Six dollars

Wood Design & Building®

Fall 2019 — Number 83

SUSTAINABLE DESIGN

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Hitchcock Center for the Environment
Practicing what it preaches

Ecological Living Module
A self-sufficient tiny home

The Arbour: A New Paradigm
Innovations and applications

WOOD DESIGN & BUILDING®

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Above and **on the cover:** HITCHCOCK CENTER FOR THE ENVIRONMENT
PHOTOS: Peter Vanderwarker

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SUSTAINABLE DESIGN

Designing for climate change

According to the International Energy Agency, buildings and the construction sector now account for 36 percent of the planet's total energy consumption and nearly 40 percent of direct and indirect CO_2 emissions; we can do better, and yet these numbers continue to rise.

In the context of climate change and CO_2 emissions, the carbon-sequestering quality of wood has become a hot topic – although complicated, given the challenges around supply chains, limited manufacturing facilities, building codes and sustainable forestry in some regions. Thankfully, many of these challenges can be solved. In the meantime, what are some of the immediate actions we can take to mitigate the effects of climate change, besides building with wood and designing structures that can withstand fires, floods and other natural disasters?

An answer is right in front of us, and has been for a long time: reduce, reuse, recycle. There's a clear reason they are in that order, because the best place to start is by reducing our consumption of resources, followed by reusing materials and finally, recycling. When these principles are applied to the building industry, some interesting solutions arise; century-old wood bridge trestles are milled to become the siding of a LEED Platinum home (on p.6), or a 230-sq.ft. structure is designed to be completely self-sufficient (the ELM project, on p.31).

One of the best ways to conserve resources is to restore, rather than demolish, a building – as Kearns Mancini Architects did when the firm renovated a 130-year-old wood-frame farmhouse (on p.26), while also achieving Passive House standards.

Holistic design is also pointing towards a new paradigm, as Carol Phillips, partner at Moriyama & Teshima Architects, explains in her article about The Arbour (p.37) – a highly anticipated, 10-storey mass timber building that promises to pave a new path for sustainable design. "Human beings are literally shaping the planet and environment," she notes, "[and] as designers, our time has come to make the planet our design purpose, if only one project at a time."

To date, almost 650 firms have signed the online Architects Declare "Climate and Biodiversity Emergency" proclamation, which was launched by 17 UK firms and Stirling Prize winners, including Zaha Hadid Architects, Foster + Partners and David Chipperfield Architects. Momentum to promote sustainable building practices is growing as architects recognize their role in leading change – and the role that wood plays in building a better world.

Popi Bowman
Managing Editor

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 pbowman@dvtail.com.

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WHAT I'VE FALLEN FOR THIS MONTH...

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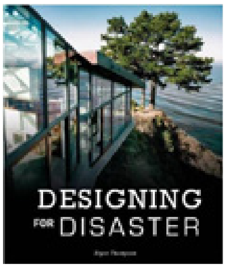
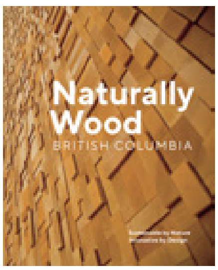
FEELING BOOKISH

Spending time with a good book is one of my favorite things, especially if it features beautiful buildings. As we produced this issue of the magazine, we were also putting together the yearly Wood Design Awards book, which is packed with inspiring projects – I've already read it from cover to cover, but I can't wait to get my hands on a copy! Here are some other new publications you should add to your library.



Designing for Disaster: Domestic Architecture in the Era of Climate Change, by Boyce Thompson

When we think of resilient design, we don't necessarily equate it with beauty – but this full-color, hardcover book from Schiffer Publishing proves that planning for extreme conditions also can produce excellent aesthetic results. Not coincidentally, many of the projects feature wood, in chapters organized around the elements: water, earth, fire and wind. As the author notes, "The homes in this book show that the needs of resiliency, aesthetics and livability can work in harmony." Buildings that can endure floods, storms, earthquakes and fires require creativity, careful planning and expertise, all of which are showcased beautifully by 16 U.S. projects – including the Mazama House by FINNE Architects, which won a 2015 Canadian Wood Council Award. Built in an area of Washington State that experiences frequent wildfires, the home is a testament to the beauty, and utility, of wood.



Naturally Wood British Columbia: Sustainable by Nature, Innovative by Design, by Forestry Innovation Investment Ltd.

Available as a PDF download at naturallywood.com, or as a paperback via Amazon, this publication features more than 65 projects that demonstrate the many applications and types of wood products used in some of the finest examples of architecture on the West Coast of Canada. Buildings are grouped in chapters according to program: community and culture; pools and arenas; urban communities and recreation; tourism and attractions; multi-family residential and accommodation; education and schools; health care and wellness; public and institutional; commercial and industrial.

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Reclaiming History

Countless projects around the world illustrate the value of rethinking architecture as a way to reuse and reclaim materials, and even entire structures – like The Reach Guesthouse, featured on p.26. Wood plays an important role in sustainable construction because of its longevity, as one of the few structural components that can maintain its strength and durability for hundreds of years. Each of the following projects are uniquely innovative, proving that creative reuse – while featuring wood – can lead to amazing results.

PaaHaa Ranch Barn, Canyon Lake, Texas: Constructed using salvaged wood from the original barn on site, this "party barn" complements the main house, which was built in 1875 and was recorded as a Texas Historic Landmark in 1972. The barn serves as the central gathering area for guests; the bar, game room and lounge feature reclaimed wood and rough sawn timber, providing an elevated reflection of the ranch's past. Salvaged timber is used for the stair treads, plus ceilings, walls and flooring.

1200 Pennsylvania Sustainable House, Lawrence, Kansas: This LEED Platinum–certified home features refurbished Western red cedar siding that was milled from 100-year-old railroad trestles, then treated with three coats of Penofin oil. Inside, repurposed marble from a 1930 office building was used for the kitchen counters and walls. The project was built by architecture master's students at the University of Kansas, under the direction of professor Dan Rockhill; the Studio 804 program has produced 10 LEED Platinum buildings, three of which are Passive House certified.

Barn Gallery, Lopez Island, Washington: This waterfront guesthouse also functions as the owner/designer's art gallery and sustainable design showcase. While retaining the original structure's footprint for minimal impact on the site, the existing home was deconstructed, and 80 percent of materials were either reused or upcycled. The siding planks were cut from the original floor joists, made of wood harvested from the property in 1970. When the designers ran out of recycled wood, they looked to other sources, including an old warehouse in Los Angeles, which provided some of the exterior siding panels. The 8-ft. pivot front door was fabricated from pine planks sourced from a deconstructed 75-year-old building in eastern Washington. Inside, wood siding from the original house was sandblasted and reused as wall panelling.

The Department Store, Brixton, London: Architectural firm Squire and Partners purchased a dilapidated, three-storey Edwardian department store that was built in 1906; it was one of the first steel-framed buildings in England. As part of its renovation, a fourth floor was added, with an exposed wood structure composed of approximately 50 tonnes of oak. The wood was chosen for its sustainability, but also for its warmth and natural color which, in the architect's view, complemented the age and character of the original structure. The architect's goal was to celebrate the history of the store; original mouldings, decorative metalwork and teak and mahogany floors were all preserved. The building is now the practice headquarters, with retail and creative units at street level.

1. PaaHaa Ranch Barn
   Architect: Lake | Flato
   PHOTO: Casey Dunn

2. 1200 Pennsylvania Sustainable House
   Architect: Studio 804
   PHOTO: Dan Rockhill

3. Barn Gallery
   Architect: InclineDesign
   PHOTO: Steve Horn

4. The Department Store
   Architect: Squire and Partners
   PHOTO: James Jones

PHOTO: Michael Green Architecture/The Catalyst Building

PHOTOS: Katerra

Katerra Builds Largest CLT Plant in North America, Supplies Spokane's First Net-Zero Structure

A new 270,000-sq.ft. mass timber facility for Katerra, a "vertically integrated" construction company based in California, is already delivering three- and five-layer CLT panels in limited production, while the manufacturing building in Spokane Valley, Washington, is completed. The five-storey, 150,000-sq.ft. Catalyst Building in Spokane's University District is the first project to use the new factory's products; it is also the first office building in the state to be constructed of CLT, and will be one of the largest net-zero buildings in the world. As part of an eco-district development, the Catalyst Building – designed by Michael Green Architecture (which was acquired by Katerra in mid-2018) – features solar panels, a gray-water system for rainwater recovery, low-flow plumbing, heat recovery systems, LED lighting and other energy-efficiency measures.

katerra.com; catalystspokane.com

Net Zero Carbon Buildings Commitment

The World Green Building Council challenges companies, cities, states and regions to reach net-zero operating emissions by 2030, and to advocate for all buildings to be net-zero in operation by 2050. At press time, the Commitment was signed by 23 cities and six regions, including California, Scotland, London, Toronto, Montreal, Paris, New York City, Tokyo, Cape Town and two cities in Spain (Catalonia and Navarra). The Commitment provides a framework for organizations to develop globally ambitious yet locally relevant, flexible and universally viable solutions to both reduce energy demand and achieve net-zero carbon emissions.

worldgbc.org/thecommitment

PHOTO: Dialog

Vancouver Continues to Attract Innovative Mass Timber Projects

In August, Fast + Epp began site preparations for its new office, a four-storey hybrid mass timber building scheduled to be erected in 12 days. Designed collaboratively with f2a architecture, the structure will feature earthquake-resistant technology with resilient slip friction joints to anchor the CLT shear walls, one of the first applications in North America.

Earlier this year, health food manufacturer Nature's Path announced it is planning to build a 10-storey mass timber building, designed by Dialog (with perimeter timber braced frame developed by Fast + Epp), to accommodate its global headquarters, including up to 2,000 employees as the company grows; initially, it will occupy the first three floors and lease out the additional space.

fastepp.com; f2a.ca; dialogdesign.ca/projects/2150-keith-drive

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York Region

Bill Fisch Forest Stewardship and Education Centre

A net-positive building demonstrates wood's enduring appeal and environmental performance

Whitchurch-Stouffville, ON

Built on a previously developed site and surrounded by a 90-year-old forest, the Bill Fisch Forest Stewardship and Education Centre is designed to be an integral part of one of the most successful forest regeneration projects in the world, helping residents of York Region learn about the importance of natural resources and forest ecosystems.

Situated between Toronto to the south and Lake Simcoe to the north, the Regional Municipality of York is home to just over 1.1 million people, many of whom were drawn to the area's affordable suburban housing over the past several decades. Prior to that, York Region (formerly known as York County) was known for its rich farmland, and many of the native forests were cut down as the area's population grew. After significant soil erosion and demand from citizens to restore the nearly forgotten forest, however, the region set to work reclaiming its nearly lost forests. As a result, the York Regional Forest is internationally recognized as a leader in site restoration and forest management, and it is the first public forest in Canada to be certified by the Forest Stewardship Council.

Conceived as being "of the forest" and not "in the forest," the Bill Fisch Centre replaced another facility that was on the site since the 1940s. The single-storey, 4,000-sq.ft. building includes space for corporate meetings and community educational programs. It was designed for an almost 100-year life cycle, respecting the heritage and legacy of the old-growth forest that surrounds it on all four sides.

Cross-laminated timber panels are the structural elements for the exterior walls and are also their exposed interior finish. The insulation is located on the exterior of the CLT walls, and the cladding is reclaimed Douglas fir. Unlike in most post-and-beam buildings, the structural beams are located above the CLT roof to provide interior clearance and a clean appearance for the ceiling. The glulam columns that support the beams have a shoulder at the top, over which the CLT roof panels were placed. The shoulder does not provide structural support for the CLT panels; it provides a gap-free joint between the

columns and the roof panels. The CLT roof panels and the entire structural load of the roof are suspended from the glulam beams by means of self-tapping, engineered screws and bolts.

The predominant interior finish is the exposed surfaces of the CLT wall and roof panels. The CLT and glulam columns are coated with a zero-VOC stain, which is used on all exposed surfaces. Several featured interior wall panels are clad in maple-veneered, FSC-certified plywood. These panels are located within the administrative areas of reception and open office workstations. Similarly, the open office areas are separated from the circulation corridor by a series of horizontal maple louvres which are supported on a metal frame. Reclaimed ash salvaged from the area is used for the main entry reception desk as an educational feature. It retains the tracks of the emerald ash borer insects that have devastated ash forests in Ontario.

The numerous floor-to-ceiling windows created a challenge for developing adequate shear wall strength, which was provided by using tie-down connections and vertical reinforcing plates for the portions of CLT walls between the windows. The results are worth it: Every occupied interior space features windows that provide access to fresh air, and natural light is abundant. Operable windows at the clerestory also provide ventilation to circulate air between the upper and lower windows. With no other cooling for the building, an automation system opens windows when the outside temperature exceeds 10°C.

The structure is designed to generate more energy than it uses and feeds excess renewable power back into the grid. This is made possible through roof-mounted photovoltaic panels, and energy-conserving features such as a high-performance building envelope, heat recovery ventilators and LED lighting. On an annual basis, the Education Centre is expected to have a net positive energy balance of 8 mWh. Heating energy is provided by a wood-burning masonry fireplace fuelled by locally collected deadfall – but, in accordance with Living Building Challenge requirements, the wood heating is not a significant contributor to the energy performance of the building.

Similarly, the project can be described accurately as

"net positive water," with all water used in the building returned to nature just as clean – if not cleaner – than it was before. Water systems and components include a well water supply system with non-chemical treatment, rainwater harvesting system including cistern, pumping and treatment devices and low-flow plumbing fixtures. The building is connected to two wells, one existing and one new, to meet the demand for potable water. The non-potable water is provided from on-site groundwater and rainwater collected on the roof of the building and drained into an underground cistern.

The Bill Fisch Centre is intended to be a living demonstration that a highly green and energy-efficient structure also can be nurturing, comfortable and healthy – without compromising aesthetics and the quality of the indoor environment. Right from the start, the Certified Living Building was designed to be completely integrated with the surrounding ecosystem. This, along with the extensive use of wood, creates a sensation of biophilia that goes well beyond interior patterns and finishes.

CLIENT
Regional Municipality of York
Newmarket, ON

ARCHITECT/STRUCTURAL ENGINEER
Dialog
Toronto, ON

GENERAL CONTRACTOR
Struct-Con Construction Ltd.
Brampton, ON

WOOD SUPPLIER
Nordic Structures
Montreal, QC

PHOTOGRAPHY
Cindy Blazevic
Toronto, ON
Evan Dion
Toronto, ON

Hitchcock Center for the Environment

A building that practices what it preaches – while wood delivers the message

Amherst, MA

The Hitchcock Center for the Environment aims to teach environmental literacy to all ages, while seeking sustainable solutions through the study of natural systems. To that end, this Certified Living Building not only helps students recognize the importance of science and engineering in meeting many of the environmental challenges we face today, but also that the natural world itself holds abundant wisdom and solutions.

Given such an ambitious mission, it's no surprise the 9,000-sq.ft. center – complete with classrooms and a resource center with live exhibits and interactive learning tools – practices what it preaches. Among its many sustainable attributes, the net-zero building harvests and recycles its water, uses composting toilets and is made of responsibly sourced, non-toxic materials. Recycling and compost throughout the building was designed to make collection as seamless as possible for staff and visitors.

As part of the holistic effort to reduce its carbon footprint, the center also utilized an innovative all-wood structural system, with a frame and shell system built from locally sourced Eastern white cedar. The timber frame is clad on all sides (both walls and roof) with continuous tongue-and-groove decking that acts as diaphragm, lateral system and interior finish. This shell is covered in an air and vapor barrier to ensure that it's watertight. The all-wood envelope and structure is based on the idea that solid wood can be used as a building material for both its carbon sequestration properties and for its thermal effusivity (its capacity to radiate thermal energy). In this way, along with creating a strong visual character and structural capacity, the wood provides both literal and figurative "warmth" to the space.

Further to the center's commitment to sustainable living, the design team used a combination of certified, locally sourced and reclaimed materials to create a responsibly sourced building. The bulk of the wood was FSC certified and included engaging two millwork contractors to renew their FSC Chain of Custody. Black locust bollards, from this Massachusetts invasive species, were harvested only 25 mi. away by a family-owned facility using FSC principles. Other site-salvaged materials include oak benches from cleared wooded areas and a "basking boulder" installed inside to illustrate warming techniques of cold-blooded animals. Nearly all materials were sourced within a 300-mi. radius. The all-wood building structure is primarily bolted and screwed together to facilitate end-of-life disassembly and reuse.

While one part of the construction team focused on restoring the site's contaminated soil and reintroducing native vegetation to the roughly three acres of property, another focused on the building itself, which features numerous elements designed to promote human


WATERSHED
RAINWATER
CAPTURE

interaction. Outside, a series of log benches, salvaged from site work during construction, serve as places to sit, talk and climb, while the courtyard decks further encourage exploration and conversation. Inside, a reading nook is lined with a low bookcase that doubles as a seating ledge, with a row of storage cubbies in the north hallway performing the same function. From every angle, the center was designed with human-scaled spaces in mind, with an eye to the benefits of spaces designed for children, where they can feel comfortable climbing, crawling and engaging with their surroundings.

The center is committed to serving as a public resource to promote environmental literacy. Much of its programming is offered at no or low cost, and a scholarship helps low-income families participate in its summer camp programs. There is no entry fee to tour the building, and the outdoor classrooms, demonstration gardens, courtyards and nature play areas – including a "mud kitchen" – are easily accessible.

The result of this synchronicity between structure and programming is a powerful learning destination that closes the gap between people's aspirations for a sustainable future and the knowledge, skills and attitudes they need to achieve that future. Here, the important role of wood creates a foundation for discovery.

CLIENT
Hitchcock Center for the Environment
Amherst, MA

ARCHITECT
designLAB Architects
Boston, MA

STRUCTURAL ENGINEER
Structures Workshop
Providence, RI

GENERAL CONTRACTOR
Wright Builders
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PHOTOGRAPHY
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Boston, MA

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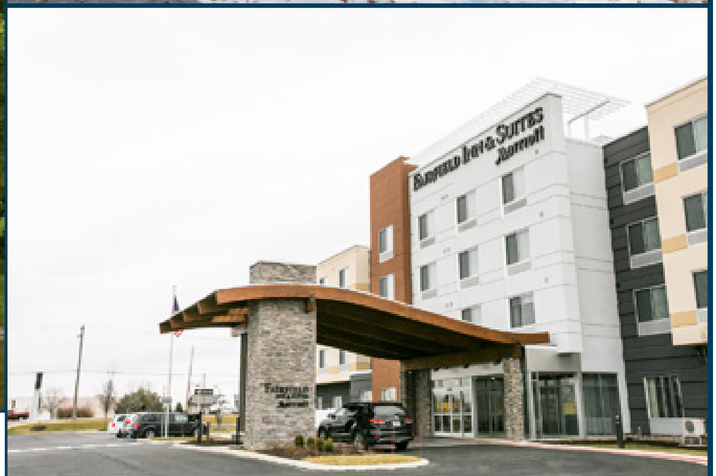

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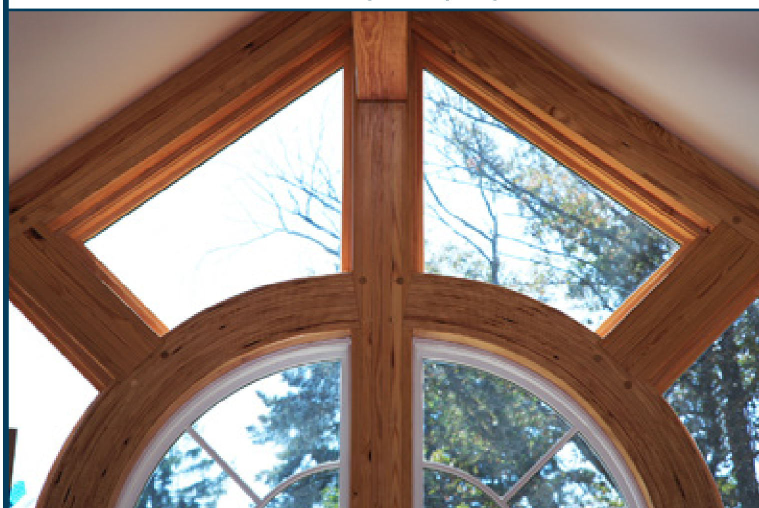

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Ekoladan

A 100-year-old barn is transformed into an innovative, sustainable retreat

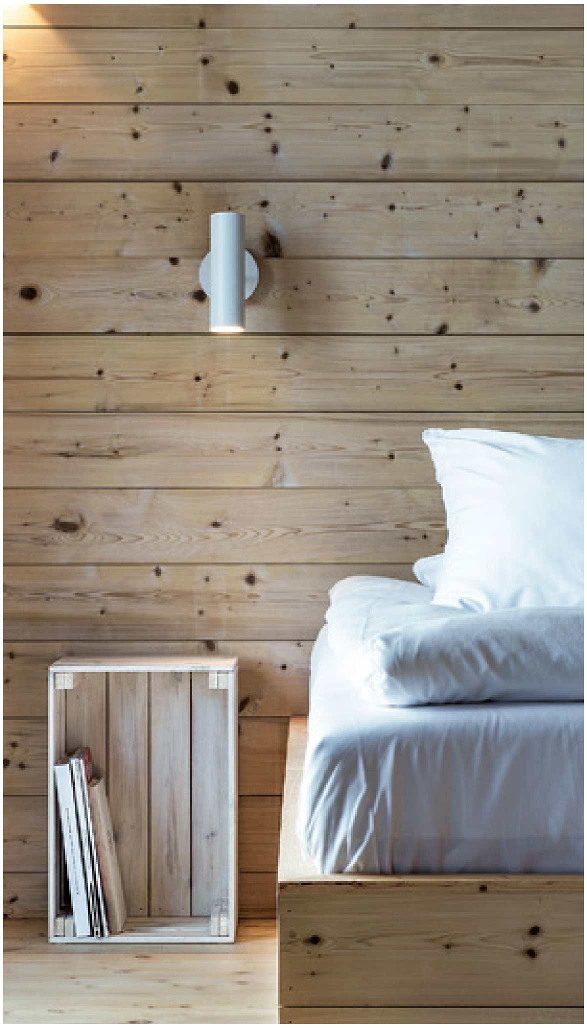
Vrena, Sweden

At the end of a road in the middle of the Swedish countryside, roughly 90 minutes southwest of Stockholm, lies Ekoladan ("Eco Barn" in Swedish), a formerly dilapidated barn that underwent an extensive redesign and renovation to become a hotbed for exploring sustainable methods of farming, while inviting guests to connect with nature and themselves. The retreat is owned by a young family that dreamed of encouraging people to think and act more holistically. To that end, they embarked on a journey to transform their 100-year-old barn into a sustainable retreat that is completely integrated into the farm's ecosystem.

Wood was the natural material of choice for the project. All the timber needed to rebuild the barn was harvested from the surrounding forest and transported to a local mill by horse to avoid ground damage. Wood is used at Ekoladan not only because it is the only renewable construction material, but also because it makes the building itself a carbon sink, storing carbon dioxide. In addition to a long service life, the many characteristics of wood combine to deliver the best possible load-bearing capacities, as well as thermal, acoustical and insulating properties. All millwork – including kitchen cabinets, sleeping lofts, bed platforms and built-in furniture – along with windows and doors are custom-made of solid pine, while all floors are formed from solid pine planks.

The renovation of the 11,840-sq.ft. barn includes large windows to capture views of a nearby lake. Hotel guest rooms are furnished with organic materials, including natural rubber mattresses, while a farm-to-table restaurant serves organic dishes. The insulation in the walls and ceiling is made from sheep wool and linen, and the foundations are insulated with recycled glass. Air conditioning is provided in the summer by routing air through pipes deep down in the soil. To further minimize impact on the ecosystem, wastewater from the kitchens, toilets and showers is treated 100 percent biologically with plants and microbes before it flows into a pond on the property.

As the world's first climate-positive hotel and retreat, Ekoladan is also equipped with cutting-edge solutions that convert carbon dioxide in the atmosphere into carbon storage in the soil. Heating comes from a pyrolysis process where organic matter, such as agricultural waste and excess wood, is burned and converted into biochar, which is then used to fertilize the crops on site. The carbon dioxide absorbed from the air remains in the biochar, which then stores carbon while integrated into the farm's organic soil; the more the building is heated,



the less CO_2 goes into the atmosphere. The barn produces electricity using solar power and Stirling engines that run on the pyrolysis process, powering the whole farm operation.

Of course, no place of relaxation in the Nordic region is complete without a *bastu*. The retreat's sauna is constructed entirely in pine planks, with the wall panels stained using eco-friendly paint. Speaking of paints, the building's exterior is covered with traditional red Falu paint – a sustainable, low-maintenance, locally sourced finish that has been used in the Nordic countries since the 16th century.

Over the next few years, the owners plan to add a second floor within the existing volume for additional hotel rooms, as well as a post-and-plank building extension for a conference room and larger kitchen and dining room. Although the Ekoladan project relies on wood to accomplish its eco-friendly goals, its greater purpose is to provide an environment that encourages a more holistic way of thinking by taking nature into consideration. The project proves that traditional and time-tested wood construction methods can be combined with cutting-edge systems to produce climate-positive results.

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STRUCTURAL ENGINEER
White Arkitekter
Linköping, Sweden

PHOTOGRAPHY
Ken Pils Fotograf
Linköping, Sweden

The Reach Guesthouse

A Passive House project makes an active case for preserving the beauty of the past

Prince Edward County, ON

Perched on the top of a waterfront escarpment in Ontario's rustic Prince Edward County, this renovated farmhouse was a journey, as most renovations tend to be. Yet despite the slow progress, the design team managed to create a systematic combination of archaeological discovery, preservation, encapsulation and architectural reinterpretation.

The original farmhouse, built 130 years ago, was reduced to its barest hand-hewn wooden structure, then meticulously cleaned and sealed inside an airtight skin. A new jacket of R43eff structural insulated panels was then added to the walls. A new roof truss structure surmounting the existing roof provided the space to blow in 600 mm. of cellulose insulation with an R-value of R80, and a new front gable window was intentionally oversized to allow a glimpse of the original house within the new house.

One of the many challenges of this project was to get an airtight seal around the existing structure. To achieve this, the team had to lift all ground-level floorboards, insert an oriented strand board layer and then relay the floorboards. The old board and batten walls had to be pried loose, working progressively around the building so that the floor could be sealed to the air/

vapor barrier wrapping the house.

The design team had several goals for this project, among them the re-presentation of an existing wood structure as a new expression of something old and never seen before. Heritage is the keyword here: The hand-hewn structure demonstrates the woodcraft of the late 19th century while the bones, though never visible in the past, have resurfaced like lost treasure found again.

Another goal of this Passive House project was to create a comfortable and healthy living environment with the most minimal use of man-made energy. On that front, the results speak for themselves; earlier this year, an electric "hair dryer" (in truth, a tiny electric heater purchased at a yard sale) maintained comfortable temperatures despite the -25°C temperatures of the Canadian winter outside.

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STRUCTURAL ENGINEER
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GENERAL CONTRACTORS
Neil Thompson Contracting
Picton, ON

Green Giant Design Build
Picton, ON

PHOTOGRAPHY
Industryous Photography
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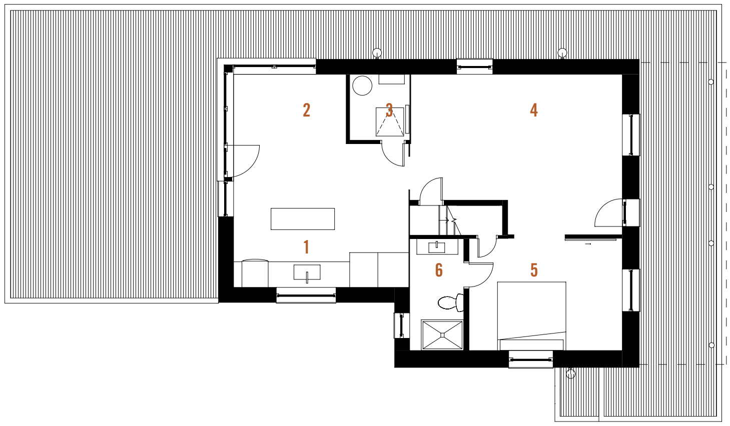
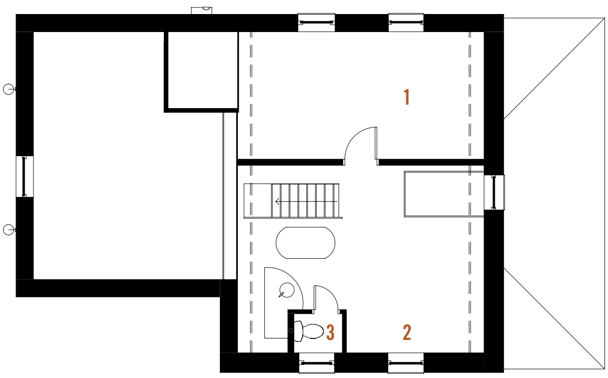


1. kitchen
2. dining room
3. utility room
4. living room
5. bedroom
6. restroom

GROUND FLOOR PLAN



1. bedroom
2. landing/restroom/sitting room
3. restroom

SECOND FLOOR PLAN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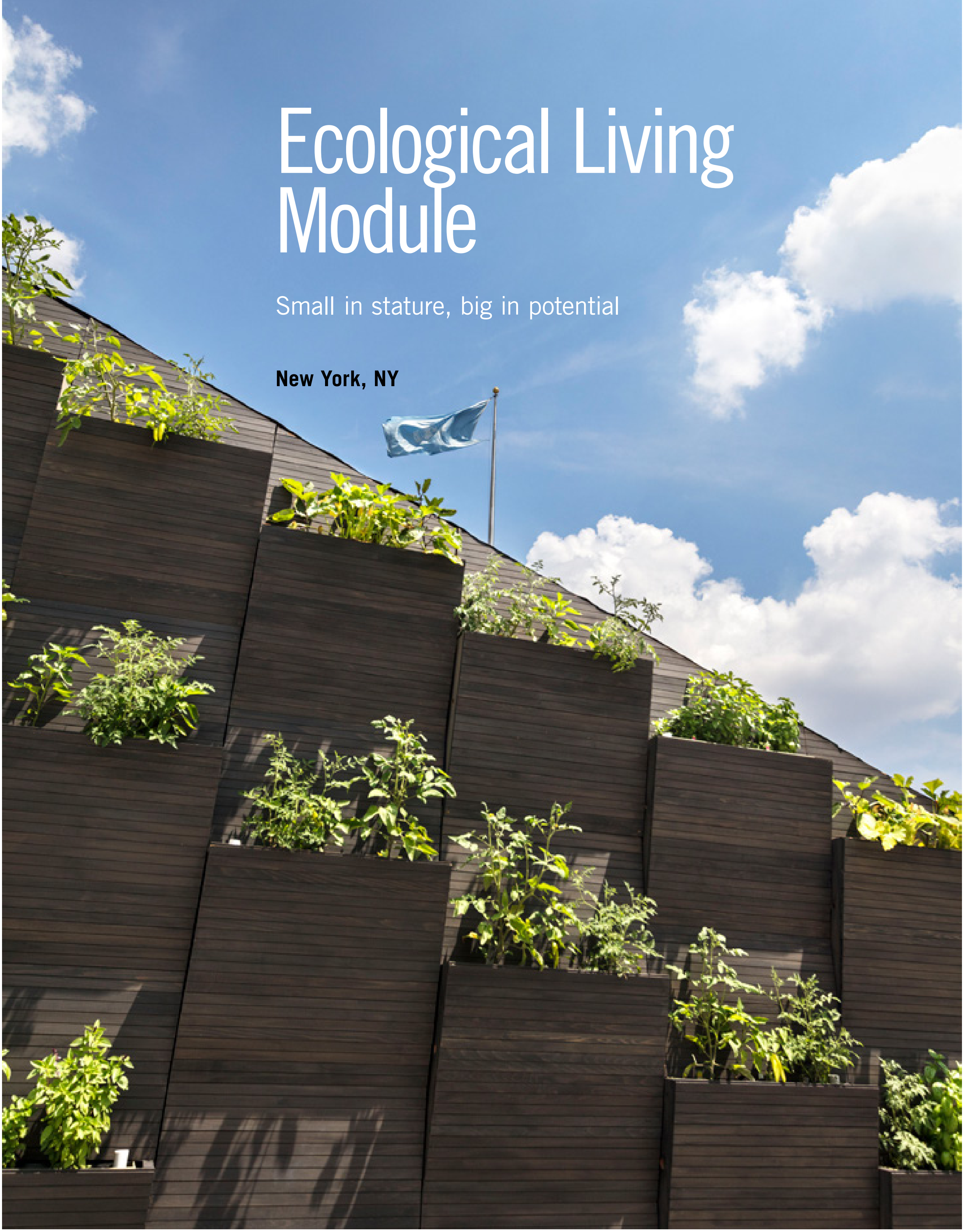


Ecological Living Module

Small in stature, big in potential

New York, NY

Juxtaposition in art is about combining elements that may not naturally occur together to create visual interest. It's an impact that turned heads at the United Nations Headquarters in New York last July, when visitors discovered a tiny eco house temporarily erected in the expansive, concrete plaza. Small in stature but large in potential, the Ecological Living Module, or ELM, was commissioned by the UN Environmental and Habitat programs to underscore the need for innovation in the face of a global housing crisis and climate change.

Designed and fabricated in only seven weeks by Connecticut-based Gray Organschi Architecture, in collaboration with the Yale Center for Ecosystems in Architecture, the ELM fuses Nordic simplicity with state-of-the-art technology to create a prototype structure that is both affordable and sustainable. It was a tall order to deliver in a short time span.

"The ELM was prefabricated in just four weeks and installed in three days by our team of 16 people," notes Alan Organschi, design principal and partner at Gray Organschi and a faculty member at the Yale School of Architecture. "We designed and

built a 230-sq.ft. home that is adaptable, efficient and fully off-grid, while making use of sustainable materials, simple construction techniques and next-generation green technology." Organschi also admits taking on the project was one of the most high-pressure experiences of his life. "It was a combination of the time frame, which was incredibly narrow, not only for manufacturing, but also for assembling and installing it on site; the incredible scrutiny of UN security watching every move we made; meeting OSHA [US Occupational Safety and Health Administration] compliance; and, just the number of people wandering through while we were working in the plaza."

Anna Dyson, founding director of the Yale Center for Ecosystems, oversaw the project's sustainable technologies, working with Jacobson Structures and JIG Design Build to engineer the ELM, which was prefabricated at an off-site production facility and transported via truck to the building site. Quebec-based Nordic Structures donated 8 x 24-ft. panels of five-ply CLT for the floor, Structure Fusion contributed 35-mm. three-ply CLT for the walls and 475 High Performance Building Supply provided cellulose- and wood-based rigid insulation for the walls and roof. The structural elements are PSL posts and LVL beams, while the facade is Western red cedar.

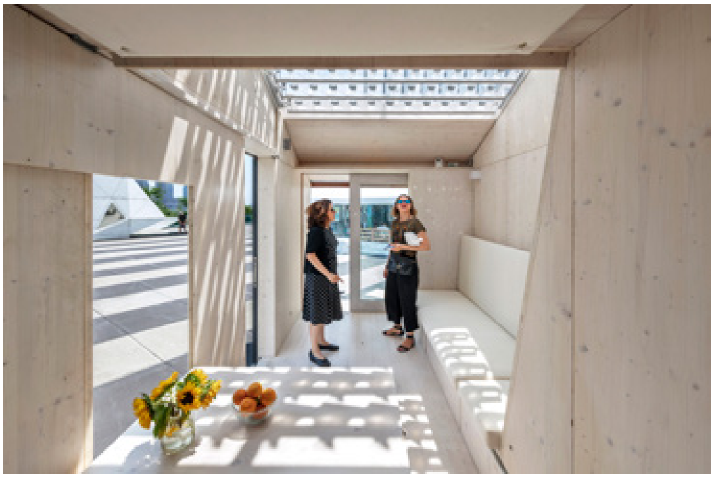
Arriving as a compact 8 x 8 x 22-ft. container, once the ELM was set onto its lightweight foundations, the roof assembly pivoted on a steel hinge to create a 16-ft. double-height interior space with a built-in sleeping loft. The prefabricated wall panels were then manually set in place. With sleeping and living space for four people, a full kitchen and a bathroom with shower and composting toilet, the ELM is suitable for both domestic and commercial uses. If put into large-scale production, it's estimated to retail at under $50,000 per unit.

The project sparked excitement and new ideas for the design team. The ELM's form and orientation helps manage solar heat gain, promotes air circulation and ventilation, provides natural light and maximizes sun exposure for its HeliOptix solar power system; the system integrates an array of concentrated solar cells into the skylight glazing, generating energy and serving as a sunshade to limit heat gain and reduce overall energy needs. The group says that the HeliOptix system produces greater power output than traditional solar, while using less than one percent of the semiconductor material.

All water needs for the ELM are met on site, with 80 percent of rainwater from the roof captured, stored and filtered for potable water. During humid weather, moisture is pulled from the air by a dehumidifier system that supplements the rainwater supply. Meanwhile, wastewater is recycled to irrigate food crops integrated into the micro-farming wall on the west facade. A modular wall, or Active Modular Phytoremediation System, is composed of pods containing hydroponically cultivated plants whose exposed root systems facilitate air purification. Planters on the exterior walls can grow enough vegetables for several servings per person per day.

Organschi sees the ELM as a prototype that can be constructed in remote parts of the world, and reconfigured according to local resources. Designing a universal model and then shipping it would actually cost more in energy, he suggests: "We were trying to create a truly sustainable system of building development and to get across this message about how to create global applicability without requiring the global economy to work on it." Organschi adds, "We looked at it in a holistic way. By building with renewable, biogenic materials and incorporating systems for on-site energy, water, air and waste management, we sought to limit the energy and resources required to produce and operate the ELM over its entire life cycle."

The point wasn't to advocate the micro aspect of the ELM, but to create high-quality housing for areas where there might be food scarcity and water insecurity. The team aimed to build a



small house that "could provide all of the amenities of home in an optimized space for up to four people, and have it be a convivial environment in a really insecure location."

The project also was meant to push people into thinking more holistically about the materials they are using, how to optimize them and how to reduce impacts. "We wanted to demonstrate all the capacities of wood fiber: that we could use thinner CLT systems for the interior finish and structure of the building but also reuse it as siding. We didn't use fiberglass or rock wool, but used cellulose insulation instead," Organschi explains.

The concept's potential has not been lost on private builders, with several from around the world contacting the architectural firm for insights on developing entire communities of ELMs for urban workforces. Organschi says that progressive cities like Vancouver, Portland and Seattle are looking at ways to introduce municipal bylaws that will allow for such small-scale settlements. "What I really loved about the project – more than the building, more than the spectacular media coverage it got and more than the high-stakes execution – was the incredible wealth of intelligence that a lot of people offered," he adds. "There is a whole generation of people just entering the profession now who really care about this."

The ELM's reduced carbon footprint and off-grid systems address a number of issues critical to global sustainable-development goals: Reduced energy needs limit the financial and resource burden; renewable bio-based materials preserve rural landscapes and finite resources; and, if aggregated at a global scale, low-carbon, wood-based residential development has the potential to dramatically reduce the effects of climate change. To accommodate an ever-growing population, a smaller building footprint (both literally and figuratively) makes sense from every angle. – *Jana Manolakos*

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The Arbour: A New Paradigm

Carol Phillips

Fig. 1: Perspective view from the east

For most of Canada, as we embarked on our familiar seasonal routines this year, another awareness settled in: It is impossible to ignore that the weather has become unpredictable. Deluge rains overwhelm the sewers and roads, temperatures often seem colder (or warmer) than seasonal norms, wind storms and water levels are washing out beaches and shorelines. Without a doubt the climate has changed; the shape of the land is shifting; the climate crisis is upon us, and our actions matter.

Perhaps these observations have the potential to galvanize the entire design and building community locally, nationally and internationally around the purpose of designing with the planet in mind. As designers, however, we are often put in a position of choosing between our direct responsibilities to one particular building project, or seeing our designs as part of a greater system. Design and architecture always have signaled collective identity, reflecting context and culture; however, this often contradicts the aspiration to be completely unique, whether the motivation is mandated by a client, or simply to drive creative innovation, contained within the parameters of a particular project's needs.

The potential for this dichotomy was embedded in the design process for The Arbour. Procured by Toronto's George Brown College through an open call, five teams were invited to an international design competition. The implicit mandate was to seek a highly innovative, unique solution to the design brief, while bringing attention to highly sustainable, low-carbon designs. Our design team, led by the collaboration of Moriyama & Teshima Architects (MTA) and Acton Ostry Architects (AOA), chose to pursue a unique project that would implement directly transferable principles and innovation so that others could benefit from our design.

We approached the project with the hope that in order to have real impact, we would demonstrate that the remarkable was achievable within reasonable parameters. Our goal was to inspire our industry to think that low-carbon and high-sustainability targets were not only for the bespoke icons, but for every building, and in so doing propel the green building and the nascent mass timber industry forward. Our approach to creating a very specific landmark design was to embrace the waterfront context and the challenges of vertical post-secondary campuses, while seeking innovative solutions to the issues that deter most from using timber structures – namely, the perceived limitations with depth and spans. Similarly, the approach to energy consumption was to focus on achievable steps that any everyday project could adopt or relate to. Simply put, we strove for inspirational but tangible targets.

To achieve a highly sustainable building, the approach for The Arbour was to design holistically, integrating architecture, planning, form and systems from the concept stage onward. Rather than designing a building and retrofitting the systems into the design, The Arbour is as much a product of inspiration as it was the systems that contribute to the building's design performance. From the initial concept, key contributors to the MTA/AOA team were Fast + Epp Structural Engineers, Transsolar KlimaEngineering and the Integral Group; as the design progressed, Morrison Hershfield Building Envelope Consultants and GHL+CHM Code and Fire Engineering supported the team.

Beyond the project specifics, the forces that really define and enable a systems approach to a sustainable future in buildings are regulations and incentives. Two examples are the Toronto Green Standards and the GCWood Program, one municipal and the other federal (respectively), both of which influenced The Arbour's design. The general parameters of The Arbour as defined by George Brown College are that it is an assembly occupancy, tall mass timber building designed to LEED Gold and TGS Tier 4 (the highest tier), resilient, future-proof and smart. The following summarizes the key (transferable) principles and notes the relationship between the evolving design and these two programs.

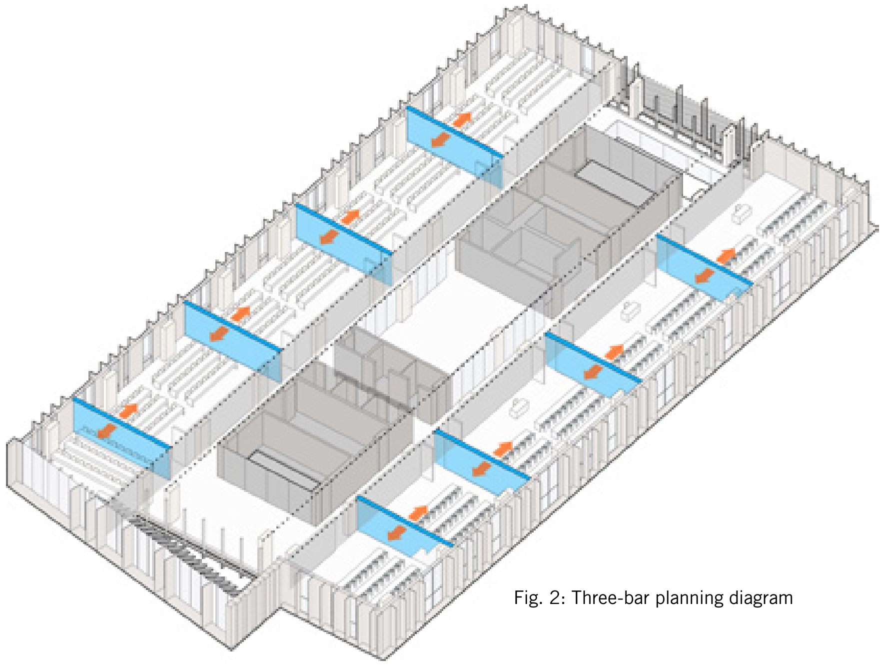


Fig. 2: Three-bar planning diagram

Planning and Organization

Principles: Distribute social and learning spaces to the perimeter; allow for contextual views and connections; plan for future-proofed occupancy; design a great envelope; create striking profiles linked to solar harvesting.

The Arbour is organized sectionally around "breathing rooms," or social spaces, distributed throughout the vertical expanse of the building's 10 storeys. Recognizing the challenge of vertical campuses to attract student activities throughout the structure, we distributed higher-volume spaces at a variety of scales to encourage social community at all levels, rather than contain it solely to a centralized volume. The "breathing rooms" are located at the perimeter of the building on the north, east and west sides; the first "room" is the learning landscape, a tiered space that rises up three storeys along Queens Quay Blvd. From the fourth floor onward, rising in a skip pattern, are cozier two- and three-storey rooms, bookending each floor and meant as informal gathering spaces for students.

The project is organized around a three-bar plan. The dark program – cores, services and vertical circulation – primarily occupy the middle bar, protecting the perimeter for classrooms and breathing rooms. This also allows for maximum access to daylight and reduces artificial lighting loads in the occupied areas, rather than placing the public and teaching spaces deep into the floorplate. This organizational pattern fits well into a regular repeating grid, as the classrooms are only restricted in one direction by structure; it also contributes to the future-proofing or resiliency of the project, whereby lightweight non-structural demising walls can be relocated over time, as needs and programs change, which adds to the long-term life of the building. The planning is further refined to limit all computer labs to the north side of the building to avoid the large energy draws from being further taxed by southern heat gain.

The building envelope also is organized to consider future needs. Curtain wall expanses are strategically located to take advantage of the views and contribute to an active waterfront community. The main body of the building is envisioned as a protective, high-performance prefabricated envelope to protect the timber and provides a well-insulated sealed envelope targeting just over a 40 percent window to wall ratio. Windows placed every 3 m. support the idea that demising walls can move; even the smallest unit, an office space, can have access to natural light and air. The R-value of the envelope's solid portions are designed to R-30. In the context of a prefab envelope, the weak points are the seams between panels, currently under careful development as the design progresses.

Perhaps one of the unexpected revelations about The Arbour's design is that one of the primary elements contributing to the project's sustainability is the form of the building. From a planning and design perspective, the project's proximity to Sherbourne Commons – a public park – gives the opportunity to consider a striking profile that will be legible in perpetuity because the adjacent property will not be developed. The most striking form, the significant peak of the project, is derived from three major sustainability measures:

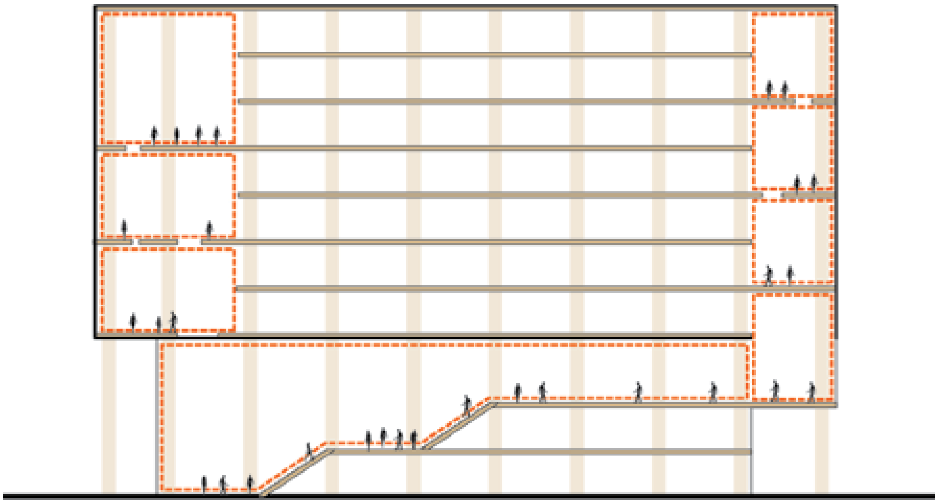
1. The east and west facades are solar chimneys and have to extend vertically even higher than the top floor to create natural convection that will be the passive engine for natural ventilation, and will also be non-fan-assisted exhaust when the building is in active mechanical mode.
2. The building stretches up to the north to maximize the soft northern light to the upper floors and slopes to the south to minimize heat gain.
3. The slope becomes a natural armature for the solar PV, utilizing attachments to the standing seam roofing rather than a full secondary armature to create the slope.

It is also important from a regulatory perspective to note that there is a strict 38-m. street wall along Queens Quay Blvd. that contributes to the continuity of the urban fabric of the development.

Metrics: 7.2 x 9-m. grid; three-bar planning; distributed social spaces in the building.

Energy Performance

Principles: Set an energy target; design a great envelope; maximize light and fresh air; decouple ventilation and conditioning; effectively manage equipment energy.



Top, Fig. 3: Sectional diagram of The Arbour
Bottom, Fig. 4: Elevation detail

Contributed by Mike Godawa of the Integral Group:

The first step is to set an energy target. In the case of The Arbour, the client's goals were LEED Gold (minimum), net zero carbon and Toronto Green Standard (TGS) v3 Tier 4. The TGS targets for a building of this type (post-secondary academic) are not specified; however, a commercial office building targets provided aggressive metrics for the design team. These metrics are:

- Total Energy Use Intensity (TEUI) at 65 kWh/m^2/year
- Thermal Energy Demand Intensity (TEDI) at 15 kWh/m^2/year
- Greenhouse Gas Emissions Intensity (GHGI) at 4 kg/m^2/year

The next step was to design a great envelope. This involved an integrated design approach obtaining feedback from all team members. The appropriate massing and building orientation also played a key role in the envelope design, ensuring passive design before active design. The thermal envelope requires continuous insulation to prevent thermal bridging, an airtight envelope to prevent infiltration and careful selection of the amount of glazing, type of glazing and shading devices (both external and internal). Energy modeling provided valuable feedback to ensure the energy targets were being met; multiple iterations were required and are ongoing as part of the design process.

The design of a great envelope transitioned into the next step, which was to maximize light and fresh air. It is important to find the right mix of not too much glass but enough to provide good daylighting, so that artificial lighting can be turned off as much as possible. In terms of fresh air, the building is designed to have an engineered natural ventilation system so that it can be ventilated using fresh air when outside conditions are suitable (mainly spring and fall seasons). The east and west facades act as passive solar chimneys, allowing fresh air to be drawn from operable windows in classrooms and offices, through the corridors and then out to the solar chimney at each floor. Each solar chimney starts on the second floor and continues up above the building roof, creating a dramatic, unique and integrated design feature.

When natural ventilation is not possible due to temperature, humidity, pollen or inclement weather, then mechanical ventilation is used. This is the next step in the process: to decouple ventilation and conditioning. The building has a very high student and staff population (3,400 people), which is the size of many small towns. The approach taken for mechanical ventilation was to decentralize the system by using two mechanical rooms per floor; each mechanical room draws fresh air from the south side of the building and discharges exhaust air to the north, using high-efficiency energy recovery ventilators (ERVs) with heating and cooling coils for supplemental conditioning. Humidification is also provided at the ERVs to ensure proper thermal comfort conditions during dry winter conditions.

The building also uses a raised access floor system that provides a pathway for the conditioned fresh air to reach the occupants. The fresh air is discharged through variable air volume floor diffusers that are controlled by carbon dioxide sensors in each classroom or office. In order to decouple the fresh air from the conditioning of the various spaces, radiant chilled/heating ceiling panels are used. These systems provide excellent thermal comfort while minimizing energy use. In addition to the ceiling panels, variable-speed ceiling fans ensure good air movement in the classrooms and offices to further enhance thermal comfort. In computer labs, fitness rooms and other high-load

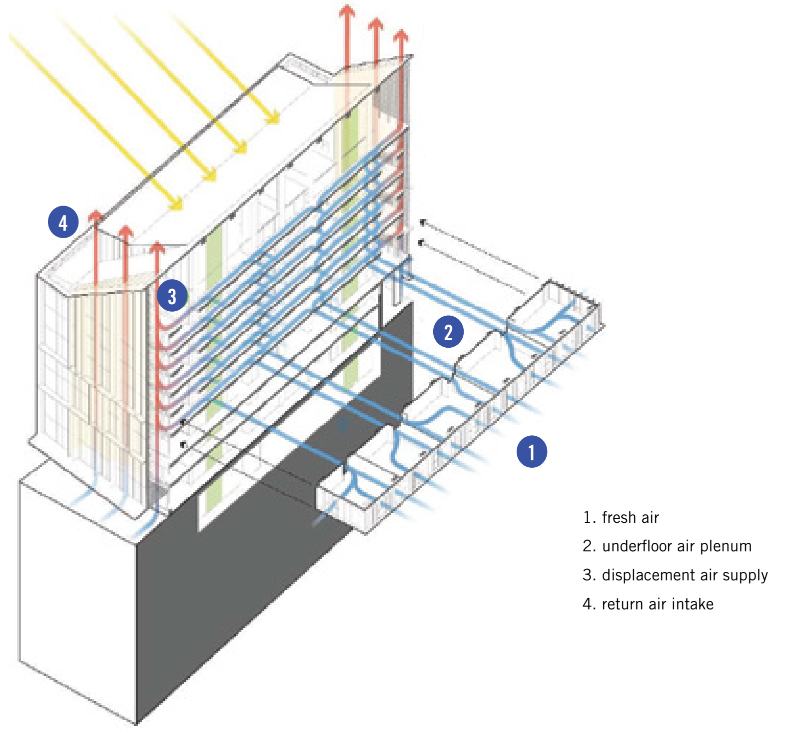


Fig. 5: Passive mode diagram

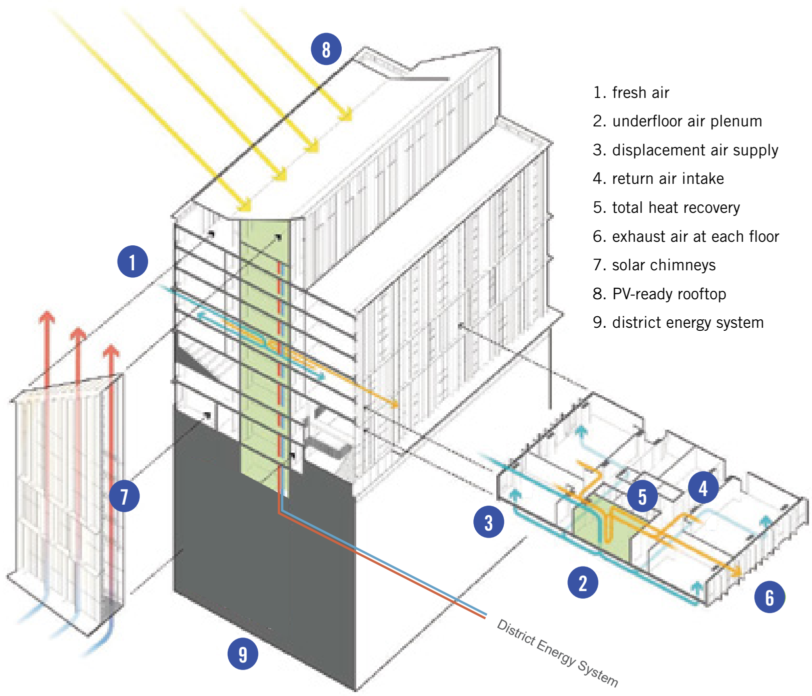
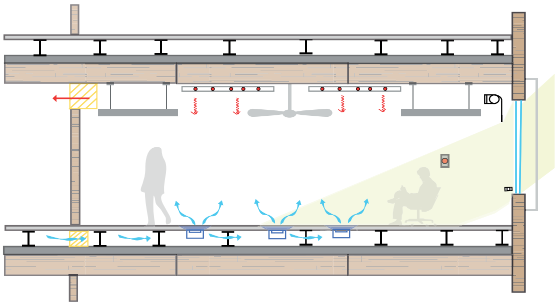
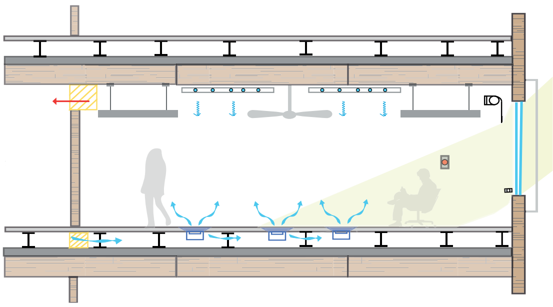


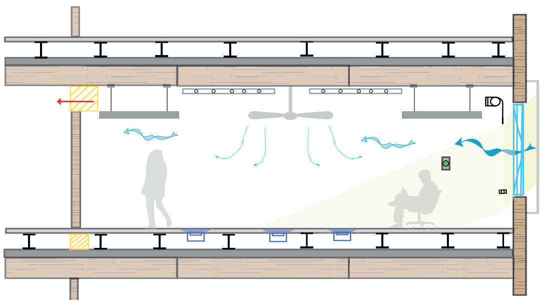
Fig. 6: Active mode diagram



Winter Heating Mode
In heating mode air enters from the under floor plenum. As the air heats up, it rises and is exhausted to the corridor through the acoustically protected vent. Any additional space heating required is done with radiant ceiling panels.



Summer Cooling Mode
In cooling mode, air enters from the under floor plenum. As the air heats up, it rises and is exhausted to the corridor through the acoustically protected transfer vent. Any additional space cooling required is done with radiant ceiling panels.



Natural Ventilation Mode
In natural ventilation mode, the windows open directly to the outside to allow airflow from outside. Mechanical ventilation and the radiant ceiling panels are turned off. To exhaust, air is transferred to the corridor where it is released, driven by the solar chimney at the top of the building. A fan installed for smoke control can be used at very low speed when solar energy and stack effect are insufficient to drive natural ventilation for air quality and temperature control. Some internal spaces may use mechanical ventilation and/or cooling while the other spaces are in natural ventilation.

Fig. 7: Typical classrooms in natural, heating and cooling modes – courtesy of Transsolar

spaces, fan coil units with electronically commutated motors are used in combination with the radiant ceiling panels. The key reason to decouple the fresh air systems from the conditioning systems is to allow the fresh air system to reduce speed and completely turn off when the occupant load is low, and thus ensures the energy cost of heating/cooling is minimized. The fresh air systems will be turned off when the building is not occupied (late at night and parts of the weekend), and the radiant ceiling panels will continue to keep the building at a set-back temperature.

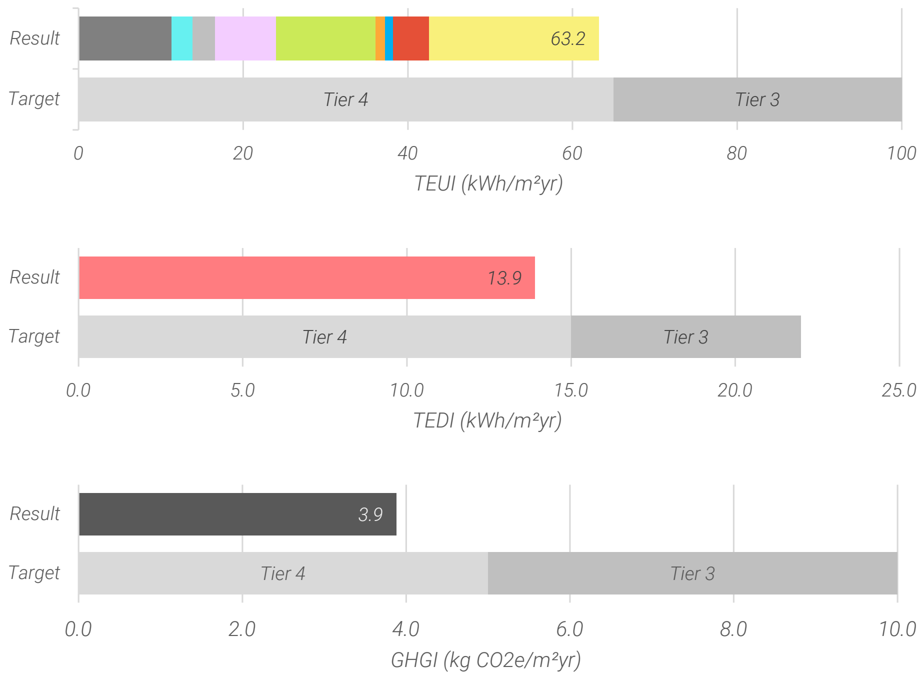
The last key step is to effectively manage equipment energy, which includes lighting, receptacle (plug) load, audio-visual equipment, process loads and any other electrically driven equipment. An intelligent lighting control system will be employed to minimize the use of artificial lighting whenever possible. The plug loads in this building are about 10 times the lighting load, mainly as a result of the student population and the need for power to run computers and other equipment. The building will be designed to prevent standby power consumption and will require Energy Star appliances. In addition, the south-sloping roof will use photovoltaic panels to generate electricity, offsetting at least five percent of the building loads.

Mass Timber Innovation

Principles: Generous span to accommodate classrooms; beamless solution to maximize height and minimize variance from zoning; exposed wood where it is most impactful; solutions that can be produced in Canada; transferable system exercising structural rigour and limiting specialized bays.

The decision to use mass timber came from George Brown College. The material's correlation to sustainability is not always clearly evident, since most yardsticks measure energy; however, there is growing interest in embedded carbon. Sustainably harvested forests have the potential to be not only a renewable resource, but they also sequester carbon without needing an energy input other than the sun, and once harvested, bind and remove carbon out of our atmosphere for the practical, long-term use of a structure. Canada's forests have one of the highest standards in the world with respect to sustainable management, and there is tremendous room for growth in an industry that can, by continuous growth, harvesting and managed reforestation, put a tremendous dent in offsetting the carbon in our atmosphere.

The generator to setting a structural objective was to look at the key driver for the project, which was, without a doubt, classroom space. The program provided by George Brown College was primarily 40-60 student classrooms and labs requiring good sightlines and accommodation for both traditional instruction and active learning. Layout and furniture tests



	End Use	Annual Energy (MWh)	EUI (kWh/m²/yr)
	Interior Lighting	352	19.6
	Heating - DES	73	4.1
	Cooling - DES	17	0.9
	Pumps	20	1.1
	Fans	187	10.4
	Service Water Heating	114	6.3
	Exterior Lighting	50	2.7
	Elevators	46	2.5
	Plug Loads	243	13.5
Total		1100	61.1

Parameter	Target	Result	Tier 4 Compliant
TEUI	65	61.1	yes
TEDI	15	12.9	yes
GHGI	5	3.7	yes

Fig. 8: Energy model results – courtesy of Transsolar
50 percent of the year The Arbour can operate passively; no fuel-fired equipment

indicated that a 9-m. span in one direction could accommodate this. Another significant constraint was to limit the overall height of the building – both to be within reasonable compliance of the zoning and to minimize the envelope for economy. The resulting solution was to seek a "beamless" system that could liberate and maximize space for use but achieve a minimum 9-m. span in one direction.

Contributed by Fast+Epp Engineering: Each mass timber floor will be exposed from the underside, and structural concrete topping will be added to achieve a 9-m. span conducive to institutional programming. These floors will be supported on glulam columns from the ground floor all the way to the upper roof. Concrete slabs at the main and basement levels add robustness to the structure, which is supported on concrete caisson piles extending down to bedrock below.

From levels two to nine, CLT panels are used as the primary floor system. To eliminate the use of beams and create more head clearance, as well as space for mechanical and electrical components, seven-ply CLT panels span 9.2 m. in the north-south direction to act as slab bands on which thinner, seven-ply CLT panels will bear in the perpendicular direction. The typical 430 x 1178-mm. columns, or "wallumns," supporting the main CLT "bands" are designed to resist the weak-axis bending induced by the thinner CLT panels. As shown (Fig. 9), 50-mm. non-structural and 150-mm. structural concrete topping is added onto the CLT panels not only for an architectural purpose, but also to further reinforce the panels. The engagement of the concrete topping with the timber below will be maximized by the use of various steel connections, one of which will be chosen through full-scale testing in the coming months.

The column-to-column connection is configured as shown (Fig. 10) to provide a direct load transfer between vertical elements rather than transmitting forces through the CLT floor panels. Glulam columns will arrive on site with a steel connecting plate and HSS stubs fastened to the end-grain with glued-in rods. The glulam column above will have a similar connection, with smaller-diameter HSS stubs. Stubs are connected together using bolts, allowing for simple installation and acting as a tension connection in the extreme event where a column below is eliminated, pursuant to progressive collapse principles. CLT floor panels will be notched around the HSS tubes and bear directly on the column below.

The structure has been designed for a

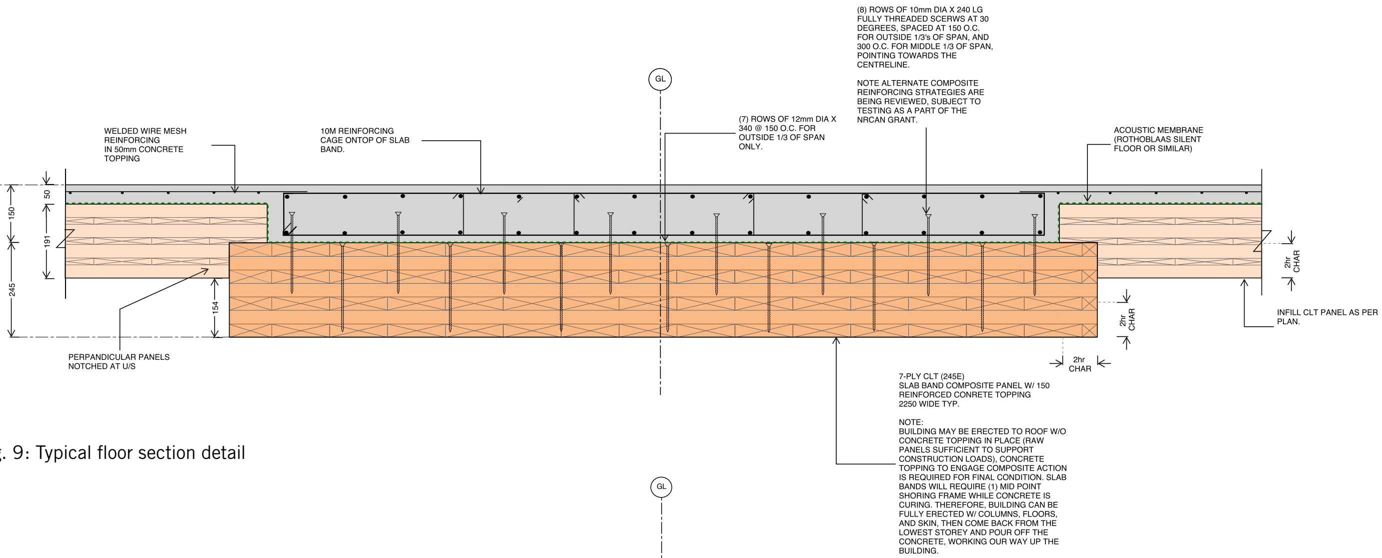


Fig. 9: Typical floor section detail

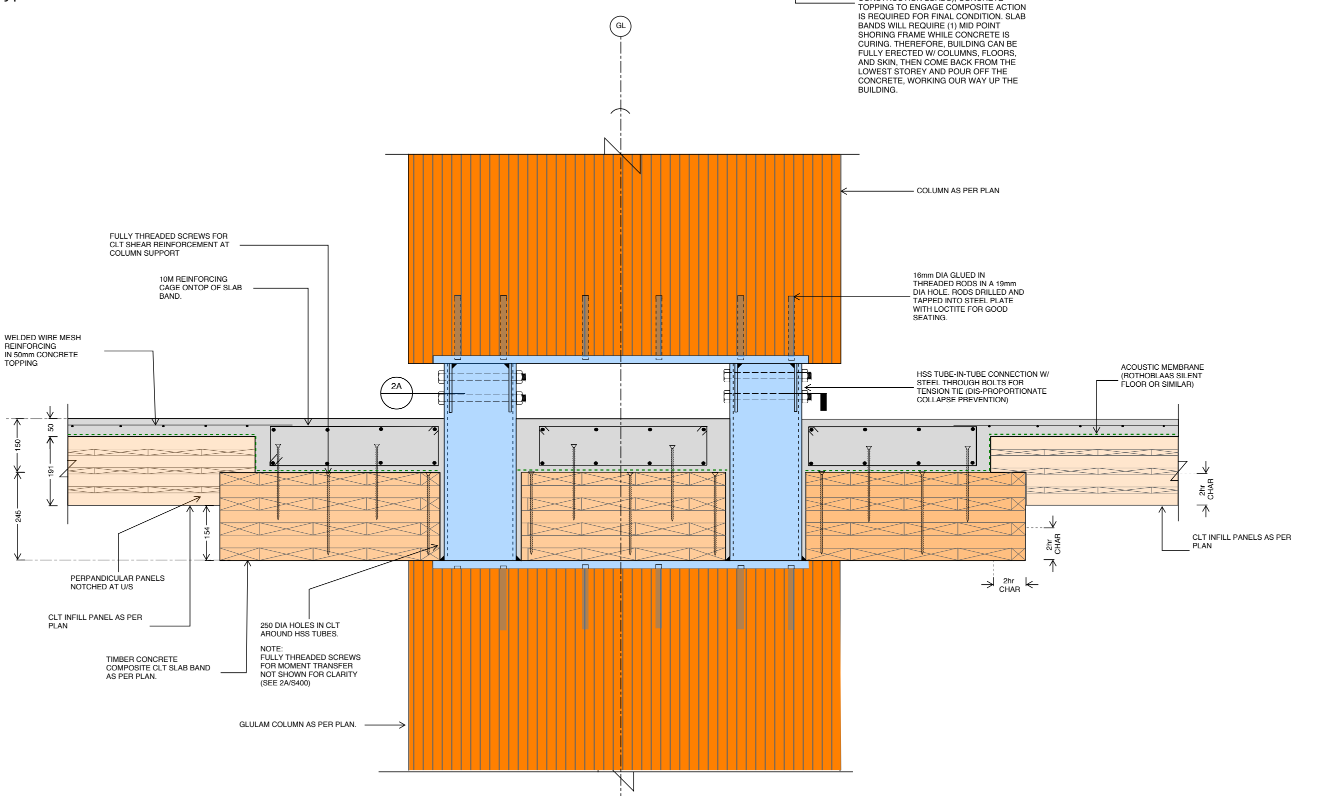


Fig. 10. Typical floor to column connection – courtesty of Fast + Epp

two-hour fire event, with all structural timber fully exposed. A char analysis has been undertaken with the provisions given in Annex B of the Wood Material Standard, CSA O86- 14 Update No.1. In addition to this char analysis, supplemental calculations also were undertaken using the MMAH Supplementary Standard, SB-2 Fire Performance Ratings, in subsection 2.11 of the Ontario Building Code (OBC) for glulam timber beams and columns. The structural steel in the project also will be required to achieve a two-hour rating.

Funding from the GCWood Program has been partially applied to the engineering mockup and testing of the proposed "wallumn" and slab band bay currently in fabrication through Structurlam in Penticton, B.C., to be tested this fall at the University of Northern British Columbia. The load and vibration testing will be summarized in a report that will be made public through the GCWood Program, and this system will be available to kickstart other projects that may find this particular innovation applicable, or as a launching point for new variations on beamless systems.

Beyond the structural proofs, the project is currently undergoing applications for alternative compliance to the current OBC. The GCWood funding also supports these applications. Recognizing that innovation should not be penalized, the funding is specifically in place to assist George Brown College in closing the gap on soft costs associated with being the first in this application of timber structure. Costs over and above those for a typical concrete or steel building are eligible to be funded from the grant, and specifically, the alternative compliance is just such a case.

Under the current OBC and National Building Code, The Arbour as it is designed is not permitted. Ten-storey timber construction for assembly occupancy is not defined in the code. In the upcoming revisions to the OBC, 12 storeys will be permitted but these changes apply to C&D occupancy.

The Arbour is undergoing a process with the City of Toronto to pursue compliance by using alternative methods to bring the performance up to, or better than, what is currently permitted in the code for the height, area and occupancy. An example of this is the two-hour fire rating; for this size and scale of A2 occupancy, the rating is typically one hour. Although it is not a defined pathway to compliance, two-hour fire resistance is proposed as an alternative to create safeguards to match, or in the case of steel exceed, what other structural materials could resist. The process has included several meetings and exchanges with the city prior to the application; those meetings have influenced both the design and the process.

Next Steps

We are now in the process of realizing The Arbour; detailed design has advanced, the site plan application approval process is underway and we are understanding the procurement and specifics of the wood fabrication, along with the constructability analysis by PCL Construction. During this time we have been embedded in what seems to be a burgeoning industry and, as in no other time in my career, a sharing of knowledge and information. It is a hopeful and positive time for the architecture community to work cohesively towards an end goal.

But within this communal atmosphere, what of innovation and unique solutions?

In the age of the Anthropocene – our proposed geological epoch, when human activity is the dominant influence on the climate and environment – the role of the designer seems to emerge as an obvious force. Is it possible that both the aspiration for original solutions and a systems approach can coexist, rather than be dichotomous? This would be analogous to a "bio-diversity" approach to design – unique and specialized designs that play a role in a much larger system; architecture that is reflective of the unique mandate, site and culture of a project and its users – while adjusting a microclimate, supporting green industry and driving adaptation of the very users that the building serves – to make a significantly positive, cohesive impact on the environment.

Upon reflection, this is exactly what The Arbour aspires to do, a remarkable but transferable paradigm for sustainability. As the dominant influencers, human beings are literally shaping the planet and environment; as designers, our time has come to make the planet our design purpose, if only one project at a time.

Carol Phillips is a partner at Moriyama & Teshima Architects; with contributions from Mike Godawa, Integral Group, and excerpts from reports by Fast+Epp and Transsolar KlimaEngineering.

Wood WARE

Carving a unique niche in wood maps

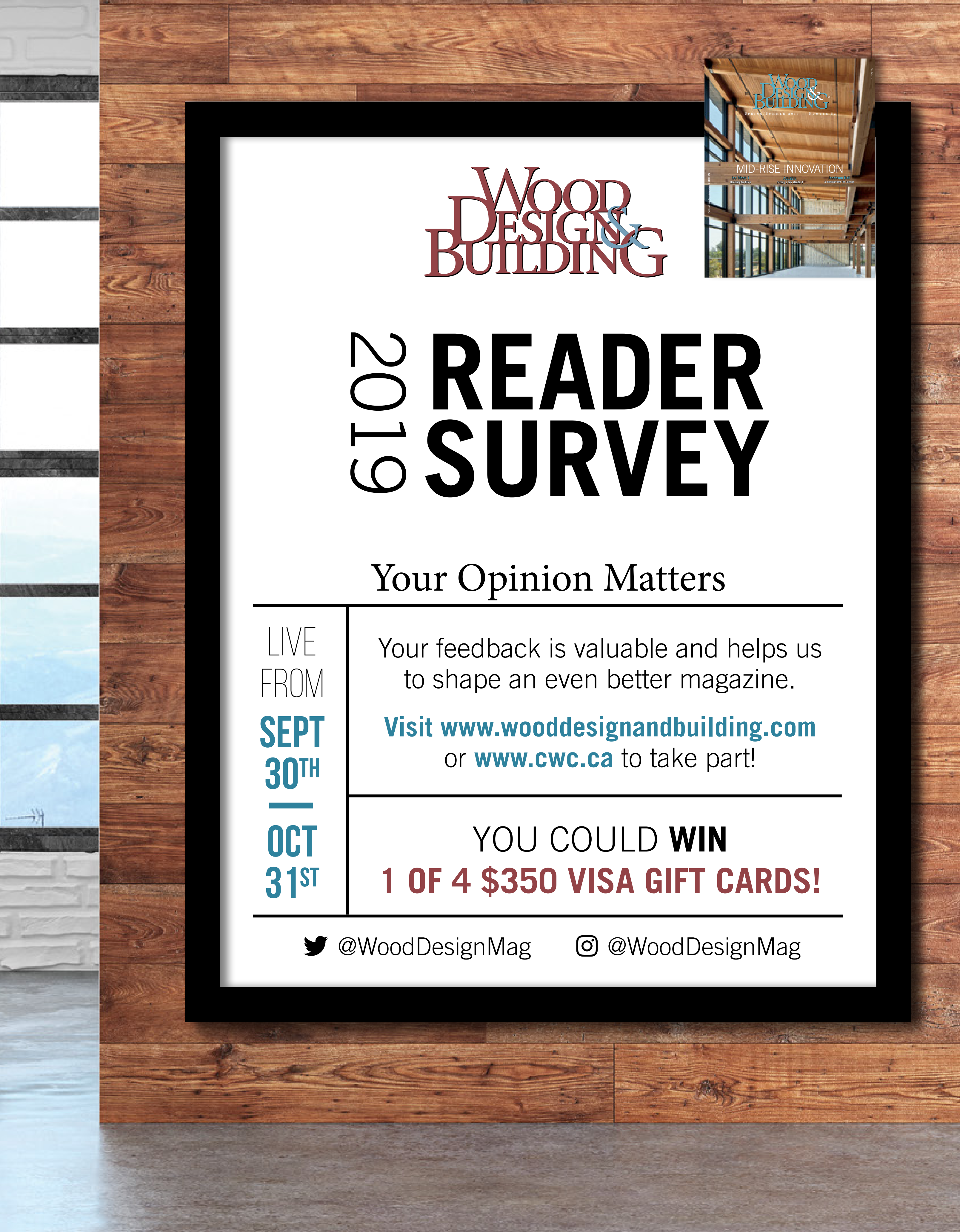
The idea of creating maps out of wood is not new, but one Canadian design duo has carved out a unique niche in this arena by creating bathymetrically accurate wall art, with finely finished detail that shows intricate coastlines and the depths of glistening blue lakes and rivers.

The topographic relief carvings by Curae are made from responsibly sourced Ontario hardwoods, hand sanded and finished. The water features are CNC-carved into planks of wood, and the impression of the depth features is then filled with clear blue epoxy resin that is cured to produce a glossy finish, while the shade of blue turns darker as the water depths increase.

Each one-of-a-kind piece takes the designers anywhere from a dozen to hundreds of hours to produce, in a process that blends geographic techniques, illustration, 3D design and CNC technology. With such accuracy in play, the wooden artworks also function as depth charts, says the Curae team.

Since launching their design studio in downtown Kingston, Ontario, Robin Saunders and Grace Sylvester have produced their 3D maps and charts for customers worldwide, as far away as Hong Kong.

curae.ca



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