense. Research in architectural acoustics drove the form, materials, and detailing of the house, not only to shield the property from the sound of the village, but also to manipulate interior details to create a unique acoustic character for the house, one that will instill lasting memories for the family and their guests.

The house is comprised of a series of parallel walls that provide layers of privacy and insulation from the sound of the village. The walls project beyond the living spaces and ascend in height, building from a human-scale wall at the entry to a high wall along the center of the house. The walls diffract the sound waves moving past them, casting an acoustic shadow over the property to create a quiet outdoor gathering area.

The walls are built with insulated concrete forms. The wall assembly is nearly 20 inches thick and is comprised of a poured concrete core that is continuous from footing to roof, wrapped in insulating foam that also served as formwork during construction. These walls provide thermal insulation and low sound transmission coefficient.

The custom stainless steel clips that attach the wide cedar board siding to the walls were designed to prolong the life of the siding. Traditional wood siding eventually fails because the natural expansion and contraction of the wood is constricted by the screws or nails that rigidly fasten it in place, slowly pulling out the fasteners or splitting the wood. The spring-like clips, however, hold the boards in tension against the house while allowing freedom for the natural movement of the wood.

Inside, variations on the clips are used for robe hooks, cabinet pulls, and as hinges for an adjustable sound baffle in the central gathering space. The hinges hang cedar boards in front of a felt panel with spaces between them. Sound waves pass through the gaps between the boards, are trapped behind them, and absorbed by the felt. The hinges allow the spacing of the boards to be adjusted so the room can be acoustically tuned for intimate gatherings or boisterous parties. The white oak staircase is also tuned to create a subtle

acoustic experience. The stair treads taper in thickness, changing the pitch of footfalls as one ascends from the woodshop in the basement, past the main floor with public spaces, guest room, and master bedroom, up to the children's rooms on the upper floor.

The research of sound and how it affects our perception of space informed the details, materials, and form of the project. This approach to the design led to a richer and more meaningful home for the family.

ARCHITECT
Bates Masi + Architects
Sag Harbor, NY

STRUCTURAL ENGINEER
Steven L. Maresca
Hampton Bays, NY

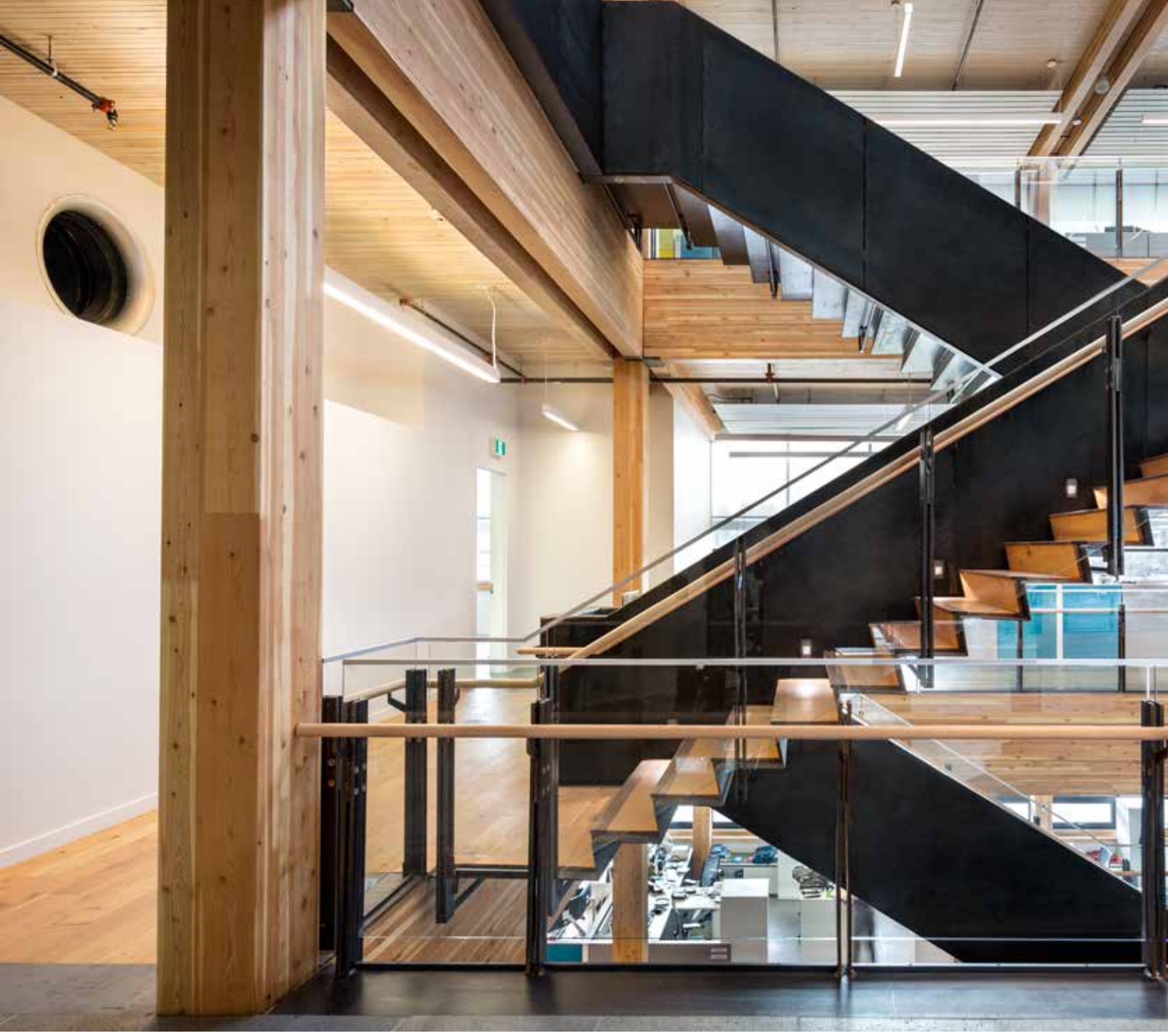
GENERAL CONTRACTOR
Bates Masi + Architects
Sag Harbor, NY

PHOTOGRAPHY
Bates Masi + Architects
Sag Harbor, NY

Mountain Equipment Co-op

Retailer embraces post and beam construction for its new headquarters

Vancouver, BC



Mountain Equipment Co-op (MEC) is one of Canada's most progressive retailers, having embraced a philosophy of corporate, social and environmental responsibility since its inception in 1971. With each new building project it undertakes, MEC endeavors to advance its sustainability agenda.

In this respect, wood has played an important role: a reclaimed wood structure for its store in Ottawa, ON; a demountable post and beam frame for its store in Burlington, ON; and now an exposed heavy timber structure for its new four-storey 130,000-sq.ft. head office in Vancouver, BC.

Completed in the fall of 2014, the new facility is home to all MEC's head office functions, accommodating a staff of 375.

The plan consists of two intersecting wings, oriented to optimize daylight and natural ventilation. The narrow floor plates are organized so that enclosed offices and service rooms are in the centre and open plan offices close to exterior walls and windows.

The arms of the plan intersect at the atrium, the social focus of the building where employees can meet, and the activities on one floor can be seen and heard from another. This feature is just one of many in the building that demonstrate MEC's commitment to the well-being of its staff.

This commitment also influenced the choice of wood for the structure, which creates warm and welcoming interior spaces that could not have been realized using any other material.

With the desire for simplicity, economy and flexibility, a glulam post and beam system was chosen for the primary structure and mass timber panels were specified for the floors. The preferred option was to use cross-laminated timber (CLT) panels for the floors, but to design in such a way as to permit nail-laminated timber (NLT) panels to be carried forward as an alternate. At the time of tender, NLT proved to be the more economical choice.

To limit the cross-grain shrinkage that can be a challenge in a building of this height, the structure was designed with single storey-height glulam posts, placed one on top of the other with end-grain-to-end-grain bearing. A combination plate and saddle connection secures the base of one post to the top of the next and provides bearing plates for the beams that run either side. The plates are secured to the top of each column with wood screws. Rebar dowels above the plate are epoxy-grouted into holes drilled into the bottom of each post.

Each main bay of the building is 60 feet wide and is divided into three equal sub-bays of 20 feet. Thus, there

are four lines of glulam columns connected by three sets of paired glulam beams in each main bay. The NLT panels are four feet wide and 40 feet long so that they span two sub-bays of the building. To facilitate diaphragm action, the panels are laid in an overlapping pattern to minimize continuous joints. Plywood sheathing is similarly laid across two adjacent panels in a staggered configuration, again to facilitate diaphragm action.

The heavy timber post, beam and panel structure provides a minimum one-hour fire-resistance rating.

The MEC Head Office offers us a glimpse into the past and the future simultaneously. In the 19th and early 20th centuries a significant proportion of Canada's commercial buildings were constructed using a heavy timber post and beam frame structure, with floors of solid nail-laminated dimension lumber. This system was chosen for its economy, strength and durability, and many examples (including the nine-storey Landing building in Vancouver, BC) can still be found.

Today, wood structures continue to deliver on the promises of the past, but now our understanding of wood has broadened to include its benefits to environmental sustainability and human health. These contemporary concerns are central to the corporate philosophy of Mountain Equipment Co-op, which has demonstrated its commitment to environmental stewardship for more than 40 years, and whose concern for employee well-being is recognized. Its new head office may well prove to be a prototype for a new generation of commercial buildings.

ARCHITECT
Proscenium Architecture + Interiors
Vancouver, BC

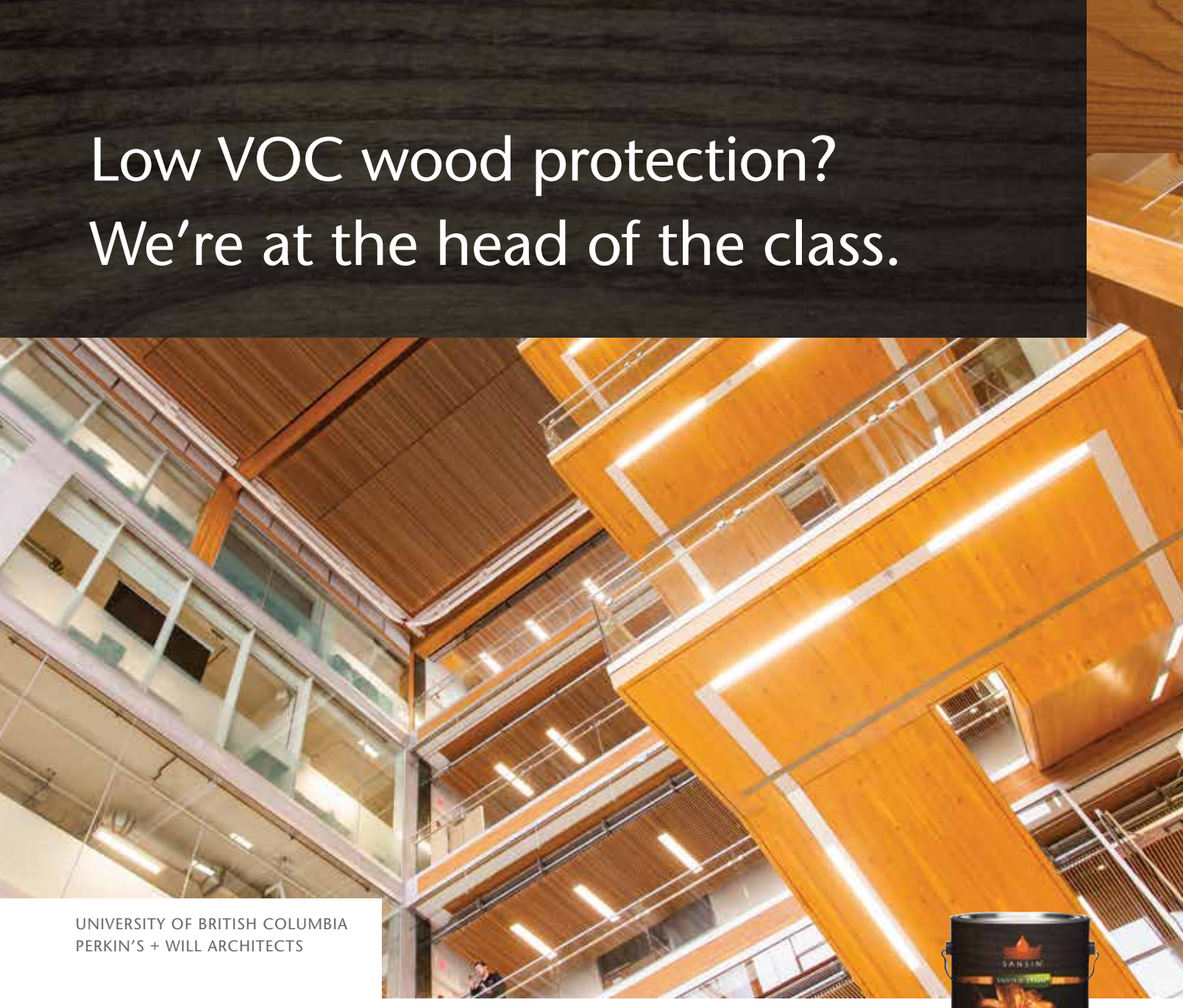
STRUCTURAL ENGINEER
Fast + Epp Structural Engineers
Vancouver, BC

GENERAL CONTRACTOR
Ventana Construction Corporation
Burnaby, BC

GLULAM SUPPLIER
Structurlam
Penticton, BC

PHOTOGRAPHY
Ed White Photographics; Courtesy: Wood *WORKS!* BC
Vancouver, BC

Low VOC wood protection? We're at the head of the class.



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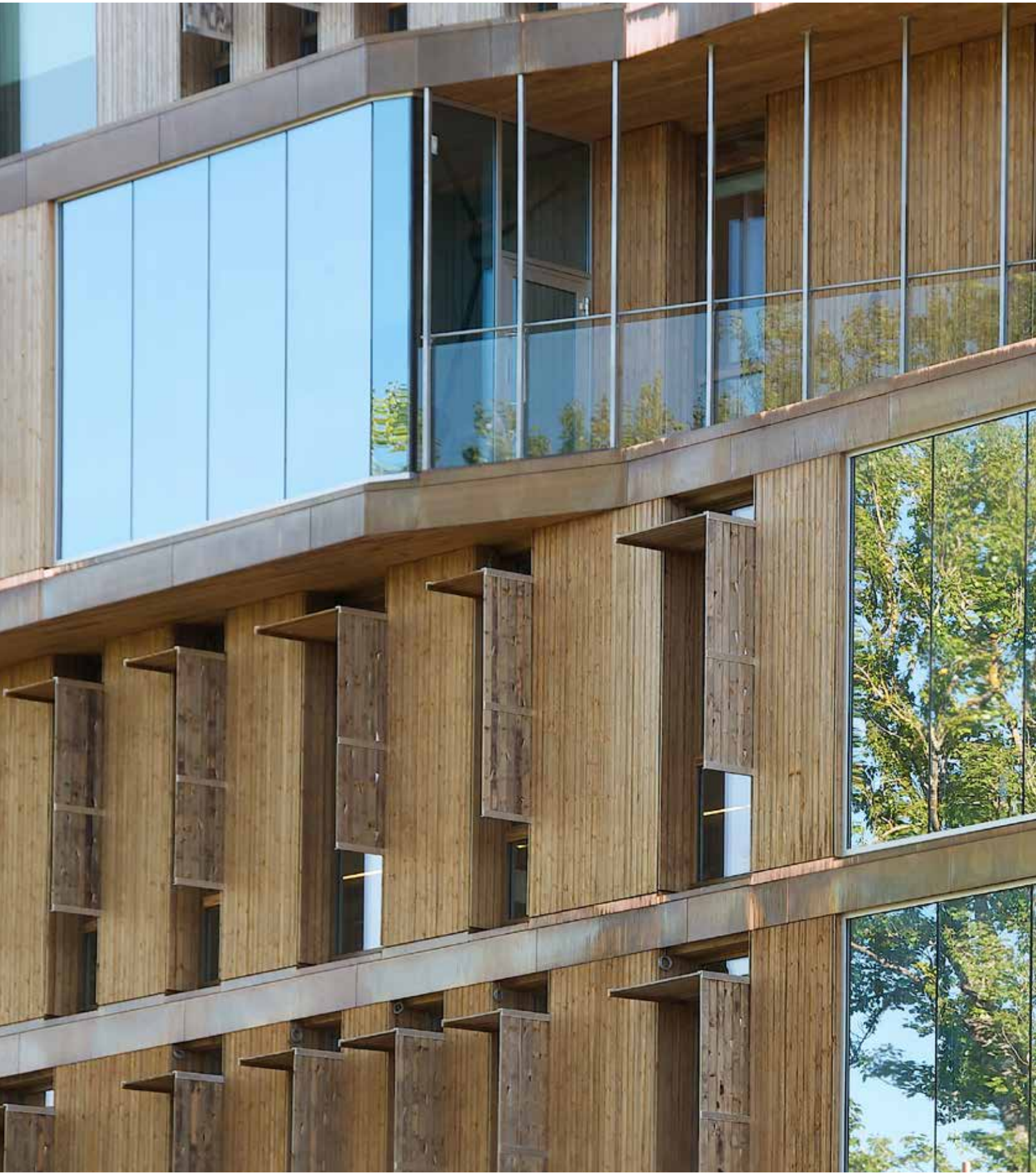


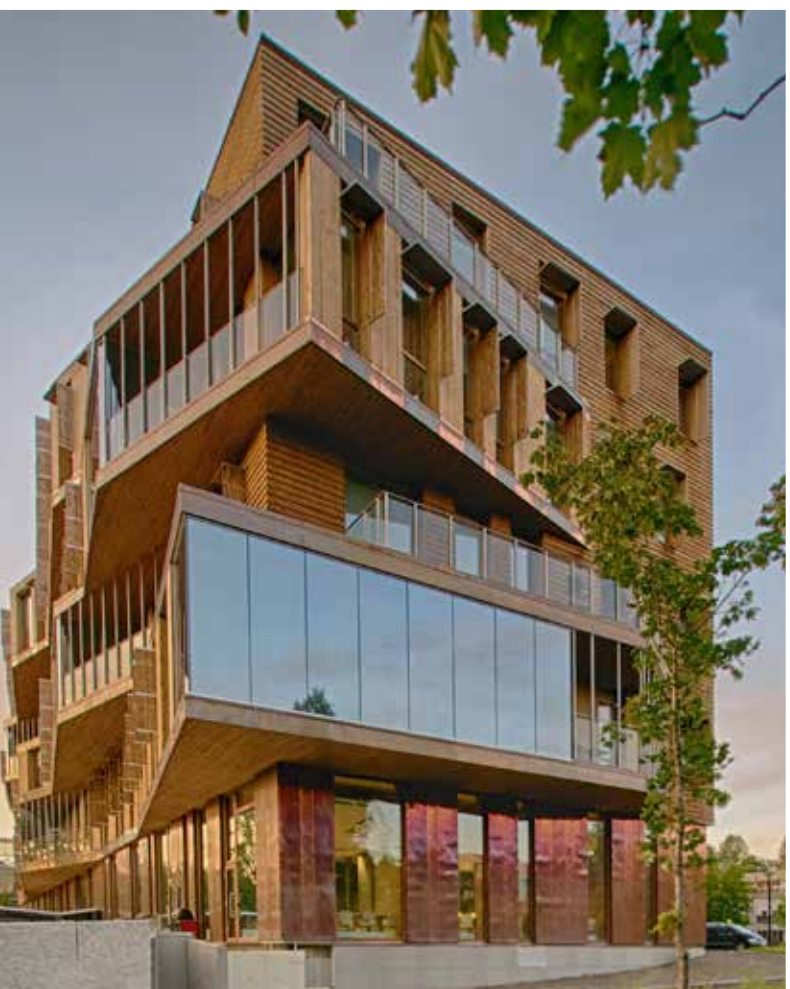
NINA

Wooden office block is simple and playful

Trondheim, Norway

Work on the Norwegian Institute for Nature Research (NINA) project began through an invited architectural competition. The institute requested a new headquarters that clearly expressed itself as an establishment for nature research.

The architect proposed a simple concept for differentiating between several layers of the institute's activities. The concrete plinth of the project, a stylized "glacier", holds the rougher laboratories, wardrobes, technical rooms and storage spaces. On top of the glacier stands a precise wooden box which is an office block in four floors, with some lighter laboratories. In between is the copper-clad ground floor with the main entrance, foyer, library and shared cafeteria. The main floor is connected to the basement through a glass-covered crack in the glacier, in which a semi-public meeting center is located. The top of the glacier is a roof garden, accessible from the library and the canteen.



PROJECT FACTS

Floors
6 (including basement)

Project Size
90,137 sq.ft. (8,374 m2)

Cost
$32 million USD (250 mill NOK)

Energy Consumption
70kW/m2 per year

Completed
2014

The building sits between a university and a housing area. The plinth marks the end of the large university campus. With its low height and nature-like construction, it provides a smooth transition to the residential area of quad houses with gardens. The higher office block was placed as far east on the site as possible to avoid casting shadows on the houses. In contrast to the more organic forms of the basement, the office block has precise and cultivated details. The facades that face the university to the north and east have a tight and simple expression, while the facades to the south and west are more playful, undulating with a variation of protruding semi-climatized spaces and balconies.

The building was designed with a focus on flexibility (both in daily use and to accommodate change over time), low energy consumption and natural materials. The basement's exterior insulation is clad in large prefabricated elements of white concrete that resemble ice blocks. The rocky roof landscape is covered with Norwegian mountain plants that grow from cracks in the "ice". The floors are made up of approximately 5,000 massive wooden floor slab elements (size 3.9 ft/1.2 m x 15.7 ft/4.8 m), with a thickness of 6.7 in (170 mm). On top of the wood slabs there is an installation floor, to ensure flexibility in the floor plan and furnishing. This also permits the exposure of the wood elements in the ceiling of the floor below. This surface is left untreated and the massive wood helps regulate the indoor climate (heat and moisture).

The exterior cladding uses untreated Kebony pine that in time will turn gray. Window fittings, gutters and other details are made of copper. The inside of the exterior walls have spruce paneling which act as part of the acoustic system, putting the thick layer of insulation to double use.

The building is equipped with a conventional balanced ventilation system, with heat exchangers and heat recovery, and meets the Norwegian passive house energy standard for office buildings. Even in the relatively cold Norwegian climate, conventional office buildings need cooling during the warm seasons of the year. To help reduce the energy used to power fans and cooling appliances, the system is connected to motorized windows in the office spaces that automatically open at night. This passive ventilation cools the building overnight without the use of energy.

To avoid excessive solar gain, a fixed sun shade was designed to stop the afternoon sun from entering the building during working hours. The exterior shades have become a characteristic feature of the building design. They are made from the same wood as the cladding and are perforated in an abstract pattern of leaves that creates a subtle play of shadows on the facade.

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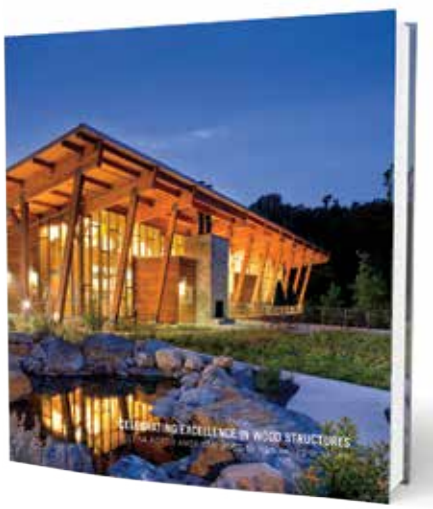

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Cost Analysis

Mass timber can be a cost-effective solution for large buildings

Michelle Maybee

PHOTO CREDIT: Ed White Photographics; Courtesy of Wood *WORKS!* BC

Wood is renewable, sequesters carbon and is locally produced. These are a few of the positive environmental attributes which contributed to the selection of wood for the new Mountain Equipment Co-op (MEC) office building in Vancouver, BC. Although wood was the natural choice for this project, it is not necessarily considered for other similar projects. Cost is the main driver in most projects, and if wood cannot compete at a similar price point then it will not be selected.

Reports on tall wood structures have shown that mass timber can be a cost competitive choice for these buildings. But what about large-scale, low-rise commercial buildings? Is mass timber still an economical choice? Are there other factors that need to be taken into consideration to ensure viable economical systems are being presented to the market? The Canadian Wood Council endeavored to answer these questions when it commissioned a cost comparison, using the recently completed MEC building as a benchmark.

Structural Systems

The four-storey MEC office building has a hybrid mass timber and steel structure that was approved for construction under the *City of Vancouver Building By-law 2007*.

For the cost comparison study, the MEC project team including, Fast + Epp, Proscenium Architect, LMDG Code Consultants, Ventana Construction Corporation and Seagate Consulting Ltd., evaluated the existing building's design and cost parameters and then reworked a number of project variables to create four similar hypothetical buildings.

Hypothetical structural building systems considered:

- A mass timber system incorporating glulam post and beam structural elements, nail-laminated timber (NLT) panels and steel buckling-restrained braces for shafts and cores.
- A structural steel frame system incorporating open web steel joists with metal deck and concrete topping, and steel buckling-restrained braces for shafts and cores.
- A structural steel system incorporating precast concrete hollow core panels and buckling- restrained braces for shafts and cores.
- A reinforced concrete system incorporating two-way flat plates and concrete shear walls.

The building options were carried out to a schematic design level. The plans, elevations, sections and an approximate palette of materials were provided by the consultants. A Class C cost estimate was completed based on this information. From the documentation and information provided, quantities of all major construction elements were assessed, measured and priced. The estimate was a determination of the fair market value for the construction of the project in Vancouver, not a prediction of the low bid.

The new designs and specifications created by the project team were subsequently reviewed to assess secondary impacts and their related costs. Secondary impacts are cost items significantly impacted if the main structural system is changed. These secondary components or assemblies must be identified to achieve a comprehensive understanding of the actual cost of the structural systems under consideration.

Mass Timber System

According to the report, there are several reasons why a glulam post and beam frame with NLT floors was selected as the system for the hypothetical mass timber building. The system is easy to design, fabricate and construct and uses standard commodity wood products that are readily available across North America from many supply sources.

The building technology is not new. This type of structural system has a proven performance history, with many examples today of buildings built 100 years ago using heavy timber post and beam frames and nail-laminated floors. The difference with the MEC project is that the design and construction team brought together advanced CAD design and engineering solutions with better performing and more predictable elements.

The Building Code defines heavy timber construction as a type of combustible construction in which a degree of fire safety is attained by placing limitations on the sizes of wood structural members and on the thickness and composition of wood floors and roofs and by avoiding concealed spaces under floors and roofs. The construction requirements for the project permit the building to be constructed with heavy timber, however, the use of NLT floor assemblies required a demonstration of equivalence to the acceptable solutions within the Building Code through an alternative solution process. A char rate analysis, based on exposure to fire for one hour, demonstrated that the remaining thickness of load-carrying wood supports the loading conditions required under fire conditions. The top surface of the NLT panel was layered with a plywood diaphragm and a concrete topping (or other non-combustible finish), which contributed to the overall fire resistance of the floor assembly.

Cost Comparison

In general, the total costs for the four hypothetical buildings were comparable. There was only a 2.5% difference between the highest and lowest cost building.

Benefits of Mass Timber

LOWER COST FOUNDATION: The cost of the foundation was lowest for the wood building due to the lesser weight of the structural framing. The site conditions and the structural material selected can have a significant impact on foundation requirements. In this case, the site had poor soil conditions, resulting in a higher impact on the foundation requirements.

LOWER COST MECHANICAL AND ELECTRICAL: A cost savings was taken into account for the mass timber building due to easier installation of hangers, drilling and scheduling advantages.

LOWER COST INTERIORS AND FINISHES: For comparison, it was assumed that the detailing of interior finishes had to match the quality and performance of the exposed wood elements. The costs for the steel and concrete buildings were higher because of additional requirements for millwork, finish carpentry, drywall ceilings, painting, etc. The cost of fireproofing was also considered, which increased the cost of material and added time to the construction schedule for the two steel buildings.

FASTER SPEED OF CONSTRUCTION: The estimated construction times ranged from 16 weeks for the mass timber building to 29 weeks for the concrete building. The costs considered were for a general contractor to operate the construction site. Not considered were the savings in capital carrying costs and early delivery to the client; these savings could be significant.

EQUIVALENT SPRINKLER COSTS: All hypothetical buildings required a sprinkler system due to the interconnected floor space. For the purpose of the study, the same cost was assumed for all buildings, however, there is potential for cost savings in the mass timber building due to easier installation of the sprinkler elements.

Challenges of Mass Timber

COST OF SUPERSTRUCTURE: The cost of the superstructure was highest for the mass timber building and lowest for the concrete building. However, utilizing simple, repetitive systems and elements, optimizing the structure, and refining the manufacturing and installation process all have potential for reducing the cost of the superstructure.

SPRINKLER COSTS: If the building did not contain an interconnected floor space, then the steel buildings and the concrete building could be permitted without a sprinkler system. This would represent a cost advantage over the mass timber building.

WEATHER PROTECTION DURING CONSTRUCTION: The cost of a substantial weather protection strategy was not included in the cost comparison for any of the hypothetical buildings. Some additional costs were added to the wood building to cover the cost of touching up the finish of the exposed wood elements, which could have been avoided with weather protection. In some locations where construction during sub-zero temperatures is required, the cost of weather protection must be considered for the concrete building as well. A well-planned strategy for weather protection can enhance the speed and quality of construction for any project, but is not necessary under all circumstances.

Cost Neutral

The building envelope costs were considered for the comparison but resulted in no significant cost differential between the four hypothetical structural building systems. Depending on the thermal performance desired, the building envelope is an area where mass timber could result in cost savings.

The soft costs of fees, general conditions, and items such as site security, demolition, site services, elevators, etc. were considered for the comparison and found to be about the same amount for all four buildings.

For the purpose of the analysis, insurance premiums were kept the same for all hypothetical buildings. In the current marketplace, the cost for course of construction and wrap up insurance varies from project to project, therefore it is difficult to quantify and compare.

Conclusions

The benchmark cost comparison and related design analysis of these four hypothetical buildings suggests that the design, specification and construction of large, four-storey commercial office buildings utilizing mass timber products and hybrid structural details are viable and cost competitive when building design, material selection and construction methodology are coordinated.

Secondary impacts, such as speed of construction and the cost of interiors and finishes favor the use of mass timber and help to offset the additional net cost for the superstructure material. By understanding the relationship between a structural framing system and these secondary impacts, building designers can make an informed decision when considering the overall budget of a given project.

Insurance is typically an area where wood frame buildings are more expensive, however, this amount can vary significantly. Currently, there is no distinction considered between mass timber systems and light wood frame systems, even though these products perform differently. As a greater number of mass timber buildings are constructed and perform well, there is potential for a reduced premium in the future.

Early input from general contractors, suppliers and other sub-trades can further improve the cost competitiveness of mass timber systems. This approach will achieve a material and system-compatible design that fully respects the manufacturing, assembly, logistics and installation sequencing, therefore further reducing the total cost. It is important to understand the distinction between the material supplier, fabricator and installer; the same firm may represent all three aspects or there could be multiple firms involved. Early involvement from each level is valuable and all bring individual perspective and expertise to the team.

Mass timber systems have the potential to be further refined and made more efficient from design, supply and construction perspectives. Each project completed is an important step to a better understanding of these systems and where cost savings can be achieved. Mass timber can be an effective and efficient solution for large buildings.

Michelle Maybee, P.Eng., is Technical Advisor, Ontario Wood *WORKS!*/Canadian Wood Council. She can be reached at (866) 886-3574 or mmaybee@wood-works.ca.

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Building Relationships

Wood construction has architects and suppliers working closely together

Hermione Wilson

We rarely think of it when we contemplate the finished building, but behind every great wood structure is a team made up of many different players. Each player brings his or her own unique perspective to the wood construction process. Sometimes the gulf between these different perspectives can seem quite vast and though this can give rise to complications, it can also be fertile ground for a creative collaboration.

Working Together

The detail-intensive process inherent to wood construction means a close working relationship should be built between architects, engineers and suppliers, says Max Closen, Technical Director and Timber Engineer at MyTiCon, a timber connectors manufacturer. He observes a hesitancy from engineers to contact him with questions about the timber connection systems his company makes.

"The typical structural engineer has to deal with steel, wood and concrete, with all the connection systems he is using in his project," Closen says. "I believe it's highly efficient to contact a specialized timber supplier and ask questions about these systems, and get help, instead of wasting time making wrong assumptions." As a specialized timber supplier, Closen says he has expert knowledge about wood systems, knowledge that could save the engineer hours of research.

Closen offers webinars on connection systems new to the North American market to educate engineers about the technology. "We believe that the technology we have can significantly reduce costs and give engineers new tools to make bigger timber structures more cost-efficient."

"We're in this evolutionary phase of wood," says Michael Green, Principal at Michael Green Architecture (MGA). Once limited to the European market, innovative wood manufacturers are now moving into the North American market, providing more options to designers and driving down prices. The resurgence in wood manufacturing and massive wood construction has led to the development of new products like cross-laminated timber (CLT) and other mass timber panels, and a renewed interest in timber products like laminated strand lumber (LSL).

"[As a designer] you used to shop out of a catalogue for materials; now you're actually much more involved in relationship-building and getting to really understand the materials," says Green.

It is always necessary for architects and engineers to be educated about all the materials they will be employing in their project, but it is more important in wood construction. "No two pieces of wood are ever the same," Green says. "It means, as a design professional, you're going to be much more hands-on in the selection of the material than you might be if you were specifying something like aluminum."

Suppliers can be a good resource for designers looking to find out more about a product, but it's important to maintain a professional distance, Green says. "They know their products, but they're in the business of selling products," he says. "You have to decipher fact from fiction and make sure you understand the differences from one product and one supplier to the next. As a designer, it's important to do your own research about the materials you're using, where they are sourced and what their capabilities are, and not rely solely on a supplier's expertise."

Larry McFarland, Principal at McFarland Marceau Architects Ltd., disagrees. "That is a very traditional perspective," he says. "I think it's changing as designers push the envelope in design, particularly in wood. Research undertaken by organizations such as FPInnovations bridges the gap between designer and supplier, which I think addresses the issue of conflict of interest."

"It's a bit of back and forth," Green says. "We have to create the demand for their products and then they'll fill that demand, but we need to also remain independent from those companies to make sure our clients get the best value out of the competitive marketplace."

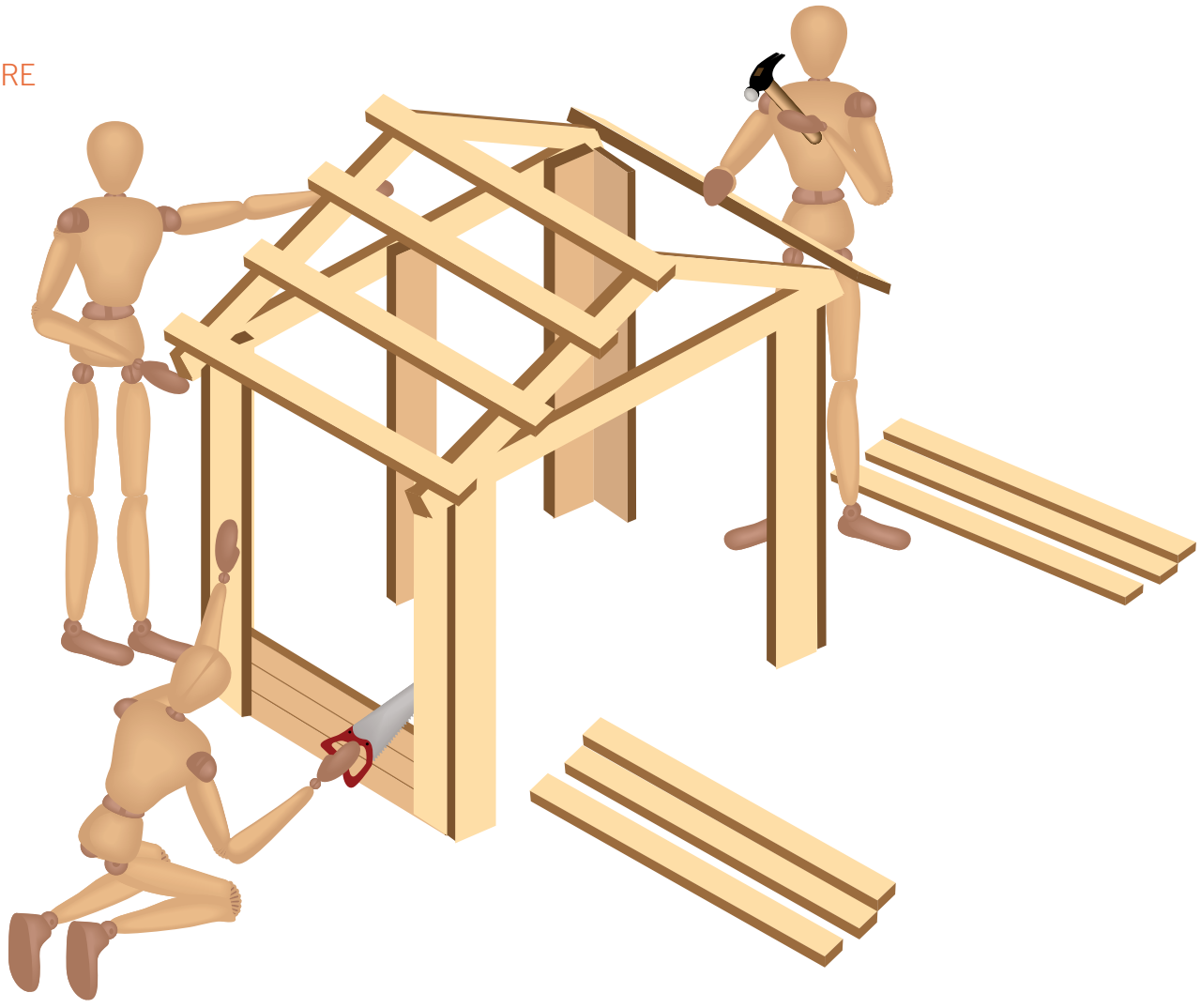
TIPS FOR WORKING WITH SUPPLIERS

Architects should…

- provide feedback to suppliers about their product. "Be honest and frank with [suppliers] about how they can make their products better," says Michael Green of MGA. "Everybody wins when you do that."
- "not get so close to a supplier that your judgement is clouded concerning the value of their competition," Green says.
- get suppliers involved early. "What works best for our business model is when we can give early budgets that we then commit to," says Gerald Epp, President, StructureCraft Builders.

Suppliers should…

- not promise more than they can deliver. "Understand your supply chain so you know what you can deliver and not disappoint," Epp says.
- stay educated and up-to-date with new developments in the field. "I try to know more than they do," Epp says.



As an architect, Green is constantly negotiating with suppliers about the price, product design, and aesthetic of the materials they're offering, and making suggestions about how they can make their product more attractive to other designers. For example, the CLT panels manufactured in Canada tend to be made from layers of wood that are 35 mm thick. Green says demand is growing among architects for CLT with thinner layers, more in keeping with the 18 mm-thick layers of European CLT. "By using thinner layers it actually means that we can span structurally further with less volume of material and still be resistant to fire," Green says. Designers need to articulate that need to suppliers and create a demand for it here in North America, he says. "We're all learning that the more we work together, the better the products are," Green says.

A Return to Craftsmanship

The architect-engineer-supplier relationship can be a collaborative, creative process, says Craig Beere, President of Beere Timber Company, who sees it as his job to make an architect's artistic design a reality. Beere has been in the lumber business since 1978 and his network of mills, fabricators and suppliers is a well-oiled machine. Architects come to him for specific information on timber, siding, decking, and new composite products. "We know where to go to find the material, we understand how to have the material cut," Beere says. "We can help fulfill the architect's vision."

Beere cites the example of a project in Vancouver, a residence for actor Eric McCormack, where the client wanted reclaimed timber. The problem was, when the company looked at their client's cut list, they realized it would be almost impossible to find reclaimed timber in the size they were looking for. Instead, Beere proposed cutting a big piece of boxed heart timber with a circular saw with bent teeth, then sandblasting and oiling it to give the wood an aged look.

"It's not just changing structural elements or architecture; sometimes we help them create a vision from material that isn't readily available today," Beere says. "We provide solutions."

According to his company website, Gerald Epp, President and Chief Engineer at StructureCraft Builders, founded his company "as a response to the desire of architects to reconnect with the engineer and craftsman." He says there is a disconnect between design and construction in the wood building process compared to when great architects-engineers of the 1800s, like Alexandre Eiffel in France and the great bridge builder Isambard Brunel in England, were heavily involved in the construction process as well as the design.

"Over the course of the last 150 years, there's been a separation of disciplines," Epp says, as the construction industry has become highly specialized with the advent of new technology and new techniques. "We wanted to restore that sense of craftsmanship. Now it involves sophisticated engineering and 3-D modeling tools and machinery that are all available to us. We have a new paradigm under which we can work."

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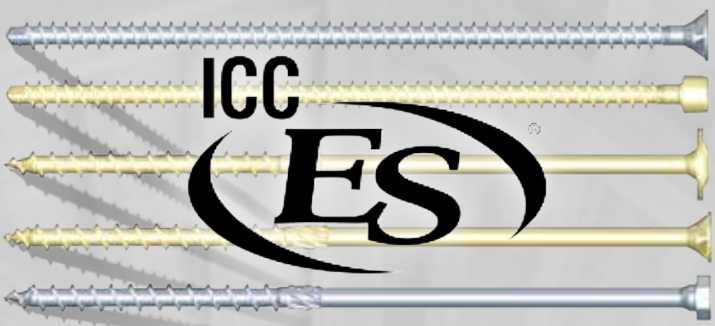

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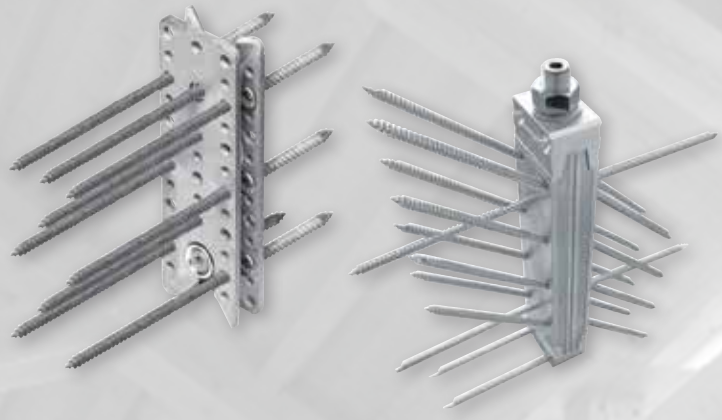

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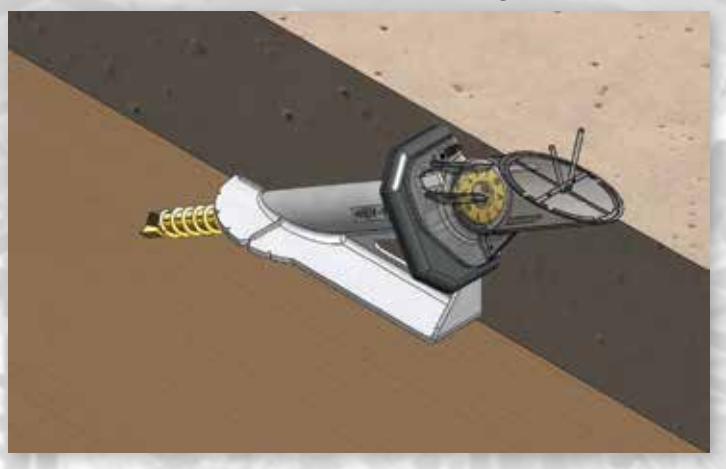

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Timber Framing

The traditional craft is enjoying a renaissance as commercial and public structures employ modern timber frame construction

Jeff Arvin

In May of 2014, something big came to Pemberton, British Columbia. Several truckloads of Douglas fir timbers and more than 60 instructors and volunteers, from all over the U.S. and Canada, came together for a community building project. In the span of 14 days, 650 pieces of timber, amounting to more than 66,000 board feet, were transformed into the Pemberton Market Hall, a beautiful example of modern timber frame construction.

Timber joinery traditions developed in forested cultures throughout the world so the timber frame community is quite diverse. Thousands of buildings ranging in age from 500 to 1,000 years, and many even older, offer dignified testimony to methods and materials of indigenous builders. In North America, the dominant timber frame influence came from northern Europe, though timber structures of Coastal Salish peoples significantly pre-date the buildings of European immigrants. Throughout the period of European settlement, timber framing was at the root of distinctive residential building styles but may be most recognizable in pre-20th century barns and agricultural buildings where the timbers and joinery are fully in view. With a rapidly growing population and Western expansion in the latter part of the 19th century, craft traditions, including timber framing, were displaced by other technologies better suited to meet the demands of the times.

The modern rediscovery and revival of timber framing is now nearly a 50-year phenomenon. By some estimates, the total value of buildings featuring timber framing approaches $500,000,000 annually. Historically, the majority of the work has been residential, but the number of commercial and public buildings is on the rise and increasingly represents a significant part of the total. Within the timber frame segment of the industry, practice varies widely. Some companies focus solely on timberwork and coordinate with other professionals to complete buildings. Others offer a range of professional services which may include architectural design, structural engineering and general contracting. Some are also offering historic preservation services as communities and clients are requesting restoration and adaptive re-use of culturally significant buildings.

Diversity within the industry is illustrated by the technology for making mortises, or slots, that receive mating pieces known as tenons. Some employ a boring machine, a 19th century human-powered apparatus that appears to be a cross between a drill press and an egg beater which, despite its archaic appearance, is a very effective tool. Others employ the 20th-century version, refined and powered with an electric motor. Still other compa-

While wood-to-wood connections are part of the traditional definition of timber framing, in modern practice, crafted metal is used to great structural and aesthetic effect.

PHOTO CREDIT: Holmes King Kallquist Architects, courtesy of New Energy Works Timberframers

The Pemberton Market Hall is an example of modern timber frame construction. The frame was the product of a collaboration between the Timber Framers Guild and the Village of Pemberton, British Columbia.
PHOTO CREDIT: Randy Churchill

Many contemporary timber framers perform authentic historic reproduction. The Henricus (Virginia) Church, originally constructed in the 17th-century, was reconstructed in 2014.
PHOTO CREDIT: Trillium Dell Timberworks

nies produce complete timber frames with complex CNC machinery driven by 3-D CAD models, and the conversation doesn't stop there.

While many companies prefer to adhere to traditional models of timber frame and joinery design, others base their structures on modern engineering. Driven in part by expectations of modern building codes, which require mathematical confirmation of a structure's expected performance, many timber frame companies regularly incorporate crafted metal work to extend the capacity of wood to wood connections. Often in commercial and public structures, like the building in Pemberton, the scope of the timber frame structure requires steel-assisted connections to sustain the environmental loads.

One additional and important development in the timber framing world since the mid-1980s is an emphasis on energy efficiency, with special attention to the building envelope. One of the advantages of post and beam construction is that structure is separated from enclosure. Structural insulated panels (SIPs) have been paired with timber frames for over 30 years with great results but, more and more, companies are developing their own carefully constructed enclosure systems that are achieving astonishing results. Several companies report blower door tests of their tightly constructed buildings indicating 0.5 air changes per hour!

In reality, timber framers were practicing "energy efficiency" and "green" and "sustainable" building before these terms were as common as they are now. Re-use, reclaimed timbers, renewable, recycling, carbon sequestration, carbon footprint, pre-fabrication, waste reduction, and using waste to fuel fabrication can be added to the list of what timber framers have been doing at least since the early 1980s for the good of their fellow workers, their businesses, their communities and the earth.

They seek to elevate craftsmanship, the thoughtful, precise execution of the design intent. These values promote beauty in the built environment and facilitate an economy of material, action, time and cost and thereby create structures that are cherished and appreciated by their occupants, the most important attribute a building can possess to ensure its longevity.

Back in British Columbia, the Pemberton Market Hall is now a year old and the village is anticipating its first full season of use. The Saturday Farmers' Market will be a regular fixture, but the structure will be available to any cultural or community event. "The barn creates a sense of arrival," says Suzanne Belanger, project manager for the Village of Pemberton. "It will be a magnificent piece of art in our downtown."

Jeff Arvin is Executive Director of the Timber Framers Guild. For more information, go to www.tfguild.org.

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HARDWOOD

Sara M. Babinski

Natural realism is one of the hottest trends in interior design today and many of the latest styles are wood or 'wood look'. The use of wood is becoming commonplace for floor applications, wall treatments and everything related to decorating and designing. Hardwood flooring is a popular product that brings nature indoors, with the authentic look and feel of wood we all love. It is appreciated for its natural color and beautiful character and valued for its knots, mineral streaks, grain figuring and general uniqueness. Our homes are our sanctuaries and a reflection of personal tastes and values. Consumers want products that are timeless, warm and extraordinary at the same time – this is wood.

Flooring design focuses on visual and tactile interest achieved through texture, color, finish, or pattern. A popular look is anything rustic or textural with a rich patina and interesting surface effects touched by time or hand. This look can be achieved with wire brushing, scraping, saw marks or weathering and highlights knots and grain definition. This time-worn appearance with vintage board to board pattern mix has tremendous appeal and can include partially painted effects. It is often a simulation of authentic aging or artisan craftsmanship and is an important aesthetic for both residential and commercial interiors. Smooth, contemporary wood finishes are also coming back into vogue, especially on the West Coast.

Color is also important to the overall look of hardwood. Dark colors have become popular, but lighter natural colors are emerging. Beach colors play an important part in today's best selling shades of warm browns, whites and the ever popular grays. Taupe, ivory and subdued tans are reminiscent of the sand and driftwood inspires the use of gray.

Gloss levels of hardwood can vary from a very low gloss, to medium or high. A growing trend is toward a neutral, muted gloss. This gives the wood a very natural look and helps to disguise dust and minor scratches on the floor. Low gloss lends itself to understated and natural looks while a higher gloss will add light reflectivity and brightness to a room.

Current trends are toward larger and wider planks, using multiple-sized planks in a single design, and toward more exotic domestic species like hickory, cherry and walnut.

Design by nature is the natural choice for interiors, especially now that trends related to the environment are playing a primary role in the home and office. Earthy colors and nature's neutral palette are the perfect backdrop for bright accent colors and favourite furniture pieces. Hardwood flooring is a big part of the discussion for clients, especially homeowners, who want to live a green lifestyle and play a part in preserving the world's natural beauty. Going green at home means considering several factors when choosing materials like hardwood floors.

FLOORING

For example:

- **EMBODIED ENERGY** – Natural wood products take less energy to produce. Advances in manufacturing technology and processes also make efficient use of wood waste and by-products. For example, tree bark is shredded into mulch, and sawdust becomes animal bedding or fuel used to operate kilns.

- **CARBON FOOTPRINT** – Growing trees, particularly young trees, absorb carbon dioxide from the atmosphere and separate the carbon and oxygen atoms. The oxygen is released back into the atmosphere, while the carbon is used to grow wood fiber. Products made from wood sequester or store the carbon for their lifetime. Sustainable management creates healthier forests that serve as a "carbon sink" to clean air of greenhouse gases and purify drinking water for wildlife and municipal water systems.

- **TRANSPORTATION COSTS** – Flooring is generally heavy and expensive to transport long distances. Locally manufactured products are generally cost-advantageous and have a lower environmental impact.

- **LONGEVITY** – The lifetime of a solid hardwood floor can be more than 100 years and a hardwood floor can be refinished several times to bring back its original luster.

Hardwood flooring doesn't collect dust or allergens that can become trapped in other materials and contribute to health problems. Plus, hardwood flooring is easy to clean and maintain, which means a home can be allergen-free with little effort.

Wood is extremely durable and normally lasts the lifetime of the home, with minimal disposal impacts. It does not emit appreciable levels of volatile organic compounds (VOCs) and actually has far lower VOC levels than most carpeting.

Some wood flooring products can be installed without using adhesives. When needed, specify adhesives that meet the strictest indoor air-quality standards including the *South Coast Air Quality Management District* requirements (SCAQMD) for adhesives and sealants required by LEED. Most engineered wood can be installed without adhesives, using Lock, Staple and Float techniques. Using pre-finished solid and engineered floors means no site-finishing which minimizes the amount of VOCs released into the home. Many wood species are harvested in NA.

The environmentally conscious U.S. buyer will look for CARB-compliant (California Air Resources Board) products and other sustainability attributes that are important to them, however products that provide appropriate performance and durability for the space should always be selected.

Sara M. Babinski is Design Manager, Hardwood and Laminate, Armstrong World Industries.

Wood WARE

Formation Association + Edgar Arceneaux
PHOTO CREDIT: Grey Crawford

Abramson Teiger Architects
PHOTO CREDIT: Grey Crawford

RNL
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d3architecture
PHOTO CREDIT: Grey Crawford

Cat Shelters

Last year, 14 Los Angeles-based architectural firms teamed up to create cat shelters that were donated to FixNation, a non-profit organization whose focus is to reduce the homeless cat population using non-lethal techniques. The results were stunning, well-thought out shelters constructed from a variety of materials. In most cases, wood was the main building material. Lehrer Architects constructed a posh structure out of 23 layers of wooden slats, adding a touch of green turf for texture. Meanwhile, Formation Association + Edgar Arceneaux created a multi-use bench out of Western red cedar. John Chan, Design Director, noted that wood was chosen due to its aesthetics and ease of use for volunteers who helped construct the designs over a two-week period.

www.architectsforanimals.com

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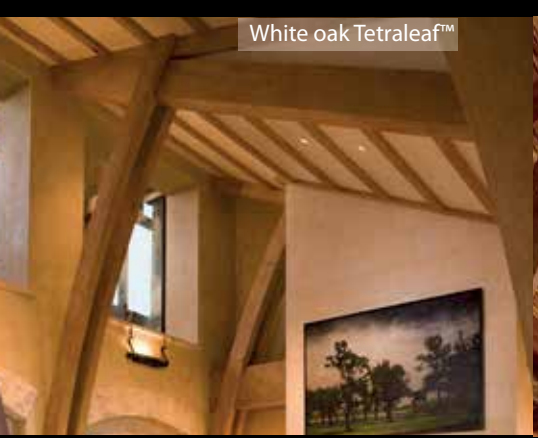

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