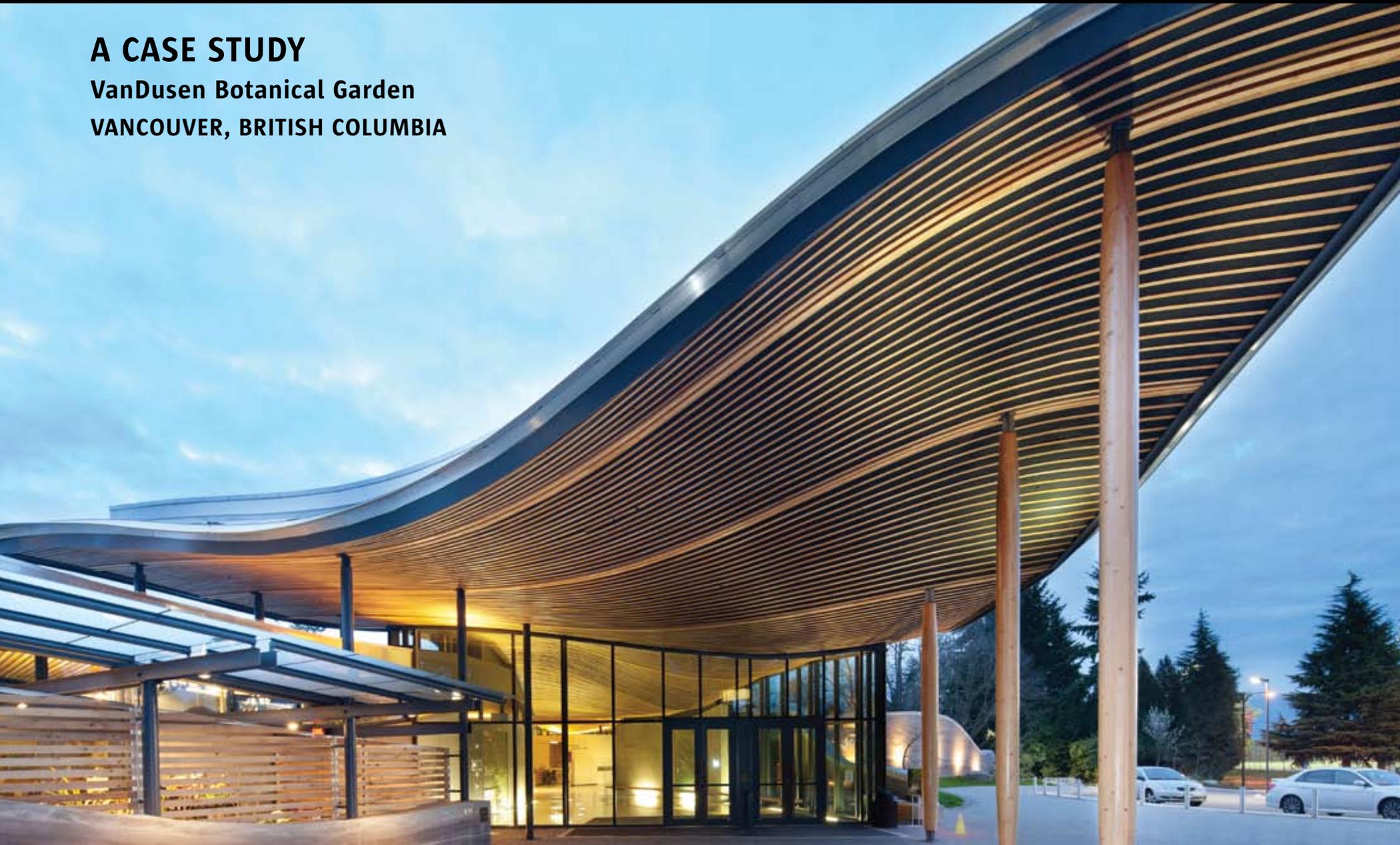


# VanDusen Visitor Centre

## A CASE STUDY

VanDusen Botanical Garden  
VANCOUVER, BRITISH COLUMBIA



# VanDusen Visitor Centre

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## INTRODUCTION

The VanDusen Botanical Garden in Vancouver, British Columbia, was founded in 1971; doors opened to the public in 1975. By the year 2000, two existing buildings, the Floral Hall and the Garden Pavilion, were seeing much wear and the Garden’s entrance needed higher visibility. There was also a desire to attract more visitors and reach out to a younger demographic. Changes were needed.

In keeping with existing buildings on the site which were built of heavy timber construction, any new building would also use a wood-based construction system. It seemed the most appropriate choice for a natural garden setting.

## Project Description

The VanDusen Visitor Centre is the focus of modifications brought to the Garden. The project also included the deconstruction of an entrance structure, some modifications to existing buildings, and the addition of one pedestrian bridge and modification of another.



The 22-hectare VanDusen Botanical Garden is home to more than 250,000 plants from around the world, representing over 7,300 different plant families.



Photo: Courtesy Nic Lehoux



### **The VanDusen Visitor Centre**

The new Visitor Centre acts as the gateway to the Garden. The 1,858 m<sup>2</sup> single-storey structure's unique organic form is based on the petal structure of a native British Columbia orchid. The roof undulations, which blend seamlessly and seem to grow from the surrounding landscape, represent several flower petals. They all converge at the "oculus," a skylight feature which tops the central atrium area in the building.

**Vancouver landscape architect Cornelia Oberlander, with Perkins+Will, through their research of Karl Blossfeldt plant photos, helped to develop the orchid analogy which describes the organic expression of the Visitor Centre's roof.**

Once in the building, the oculus soars dramatically overhead. The atrium area serves as a transition zone to the gardens and a gathering space for events being held at the Visitor Centre. It currently contains the information and ticket counters but will eventually play host to informative displays. Fully glazed walls on the garden side of the building beckon visitors onto the grounds.



The Visitor Centre features a gift shop (including an exterior area for plant sales), a café, an extensive volunteers' lounge, a classroom for educational programs and three flexible spaces for event rentals. These three spaces have the versatility to create one larger space that is suitable for various functions. The Visitor Centre also accommodates the Garden's expanded library, relocated from the Garden Pavilion, and various support spaces, including information and membership sales counters, and a fundraising office. An all-weather children's outdoor classroom will eventually be housed under a 12-metre overhang designed for that purpose which extends beyond the south end of the building.

### **Guiding Principles / Objectives**

The need for increased visibility to attract more visitors; the particular desire to grow interest in the Garden among a younger demographic; the lack of casual dining facilities on the Garden's grounds; and buildings in need of repair – these formed the initial basis for discussions on how to develop a capital project for the VanDusen Botanical Garden. The new Visitor Centre was to create a visual interest that would help draw people into the Garden, and provide services that would more adequately cater to users' needs.

The design team suggested taking a truly sustainable approach to the project by signing onto the *Living Building Challenge* (LBC).<sup>1</sup> It was an approach that the Vancouver Board of Parks and Recreation (VBPR), owner of the VanDusen Botanical Garden, could fully embrace. Combining the LBC with targeting a LEED Platinum green building rating<sup>2</sup> helped to define the project.

<sup>1</sup>The VanDusen Visitor Centre was the first project to apply for certification to the LBC in Canada.

<sup>2</sup>Vancouver municipal facilities over 500 m<sup>2</sup> must all meet a minimum of LEED Gold requirements.



## THE DESIGN PROCESS

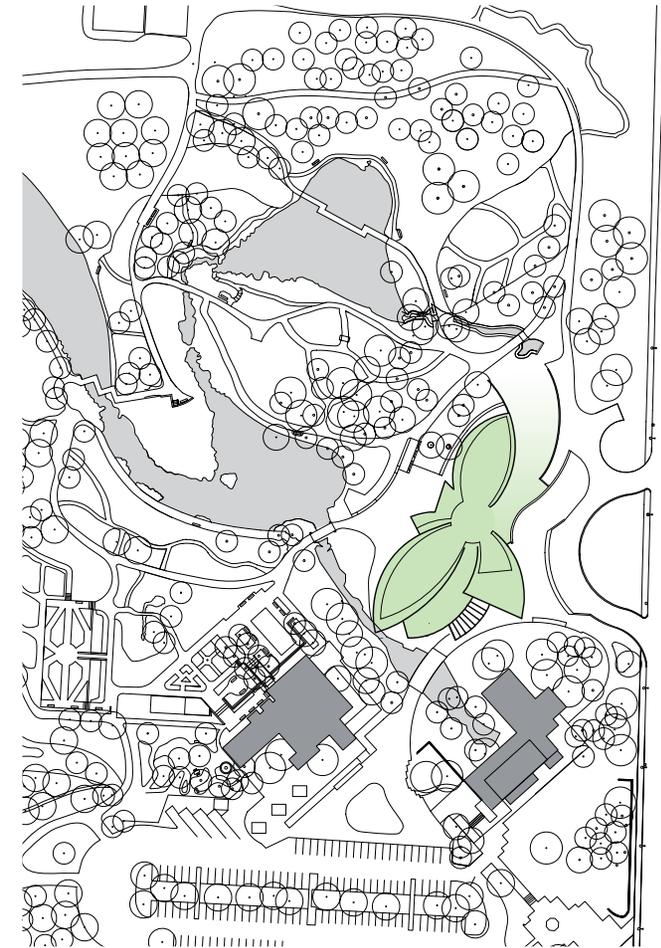
### Siting and Scope

When Perkins + Will Architecture Canada came on board in 2007, the site had not yet been chosen for the Visitor Centre. Before the design of the building could be initiated, a location had to be chosen within the Garden that would afford the desired visibility. A boggy, under-utilized area in the south-east quadrant of the Garden with close proximity to Oak Street was ultimately selected and the grade of the area was raised.<sup>3</sup> The trees that needed to be removed for the building and access road construction were set aside for future use in Garden installations.

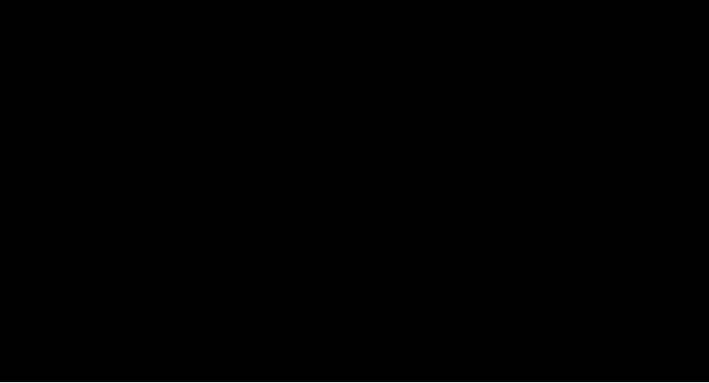
Budget considerations ultimately determined the scope of the project. The older buildings would be maintained and only the covered walkway was deconstructed to help open views into the gardens. Since the services from the two existing buildings did not need to be accommodated within the new Visitor Centre, the new building could be smaller than originally planned. At this point, sustainability objectives began shaping design decisions for the Visitor Centre.

### Sustainability Objectives

Even before it was agreed to adhere to the LBC, the project was destined to be radically green. All energy needed to run the Visitor Centre would be generated on-site; there would be a green roof to help insulate the building and reduce water run-off; and the highest level of LEED certification would be targeted. The LBC, however, brought sustainability efforts to an entirely different level and had major impacts on installations and material choices.



<sup>3</sup>Clippings of the holly trees that grew in that corner of the Garden were sent to other gardens where they might better thrive.



## Code Considerations

### Fire Protection, Occupant Safety and Accessibility

The Visitor Centre falls under the assembly occupancy, Group A, Division 2, according to the Vancouver Building By-law (VBBL).<sup>4</sup> A combustible construction system was allowed for the fully sprinklered, single-storey building. The wood structure was not required to be constructed of heavy timber due in part to the fact that the building was sprinklered throughout, but also because the area of the building was below the maximum permissible size of 2,400 m<sup>2</sup>.<sup>5</sup>

There were two instances where two-hour fire separation walls were required. One was to isolate the non-sprinklered electrical room from the rest of the building; the other was for a major occupancy separation at the loading dock area. A smoke separation was required around the janitor's room, but no fire-resistance rating was required for that assembly. There was no requirement for any other fire separation in the building.

The entrance drive and drop-off area for the Visitor Centre was designed to meet the requirements for a fire access road.

### Sprinkler Details

The building's sprinkler system was designed to meet the requirements of the National Fire Protection Association *Standard for the installation of sprinkler systems* (NFPA 13). The building's deep overhangs had implications on this system. The interior of the building needed to be sprinklered, but the exterior combustible overhangs required them as well. Such unheated exterior applications require a dry sprinkler system. The decision was made to go with a dry sprinkler system throughout, atypical for this type of structure.<sup>6</sup>

The lay-up of the complex roof panels created their own challenge. To avoid the need for sprinklers within the concealed space of these assemblies, the distance between the top of the ceiling joists and the bottom of the roof joists could be no deeper than 150 mm. Fire blocking was not required as none of the concealed spaces was greater than 300 m<sup>2</sup> and no dimension was greater than 20 m in any direction.

<sup>4</sup> Single storey, sprinklered building with no basement, VBBL Article 3.2.2.27.

<sup>5</sup> Ibid.

<sup>6</sup> Dry sprinkler systems are more often used for underground parking structures.



Graphic:  
Courtesy Perkins+Will

### 3D Modeling

Visualizing the curved roof structure from two-dimensional architectural drawings was very difficult. Modeling in 3D using various software programs was not only necessary to envisage the final product, it was essential for completion of the design. The initial roof geometry was developed using Rhino® 3D and Autodesk® Revit® 3D modeling software. Fast + Epp, the structural engineers, used the geometry to arrive at the structural design. At that point, StructureCraft, responsible for the roof fabrication and installation, took the model and worked with Grasshopper®, a design add-in to the Rhino software, to develop the final geometry and digitally panelize the roof's series of overlapping petals, and the central atrium area and oculus.

The geometry of each of the 70-plus panelized sections (panels) that make up the roof structure was unique and each described compound curves. The 3D modeling was used to play with the curvature of the glulam beams (located at the panel edges) in order to optimize the number and thickness of laminations and keep the costs down. By using larger radii for the curves, stock laminations could be used.<sup>7</sup> The modeling was also used to identify appropriate locations for the low points in each panel segment for the most favourable placement of down pipes to drain the sprinkler system and for placement of the roof drains, as well as to ensure visual continuity of the ceiling.

After the optimization process was complete, the structural engineers, glazing contractor, steel column fabricator and architects could use the approved 3D form to finalize their own detailed designs and produce shop drawings. The roof fabricator then worked with the architects and engineers to define load paths for the roof and finalize the edge detailing for the cantilevered overhangs. Column placement and connections were optimized for efficient use of materials and the desired architectural expression. The optimum shape and depth of each panelized segment was determined to control the depth of the concealed space to keep it under 150 mm, and to optimize delivery options to the site. At this point, the model was converted to Autodesk Inventor® 3D and the fabricator developed working drawings for production, assembly and erection of the roof panels.

<sup>7</sup> Sharper curves require thinner laminations which result in increased costs.

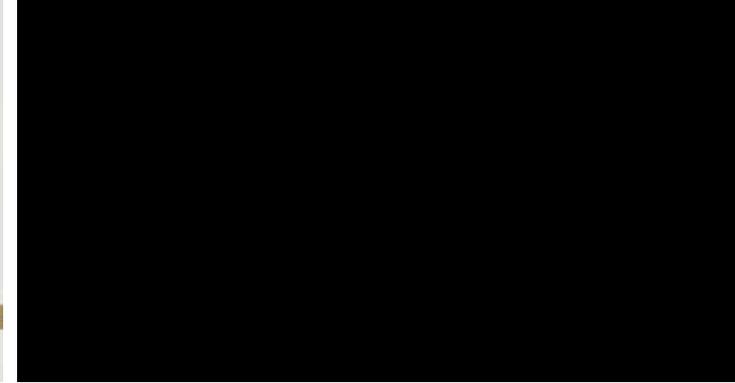


Photo: Courtesy Nic Lehoux

## Fast-track Implications

From the start, the federal government's contribution to the project through the Infrastructure Stimulus Fund set a very tight timeline of 16 months for the project. This timeline forced a fast-track approach to the project which created a whole set of challenges, starting with the design phase.<sup>8</sup>

One of the main challenges for the engineers when developing the complex roof form was to keep the structure from being compromised despite the fast-paced construction schedule; some decisions had to be made before other elements dependent on those decisions were even designed. For example, column placement for the roof supports was determined, and foundations were poured, before the roof details were completely resolved. The geometry was there, but the assembly details were not yet finalized. Neither was there time to resolve how the different petals of the flower would come together in the field. These and many such decisions were determined on-site as the need arose.

The typical set of complete permit drawings prepared by the architects and submitted for the application of a building permit was not available with the fast-track approach to the Visitor Centre. There were actually eight or nine tender packages prepared sequentially, including site clearing and siting; concrete foundations; structural columns and bracing (for the roof structure); rammed earth and concrete wall systems; roofing; glazing; mechanical and electrical systems; and millwork. Construction started as the first packages were completed and the expedited permits received.

<sup>8</sup> The Stimulus Fund program eventually extended the deadline by six months for all projects receiving funding.



Photos: Courtesy StructureCraft





Photo: Courtesy Larry Goldstein

## THE BUILDING

The VanDusen Visitor Centre, the result of extraordinary teamwork and innovation “on the fly” is far from ordinary. Its grassy, undulating roof seems to hover over the actual building, creating a lightness and whimsy which belies the importance of the installations it accommodates. This effect was accomplished by favouring glazed interfaces with the underside of the roof. Even solid walls are topped by a one-metre clerestory, whether internal or external. The roof itself houses a green roof, a rain water collection system and a large array of solar tubes.

The 13.5-metre-high glazed oculus, at the meeting point of the different roof petals, has operable windows which promote air circulation. When hot air rises and goes out the open windows, cooler air is pulled in from the bottom, creating convection currents. To optimize this effect, especially during the warmer summer months, a perforated aluminum “sun catcher” is hung in the oculus to help create the temperature differential needed to favour the convection currents. The beauty of the oculus and the useful task it performs are perfectly intertwined.

The undulating wood-slat ceiling is visible throughout. Most ductwork in the building is installed underground, along with a water-based radiant floor heating system, so no overhead installations detract from the wood ceiling. A special treatment of the concrete floor brings the grains of sand to the surface, giving the smooth surface a textured appearance.

A deliberate attempt to create a unified expression was used in the wood furnishings and wall finishes for the building. Strips of 1/4 inch plywood are used as cladding to recreate the ceiling expression on exterior wood walls, interior sliding doors and the front of the reception desk. A 30-metre-long curved wooden bench made from milled reclaimed timbers seems to float in the foyer, its shape mimicking the curved form of the glulam roof beams visible overhead. This curved form is also reflected on the wood reception desk and garden shop counter-tops. Wood millwork is used throughout and reclaimed wood was milled to make most interior wood doors and bathroom partitions on the project.

There are two rammed earth walls on the east side of the building which become important features, inside and out.<sup>9</sup> Varying the earth-tone pigmentation in the walls helps to create a sinuous expression which mimics the curving roofline. The flowing expression of the building can be read in all aspects of its materials, their use and the spatial interrelationships created within and without.

<sup>9</sup> The rammed earth process uses natural local materials (chalk, lime, soil and pigment) to create a sustainable and durable system.



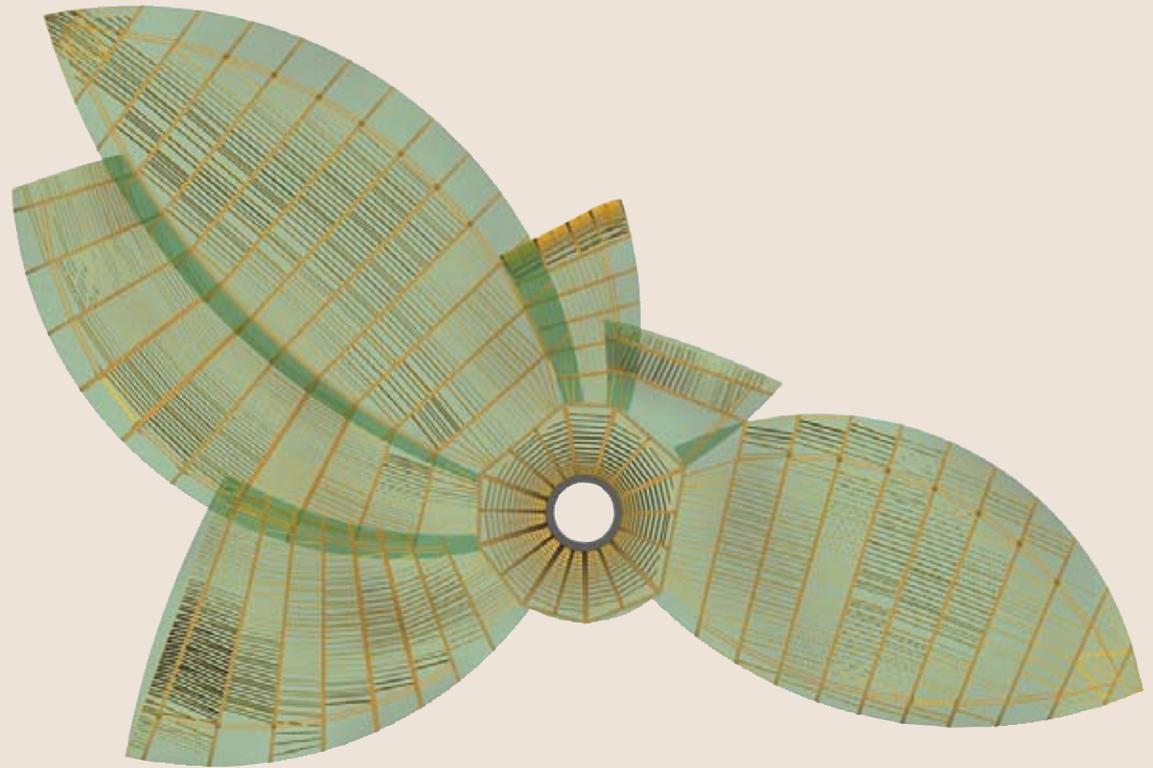


## Its Structure

### The Roof

Since construction would occur primarily through the wet winter season, the decision was made to have the roof system manufactured off-site in a controlled interior environment, essentially creating two simultaneous construction sites.

The roof is comprised of more than 70 very different panelized segments, each geometrically distinct from the other. They were delivered to the site complete with rough mechanical and electrical installations already installed, as well as the finished ceiling. There are 62 segments assembled to represent six petals of the hybrid flower on which the roof form is based; the remainder form the oculus. The petal edges are superimposed but at different elevations until they all join together at the oculus. Clerestories bridge the vertical separations between the petals, the details for which were resolved on-site. The majority of the roof is finished as a green roof; one of the petals is a rainwater catch-basin and another holds a solar hot water tube array.



Optimized roof shape using Rhino® 3D



### *Composition of Panelized Sections*

Most of the roof's panelized sections are tapered with splayed glulam beams creating trapezoidal-shaped panel sections. Two 80 x 532 mm-deep glulam beams, each with their individual compound curves, set anywhere from 2.5 to 3.5 metres apart, form the longitudinal edges of the panelized sections; the longest panels were 20 metres long and weighed nearly 5,500 kg. To build the panelized sections, the beams were set on temporary supports at the shop in the exact position in which they would eventually be installed on-site.

The roof deck is constructed using 38 x 184 mm dimensional lumber roof joists to frame the space between the beams. They are installed at 600 mm centres using pressure blocks and sit flush with the tops of the beams. The joists are topped with two layers of plywood (first 12.5 mm then 9.5 mm). The top layer of plywood was left off for approximately 300 mm along the longitudinal edges of the panels to facilitate assembly of the roof diaphragm on-site. A peel-and-stick roof membrane was shop-installed to the upper plywood layer, with enough extra to cover the joint between panels on-site. Since the roof installation took place during the rainy season, the membrane helped to keep the panels dry until the roof could be completed.

Once the top layers of plywood were installed, the rainwater leaders for the roof drains were mounted by the mechanical contractor, the joist cavity was sprayed with closed-cell foam insulation and the plywood thermal barrier was installed to the underside of the joists. Next came the sprinkler installation: lines had to undulate with the shape of the roof; the sprinkler mains were positioned to be hidden in the walls and sprinkler heads were aligned with the ceiling slats. The rough electrical wiring was then installed and work on the ceiling structure commenced.

The finished ceiling of double thickness shop-laminated plywood slats (6 mm each) is supported by ceiling joists set near the lower edge of the glulam beams. The joists are custom profiled dimensional lumber (38 x 89 mm or 38 x 140 mm) set at 1.2 metres on centre using pressure blocks. The varying elevations and profiles of the ceiling joists create the ceiling undulations which are independent of the roof's exterior undulations.

A black fabric-faced mineral wool acoustic insulation was installed followed by 65-mm-wide, 7- to 10-metre-long, ceiling slats with offset end joints, parallel to the beams. Since the slats are a constant width, their spacing varies to accommodate the trapezoidal space between the beams. The black fabric is left apparent between the slats. The finished ceiling surface is inset 25 mm from the bottom of the glulams.

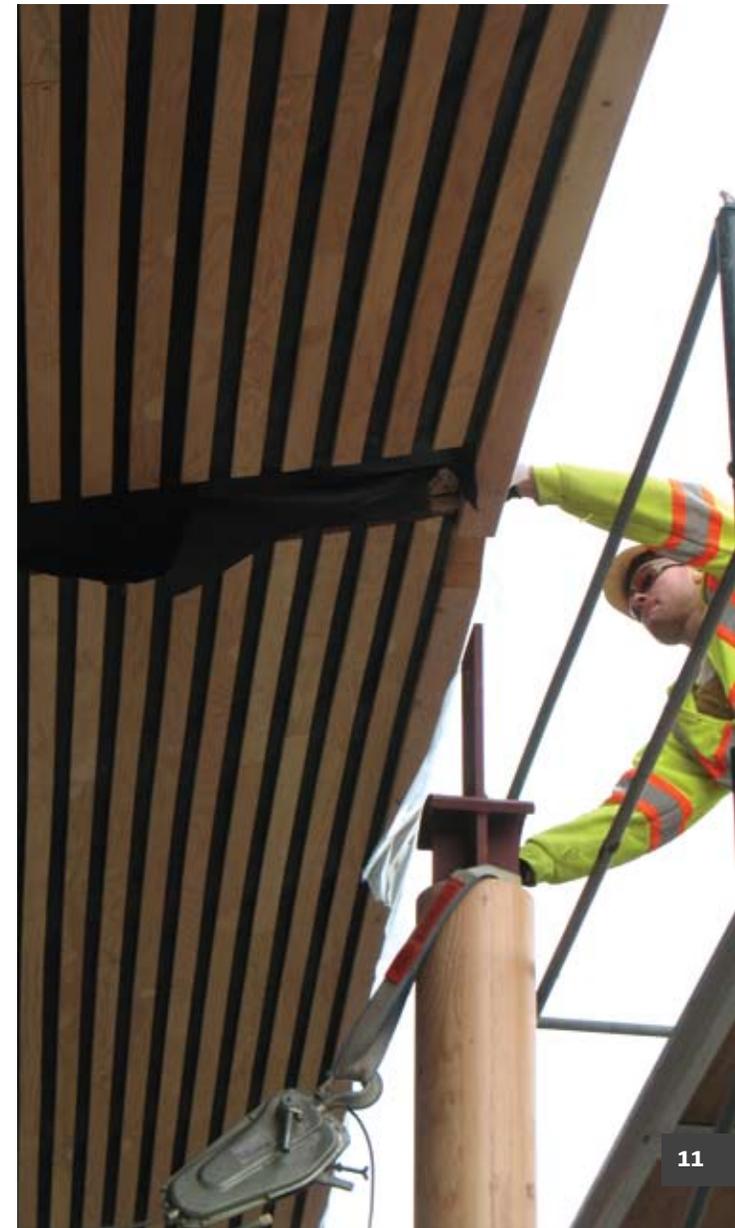




Photo: Courtesy StructureCraft



### *Special Details*

Parallel-strand or laminated-strand lumber and built-up lumber headers, notched into the glulam edge-beams, were installed in “glazing pockets” in the panelized sections. These provided structural backing for the glazing contractor’s headers and deflection channels. The location of these glazing pockets actually dictated the slab contour, which explains why the concrete slab was poured in segments, only as the installation of roof sections progressed and defined the footprint of the building. The glazing pockets also defined the location of nearly all the project’s walls as very few walls actually meet the underside of the roof structure; a one-metre-high clerestory perches atop nearly every wall in the project to interface with the roof. From any place in or around the building, one can read the roof undulations as the various roof petals hover and flow over the walls.

The wide building overhangs also required special attention. The portions of the roof panel sections that would serve as the building overhangs were not insulated and would not be supporting a green roof. Shaping the ends of these panel segments to bring them down to a thinner roof edge at the overhangs was a challenge, especially when trying to create a smooth geometry, both horizontally and vertically. Flat-seam metal roofing used in conjunction with a proprietary aluminum composite product helped to achieve the desired effect.

### **Load-bearing Supports**

A strategic placement of load-bearing walls and bracing was used to develop a lateral support system for the heavy green roof that would not compromise the expression of the free-floating roof form overhead and views to the garden.

There are 18 turned glulam columns used on the glazed garden-side of the building, and near the entrance and central oculus area. The column support line for the glazed exterior walls is located from 300 to 450 mm inside the actual building envelope. Columns are topped with a universal connector joint designed to be versatile enough to fit most angles of the panelized roof section edge beams where they connect.



## Its Green Building Features

Green building features in the VanDusen project revolve primarily around the requirements for net zero water and net zero energy use.

### Energy

The VanDusen Visitor Centre is designed to achieve net zero energy requirements – it generates enough energy to offset the amount of energy it uses and none is generated through combustion. Several features help to achieve the net zero energy requirements.

Photo voltaic (PV) panels located in the parking lot provide 11 KW of power to the Visitor Centre.<sup>10</sup> There are also 400 solar hot water tubes located in arrays on the Visitor Centre and Floral Hall roofs. The hot water generated is stored in 55 six-metre deep geoexchange boreholes dug at the periphery of the Visitor Centre's north end; this thermal energy is used for heating the building's water and for heating or cooling needs, depending on the season.

Passive solar aspects which help to control energy needs include the wide roof overhangs which help to prevent heat gain and have the added benefit of providing rain protection; the green roof which provides added insulation for the building; and the oculus which facilitates air circulation to cool the building. A heat recovery unit also maximizes the benefits from the return air that is naturally warmed and captured from the oculus or from the thermal mass of walls.<sup>11</sup>

The Visitor Centre generates more heat energy than is needed from its systems and transfers excess to the Garden Pavilion in exchange for an equivalent amount of hydro-electric generated electricity from the grid.

<sup>10</sup> Vancouver's high number of rain days makes energy generation very difficult. The PV panels were located where there was the most potential for sun exposure.

<sup>11</sup> It should be noted that instantaneous control over heating and cooling systems, as is found with more conventional energy-dependent systems, cannot be expected in buildings using active and passive solar techniques.



Photo: Courtesy StructureCraft



### Other Features

A covered entrance walkway that linked the Floral Hall and the Garden Pavilion was deconstructed to give better views into the gardens. Timbers from that structure were re-surfaced and coated for use as balustrades and decking for a new pedestrian bridge built on the pathway leading to the Visitor Centre from the parking lot. The salvaged timbers were also used for decks and walkways as well as the floor of a smaller stone bridge which was replaced near Livingston Lake, in order to widen the access to allow for service vehicles.

### CONSTRUCTION

Construction at the VanDusen site was a sequential process. Construction progressed in stages starting at the north end of the building and advancing toward the central oculus area. Columns, load-bearing walls and bracing went up in the section under construction and then the panelized sections for that area were installed.

The larger roof panels were delivered singly, although the trucks could transport up to three of the smaller panels at one time. At the height of construction efforts, about one and a half panels were installed per day. Each panel was lifted and set into place within 50 mm of the adjacent panel and then the “stitching” process began. The insulation was blown into the space between the panels (150 mm of closed-cell foam), and the plywood and roof membrane were installed over the panel joints. The connection of sprinkler pipes and wiring was carried out, and the panels were bolted together.

When the north end was completed, work moved to the south end of the building, once again advancing toward the oculus using the progressive stage approach; the oculus was constructed last, and proved to be the most challenging. Panels at the oculus curved upward almost 90° with all petals arriving at the same elevation at the bottom of the oculus. There was no precedent for dealing with the complex roof geometry and many details had to be worked out on-site, including the installation of ceiling slats in that area which could only be done after all of the petals were connected.

The prefabrication of roof panels off-site made it possible to optimize the construction process and allowed trades to meet their own deadlines. There was minimal waste generated on-site from the roof system installation as the panels were delivered completely finished on the lower surface (ceilings and soffits – with the exception of the oculus area), and ready to receive the roof installations on the upper surface.





## THE FINAL PRODUCT

The new Visitor Centre blends seamlessly with its surroundings in the VanDusen Botanical Garden. The warm and inviting wood building in its garden setting has become a favourite for special lectures and wedding receptions. Its facilities are in constant demand from varying interest and age-groups. People are drawn to this dramatic building with its natural wood structure and finishes. Classrooms are busy with different courses such as those given by members of the Vancouver Chapter of BC's Master Gardener program, which is now based out of the Visitor Centre. The Master Gardeners provide volunteer services to the Garden and make extensive use of one of the biggest botanical libraries available anywhere.

Challenges notwithstanding, the City of Vancouver received excellent value for the public dollar on the Visitor Centre project and the Vancouver Board of Parks and Recreation is very happy with the results. The choice of a wood construction system creates benefits to the environment, to the building, and to its occupants and users. This choice will continue to garner benefits throughout the useful life of the building. The VanDusen Visitor Centre is destined to become an enduring architectural statement and a monument to sustainability objectives for the benefit of the Garden's denizens well into the next century.

## THE TEAM

### OWNER

**City of Vancouver Board of Parks and Recreation**

2099 Beach Ave., Vancouver, BC V6G 1Z4  
604-873-7000 • [www.vancouver.ca/parks](http://www.vancouver.ca/parks)

### ARCHITECTS

**Perkins+Will Canada** (formerly Busby Perkins+Will)

1220 Homer St., Vancouver, BC V6B 2Y5  
604-684-5446 • [www.perkinswill.ca](http://www.perkinswill.ca)

### ENGINEERS

**Fast + Epp Structural Engineers**

201-1672 West 1st Ave., Vancouver, BC V6J 1G1  
604-731-7412 • [www.fastepp.com](http://www.fastepp.com)

### GENERAL CONTRACTOR

**Ledcor Construction Limited**

1200-1067 West Cordova St., Vancouver, BC V6C 1C7  
604-681-7500 • [www.ledcor.com](http://www.ledcor.com)

### ROOF FABRICATOR/ERECTOR

**StructureCraft Builders Inc.**

8279 River Way, Delta, BC V4G 1G9  
604-940-8857 • [www.structurecraft.com](http://www.structurecraft.com)

### PHOTOGRAPHY (unless otherwise specified)

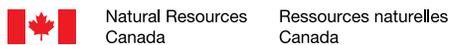
**Stephanie Tracey, Photography West**

#101 - 1447 Ellis Street, Kelowna, BC V1Y 2A3  
250-860-3563 • [www.photographywest.ca](http://www.photographywest.ca)



Photo: Courtesy Nic Lehoux

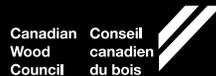
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