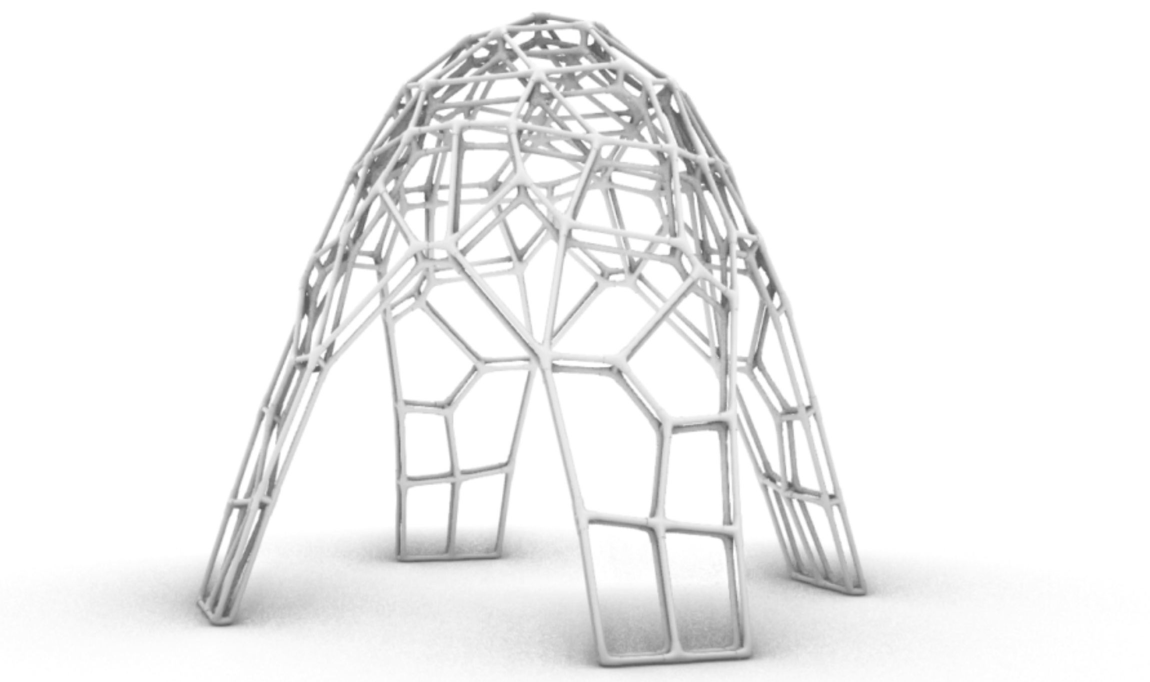
# From Form-Finding to Fabrication: Pabellón Generativo Michoacán

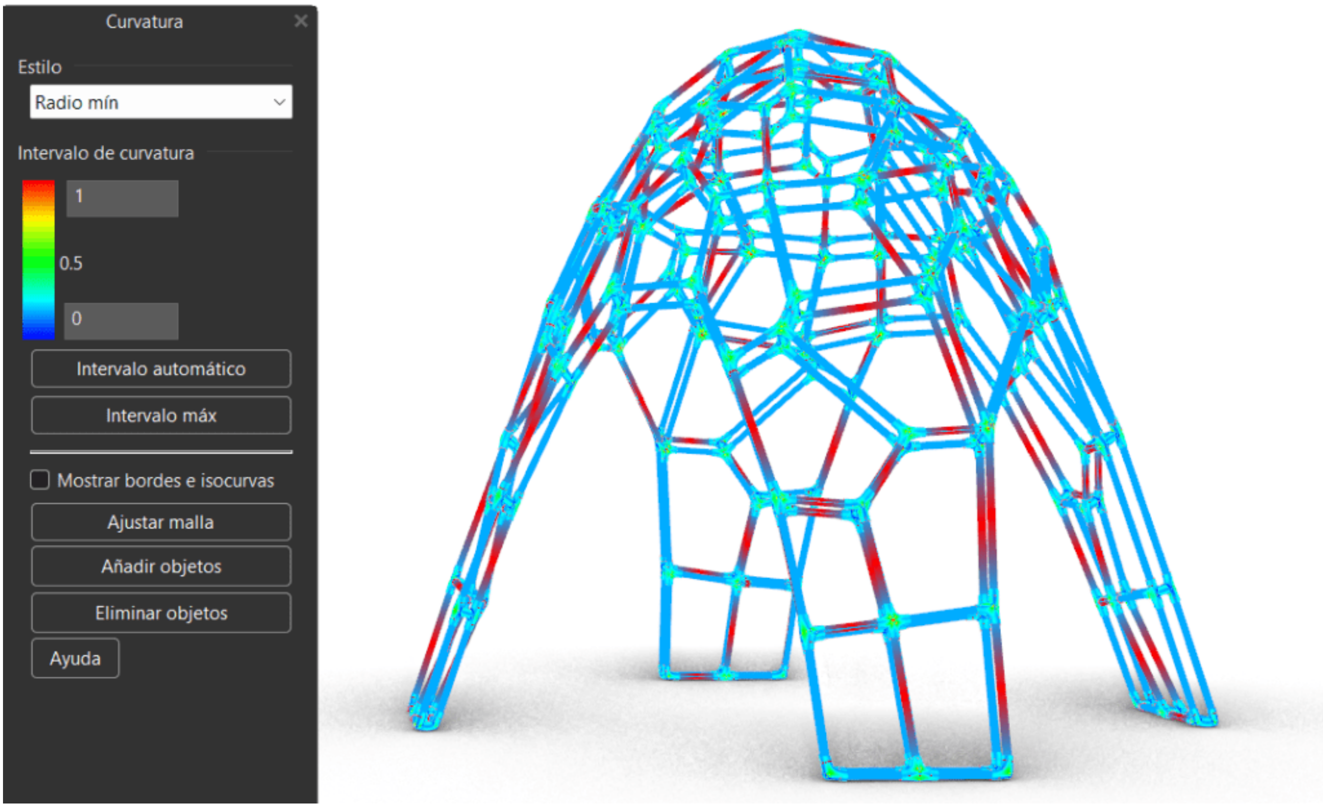
Located in Morelia, Mexico, *Pabellón Generativo Michoacán* explores the relationship between computational design, structural optimization, and digital fabrication through the construction of a fully realized parametric pavilion. Developed as part of the Master's Degree in Advanced Design at the Universidad Michoacana de San Nicolás de Hidalgo (UMSNH), the project investigates how generative systems can move beyond digital experimentation and become viable physical construction methods.



*Digital rendering of the pavilion geometry generated through form-finding and Voronoi-based structural subdivision.*

The pavilion was conceived through an advanced computational workflow centered around form-finding techniques and algorithmic segmentation. Rather than beginning with a predefined geometry, the design process started with a structural simulation intended to identify an efficient equilibrium form.

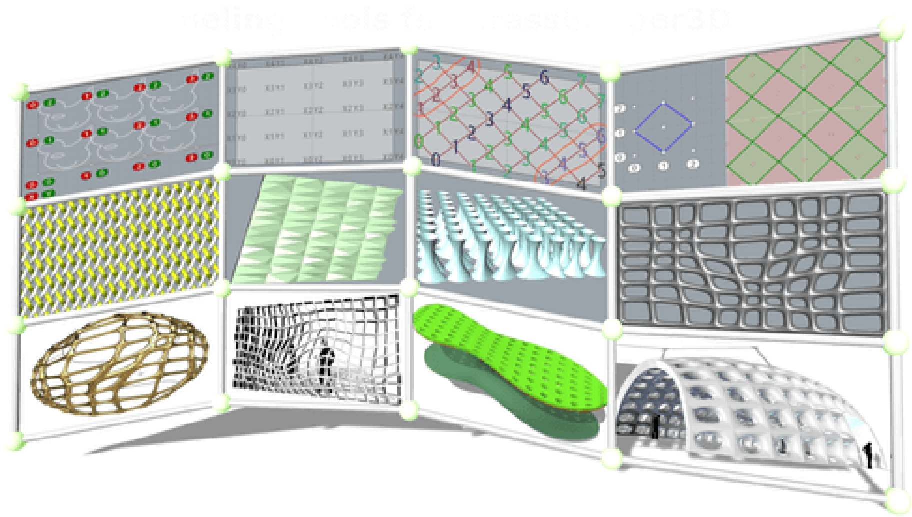
Using Rhino 8 and Grasshopper, the team developed a dynamic relaxation system with [Kangaroo2]() to simulate the behavior of a mesh surface under gravitational and vector-based forces. The resulting geometry followed the logic of an inverted catenary, allowing the structure to work primarily in compression while reducing bending stresses across the system.




*Curvature analysis and structural evaluation of the pavilion geometry within the digital modeling environment.*

Once the global geometry was established, the pavilion surface was subdivided using a Voronoi-based generative algorithm. Instead of relying on traditional topological subdivision methods, the project explored self-organizing geometric logic to generate the structural network. Point density across the surface varied according to structural behavior, producing differentiated Voronoi cells that responded to local conditions within the pavilion.

From these cells, the structural vectors of the pavilion were extracted. Each segment was calibrated according to the dimensional limitations of the available construction material, creating a direct relationship between the digital model and fabrication constraints. This stage became fundamental in transforming the generative geometry into a physically constructible system.



## See Also

**PANELING TOOLS FOR GRASSHOPPER**

Grasshopper functioned not only as a modeling environment, but as the central engine for the pavilion’s structural and fabrication logic. Additional plugins, including Kangaroo2, LunchBox, and Wasp were integrated into the workflow to manage physical simulation, data organization, and aggregation strategies throughout the project.

The computational process automated several critical operations, including generating unique connection nodes, vector orientations, insertion angles, and assembly tolerances.


*3D printing process of a custom PETG connection node* *fabricated through FDM printing for the pavilion’s structural assembly system.*

A total of 108 double nodes were generated parametrically to accommodate the exact angular conditions of the pavilion’s structural vectors. Each node was customized according to its position within the network and fabricated through FDM 3D printing, using PETG filament. Because PETG presented greater thermal deformation and adhesion challenges than standard PLA, the fabrication process required multiple rounds of calibration and environmental control before achieving reliable results.

The orientation of each print was also optimized to improve resistance against tensile and shear stresses generated during assembly. More than 27 kilograms of PETG filament were consumed during production.

The structural vectors themselves were constructed from recycled 1-inch CPVC hydraulic pipes collected from nearby construction waste. Following principles of circular economy and material reuse, the pipes were cleaned, sanded, classified, and cut according to the dimensions extracted directly from the digital model. The project intentionally avoided adhesive-based assembly methods, relying instead on pressure-fit and mechanical insertion systems that would allow future disassembly and recycling of the components.

*On-site assembly process of the pavilion structure using recycled CPVC vectors and custom 3D-printed nodes.*

One of the project's main technical challenges emerged during fabrication and on-site assembly. Due to the large number of unique geometries and the precision required between printed nodes and CPVC vectors, even small tolerance deviations generated significant stresses during installation.

Some nodes fractured during assembly because the insertion clearances were tighter than expected once material behavior and fabrication inconsistencies were introduced at full scale.

To address this, the team incorporated conical internal cavities within the node geometry to absorb minor diameter variations in the recycled CPVC pipes. A 2 mm tolerance gap between node and tube was also calculated to improve the assembly process. In parallel, a digital labeling and coordinate-based assembly system was developed to organize both nodes and vectors during construction.

*Interior view of the built pavilion showing the spatial density and connectivity of the double-mesh structural network.*

Despite local failures during installation, the pavilion demonstrated an important structural characteristic: the redundancy of the double-mesh geometry redistributed loads effectively across the network, preserving the overall rigidity and stability even after individual component fractures.

Beyond its final geometry, the project became a practical investigation into the relationship between digital precision and real-world material behavior. The experience highlighted the importance of prototyping tolerances early in the design process, especially when combining rigid 3D-printed components with industrially manufactured extruded materials.

*Final built view of Pabellón Generativo Michoacán installed at full scale.*

The pavilion was successfully constructed with the participation of first-year students from the Master's Degree in Advanced Design at UMSNH and currently remains installed at the Faculty of Architecture in Morelia as a full-scale prototype for computational design and sustainable construction research.

# CREDITS

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