Mathematically defined surfaces are not new to architecture and engineering. Early surface geometer Antoine Gaudi was the first to use the hyperbolic parabola extensively to inform masonry construction. Twentieth century reinforced concrete pioneers exploited the possibilities of linear ruled geometries to stretch the limits of wood formwork. In addition many artist and sculptors from the Russian Constructivist Naum Gabo to the 60's screen patterns of Erwin Hauer explored similar constructions. By allowing easier and faster generation of formally complex surfaces than in previous analog methods, the current state of computation has liberated designers. The visualization and modeling of equation based surfaces in Mathematica enables a new architectural investigation into surfaces geometries based on the pure logic of mathematics that were previously unattainable.

Although the inherent beauty of the actual surfaces is a welcomed byproduct, more important to the architectural investigation is the topological characteristics of math surfaces. The relationships that emerge begin to suggest an organization at every scale of design. In architecture, this ranges from the macro which can be programmatic and structural organization of buildings to the micro of material and fabrication technique. The research occurs in three phases; the first deals with diagramming topological signatures of minimal surfaces by kaleidoscopic patching, the second focuses on specific architecture applications using minimal surfaces to organize program and structural performance (verified through nonlinear finite element analysis) and the third phase looks at fabrication possibilities that emerge from differential geometry and parametric modeling.

Parametrically-derived surfaces provide their own unique topological signatures of internal organization. These principles can be used to embed performance qualities inherent to the surface logic. The results of this research build on the rich history of surface logic in architecture suggesting new possibilities in contemporary architectural practice.

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