INNOVATION IN HYBRID MASS TIMBER CONSTRUCTION

WOOD INNOVATION RESEARCH LABORATORY

"This building has caught the attention of Passive House researchers around the world because it demonstrates how an industrial structure, constructed with wood, in a northern climate exceeds a rigorous, internationally recognized energy efficiency standard."

CHAIR OF THE ENGINEERING IN INTEGRATED WOOD DESIGN PROGRAM, UNIVERSITY OF NORTHERN BRITISH COLUMBIA

Michael Elkan

INTRODUCTION

The Master of Engineering in Integrated Wood Design program at the University of Northern British Columbia (UNBC) equips current and future design and construction professionals with the knowledge and expertise necessary to sustainably use wood products in future building projects. Located in Prince George, British Columbia (B.C.), the program is hosted in the Wood Innovation Design Centre, an 8-storey glue-laminated timber (glulam) post and beam building with a cross-laminated timber core.

As the program expanded, it became necessary to increase the laboratory capabilities. The new research and teaching facility, the Wood Innovation Research Lab (WIRL) was built and completed in April 2018. Owned and operated by UNBC, WIRL is a 10 metre (m) tall single-storey, mixed-use building, with a large wood laboratory, classroom and office space. The superstructure is composed of mass timber glulam columns and beams and the external walls are framed with wood trusses.

UNBC wanted the building to achieve Passive House certification, an internationally recognized and independent building performance program. Buildings designed to this standard have been shown to have reduced space heating and cooling demands, due to the high thermal performance of their envelopes. In July 2018, the Wood Innovation Research Lab became one of the first certified industrial buildings in the world. It is also the first certified industrial building, and current record holder in Passive House airtightness, in North America.

FACTS

- Height is 10 m (1 storey with mezzanine)
- Floor area is 1,070 m²
- Approximate footprint is 961 m² (31x31 m)
- Site area is 1,320 m² (40x33 m)
- Treated floor area is 1,042 m²
- Ventilated space is 9,686 m³


Michael Elkan

FRONT COVER
Guido Wimmers, UNBC

BACK COVER
Michael Elkan

DESIGN OVERVIEW

The Wood Innovation Research Lab provides UNBC faculty and students with education, research, and product testing facilities for mass timber design and construction. The design and construction project was managed in-house by UNBC's Assistant Director of Facilities Management, and the project team was selected through a competitive bidding process with a design-build project delivery system.

The construction manager and builder, who led the design-build contract, was based in Prince George, while the design team was based in Vancouver. A Germany-based consultant acted as the third-party Passive House certifier to assess the project's compliance to the standard requirements.

Stantec

THE BUILDING

UNBC will use WIRL to showcase mass timber as an alternative structural material to steel, which is typically used in industrial buildings. Mass timber was preferred because of its high strength-to-weight ratio and thermal performance. Additionally, mass timber prefabrication allowed the trades to do most of the work in a safe and controlled shop environment, particularly advantageous for cold climates like Prince George. Prefabrication also enabled greater precision and facilitated moisture control which reduced the risk of shrinkage or swelling of the wood components.

The foundation of the building is a 31 by 31 m concrete raft slab. The superstructure is composed of mass timber glulam columns and beams on a six-metre grid. The exterior envelope, including the roof, is framed using dimension lumber trusses with oriented strand board (OSB) sheathing. The second level floor is made of prefabricated wood I-joists and covered with plywood sheathing. All the interior walls are also covered with plywood sheathing. In the lab portion of the building, the OSB is left exposed for the interior finishing as an expression of the industrial use of the space.

Top: Installation of prefabricated envelope panel.
Bottom: Installation of exterior air barrier and window.
Photos: Guido Wimmers, UNBC

Michael Elkan

"The Wood Innovation Research Lab stands as proof that Passive House design can be successful in our Canadian climate. Our integrated design and construction team's commitment to Passive House certification and wood innovation is what made the successful completion and certification of the Wood Innovation Research Lab possible—setting a new bar for high-performing wood and educational buildings."

ASSOCIATE AND BUILDING PERFORMANCE ENGINEER AT STANTEC

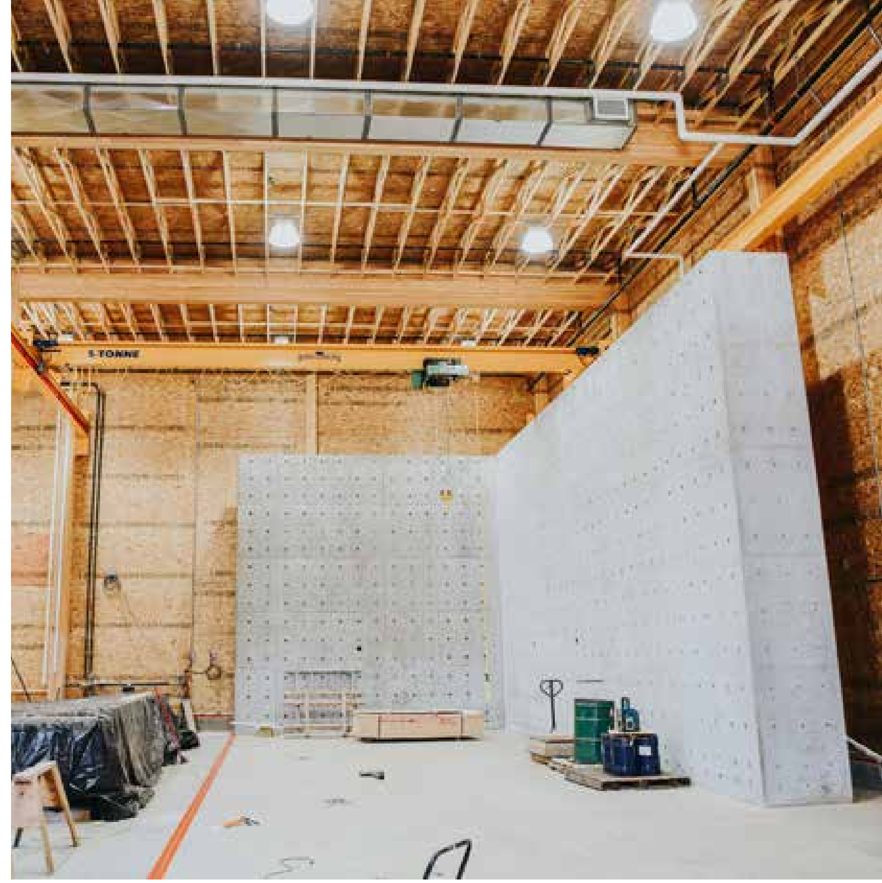
DESIGN OVERVIEW CONT.

LAB-SPECIFIC DESIGN FEATURES

The Wood Innovation Research Lab is one of the few facilities in B.C. and the first in Northern B.C. that allows complex research and testing of structural wood products, connections, and assemblies. The lab can be used to test different characteristics of wood products such as strength, stiffness, and failure modes. An overhead crane runs the length of one of the two bays, which allows for the safe maneuvering of large products and assemblies.

In one corner of the lab is a concrete strong wall and strong floor. The strong wall and floor are separate from the building structure and made of highly reinforced concrete with anchors on a 400 millimetre (mm) grid to anchor the materials. A hydraulic power unit (HPU) is used to imitate various types of gravity and lateral forces on the wood elements, connections and assemblies to study load bearing capacity and breakage point.

The building also has a universal testing machine (UTM) for tensile and compression tests, a Hundegger brand computer numerical cutting (CNC) machine, a programmable robot used for large three-dimensional fabrications, and a wood conditioning room. The conditioning room is equipped with humidifiers and ventilators to regulate temperature and humidity for normalizing moisture content of wood specimens — crucial for the consistency and reproducibility of the structural tests.



Top:The strong wall and floor system is designed to resist up to 6,000 KN moment, 1,500 KN shear, and 1,000 KN of point load up to a height of three metres from the floor.

Bottom: The moisture barrier in the wall assembly of the conditioning room prevents the room's temperature and moisture from equalizing with the rest of the building.
Photo: Guido Wimmers, UNBC

SPECIAL CONSIDERATIONS

According to the BC Building Code-2012, WIRL is categorized as combustible construction of business/personal services (Group D) major occupancy.

FIRE PROTECTION

The fire risk during construction was very low, due in part to the wood elements being installed during the winter, when the average temperature is - 6˚ C. Mass timber products such as glulam also offer inherent fire-resistance characteristics that are critical in structural applications. When exposed to fire, the outer layers of thick mass timber members char, insulating the wood, slowing combustion and delaying the rate at which heat penetrates into the component. The building exterior was enclosed quickly in non-combustible mineral fibre insulation so that the lumber trusses in the envelope panels were left exposed for only a few days.

The building is equipped with fire suppression systems including a municipal-fed automatic sprinkler system throughout the interior space and fire extinguishers at the three entrances. The exterior walls that are close to adjacent buildings required fire rating for spatial separation. The south and east walls are covered with a 45 minute and the west with one hour fire-rated sheathing. Quick-response sprinklers were installed along the inside face of the south, west, and east exterior walls to create a water curtain. The north side, which faces a wide street did not require a fire resistance rating. The electrical transformer, located on the south-east corner, is enclosed within concrete walls.

MOISTURE CONTROL

Prince George has a cold and relatively dry climate, especially in winter, so moisture control was not a significant challenge. However, the structural members stored near the construction site before installation were protected from potential moisture and water damages. The glulam was covered with plastic wrap until enclosed within the envelope panels and roof. The trusses were already sealed on the interior side with OSB panels when brought on site. Prior to the installation and enclosure, the envelope panels were covered with tarp and snow was easily brushed off. The exposed western red cedar wood cladding on the north east and south east are protected by a water resistant coating, which reduces moisture damage while providing a natural finish.

The exterior wall is designed to eliminate the condensation risk that can occur if there are humidity and temperature differences between the interior and exterior environments. The wall assembly includes an innovative airtight membrane on the inside which responds to temperature. It seals to prevent vapor diffusion from inside in the cold months, when the outside temperature and moisture content are low. Through chemical reactions during the warm months, the membrane opens to allow the wall to dry out as vapor travels from outside. Since this is the first application of the product in this environment, the manufacturer conducted tests to ensure compatibility with the other assembly products, such as the taping adhesive that was used to lap the membrane joints.

ACOUSTICS

The interior walls that separate the office and classroom spaces from the lab are filled with sound absorbent insulation. Additionally, a metal resilient channel was used to connect the drywall to the studs and create an air space to reduce noise transmission. The exterior wall assembly, which includes a thick layer of mineral wool insulation, provides enough acoustic barrier to prevent noise from being transferred outside of the building.

The main acoustic concern for the building was the reverberation time — the time it takes for the sound to be absorbed by the surfaces of surrounding objects in the lab space. Specifically, the high-frequency, high-volume noises from lab equipment reverberating against the hard and reflective surfaces of the concrete strong floor and walls, gypsum board walls, and OSB wall finishes. If not mitigated, the reverberation time could, according to a preliminary student analysis, be over five seconds and become an issue for the lab, classroom, and office spaces.

As part of course projects, UNBC students refined the original interior design of the lab by adding sound reflective surfaces (plywood panels) on the OSB wall surfaces and sound absorbent baffles on the ceiling. The plywood panels in the lower section of the room divert sound waves towards the ceiling without absorbing or collecting saw dust. The solution is calculated to cut the reverberation time down to approximately two seconds, which exceeds the standard workspace requirements.

Left: Adding the wall and roof insulation in winter.
Right: Envelope panels covered in tarp prior to enclosure.
Photos: Guido Wimmers, UNBC

PASSIVE HOUSE

The anticipated heating costs for WIRL are expected to be 90% less (about $10,000 per year) than a similar building designed to the current code requirements.

PASSIVE HOUSE STANDARD

WIRL received Passive House certification in July 2018. Passive House is an internationally recognized standard and certification program, developed by the Passive House Institute, an independent research institute based in Germany. The standard is intended to result in buildings with extremely low space heating and cooling needs and consequently lower environmental impacts, as well as a comfortable indoor temperature and air quality.

To improve envelope performance, Passive House buildings use strategies such as:

- high levels of insulation with U-values less than 0.15 W/m^2K;
- stringent airtightness (air change rate at 50 Pa pressure difference less than 0.6 per hour);
- eliminations of thermal bridges; and
- high thermal performing window and door assemblies.

To maintain high indoor air quality, a reliable ventilation system is a crucial requirement in the Passive House design. These buildings typically use highly efficient, heat-recovery ventilation systems which recover a minimum of 75% of the energy from exhaust air and use it to condition the fresh intake air.

In addition to reducing heating and cooling demands, Passive House buildings minimize the heat loss in the distribution of domestic hot water through insulation of the pipes and equipment, and reduce electricity consumption by using high-efficiency lighting and electrical devices.

WIRL PASSIVE HOUSE CERTIFICATION

WIRL was the first building in North America to seek Passive House certification in an extremely cold climate. In Prince George, the average summer temperature is 16˚C and the average winter temperature is -6 °C, resulting in 234 days per year that require mechanical heating or cooling. The severe climate condition was one of the main challenges for achieving Passive House certification. UNBC conducted an early feasibility analysis and specified certification as a requirement in the bidding process to ensure that the project team was committed to designing and building the project to Passive House standards.

The Passive House certifier awarded the certification based on the review and approval of the building’s overall design and performance. This was demonstrated through the Passive House Planning Package (PHPP) energy model, a blower door test, the commissioning of mechanical system and construction documentation. As a research and education opportunity, UNBC will continue to monitor the performance of the building captured through temperature and moisture sensors and electricity meters.

Envelope Penetration Detail

Installation of Roof Insulation

Photos: *Guido Wimmers, UNBC*

The design team used the Passive House Planning Package (PHPP) modelling tool to estimate the energy performance of the building. PHPP is specifically developed to design Passive House buildings and is based on a combination of several existing, proven and verified calculation methods that are compliant to the European standard for the thermal performance of buildings (EN 832).

Tables extracted from Passive House certification document.

WIRL EXTERIOR COMPONENTS THERMAL PERFORMANCE

Enclosure element	U-Value (W/m²K)
Walls	0.079
Windows	0.77
Doors	0.91 - 0.97
Roof	0.057
Floor	0.166

U-value measures the effectiveness of an object as an insulator of heat. Objects with lower U-value are better heat insulators therefore more energy efficient.

WIRL PASSIVE HOUSE PERFORMANCE

Parameter	Building Characteristics	Unit	Passive House Criteria	Passive House Alternative	WIRL
Space Heating	Heating Demand	KWh/m²a	15≥	-*	12
	Heating Load	W/ m²	-	10≥	10
Space Cooling	Cooling & Dehumidification Demand	KWh/m²a	15≥	15≥	0
	Cooling Load	W/ m²	-	11≥	1
	Frequency of Overheating (>25˚ C)	%	-	-	-
	Frequency of High Humidity (>12 g/kg)	%	10	-	0
Airtightness		ACH @50 Pa	0.6≥	-	0.07
Non-Renewable Primary Energy (PE)	PE Demand	KWh/m²a	120≥	-	116
Primary Energy Renewable (PER)	PER Demand	KWh/m²a	-	-	61
	PER Generation	KWh/m²a	-	-	0

** "-" means: No requirement.*

Primary Energy is the total energy used in the building operations including heating, cooling, lighting, equipment, hot water, and plug loads.

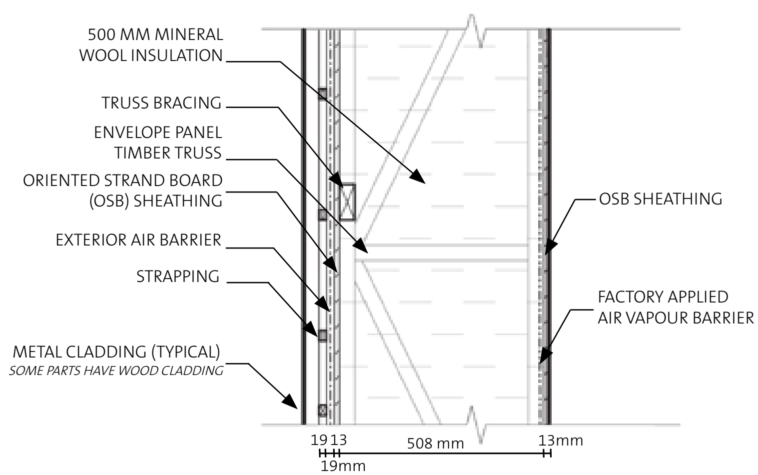
PASSIVE HOUSE CONT.

ENVELOPE PERFORMANCE

Since the lab portion of WIRL required high-height bays, the building has a significant volume of interior heated space relative to the floor area, about three times higher than a typical commercial building. This means the heating demand of the building had to be about one third of a commercial building to meet the Passive House standard, which bases the maximum acceptable heating demand on the gross floor area regardless of the ceiling height. Therefore, the envelope performance of WIRL had to be considerably better than a typical commercial building built to the Passive House standard.

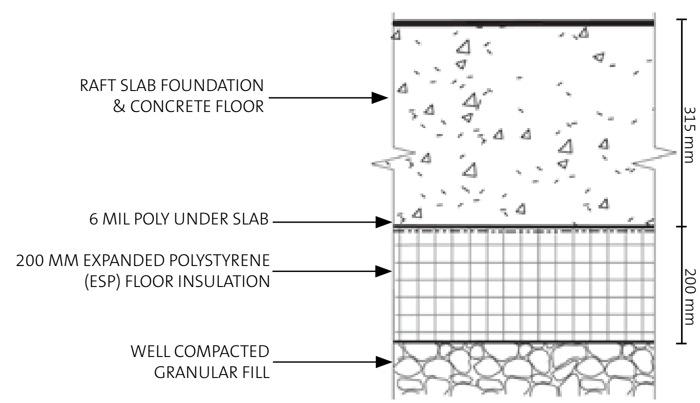
The thermal performance was achieved through an increase in thickness of insulation. The exterior walls were designed to accommodate 500 mm of mineral wool insulation and the roof assembly included 600-800 mm of sloped expanded polystyrene (EPS) insulation. Reducing thermal loss from the concrete foundation was more challenging, because of the high thermal conductivity of the steel reinforcing. Insulating the strong floor was particularly difficult, as the insulation had to endure higher than normal forces from the structural tests. A special high-density, strong EPS insulation was used below the strong floor, while the rest of the foundation was insulated with medium-density EPS.

High-performance windows and doors are critical in achieving the tight thermal performance required by the Passive House standard, because inefficient fenestrations create significant heat loss. The windows were designed to limit overall frame length while making sure the glazing area provided sufficient heat gain and natural light. Passive House certified doors and windows with well insulated frames were used, and installed along the mid line of the wall assembly to reduce thermal bridging and increase airtightness. The results of the preliminary blower door test indicated the building's air tightness is 0.07 air changes per hour when the air pressure is 50 Pascal (0.07 ACH @ 50 PA) — well beyond the Passive House requirement.



Typical Exterior Wall Section

All details are based on Stantec architectural drawings.



Typical Ground Floor Section

MECHANICAL SYSTEMS

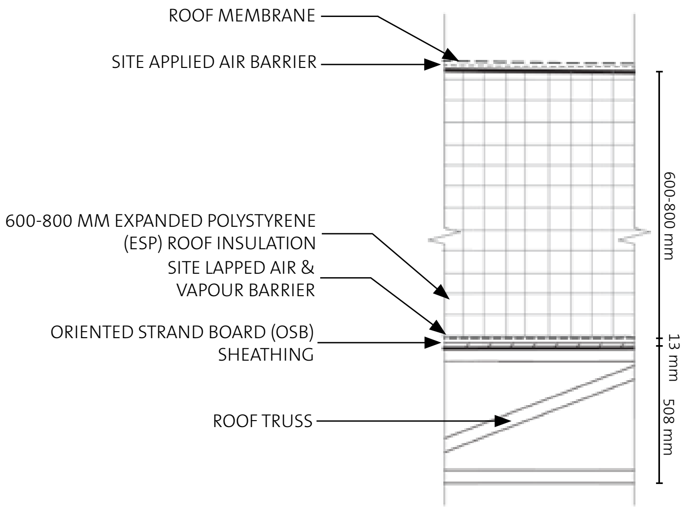
The high level of airtightness in Passive House buildings, make it necessary for a reliable ventilate to ensure indoor air quality and low levels of carbon dioxide (CO_2) and other contaminants. Efficient heat recovery ventilation (HRV) systems are used to recover and reuse indoor heat. The HRV installed in WIRL has an efficiency of 80% in recovering heat from the exhaust air, which is more than the recommended 75% by the Passive House Institute.

The building's small heating demand could have been met by a 15 KW gas powered furnace, which is the same furnace capacity used in an average single-family house in Canada. However, a 35 KW natural gas furnace was installed to ensure there would be no shortage of heat in the cold winters of Prince George. The heat is distributed through the lab space by in-floor radiant heating with a low flow temperature of approximately 22°C. In the future, the natural gas could be replaced with renewable biogas which could reduce the carbon emissions associated with heating the building by up to 90%.

The building does not need any mechanical cooling except for when equipment with high energy consumption levels operate, causing additional internal heat gain. For instance, the high pressure unit (HPU) can generate about nine times more heat than the furnace. Equipment generated heat gain was taken into account in the PHPP model and the mechanical system designed with the capacity to exhaust the excess heat by increasing ventilation volume and active cooling in warmer months.

Cutting wood pieces results in significant quantities of wood dust, which are both a health and fire safety risk. The lab space in WIRL is served by a large dust extraction system with the capacity to run about 10,000 m^3 of air through filters per hour. The system reduces energy losses by circulating the filtered air back into the space. As required by Work Safe BC, the system also allows full air exhaust, if hardwood or cedar wood dust is generated in the lab.

The dust extraction system is located outside of the building to minimize the risk of the lab being affected in the event of an explosion caused by the static friction of the wood dust moving through this system. To compensate for the unavoidable heat loss in the lab space resulting from circulating warm air through the dust extraction system, additional thickness is included in the envelope insulation.



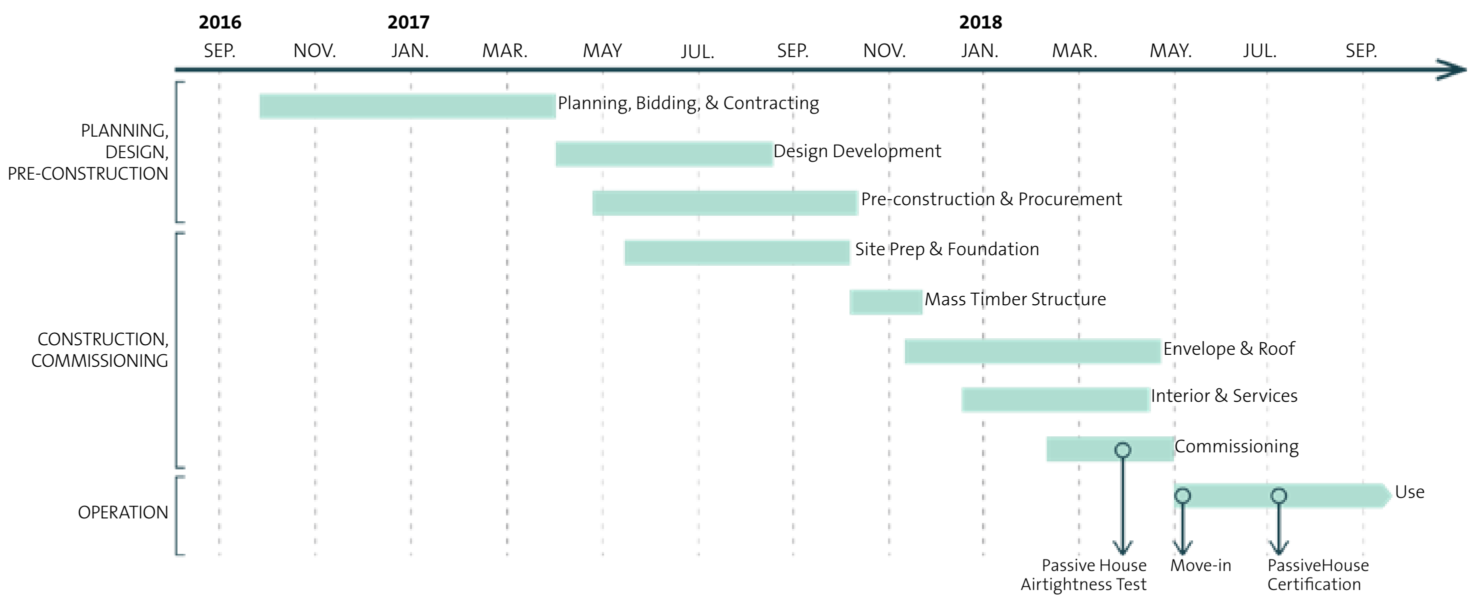
Typical Roof Section

PROJECT SCHEDULE AND COST

UNBC's internal technical consultant team, comprised of a faculty member and a research assistant at the Engineering in Integrated Wood Design program, and project manager began planning the building in September 2016. The request for proposals for the design-build contractor went out in November 2016 and the bidding process was complete by March 2017. The design process finished in August 2017, and pre-construction started in May 2017, one month ahead of schedule, and finished, on time, in April 2018. The Province of BC and the Government of Canada provided funding for design, construction and research. As part of the Downtown Revitalization Initiative, the City of Prince George contributed a former brownfield site, located next to the Wood Innovation and Design Centre.

"As a result of prefabrication and partial assemblies in the factory, the construction time was reduced by one third, compared to a common construction process of a comparable industrial building in the region."

CHAIR OF THE ENGINEERING IN INTEGRATED WOOD DESIGN PROGRAM, UNIVERSITY OF NORTHERN BRITISH COLUMBIA



Project Timeline

Based on the project schedule provided by UNBC.

FABRICATION AND INSTALLATION

Wood products were sourced regionally, wherever possible. The glulam columns and beams were made from B.C. wood and manufactured in Edmonton. This supplier was selected due to cost considerations as the facility is a similar distance as the B.C.-based manufacturers. The dimension lumber trusses were made in Prince George with the raw materials procured from a local sawmill. Passive House certified products like doors, windows, and heat recovery ventilator (HRV) were acquired from European distributors in the U.S. or east coast of Canada.

The glulam beams and columns, prefabricated with steel connections, were brought on site ready to be assembled. A partial prefabrication approach was used for the wall panels because the local industry did not have the capacity to completely fabricate the panels in the factory. At a local facility in Prince George, the timber trusses were framed and four trusses connected with OSB sheets to shape the 3x10 m panels, with interior airtightness and vapor barrier layer applied to the OSB. Once shipped to the site, the panels were craned into place with the trusses upright to act as posts. A crew of four installed and affixed the panels, then added exterior OSB sheathings and exterior airtightness layer. Simultaneously, another crew of two filled the 500 mm wall cavity with mineral wood insulation. Lastly, the strapping and exterior cladding were installed.

Top: Installation of glulam beam.
Middle: Adding blown-in mineral wool insulation.
Bottom: Installation of window.
Photos: Guido Wimmers, UNBC

ENVIRONMENTAL IMPACTS ANALYSIS

LIFE CYCLE ASSESSMENT (LCA)

Life cycle assessment (LCA) is an internationally accepted scientific method to assess the environmental performance of products or systems. In the standard building LCA methodology (EN 15978:2011), data on the use of materials, energy and other resources in the production, construction and operation of the building is used to estimate a set of immediate environmental impacts, displayed through standardized indicators. These indicators, such as global warming potential, are a proxy for broader environmental and human health hazards, like ecosystem deterioration, which are harder to calculate or associate directly with the specific activities during a building's life cycle.

In a building LCA, the resource inputs and outputs (e.g. energy, water and materials) are measured across all of the phases of a building's life cycle, including production, transportation, installation, maintenance, repair and end of life. According to this methodology the impact beyond the building's life time can be assessed but should be reported separately.

ENVIRONMENTAL IMPACT INDICATORS*

- Global Warming Potential (unit: equivalent kilograms of CO_2)

  The amount of greenhouse gas (GHG) emissions, typically generated from fuel consumption, causing atmospheric warming by trapping heat in the atmosphere.

- Ozone Depletion Potential (unit: equivalent kilograms of CFC-11)

  The amount of ozone-depleting gases (previously common in refrigerants and insulating foam blowing agents) that break down the protective ozone within the stratosphere and increase ground level solar radiation.

- Acidification Potential (unit: equivalent kilograms of SO_2)

  The amount of corrosive acidic gases, typically generated from combustion of fossil fuels, which increase soil acidity or cause acid rain.

- Eutrophication Potential (unit: equivalent kilograms of N)

  The amount of substances released from activities such as poorly-managed agricultural lands, construction sites, sewers, and drainage systems, as well as burning fossil fuels, which increase the nutrient level of surface water, causing excessive algae growth and increased aquatic toxicity.

- Smog Potential (unit: equivalent kilograms of O_3)

  The amount of substances, emitted from fossil fuel combustion and certain solvents used in paints and coatings, which react with sunlight and create ground-level ozone causing damage to crops and human health.

- Fossil Fuel Consumption (unit: mega Jules of energy)

  The amount of fossil fuel use, including oil and natural gas, as a non-renewable energy resource during the life cycle of the building.

According to the European standard for environmental performance of buildings (EN 15978).

WIRL LCA

UNBC researchers conducted an LCA on WIRL to assess the environmental impacts of different life cycle stages and building elements. The study compared the building with two alternatives, both built to the current building code standard for energy performance: one with steel structure and steel envelope framing and the other with glulam structure and wood-frame envelope. The study aimed to assess the environmental performance differences between a steel and wood structure and also between current code and Passive House compliant design. The LCA estimated the impacts from operational energy during the 60 years' service life of the building as well as the embodied impacts from production, construction, use, and end-of-life phases of the components and materials used in the foundation, superstructure, envelope, fenestrations, interior partition walls, and floors.

Additionally, the LCA estimated the environmental impacts and benefits from activities that happen beyond the building's lifetime, which are reported separately. Predominantly among these are material reuse or recycling (offsetting the impacts of new materials in other projects) and carbon sequestration in wood and concrete. In wood, carbon is sequestered during the photosynthesis as the tree grows. When the tree is cut down, this carbon is stored in the wood for the life of the product. Concrete gradually sequesters carbon from the atmosphere through a chemical process when exposed to air and moisture during its life cycle.

[1] *The alternative buildings followed National Energy Code of Canada for Buildings, 2011.*

WIRL LCA RESOURCES*

- Building LCA tool: Athena Impact Estimator for Buildings v.5
- LCA Standards: *EN 15978:2011 (LCA calculation methods for building), ISO 14040: 2006 (LCA principles and frameworks), ISO 14044:2006 (LCA requirements and guidelines)*
- Life Cycle Inventory (LCI): Athena LCI database, US LCI database, Ecoinvent LCI
- Life Cycle Impact Assessment method: U.S. Environmental Protection Agency's *Tool for the Reduction and Assessment of Chemical and other Environmental Impacts (TRACI v 2.1)*

** LCA conducted by University of Northern British Columbia, Master of Engineering Faculty*

ESTIMATED ENVIRONMENTAL IMPACTS OF WIRL OVER THE 60-YEAR LIFE OF THE BUILDING

Impact Indicator	Unit	Total Impact
Global Warming Potential	kg CO_2 eq./m^2	746.51
Ozone Depletion Potential	kg CFC-11 eq./m^2	0.0000002
Acidification Potential	kg SO_2 eq./ m^2	3.36
Eutrophication Potential	kg N eq./m^2	0.12
Smog Potential	kg O_3 eq./m^2	42.81
Fossil Fuel Consumption	MJ/m^2	9,688.23

The LCA study showed that incorporating wood elements, and building to the Passive House standard reduced the buildings overall environmental impacts, as indicated by GWP. However, using more insulation inversely affected the embodied environmental performance compared to a wood building alternative designed to the current code.

GLOBAL WARMING POTENTIAL

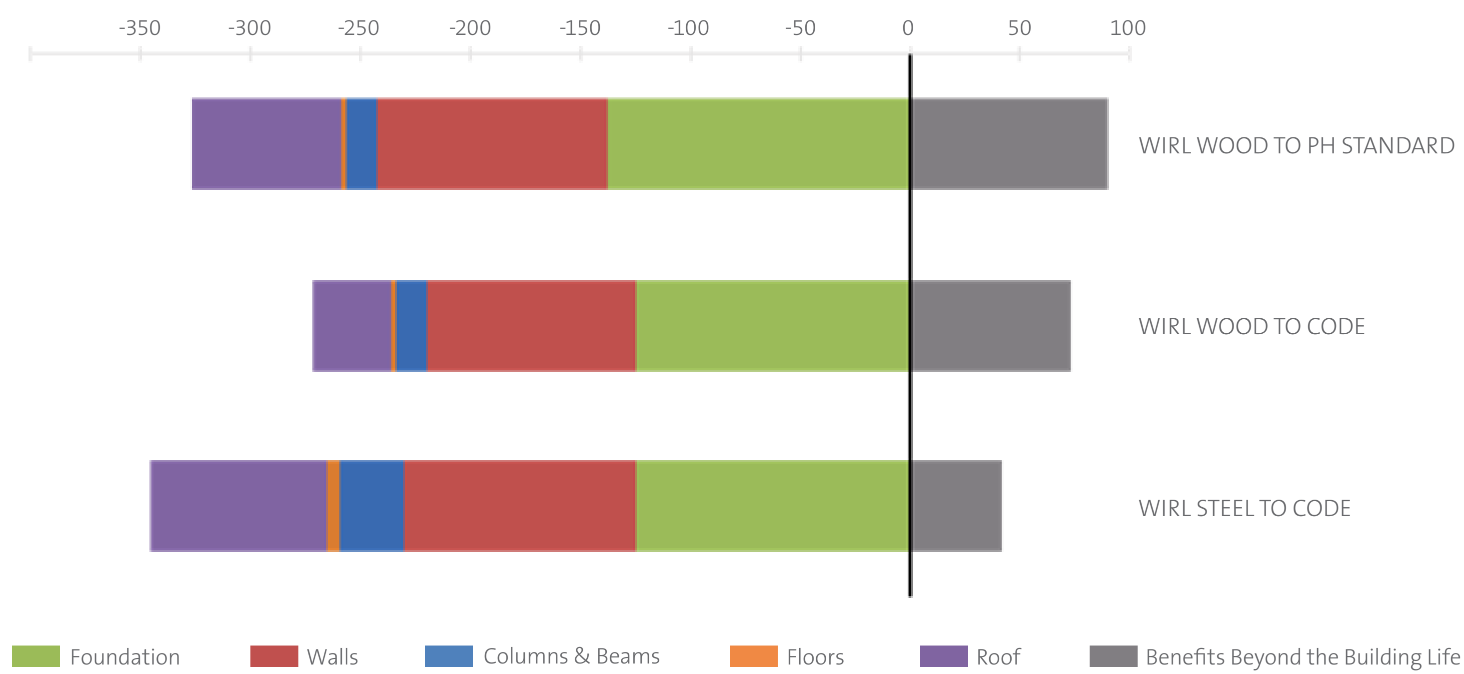
Of all the indicators, UNBC researchers considered global warming potential (GWP) of the building materials used in WIRL as the most significant indicator. Of the three designs, the actual WIRL building has the best overall environmental performance, by about 72% less GWP, compared to the wood and steel alternatives. This is largely due to WIRL's lower operational impact, which is 80% less than both alternatives, and is achieved through reducing the operational energy use by complying with the Passive House requirements.

GLOBAL WARMING POTENTIAL OF THE LIFE CYCLE STAGES
WIRL COMPARED TO ALTERNATIVE DESIGNS (TONNES CO_2 EQ.)

In terms of embodied environmental impacts, WIRL performs better than the steel building alternative (by 5%), but worse than the wood building alternative (by 20%). This is due to the large quantities of insulation used in the foundation, walls, and roof of WIRL to meet the Passive House standard. The comparison shows that while the Passive House design reduces the operational energy consumption and associated GHG emissions, it inversely affects the embodied environmental impacts.

To minimize the increase in the embodied impacts of WIRL, durable building elements and components with lower embodied environmental impacts were used whenever financially feasible. Examples of these choices include: mass timber superstructure, wood-frame envelope, wood-frame fenestration, and mineral wool insulation for the envelope. The materials in WIRL, such as mass timber, also have a greater potential for benefits beyond the life of the building than both the wood alternative (by 23%) and the steel alternative (by 117%).

GLOBAL WARMING POTENTIAL OF THE BUILDING ELEMENTS
WIRL COMPARED TO ALTERNATIVE DESIGNS (TONNES CO_2 EQ.)

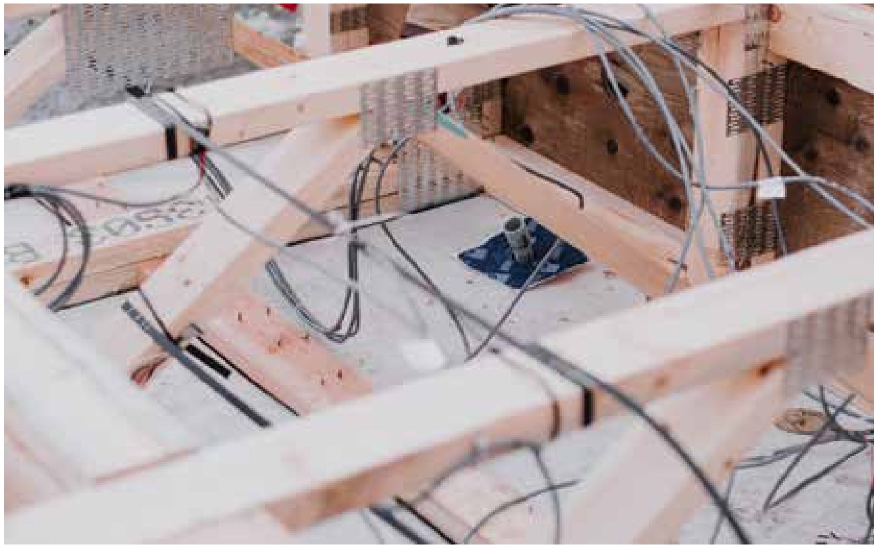


Guido Wimmers, UNBC

STUDENT ENGAGEMENT

In addition to serving as an educational and research facility, the design and construction of WIRL has provided a learning opportunity for UNBC students. Through course projects, students were involved in the conceptual design, preliminary structural studies, detailed design aspects, generating a building information model (BIM) and acoustic study of the large open-space lab.

Researchers in the Master of Engineering in Integrated Wood Design program at UNBC identified early on that long-term monitoring of the building performance could provide valuable insights into the construction of future buildings. As a result, multiple sets of temperature and humidity sensors have been installed in the exterior walls and foundation to monitor the interior environment and exterior weather conditions. The collected data will help identify the boundary conditions for heat and moisture transfer through the envelope assemblies, as well as compare the actual building performance with the predictive energy models.



Temperature and humidity sensors were installed in six locations at three different heights in the south and north facing exterior wall panels and in a layered grid along the foundation. This configuration of sensors allows heat and moisture transport to be monitored in two dimensions.
Photos: Guido Wimmers, UNBC

LESSONS LEARNED

The Wood Innovation Research Lab provides UNBC with a much-needed wood products research laboratory and showcases feasible and effective solutions to significantly reduce the overall environmental impacts of an industrial building in a cold climate.

The project team significantly reduced the operational energy impacts by complying with the Passive House standard. The building successfully met or exceeded the Passive House performance criteria, making it the the first Passive House project in a North American cold climate and one of the first industrial Passive House buildings in the world.

- In the planning phase, UNBC experts and the project manager ensured that a Passive House project was technically and financially feasible in Prince George, which was key to completing the project within a tight schedule and budget.
- UNBC clearly defined the main project objectives, including a Passive House level performance, in the bidding process. Thus, the project teams involved were motivated and willing to learn and collaborate to achieve the expected performance.

Recognizing that while a Passive House design would significantly improve the operational environmental performance of WIRL, the larger quantities of insulation would increase the embodied impacts, the project team implemented strategies to reduce the environmental impacts of materials.

- The design was kept simple to reduce the total elements and components within the building. This includes leaving the OSB exposed as the interior finishing of the lab facility in the building, which also helped to express the industrial use of the space.
- Priority was given to using durable building elements and components with lower embodied environmental impacts, if they were cost-effective. These included using mass timber superstructure, wood-frame envelope, wood-frame fenestration, and mineral wool insulation for the envelope.

UNBC used the building as a research and education opportunity for academics and professionals. They will continue to study this building and share their findings with the industry, to inform and help to improve future projects.

- The LCA study showed that incorporating wood elements, and building to the Passive House standard reduced the buildings overall environmental impacts, as indicated by GWP. However, using more insulation inversely affected the embodied environmental performance compared to a wood building alternative designed to the current code.
- UNBC researchers and students will continue to monitor and improve the performance of WIRL in aspects such as acoustics and enclosure’s thermal and moisture performance.

The WIRL project is a successful demonstration of working with the available expertise, technologies, materials, and products in the region to significantly reduce the operational impacts of an industrial building in a cold climate, while being mindful of the building materials’ life cycle environmental impacts.

CASE STUDY

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The exterior envelope panels were partially prefabricated at a local facility, where dimension lumber truss framings were connected with the interior OSB sheathings.

PROJECT PARTNERS

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OVERVIEW

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