PROJECT

Top Heavy

ANDREW COLOPY
Rice University

Top Heavy is a set of model display pedestals designed for a school of architecture. Initiated to fulfill a practical need, the project serves as a modest examination into the limits of shape as an underlying construct and criteria with respect to a project's materialization. Shape in this context is understood as a discreet planar area or volume.[1] Such criteria formed the basis on which design decisions were structured and evaluated, establishing two initial parameters: where possible, the design would be made from plastic sheet materials and would be CNC-milled or laser-cut.

Each parameter was a means of restraining complexity and higher-order dimensionality. CNC fabrication ensured greater invariance and could be instrumentalized using principally 2D information. While sheet materials aided in restraining complexity and aligned with fabrication techniques, the choice of plastics also permitted economical, non-mechanical assemblies (less reliant on higher-dimensional tectonics) yet a wide range of aesthetic and performative material possibilities.

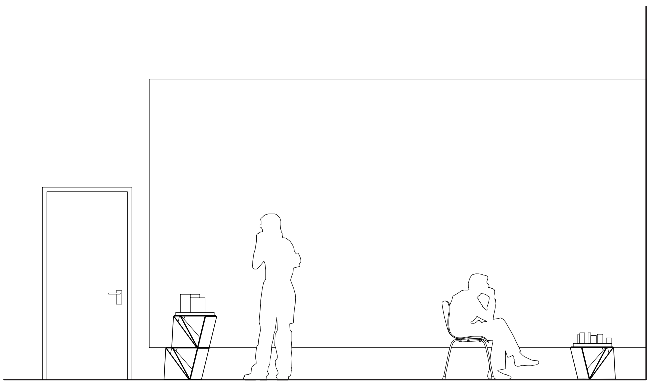

Figure 1. Elevation of pedestal in use. Image by author.

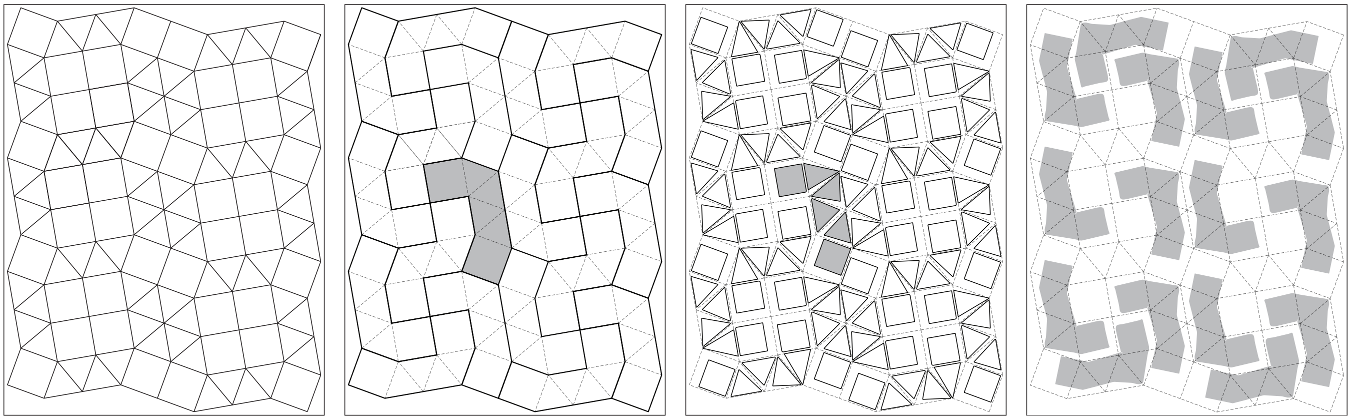

Figure 2. Final panel and interlayer shapes shown relative to the regular tesselation and selected subset . Image by author.

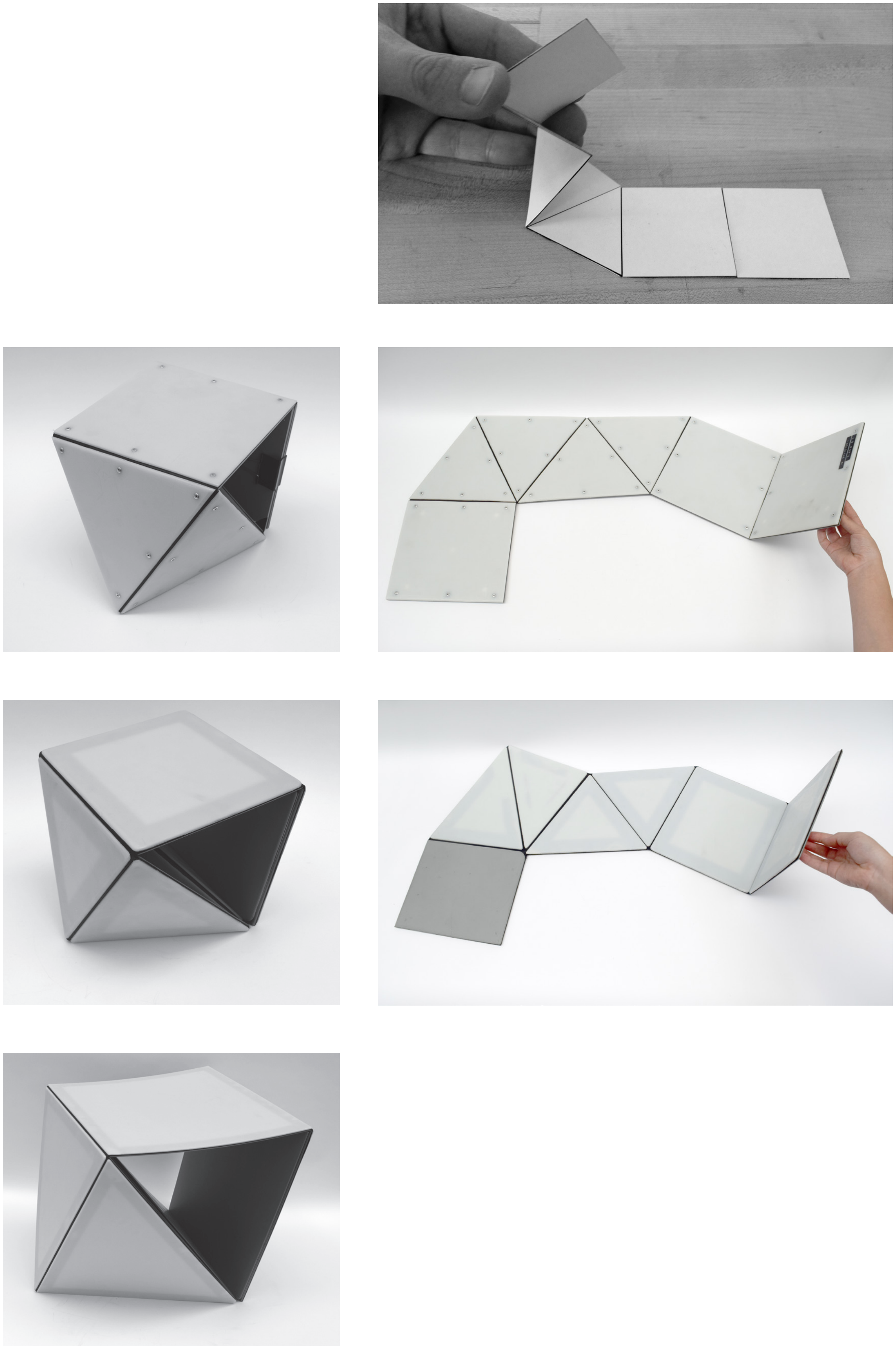

Figure 3. Iterative development of prototypes, including paper concept model (top), half-scale prototypes 1 and 3, and the first full-scale prototype. Image by author.

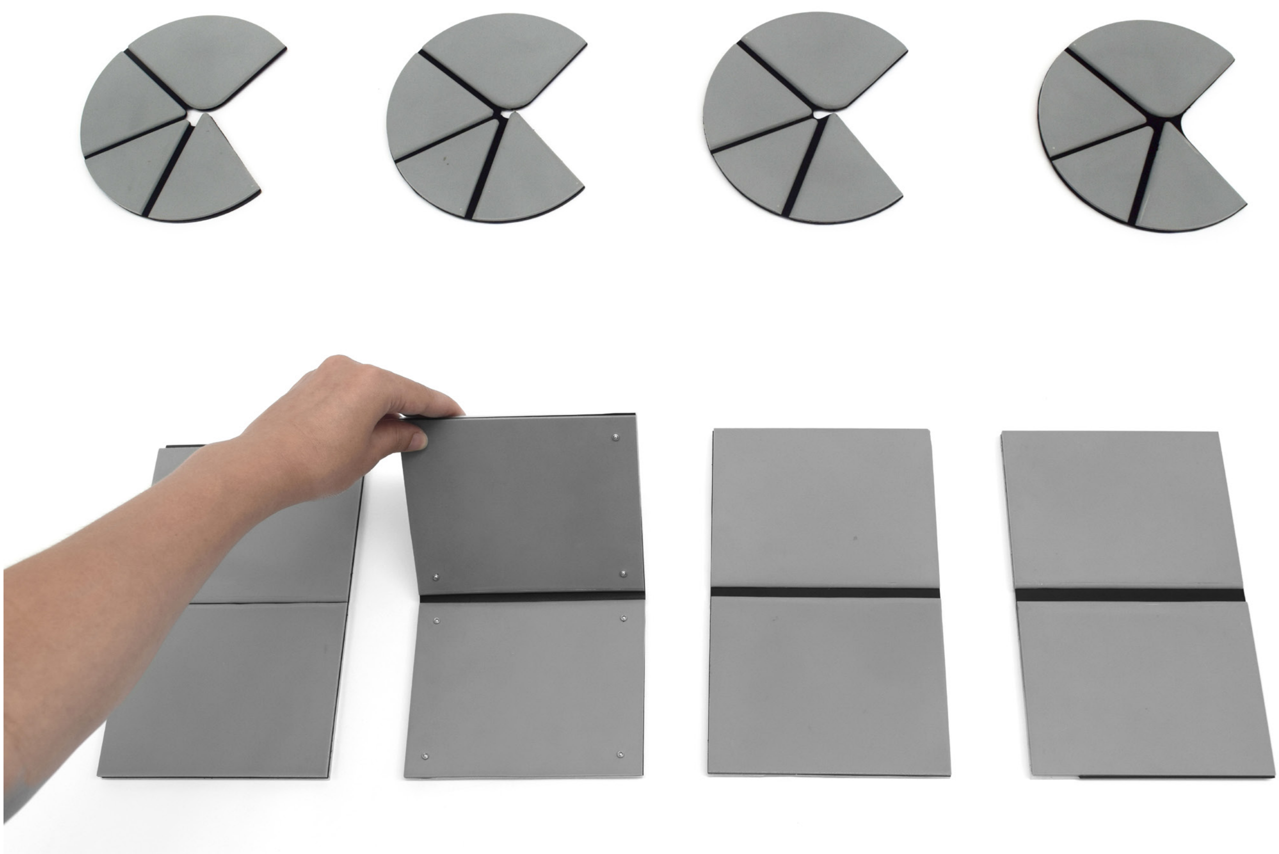

Figure 4. Linear and corner joint folding tests (HDPE, acrylic and neoprene). Image by author.

The design process began by testing various k-uniform tilings—regular planar tessellations—that presented objective, Euclidean shapes and the potential for near 100% sheet material efficiency in fabrication. A 2-uniform tiling of equilateral triangles and squares[2] was selected in which repeated groupings produced higher order tessellations that could be folded three-dimensionally into a desirable partial polyhedron, one with rectilinear geometry alone visible frontally and triangular geometry visible obliquely.

Once this geometric logic was established, the investigation began to address conditions of material, scale and fabrication. Initial paper study models were tested iteratively with full-scale joint tests, half scale and eventually full-scale prototypes using various plastic compositions. Throughout the process, the intention was to create an assembly that behaved much as the original paper models—that could fold and unfold, and flat-pack for storage. This tessellated logic of material efficiency was maintained to the greatest extent possible. Material thickness and other contingencies were accommodated through micro-adjustments to geometry with deviation of the regular shape and material inefficiency interpreted as the inability of shape to meet material and performative criteria.

The design makes use of a flexible interlayer structured by a rigid sequence of panels adhered to either side. Initial prototypes utilized a lamination of five different polymers: High-Density Polyethylene (HDPE), Nylon Cloth-Inserted Neoprene (itself a composite), Acrylic (grey), and 3M Adhesive Transfer Tape (a proprietary thermoplastic).

These early prototypes adhered closely to the regular geometry, using the inherent elastic quality of the Neoprene to permit folding at the joints. However, the material posed several challenges, it induced shear on the adhesive and produced an overly flexible (and heavy) assembly. Ultimately, a non-elastic, and light-weight ballistic nylon was used that required varying each rigid panel slightly to account for the relative angles between each in the final configuration to maintain a taut assembly. At this point, a means of visualizing and calculating such relationships also became necessary using a parametric model.

Through subsequent iterations, the rigid materials were also substituted, largely without changes to the geometry. The outer panels were replaced with a thicker, more rigid and UV stable marine-grade HDPE[3] to reduce deflection, increase opacity and prevent discoloration. Kydex[4] (a PVC-acrylic alloy), lighter in weight, less brittle and more scratch resistant, was also substituted for the inside lamination of grey acrylic. Their respective thicknesses were also modified for improved structural performance.

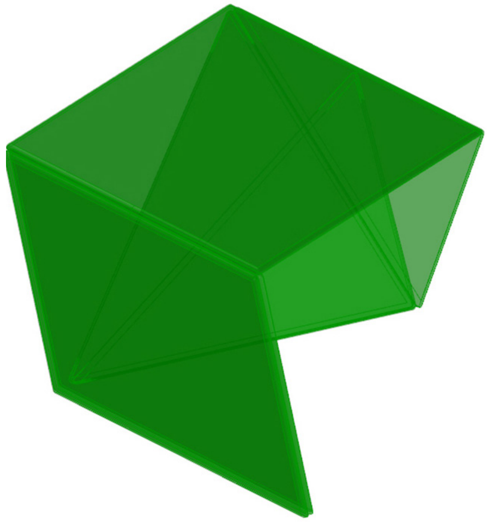

Figure 5. Screen capture of Grasshopper model used to parametrically model joints. Image by author.

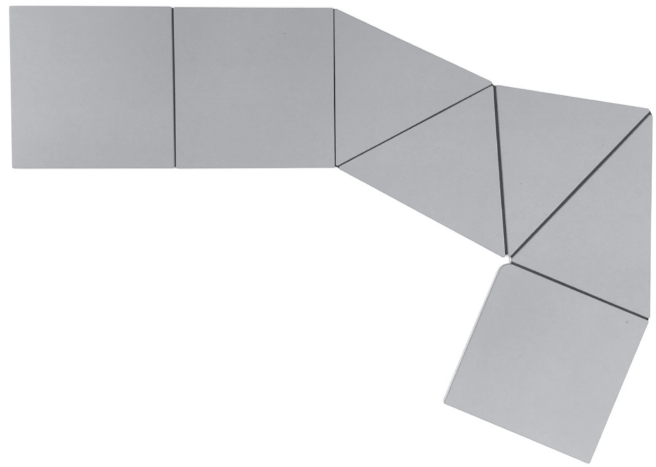

Figure 6. Prototype 5 with parametric joints unfolded. Image by author.

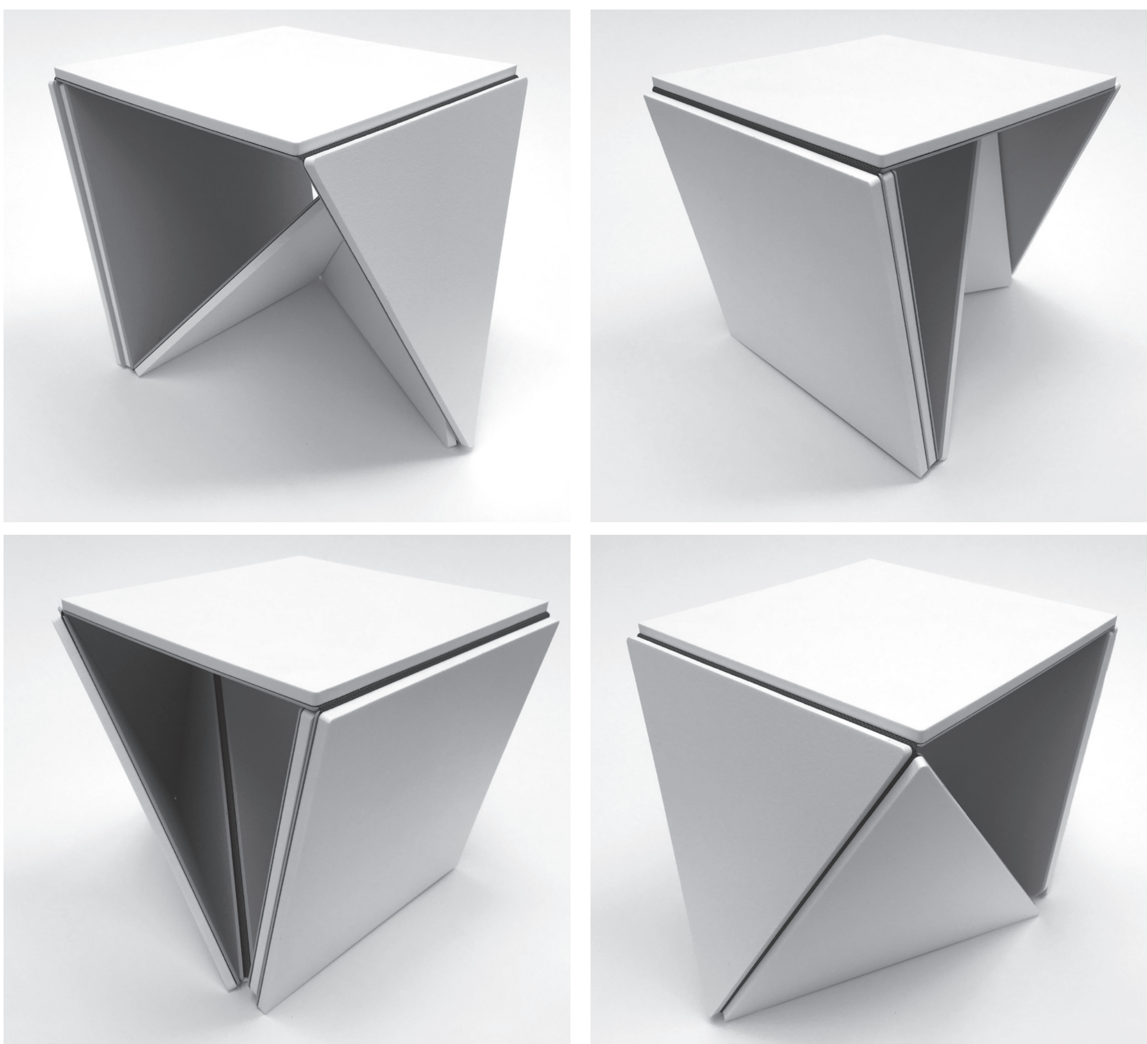

Figure 7. Final half-scale prototype (5) from four vantage points. Image by author.

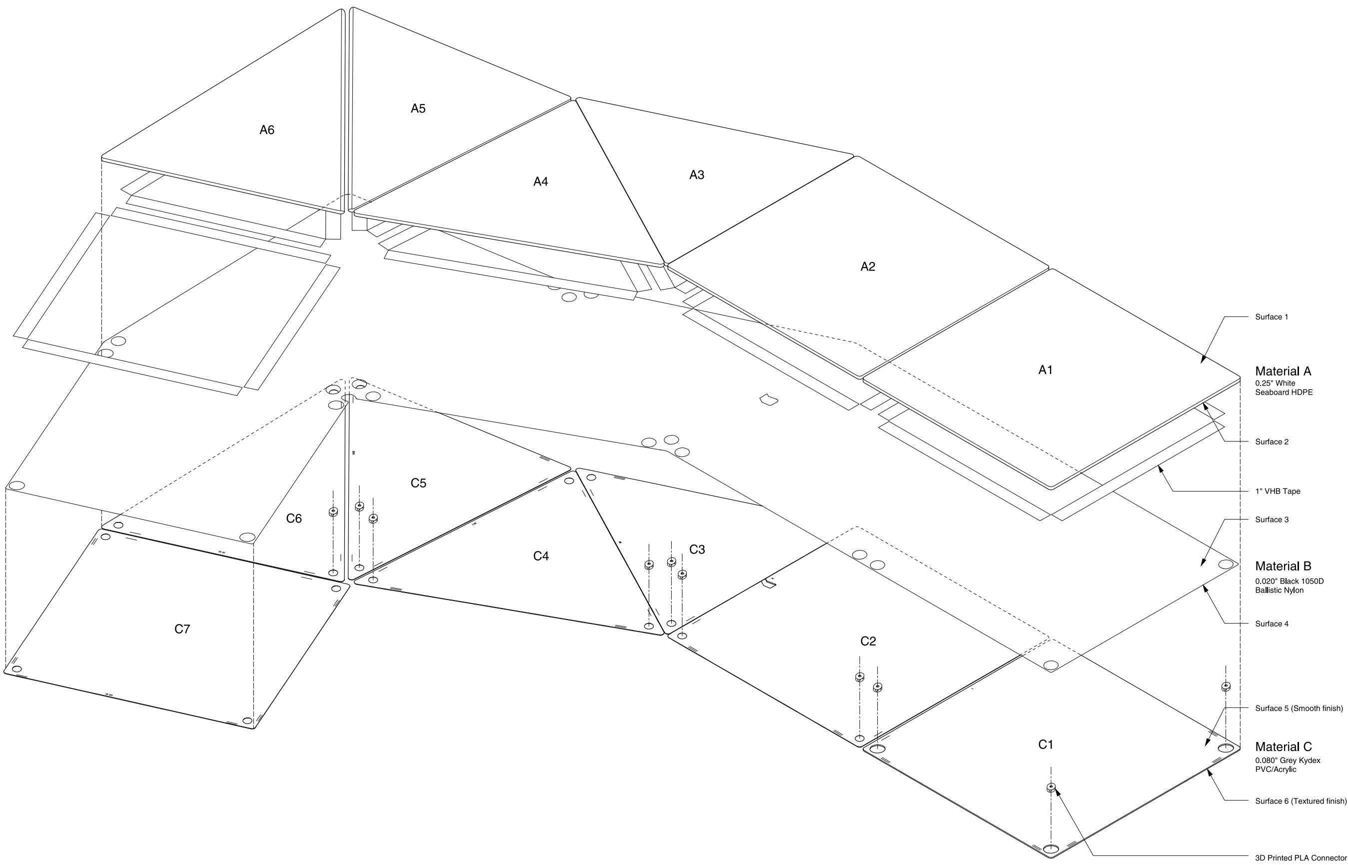

Figure 8. Final assembly. Image by author.

The last significant challenge was to address the lack of adhesion under shear while maintaining the project intent of a fully plastic and non-tectonic assembly. With no known viable, superior method of adhesion, an all-plastic mechanical connection was developed between opposing laminations and concealed within the panel assembly. A shallow, undercut, elliptical pocket on the inner surfaces of the rigid opposing panels receives a custom, 3D printed, PLA connector that turns to lock in place. The pockets are then filled with an epoxy, aided by the connector as a scaffold during assembly.[5]

The final pedestal retains a high-degree of fidelity to the regular polyhedron. Perceptually, that it is not comprised of true squares and equilateral triangles is of little import. That the design of any real, material object could be reliant entirely on such abstraction is, of course, a conceit. And, neither was it the actual expectation of the undertaking. Rather, the endeavor attempted simply to circumscribe the conceptual within the virtual. While design decisions can be structured to privilege the reading and perception of an object on such terms, and doing so may admittedly produce novelty in the act of making, design decisions not met with parity between the conceptual and the actual risk a loss of agency in the real world of objects

The final assembly did, however, make explicit the unique properties and performative interaction of different polymers that are often understood as a single class of materials. Each type being used for its inherent flexibility, stiffness, durability, moldability and adhesive properties, with each layer privileging a particular performance or quality. Supporting this claim is the fact that each material in the initial prototype was exchanged for another (or tested in multiple) in the course of development. Such a strategy displaces the narrative of plastic as either a single class of materials or as a single material capable of any feat of performance. The project, in its composition as a set of polymers adhered in laminations and partially mechanically fastened (though cast in situ), also strains our definition of what constitutes a composite material.

ENDNOTES

1. Invariant in the common sense of shape as defined by the ***Oxford English Dictionary*** to include “constant relations of position and proportionate distance among all the points composing its outline or its external surface.”
2. The 2-isogonal tiling ($3^3.4^2;3^2.4.3.4;4^4$) as described in D. Chavey, “Tilings by Regular Polygons—II,” *Computers & Mathematics with Applications* 17, no. 1–3 (1989): 147–65.
3. Seaboard®, a proprietary product from Vycom Olefin and PVC Solutions.
4. Kydex® 100, a proprietary product from Sekisui SPI.
5. Design and production of Top Heavy was led by the author but was supported by students throughout development, including Anastasia Yee, Lara Hansmann, Jacob Andrew, Corey Phelps, Logan Halterman, and Veronica Gomez.

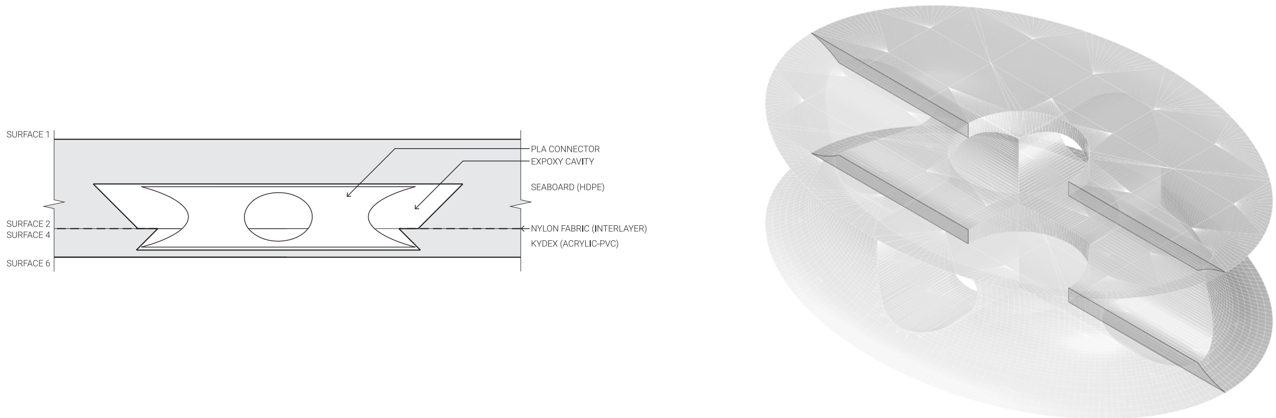

Figure 9. Details of 3d-printed connector. Image by author.

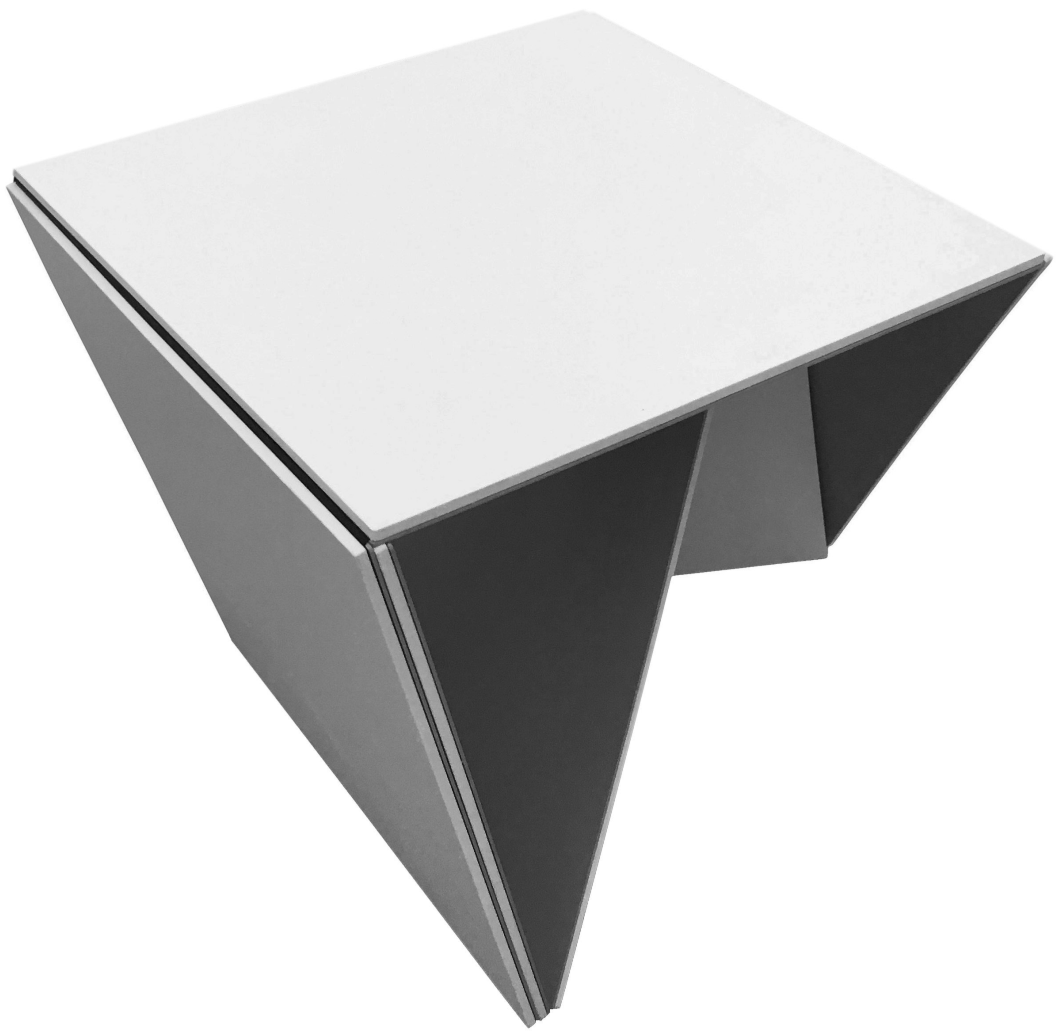

Figure 10. Final, full-scale prototype. Image by author.