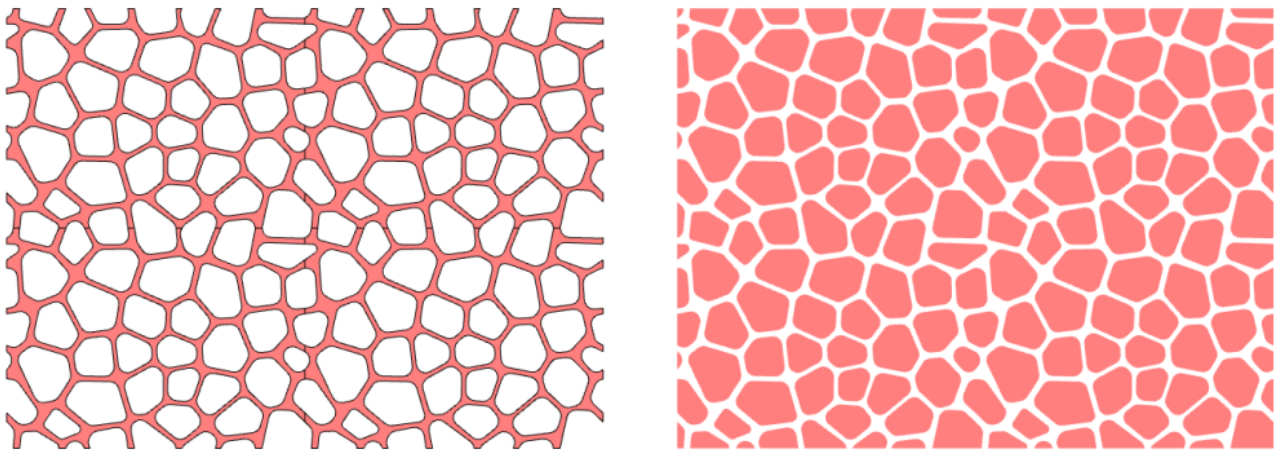


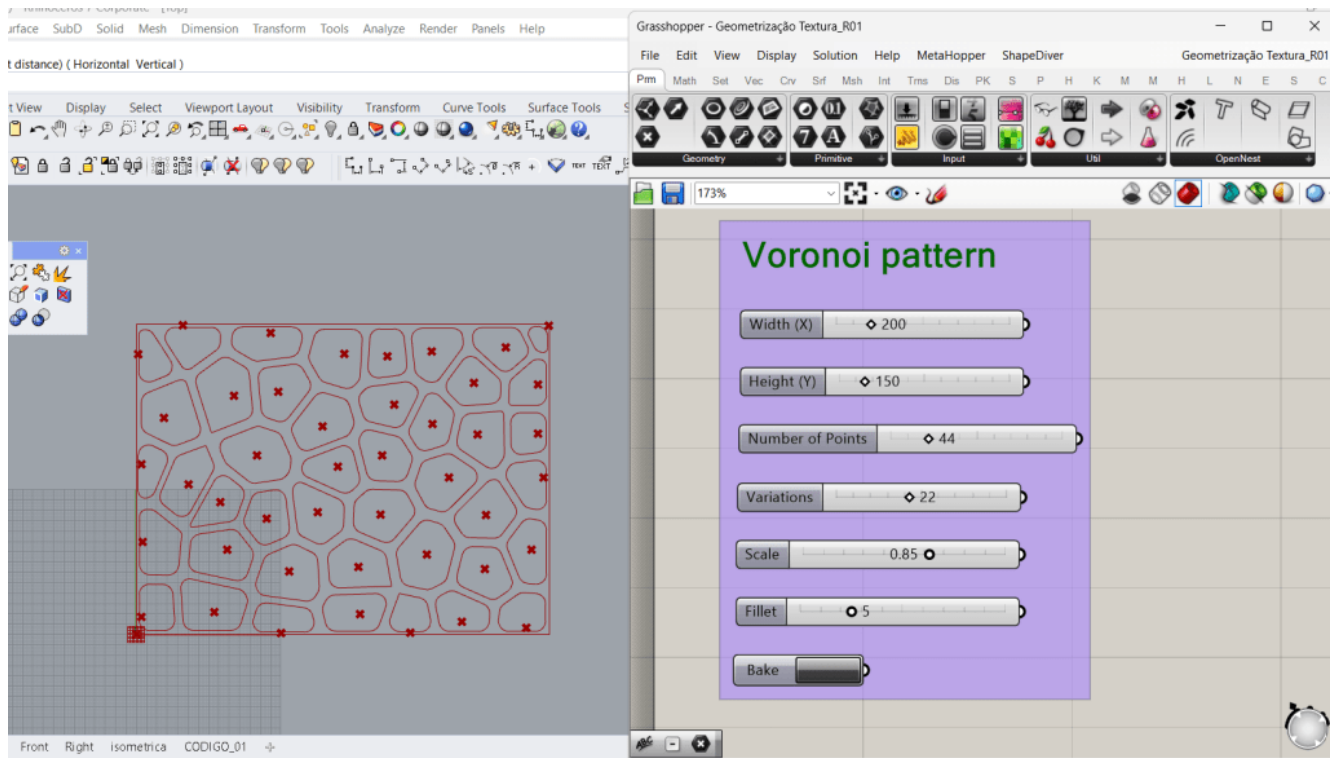
Scaling Nature: From Biomimetic Patterns to Furniture Design

Not every script is born to solve a single project. Some begin as exploratory studies and, over time, reveal possibilities that go far beyond their original intention. This was the case with a parametric definition developed by Ana Luisa Martins during the Biomimetic Design course at [Fatec Tatuapé – Victor Civita](#), where the aim was to investigate patterns found in nature and translate them into geometric systems capable of generating textures.



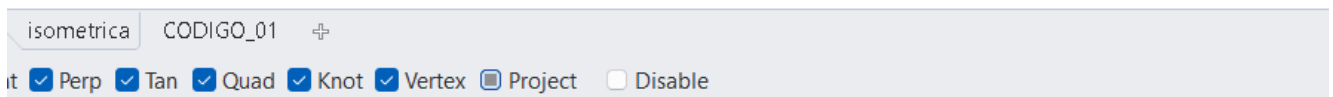
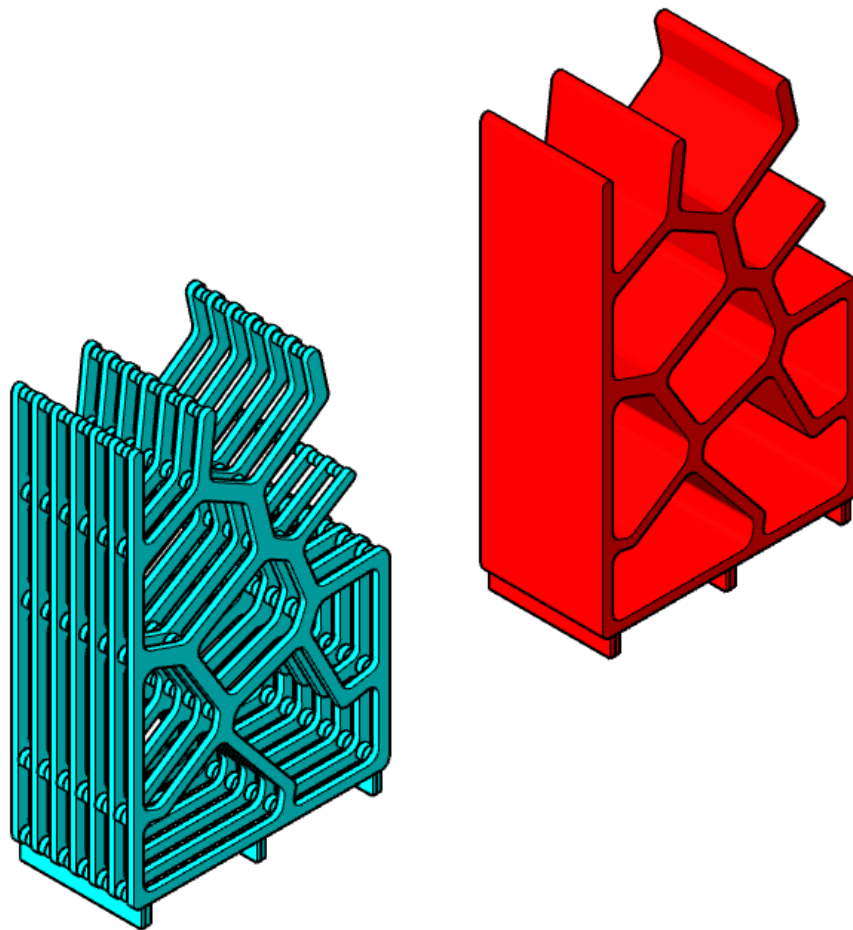
Final Voronoi texture showing openwork and filled tile variations generated from the same definition.

The research began with the observation of natural structures such as loofah fibers, bubbles, cracked soil, tortoise shells, giraffe skin, and other irregular cellular organizations. Rather than reproducing these forms literally, the project focused on understanding their underlying logic: porosity, non-uniform distribution, and organic variation.



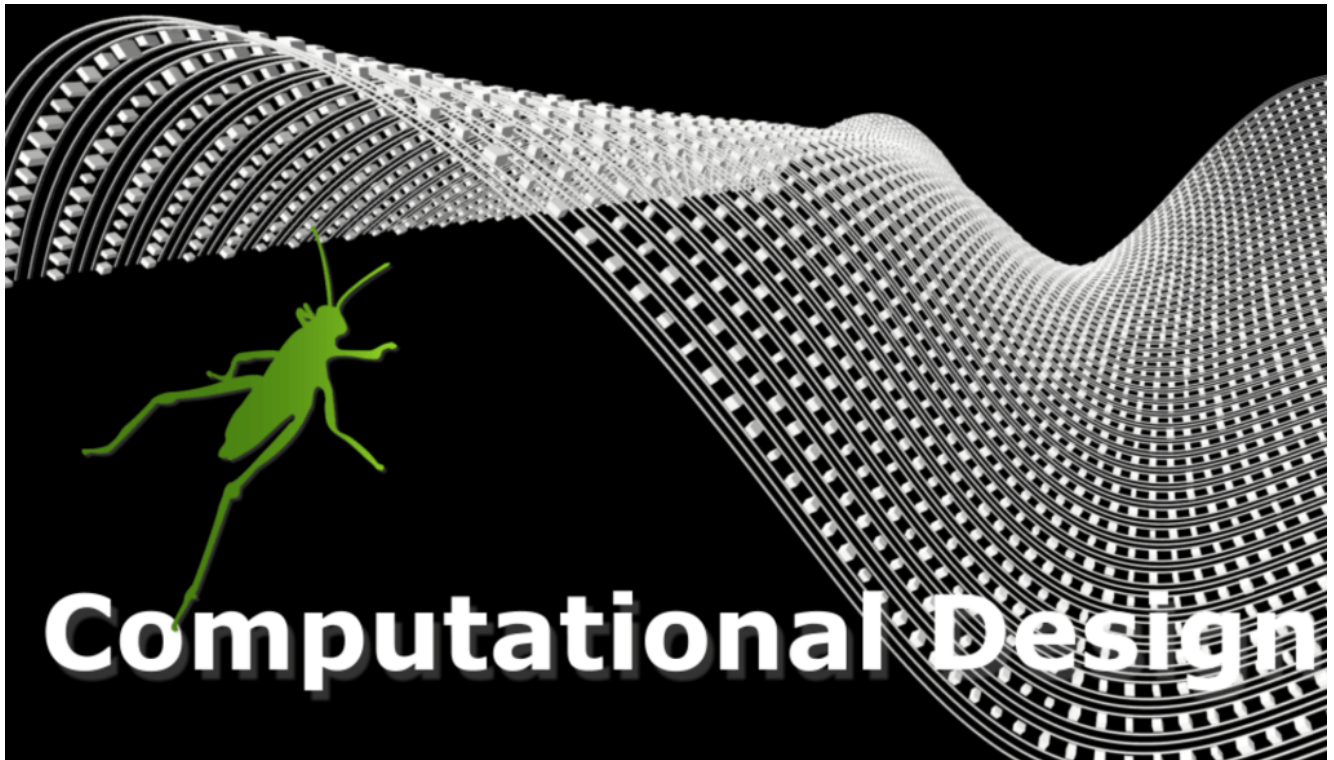
The adjustable parameters used to control the Voronoi pattern.

Using [Rhino](#) and [Grasshopper](#), Ana Luisa developed a parametric definition based on the Voronoi diagram. A Voronoi pattern divides a space into regions according to their distance from a set of seed points, generating irregular polygonal cells that can resemble cellular structures, crack patterns, or natural growth distributions.



Comparison between the 3D-printed prototype version and the CNC-ready production file.

The Grasshopper workflow was intentionally simple and adaptable. The script begins by defining the panel boundary, then generates the Voronoi cells from a distribution of points. These cells are scaled to create the profiles between the openings, softened through fillets, and finally baked into Rhino for further editing. The main adjustable parameters include the panel dimensions, number of points, randomness of the point distribution, scaling factor, and fillet radius.

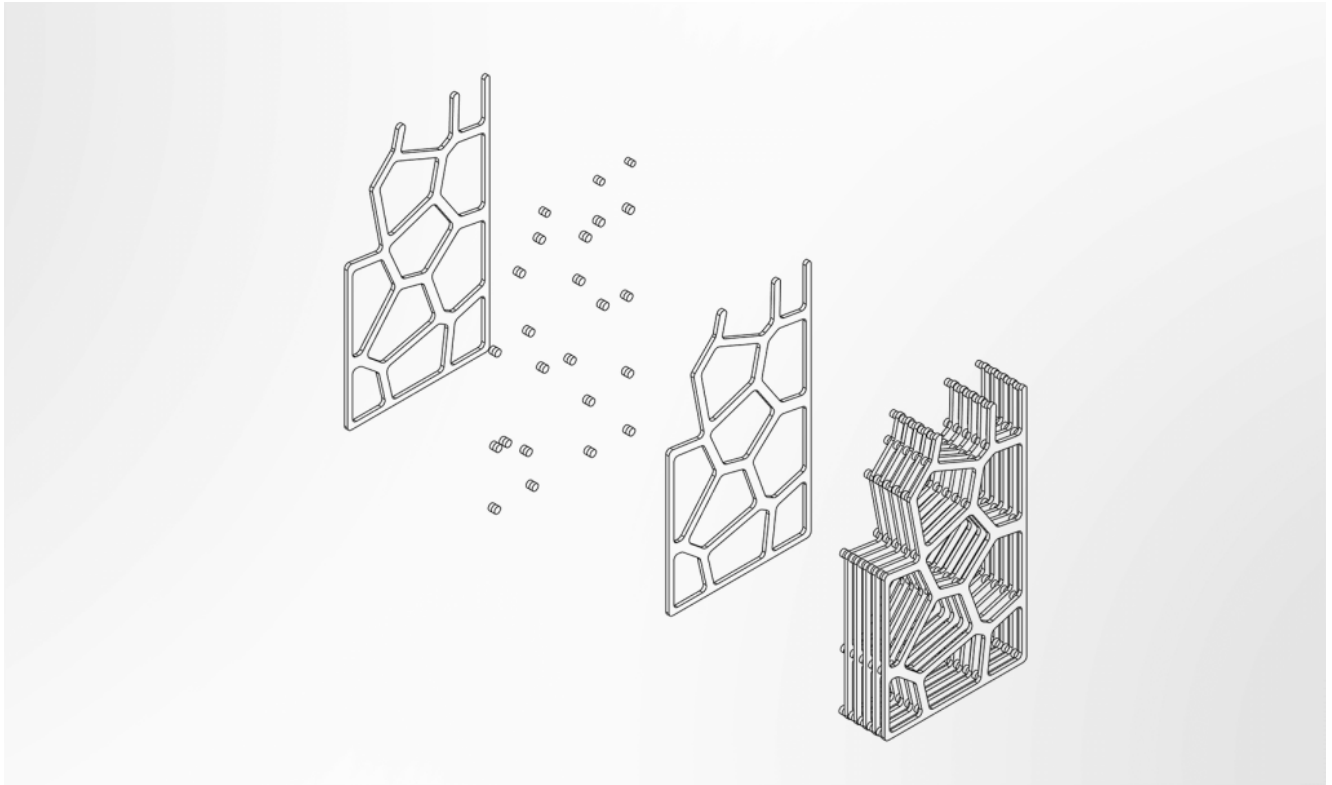


[See Also](#)

[COMPUTATIONAL DESIGN WITH GRASSHOPPER](#)

At first, the system was conceived as a microtexture generator. The pattern could be developed as a vector tile, adapted into a seamless rapport, and applied to surfaces such as fabrics, panels, tiles, and light fixtures.

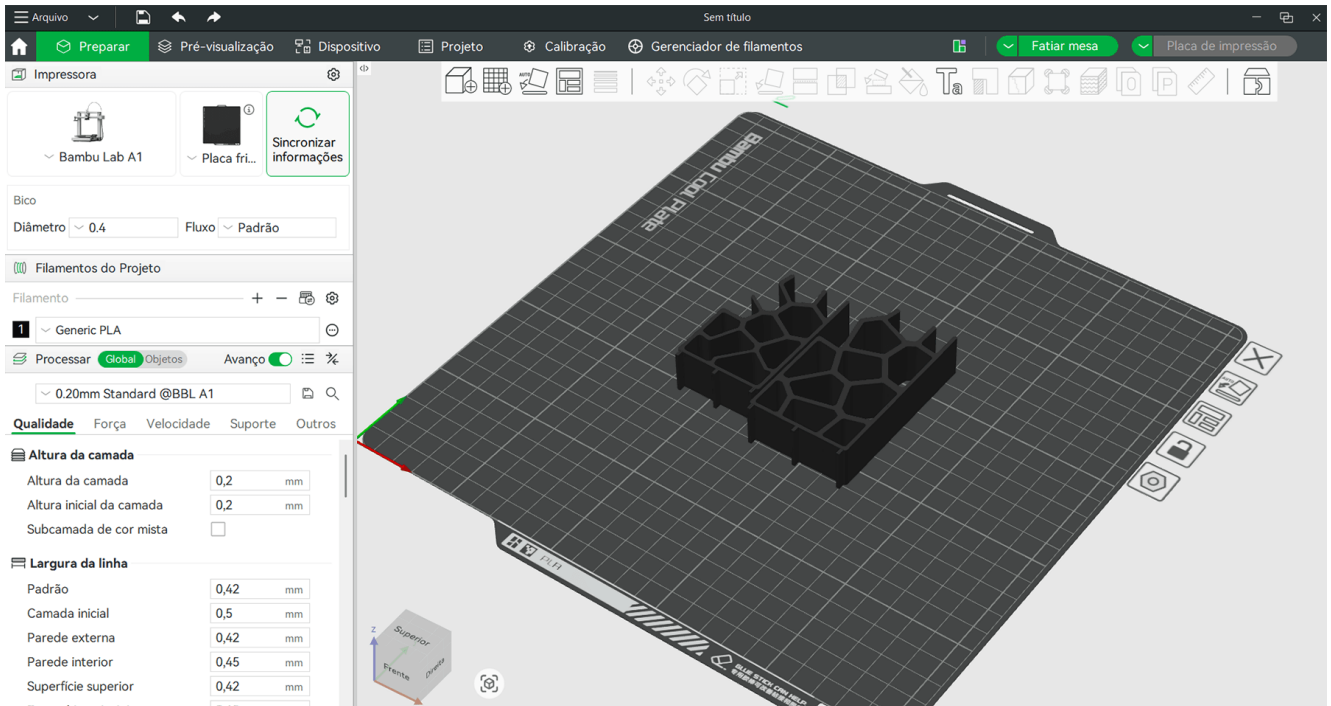
In this stage, one of the main challenges was maintaining continuity between the cells so that the base vector could repeat seamlessly across a larger surface. This adjustment was completed directly in Rhino after baking the Grasshopper geometry.



Exploded view showing the panels, spacers, and assembly logic of the shelf.

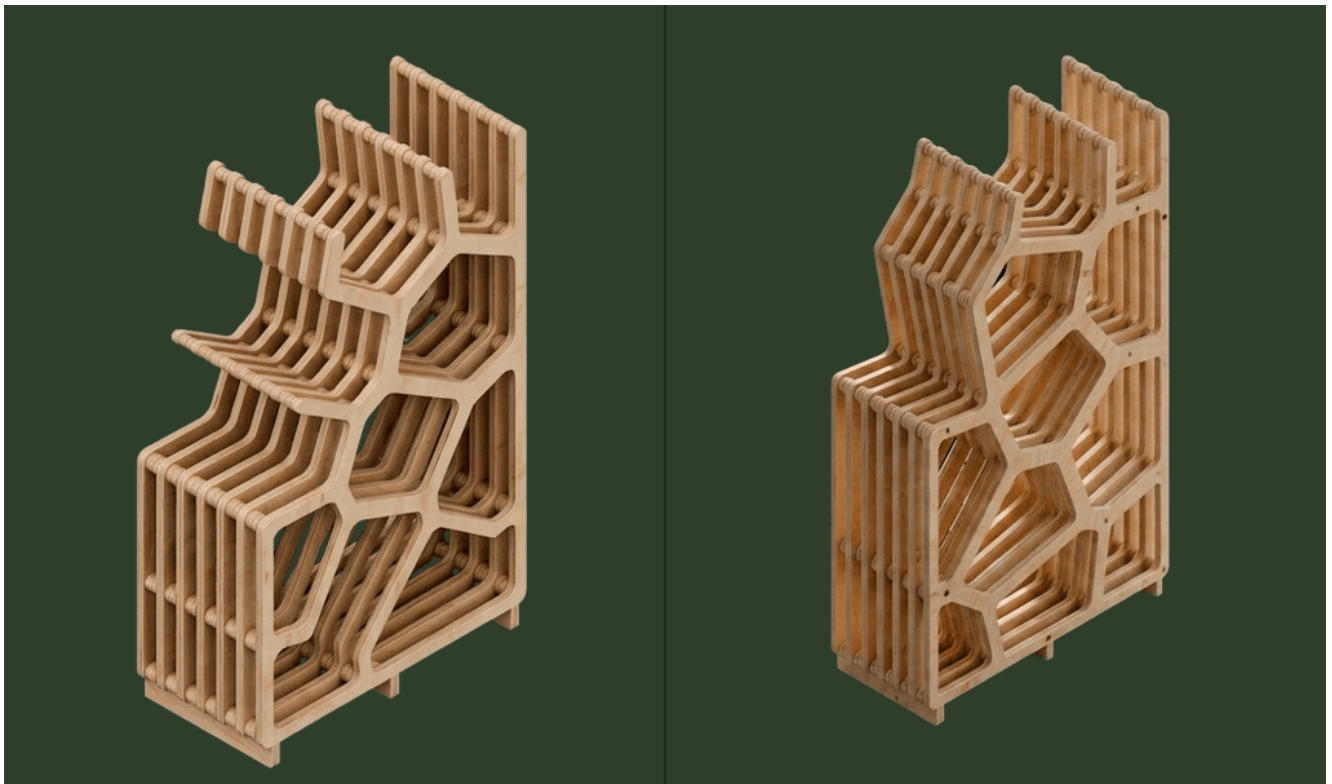
However, the most interesting development came when the same definition was reinterpreted on a much larger scale. In a later undergraduate project—a backpack and shoe storage shelf—the Voronoi logic was used to generate the geometry of a repeated side module. This gave the furniture both depth and a distinct visual identity. What had started as a microtexture began to operate as a structural and compositional element.

This shift in scale introduced a new set of fabrication constraints. Since the shelf was conceived with CNC milling in mind, the geometry had to respond not only to visual criteria but also to machinability, material strength, and structural stability. Minimum thicknesses were adjusted, fragile regions were removed, and the balance between openwork and rigidity became central to the design process.



FDM 3D printing preparation of the shelving prototype in the slicer software.

For the furniture application, fewer seed points were used to create larger openings suitable for storing backpacks and shoes. At the same time, the scaling factor was increased to create a stronger structural frame. The final design also considered the use of threaded rods and circular spacers to increase the rigidity of the piece, a construction strategy previously explored in other parametric bench projects.



Two shelf variations generated from the same parametric Voronoi logic.

Two versions of the shelving unit were developed: one optimized for FDM 3D printing to simplify prototype production, and another prepared for CNC machining, showing the structural profiles and circular spacers through which the threaded rods would pass in the final manufactured piece.

Through this process, the project demonstrates one of the strongest qualities of parametric modeling: the ability to create systems that can evolve. Instead of producing a fixed form, the Grasshopper definition became a flexible design logic, capable of moving from texture to product, from surface to structure, and from academic experimentation to fabrication-oriented design.

CREDITS

Project: From Texture to Furniture: The Evolution of a Parametric Definition

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Institution: Fatec Tatuapé – Victor Civita

Course: Biomimetic Design

Image Credits: Ana Luisa Martins