rjc
Engineers

GNW Pavilion

ON GREAT NORTHERN WAY

An Artistic Lotus Shaped Gathering Place that Inspires Creativity

THE VISION

As a joint effort, the Emily Carr University of Art + Design and PCI Developments wanted to create a communal pavilion between the University Campus and PCI's new technology focused office development, creating a space that would act as a gateway between the two buildings to engage dialogue and inspire creativity.

Visionary Chip Wilson, well known entrepreneur and founder of Lululemon, tasked Perkins + Will architects to provide several concepts for the pavilion. An inventive red flower shaped design was selected to stand out in the transforming industrial neighbourhood of Vancouver.

An artistic sculpture shaped to form an upside down Japanese lotus flower.

The resulting building became a hybrid timber-steel structure shaped as an upside down Japanese lotus flower, which now provides the students of Emily Carr and adjoining office development an inspiring community gathering place with a coffee shop inside.

INNOVATION THROUGH COLLABORATION

RJC worked closely with Spearhead Inc. (digital modeller and fabricator) throughout the entire project as part of an integrated design team to support the architectural vision of Perkins + Will. Facilitated by digital modelling, Spearhead and RJC developed a unique yet simple structure to support this complex shape. Digital modelling was further utilized to maximize the benefits of prefabrication, economize shipping and simple erection. The digital model in the end was also utilized to drive the CNC machinery which cut all the individual pieces.

RJC was brought on board to explore alternative options to a solid mass timber solution that was previously proposed, yet found not to be practical. Our role was to provide support to the fabricator in developing a buildable, efficient structural form to respect the complex lotus shape.

Unlike a typical structure, this unique shape required out of the box thinking. What type of structure would be both efficient and buildable? Simplifying something so complex.

Creative collaboration amongst the project team allowed the project vision to blossom into reality

TECHNICAL EXCELLENCE

Using the digital model to facilitate strong visualization sessions, it was decided to incorporate a curved wood dome structure supported on the five inner petals which would carry all the gravity and lateral loads. The outer petals then became secondary, supported on the primary inner structure.

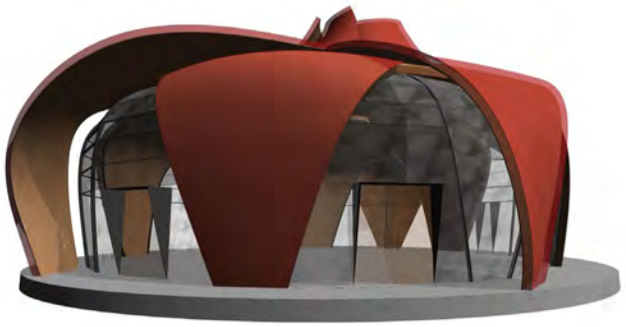
Various material options were considered, a Nail Laminated Timber (NLT) option - which was found to have high material volume, a high construction cost and be an inefficient use of material and a Glue Laminated Timber (GLT) option, with a glulam frame / truss between the upper and lower petals - which the 3D model quickly indicated would be complex to construct with a high construction and fabrication cost.

The final principal structure would consist of five inner petals constructed of curved glulam members and seven glazing columns that support a hybrid timber-steel dome. The five outer curved petals would be sculpted from engineered wood and supported on the lower dome and petals.

With the digital model, we were able to quickly and efficiently review each idea at each stage of the design process, as outlined in the timeline graphic to the right.

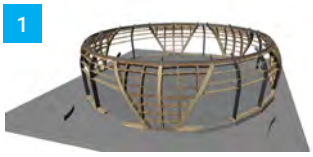
We were able to find solutions tested against the digital model which were used to program the CNC machines for the cutting of all steel and wood components. The complete structure was fabricated from approximately 40 prefabricated sections comprised of over 7,000 individual pieces of wood and steel, all cut with tight tolerances from CNC (Computer Numerical Control) machinery.

The structure was digitally built from the ground up, breaking each architecturally unique form into shop fabricated assemblies, that could efficiently be erected in the field. The main structure was erected in just under a month.



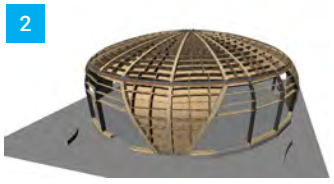
The model

1



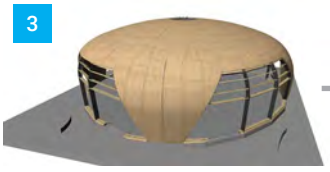
Primary Structure
Lower Structural Walls (Five Petals) Segmented for Prefabrication. Constructed using curved glulams, secondary LSL framing and a steel tension ring and support mullions.

2



Lower Dome Structure
Shell structure constructed from curved glulams and curved LSL secondary framing.

3



Lower Dome Structure (Outer later)
Two thin layers of plywood glued and screwed allowed double curvature of skin.

4

Support Structure for Upper Petals
The short walls bear over glulam arches and the upper oculus acts as a skylight to support the five upper petals.

5

Upper Petals
Divided into three primary sections; lower petals, middle section and upper section.

6

Upper Petals - Upper section
Double ply sheathing system used to brace members and add lateral stiffness to structure. Glazing infilled in-between the steel mullions and wood petals.

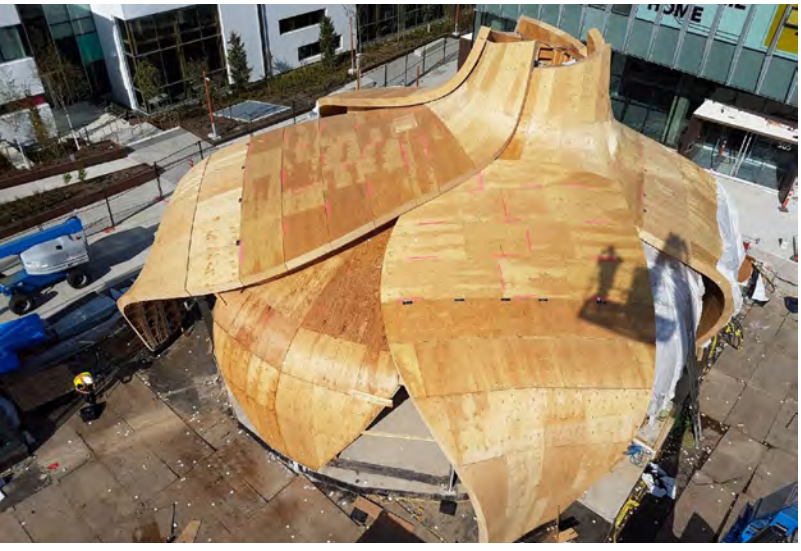
SIMPLIFYING COMPLEXITIES

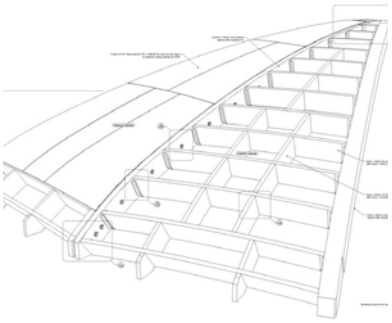
Creating the initial form to be both efficient and buildable while respecting the complex shape was the biggest challenge. Our solution was a wood shell structure for the lower portion of the roof - creating a very efficient structure for gravity loads.

Secondary complexities included the selection of materials to create the double curvature shapes of the petals and the design of a steel moment connection at the top compression ring that would allow the glulam members to shrink unrestrained.

Complex Geometry

To address the complex geometry, a shallow dome structure was incorporated into the lower roof structure. Digital modelling made for a clear process that ensured the architectural requirements were met. Some simplifications of the lower petals were created to allow a typical single curvature glulam member to form the ribs of each lower petal. To create the double curvature, LVL (laminated veneer lumber) was selected to span horizontally between the curved glulam ribs as the unique shapes could be custom cut from large sheets of LVL.





The glulam ribs of the upper dome created a connection challenge at the peak of the dome. Due to the size of the members, a compression ring six feet in diameter was required to suitably connect all the arched glulam members at the peak. The steel connection also needed to develop a moment connection at the wood / steel interface while not restraining shrinkage of the glulam's. A unique screwed base combined with a rocking top connection met these stringent requirements.

The Digital Model

The accuracy of the digital model can be used to feed multiple CNC machines across numerous material scopes. – steel, wood, concrete. The digital model can feed multiple CNC machines at various locations, and when brought together, the pieces should fit seamlessly.

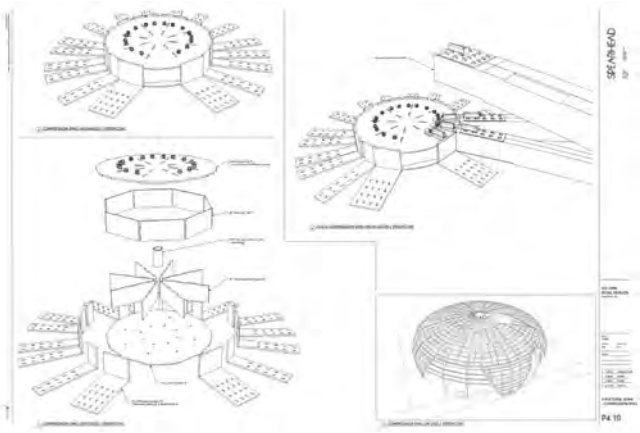
Through the integrated design, the model for design became the model for many other aspects of the project including:

- Identifying material parameters
- Optimizing shipping
- Optimizing the split up of members for prefabricating large pieces
- Ensuring optimal fit-up under ideal conditions to reduce time on site
- Synergizing ideas in a collaborative way to create a form that best suited the project for design, fabrication and erection

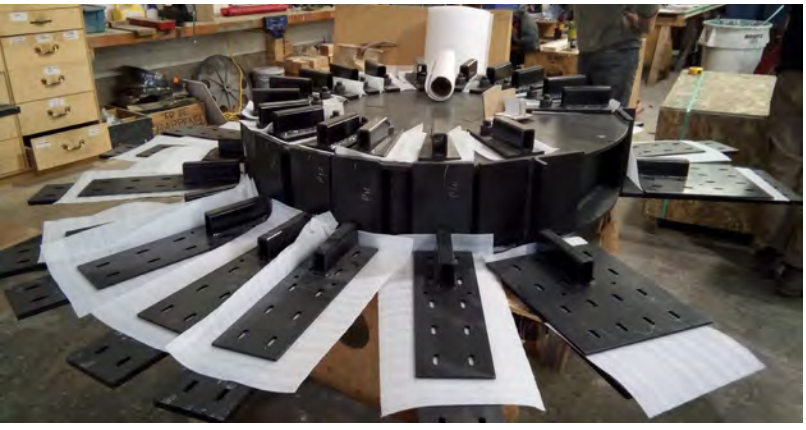
The accuracy of the digital model allowed us to eliminate the challenge of complex geometry. Through testing of ideas virtually, new methods that may have not otherwise been feasible were explored. Digital modelling provided a strong visualization to create an efficient structure that respected and maintained the architectural desire. Planning and fabrication become simplified and allowed optimization of shipping and erection.

For example, the compression ring at the top of the structure was developed and tested through trial and error in a virtual environment - allowing an accurate comparison of alternatives to find the best suited option in terms of constructibility, efficiency and cost. The ring was tested virtually using the model, in the shop and assembled smoothly on site.

Installation on site



Digital model used as shop drawing



Shop test

Material Selection for Construction

Through the integrated design process and the use of one model, the streamlined process allowed us to manage control of the steel and wood components. This avoided a silo approach and provided efficiencies during construction by eliminating shop drawings through use of the model.

All connections had been tested through the model which resulted in no fit up issues on site. The lower main structure was erected in about two weeks and the upper structure was erected in five weeks.

- 7,000 unique CNC cut wood components shipped to site in approximately 90 assemblies
- 5,000 small connectors and straps
- No typical details required for field interpretation
- No waste on site
- No doubling up of orders, as quantities were all maintained within the model.

A unique structure supports the complex shape

Planting A Future Community

INSPIRING COMMUNITY THROUGH PUBLIC REALM

Public spaces that encourage dialog and inspire creativity are far and few between.

With the pavilion centered between the front doors of the office building and art school, this was the perfect place to situate such a structure. The space provides a stimulating focal point within the neighbourhood that continues to inspire as you enter the lotus, which appears to be floating as you walk through its doors.

Not only does this affect the mind and spirit as you enter the space, but it provides a platform to openly discuss your greatest ideas. The pavilion offers a unique gathering place between academic arts students combined with the day-to-day on goings of office workers from the adjoined office building. This allows for the cross sharing of ideas between both arts and business and will ultimately lead to some cutting-edge discussion.

Always keep an open mind as you enter through its petals!

RESPECTING THE ENVIRONMENT

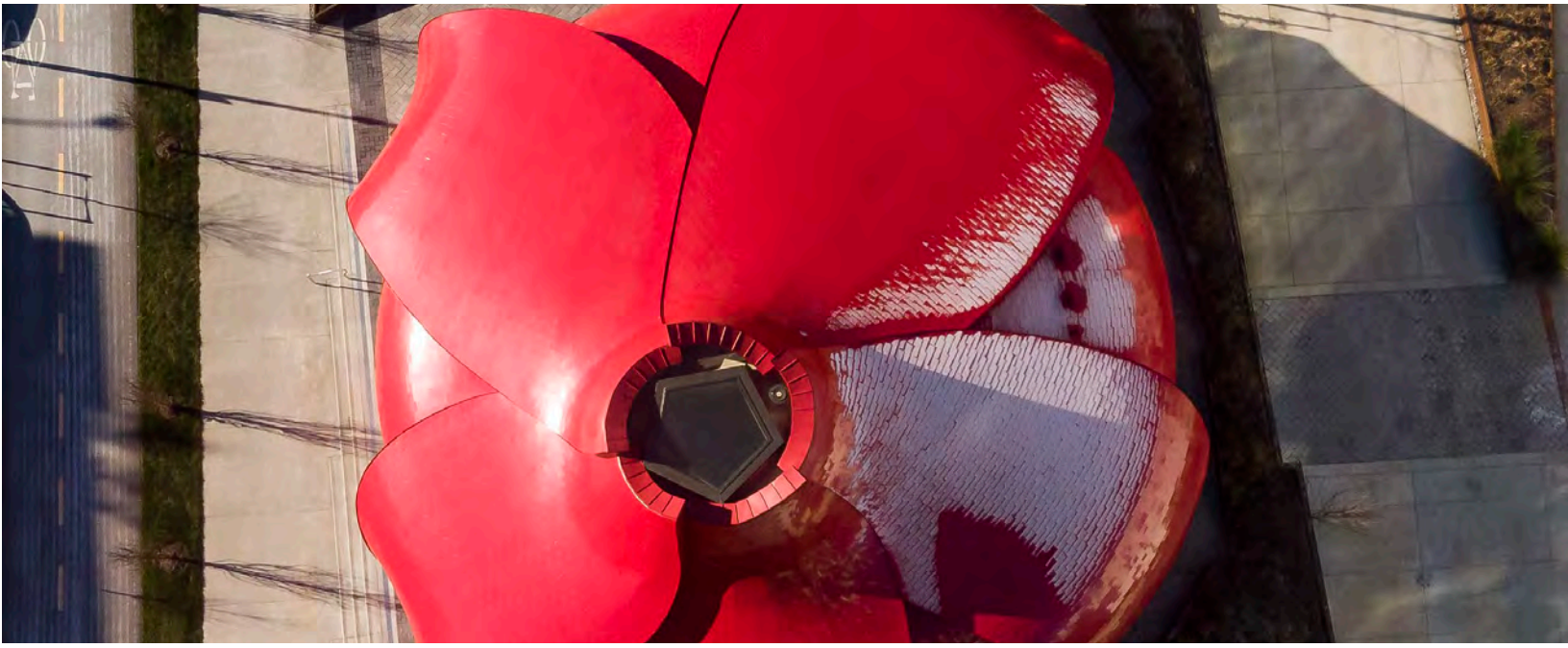
It is understood that two highly important aspects of environmental and sustainability practice include the efficient use of material and materials that promote both a low embodied energy as well as high sequestered carbon. Wood is the material of choice that meets both these benefits.

Below the structure, although may not be apparent, there is an underground parkade which supports the pavilion. With the random layout of petals unable to follow a regular parking column grid, we utilized wood as a light material to reduce the transfers required to support the structure. This allowed the supporting structure to be designed with less concrete and rebar.

A second benefit of the system chosen is there are no interior columns. This allows complete flexibility of the use of the space now and for generations to come. Flexibility of space is at the cornerstone of promoting a sustainable building for the future.

A third benefit is that digital modelling allowed for each of the 7,000 members to not only be uniquely cut so to minimize the material, but was able to efficiently utilize the model to minimize wastage of materials and optimize shipping and erection - adding a fourth dimension over conventional projects.

Custom fit up and prefabrication of the larger components allowed for a non-sawdust approach on site, and considerably reduced construction time making the most efficient use of material, energy, and people during construction for a synergistic erection of the pavilion structure.



WORKING TOGETHER TO MEET CLIENT GOALS

With Spearhead, Perkins+Will and PCI Developments as our clients, the main goal was to develop a unique structure which would be light, efficient, buildable, and economical while meeting the design intent for this lotus shape structure.

Through digital modelling, we were able to quickly and efficiently review each idea at each stage of the design process. We were able to find solutions tested against the digital model which would eventually be used to program the CNC machines for the cutting of all steel and wood components.

This highly collaborative approach to each design idea, supported by a strong digital understanding and testing of each idea, allowed us to quickly come to a final solution which met the goals set for the team.

THE RESULT

The team was able to successfully create this unique structure which was light, efficient, buildable, within a reasonable budget. Through digital modelling, the team was able to test each idea and incorporate the needs of all the trades including glazing, structural steel, and wood manufacturing. One model allowed for precision cutting of over 7,000 pieces, fit-up, shipping optimization, prefabrication, and minimal time on site - which made this project a success.

This project was completed in collaboration with

PCI Developments - Owner
Spearhead Inc. - Digital Modeller & Fabricator
Perkins + Will - Architect
Ledcor - Construction Manager

Creative Thinking **Practical Results**