Fabricating Bilayer Surfaces using Variational Surface Cutting

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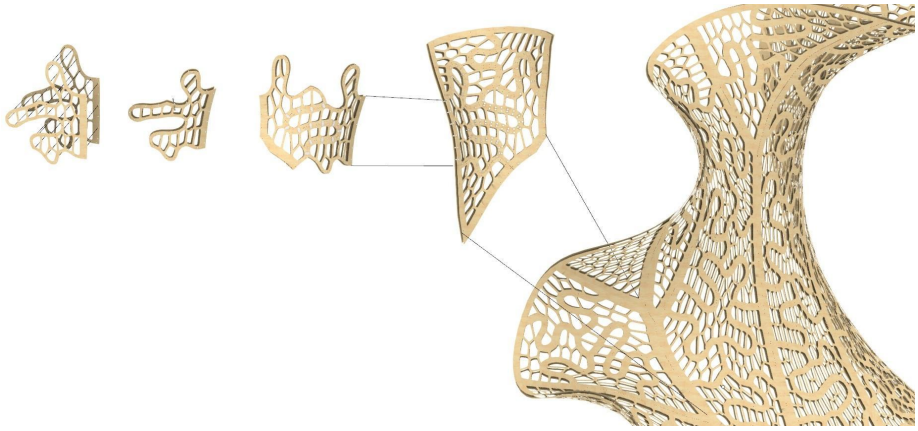

Figure 1: Diagram of panel assembly for sculpture

We present a method for constructing arbitrary smooth surfaces from flat panels. Unlike other methods, we do not break the surface down into precisely developable panels. Instead, we use the variable surface cutting technique from Sharp[1] to optimize panels until they are flattenable to within some tolerance of area distortion. The flattened panels are then fabricated with precise alignment holes and connected with rivets. The panel shapes and alignments are used to reconstruct the surface without the need for any additional instructions or formwork. We employ this method to make a series of lamps and sculptures from wood veneer and thin plywood

Flattening alone only captures intrinsic geometry, therefore it cannot be used to reconstruct arbitrary surfaces. For instance, an arch only has mean curvature and no gaussian curvature, so this method would just produce a flat sheet. In order to capture extrinsic curvature, we add a bilayer construction. After optimizing our panels, we offset them normal to the surface by a small distance, creating an inner and outer pair of panels. The panels are then flattened after offset. The difference between inner and outer panels now encodes the total curvature of the surface. We add alignment holes both between inner and outer panels as well as neighboring panels.

Additionally, we add perforations to the panels to account for the fact that they are not precisely developable. This adds a necessary amount of flexibility to the panels to feasibly assemble them. Conceptually, we think of this as pushing the excess curvature into the holes of the perforations. The error left from flattening the panels is allowed to relax into the void spaces.

Figure 2: A sphere or gyroid can be constructed with a single layer since the surface is entirely intrinsic

REFERENCES

[1] Sharp, Nicholas and Crane, Keenan. 2018. Variational Surface Cutting. ACM Transactions on Graphics 37-4. New York, NY