

Cnidaria Pavilion: A Novel Approach to Load-Bearing Architectural Skins

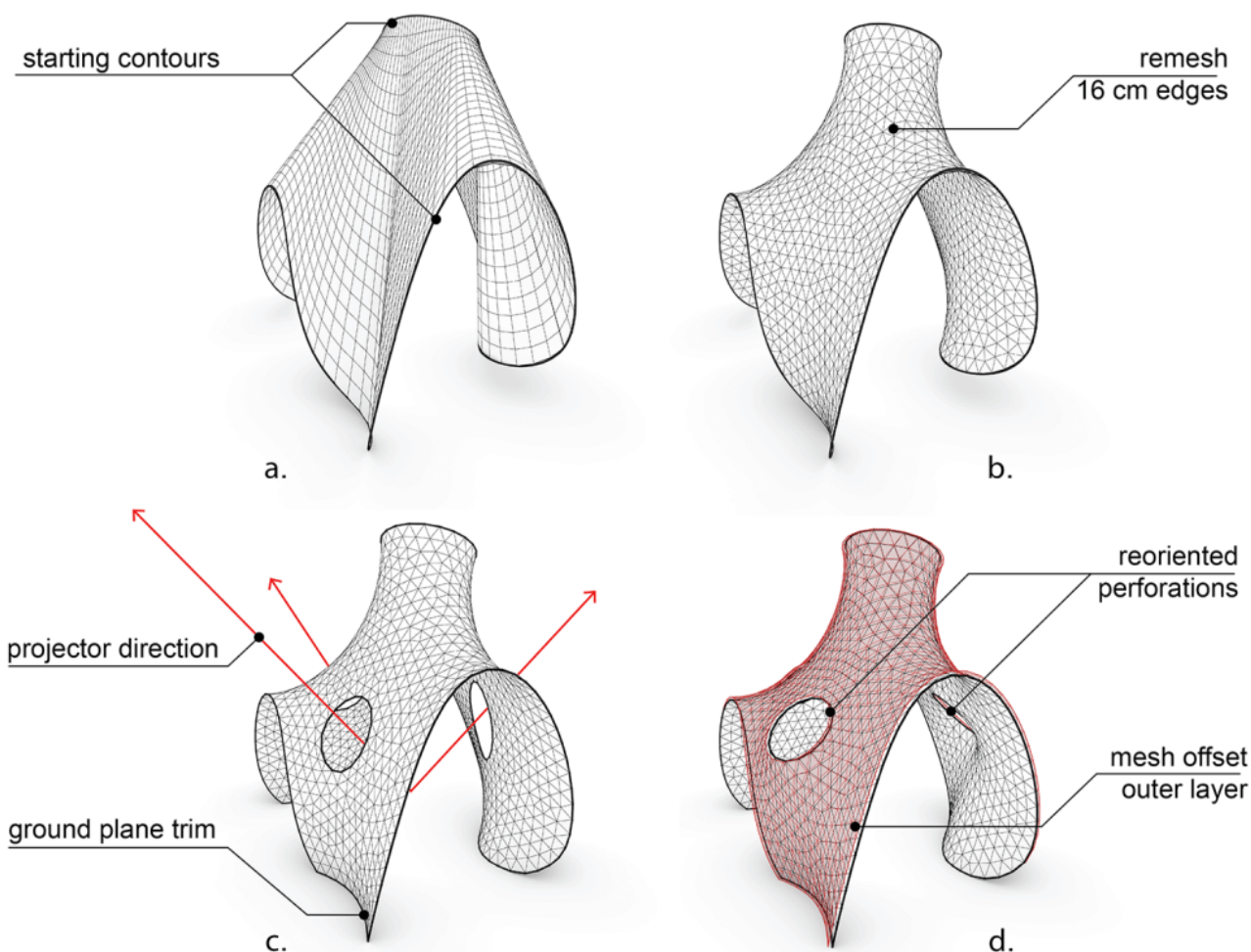
The [Cnidaria Pavilion](#), developed at the [Université de Montréal's School of Architecture](#), presents an innovative structural and assembly system for large-span, doubly curved architectural surfaces. Designed as both an architectural and artistic installation, this research pavilion combines cutting-edge computational design, digital fabrication, and manual assembly techniques to create a lightweight yet structurally robust form.



EXBO
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DESIGN INSPIRATION & FORM-FINDING PROCESS

Inspired by the structural elegance of sea anemones and the acoustic properties of sound-focusing shells, the 25 m² aluminum pavilion was developed through an iterative form-finding process in [Grasshopper](#) using [Kangaroo](#) physics simulations. A soap-bubble simulation optimized the surface area between boundary splines, ensuring an efficient structural form that can evenly distribute loads. The final design features three access points and a funnel-shaped oculus, enhancing usability and acoustic performance.

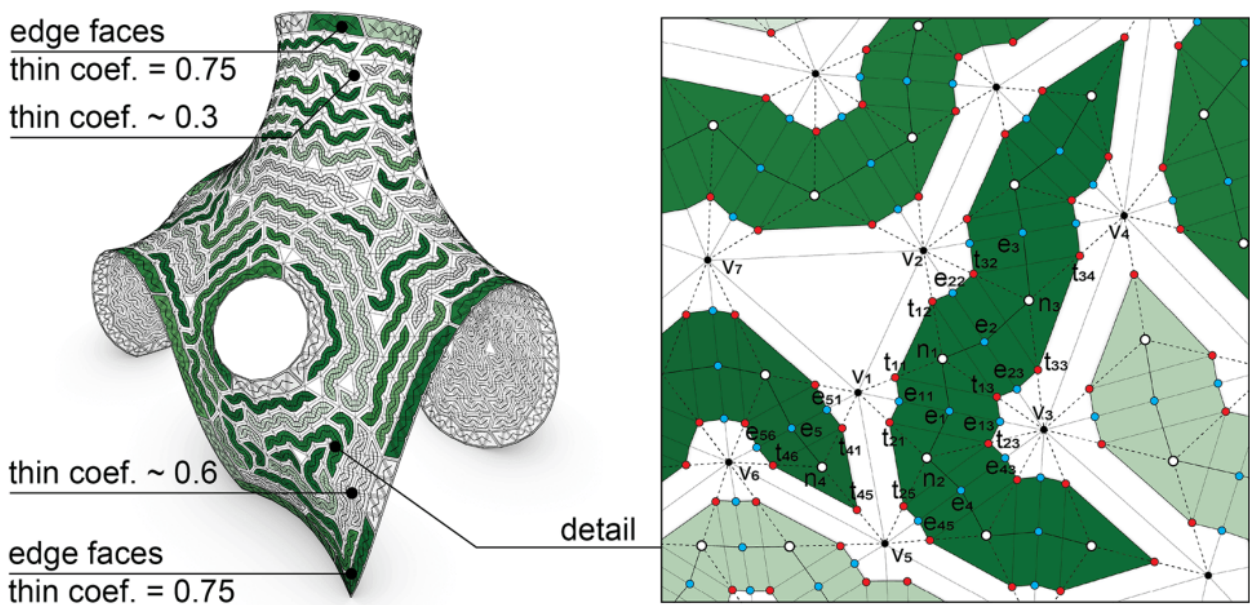


STRUCTURAL CONCEPT & MATERIAL STRATEGY

The pavilion consists of a dual-layer aluminum shell, where each 1mm-

thick strip plays a specific structural role:

- The outer layer acts as a continuous load-bearing membrane, handling axial forces while also serving as a smooth projection surface for digital art.
- The inner layer, designed with a more sparse, organic pattern, resists bending and shear forces, reinforcing the overall structure.
- A series of bridging elements were introduced in the inner layer to mitigate possible bending deformations parallel to the thinned strips



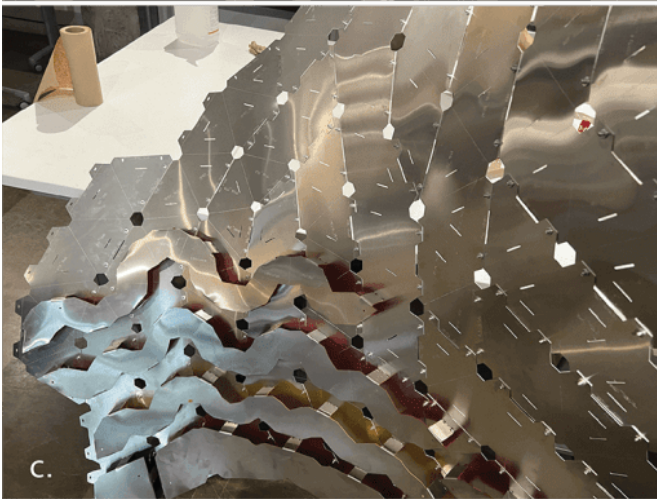
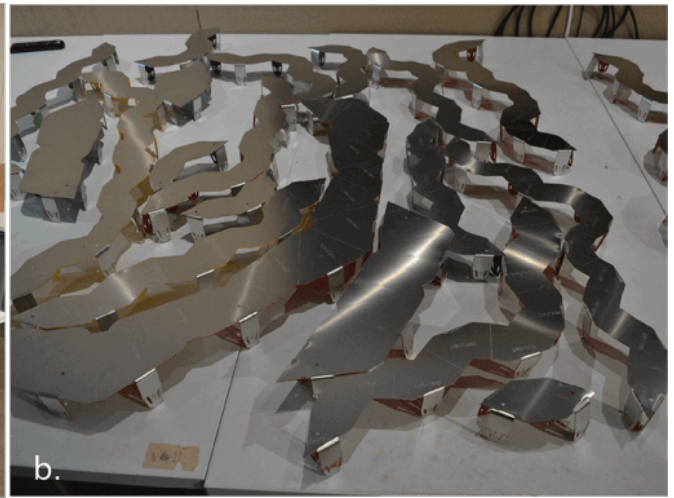
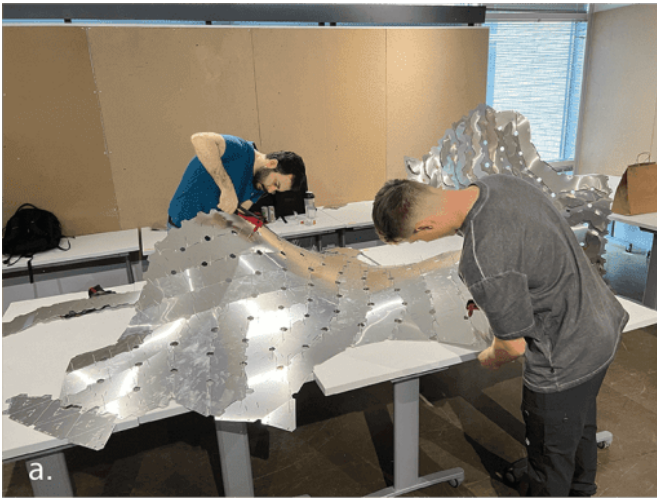
The outer layer's segmentation follows principal stress paths, achieved using mesh-flow algorithms and the Grasshopper add-on [Ivy](#). Meanwhile, the inner layer was optimized using a combination of Ivy (the Grasshopper add-on) and an orange-peel segmentation algorithm to create concentric structural patterns

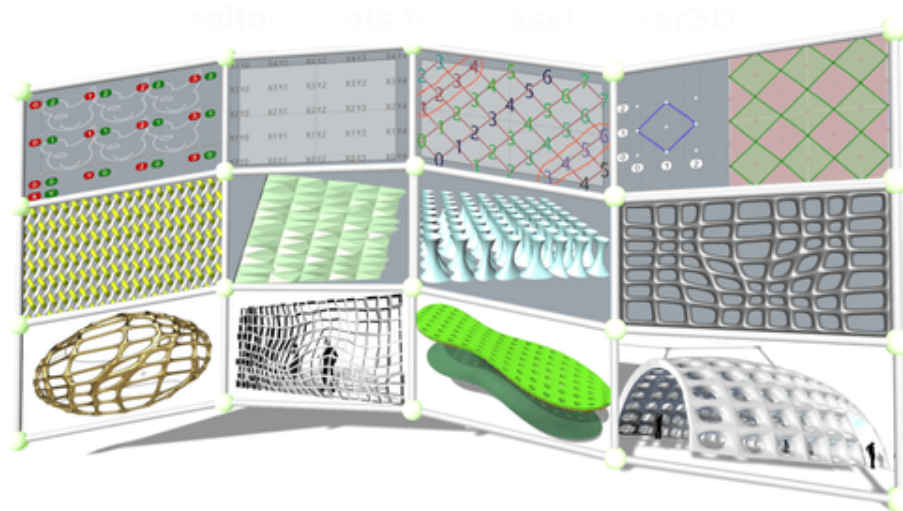
FABRICATION & ASSEMBLY

Designed for rapid, manual assembly, the pavilion was divided into 12 independent sectors, each fabricated and pre-assembled separately. The aluminum strips were laser-cut, ensuring tight tolerances for the innovative snap-fit interlocking system, which allowed tool-free

assembly and minimized fabrication complexity. The process followed three key steps:

1. Outer Layer Assembly – Aluminum strips were riveted together to form the continuous shell.
2. Inner Layer Integration – Connectors were folded, and the inner layer was attached.
3. Bridging Elements Addition – Additional reinforcement was introduced to increase stiffness.





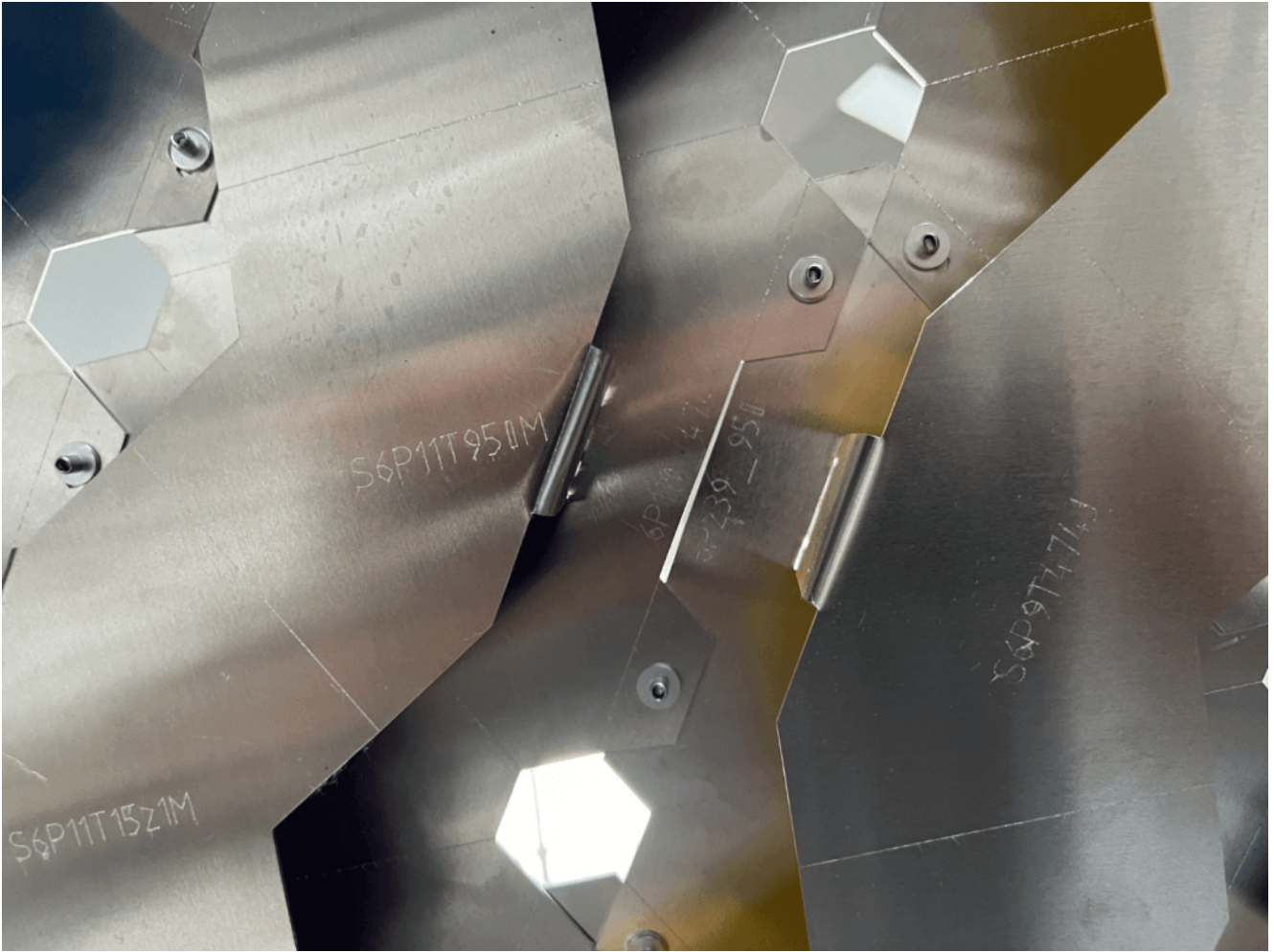
[See Also](#)

[PANELING TOOLS FOR GRASSHOPPER](#)

STRUCTURAL PERFORMANCE & DIGITAL INTEGRATION

A finite element analysis (FEA) using [Karamba3D](#) demonstrated the significant advantages of the dual-layer shell over a single-layer structure. Under dead loads, a single-layer shell exhibited 12 cm of deflection, whereas the dual-layer system reduced deflections to just 0.3 cm, proving its superior stiffness and structural integrity.

Future research will focus on enhancing connection stiffness, refining inter-layer spacing, and implementing genetic algorithms to further optimize segmentation based on structural performance.



BEYOND STRUCTURE: SEATING & DIGITAL INTEGRATION

The pavilion includes a custom seating system that complements the shell. This system consists of steel rod networks with 3D-printed nodes and robotically milled double-curvature foam cushions. These ergonomic seats provide adaptable comfort and showcase hybrid digital fabrication techniques.

The pavilion also functions as a projection surface, reinforcing its role as an interactive digital arts venue. By bridging manual and digital fabrication techniques, the Cnidaria Pavilion redefines the possibilities of architectural skins, offering an efficient, scalable, and visually striking approach to structural design.



Interested readers can find out more from the [ACADIA paper](#).

CREDITS

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