Innovative Wood Use in BC

wood WORKS!
Project of the Canadian Wood Council

Canadian Wood Council
Conseil canadien du bois

Elkford Community Conference Centre

North Shore Credit Union Environmental Learning Centre

The City of North Vancouver Civic Centre Renovation

A CASE STUDY SHOWCASING THREE DEMONSTRATION PROJECTS

Innovative Wood Use in British Columbia

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ELKFORD COMMUNITY CONFERENCE CENTRE

Courtesy McFarland Marceau Architects

NORTH SHORE CREDIT UNION ENVIRONMENTAL LEARNING CENTRE

Courtesy Photography West

THE CITY OF NORTH VANCOUVER CIVIC CENTRE RENOVATION

EXECUTIVE SUMMARY

This document includes case studies on the Elkford Community Conference Centre, the North Shore Credit Union Environmental Learning Centre and the City of North Vancouver Civic Centre Renovation. All three projects benefited from BC provincial funding support through the Wood Enterprise Coalition (WEC) demonstration project program. WEC was put in place under the province's Wood First Initiative,[1] and has a mandate to help bring newly-developed technologies, as well as innovative uses of new and traditional wood products, to the marketplace. The emphasis is on commercial viability of non-traditional solutions, in particular, innovations in commercial and institutional buildings.

The three projects in the current case study were selected by the demonstration project program by virtue of their innovative structural or architectural applications of wood-based products, including but not limited to the use of cross-laminated timber systems or other pre-manufactured components and systems, and wood components that serve multiple functions.

[1] The Wood First Initiative was established by BC's Ministry of Forests and Range in 2009 to encourage the choice of BC wood products in construction; this Initiative assists with the implementation of the BC Wood First Act – Bill 9.

Elkford Community Conference Centre

Courtesy Douglas Sollows Architect

1,800 m² comprehensive community centre in an isolated BC mining community

DATE OF COMPLETION
June 2012

WOOD CONSTRUCTION MATERIALS
CLTs, glulams, SIPs

SPECIAL/INNOVATIVE FEATURES
Load-bearing CLT tall shear walls, total building prefabricated off site

GREEN BUILDING RATING PROGRAM / AWARDS
Wood *WORKS!* BC Community Recognition Award, UBCM Community Excellence Award[2]

[2] Small Community, Leadership and Innovation

North Shore Credit Union Environmental Learning Centre

Courtesy McFarland Marceau Architects

850 m² communal facility for the North Vancouver Outdoor School in Brackendale, BC

DATE OF COMPLETION
May 2012

WOOD CONSTRUCTION MATERIALS
CLTs, reclaimed timbers, glulams, light-framing elements, plywood, LVL

SPECIAL/INNOVATIVE FEATURES
All-wood building raised above a 200-year flood plain; uses CLT floor panels and 100-year-old reclaimed timbers

GREEN BUILDING RATING PROGRAM / AWARDS
Registered for LEED Platinum, Holcim Award[3]
Canadian Architect Award of Excellence[4]

[3] 2008 Acknowledgement Prize for Sustainable Construction
[4] 2011 Award of Merit

The City of North Vancouver Civic Centre Renovation

Martin Tessler photo, courtesy Michael Green Architecture

1,020 m² addition and 2,500 m² renovation of the City of North Vancouver's Civic Centre

DATE OF COMPLETION
June 2012

WOOD CONSTRUCTION MATERIALS
LSL, glulams, dimension lumber, reclaimed cedar sunshades, lumber from removed elm tree

SPECIAL/INNOVATIVE FEATURES
Prefabricated 9.75-metre-long LSL cross-laminated roof/ceiling panels, wood-concrete composite floor

GREEN BUILDING RATING PROGRAM / AWARDS
Targeting LEED Silver

Elkford Community Conference Centre

INTRODUCTION

Elkford is a small isolated mining community surrounded by the crags of the Canadian Rockies in south-western British Columbia. There was a need to expand the community centre to provide the opportunity for larger functions and to meet added needs. An unused school building was purchased in 2006 and a case study was undertaken by the District of Elkford to see how the building could be repurposed to help fulfill those needs. Before that could happen, there was a fire and the building was damaged beyond repair. The work done on the case study had already helped the town council determine the services it wanted to provide. Insurance monies got the rebuilding efforts off the ground, but the project had gone from the repurposing of an existing building to a totally new construction and more monies were needed. Fundraising efforts delayed the start of the proposed Elkford Community Conference Centre (CCC) and plans for a new building had to be developed.

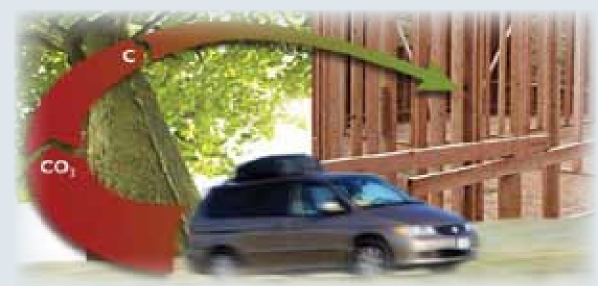
Henry Georgi photo, courtesy Alfred Horie Construction

Guiding Principles / Objectives

The annual meeting of the Union of British Columbia Municipalities held at the Vancouver Convention Centre in 2009 proved to be a significant event for the community of Elkford and plans for its community centre. The Vancouver centre's impressive use of native BC lumber, coupled with then Premier Campbell's presentation in support of the BC forest industry which culminated with an impassioned chanting of "Wood is good!" by attendees, left its mark on Elkford Mayor Dean McKerracher who was in attendance. Then and there, Mayor McKerracher thought, "If wood is good enough for the Premier, it's good enough for the mayor of Elkford." He approached the town council and they agreed – Elkford's new community centre would be built using a wood construction system, and doing so would help the District of Elkford's objective to reduce its carbon footprint.

The next significant circumstance to influence the outcome of the CCC was timing, and the imminent production of Canada's newest structural wood product – cross-laminated timber. A manufacturing facility was under construction in BC's interior and its first panels would be destined for Elkford's new community centre. The use of this innovative wood product, in combination with other engineered wood systems, helped the community achieve its sustainability objectives.

A typical 216 m² wood-frame house sequesters 28.5 tonnes of carbon dioxide, an amount equal to the emissions of a small car over seven years.[5] The continual regeneration of the forest, combined with the use of wood in buildings with a long life expectancy, helps to soften the instability of the earth's carbon cycle which contributes to global warming.



[5] The basis for this calculation is average U.S. car and light truck gas mileage and average U.S. annual driving distances. The variability in how many years of driving 3,200 gallons of gas is worth varies from approximately three years for the largest SUV to 11 years for a small hybrid. Source: FPInnovations.

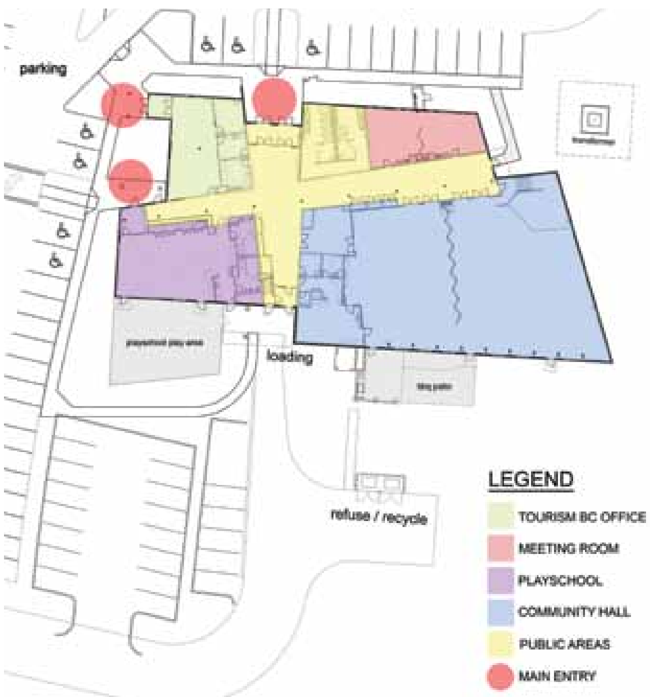

Courtesy Douglas Sollows Architect

Project Description

The CCC is a multi-purpose, single-storey facility which mimics the local geography. The lack of right angles in the building and its jagged roof lines blend in with the local rock formations. The centrally-located cruciform corridors, which act as spines that demarcate the distinct quadrants of the building, in and of themselves create areas that can be used as meeting or reception spaces. The longitudinal corridor, 2.5 metres wide at the west end of the building, widens to 5.5 metres at the east end and comfortably accommodates 300 people during events.

The 7.5-metre-high central area is flooded with daylight from clerestory windows and includes a large fireplace and sitting area for citizens – the Elkford Room. This inviting space truly belongs to the community and is accessible to all visitors whenever the building is open.

The largest area of the building is the banquet hall, or *Teck Hall* (south-east), which also includes a commercial kitchen and bar area. Access is provided to the kitchen and bar from the Elkford Room should events be held in other parts of the building. The remaining areas of the building comprise a communal meeting room which can be divided into several smaller spaces (north-east); a playschool designed with its own bathrooms and independent access for flexible operating hours (south-west); and a visitor information centre with provision for a retail component, also with its own independent access (north-west).



Courtesy Douglas Sollows Architect

Courtesy Douglas Sollows Architect

Courtesy Douglas Sollows Architect

THE DESIGN PROCESS

The architectural team at Douglas Sollows Architect in Edmonton, and the engineering team at Associated Engineering in Burnaby, took into account several practical considerations when making their choice of construction system for the new community centre, in addition to city council directives for a sustainable building that would be energy efficient, use locally-sourced sustainably-renewable wood construction materials, and address other factors such as indoor air quality and minimal site disturbance. The seismic zone, heavy snow loads and high wind potential of the Elkford region figured prominently in their deliberations, as did a few other aspects.

One of the area's many charms proved to be one of its challenges – its virtual isolation in the Canadian Rockies with only one road leading in and out of town, a reality which often leads to delays in the delivery of construction materials. The structural system chosen would have to address each aspect, and would need to take into consideration two other realities: a restricted labour pool (the result of the area's predominant mining industry), and a short alpine construction season. The decision was made to go with completely pre-manufactured wood construction systems: cross-laminated timbers (CLT), glued-laminated lumber (glulams), and structural insulated panels (SIPs). This approach would help to reduce the time on site, bypassing potential delays for the delivery of construction materials and affording a high quality product that the existing labour force would be familiar with – wood.

About 60 per cent of the way through the design process, the design team felt that the project would benefit from the input of a construction management consultant with extensive experience in pre-manufactured systems.[6] This decision was particularly important in light of the new CLT construction system. It also proved its worth in time savings and reduced change-orders during construction. The construction manager helped establish a fast-track timeline for the project. The fast-track approach was necessary as the town had a deadline for the use of insurance monies and had to close the building before the cold weather hit.

[6] The role of the consultant, Alfred Horie Construction, would evolve into the general contractor role.

Code Considerations

The CCC falls under the Group A, Division 2 assembly occupancy according to the British Columbia Building Code 2006 (BCBC).[7] The single-storey building is allowed to be of combustible construction provided it is sprinklered. The architectural team applied a heavy-timber alternative for this first commercial project in North America designed to use wall CLT panels, and a wet sprinkler system was used throughout.[8]

THE BUILDING

Upon entering the new CCC and advancing through to the confluence of its two main axes (the centre of the cruciform corridors), it becomes obvious that this is no ordinary building. Solid CLT wood walls soar seven metres overhead where ambient light enters from the many north-facing clerestory windows; the quality of that light varies during the course of the day as the sun moves over the building.

A row of round glulam columns supports a striking heavy-timber parallel-chord glulam truss that runs from one end of the building to the other along its longitudinal axis. The truss, in combination with the CLT wall panels to either side of the corridor, support the glulam beams that in turn support the two-tiered roof. The CCC is the first building to use CLT walls for carrying point loads from beams; loads are spread within the CLT wall itself.

The lack of right angles in the building and the inclined ceiling planes draw people into each room; spaces expand or contract, much like what may be experienced rounding a bend on a rocky mountain path. Suspended birch-faced plywood ceiling panels in certain rooms and vertical birch-veneered plank baffle-structures in others add to the wood expression in the building's interior. Glulams and CLTs are left exposed, a cost-saving aesthetic treatment that creates a warmth which is far from illusion – users *feel* comfortable in this building.

[7] BCBC Article 3.1.2.1.

[8] Not more than two storeys, increased area, fully sprinklered, BCBC Articles 3.2.2.25. and 3.1.4.5.

Courtesy Douglas Sollows Architect


Courtesy Alfred Horie Construction


Courtesy Douglas Sollows Architect

Cross-laminated Timbers (CLT)

CLT panels are fabricated by stacking alternating layers or plies of structural-grade lumber at 90 degrees to each other in odd-number layups, with a minimum of three plies.[9] These are subsequently either glued together or mechanically fixed to form large panels.

Due to the nature of the manufacturing process, CLTs have improved dimensional stability with increased strength and stiffness in both directions, giving the panels a two-way action much like is found with two-way concrete slabs, only with less weight. CLT panels are available in finish and industrial finish-grades.

[9] The process is similar to the layup of veneers to form plywood panels.

Its Structure

The CCC's entire wood superstructure was pre-manufactured off site; all systems and components have high strength-to-weight ratios. CLT and SIPs (wall panels), along with glulam columns, beams and a parallel-chord truss, are used for all load-bearing requirements in the building with the exception of a few steel columns used within the thickness of a short 7.2-metre-high, 7-ply CLT wall located near the stage area in Teck Hall.[10] SIPs also provide the building envelope.

The building's foundation is predominantly a slab on grade with perimeter footings. The mechanical and electrical room is housed in a small basement, constructed of insulated concrete forms, located beneath the Elkford Room in the south-central part of the building.

The single-storey structure uses a series of 305 mm round glulam columns topped with a glulam parallel-chord truss, CLT and SIP load-bearing walls, and 215 mm x 646 mm glulam columns to support the 315 mm x 1216 mm glulam beams that make up the roof support structure.[11] Roof beams vary from 18 to 26 metres long and are either supported on the glulam columns or truss using knife plate[12]/bearing plate connectors, or sit in hand-crafted notches in the CLT walls. Riveted plates are used to carry forces between the elements of the glulam truss. Both simple span and continuous span scenarios are used.

Accommodating for lateral loading was not obvious in this non-rectangular building as no right angles existed to create orthogonal shear planes. CLT panels were used as shear walls, either singly or in conjunction with SIP panels, to develop the forces required to withstand the area's seismic and wind forces. Brackets were used as connectors for the shear panels and hold-downs were used at either end of each CLT and SIP (wall applications). CLTs and SIPs were joined using typical SIP screws for the shear wall applications. SIPs complete the roof diaphragm.

[10] The slender steel columns helped with a localized buckling potential.
[11] The glulam columns taper from 646 mm at the top to 406 mm at the bottom.
[12] Knife plates are attached using countersunk through-bolts.


Courtesy Douglas Sollows Architect


Courtesy Alfred Horie Construction

Specialty Systems

Cross-laminated Timbers – CLTs

The CLT panels used in the CCC are composed of glued alternating plies of predominantly beetle-killed Select Structural – No. 2 or better grade S-P-F boards.[13] The panels were comprised of three, five or seven plies, depending on the location. The largest panels measured 2.4 metres x 7.2 metres. All panel dimensions were precise to within 6 mm.

The CCC CLT panels were the first ones produced at the new Structurlam manufacturing facility, but the CNC[14] router needed to create the required openings and notches was not yet installed. As a consequence, panels were sent to Sperlich Log Construction where they were hand-precision-cut with guaranteed tolerances within millimetres. In this way, doors and windows could be pre-ordered before the panels were even delivered to the site.

CLT panels are used primarily as load-bearing walls in the CCC, although the floor of the stage area in Teck Hall also uses CLT panels. All CLT panels are joined together using ship-lap joints and fully threaded screws. Industrial appearance grades were specified; they were factory-sealed then lightly sanded on site and treated with a clear moisture-protection finish.

Structural Insulated Panels – SIPs

The SIPs used for the CCC were manufactured by Insulspan using 11 mm OSB[15] for the outside shells, Type 1 expanded polystyrene rigid insulation (EPS) for the core,[16] and 50 mm nominal lumber elements as required for connections.[17] Roof panels are all 260 mm thick and provide a thermal resistance rating of RSI 6.3. Three thicknesses of wall panels were provided: 210 mm (RSI 5.12) when used singly, 165 mm (RSI 4.12) and 114 mm (RSI 2.76) when used in combination with CLTs. The largest panels used measured 2.4 metres x 7.3 metres.

The SIPs used for the building envelope of the CCC are so efficient in controlling inside temperatures that air conditioning is not needed in the summer, and it takes very little to heat the building in winter.

[13] According to the *Standard Grading Rules for Canadian Lumber, National Lumber Grades Authority.*
[14] CNC stands for Computer Numeric Control.
[15] OSB panels have an Exposure 1 durability rating and meet the requirements of CSA 0325.0.
[16] Type 1 EPS has a density of 14.4 Kg/m3.
[17] Dimension lumber was S-P-F No. 2 or better.

Shear Walls

Interior CLT shear walls include the north wall of the main longitudinal corridor, the majority of walls encircling the core service area situated between the Elkford Room and Teck Hall (south-central); and the east and west walls of the shorter entrance corridor (north-central). All interior CLT shear walls are 5-ply panels. Combination CLT/SIP shear walls are located on the outside walls at both east and west ends of the building, the back (south) walls of the Elkford Room and core area (kitchen), as well as parts of the front (north) wall. The CLT panels in these combination shear walls are all 3-ply.

Courtesy Alfred Horie Construction

Courtesy Alfred Horie Construction

Courtesy Alfred Horie Construction

Courtesy Alfred Horie Construction

THE CONSTRUCTION PHASE

Pre-fabrication of the superstructure implied that construction for the CCC technically started the moment the drawings were received by the fabricators. As pre-measured components were being manufactured, preparatory work had to be arranged to ensure a smooth process on site as components would be ready for assembly as soon as they arrived. Working with a general contractor experienced in the principles and practical aspects of panelized systems more than proved its worth at this stage.

The footings and slab were poured, including the requirements for the small basement; screws for panel brackets and hold-downs were embedded into the concrete; windows and doors were pre-ordered.[18] When the pre-fabricated systems arrived on site, all were numbered and ready to go. CLT and SIP wall panels were installed first and braced in place, then the glulam columns were installed, followed by the parallel-chord truss. The beams were then fitted into their slots in the CLT walls and fixed to the columns and truss. The SIP roof panels capped it off and, where 40 days prior there had been no sign of a superstructure, there was a building, enclosed and insulated, windows and doors standing at the ready.[19]

"The CLT panels actually fit each other like puzzle pieces," said project architect Gil Hui. "We didn't expect such precision. This completely validated our approach that we based on Mark Porter's vision.[20]" Erection was nearly seamless. When necessary, panels were easily modified. All mechanical conduits were passed through holes cut on site, which would have been difficult to do with a concrete system. The surface fixing of electrical conduits was also decided on site. Some were let into the SIP panels and pony walls were used at the base of some CLT walls to hide others, although some were not encased. All-in-all, the construction schedule was reduced by three to four months because of the panelized aspects. On-site waste reduction was also significant. Such pre-fabricated systems provide excellent solutions for remote locations: they allow for quick erection, are lightweight when compared with the alternatives, and can be easily handled by local labour.

[18] This was possible since the precision of all openings was guaranteed.

[19] The concrete floors were sanded and protected with three coats of polyurethane sealant; glulams were also finished with a natural-colour stain on site then sealed for moisture protection.

[20] Mark Porter was the project structural engineer.

Courtesy Alfred Horie Construction

Courtesy Alfred Horie Construction

Courtesy Alfred Horie Construction

THE FINAL PRODUCT

The centrally-located Elkford Community Conference Centre creates a truly vibrant hub for the community. It has already made a big difference to the town. Teck Hall is so sought after that it is booked through to the end of the year; its kitchen is the envy of the valley. The town added a 90-square-metre patio just outside the hall and fitted it with propane heaters to extend its use. If the volunteer appreciation day held in early October 2012 is any indication, the community has been made stronger by the CCC's presence and the possibilities it represents.

Elkford's "I think I can" attitude inspired the innovative use of wood products in the CCC, and this may be but a sign of things to come. Mayor McKerracher would love to build a new city hall using the same construction system as that used for the CCC. A new hotel, in conjunction with the CCC, would make tradeshows possible and could tie in to the region's many activities – snowmobiles, ATVs, motorcycles and more. Elkford: one small town – one big vision.

Courtesy Douglas Sollows Architect

The Elkford Community Conference Centre TEAM

Owner:
District of Elkford
750 Fording Dr. Elkford, BC V0B 1H0
250-865-4000 / www.elkford.ca

Architects:
Douglas Sollows Architect Inc.
Suite 280, 10220-156th St., Edmonton, AB T5P 2R1
780-944-0066 / www.dsafit.com

Structural Engineers:
Associated Engineering
Suite 300, 4940 Canada Way, Burnaby, BC V5G 4M5
604-293-1411 / www.ae.ca

General Contractor:
Alfred Horie Construction Ltd.
Suite 103, 5041 Regent St., Burnaby, BC V5C 4H4
604-291-8156 / www.ahc1893.com

Fabricators:
CLTs and Glulams:
Structurlam Products Ltd.
2176 Government St., Penticton, BC V2A 8B5
250-492-8912 / www.structurlam.com

SIPs:
Insulspan – Delta
#1 – 600 Chester Road / Annacis Business Park
Delta, BC V3M 5Y3 / www.insulspan.com

North Shore Credit Union Environmental Learning Centre

INTRODUCTION

The North Vancouver School District (SD 44) has owned property and offered experiential outdoor environmental learning programming in Brackendale, near Squamish, BC for over 40 years. Students from throughout southwestern BC, but mostly from SD 44,[21] typically engage in three program visits during their elementary years. The students often regard their experiences at the *Outdoor School* as being the most memorable of their school years.[22] Experiences are as memorable for the local and regional communities.[23]

Existing buildings at the Outdoor School campus include multiple learning labs which function as classrooms, a live-in Coast Salish *big house* replica, a small meeting and conference centre and cabins from a 60-year-old family and fishing camp, along with a biodiversity farm and salmonid mini-hatchery. Some of the buildings have been compromised by occasional flooding as all were built below the 200-year flood level of the Cheakamus River. This, coupled with the fact that some are also built within riparian areas now considered to be sensitive zones, spurred a new development master plan for the Outdoor School campus facilities. The North Shore Credit Union Environmental Learning Centre (ELC) is the first of several building phases envisaged.

Courtesy Michael Elkan

Guiding Principles /Objectives

The approach of SD 44 administrators to building on their rural campus is one of sustainability: sustainability with regard to site management and utilization, sustainability with regard to building materials, and sustainability with regard to energy use for building operations and maintenance. In light of this approach, the ELC, aside from any practical purpose for which it was designed, will become an educational tool meant to demonstrate the experiential environmental leadership and learning environment for which the Outdoor School programming has become recognized, regionally, nationally and internationally.

[21] Over 25% of the students attending Outdoor School programs come from the Greater Vancouver metro area, other BC school districts and internationally.

[22] Multiple opportunities also exist for students during high school as youth leaders.

[23] For more information on the Outdoor School, go to http://www.nvsd44.bc.ca/programs/outdoorschool.aspx.


Courtesy Michael Elkan

Project Description

The main level of the 80-metre-long, cedar-clad building, which is aligned in the direction of floodwater flows, sits just over three metres off the forest floor atop slender pilotis or stilts, essentially pushing its way into the canopy of the surrounding trees, giving users a tree house experience.[24] Daylight filters in through the many skylights, around the glulam beams that bisect them; large windows give views into the trees making it difficult to say just where the building ends and the forest begins. The vertical wood structural elements within the building also blur that demarcation line. Stepping out onto one of the ELC's balconies completes the experience. Underneath, one can soak up the forest smells while taking shelter on a rainy day. The communion created between this building and its surroundings takes your breath away; it reflects the administration's desired balance between human activity on the site and its environmental conservation.

The ELC provides many basic services for the site and includes an all-electric commercial kitchen, a dining hall, large reception or welcoming spaces (both inside and out), a multi-purpose hall, two multi-purpose learning spaces, an administrative meeting room, as well as an exterior amphitheatre. It has the backup power capacity to fulfill the essential needs of campus residents in the case of a power failure until such a time as power is restored or residents are safely transported home.

[24] The underside of the main level describes the 200-year flood level.


Courtesy McFarland Marceau Architects


Courtesy Michael Elkan

Courtesy Michael Elkan

Courtesy Michael Elkan

THE DESIGN PROCESS

The design process for the architectural team at McFarland Marceau and the structural engineering team at Equilibrium Consulting in Vancouver was influenced by the site's flooding potential, seismic considerations, snow loads, poor soil conditions and sensitive riparian zones. These realities, in combination with directives from the administrators of the Outdoor School for minimal environmental impact to the site and its buildings, and the requirement to maintain and reflect the site's natural character in any new buildings, assisted the teams in arriving at the appropriate solution for the ELC.

The quality of space and light were critical aspects considered. The building's wood structure pulls double duty: the primary structural material for the main service level, and the natural expression that marries the building with its natural surroundings.

Site Considerations

The site's weak soils, a result of repeated flooding, in addition to the flooding potential itself, created a challenge when coupled with the seismic potential for the area. When dealing with areas of potential flooding, there are two options to consider. One is to curtail flood waters, a system which can have dire consequences if it fails. The other is to let flood waters go where they will. The latter scenario leads to lower and gentler flood waters and affords more control over the potential fallout.

The design team favoured the second option for the ELC, choosing to mitigate potential damage by designing for water and debris flow instead of trying to prevent it. After first developing a flood covenant for the site, they sited the linear building, a form driven by the shape of the Cheakamus River valley, in line with the longitudinal axis of the floodwater flow, then lifted it into the trees so that the main services were just above the 200-year floodplain level, a requirement of the building code. A boat analogy was used at ground level to *break* the waters, as it were, and handle any detritus.

To address the frequent power outages in the area, an on-site emergency generator had to be provided for the supply of emergency power when needed.

Courtesy McFarland Marceau Architects

Courtesy Michael Elkan

Code Considerations

The ELC falls under the assembly occupancy, Group A, Division 2, according to the BCBC.[25] The two-storey building is allowed to be of combustible construction provided it is sprinklered. The architectural team applied a heavy-timber alternative.[26] A wet sprinkler system was used throughout, which required some careful consideration as the mechanical systems run under the elevated main floor – technically an exterior space.[27]

THE BUILDING

When approaching the ELC, one is struck by how long it is, but mostly one is awed by how it sits way up in the trees. The vertical cedar lumber used to finish the exterior of the upper storey helps to make this longer-than-long building virtually blend with its surroundings. Stepping below its underbelly everything becomes silent, as if entering a forest glen. The sudden sensations of the air temperature and moisture on your skin and the sound of the even slightest breeze as it rustles through the leaves and branches of the nearby trees are vivid. An exterior amphitheatre at the south end of the building opens to the forest on three sides; spectators sit on half-hewn logs. The stage is set for the sensorial experience that is the ELC.

The design team's approach was to maintain the rustic nature of the Outdoor School with views and light quality used in such a way as to dominate the interior space, belying any systems needed to run it. Walls of windows at the upper level are used to create immediacy with the outside; the placement of skylights over glulam roof-support beams controls how light enters the building from above, as if through a canopy of trees. These treatments, in combination with the wood structural elements that are left exposed, create a space that is at once familiar, reassuring and inviting.

[25] BCBC Article 3.1.2.1.

[26] Up to two storeys, increased area, sprinklered, BCBC Articles 3.2.2.26. and 3.1.4.5.

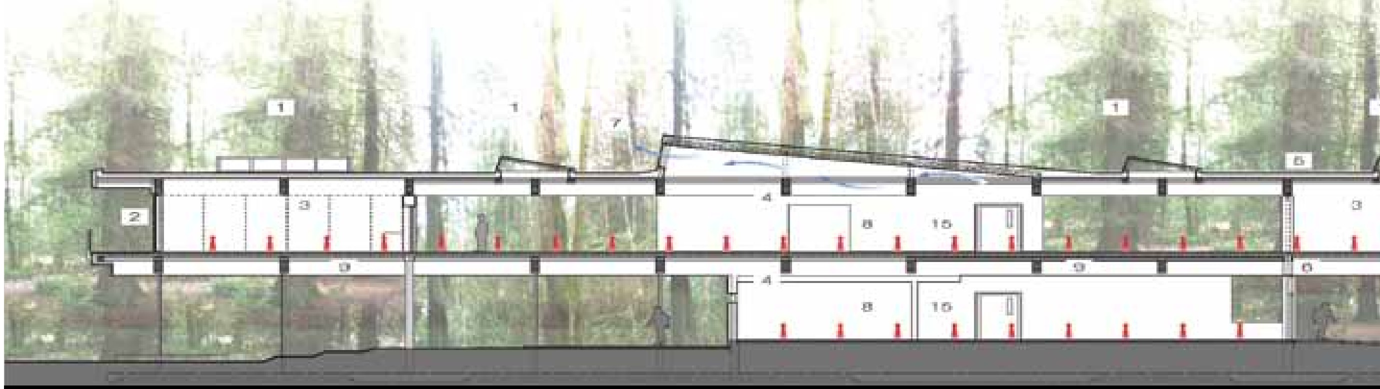
[27] A dry system would have been very difficult to achieve without a myriad of downspouts throughout the length of the building.

Courtesy Michael Elkan

Fire Resistance of Heavy-timber Elements:

Heavy-timber glulam, LSL, LVL, PSL or CLT elements, in addition to being able to support loads over large spans much like steel and concrete, behave in a very controlled and predictable way when exposed to fire. When wood is exposed to high temperatures, as in a fire, it will undergo thermal degradation, which produces a layer of char. This layer has an insulating effect which protects the unburned portion of the wood elements that have a thick enough cross-section, as with heavy timber. The uncharred cross-sectional area of a heavy-timber element retains 85 to 90 per cent of its original strength and can continue to carry structural loads.

In the BCBC, wood elements categorized as "heavy-timber construction" are required to meet minimum size requirements based on their inherent fire-resistant properties. The BCBC accepts a heavy-timber alternative in combustible construction when fire-resistance rating requirements are no higher than 45 minutes in consideration of the degree of fire safety attained by placing limitations on minimum sizes, and the avoidance of concealed spaces beneath floors and roofs.



1 Daylight Harvesting
2 High Performance Glazing
3 Occupancy / Daylight Controlled High Performance Lighting Fixtures
4 FSC Glulam Structure (Douglas Fir)
5 Reclaimed Timber Roof Structure (3x16 Douglas Fir on flat)
6 CLT Solid Wood Floor Construction (Beetle Kill SPF)
7 Natural Ventilation
8 Radiant Floor
9 Displacement Ventilation

Its Structure

The foundation for the ELC is a 200-mm-thick floating or raft slab located approximately 1460 mm below grade.[28] The edges of the heavily reinforced raft slab thicken to 450 mm. The structure at grade is comprised of a double row of 127 mm diameter steel pilotis in conjunction with two poured concrete constructions. One houses the mechanical room and grey water/fire suppression reservoir, or cistern, at the north end of the building; the other houses the mudroom and bathrooms and is located just past the centre point toward the south end.[29] In the event of a flood, the solid north end or bow of the ELC is the first line of protection against flood waters and is designed to deflect any debris. Flood waters are then allowed to flow unimpeded past the building and down through the rest of the site.

The concrete shear walls for the building include four free-standing walls set perpendicular to the building's longitudinal axis, the cistern's four walls and two walls of the elevator shaft. All rise from the raft slab and penetrate up through the building to the roof.

As unusual as this building in the trees might be, the main level and roof structure is elegant in its simplicity. It is a combination of high strength-to-weight pre-fabricated wood systems and reclaimed timbers. Glulam beams, attached to the steel pilotis using knife plate/bearing plate connections, form the support structure for the main level and cantilever beyond the rows of steel columns along both longitudinal sides of the building; 3-ply CLT panels are then attached.[30] The two lines of 175 mm x 190 mm glulam columns at the main level are offset onto the cantilevers and attached using knife plate/bearing plate connections. These columns, in combination with a few judiciously placed steel columns and beams, support the 215 mm x 608 mm main glulam roof beams, which also cantilever beyond the main floor glulam columns. Glulam column-to-beam connections use a mirrored knife plate/bearing plate configuration that is separated by a vertical plate. Secondary 215 mm x 228 mm glulam purlins complete the roof support structure, which in turn supports the heavy timber roof deck. Deck timbers are Douglas fir (D-Fir) Select beams recovered from a 100-year-old school building in North Vancouver. They were re-graded and re-milled to 64 mm x 355 mm and installed on the flat.

[28] The depth of the raft slab varies as a consequence of soil quality.
[29] The floor for each of these concrete structures is a polished 100 mm concrete slab on grade with integrated radiant heating.
[30] Attachment is directly to glulam beams or to built-up LVL ledgers bolted to the steel pilotis via lag screws.

Courtesy McFarland Marceau Architects

10 Open Loop Ground Source Geothermal
11 Rainwater Harvesting
12 Greywater / Fire Suppression Reservoir
13 Fire Suppression System
14 Heat Recovery
15 Low Flow / High Efficiency Greywater Fixtures
16 Measurement and Verification Control Systems
17 Low VOC Materials / Finishes
18 High Efficiency Electric Kitchen w/ Induction Ranges


Courtesy Michael Elkan

Maintaining the integrity of shear forces through the building proved a challenge, in part due to its length, and in part due to the many interruptions of the roof diaphragm by skylights, all of them placed directly over beams. One particularly large skylight toward the south end of the building spans over four beams and virtually lifts that part of the roof off its supports. Horizontal steel rods were used to create sub-diaphragms on either edge of the roof. Regular bolts were used to tie the building together along its entire length. The system of raft slab, full-height shear walls, roof-edge diaphragms and bolted tie-ins along the length of the building was designed to withstand seismic forces and allow for floodwater flow.

Specialty Systems

Green Building Features

The ELC's dependence on outside sources of energy is minimized. An open-loop geoexchange system provides 100 per cent of the heating, cooling and hot water needs for the ELC. Two-thirds of the rainwater harvested from the roof is passed through a physical and UV filtration system before being collected in the ground-floor cistern. This water is used for grey-water flushing,[31] and for the sprinkler system.[32] The remainder of the rainwater from the roof is slowly released to the site through a series of rain gardens.

The narrowness of the building and the extensive use of skylights bring enough daylight into the building so that artificial lighting is not required during the daytime. The lack of sunlight on the heavily-forested site made passive and active solar power generation difficult so dependence on the BC power supply network was required.[33]


Courtesy Michael Elkan

[31] A force-flow septic system was installed to move waste away from the building and well away from the river.
[32] Fire pumps give the pressure needed to operate the sprinklers.
[33] In addition, the increased potential for power outages on the site necessitated the installation of a diesel-powered backup generator which can manage all essential energy requirements for the ELC when needed.

Courtesy McFarland Marceau Architects

Courtesy McFarland Marceau Architects

Courtesy McFarland Marceau Architects

Courtesy McFarland Marceau Architects

Courtesy McFarland Marceau Architects

THE CONSTRUCTION PHASE

Construction of the ELC lasted one full year, so all weather conditions had to be accommodated, in particular – large amounts of rain. The raft slab was a major installation as it was much thicker than normal slabs on grade, with a lot more reinforcement. This was followed by the construction of ground-floor installations; formwork was needed for the cast-in-place concrete walls of the two ground floor structures and the full building-height concrete shear walls. Once this time-consuming phase was completed and the pre-fabricated elements started arriving, installation became facilitated.

The most surprising aspect for the general contractor was the installation of the CLT floor panels. They arrived in two shipments; each piece was numbered and the drawings showed exactly where each one should be installed. Installation was quick and straightforward, with very little waste on site.[34] As stated by Leanne Creech, co-project manager at D.G.S. Construction, CLT products "make everybody's life a little easier."

The main floor installations were relatively straightforward; the glulam column and beam systems were installed followed by the roof system. Once the shell of the building was up, a lot of coordination was required to install the various services. Radiant heating was attached to the CLT floor panels before pouring the 75 mm concrete topping. A plenum was created below the main floor to pass the majority of services, including lighting and occupancy control systems, sprinkler lines for the underside of the building, and mechanical ductwork. All glulam beams had pre-cut holes for this eventuality. Long screws reinforce either side of the holes to prevent stress cracks.[35] Services on the main level were passed above the roof to allow for an uncluttered experience within the building.[36]

D.G.S. Construction worked with CLTs for the first time on this project. Leanne Creech, co-project manager, looks forward to the next time. "We need more suppliers," said Ms. Creech. "We can really see the possibilities."

[34] With hindsight, it may have been advantageous to receive the panels in smaller shipments as on-site storage during the rainy season proved to be a bit of a challenge.

[35] The heat from the radiant flooring conditions the plenum air to allow for a wet sprinkler system.

[36] The Roofing Contractors Association of BC had to approve these installations.

Courtesy Michael Elkan

Courtesy Michael Elkan

Exterior Finishes

The building envelope for the ELC, designed as a rain-screen cladding system, uses light wood framing with exterior grade plywood sheathing. The 38 mm x 38 mm cedar cladding elements are attached to 19 mm x 89 mm cedar frames fixed to the plywood.[37] The cedar was treated off site with three coats of a natural water-based preservative and each element was installed individually on site. The finish will require no further maintenance for 20 years.[38] When exposed to the sun, cedar elements will turn silver. Any part not exposed to the sun will remain a chocolate colour, thereby creating a colouring that will further blend the building in with its surroundings.

Square marine-grade plywood panels (19 mm x 1200 mm x 1200 mm) are fixed to the underside of the main floor. All are individually insulated and removable to give access to the services located in the plenum. Marine-grade plywood is also used as finish siding on the concrete walls of the lower level structures, and the balcony walls and ceilings.[39] Balcony floors are 64 mm Select D-Fir T&G decking installed over D-Fir plywood.

THE FINAL PRODUCT

Construction of the North Shore Credit Union Environmental Learning Centre completes the first phase in SD 44's master plan for the Outdoor School's rural campus in Brackendale. The ELC will act as the "hub" for all future building development and program implementation in natural, cultural and sustainable systems at the Outdoor School campus.

As subsequent phases are completed, raised campus buildings, much like the ELC, aligned with the river valley and linked via pedestrian bridges, will create pockets of habitation through the site, emulating the ELC's embodiment of minimal environmental impact and intimate marriage with its surroundings.

[37] Two layers of 1-hour building paper are sandwiched between the cladding and the frames.
[38] Cedar elements are *dipped* in a Finnish wood preservative off site; no treatment is required on site.
[39] All plywood panels received one coat of finish before arriving to the site and a final coat once installed.

The North Shore Credit Union Environmental Learning Centre TEAM

Owner:
North Vancouver School District
2121 Lonsdale Ave., North Vancouver, BC V7M 2K6
604-903-3444 / www.nvsk44.bc.ca

Architects:
McFarland Marceau Architects Ltd.
115 East 8th Ave., Vancouver, BC V5T 1R8
604-733-1115 / www.mmal.ca

Structural Engineers:
Equilibrium Consulting Inc.
Suite 202, 388 West 8th Ave., Vancouver, BC V5Y 3X2
604-730-1422 / www.eqcanada.com

General Contractor:
D.G.S. Construction
Suite A101, 13761-116th Ave., Surrey, BC V3R 0T2
604-584-2214 / www.dgsconstruction.com

Fabricators:
CLTs and Glulams:
Structurlam Products Ltd.
2176 Government St., Penticton, BC V2A 8B5
250-492-8912 / www.structurlam.com

City of North Vancouver Civic Centre Renovation

INTRODUCTION

North Vancouver is a city in expansion. The North Vancouver Civic Centre (NVCC), originally constructed in 1975 and expanded in 1997, needed modifications to accommodate the additional staff and increased services required to meet the demands of the city's burgeoning community.

The existing civic complex, accessible from 13th Street and the North Vancouver Civic Plaza, consisted of two main buildings separated by an exterior north-south corridor which essentially bisected the site. The complex boasted no face for City Hall on either street; citizens entered via the narrow exterior corridor, either down a few steps from the Plaza or behind some trees from 13th Street, to find a main entrance that was inconspicuously tucked away – a remnant of a different time and philosophy. The building to the west of the corridor housed most city services; the building to the east was formerly the main library and remained empty following its replacement in 2005.[40] City administrators wanted to expand community services into the empty building and link the bisected site by creating an interior street that would connect the Plaza with 13th Street where a more prominent and welcoming entrance would be established.

Courtesy Photography West

Guiding Principles /Objectives

City administrators felt that wood was the obvious material choice for this expansion and renovation project given the importance of the forest products industry to the community's early development. A wood solution would also help to reduce the city's carbon footprint in support of its sustainability policies and climate action targets. In addition to materials choices, there was a desire to soften the previous austerity of the complex in order to exemplify the approachable nature of the current administration.

From a construction point of view, retrofits to the existing buildings would need to meet seismic resistance requirements and satisfy acoustical performance and accessibility desires. An essential ingredient of any solution would have to include a creative meshing of the old with the new.

One important aspect which would have many ramifications for the duration of the project was that City Hall would remain open and continue meeting North Vancouver citizens' needs right through the construction period.

[40] The new library building is located at the east end of the Civic Plaza (also developed in 2005); part of its function is to act as a link between the new library and the Civic Centre.

Martin Tessler photo, courtesy Michael Green Architecture

Project Description

The NVCC project was at once the construction of a new building that would serve as a link between two existing buildings; the renovation and repurposing of and extension to an existing building; retrofits to another building; and the marriage of the old with the new.

The new interior link, referred to as the atrium, opens up to the two existing buildings and establishes a vibrant hub for access to increased municipal services. The atrium houses the new reception area, a conference room, exhibition space and the potential for more community services. There is a certain simplicity in the atrium which is accomplished by the choice and treatment of its wood structure, and wood wall and ceiling finishes; by the integration of mechanical services which leaves the space uncluttered; and by creating an abundance of natural lighting. A full-height window-wall to the west, clerestory windows to the east, and a centrally-located atrium-wide skylight flood the interior with natural daylight. Acoustical ceiling treatments and new skylights in the east building, which allow light to penetrate from the roof through its depth, in conjunction with a shared structure for the adjoining walls, help to create a unity of expression between, and transition from, the higher atrium space and the bordering office spaces.

The wood deck on the Plaza side, the treatment of a north-end extension to the east building, the new cedar siding that mimics the lines of the interior wood systems and surface treatments, the reuse of the old cedar sunshades for exterior benches; all serve to give the NVCC a continuity of expression between inside and out, old and new.


Ema Peter photo, courtesy Michael Green Architecture


Courtesy Photography West

Courtesy Photography West

Martin Tessler photo, courtesy Michael Green Architecture

Martin Tessler photo, courtesy Michael Green Architecture

THE DESIGN PROCESS

Rarely do projects have complex programs that include not only the construction of a new building, but renovations to two existing buildings, and the requirement to create a unified expression throughout. Each aspect was unique in its own right. Add to this the significant complication that City Hall would remain open during the process and a picture starts to emerge of the challenges facing the design and construction teams for the NVCC.

Clarity was the overriding approach adopted by the design teams at mcfarlane | green | biggar architecture + design and Equilibrium Consulting. It was the basis for the innovative design of the wood roof/ceiling system; it was behind the integration of services to keep the space as uncluttered as possible; it helped define the massing of the space and the decision to leave wood structural elements exposed, which would save time and money; and it was obviously behind the provision for abundant natural lighting and ventilation. Clarity was also prioritized in the placement of city services; all main departments would be visible and accessible from the atrium area, and in the clear expression of the building from the main 13th Street entrance.

The obvious decision to go with a phased approach for the project was made from the start, in order to address the fact that City Hall would remain open. This would minimize disruptions and ensure a safe and comfortable work environment for City Hall employees and allow visitor access during construction.

Code Considerations

The NVCC falls under the Business and Personal Services occupancy, Group D, Division B, according to the BCBC. The two-storey building is allowed to be of combustible construction provided it is sprinklered.[41] A wet sprinkler system was used for the interior, and a dry system was used for the exterior canopy at the 13th Street entrance.

[41] BCBC Articles 3.1.2.1 and 3.2.2.54.

THE BUILDING

As one walks along 13th Street, the new NVCC beckons. The atrium`s second level advances toward the street, its fully-glazed front wall veritably opening an eye into City Hall. It creates an entrance portico that envelops visitors who, once inside, are drawn up a broad processional staircase along a dark rustic wall[42] to the modern main level above.

The atrium space, with its abundant natural light, is bright and airy with clean, uncluttered lines as there are no mechanical ducts or conduits of any kind to detract the eye; all systems are integrated into the wood design elements. The expression of the spaced structural wood elements on the lower side of the roof panels is carried to the atrium's walls and on through to the ceiling of the adjacent east building, creating continuity between the atrium and the buildings it connects.

From the Plaza side, citizens arrive directly onto the main atrium level and proceed toward the centrally located information counter. The atrium walls open to the east and west where the city's main department counters are located; all departments are easily identified by their red-stained wood counters. Trees on the roof-top garden established atop the west building are visible through a full-height window-wall. The city, for all intents and purposes, has been carried right into the building, and 13th Street is clearly visible through the windows at the end of the atrium directly ahead.

[42] Randomly stacked rough-cut lumber from an elm tree that needed to be removed on site was used to fabricate the black-stained entrance wall. It creates a contrast to the highly-engineered wood used in the rest of the structure. Legs for interior seating in the north end of the atrium are also black-stained elm.


Courtesy Photography West


Courtesy StructureCraft Builders

Courtesy Michael Green Architecture


KK Law photo, courtesy www.naturallywood.com


Courtesy StructureCraft Builders


Courtesy Stuart Olson Dominion

Laminated Strand Lumber (LSL)

LSL is a structural composite lumber product (SCL)[43] manufactured using long uniform-dimension strands of wood from fast-growing trees. The strands are oriented parallel to each other and glued. The manufacture of LSL uses an extension of the technology developed for oriented strand board (OSB) production and results in a product with increased density that can transfer lateral as well as gravity loads.


KK Law photo, courtesy www.naturallywood.com

Its Structure

The atrium space is two storeys on the 13th Street side to the south, and one storey on the Civic Plaza side to the north. A light-weight construction system was desired for the atrium area. An innovative pre-fabricated laminated strand lumber (LSL) panel system, designed by the structural engineering team at Equilibrium Consulting, provides the roof structure for the 67-metre-long atrium. The system spans the 9.75 metre distance between the two existing buildings without requiring intermediate supports; the underside is left exposed as the finished ceiling.[44]

The LSL roof panels are either supported by concrete shear walls, light wood framing, or sit atop glulam columns using wood joinery techniques and mechanical fasteners. Parallel concrete shear walls at the south end of the complex provide lateral resistance for the atrium in the north-south direction. The west shear wall, with its heavy foundation structure and deep soil anchors, supports a full-storey steel wall-truss that is affixed to and springs from it, creating a 13 metre cantilever. The shear walls and wall-truss support the roof panels over the full-width upper-level conference room housed in the cantilever. This conference room gives expression to the atrium on 13th Street.

The roof panels bear on standard light wood-framed walls that provide the lateral resistance in the north-south direction for the area north of the skylight. In the central portion of the atrium, roof panels bear on 130 mm x 457 mm glulam columns set at 1.8 metre centres.[45] These columns bear on the existing concrete structure of the two adjacent buildings, allowing those buildings[46] to be opened onto the atrium. No beams are necessary at the glulam column lines because of the structural makeup of the roof panel system. An innovative wood-concrete composite system is used for the cantilevered conference room floor, the first of its kind to be designed in North America.[47] The composite floor is supported by 175 mm x 380 mm glulam beams set at 900 mm centres.

[43] SCL is a category of proprietary engineered wood products that are produced to a consistently low MC; very little shrinkage occurs after installation. SCL is free of checks or splits and usually has greater bending strength and stiffness than standard grade dimension lumber.
[44] The system is described in the Specialty Systems section of this Case Study.
[45] Columns are fixed at the base using knife-plate connectors and stainless steel tight-fit pins.
[46] These walls were reinforced and added to as needed to support the new atrium structure.
[47] The system is described in the Specialty Systems section of this Case Study. The floor for the lower level in the two-storey portion of the building, and for the single-storey portion, is a slab on grade.

Courtesy StructureCraft Builders

Courtesy StructureCraft Builders

Courtesy StructureCraft Builders

Specialty Systems

Fabrication and erection of the glulam elements, LSL finish materials, and cross-laminated LSL roof/ceiling panels were the responsibility of StructureCraft Builders.[48] All glulam columns and beams were cut to size and notched with connections already installed or connection-ready, and coated before they left the shop floor.[49]

Laminated Strand Lumber (LSL) Roof Panels

The NVCC atrium's cross-laminated LSL roof/ceiling panel system, designed by Equilibrium Consulting, is the first of its kind. This system provides at once the roof structure, the architectural finished ceiling, and acoustical treatment for noise reduction in the atrium space.

Full-sized LSL billets, which are manufactured to 89 mm thick, 1.2 metres wide and 19.5 metres long, were cut in half to make the lengths needed in the panel assemblies, with virtually no waste. Each shop-assembled 3.6-metre-wide x 9.75-metre-long panel consists of four layers of 89-mm-thick LSL panels with a very specific layup, designed essentially as a 3-ply cross-laminated panel with a double-depth cross layer.

Since the compression and tension zones at top and bottom are the most important for load bearing, materials in the panel layup were concentrated there. The upper compression layer uses three-1.2-metre-wide x 9.75-metre-long solid LSL panels set edge-to-edge longitudinally.[50] The middle cross layer is two thicknesses of 1.2-metre-wide x 3.65-metre-long LSL strips set across the width of the sandwich panels at either end and a 305-mm-wide strip at the centre point within the assembly. The 178-mm-deep central cavity created by the cross layers allows for acoustic insulation which was installed at the shop. The lower tension layer, which doubles as the finished ceiling, is comprised of 460-mm-wide LSL strips set longitudinally 150 mm apart. The assembly is glued and screwed at the cross strips using fully-threaded lag screws.

The result is a lightweight system strong enough to span the 9.75 metres between the existing buildings with minimal depth (355 mm total) and no need for intermediate supports.

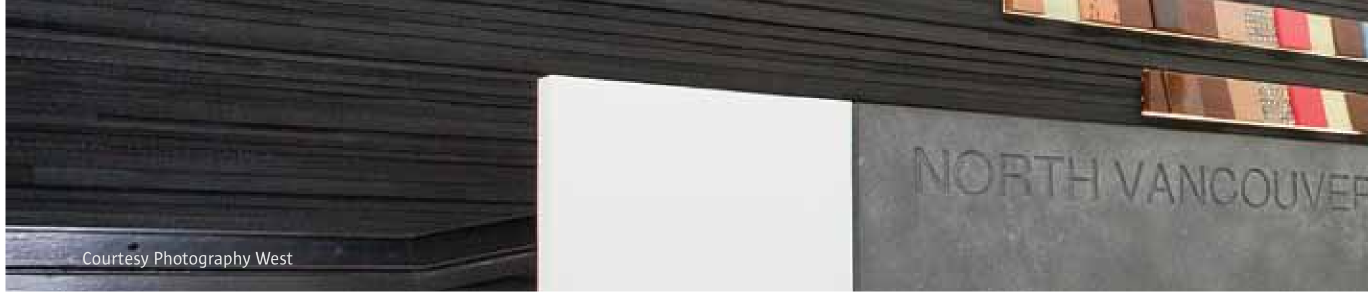
[48] StructureCraft fabricated the structural wood systems using glulams and LSL provided by third parties.
[49] All Douglas fir glulams for the project (supplied by Structurlam Products) were manufactured using clear melamine glue.
[50] The first layer of peel-and-stick membrane for the finished roof was shop-installed to the top surface of all sandwich-panel sections, with enough for overlapping at the panel joints on site.

Wood-Concrete Composite Floor System

The wood-concrete composite floor system is accomplished by creating a shear connection between the glulam floor beams and the 100 mm concrete topping; 19-mm-thick D-Fir plywood panels affixed to the glulam beams act as formwork for the concrete and are left in place. The shear connection is created through the use of HBV connectors. HBV shear connectors consist of 2.8-mm-thick perforated steel plates that are partially let into the glulam beams and glued with a proprietary epoxy. The concrete topping covers the remaining portions of the plates that protrude from the beams, thus creating a mechanical shear connection upon curing.

Courtesy Photography West

Courtesy Photography West



Courtesy Photography West

THE CONSTRUCTION PHASE

There were two main phases for the project over the 30-month construction period. In the first phase, upgrades to the old library building to the east were undertaken, as was work on the south end of the atrium, including the feature stair. This facilitated connecting the lower levels of the existing City Hall to the west and the east building to prepare for the first phase of occupancy. During the second phase, work on the atrium continued, and upper levels of the adjacent buildings were retrofitted and connected to the atrium. Seismic upgrades were undertaken during both phases, as general works were undertaken in the various areas.

The atrium included all three main structural materials: wood, steel and concrete. The interaction of these materials was not the biggest challenge on site. The biggest challenge for the construction team at Stuart Olson Dominion was tying in the construction systems of the existing buildings, each with their own very distinct complexities, to the new atrium structure.

In the atrium area, foundations, shear walls and slabs on grade were poured, the cantilevered conference room was erected and the glulam structures (columns along the longitudinal walls and beams for the main floor level) were installed.[51] The wood-concrete composite floor was constructed.[52] At the same time, work on the east building was undertaken to prepare for the marriage of its common wall with the atrium. Holes were cut through all the floor levels in the existing concrete structure of the east building to create the light wells and the skylights were installed as well as many new windows. Partitions for the new offices in the east building were all wood-framed, as was the north extension to that building.

The isolation of those parts of City Hall where work continued as usual was definitely a challenge, as was the phased hand-over of the project back to the City, according to project manager Geoff Watson of Stuart Olson Dominion. City staff was moved into those portions of the buildings that were completed while work on the atrium continued.

Once the support structure was in place for the roof system along the entire length of the atrium, the roof/ceiling panels were delivered to the site. Installation was fairly straightforward; a mobile crane was used to bring in each section. The tops of the glulam columns fit neatly into 89 mm insets at the panel edges. Each section was spaced 150 mm, similar to the spacing of the LSL strips in the lower layer of the panel assemblies, giving a very uniform appearance to the whole ceiling. Sprinkler lines were installed in the gaps, panel-by-panel, as they were erected.

[51] Columns were braced until the roof panels were installed.
[52] All poured concrete floors included radiant heating.

Courtesy StructureCraft Builders

The Building Interior

Interior wall finishes use LSL panels that match the dimensions and lines of the roof/ceiling panels' lower layer. The spaces between panels are used to integrate mechanical and electrical systems. The acoustical ceiling in the east building is achieved by using 30-mm-thick x 300-mm-wide LSL strips suspended from the existing concrete structure and set 150 mm apart, continuing the lines of the ceiling and wall treatments found in the atrium. The red-dyed wood counters and reception desks are also fabricated using LSL panels.

Natural ventilation between the east building and the new atrium is accomplished through the automation of operable windows and skylights which help draw air through the interconnected spaces.

The Building Exterior

The eyes into City Hall are created through the use of tapered box beams that are cantilevered 1.8 metres out from the building facades, north and south. The internal structure of these *eyebrows* consists of 44 mm PSL ribs on 600 mm centres.[53] These are clad with 16 mm exterior grade D-Fir plywood, top and bottom. The resulting box beams are then bolted to the main structure.[54]

Existing cedar sunshades were repurposed to fashion modern exterior seating for the site. The new cedar siding on the atrium's exterior is carried to the east building. The orientation and colour of the siding; sometimes light in colour, sometimes dark, sometimes horizontally oriented, sometimes vertical; and the use of inverted board and batten elements makes the exterior read much like the interior of the complex.

THE FINAL PRODUCT

The newly-defined and revamped City of North Vancouver Civic Centre has been well-received by the City's employees and citizens alike. The spacious atrium is awe-inspiring in its elegance. The holistic approach used for the design of the wood structure and finishes of the NVCC results in simple clear lines that belie the efforts required to create this perfect marriage of old and new.

City administrators sought a less austere face for City Hall. What they have received is a new facility that is welcoming, respectful and efficient. The NVCC is a handsome addition to the City of North Vancouver. The real benefit may be a renewed sense of the city's desire to meet the needs of its citizens. North Vancouver's City Hall has not only received a face-lift, it has been given a new life.

[53] PSL is a SCL comprised of parallel strands of wood veneers oriented along the length of the member and glued together under pressure. Properties are consistent throughout the thickness and length of the member and they are resistant to seasonal stresses.

[54] Steel channels are used at the outer edge of the eyebrows for a straight edge.

The City of North Vancouver Civic Centre Renovation TEAM

Owner:
The City of North Vancouver
141 West 14th St., North Vancouver, BC V7M 1H9
604-985-7761 / www.cnv.org

Architects:
mcfarlane | green | biggar architecture + design
now Michael Green Architecture Inc.
57 East Cordova St., Vancouver, BC V6A 1K3
604-336-4770 / www.mg-architecture.ca

Structural Engineers:
Equilibrium Consulting Inc.
Suite 202, 388 West 8th Ave., Vancouver, BC V5Y 3X2
604-730-1422 / www.eqcanada.com

General Contractor:
Stuart Olson Dominion Contractors Ltd.
Suite 300, 13777 Commerce Parkway
Richmond, BC V6V 2X3
604-273-7765 / www.sodcl.com

Fabricator / Erector
(for glulams, PSL and cross-laminated LSL roof/ceiling panels):
StructureCraft Builders Inc.
8279 River Way, Delta, BC V4G 1G9
604-940-8889 / www.structurecraft.com

FOR MORE INFORMATION ON WOOD *WORKS!*, CONTACT: www.wood-works.ca

BC Program 1-877-929-9663

Courtesy Douglas Sollows Architect

Elkford Community Conference Centre

Courtesy Michael Elkan

North Shore Credit Union Environmental Learning Centre

Martin Tessler photo, courtesy Michael Green Architecture

The City of North Vancouver Civic Centre Renovation

WOOD ENTERPRISE COALITION PARTNERS:

wood *WORKS!* Project of the Canadian Wood Council

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BC WOOD

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