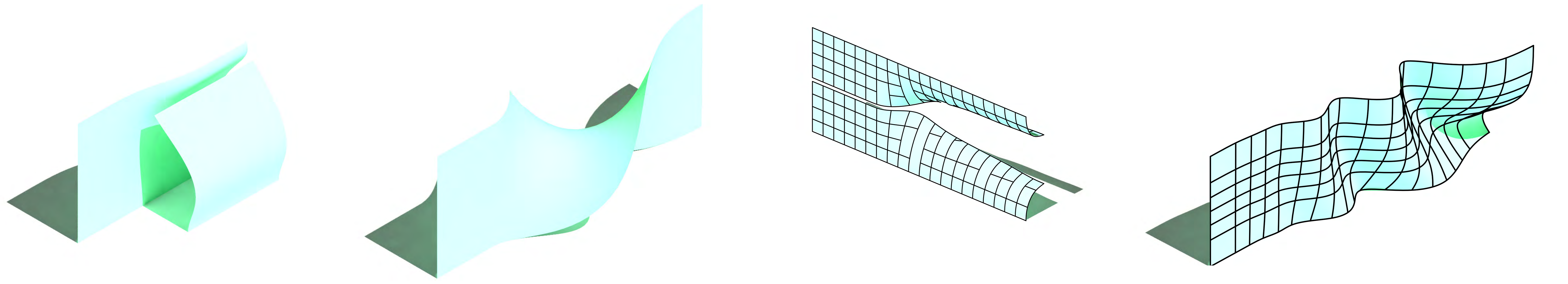
Installation Geometry

DIGI[FORM]
AUSTIN EDE | CORD READ | NATHAN BARNES
ARCH 5670-002



The goal of the installation was to demonstrate similarity and difference through both homogeneous and heterogeneous part to whole family relationships. The geometry studies (above) look for viability in application to the casting process . Constraints were, variability of the tool in it's ability to expand for panel size, projection subdivision.

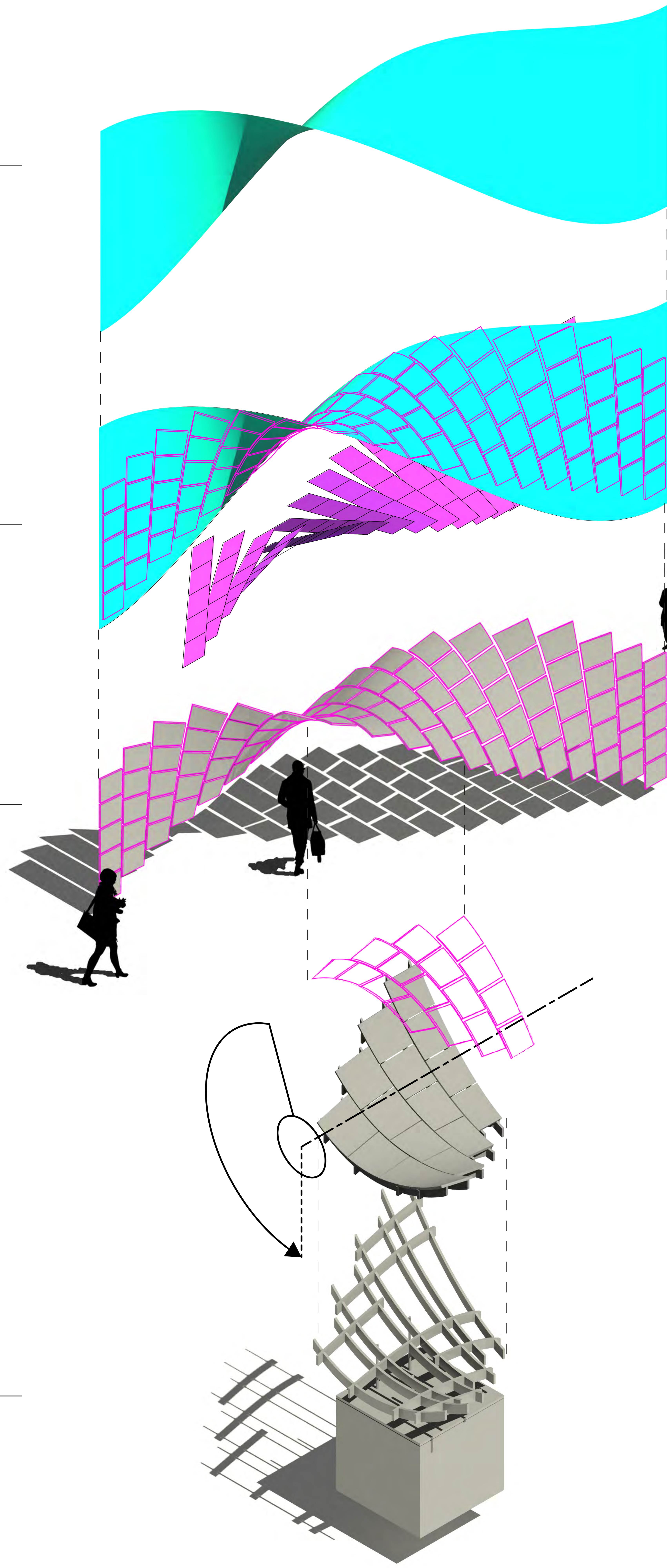
Studies

Geometry

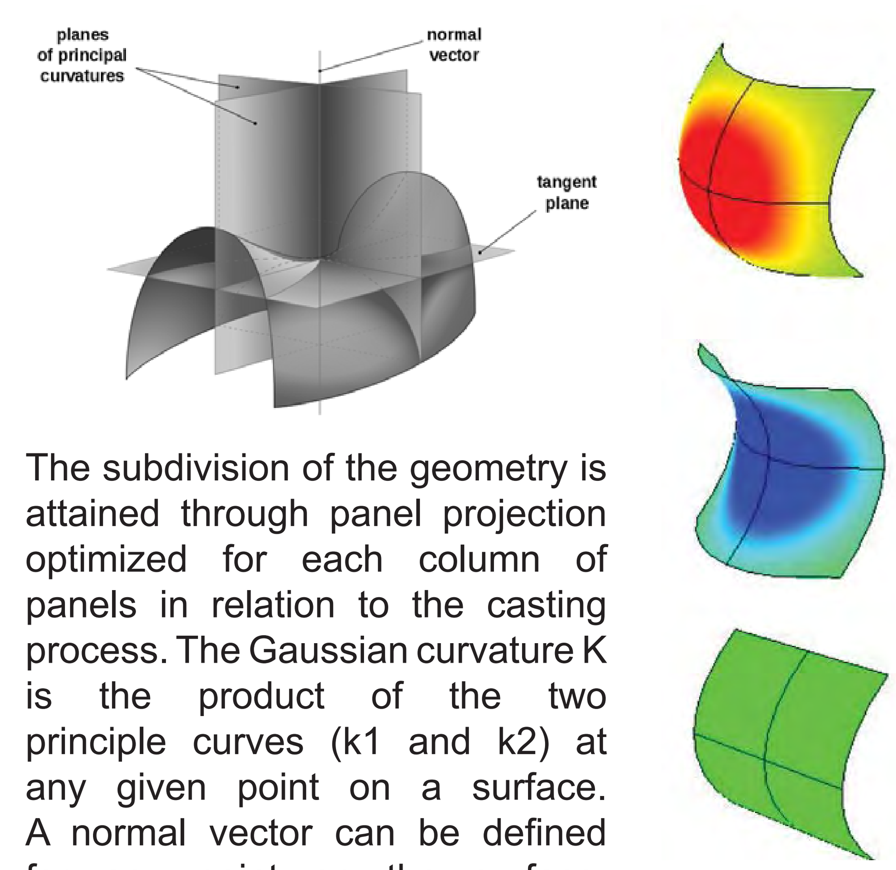
Projection

Panelized

Final Geometry

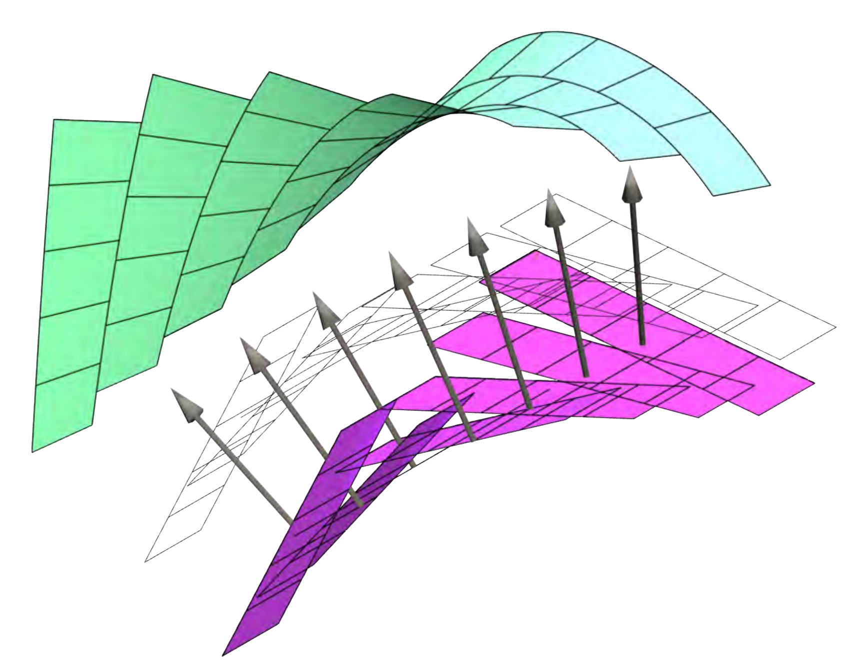


GEOMETRY CRITERIA

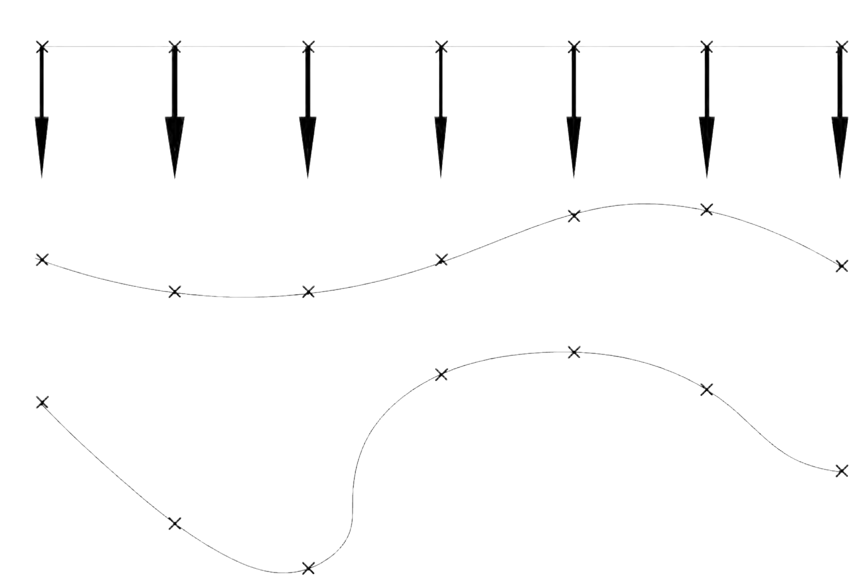


The subdivision of the geometry is attained through panel projection optimized for each column of panels in relation to the casting process. The Gaussian curvature K is the product of the two principle curves (k1 and k2) at any given point on a surface. A normal vector can be defined for any point on the surface.

PANELIZATION PROJECTION



The projection method projects a flat grid onto the surface. The grid can contain any irregular geometry but orthogonal rectangular and square grids are the most common for the projection method and most relevant to this process. The angle in plane of the panels remains the same as the projected grid for each column of panels.



An advantage of this is that the grid can be generated with the same dimensions as the flexible mold, which makes the production of the panels easier. A drawback of the projection method is when the surface contains highly shaped regions that it causes a high deviation in panel size, see figure above. This can be compensated by adjusting the grid size at these particular regions.

Installation Structure

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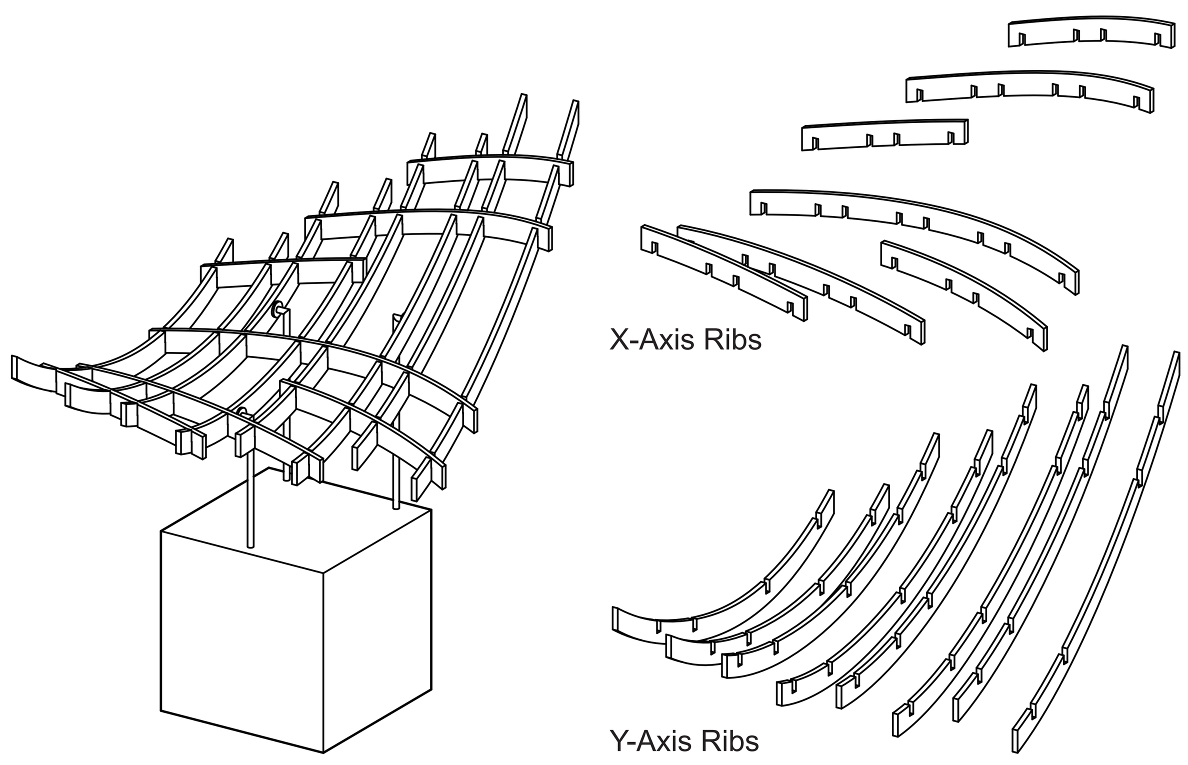
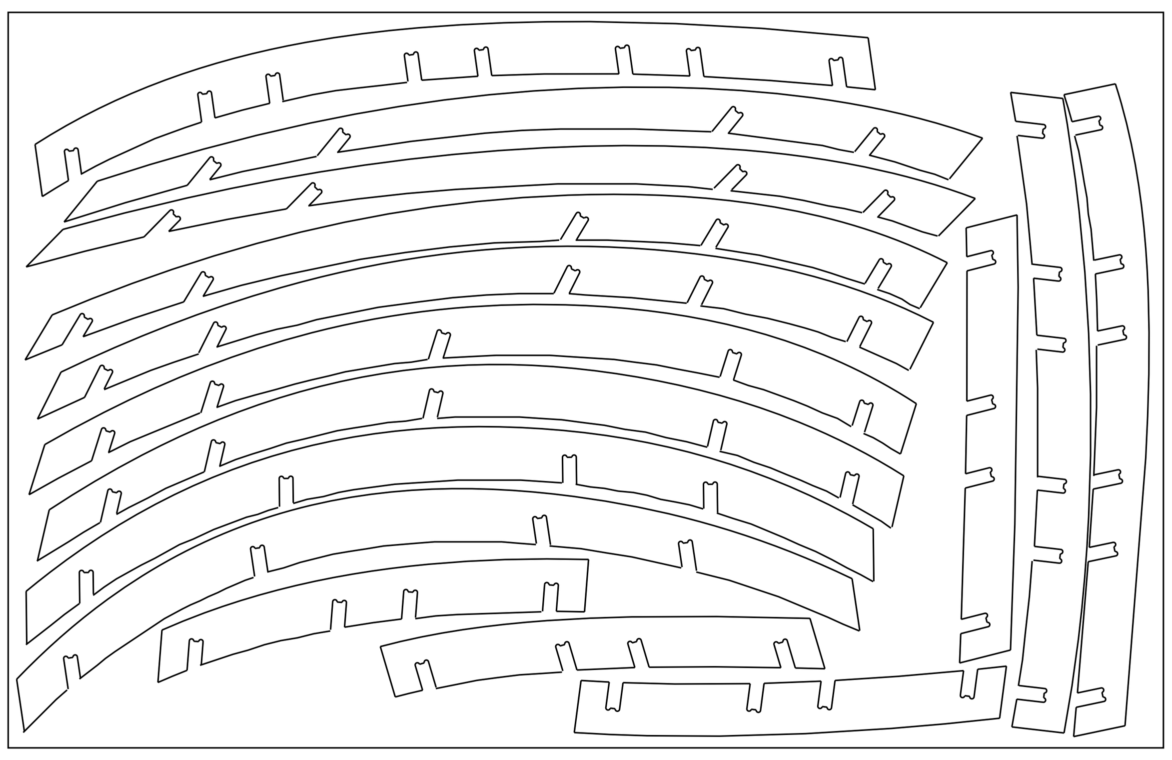
Structural Lattice

The Structural Lattice is composed of two sets of interlocking PolyEthelene ribs. The ribs are generated from contours that have been extracted from the 3D modeled Installation geometry surface. The X and Y-Axis ribs are milled with a CnC router so as to maintain accuracy through the fabrication process. Once milled these two sets of ribs are slotted together and secured in place with screws. Once joined this Lattice forms an interlocking structural framework that the cast hydrostone panels can securelly be fastened to.





Structural Joint

Accurate Structural Bracket placement is extremely important during the assembly process of the installation.

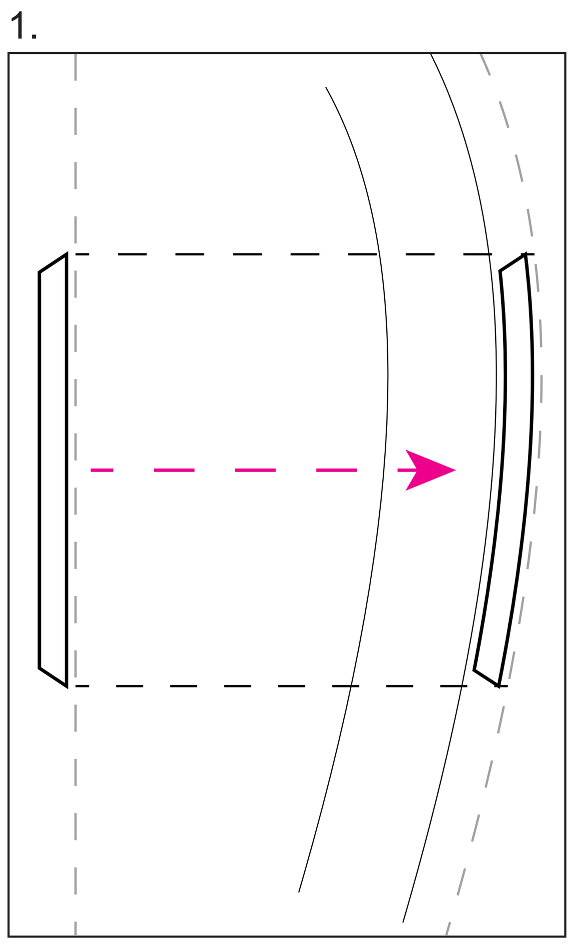
This is achieved through a series of both digital and physical means.

Each Column of panels is assigned an optimized vector for projection of the panel geometry and bracket placement. These vectors are used to compute the precise bracket placement for each panel. The Brackets are digitally located on their corresponding structural rib, and are rotated to the exact angle necessary for all brackets in a column to share the same surface normal.

Once digitally located the bracket placements are used to create a lasercut template that can be placed upon the physical structural ribs. These templates are then used to instal their corresponding brackets accurately onto the structure.

This allows the final structural placement of each panel to be much more accurate than previous iderations, limiting the possibility of misalignment during the assembly process.

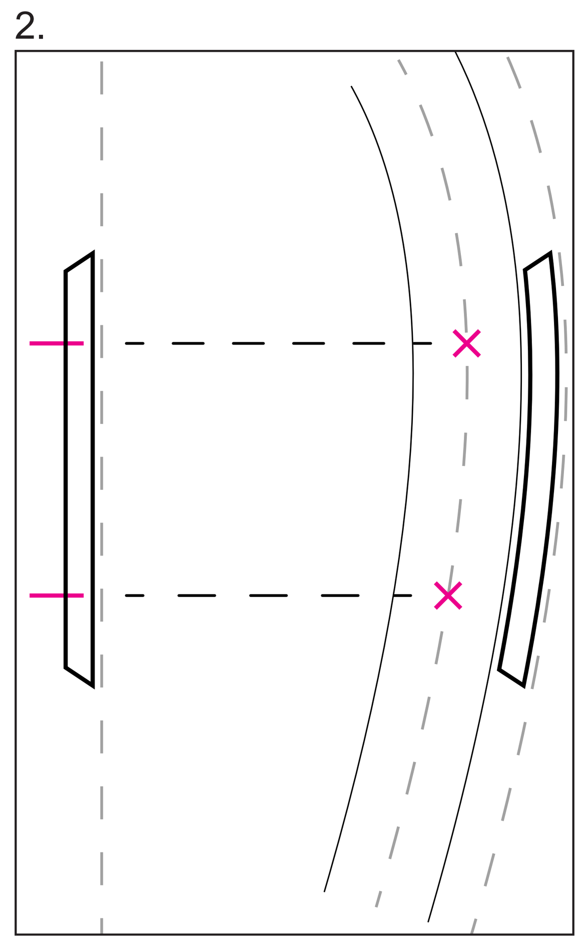
1.



Panel Projection

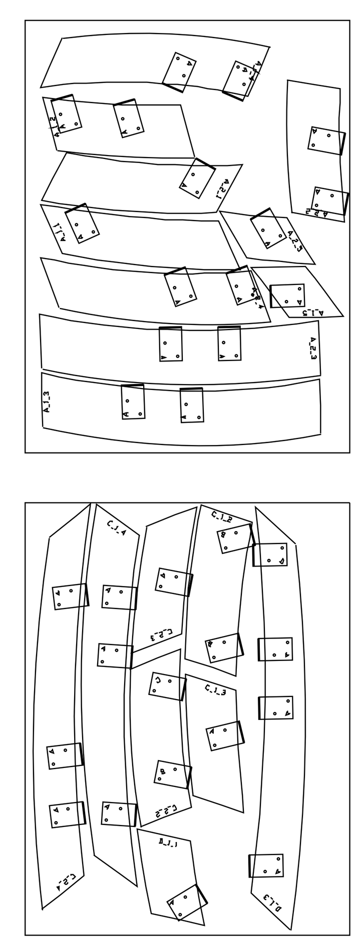
Each Column of panels is assigned an optimized vector to be used for projecting each panel from a flat plane onto a curved surface.

2.

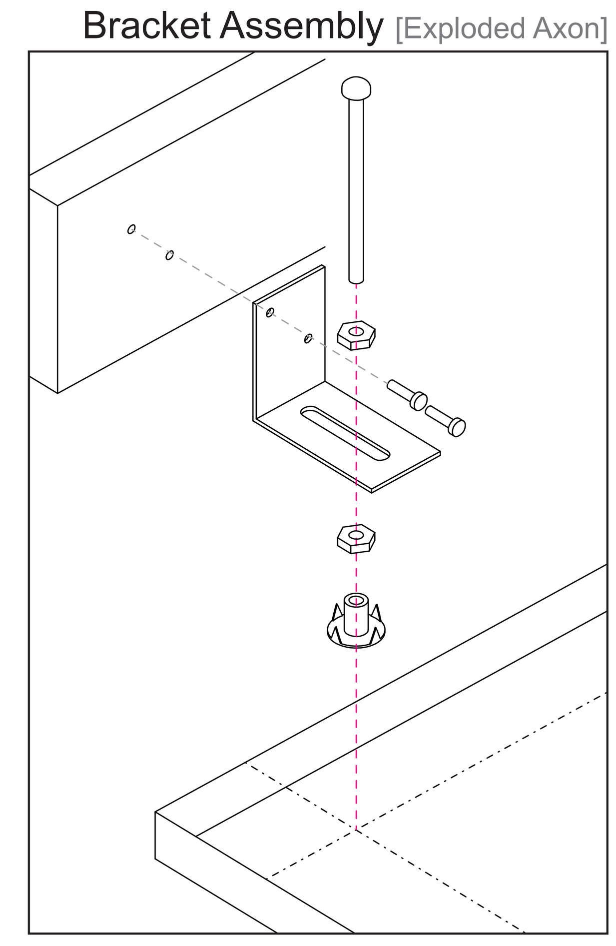


Bracket Projection

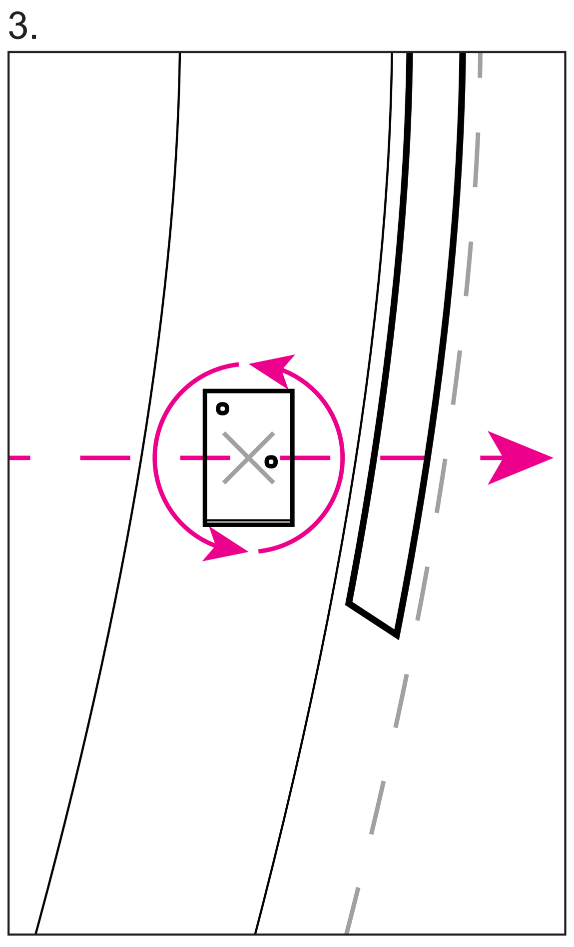
Four points on the surface of each flat panel are selected and projected onto a surface that approximates the center of the Y-Axis structural members. This projected intersection point will then be used for locating the structural brackets.



Bracket Assembly [Exploded Axon]



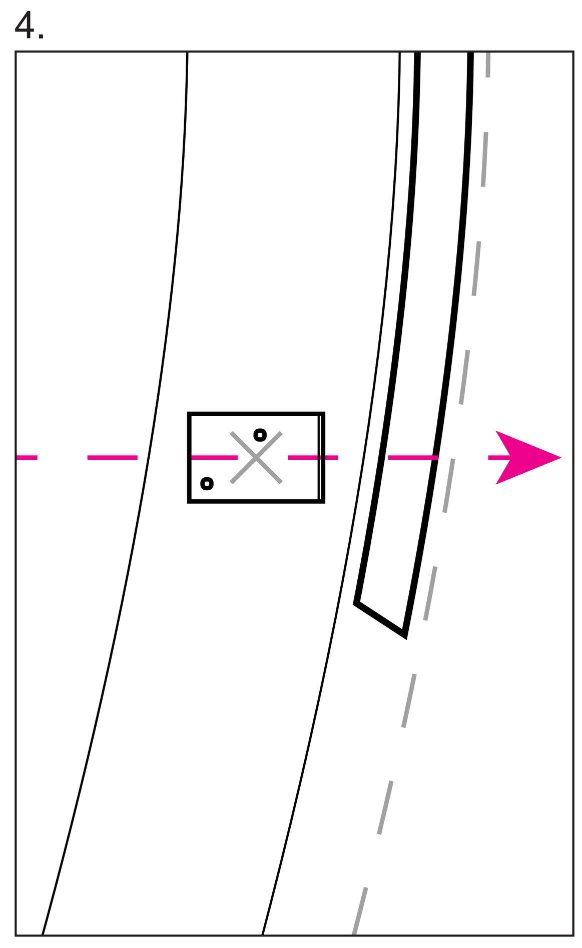
3.



Locate Bracket

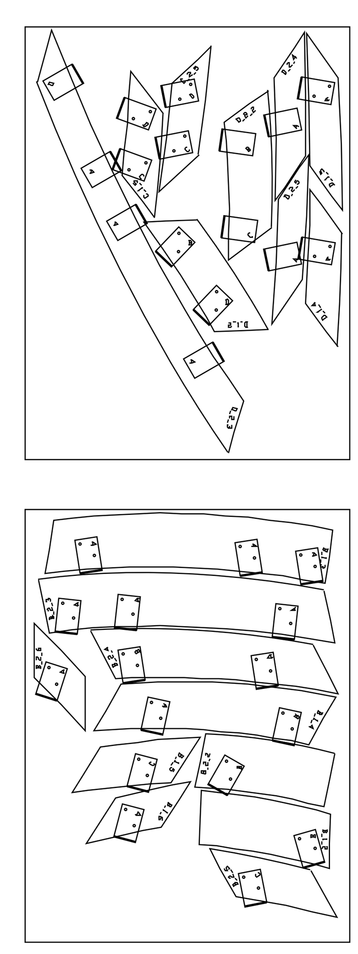
These projected intersection points will then be used for locating the center of each structural bracket onto its corresponding Y-Axis structural member.

4.

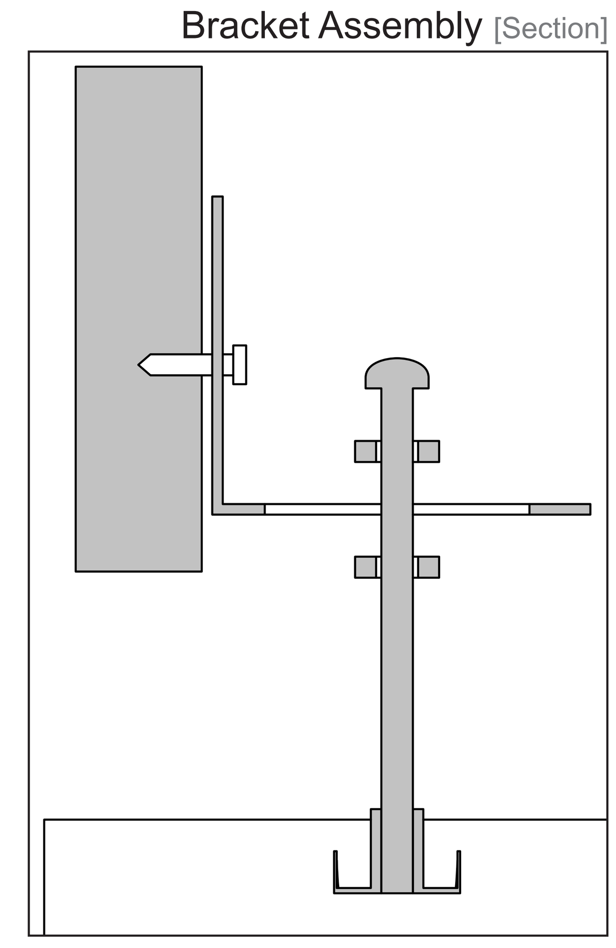


Rotate Bracket

Once the center of each bracket has been located onto its Y-Axis structural member it is then rotated so that the slotted end of the L bracket is perpendicular the column's optimized projection vector. Thus, the brackets for each panel will all be rotated parallel to adjacent panel's brackets in that column.



Bracket Assembly [Section]



Process

Casting Surface

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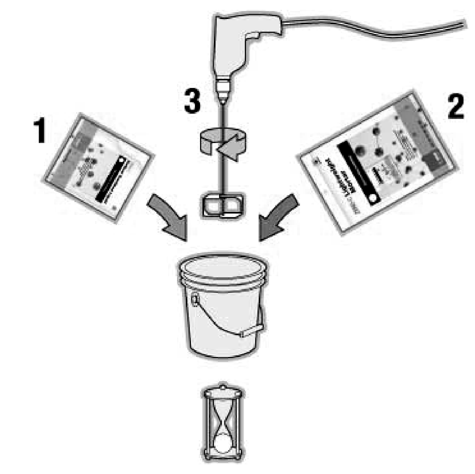
Initially the casting surface was proposed as a means to solely provide texture and a intermediary for the casting material. This was done through a series of casts at ⅛" and ¼" thicknesses. The dragon skin 20 silicone surface with 500% expansion capacity and the Dragon skin 10 with %1000 expansion were used in test casts using a milled MDF formwork with no texture and with texture to evaluate the application of the silicone and as an intermediary between the control surface and the cast piece. Our initial cast surface of ¼" demonstrated success in relatively flat casts but failed with high degree of deformation. The resulting high degree of deformation casts resulted in mid sections that did not meet our margin of surface accuracy. As a response to this a second casting surface of thinner thickness using Dragon Skin 10 silicone with 1000% ` elongation ability to allow the surface to conform to control surface geometry accurately. This resulted in a more accurate mid surface, however, both of these casting surfaces had flaws as a byproduct of the controls surface ability to interpolate the expansion of surface area. This precipitated a more intelligent casting surface that would work to adhere to the geometry of the control surface and interpolate expansion necessary for a double curved surface. With separation of function the control surface can now have mobility in how it generates geometry and the casting surface has precision of edge geometry with wall activation.



Hydrostone Mix

(1) 120 oz of weight of Hydrostone to (2) 32.5oz of weight for water and (3) mix

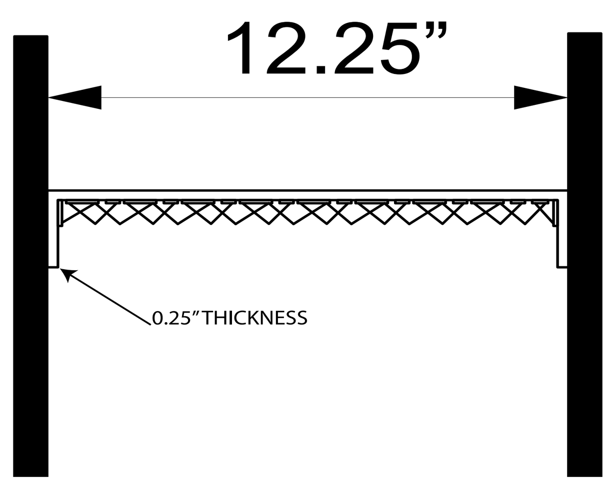
mix consistantly adding mix to water until thourghly mixed. be careful to collect powder from side walls. mix should leave slight trail as one runs an instrument through.

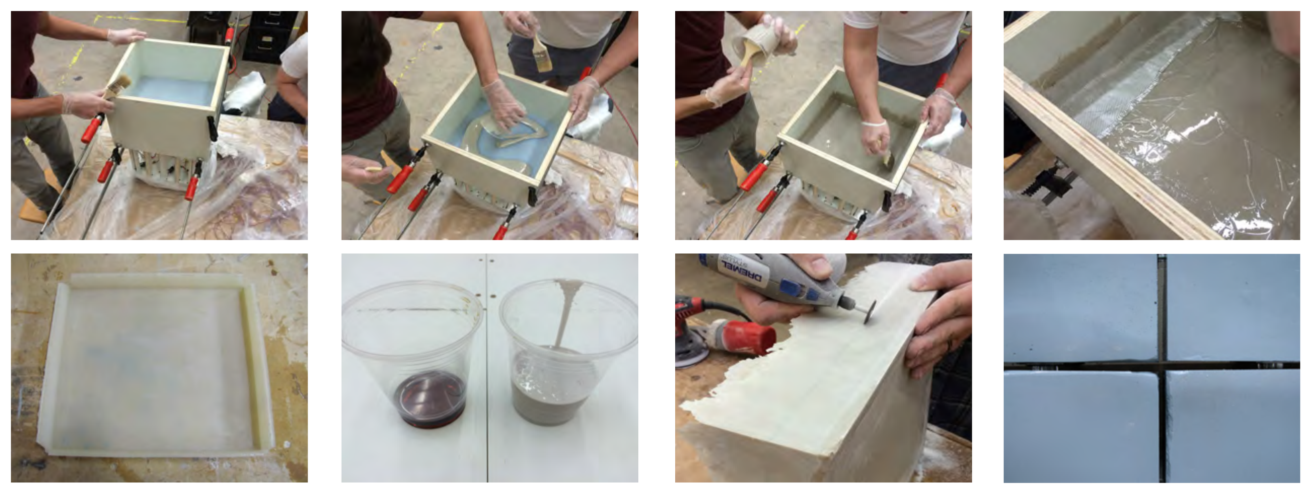
1/4" Silicone

The first casting sleeve functioned as an intermediary for the geometry. The sleeve fits over the 3D printed surface.

Initial efforts focused on alteration designs to 3d printed surface as a means to increase accuracy. shockcrete resin with fiberglass sheets were used in this initial test

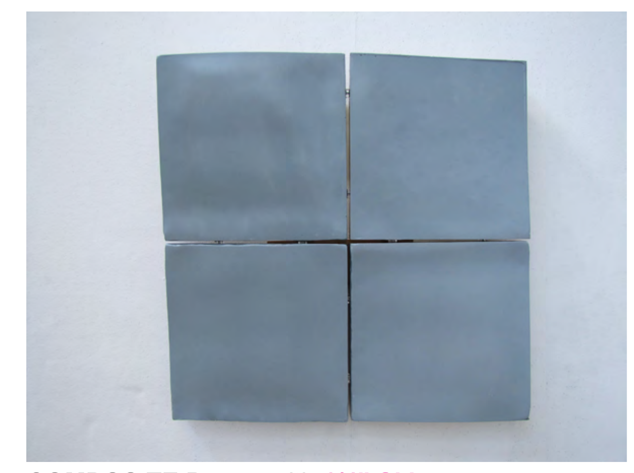
Silicone: Dragon Skin 20
Material: Composite Resin





EVALUATION

- surface accuracy to 3D model,
- extreme deformation edge gap,
- motor calibration,
- cast sleeve adhesion to control surface,
- compression causes deformation on edge

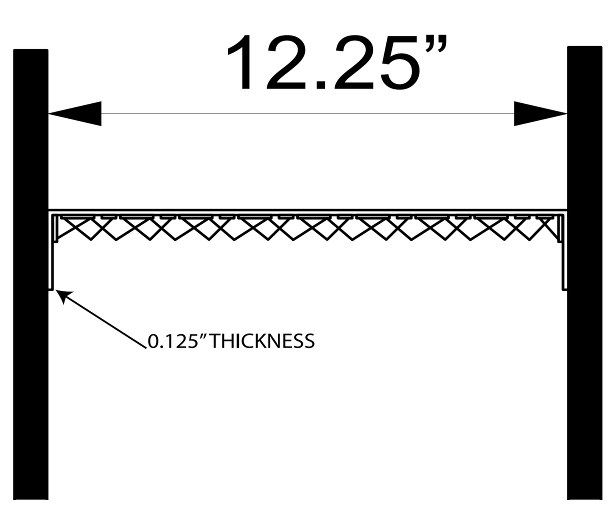


COMPOSITE Panels with **1/4" Silicon**

1/8" Silicone

This second sleeve was a test of the thickness for casting purposes. we tested a series of options to mitigate the edge situation with: clay for edge, laser cut unrolled surface paper, casting tape.

Silicone: Dragon skin 10
Material: Hydrostone



cast with 1/8" silicon   cast with 1/8" silicon + paper

EVALUATION

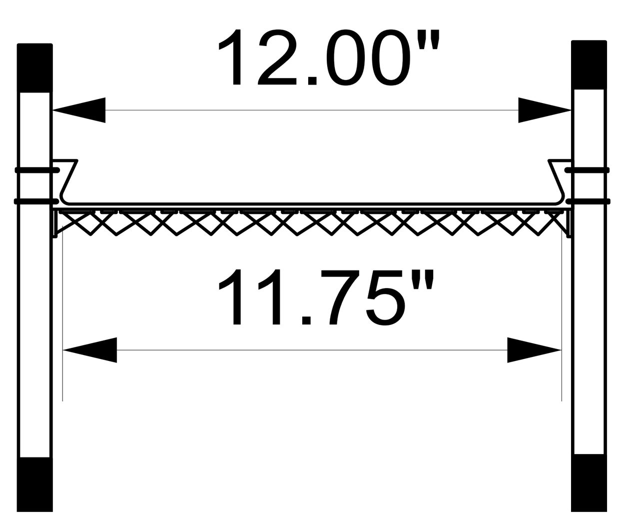
- watercolor paper bridges edge gap, but creates seal issues
- paper insert negates ability to control surface texture
- geometry expansion adaption through infill or mediation not within margin

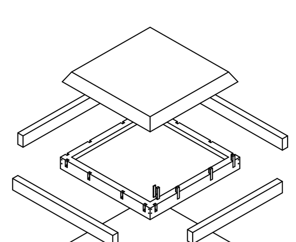
HYDROSTONE Panel with **1/8" Silicon** and **Unrolled Surface Paper** to interpolate geometry at edge of mold.

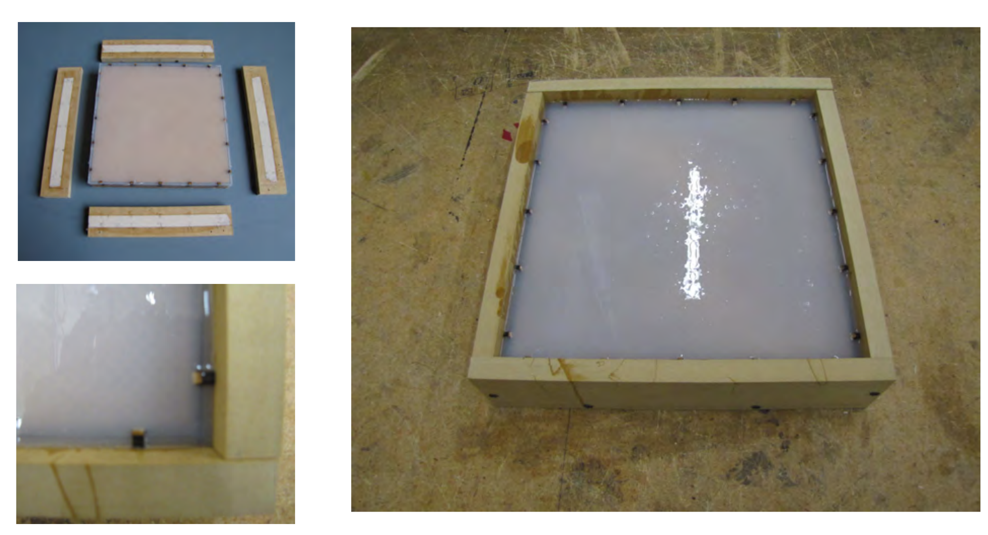
1/4" Silicone
Surface Intelligence

The next itteration focused on embedding intelligence into the casting surface with adding wire reinforcement. These wires are used to activate the the silione with the side walls. zip ties are used to adhere the surface to the sidewall.

Silicone: Dragon skin 10
Material: Hydrostone

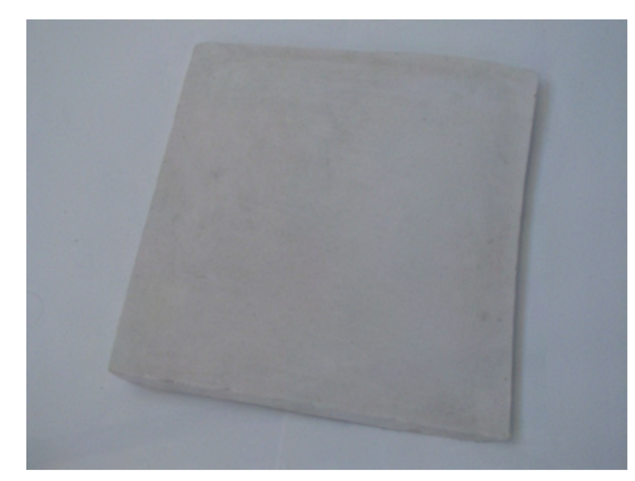






EVALUTATION

- edge condition significatly improved
- seal functional for casting
- panel geometry improved and next phase approved for testing with texture

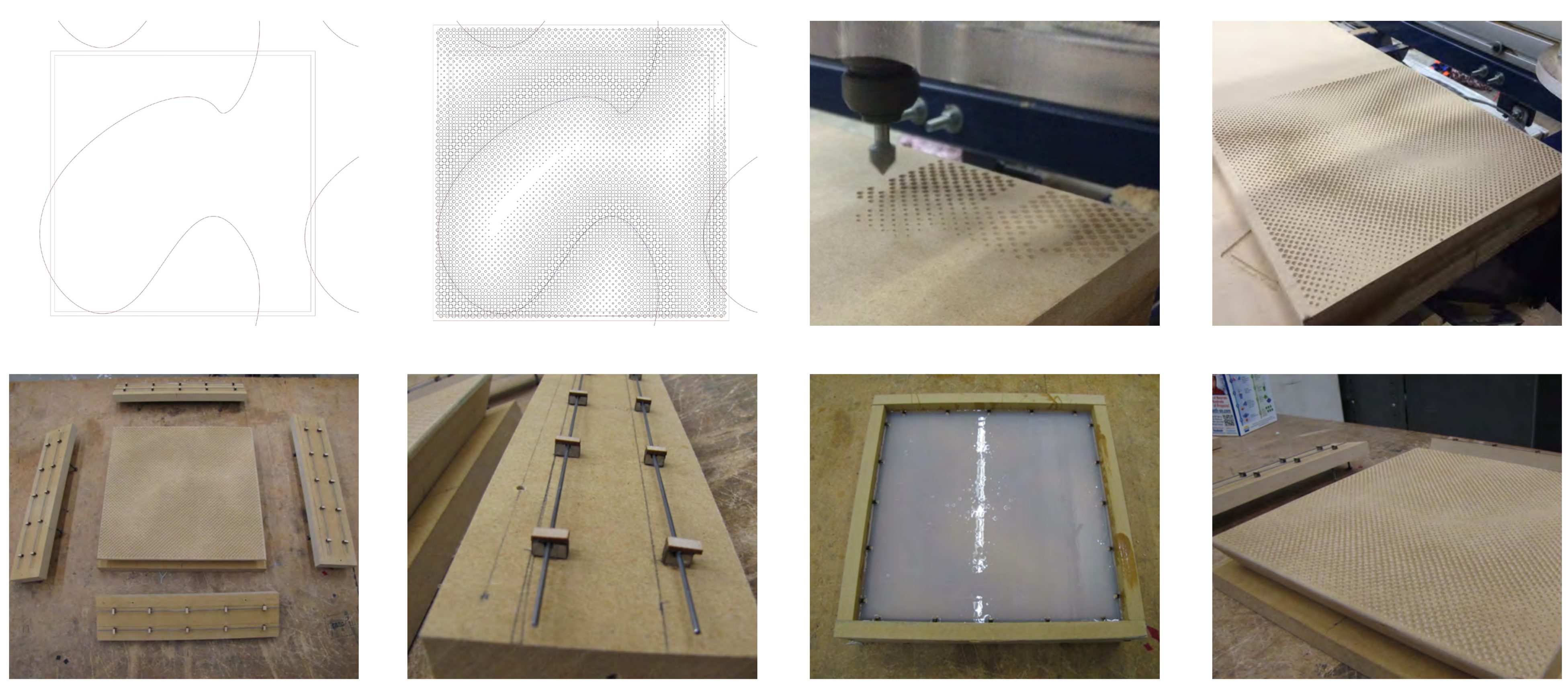


Hydrostone Panel with **1/4" Silicon** with **Beveled Edge** desing

1/4" Silicone
Texture + Wire

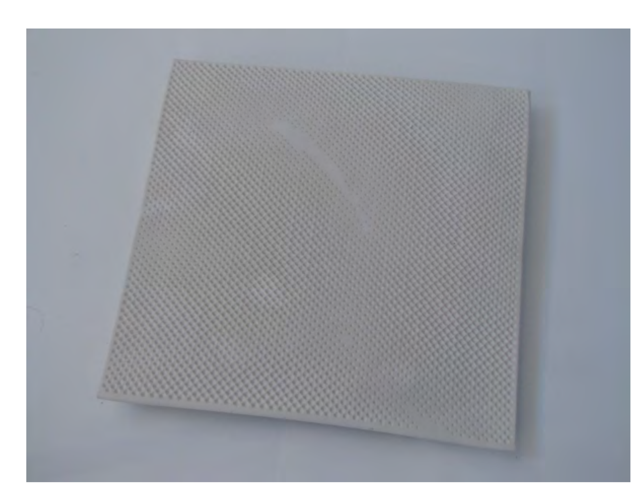
Building upon the success of the proir formwork, with small changes to thickness of silicon texture application is evaluated. this texture is based upon a visually dynamic part to whole relationship enabling the casting process to have control of the surface grain.

Silicone: Dragon skin 10
Material: Hydrostone



EVALUATION

- Edge is slightly improved and dimpling is reduced from changes.
- Prior successes remain in effect
- Texture achieves goals of visually dynamic and grain control. Alignment of texture system for next prototype.

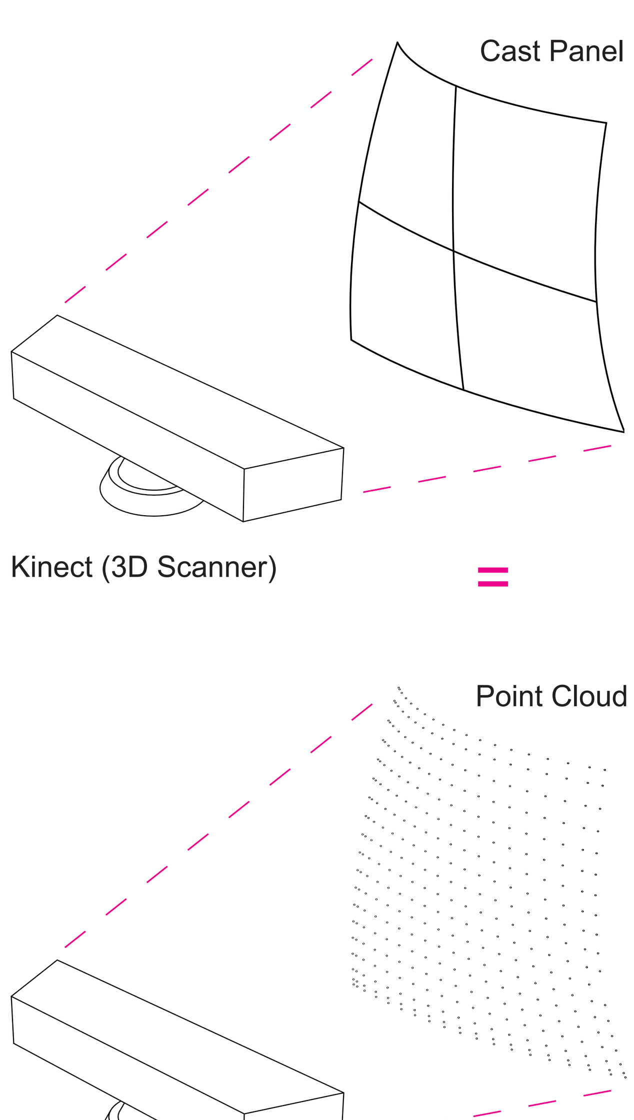


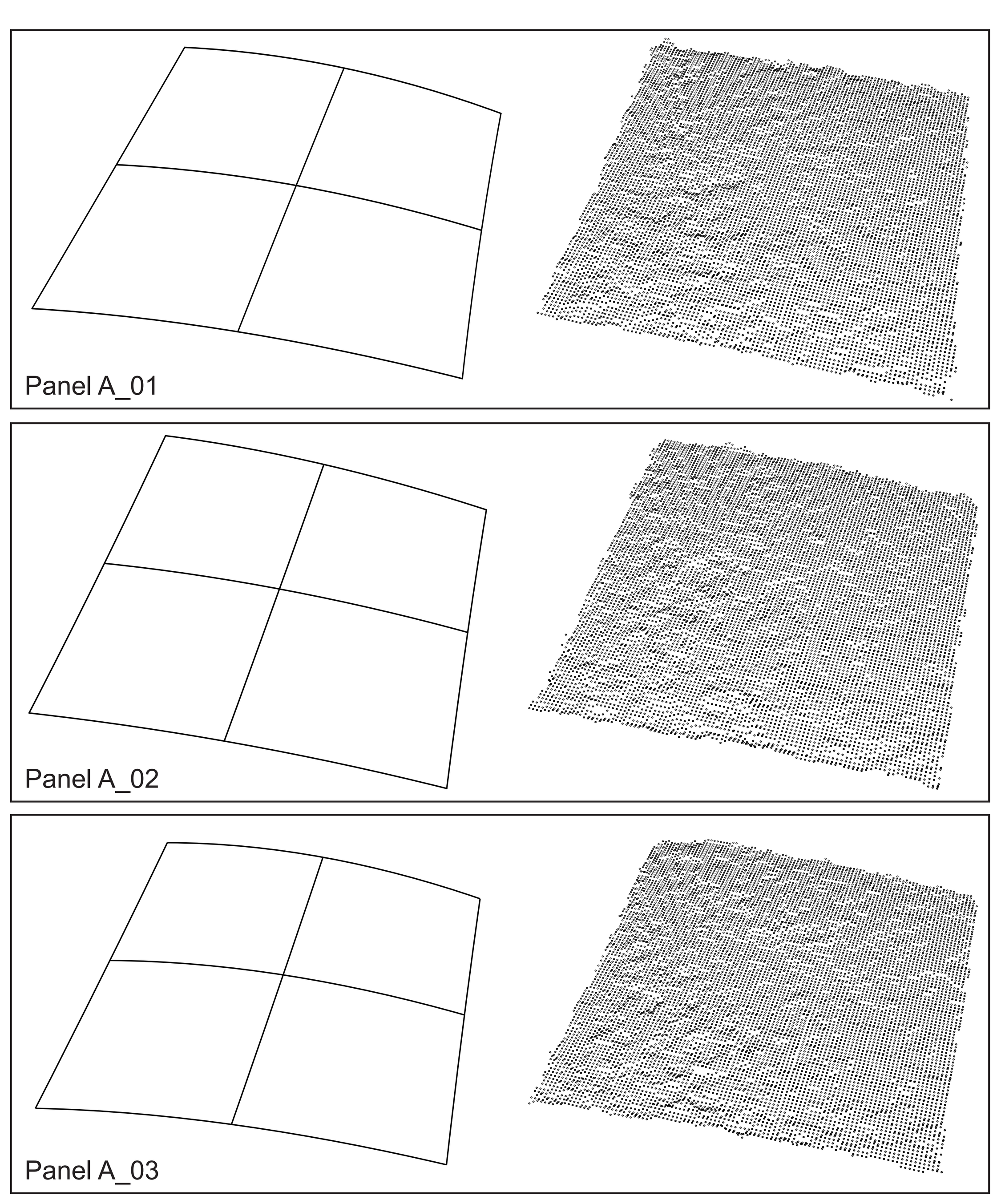
Hydrostone Panel with **1/4" Silicon** with **Texture** Application and **Beveled Edge** Mold

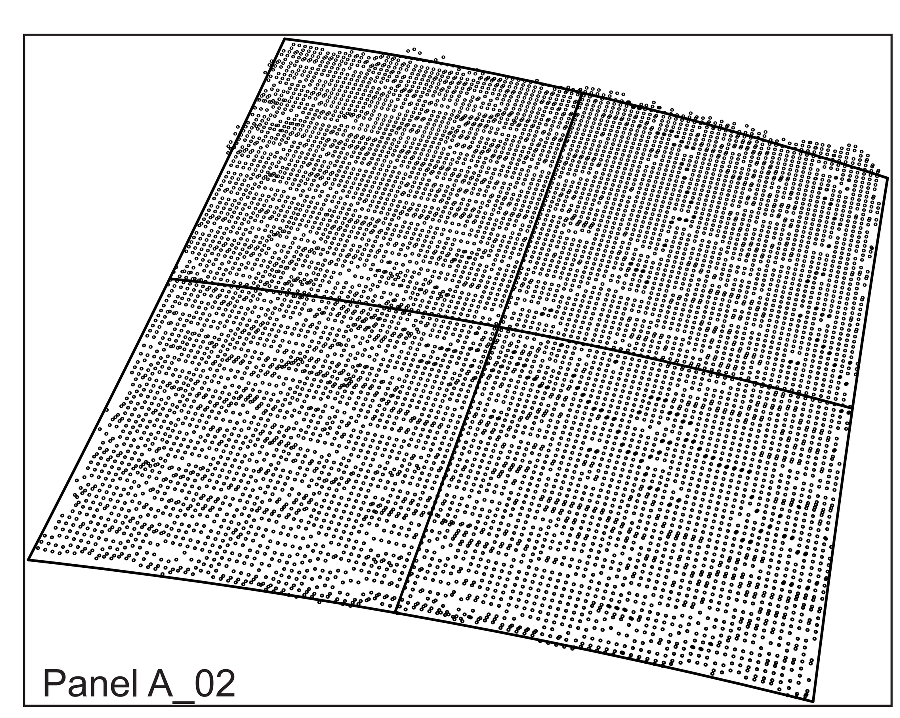
3D Scanning

A Microsoft Kinect was used as a tool to 3D scan each panel for geometric accuracy. The Kinect sends grid of IR beam out in front of it, and based on the amount of time it takes for each beam to reflect off of a surface and return back to the sensor the kinect assigns that point in the grid a distance. This process allows the tool to gather a geometric approximation of each panel for comparison to its digitally generated counterpart.

Tools: Microsoft Kinect, Hydrostone Panels







Findings

During the series of 3D Scanning tests that were conducted it was found that the geometries being output from the Reconfigurable Casting Surface were marginally accurate approximations of their digitally generated counterparts.

A maximum of 1/4" deviation was recorded throughout the tests, however these deviations were primarily found along the outer edge of the panels.

A further application of this technology could be to use it in tandum with the control surface to create a feedback loop within the geometric tuning process. This would allow for a higher level of geometric accuracy to be attained prior to casting a panel.

Prototype 2.0

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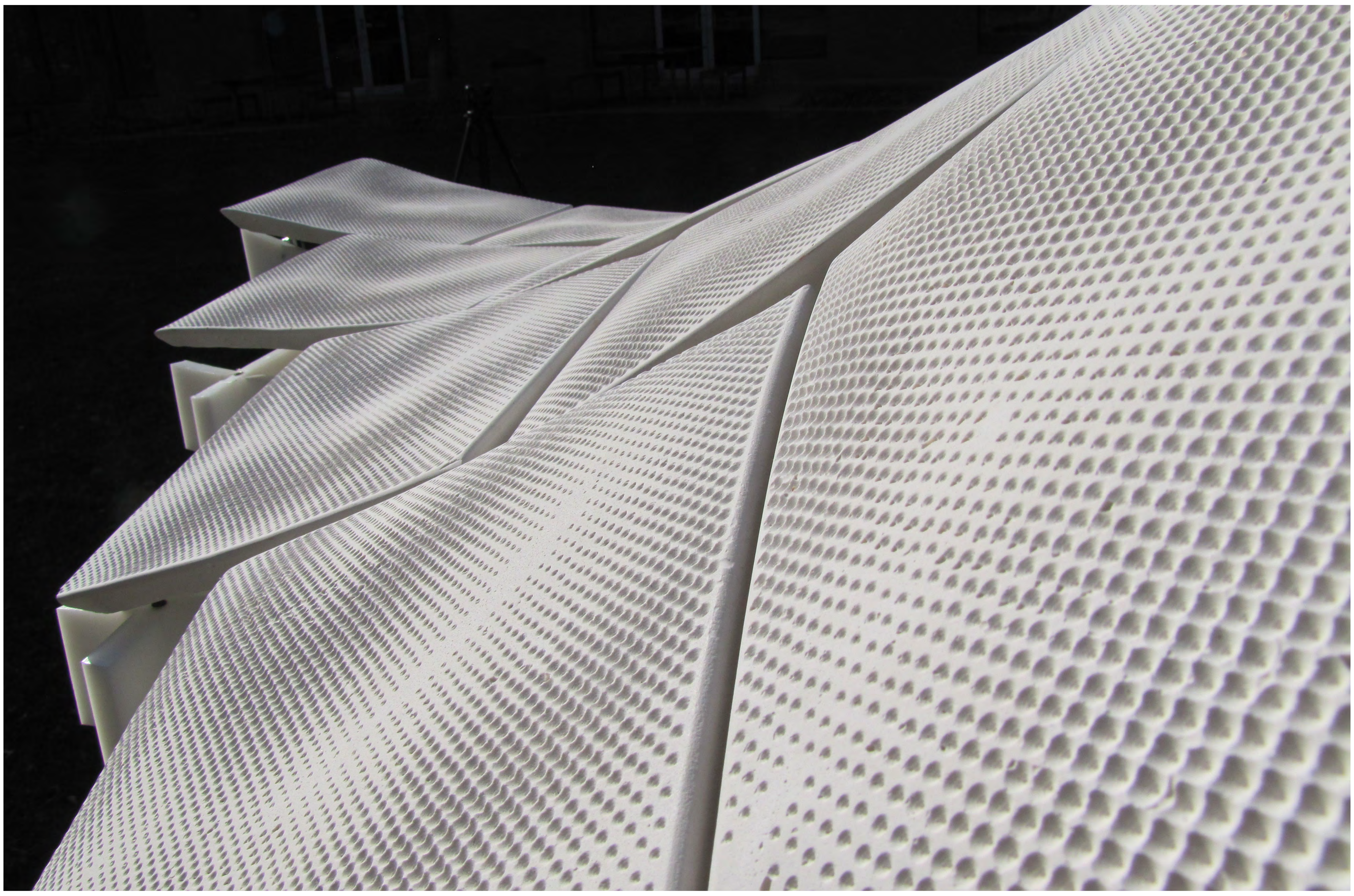
Final Prototype

A 4'x5'x6'-3" dimensioned prototype consisting of a ribbed Polyethelene structural lattice supporting 16 Uniquely shaped and textured HydroStone panels. The prototype was constructed to demonstrate the capabilities of a 3D Printed Reconfigurable Casting Surface.



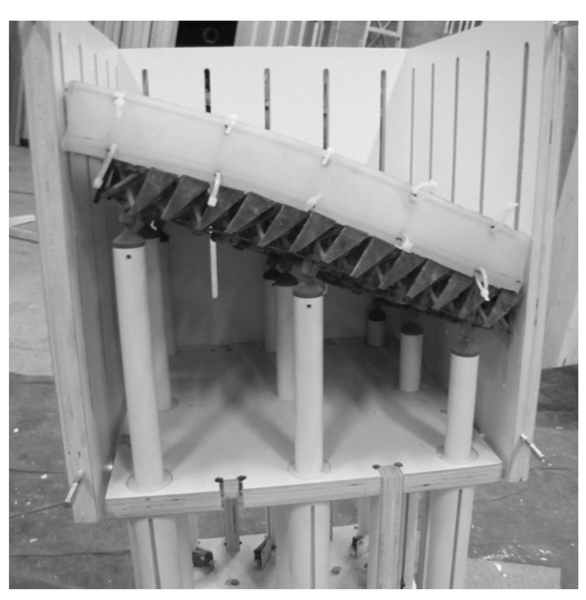
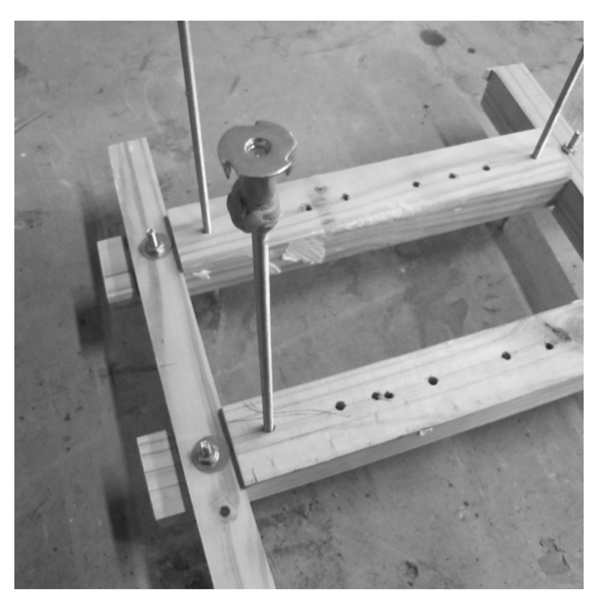
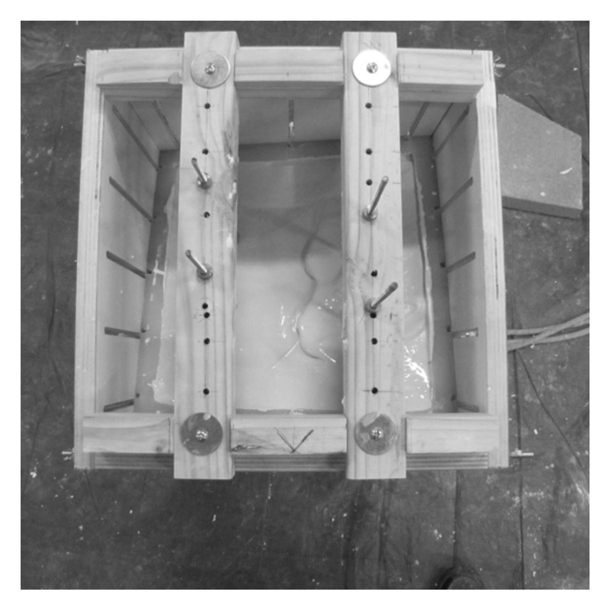
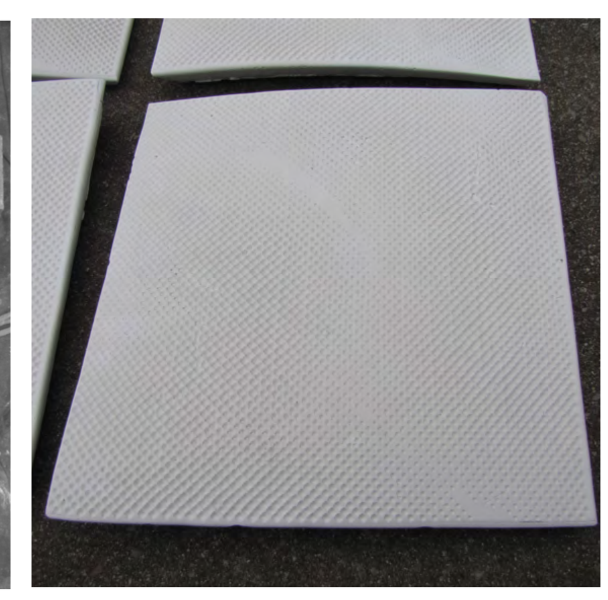
Casting

Prep

- Measure ingredients
- Configure formwork to panel desired

Casting

- Mix ingredients, pouring mix into water and stirring continuously
- Trowel hydrostone to get even distribution
- Insert structural placement jig into formwork

Conclusion

Casting Surface

Control rods, texture, and the beveling of a panels edges where used to embed a higher level of intelligence into the casting surface. Observations taken from the cast panels show that the control rods work to smooth out the surface geometry far more than prior attempts, but a smaller gauge rod could possibly allow for greater adherence. A series of tests could be conducted to test this hypothesis and further tune the silicone surface accuracy at areas of deformation.

Control Surface

The 3D printed control surface validated that the tuning of material composition can mimic the curvature of two directional SPLINE curves. Further testing should address the issues of density, variability in sizes, edge condition and the overall ability of the surface to expand while still producing curve like functionality.

Panelization Extraction

The panelization of the surface geometry in rhino and grasshopper was worked down to an acceptable margin of error. The next prototype should pay careful attention to separate the surface geometry position that the structure is calculated from and the surface geometry from which the panels themselves are derived. As a result of this miscalculation prototype 2.0 has varying spacing between horizontal and vertical panel joints, as the geometry causes concave or convex projections.