Patterns to Volume: Drawing for Fabrication in Expanded Surfaces

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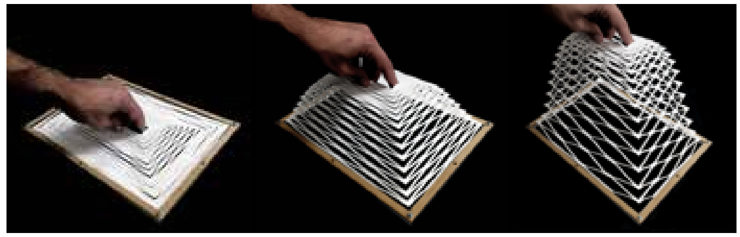
Digital modeling and parametric software make it fairly easy to design complex forms, which often need to be re-engineered for manufacturing, or at the very least translated into a suitable format such as cut sheets or G-code. This research takes a different approach, investigating how two-dimensional drawing and patterning techniques can directly translate to the manufacturing of highly variable volumetric surfaces. Expanded metal surfaces, which use a pattern of offset slits to produce a rigid and permeable sheet with zero material waste, provides a precedent for this work. Parametric software is used to control a series of 2D geometric variables, which collectively choreograph the intricate reactions that give form and structure to the material. The final form is highly dependent on the amount and direction of force applied to the cut sheet, allowing for a high degree of variability even with standardized parts. This workflow attempts to blur the boundary between representation, fabrication, and customization as acts of design.

PATTERN-TO-VOLUME

DRAWING FOR FABRICATION IN EXPANDED SURFACES

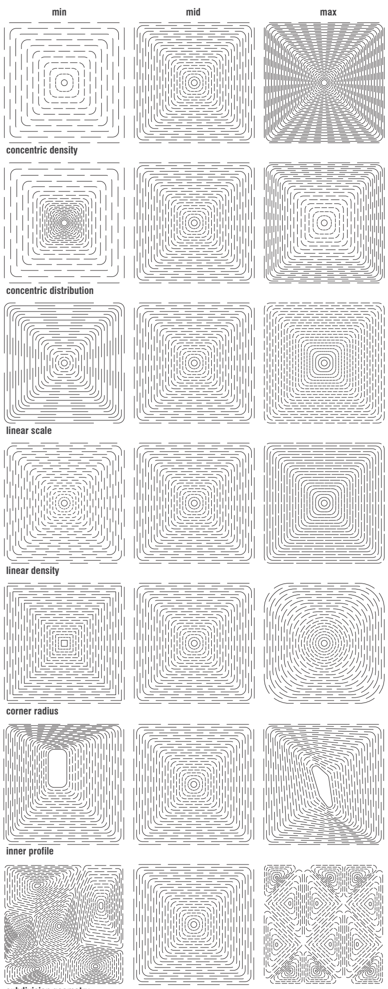
Digital modeling and parametric software make it fairly easy to design complex forms, which often need to be re-engineered for manufacturing, or at the very least translated into a suitable format such as cut sheets or G-code. This research takes a different approach, investigating how two-dimensional drawing and patterning techniques can directly translate to the manufacturing of highly variable volumetric surfaces. Expanded metal surfaces, which use a pattern of offset slits to produce a rigid and permeable sheet with zero material waste, provides a precedent for this work. Parametric software is used to control a series of 2D geometric variables, which collectively choreograph the intricate reactions that give form and structure to the material. The final form is highly dependent on the amount and direction of force applied to the cut sheet, allowing for a high degree of variability even with standardized parts. This workflow attempts to blur the boundary between representation, fabrication, and customization as acts of design.

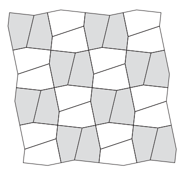


VOLUMETRIC EXPANSION

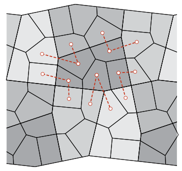
The cut sheet is secured within the Expand-O-Matic™ frame, and force is applied at a single point. As force is distributed through the material network, they undergo plastic deformation at predetermined locations, giving the sheet substantial rigidity and a semi-permanent form. A surface may be expanded to create either concave or convex volumes, which capture and reflect light differently. A single 2D cut pattern can yield a wide range of volumes and light conditions, depending on the amount and direction of force applied.

patterning variable matrix

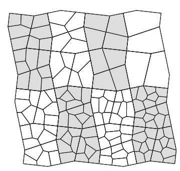




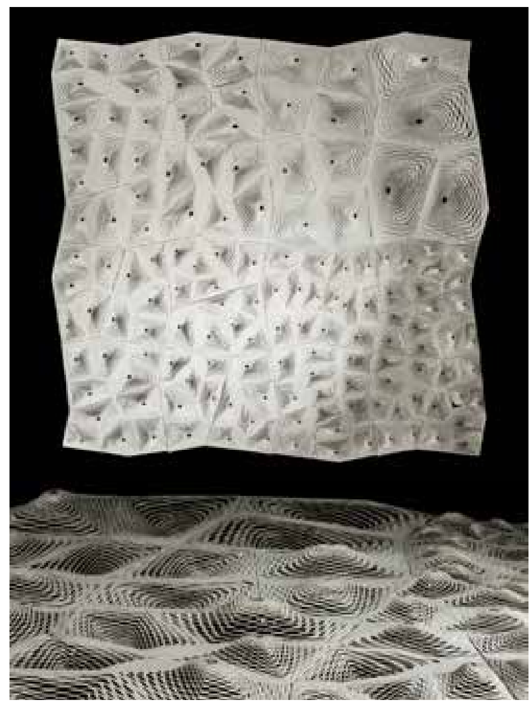
A single repeating panel is tiled through rotational and reflectional symmetry. This assembly uses a modified Cairo pentagonal tiling.



Panels are subdivided to maintain continuity at panel joints throughout panel rotation and reflection.

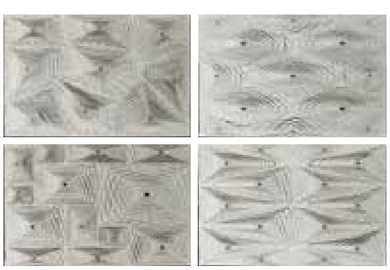


In the assembly shown at right, panels incrementally progress from a single subdivision to eight.



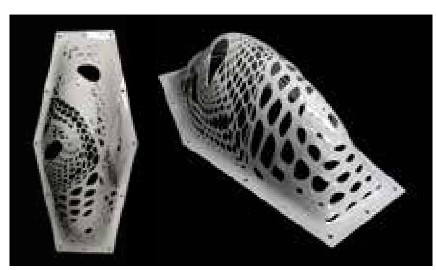
TESSELLATION AND PANELIZATION

Tessellation is used at the scale of a single surface and at the scale of a modular assembly, to minimize the perception of panelization and repetition, instead creating an impression of continuity and variation. Parametric software is used to test combinations of panel geometry and subdivision geometry, finding combinations that use rotational and reflectional symmetries to create alignments across panel joints. While panel and subdivision variation is possible, a single standardized component maximizes efficiency of manufacturing.



2D PATTERNING

Several patterning variables are parametrically controlled using Grasshopper and laser cut, allowing for rapid iteration and testing. For each variable, minimum and maximum values are found that can be successfully expanded; producing a range of volumetric possibilities.



MATERIAL APPLICATIONS

These concepts and processes are being applied to a range of materials. The process of expanding light gauge aluminum is similar to that of paper, using a steel Expand-O-Matic™ frame and a two-ton gantry crane to create an expanded surface that can support hundreds of pounds with minimal deflection. PETG plastic can be heated and slump-formed, using gravitational force to create catenary forms with intricate tracery.