

Modular Pattern Exploration

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Thesis submitted to the faculty of the Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of Master of Architecture.

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Blacksburg, VA

Dedicated to my parents

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ABSTRACT:

Traditional Indian screens utilize beautiful intricate patterns derived from nature to attain spatial definition. Even though we utilize them as static objects with rigid boundaries, the beauty of a screen provokes wonder as to what's on the other side. This sparked a question of **What if the screen itself was modular?** This question became the basis of my thesis exploration. The work is divided into two distinct studies. The first being the exploration of making rigid materials flexible via pattern developed from basic geometry. The second being the application of the first process on a 1:1 scale resulting in an interactive installation. The final installation demonstrates modularity of pattern in creating a rigid material flexible by defining an urban landscape on Virginia Techs campus.

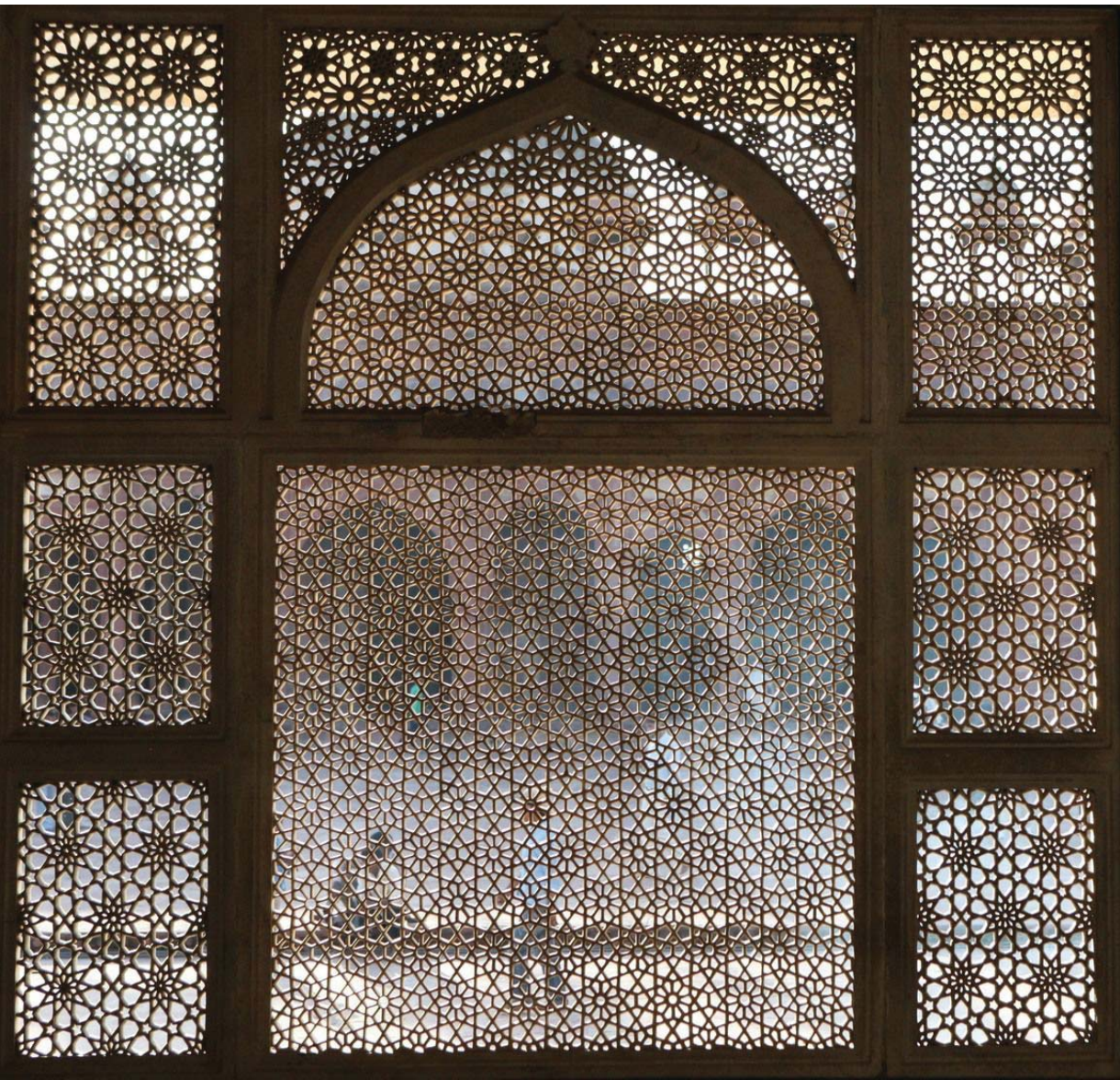


Precedent

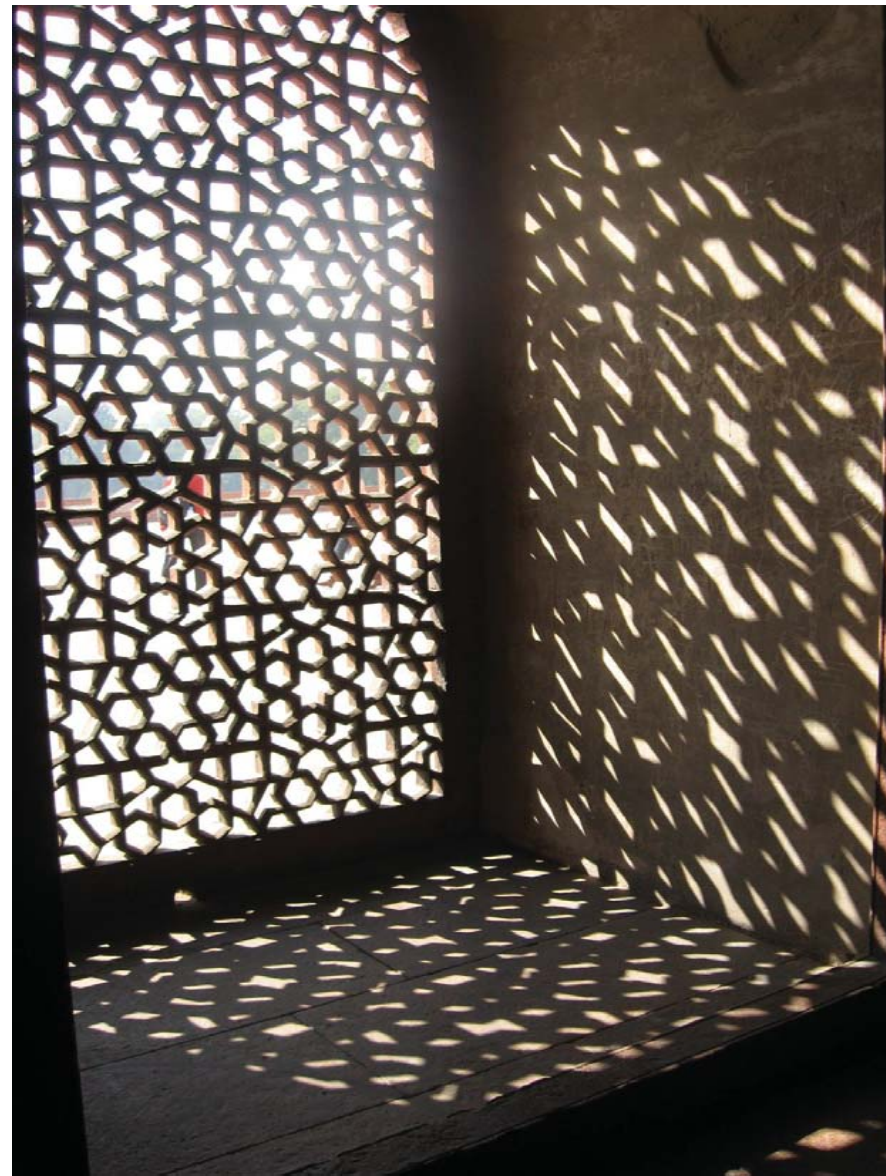
As seen in the following precedents, organic geometry derived from nature create the screen pattern. A sense of rhythm and symmetry define each perforation and cut in a given screen. The shadows created by the diffused light become just as important in defining a space as the screen it filters through. Many of these patterns also symbolize Indian culture through intricacy seen in most religious architecture.



1



2



3

7

Exploration of creating rigid materials flexible

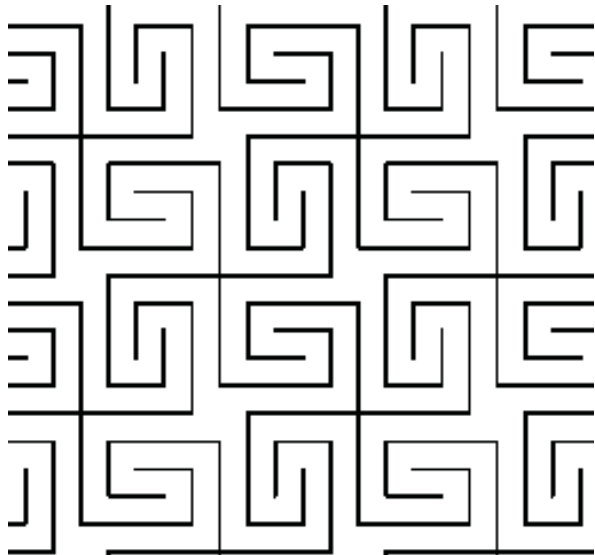
The work of Carl Frederich Gauss, a German mathematician, became important to the early stages of my thesis in developing a pattern. He pioneered in creating single/double fold objects through cuts and perforations developed from basic geometry. This became key in figuring out a pattern to demonstrate flexibility with the notion of a **double fold**. Key concepts of achieving a successful double fold is creating a working ratio between the thickness of a given material, and the size of the pattern.

Double fold - the ability of a given material to bend in multiple directions.

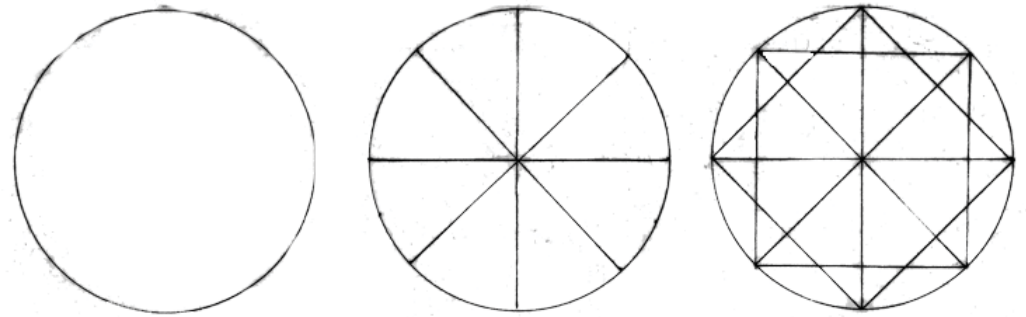
The following is one of Gauss's designs which uses only cuts to create an intertwining pattern. The pattern is used on a rigid piece of plywood to demonstrate double fold flexibility.



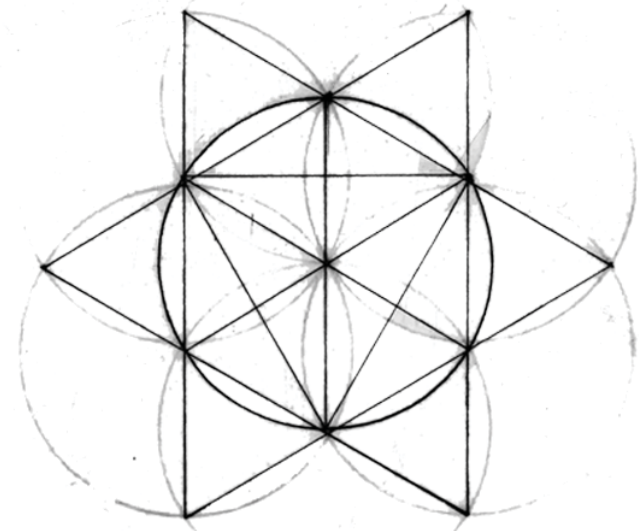
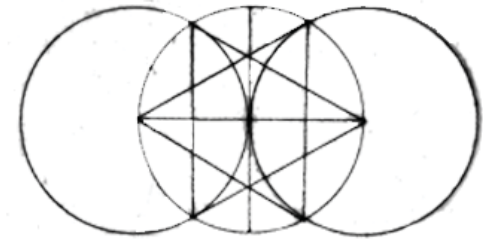
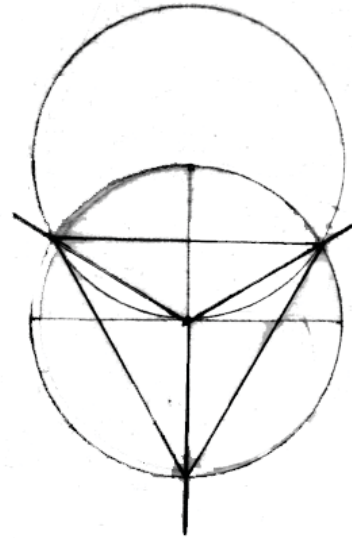
Laser-cut plywood
thickness: 3/16"



Process of creating pattern



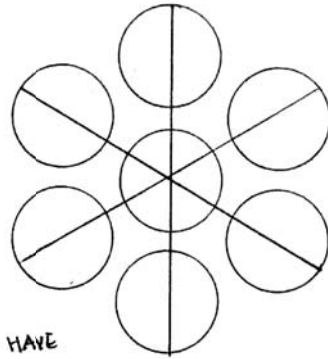
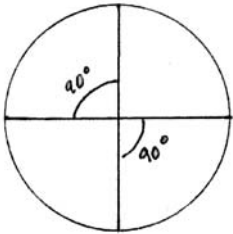
The process of the pattern started out by understanding symmetry found in basic geometrical shapes. I referenced back to the Indian screen to study this concept. The circle became the basis of my study, due to uniformity, which all other shapes stemmed off of. Starting with a circle also kept the segments of an overall pattern constant, resulting a double fold.



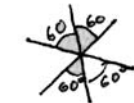
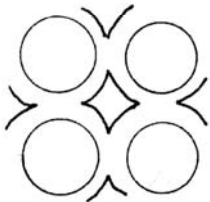
Single point forms, formed from a circle developed into tri-lateral geometries seen below.

CIRCLE

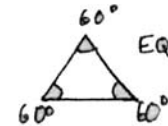
- SEMI CIRCLE WITH CURVES THAT ALSO RESULT IN 360°
- KEEP IN MIND THAT APART FROM SMALLER CIRCLES NO LARGE PERFORATIONS CAN OCCUR



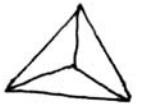
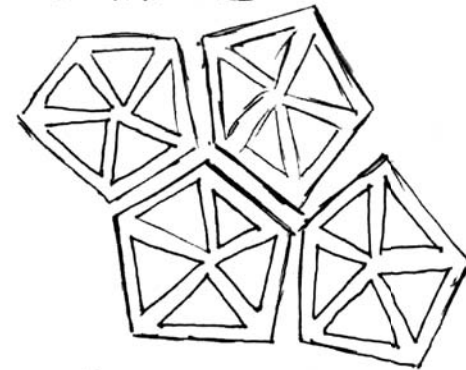
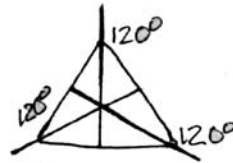
THE INTERACTION BETWEEN CIRCLES CAN HAVE A PERFORATIONS



TRIANGLE
- THREE POINTE PATTERN



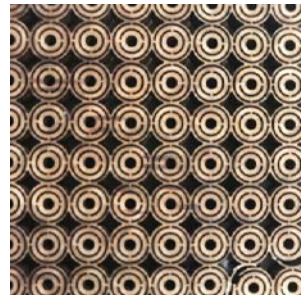
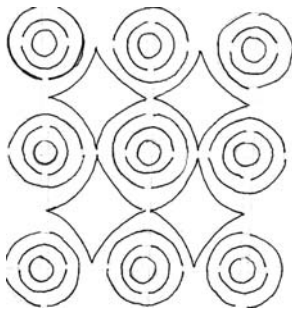
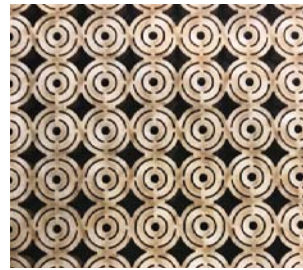
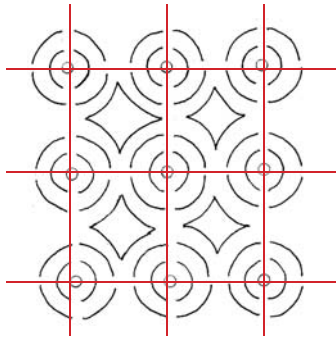
EQUALATRAL TRIANGLES



Process of creating pattern

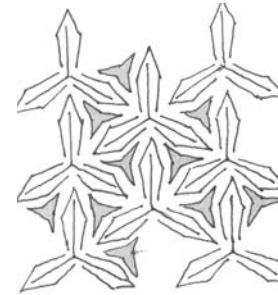
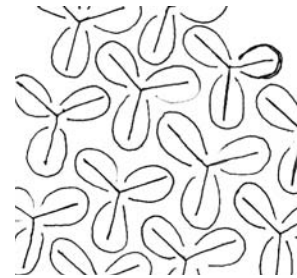
From the previous study I created two distinct patterns. The first following a basic circular geometry. The second following a trilateral geometry which almost mimicked flower petals. Each went through a trial and error process using plywood as the experimental material ultimately resulting in flexibility. The ratio between thickness of material and size of pattern were key in the study.

Pattern 1



The first piece failed due to the formation of a grid which resulted in zero flexibility, The second piece utilized the rotation of every other circle, to stop the grid, however the piece failed due pattern size being too small. The last piece demonstrated a minor flexibility, due to change in size of pattern.

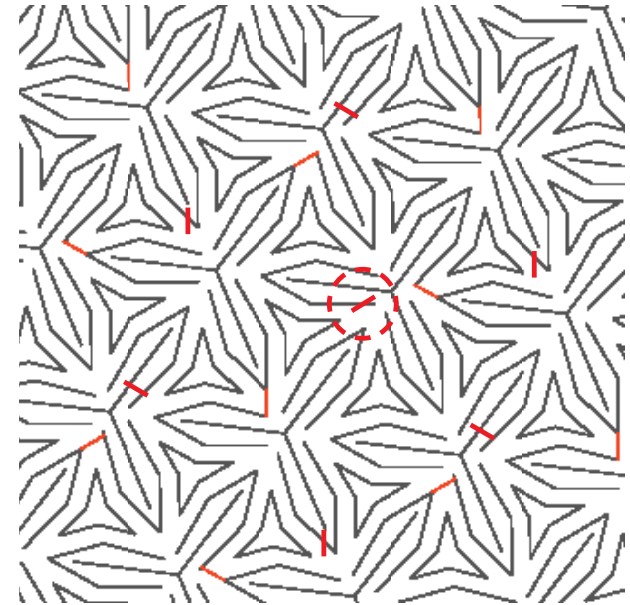
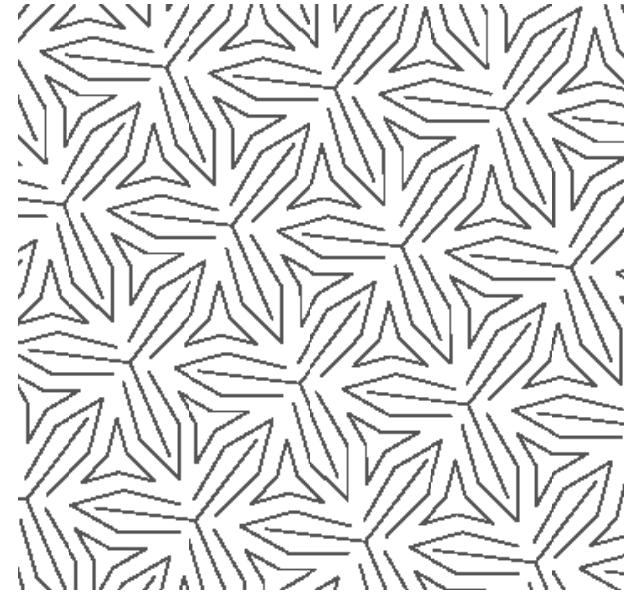
Pattern 2



The first piece failed due to the curvature of each petal. The second piece was semi flexible due to straightening of petal geometry and added perforations. The last piece demonstrated complete flexibility, due to a perfected material thickness vs. size ratio.

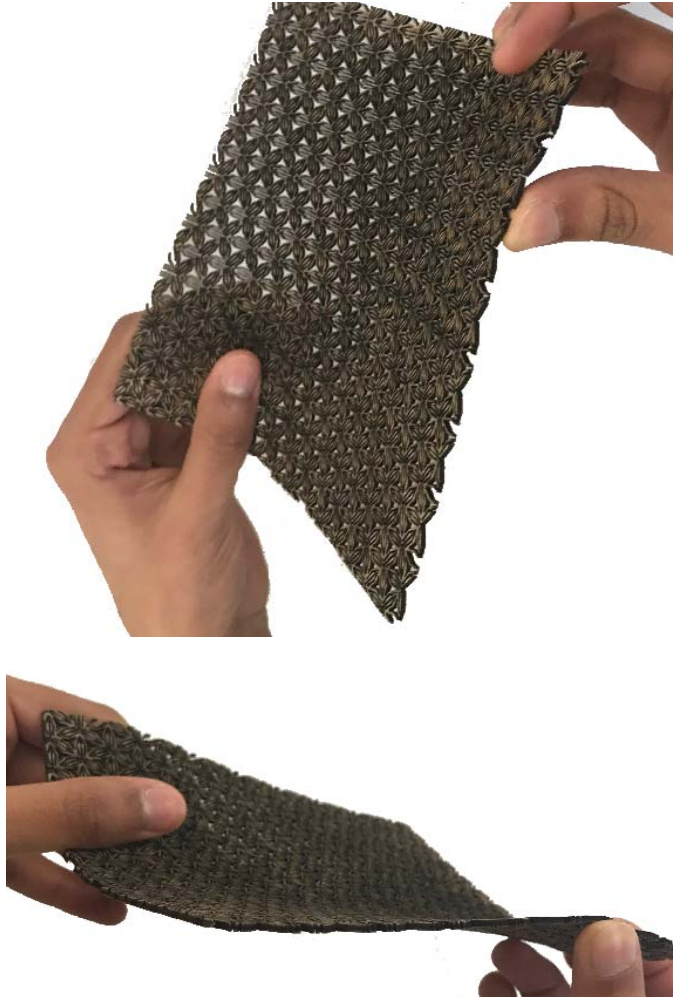
Pattern selection

Out of the two patterns, the second pattern was more successful in creating a flexible double fold. Therefore, further changes were created by adding cut lines which connected every separate petal. The exploration continued towards testing different material thicknesses of plywood. The pattern was also tested on acrylic to compare flexibility. Acrylic due to its material property created a more flexible piece. However due to the nature of laser cutting, acrylic was more prone to melt due to intricacy of pattern size. Therefore wood was determined to be the final material the exploration would continue with.



1/16" basswood

The pattern was tested on a thin piece of basswood to study how far the scale can be transformed.

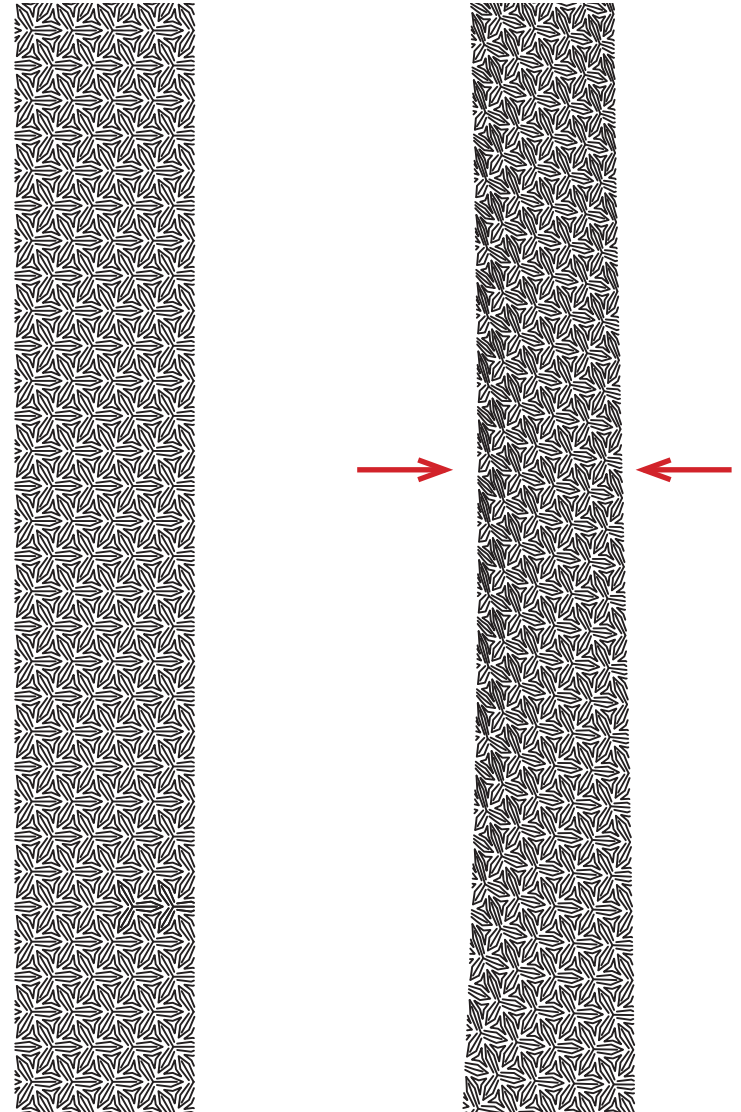


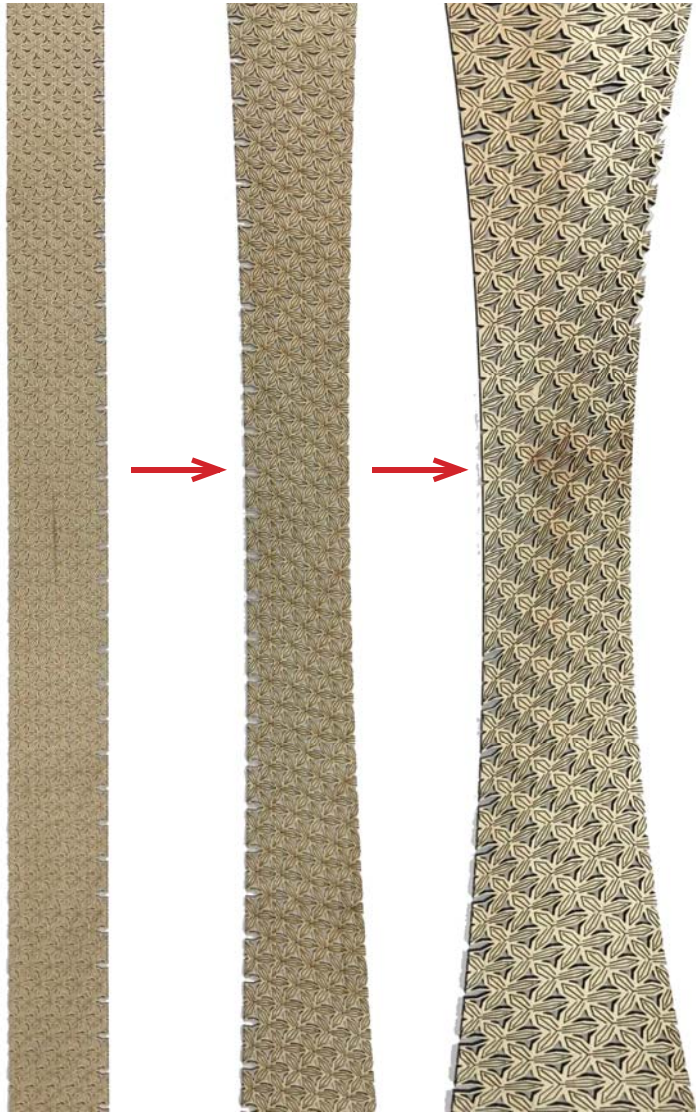
1/32" acrylic

Acrylic demonstrated more flexibility than wood, however the process of cutting was more fragile due to heat.

Modularity of Pattern

After establishing a standard ratio between thickness of material and size of pattern for maximum flexibility, I decided to explore the modularity of the pattern itself. The question became whether a targeted bend could become more flexible by adding a compression point in the pattern. Multiple tests were done using different pattern scales, on different thicknesses of wood. The conclusion of the experiment revealed that a compression in the pattern does create more durability at a targeted bend.





As seen, multiple tests of the modularity pattern were done based off of compression and material thickness for a targeted bend.



1/8" basswood

The pattern was tested on a longer plane to study durability limits

Application of Pattern

Real world applications from my pattern was narrowed down to creating a large scale urban instillation which could be used to define an existing landscape in an interactive way. The following renders were created to show a possible scale that can be given to these instillations. Keeping human scale in mind while creating these was key, due to intentional use of space.





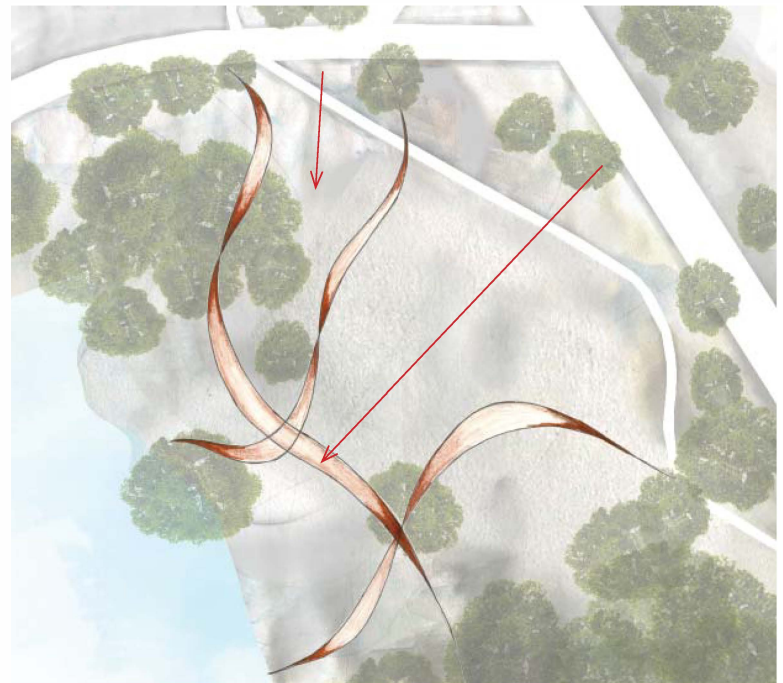
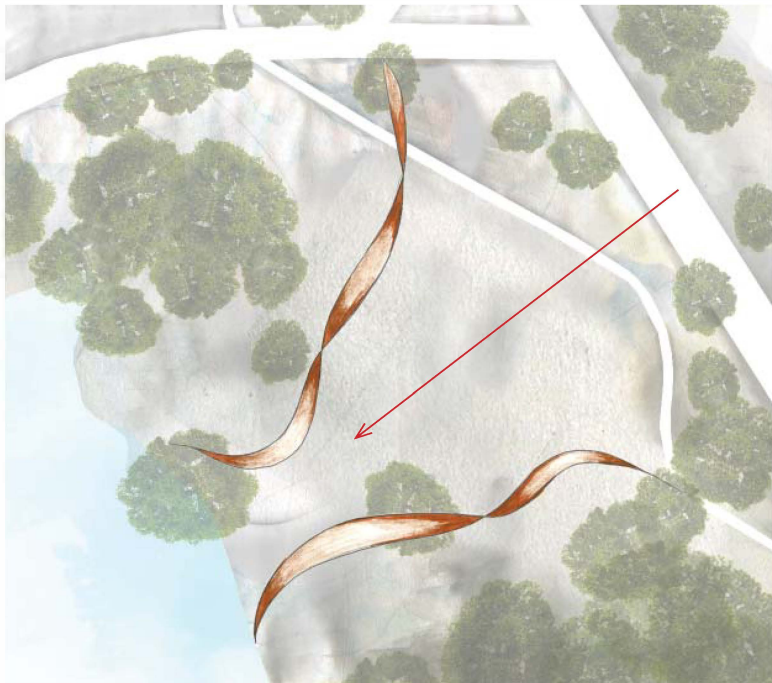
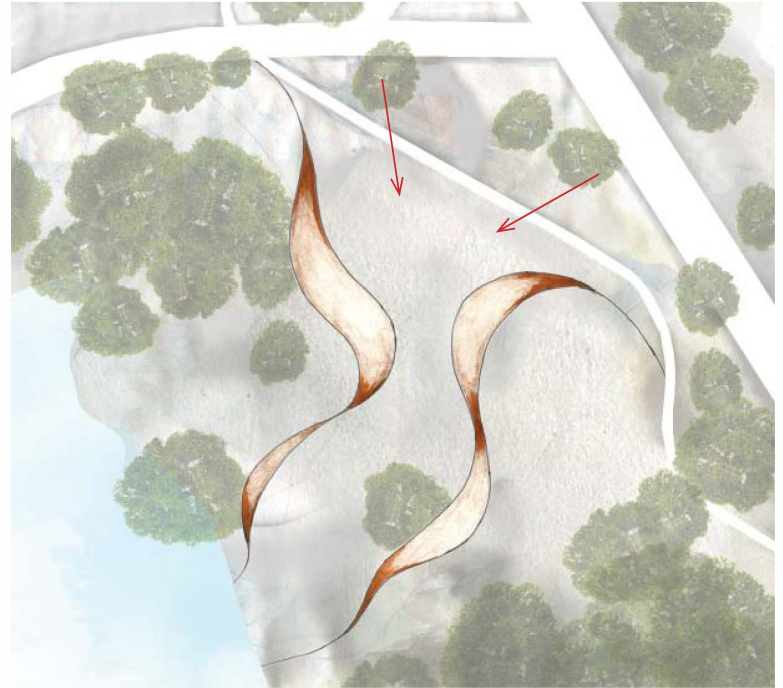
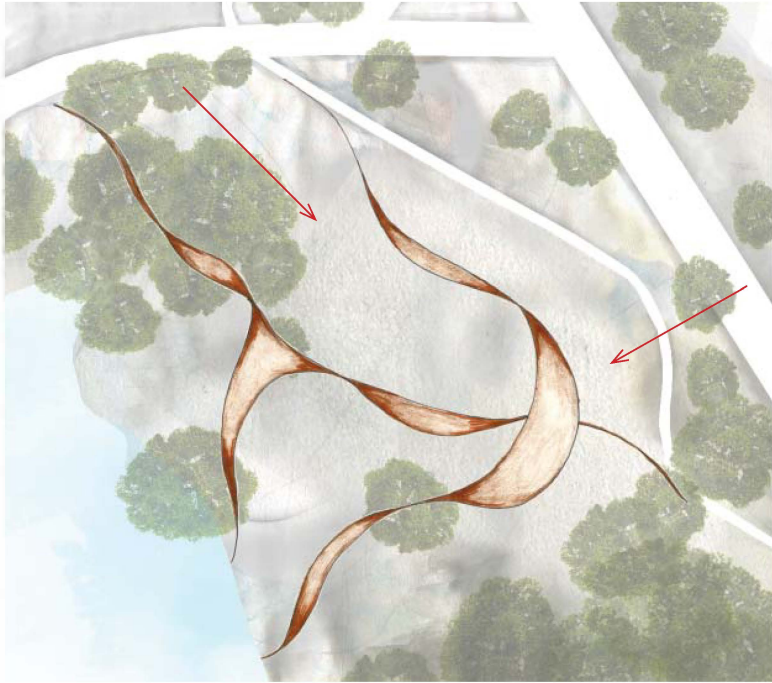
The Duck Pond on Virginia Tech's campus became the chosen site for multiple reasons. Existing vegetation acted as limitations for designing these installations. The topography has a slight grade change which also defined site boundaries. A walking path extends throughout the site which is utilized by many everyday. This presents an interactive opportunity for the site. Beautiful views towards the water also present framing opportunities by the installation.



Site Study

From initial observations, these diagrams were developed to study potential instillation placement and possible views created by them. While diagramming, successful pattern pieces with modular curves were kept in mind from the previous exploration. This narrowed down how each separate instillation would adhere to a specific double-fold bend. The diagrams primarily address views and entrances to the site based off of existing geometry and foliage.





Final Concept

For the final design, 4 separate installations were created to define the urban landscape. Two (1,2) address the free standing, durability and flexibility of the modular pattern (seen in plan). The other two (3,4) address the linearity of defining topography (seen in section). The large circular piece (1) curves over the walking path and actively engages individuals using that path. The large free-standing over head piece (2) frames views seen from the Duck pond drive, and West Campus drive towards the actual duck pond.



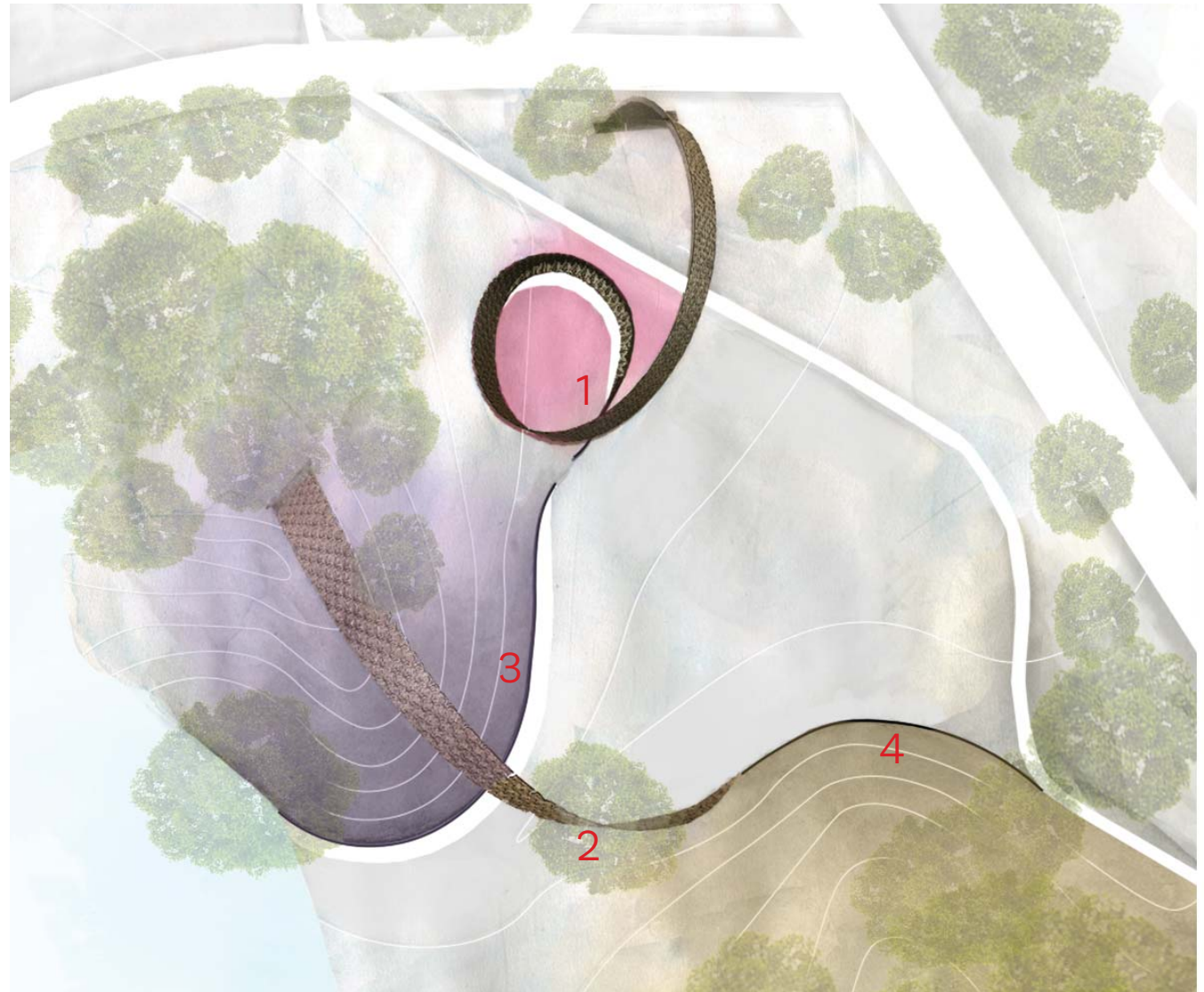
200'-0"



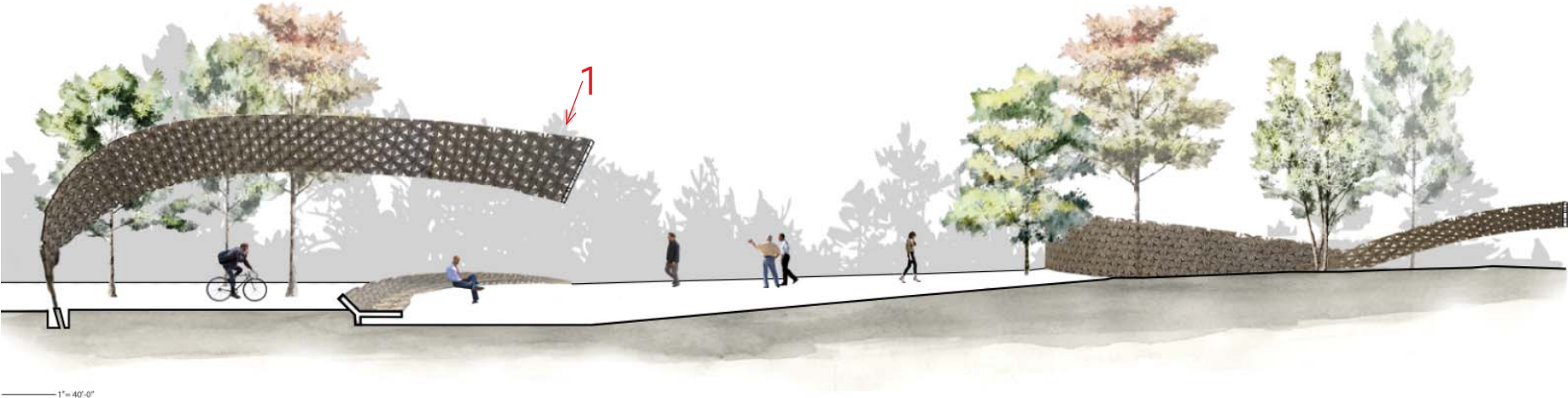
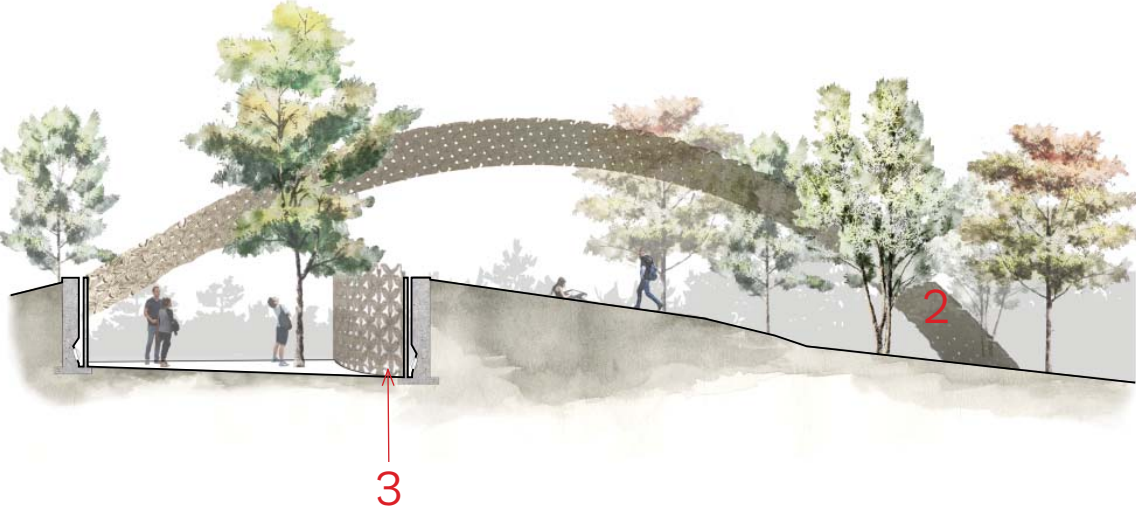
Final Concept

The spaces created by each of the instillation's is given a possible program as seen to the right. The raising of topography as shown in section allows for a unique experience of being both on top and under two instillations.

-  Exercise
-  Seating area
-  Amphitheater

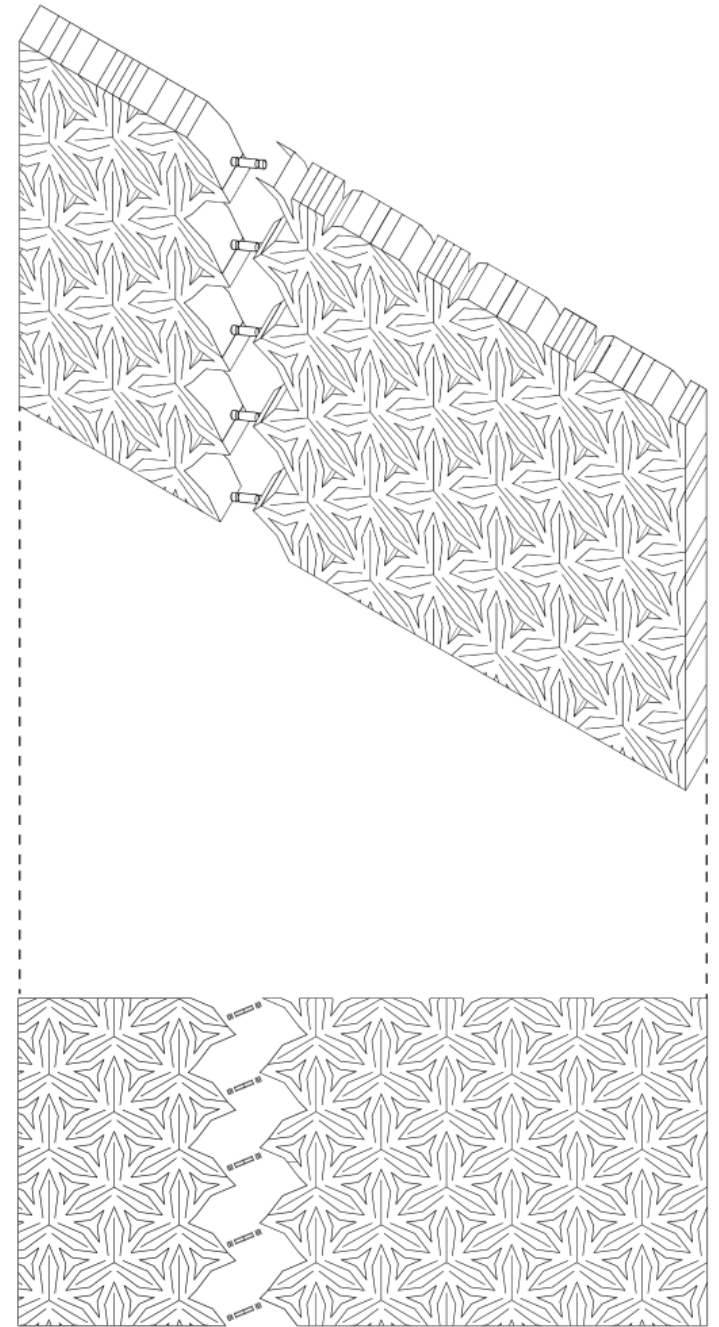


The sections show an interactive relationships between the user and the instillation

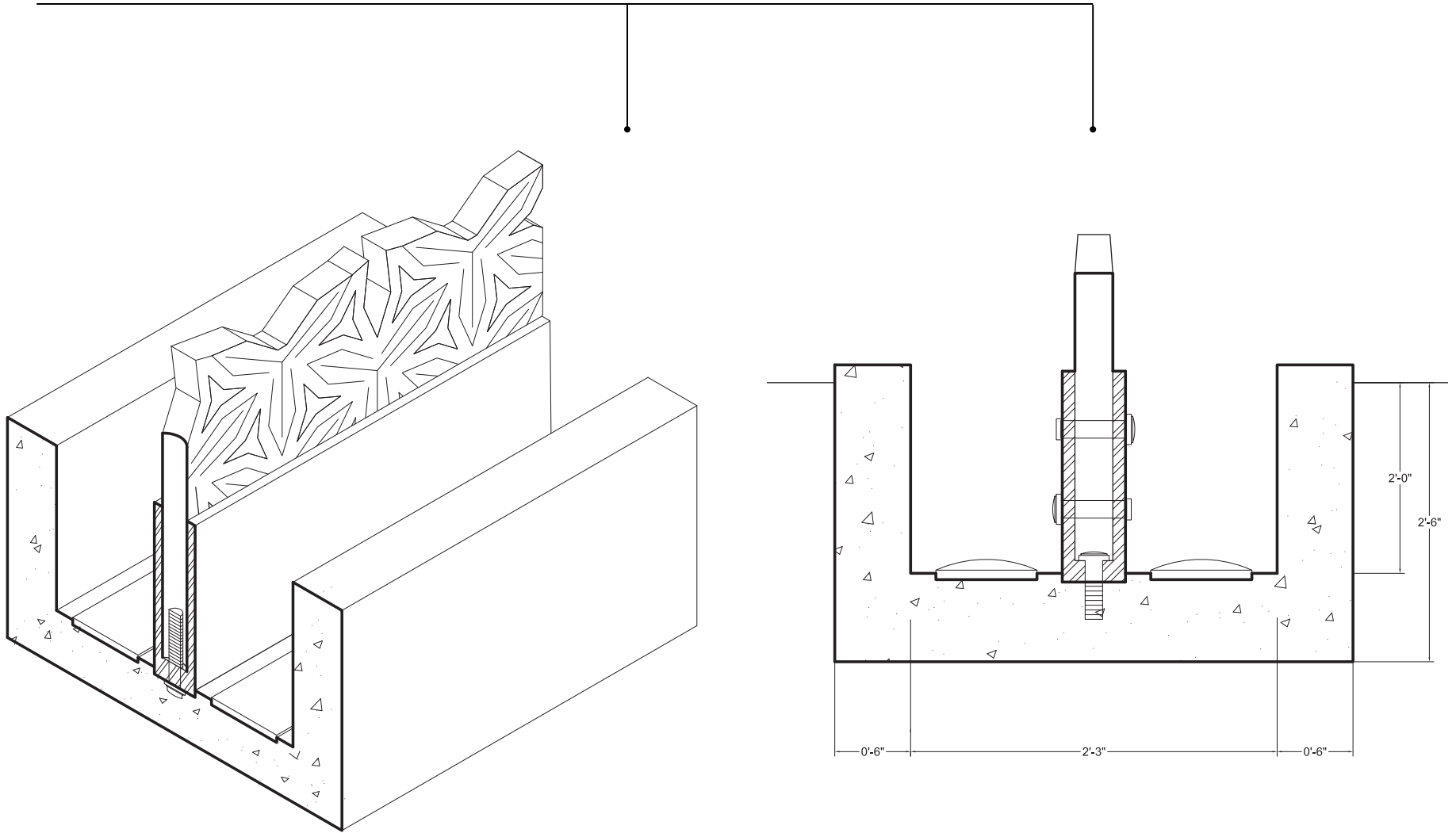


Structure concept

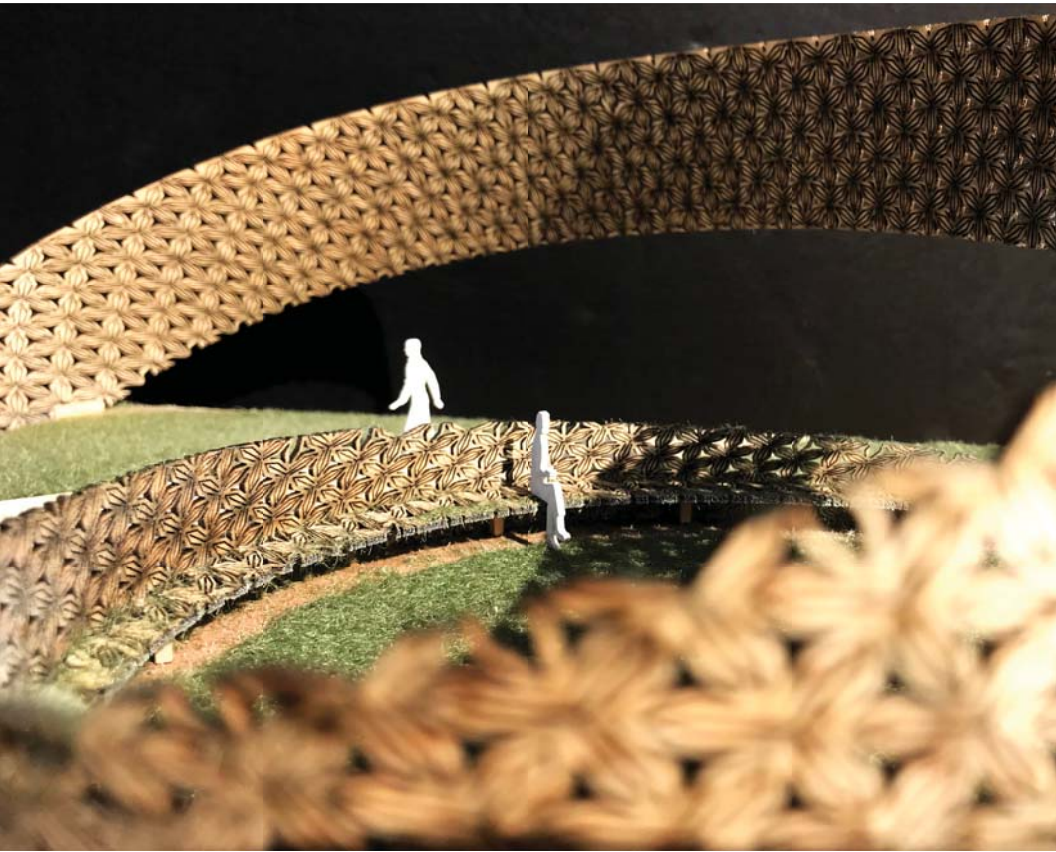
When built on a 1:1 scale, how to physically fabricate the instillation becomes a huge question. Segmenting each piece with the pattern cut in mind, with steel fasteners poses a possible solution. The diagram to the right better shows how the segmented pieces would be cut and installed.

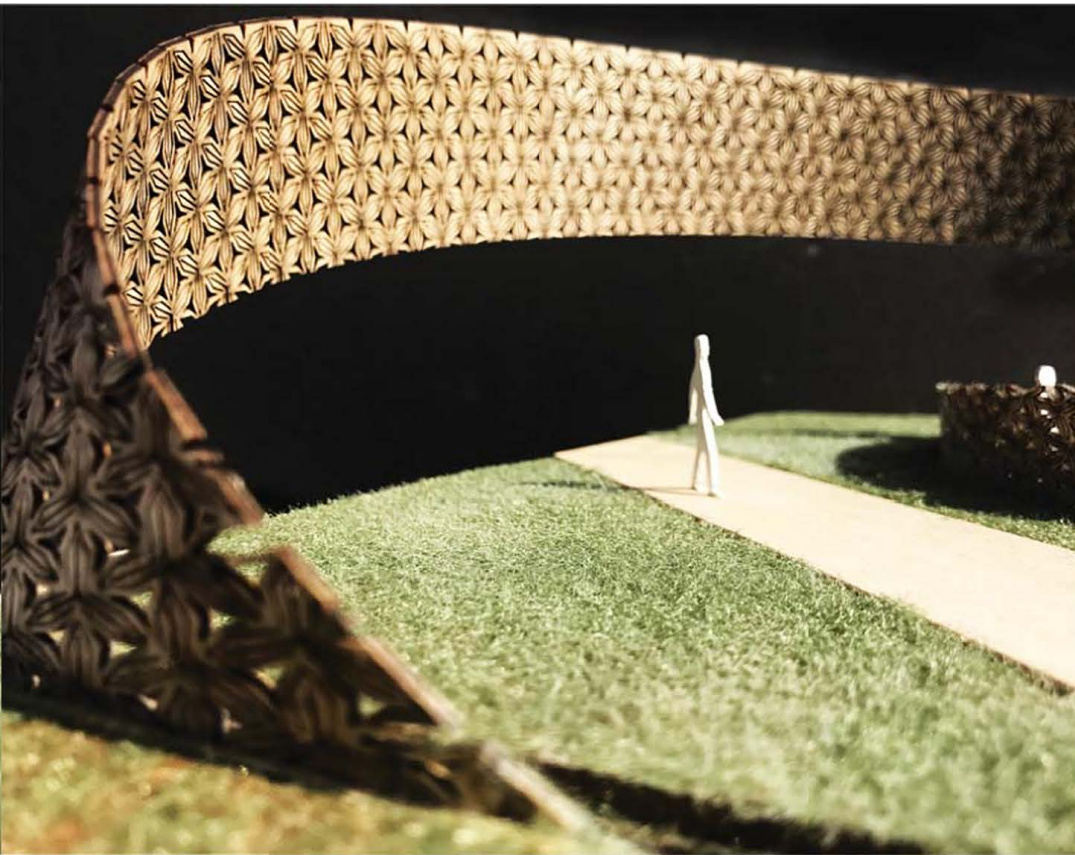


How the instillation addresses the ground can be seen through these diagrams. The piece would be submerged into a concrete footing with ample space for night-time lighting. The piece would be held together by a steel fastener with large bolts running perpendicular to the pattern.

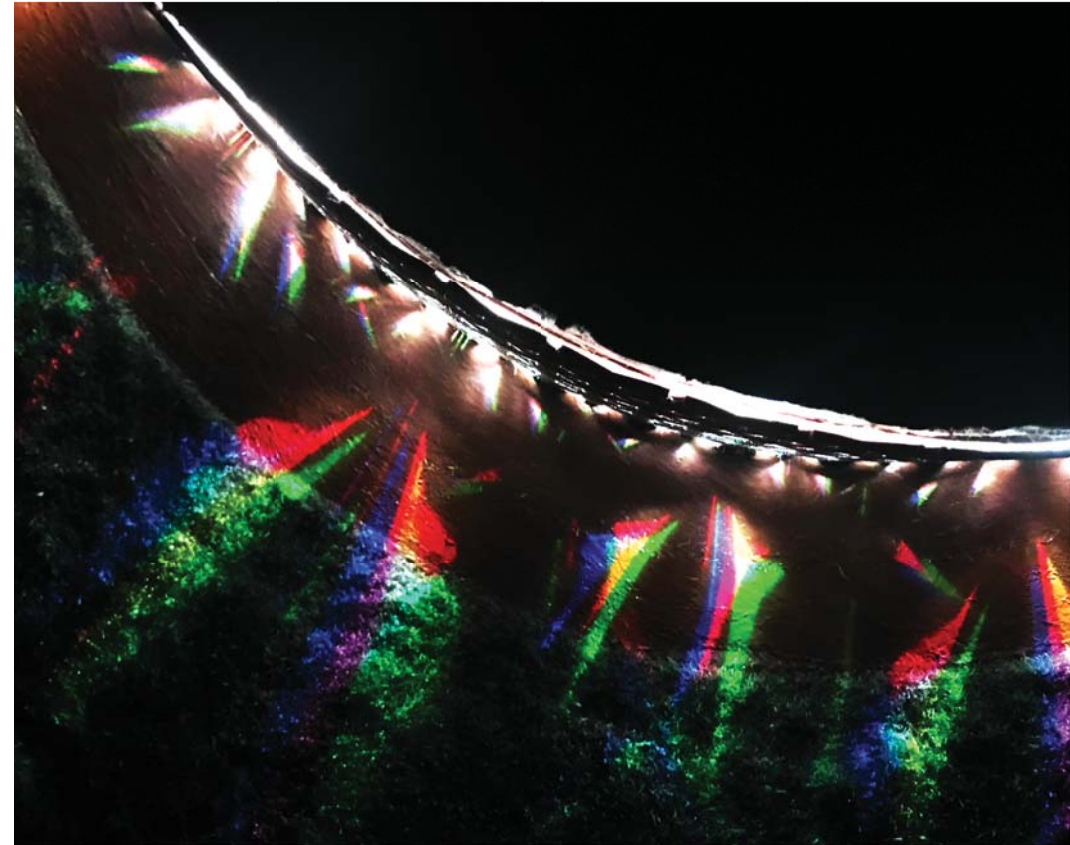
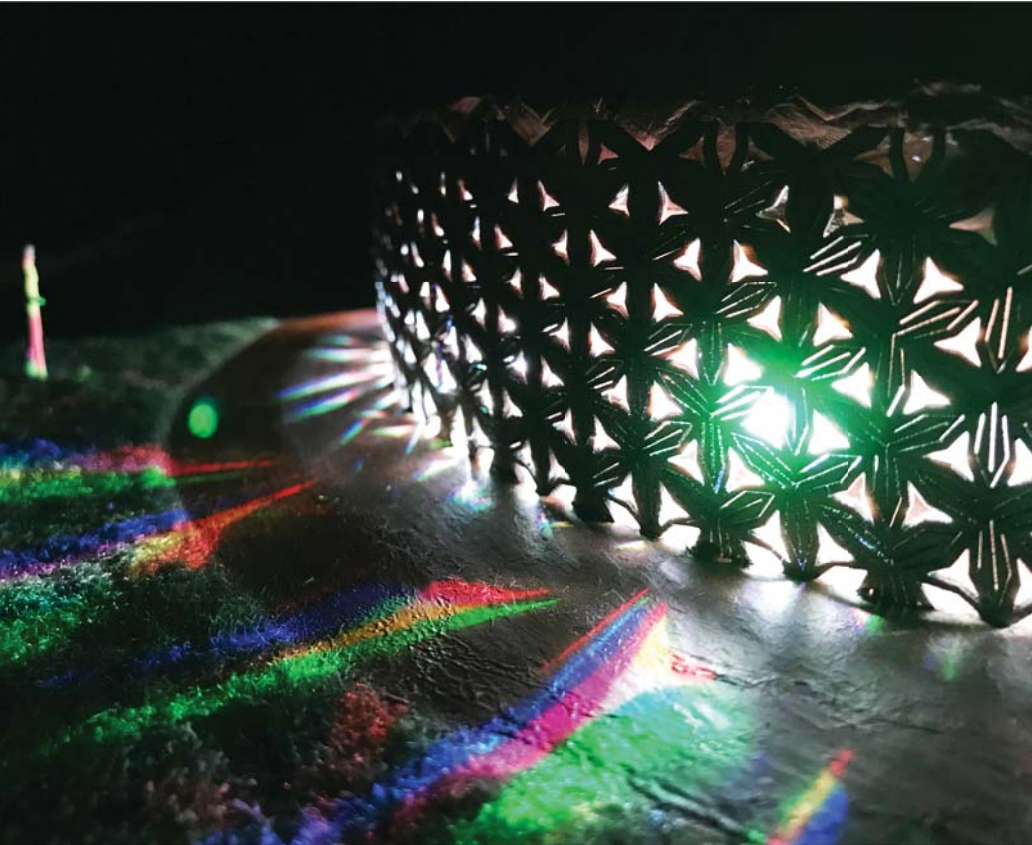


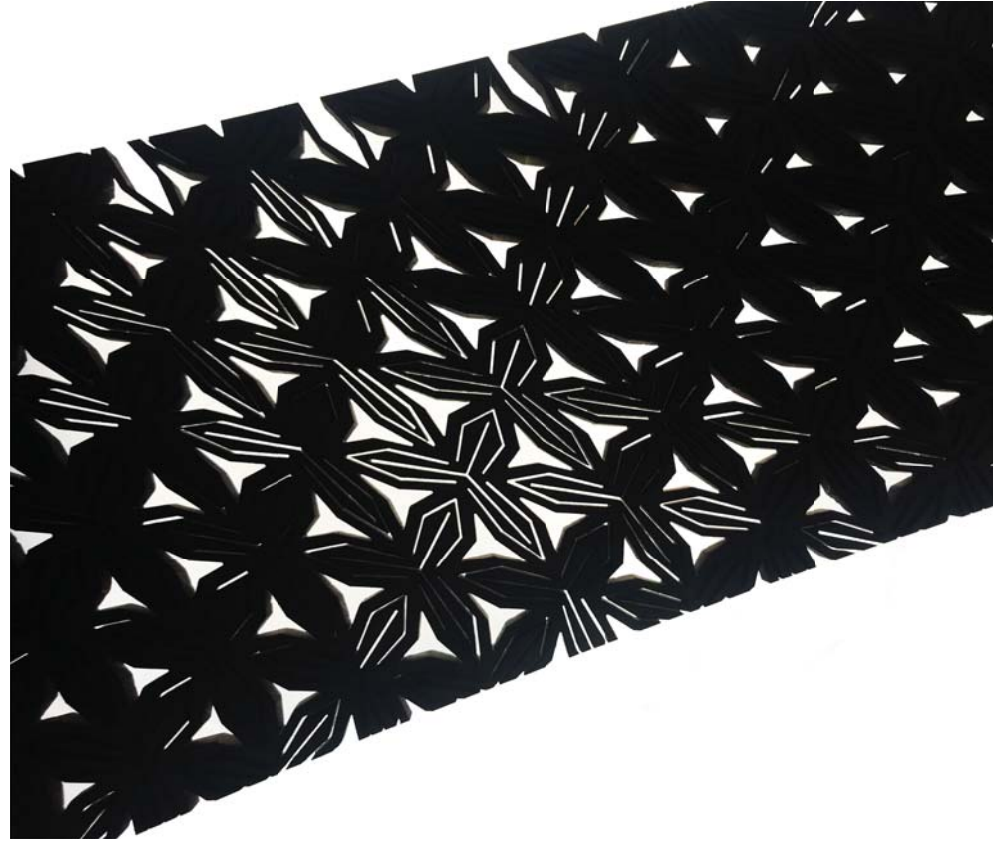
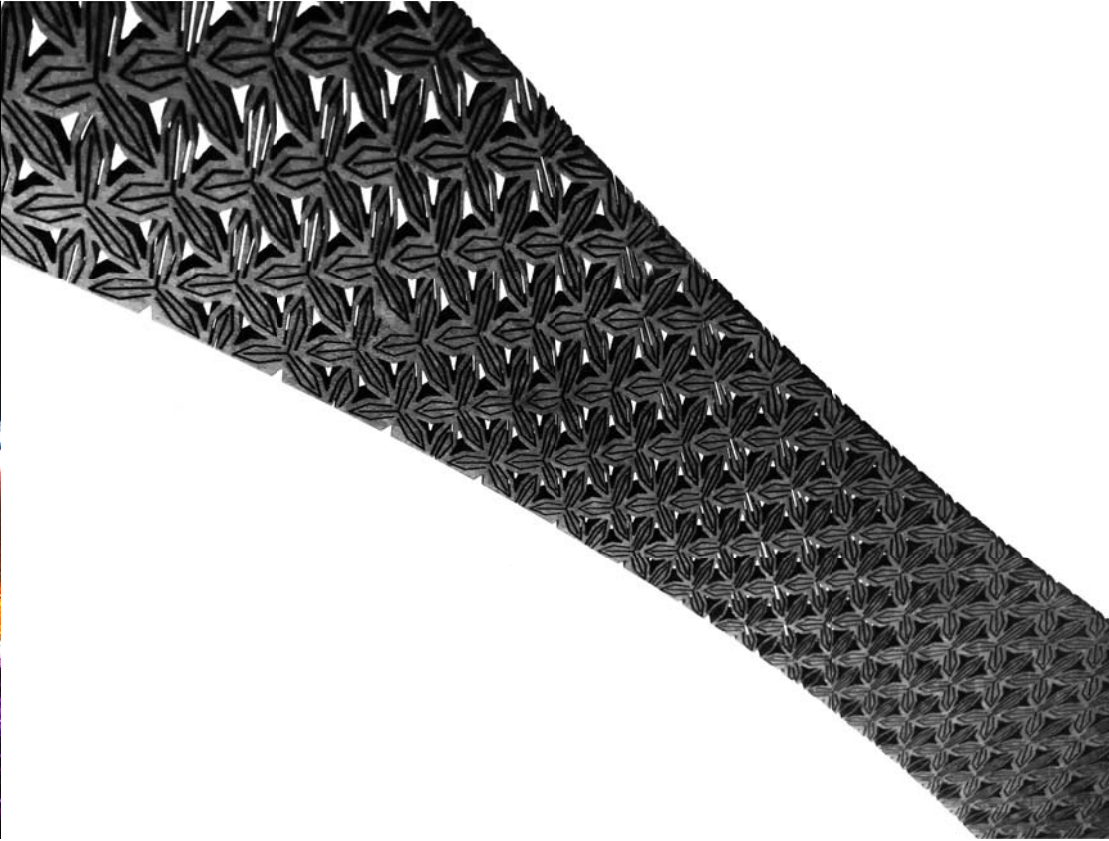
Photography – natural light





Photography - artificial light





Photography – time lapse

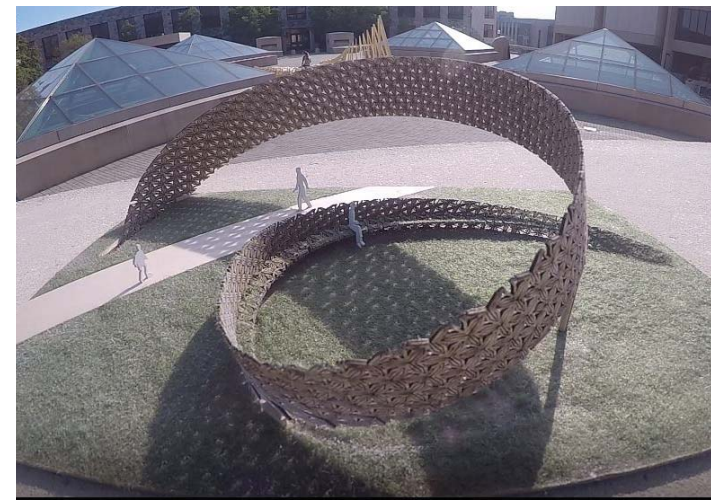
1:00 pm



2:00 pm



3:00 pm



4:00 pm



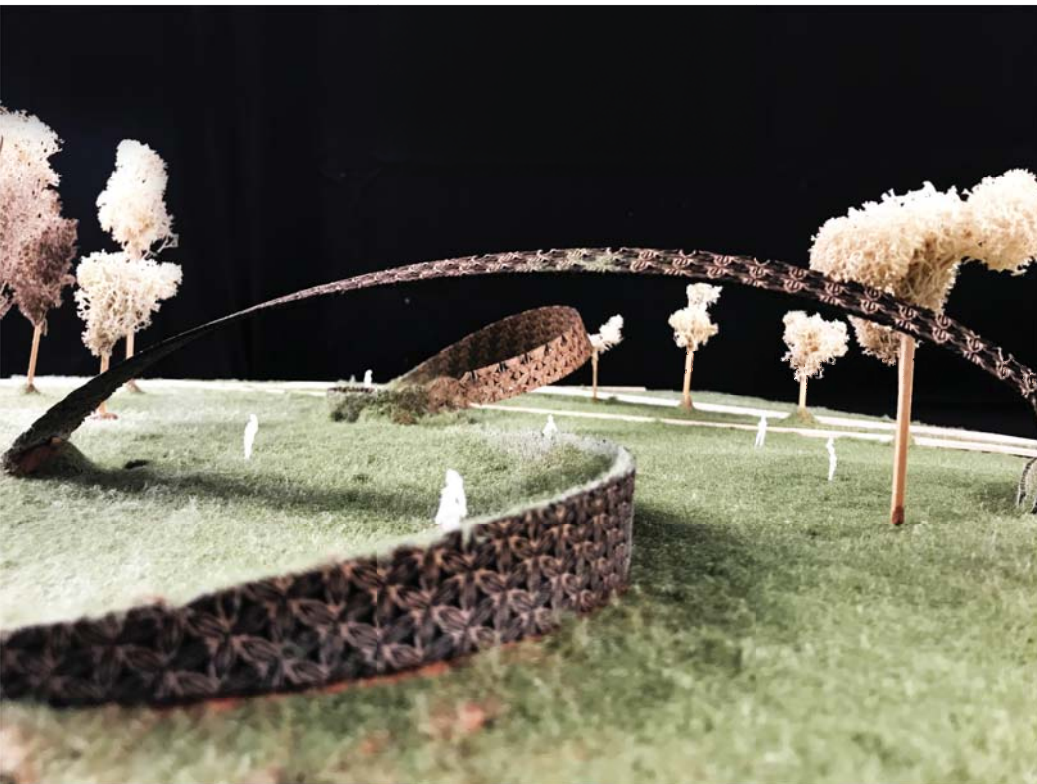
5:00 pm



6:00 pm



Photography – site model





CITATION

- 1) <http://topfurnishing.co.uk/4-panel-hand-carved-indian-screen-wooden-screen-divider-kashmeri-jali-177x183cm-2761-p.asp>
- 2) <https://www.pinterest.co.uk/pin/275071489716606563/>
- 3) <https://www.pinterest.com.au/pin/16466354857290716/>

Thank you.