Pennsylvania State University
University Park, Pennsylvania

Outside THE Blocks

by Keith Labutta and Drew Weinheimer

Figure 1: Documentation of the existing Pittsburgh Corning glass block product.

Presented with the course objective of rethinking and eventually fabricating a new glass block for Pittsburgh Corning Glass Block Corporation, our mindset was to thoroughly investigate all states of the existing product, from manufacturing to marketing and finally installation. It was from this process that we hoped to design a product that could reinvigorate the use of glass block within contemporary architecture.

Before we were able to take any steps toward design, we sought to answer the question, "What is glass block?" After researching the product and the manufacturing process, we began to understand that glass block was not only a unit of an installed system, but it was also a product of a highly efficient manufacturing system. While the product added value through efficiency, both the modularity and efficiency of these systems limited the visual and physical flexibility of glass block. This understanding informed us that our design would need to be driven by existing construction and manufacturing systems, while discovering new possibilities for the designer and product.

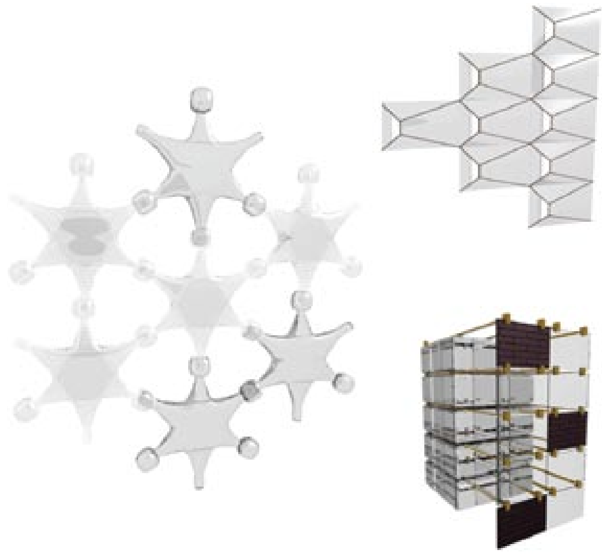


Figure 2: Preliminary schematic designs not based on final fabricated model.

Conceptually, we set out to create a design that obscured the visual modularity, yet understood the systematic presence of the existing glass block. We also set out to maximize design changes by establishing simple design guidelines. The existing system of glass block led to our thoughts concerning profile conditions, orientation, and density. It was thought this would allow strengths to lie in design and aggregation. The following ideas surfaced from these guidelines:

Variable Orientation – The form within a modular grid can be rotated to give different appearances while maintaining continuity of the overall form. Each unit can be rotated 270, 180, 90, or zero degrees. The units also have a depth so that a front facing block will protrude from the wall while a rear facing block will recess into the wall.

Figure 3: Schematic design with nine identical interlocking modules using developed design concept.

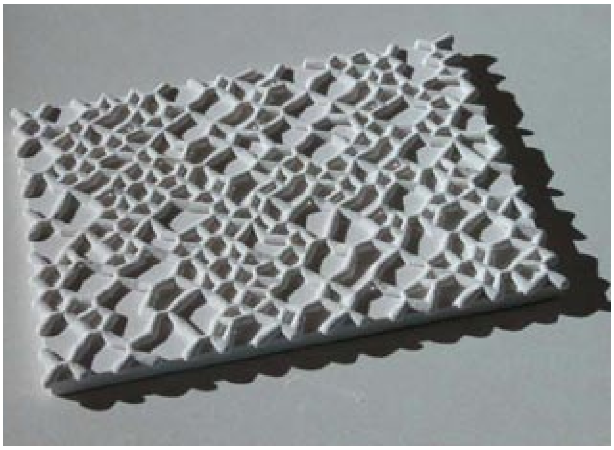


Figure 4: 3D print of two different interlocking geometries, placed randomly.

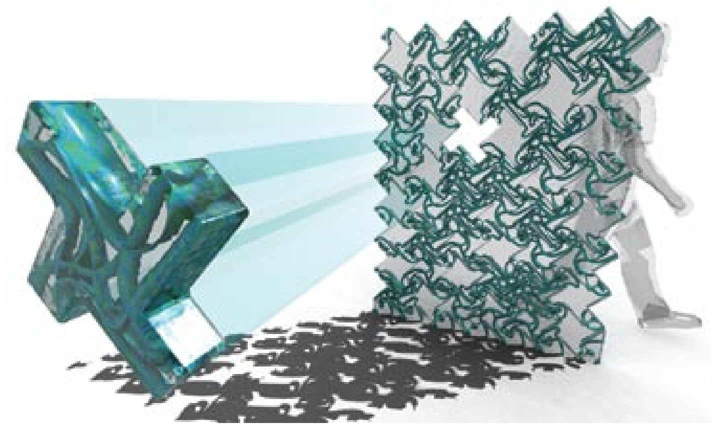


Figure 5: Exploration of wall mockup with design pattern inset within a simplified glass block form.

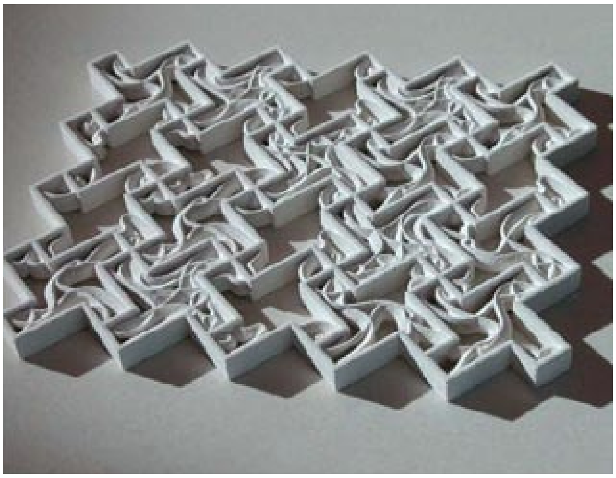


Figure 6: 3D print of inset interlocking geometry.

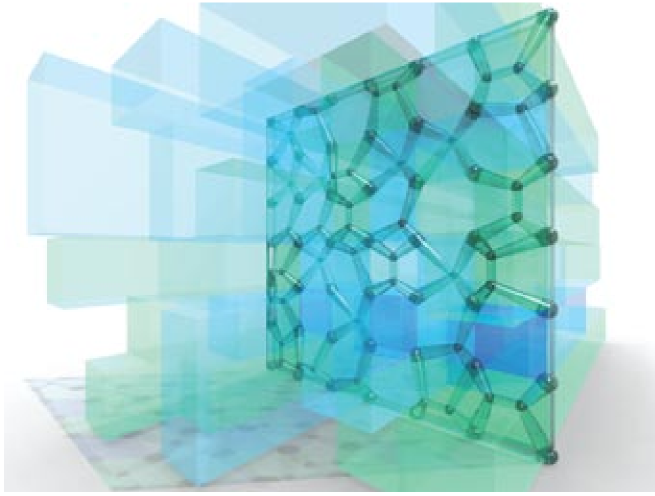


Figure 7: Visualization of three modules within one wall configuration.

Variable Density – Each unit has a different volume to fill the grid. There are three different units based upon the 8" square and has a high density. One is 16" by 8" and has a medium density. The last unit resolves variable end conditions, and merely caps other units entering into its boundaries, giving the lowest density.

Consistent Coincidental Profile Pattern – Within the boundary of each form, there are no real parameters to design. However, flow must be maintained when all the forms are aggregated so each edge condition must be consistent. The form flows into a forgiving central point from which it can flow tangentially into any other condition within the kit of parts.

Our selection of **form•Z** for design software fit seamlessly into understanding and visualizing these schemes.

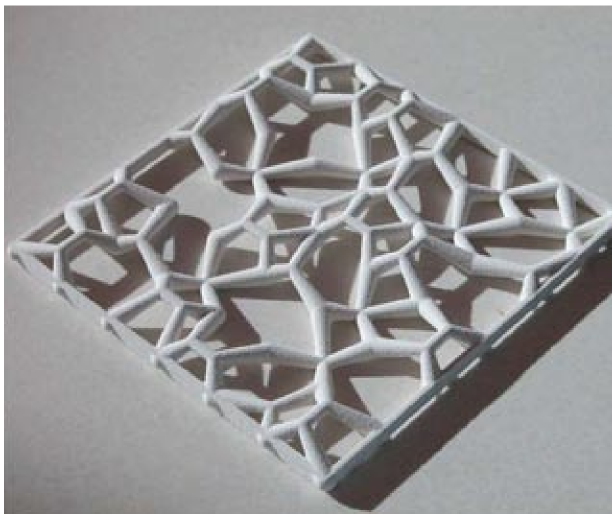


Figure 8: 3D print of visualization from previous image.

Figure 9: Understanding mold making utilizing two small units and one large.

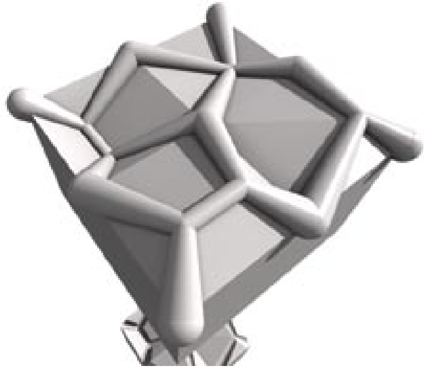


Figure 10: Modeling the positive form.

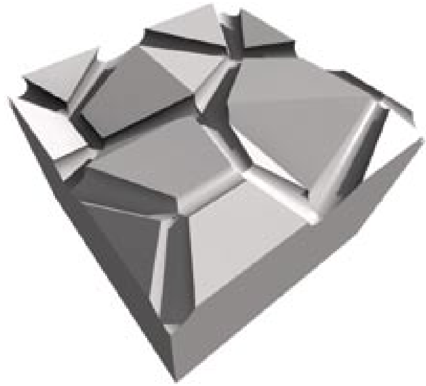


Figure 11: Boolean difference to create the fabrication mold.

While our initial design responses utilized both **form•Z** and the more traditional pen and paper, fabrication favored the digital realm. Our developing understanding of workflow between machining and software played critical roles in the design. We were discovering that **form•Z** was capable of creating files that were formatted for 3D Zcorp printing as well as CNC milling. From this point forward, we worked entirely in **form•Z** to develop everything from conceptual images to presentation images to molds for milling. As the design was set, importance was placed upon dimensional accuracy of **form•Z** models to produce the casting molds for the new glass block.

Molds were first fabricated out of high-density foam to ensure the **form•Z** designed molds were tooled correctly using Visual Mill, milling software used for tool and path selection. With our first routed molds in hand, we were confident that the milling stock that was created from layering poplar would have a similar success. The six-piece mold was cut from the 3 axis router, sanded, and shellacked to promote the release of the cast. Ultimately, this process led to the successful fabrication of four prototype urethane resin blocks.

Although the design objective was to produce a glass block wall system, perhaps this design lends itself more to plastics or metals. Glass would have a tendency to fracture at weak locations and also would not be suited for a butt-jointed socket. Synthetic materials allow more flexibility and are better suited for this type of design application.

While only one final version of glass block was fabricated, the system is very flexible. Countless versions of walls can be generated under the same design principles. The ultimate strength of the designs rests within the flexibility of form and application.

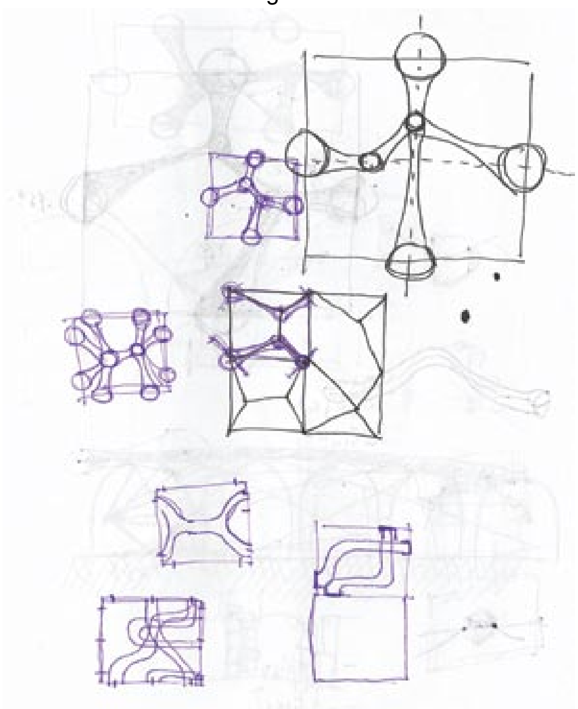


Figure 12: Sketch to change difficult corner connection to midpoint of module.

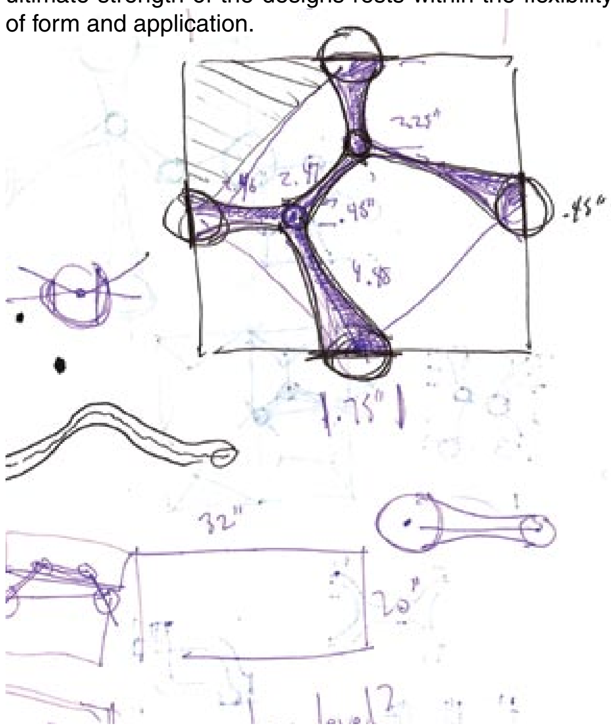


Figure 13: Sketch to determine final dimensions for fabricated product.

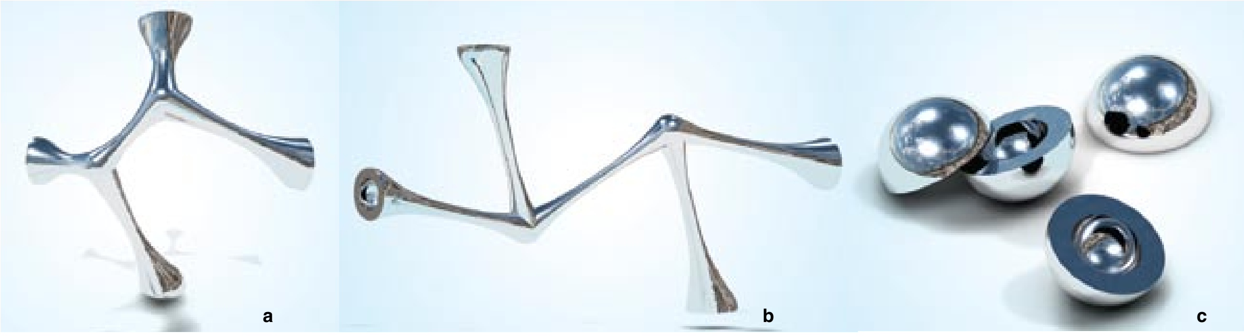


Figure 14: Final designs: **(a)** unit of new fabricated block system; **(b)** double unit for new fabricated block system; and **(c)** cap condition unit.

While we believe that we have created a successful new building product and developed it both digitally and physically, it is a new struggle to reach the market. Pittsburgh Corning was fascinated by the many designs produced by the students of our class. They were also eager to support the development of the designs through the various modeling tools, rapid prototyping and CNC milling most explicitly. However, there was a certain understandable hesitation encountered when we questioned the actual production of our product. Ultimately, the manufacturing process can be driven by forces outside of good design. There must be a foreseeable profit for the company. In retooling machines for the fabrication of custom blocks, a significant overhead must be used to mill aluminum casts, reconfigure pouring and drying procedures, and develop new packaging. Many custom designs are simply not able to offset the necessary production costs through sales to make the product manufacturable. While Pittsburgh Corning may have loved the insight provided to them as to how to reinvent their product, the manufacturing process may be better suited for mass production.

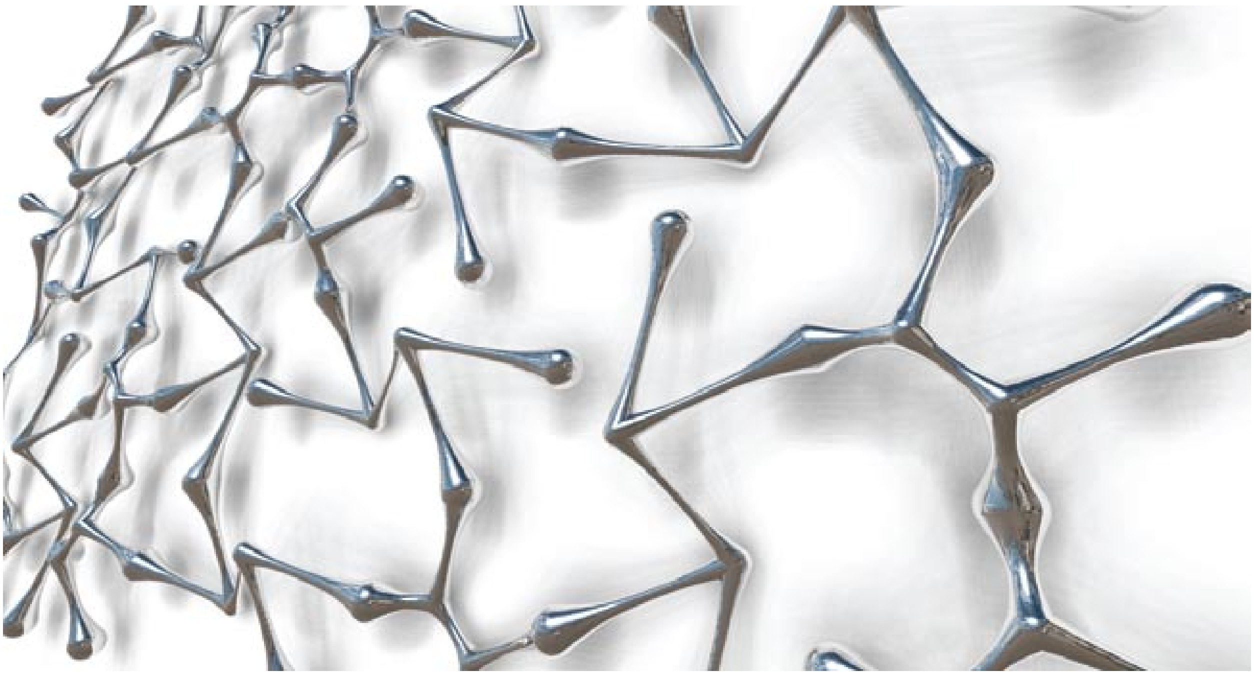


Figure 15: Final design mockup utilizing all three units of the new design.

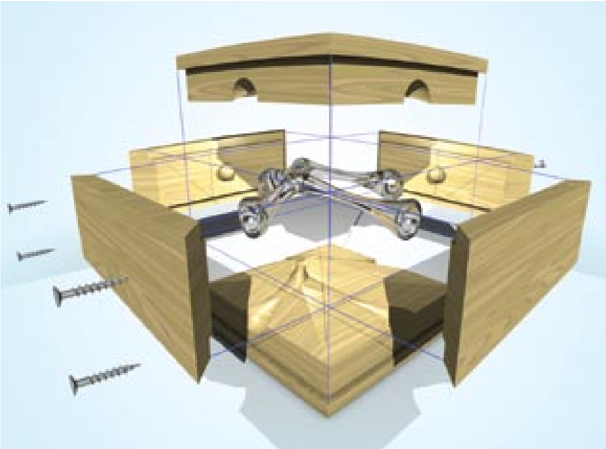


Figure 16: Exploded axonometric of mold assembly and final product.

Figure 18: Final machined poplar mold with lacquer finish for mold removal.

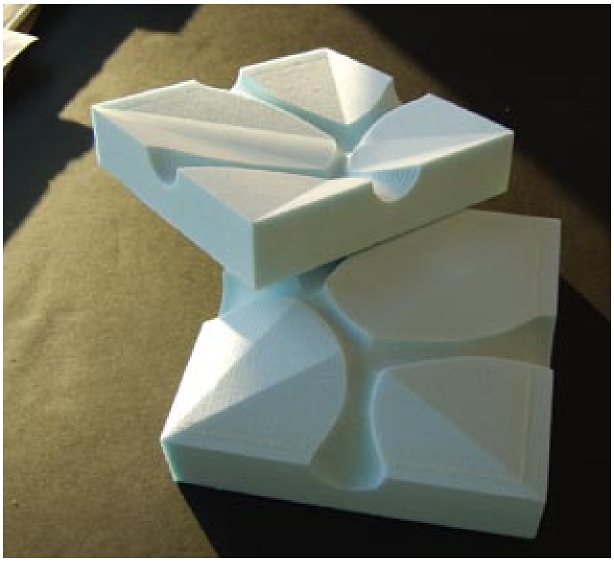
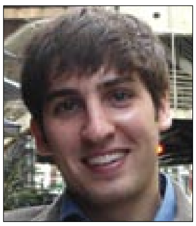
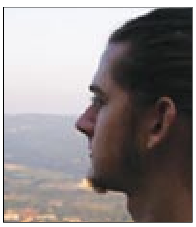


Figure 17: Trial fabrication of mold in high density foam.

Figure 19: Final casting is opened after curing process.



Keith Labutta holds a Bachelor of Architecture degree (2008) from the Pennsylvania State University. He currently resides in Chicago, where he has contributed to a variety of residential and commercial projects since graduation. His interests include utilizing and developing emergent digital fabrication techniques in practice, as well as expanding upon undergraduate research pertaining to the role and ability of the public building to foster beneficial societal change. In collaboration with Drew Weinheimer, they were the recipients of the 2008 **form•Z** Joint Study Award of Distinction in Fabrication.



Drew Weinheimer received his Bachelor of Architecture degree from the Pennsylvania State University in 2008. After graduation, he worked on several large commercial, residential, educational, and hospitality projects in Dubai, UAE while working at Burt Hill's International Studio. He is currently working on several higher education projects in Pennsylvania while working at Celli-Flynn Brennan in Pittsburgh. His interests include emergent digital design technology, phenomenology, and the human perception of architecture, design through exploration, and technical research.