MOUNDS

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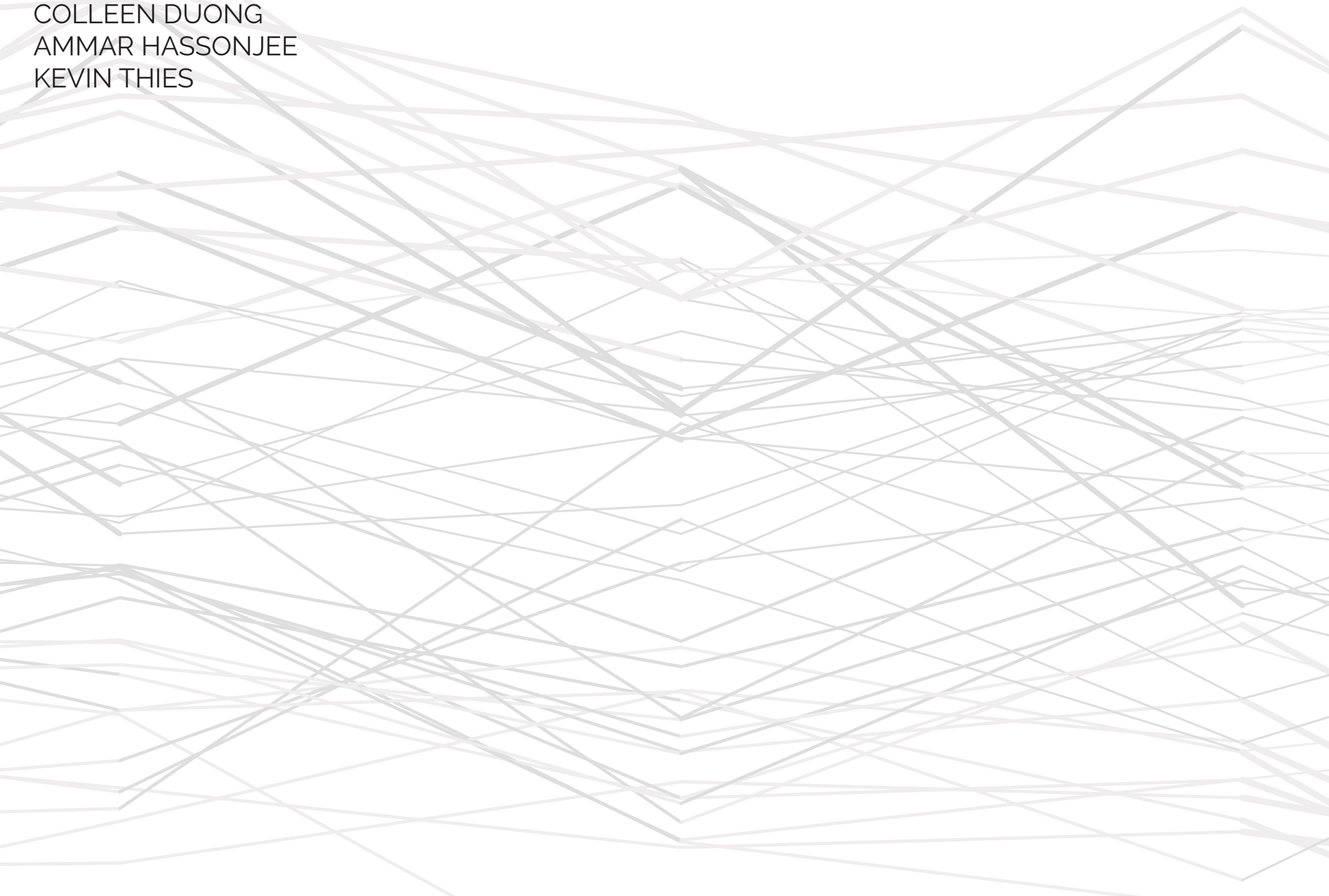


INTRODUCTION

Throughout this course, we have been exposed to unique design

workflows that revolve around the use of robotics to fabricate complex forms derived from compuational and parametric design. This project represents our experience with this workflow as we were asked to

create a set of intricate concrete casted panels.

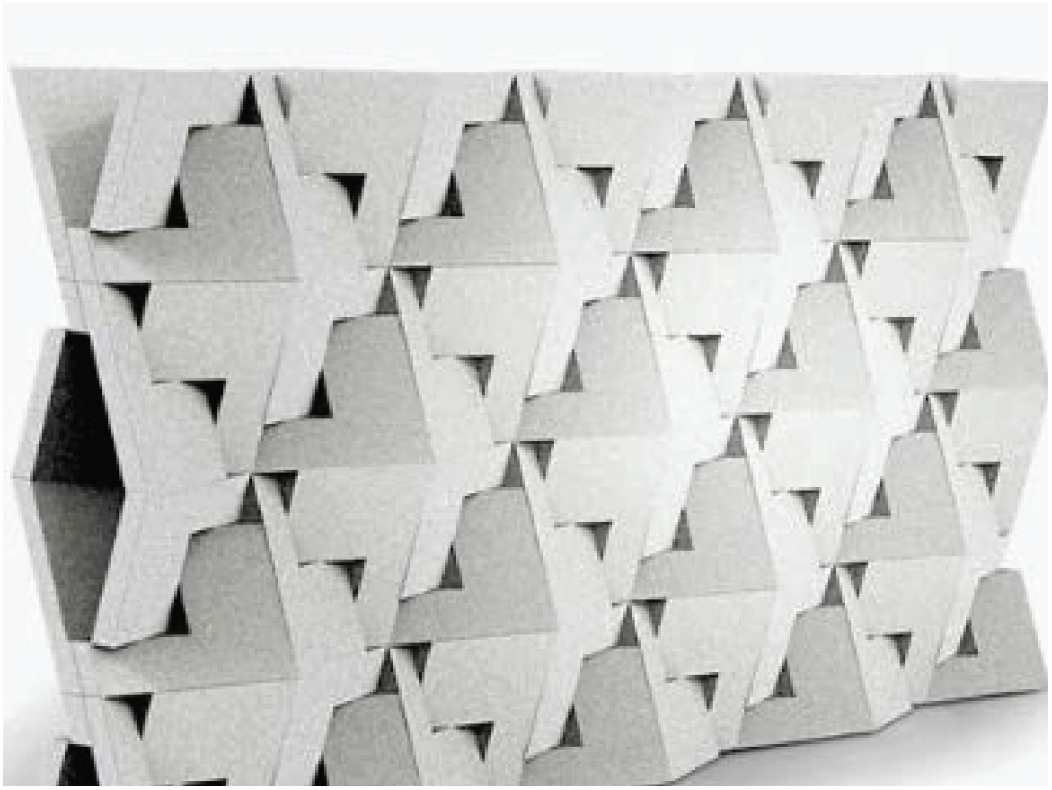
The concrete panels were fabricated using a hot-wire cutter and an IRB 6640 robot, which was programmed using a mix of RAPID Programming, RobotStudio, and HAL.

CONTENT

1 ASSIGNMENT PARAMETERS / INTENT

The assignment brief asked us to design a series of 3 panels that could be cut using the hot wire cutter tool attached to IRB 6640 robot and then be used as a mold for casting concrete.

Our initial concepts and thoughts were inspired by the natural forms we found in termite mounds and explorations with tip extrusions. The general workflow we envisioned for developing a piercing form like this was to develop a complex form in grasshopper and create contours of curves that can be used to create ruled surfaces



PROJECT SCHEDULE

CHALLENGES

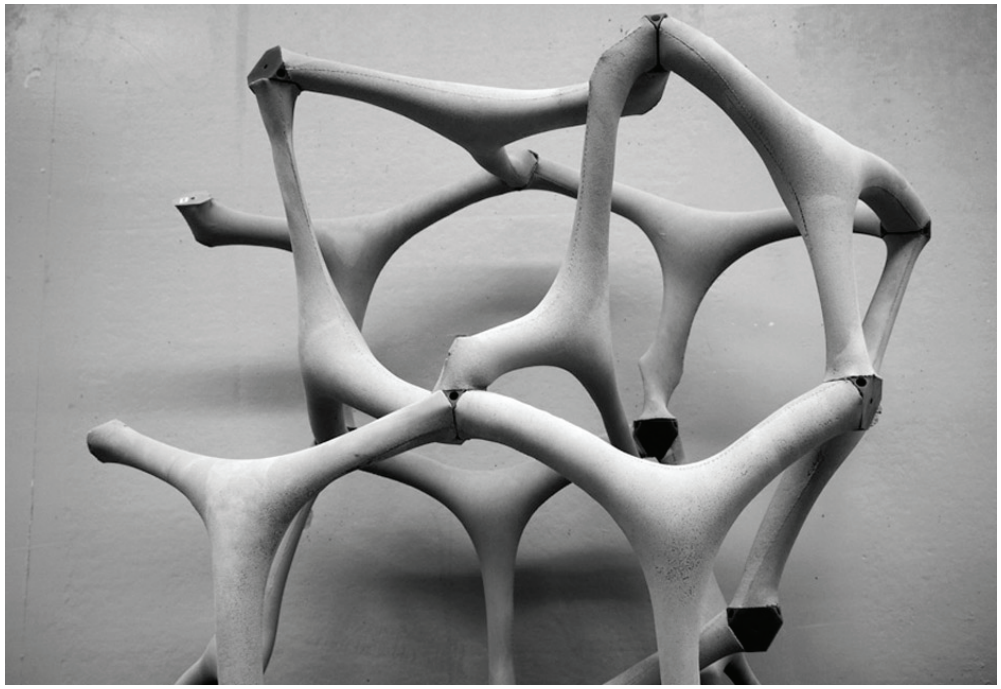
Some of the challenges we initially faced with our design and proposal were that it would be difficult to represent the radical formwork and intensity of the points of a termite mound. Also, defining the points where they're are pores within the surface also posed issues.

	11/06	11/08	11/10	11/13	11/15	11/17	11/20	11/27	11/29	12/01
Project Phase	Design Phase	Fabrication Testing	Fabrication Testing	Fabrication Testing	Project Fabrication	Project Fabrication	Project Fabrication	Project Fabrication	Project Fabrication	Project Submission
Homework	Prepare form Start fabrication testing Drawings for new design and old design Finish updating documentation	Cut foam pieces (Hopefully) finish cutting	Start prepping HAL file Update documentation	Update documentation Review and Write HAL File	Prepare Final Foam Finalize HAL Script Finalize Toolpath	Continue Final Fabrication	Continue Final Fabrication	Finish Final Fabrication Put foam pieces together Start Casting	Finish Casting	Project Submission
Work Session	Fix grasshopper file Prepare Foam	Prepare Foam Start fabrication testing Test Handcut 1		Review and Write HAL File	Finalize HAL File	Continue Fabrication Cuts Document-ation	Continue Fabrication Cuts Document-ation	Continue Fabrication Cuts Docume-`nt-ation	Finish Casting Finish Document-ation	

PRECEDENT

These precedent studies represented our interests in exploring the process and methodology in which robotics could be used to generate curved formworks with peaks or undulating curves, and also showing how apertures could be represented in concrete casted works.

Concrete Roof Exploration
ETH Zurich, Phillipe Block, and Arno Schluter

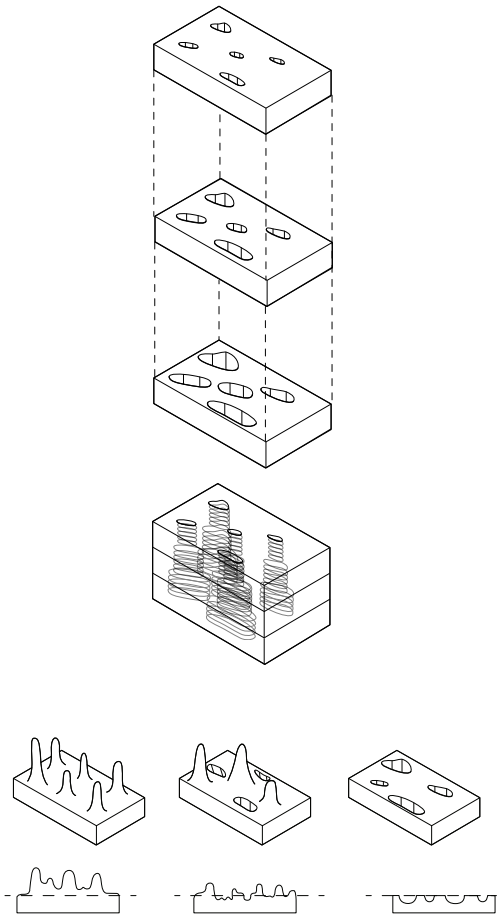


Fabric Forms Project
University of California
Joseph Sarafian and Ron Culver

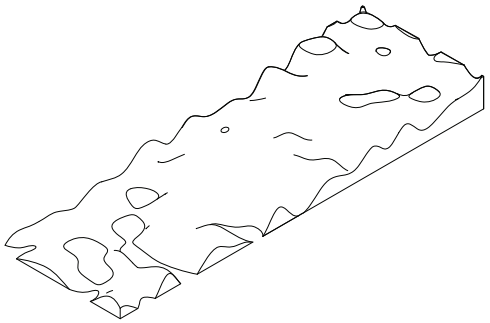
3 DESIGN ITERATIONS AND PROCESS

Our panel concept derived from the ideas of mounds and porosity. Using these two ideas we developed a spectrum of both vocabularies into a set of 3 panels to show our concept to link the ideas together. Part of the overall form results in inverted mounds that create porosity but also serve as a reflection of the vertical, pointed mounds that compromise the other panel.

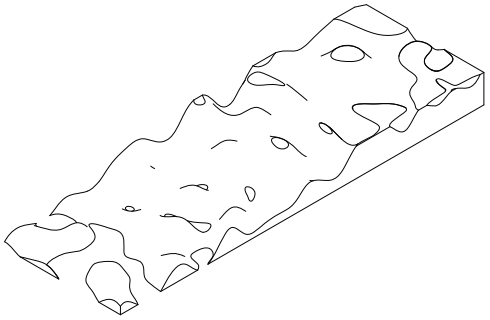
Our initial ideas were to create three tiles that would stack on top of each other to try and create the idea of porosity and mounds by creating a different language for each panel. However, that idea seemed a bit too difficult to really see the transition between a porous surface and a surface consisting of mounds. That led us to thinking of creating three different tiles that had three different languages (one of porosity, one of mounds, and one of the in between of both) that, when put together, would create one continuous surface.



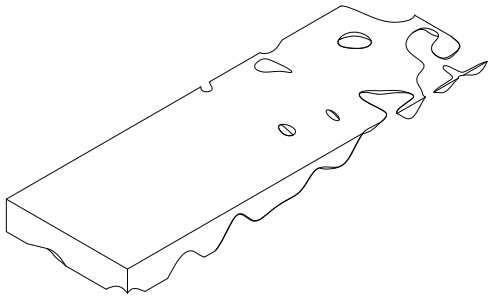
ITERATION 1

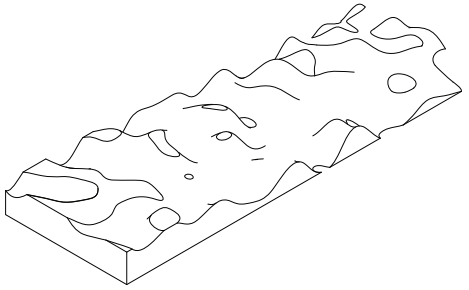


ITERATION 2



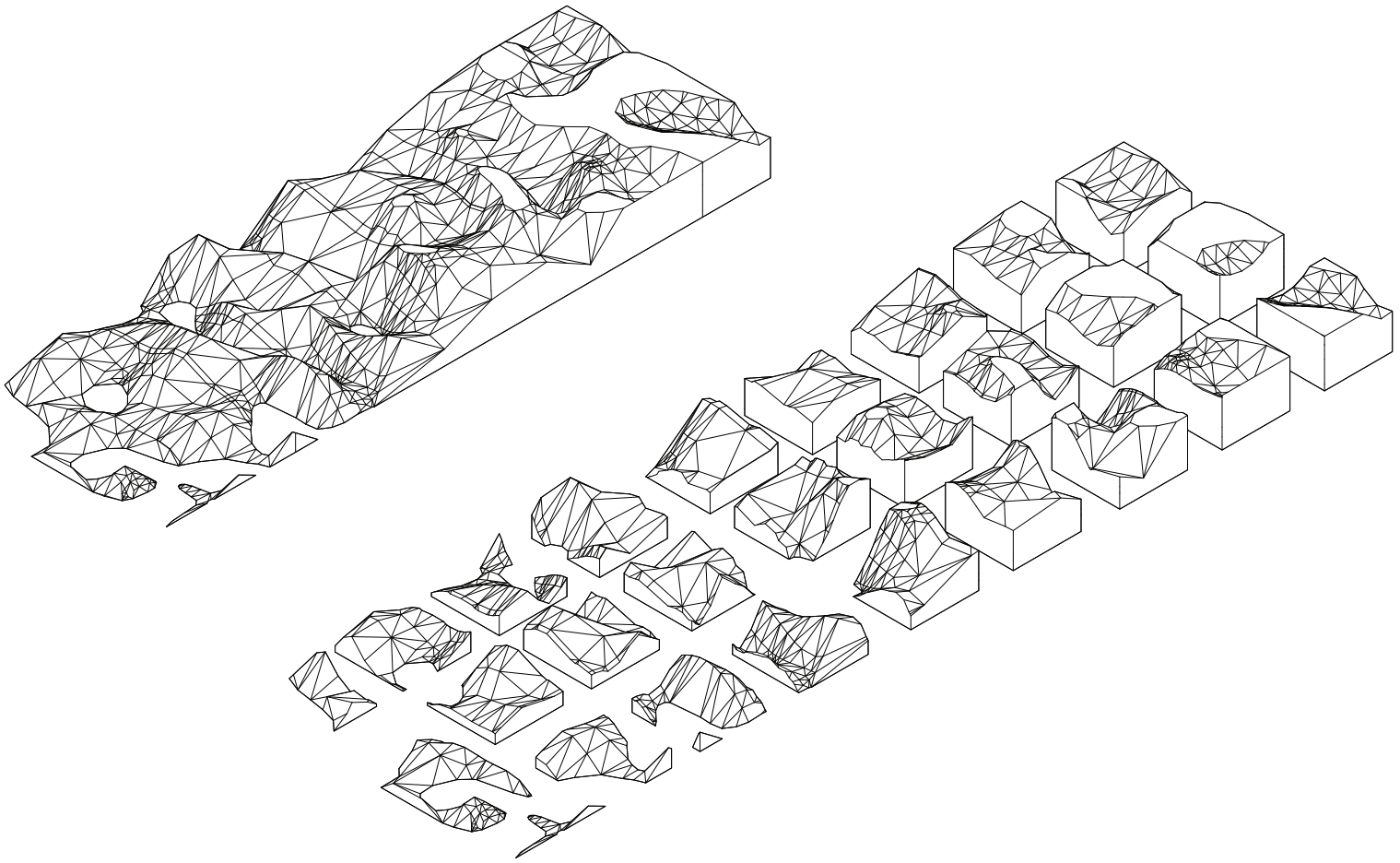
THE INVERSE (THE MOLD)





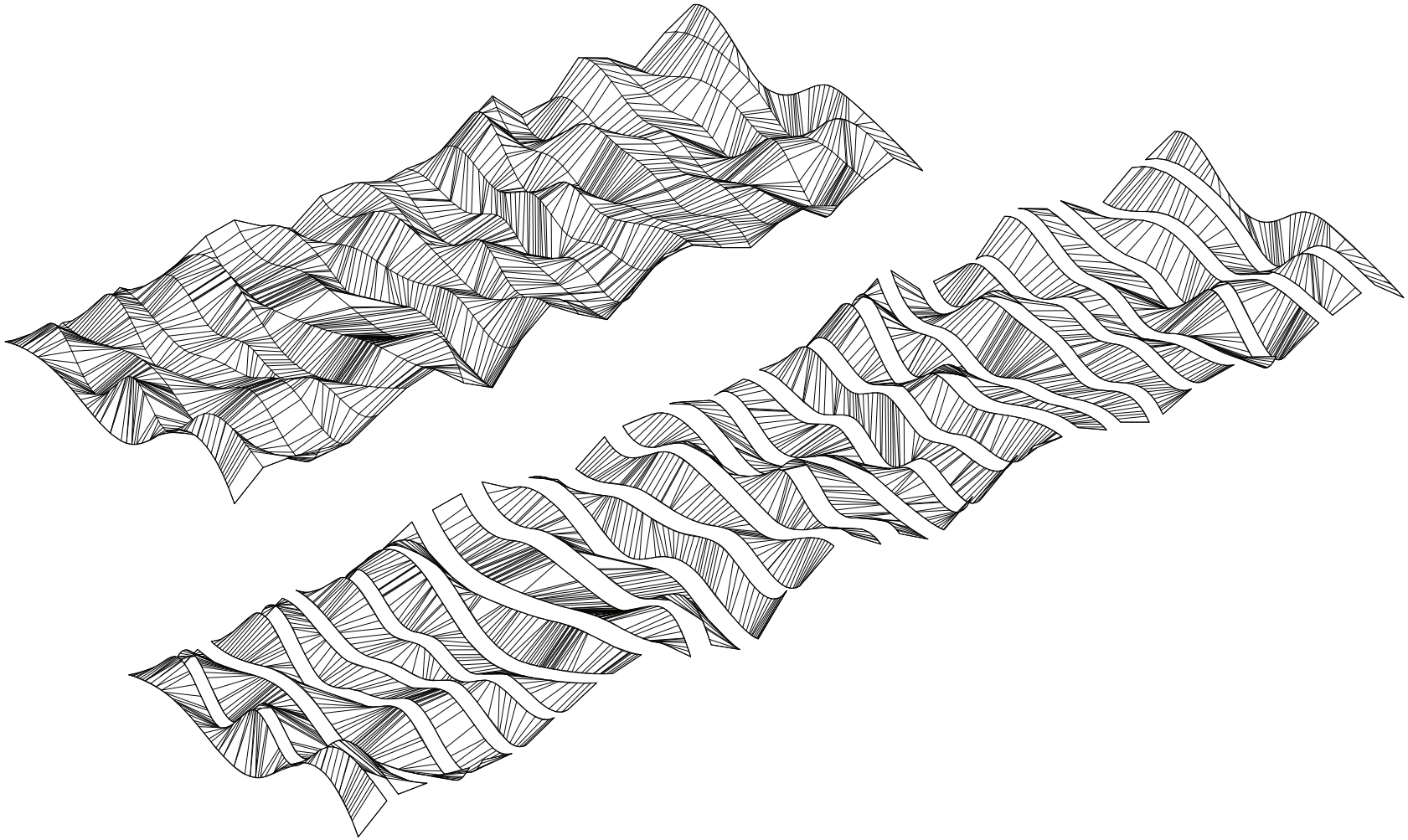
FIRST DESIGN PROPOSAL

Exploring ways of incorporating the ideas of porosity and mounds into one model, we tried to create a polysurfaced surface that was cut up into 9 pieces per tile, a total of 27 cubed pieces. However, we discovered that there were problems with this design because the robot would have difficulties cutting the dips and curves that were produced in this design. It would also bring issues with the final fabrication part of this design, like creating a sort of grid-like pattern on the final model because of the way the pieces were cut.

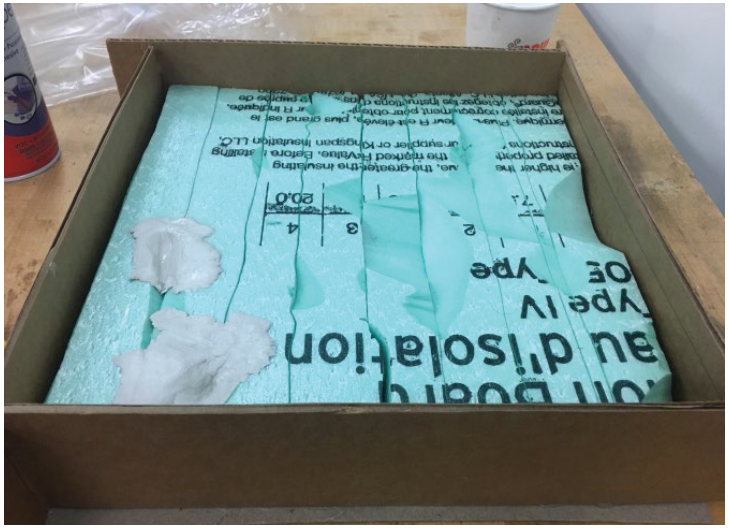


SECOND DESIGN PROPOSAL

Representing the same concepts of porosity and mounds, we designed a grasshopper script that used multiple ruled surfaced to create the form of the design that would make it easier for the robot to accurately cut the form. The seven strips are equivalent to one tile. With this design we were able to fix the issue with trying to get the robot to accurately cut the pieces to create the final form, but we ran into new issues. Since the pieces were cut along the width of the tiles rather than the full length, we discovered that it might be more time consuming and difficult for the robot to cut the pieces. It would also create a lower level of accuracy when putting together all of the tiles because of how far away each cut is from each other in comparison to cutting it along the longer length of the tiles.

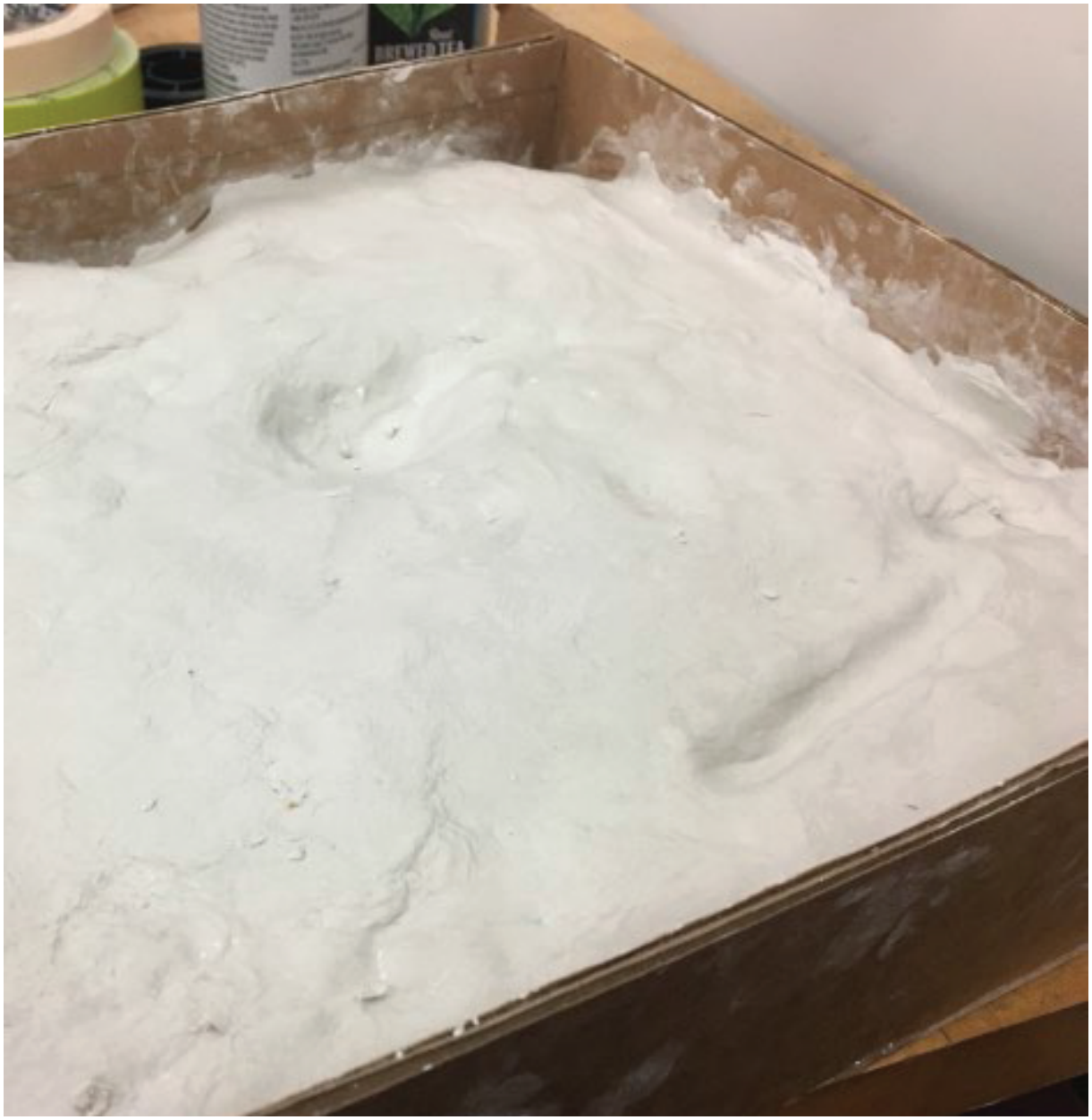


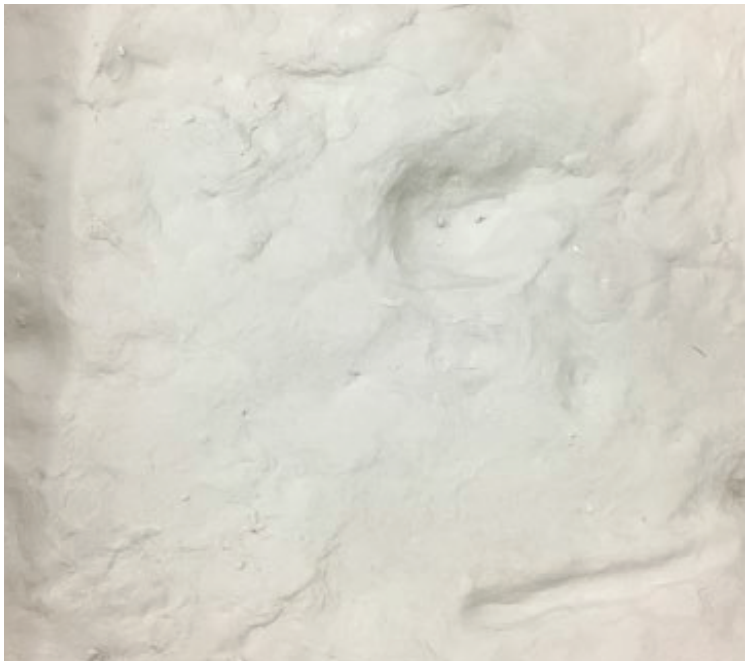
4 PROTOTYPING



Using the ruled surfaced that we had in our grasshopper script, we cut those curves into chipboard pieces to use as guides while manually hot-wire cutting. The ruled surface curves were placed on each side of a 1'-6" x 1" x 2" piece of foam to help produce the needed curved pieces to create the final surface.

PROTOTYPING





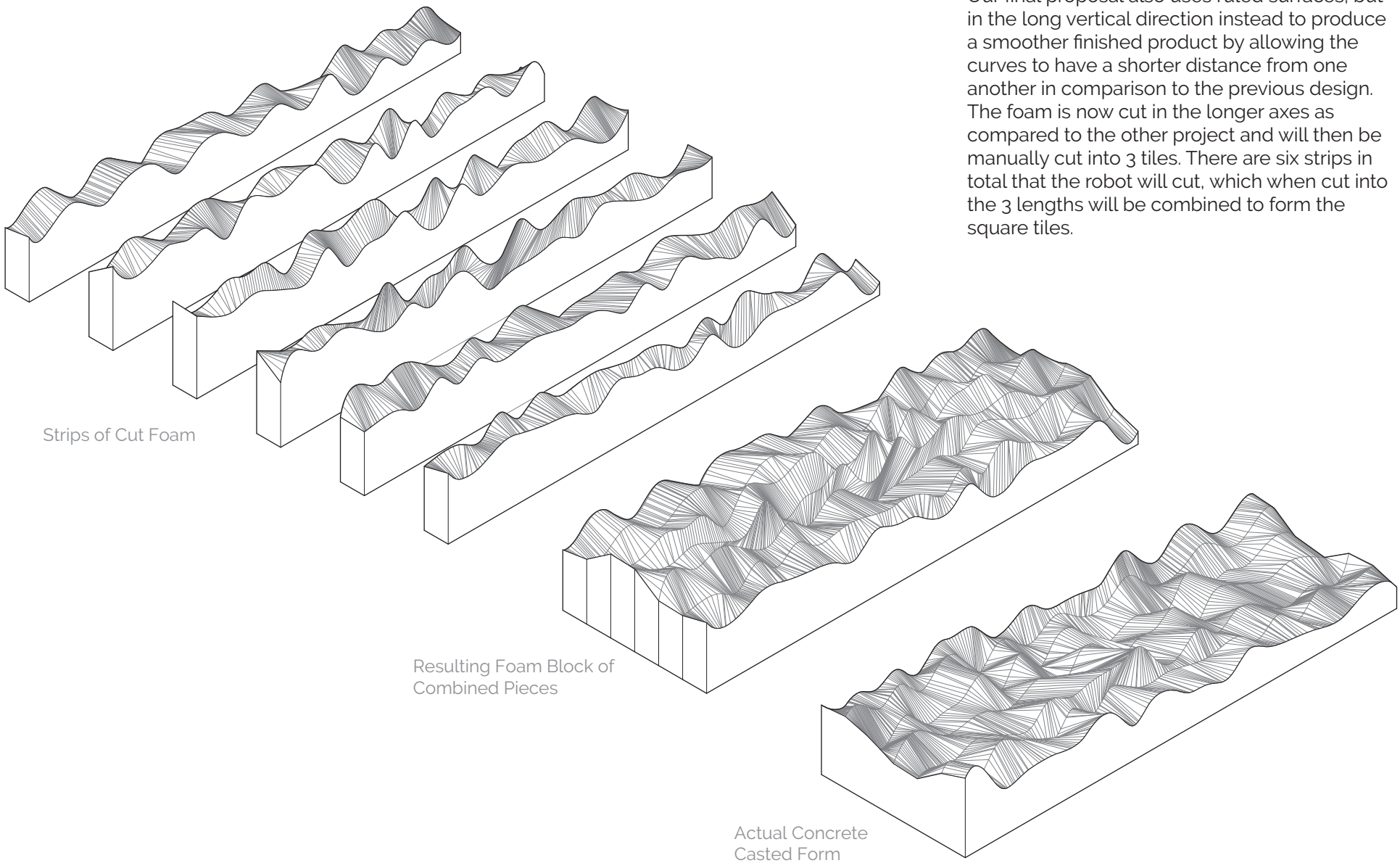
Oil based clay was used to smooth out any rough curves on the foam surface and also fill any gaps that may have formed from the manually cut pieces.

PROTOTYPING

After waiting for the rockite to dry we realized how difficult post-processing the rockite tile was because of the oil-based clay we used. It was stuck to the rockite and had to be run under water and really scraped off until we finally got the final rockite tile. In order to avoid this in the future, our plan is to use aluminum tape in order to easily remove the rockite from the foam.

5 FINAL DESIGN PROPOSAL

Our final proposal also uses ruled surfaces, but in the long vertical direction instead to produce a smoother finished product by allowing the curves to have a shorter distance from one another in comparison to the previous design. The foam is now cut in the longer axes as compared to the other project and will then be manually cut into 3 tiles. There are six strips in total that the robot will cut, which when cut into the 3 lengths will be combined to form the square tiles.

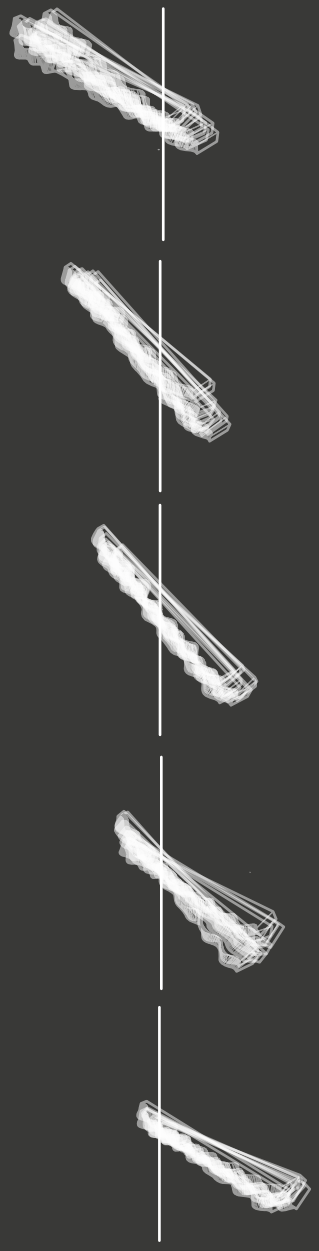


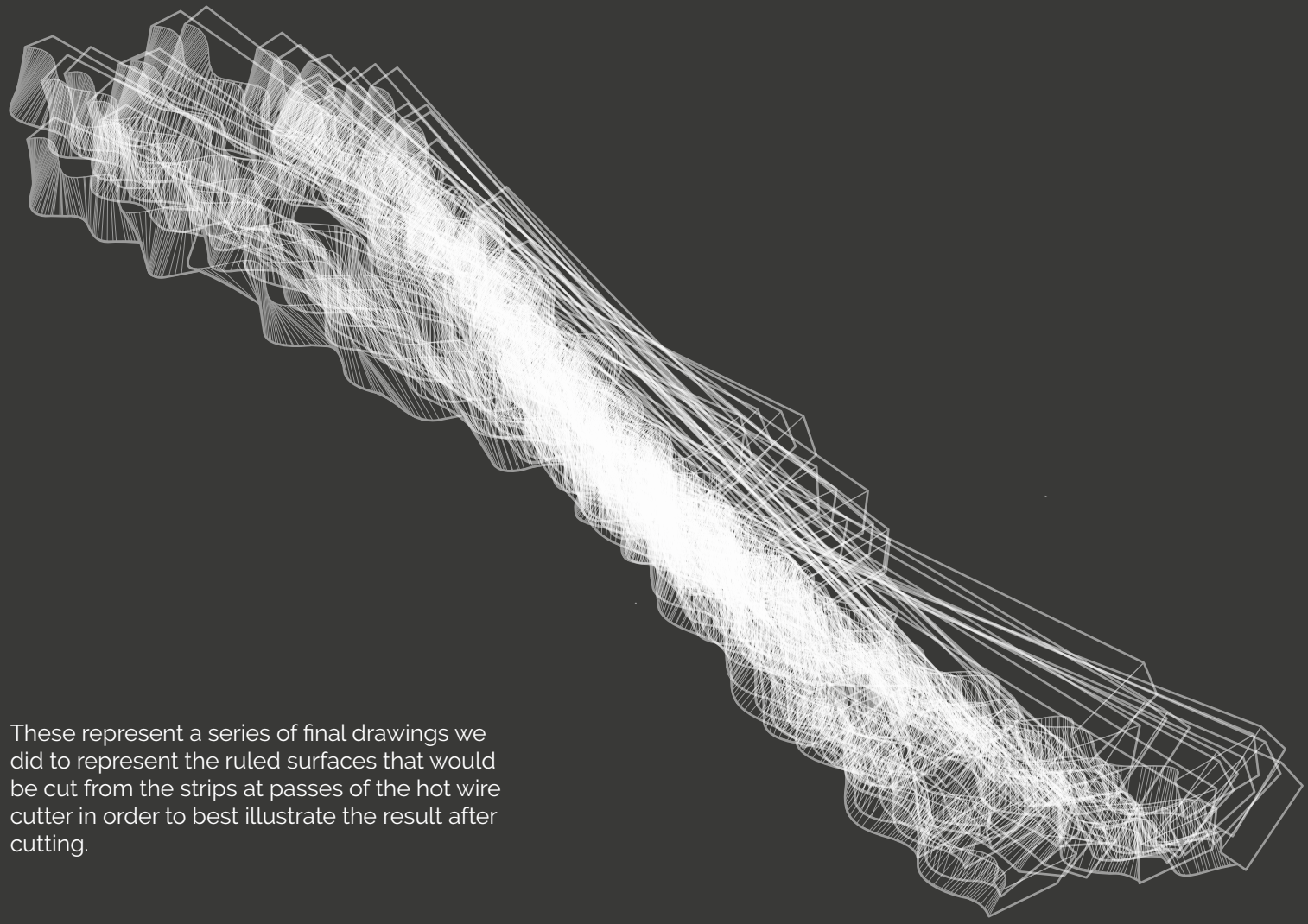
Strips of Cut Foam

Resulting Foam Block of Combined Pieces

Actual Concrete Casted Form

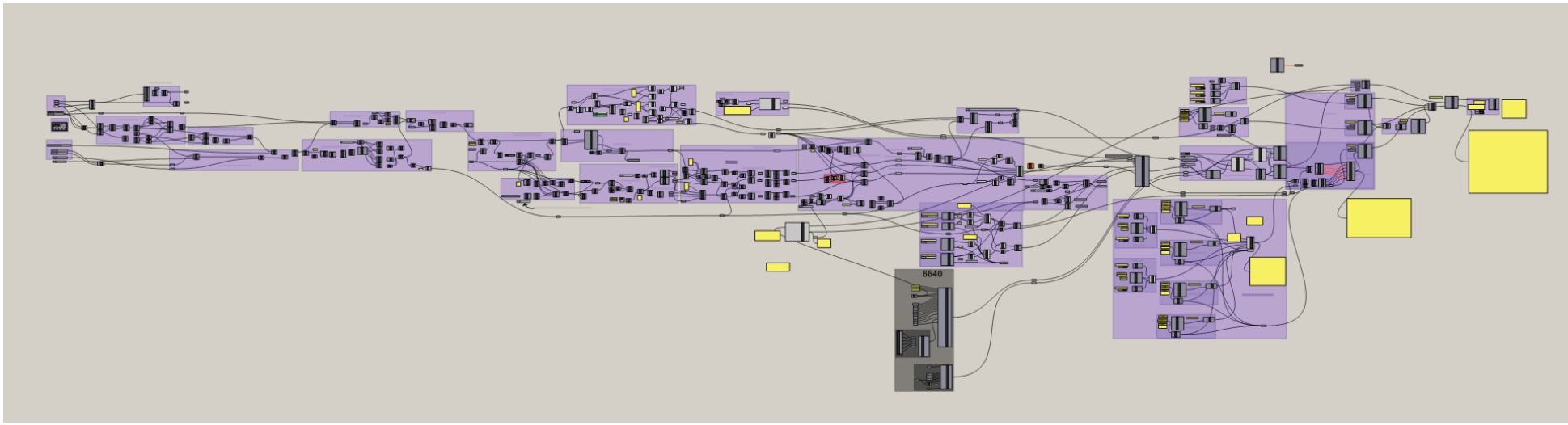
FINAL DESIGN DRAWINGS

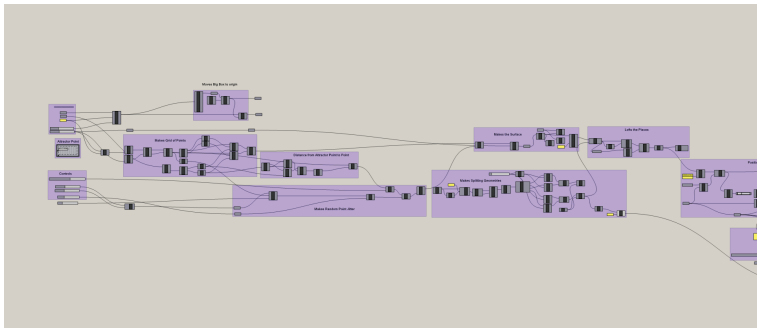


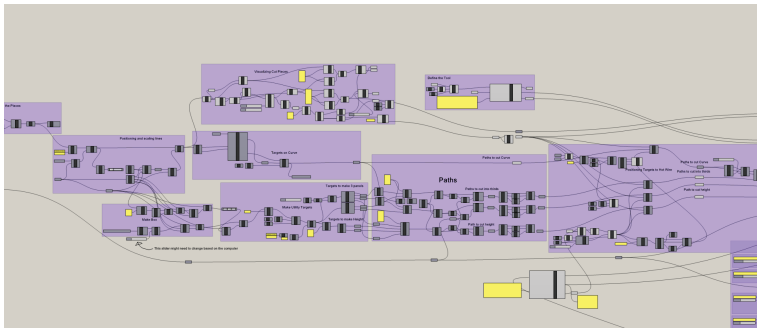


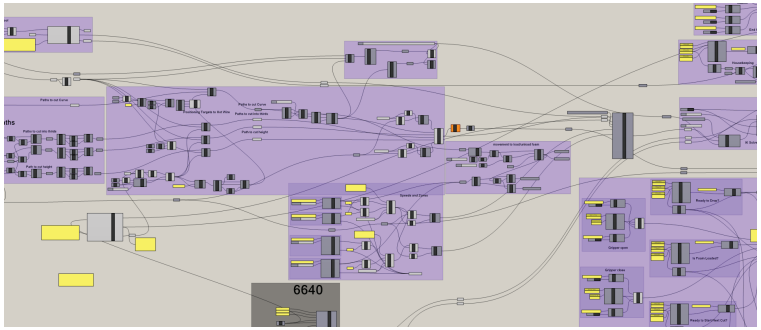
These represent a series of final drawings we did to represent the ruled surfaces that would be cut from the strips at passes of the hot wire cutter in order to best illustrate the result after cutting.

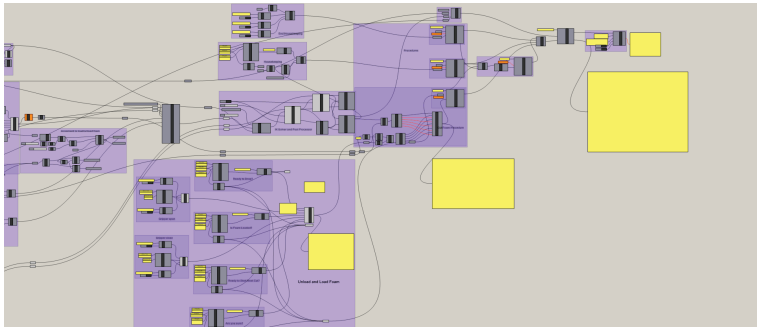
FINAL DESIGN SCRIPT











Our final grasshopper script with the HAL Robotics plugin to be used to generate RAPID code that would be fed into the robot in order to cut the foam pieces. The script uses data from the actual robot (the hot wire cutter work object) and the tooldata to synchronize with the robot.

There were many challenges associated with developing this script such as trying to get the robot's orientation to not run into configuration errors and other errors. However, after a lot of troubleshooting the issues were successfully fixed.

7 FABRICATION

Beginning to set up the foam and testing the robotic workflow in the lab. Before doing any cutting with the hot wire cutter, it was important to test the actual program to ensure the robot did not unexpectedly hit anything.