Helena Riesenberger

L O N G S H E N G

M A S T E R _ P A R A M E T R I C _ D E S I G N
18th Edition. Final Project. Part I
October 2023-January 2024

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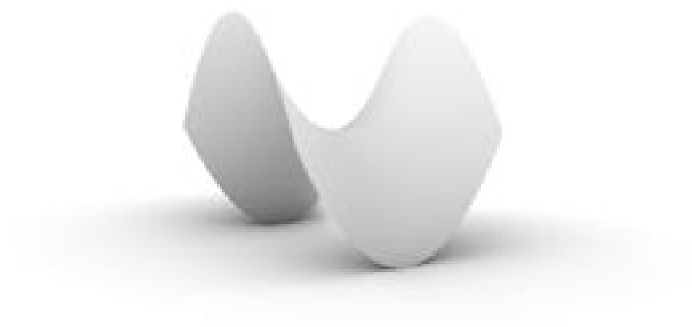
INTRODUCTION

The current thesis came to exhist from the continuos search of walking towards a greener future.

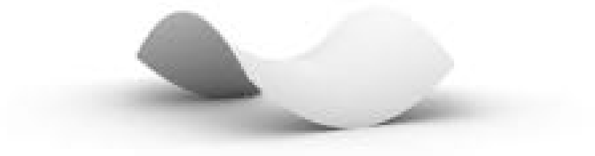
Located in the Longsheng Rice Terraces, in Guilin, China, this yoga retreat pavilion had as its main purpose to be as sustainable as possible: its shape should blend into the landscape using a form that would evolve from the study of minimal surfaces; a local analysis of the sun would be developed in order to better understand Longsheng's climate conditions and how the structure could better adapt itself to it; a structural analysis of bamboo, the material that would compose the primary structure of the retreat.

FORM FINDING

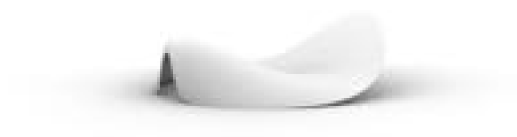
The starting point for finding the form for the yoga pavilion was the minimal surface hyperbolic Paraboloid. The goal was to this mathematical shape in order to adapt it to a final form that would be using the minimum of materials possible and that at the same time has a shape that would be well integrated in the landscape of the Longsheng Rice Fields.



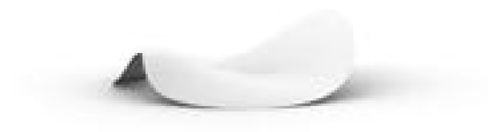
Hyperbolic Paraboloid



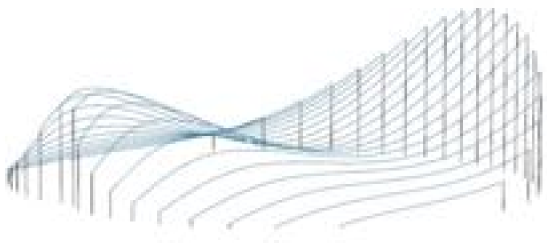
Hyperbolic Paraboloid transformed



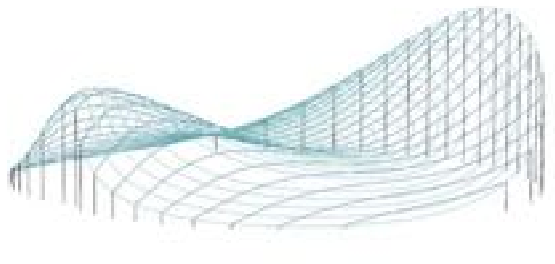
Shape from the transformed hyperbolic



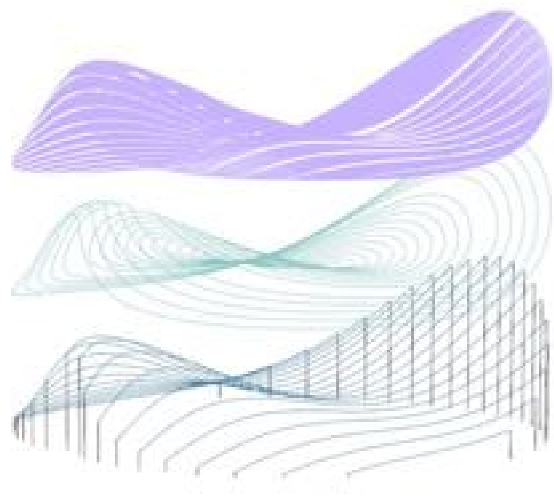
Final shape



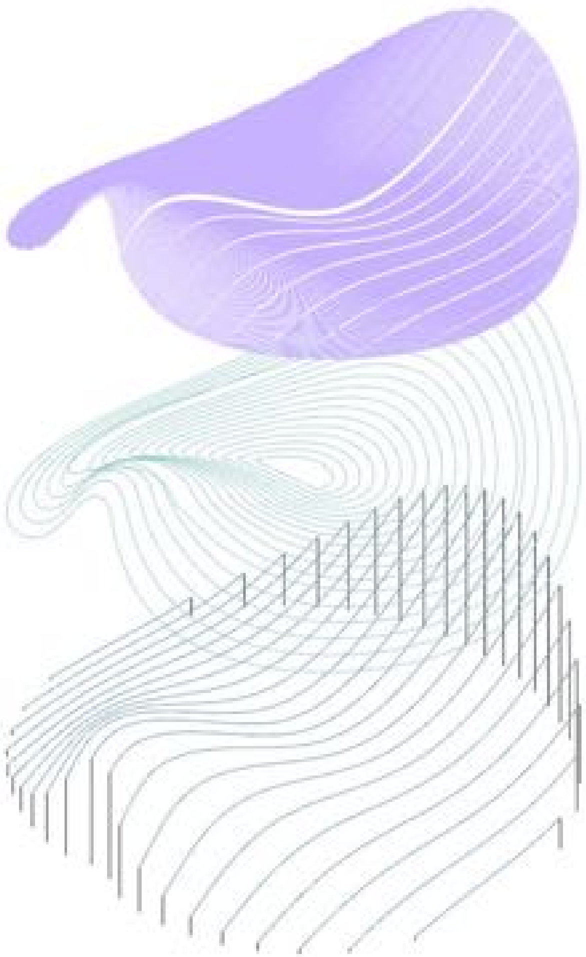
Primary structure



Primary structure + secondary structure



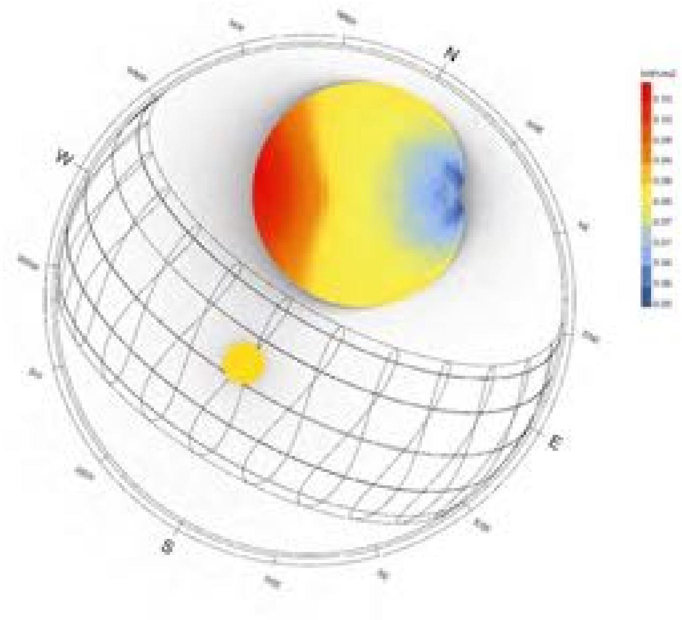
Primary structure + secondary structure + roof



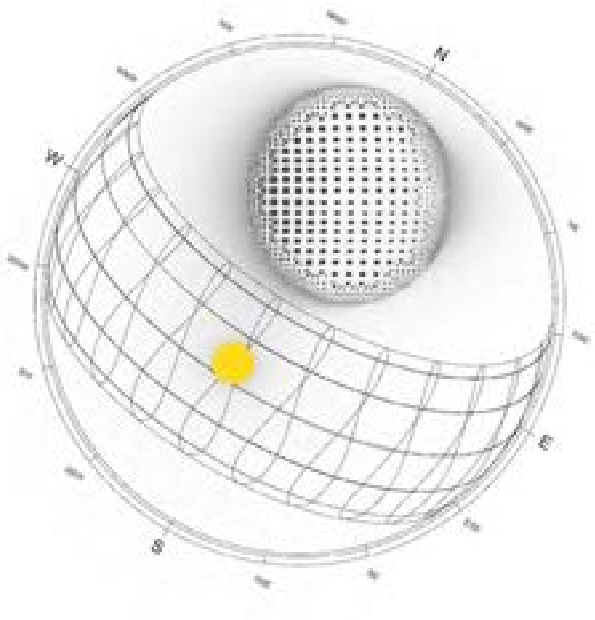
SOLAR ANALYSIS

Location: Guilin, China
Date: 10th September, 1:00pm

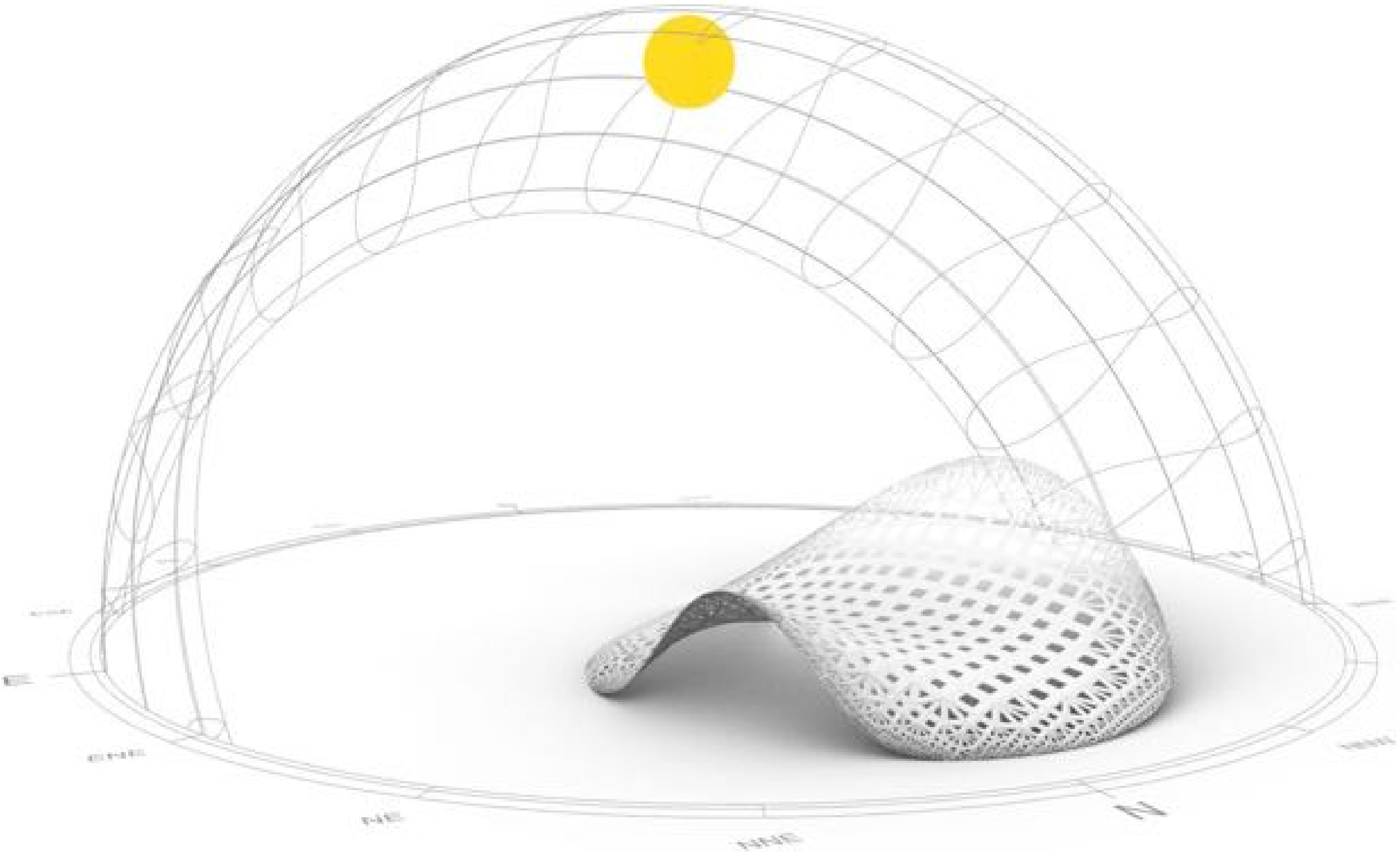
To better understand the climate conditions of the place, the **Ladybug** plug-in was used in order to identify the sun path at the site, as well as the solar radiations that would be inciding on the rooftop of the pavilion.



Solar radiation incident on the structure



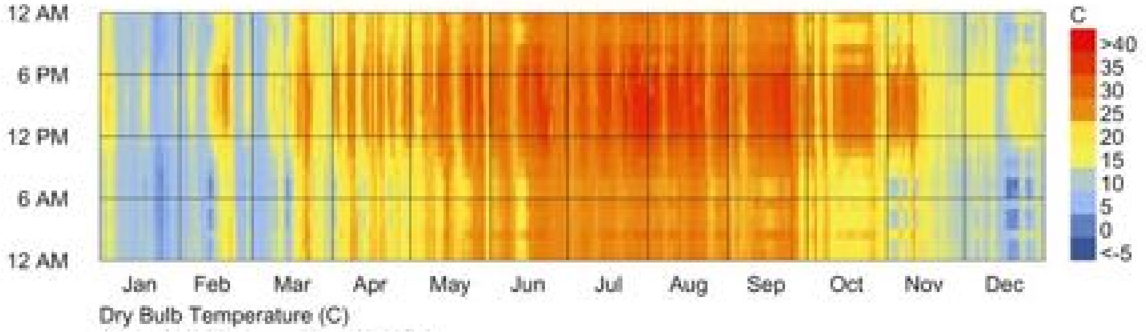
Responsive skin based on the incident solar radiation

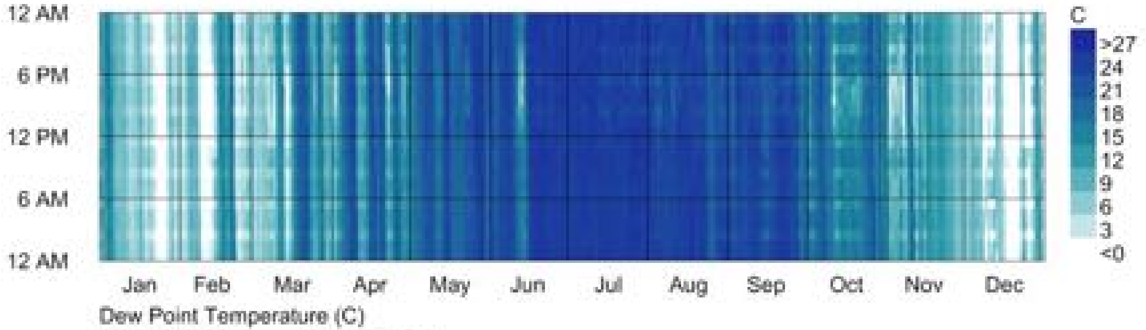

E
ENE
NE
NNE
N
NNW

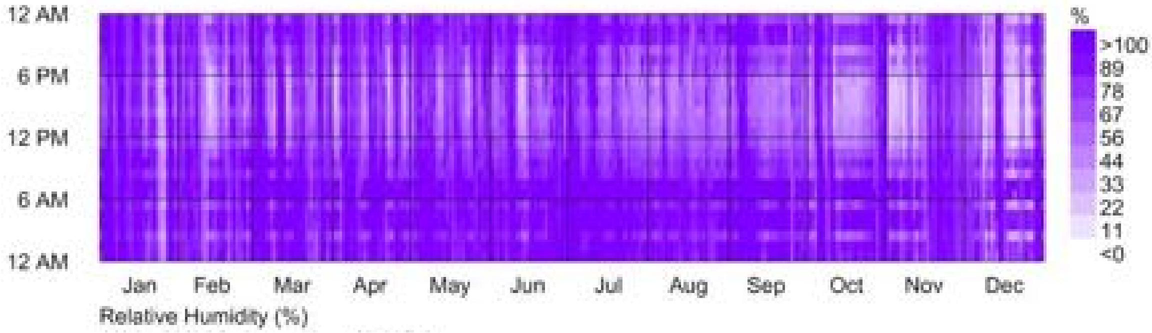
Weather Conditions

Location: Guilin, China

With Ladybug, it was also possible to understand various climate elements around the year in Guilin. The main analysis were of the Dry Bulb Temperature, Dew Point Temperature and Relative Humidity







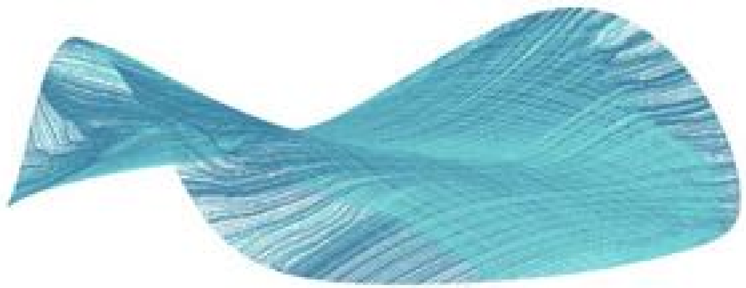
STRUCTURE ANALYSIS

Main Forces

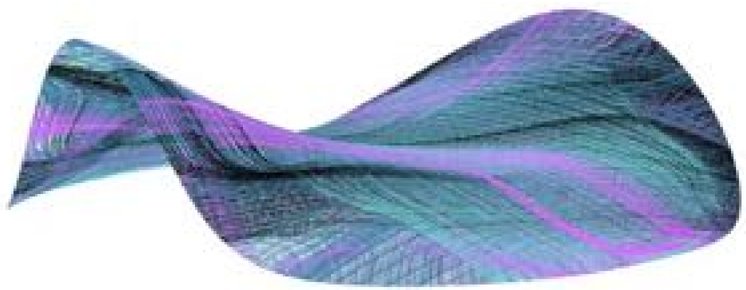
In order to better optimize the shape of the Longsheng Pavilion based on it's structure, the **Karamba3D** was used.

For starters, the Line Results on Shells was used in order to understand the main Moment and Stress existent in the roof shape.

Principal Moment



Principal Stress

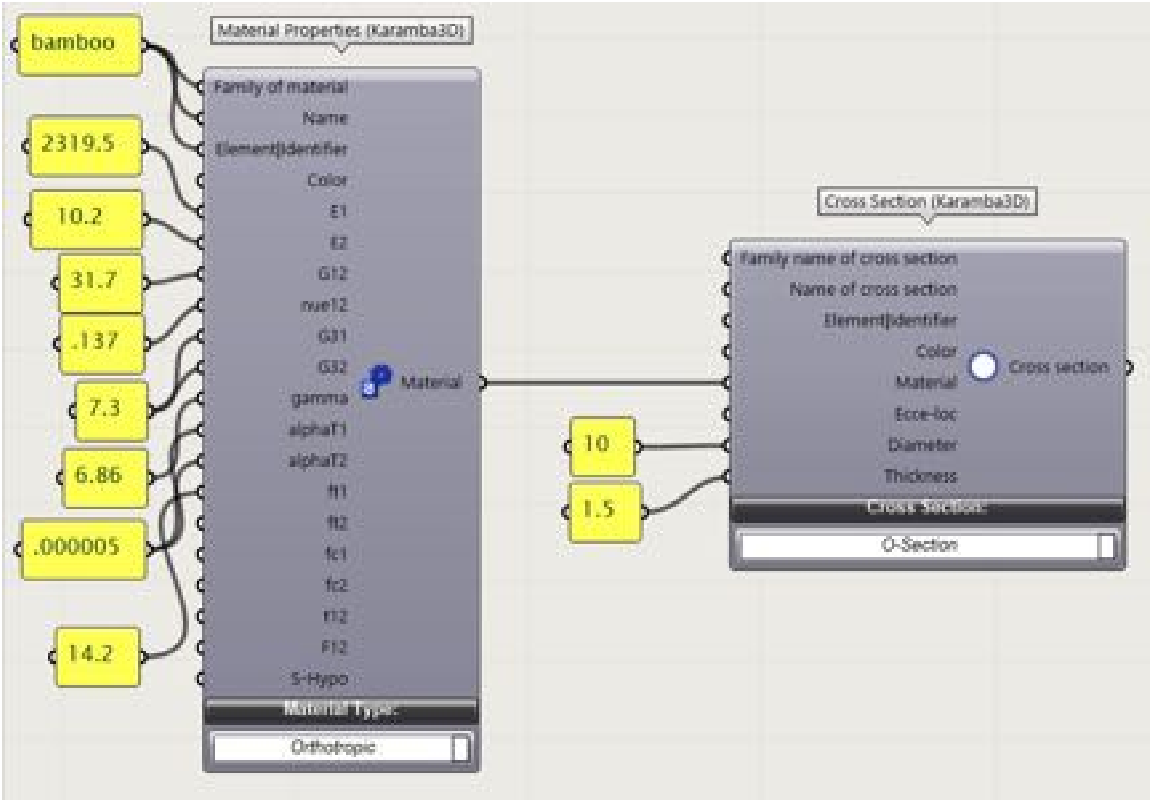


Principal Moment + Principal Stress

Bamboo Values

Since the structural material chosen is not integrated in Karamba, a Material Properties was used in order to create bamboo.

The bamboo properties were obtain thanks to a research study conducted by Edwin González.

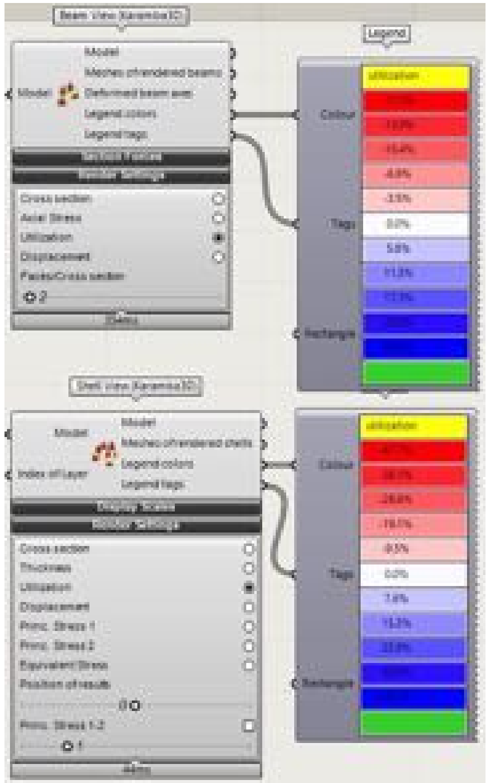


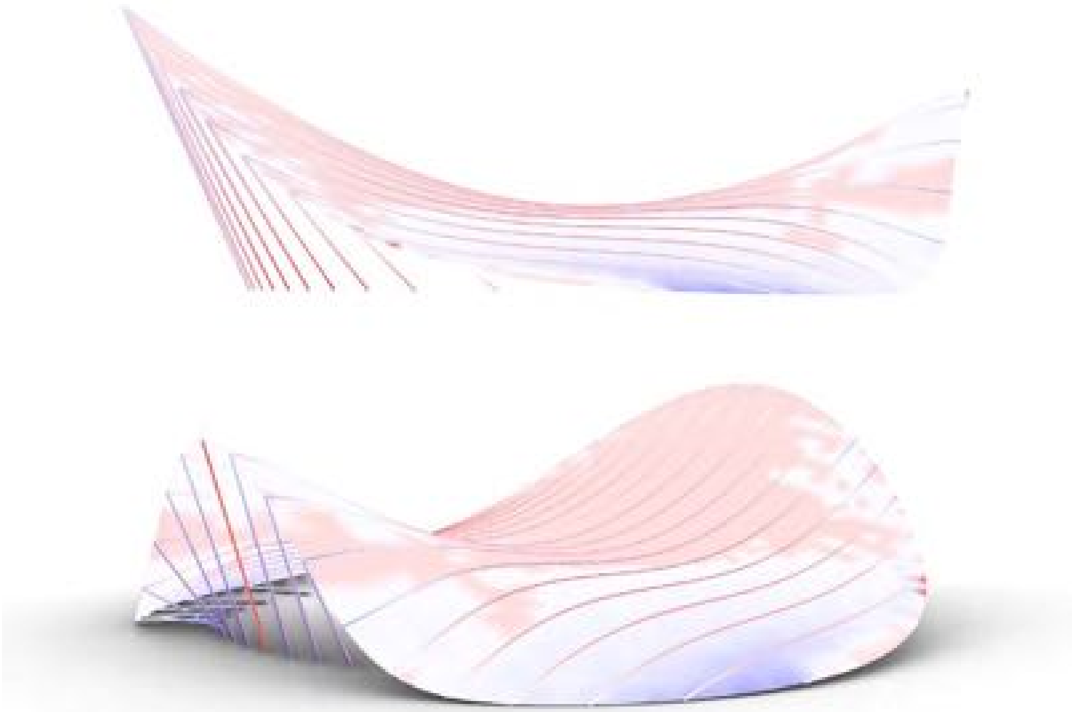
Material properties and section of bamboo (REFERENCE: Edwin González)

Structure Utilization

Analyzing the structure and the roof utilization of the structure allowed to see how it reacts to the gravity Loads and its own weight.

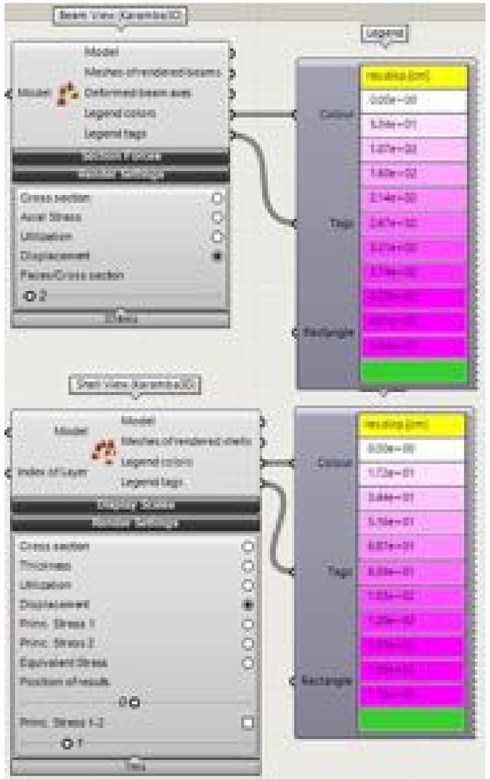
The compression is represented in red and the tension in blue.

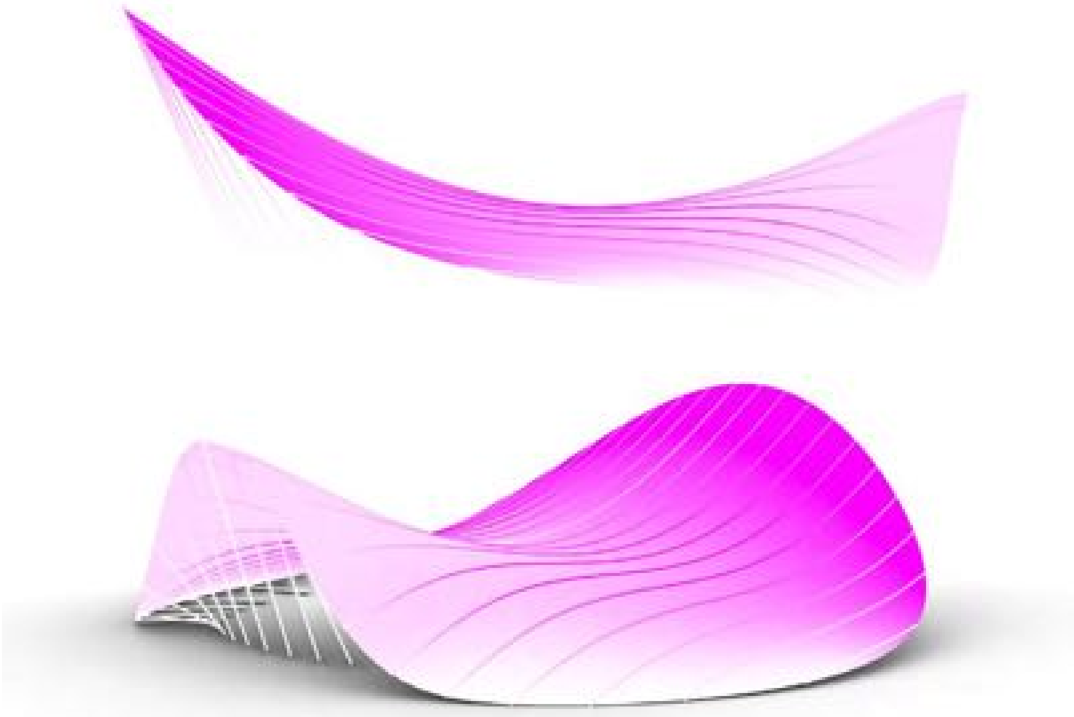




Structure Displacement

Using the same strategy, the structure Displacement was also analyzed. With the results obtained from the utilization and dispacement of the structure, it's possible to further optimize the structure.

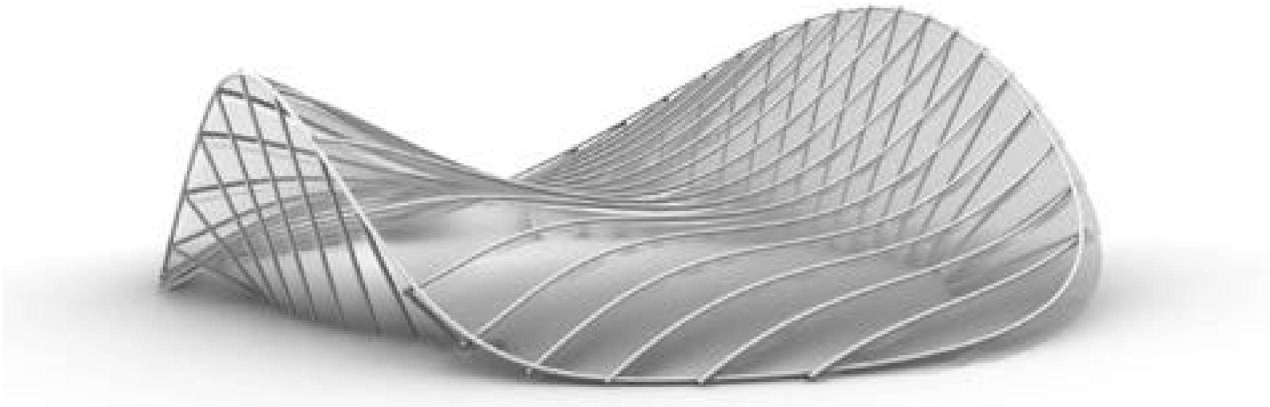


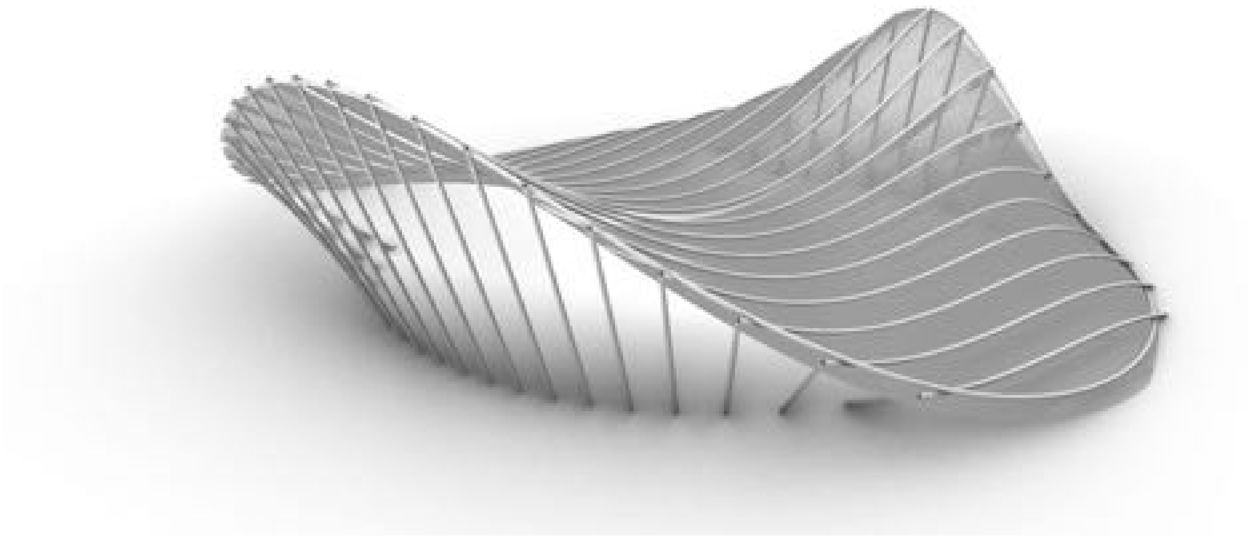


CONCLUSION

Through the study of the optimization of the hyperbolic paraboloid, the site's solar exposure, the local materials (bamboo and rice straws), and the analysis of the yoga pavilion structure, it was possible to come to a result that not only is integrated visually on the Longsheng Rice Terraces, it's also a project that is optimazed and thought for that place in the world only.

It is a work in progress and it can be further developed to obtain a even more sustainable final result and a more precise architecture details.





ADDITIONAL

Annexed to this final part is an initial idea for the pavillion that was later on dropped because of the simplicity of its shape.

However, its addition to this thesis as an appendix seemed relevant because of the interesting shape of the rice straw roof and how this one could have turned out if developed further.

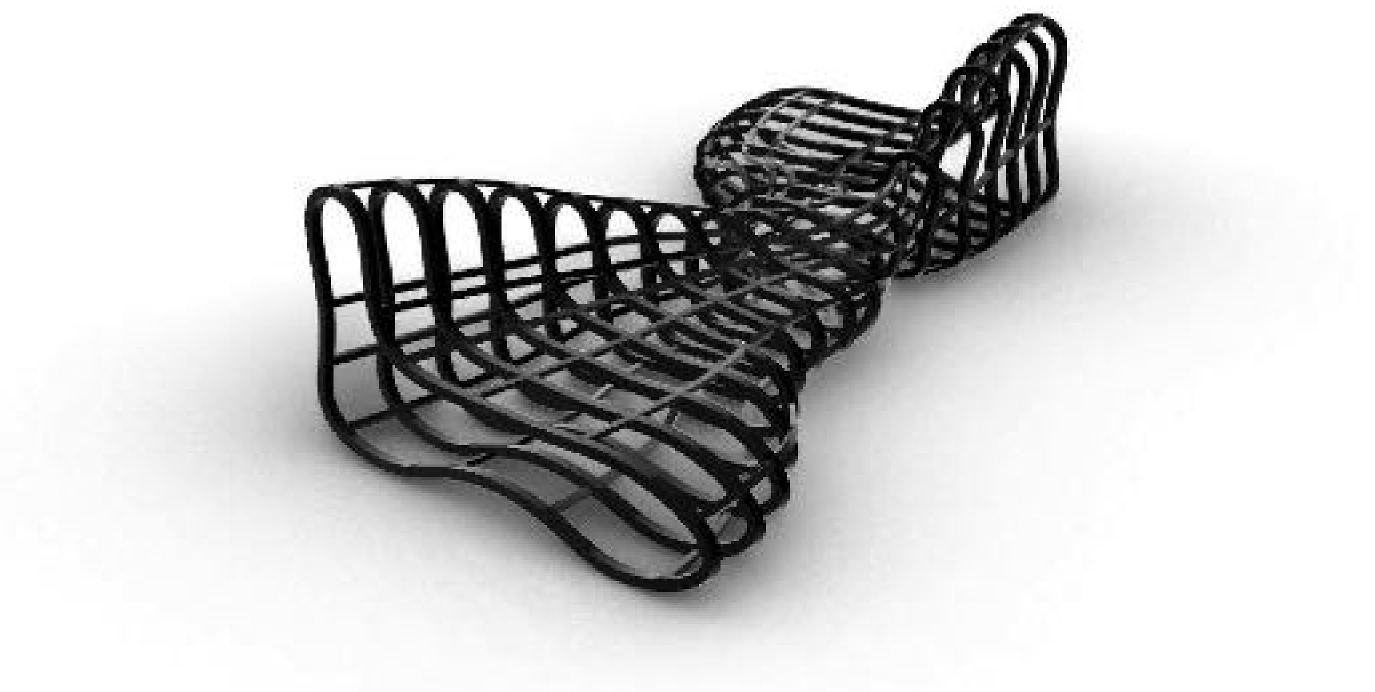
APPENDIX

Week 1

Sergio Alonso del Campo

Bench

During the course's first week we were introduced to Rhino 7 and how to model directly in this software, covering everything from points, curves, surfaces, polysurfaces and SubD.



Week 2

Andrés González

Tunnel

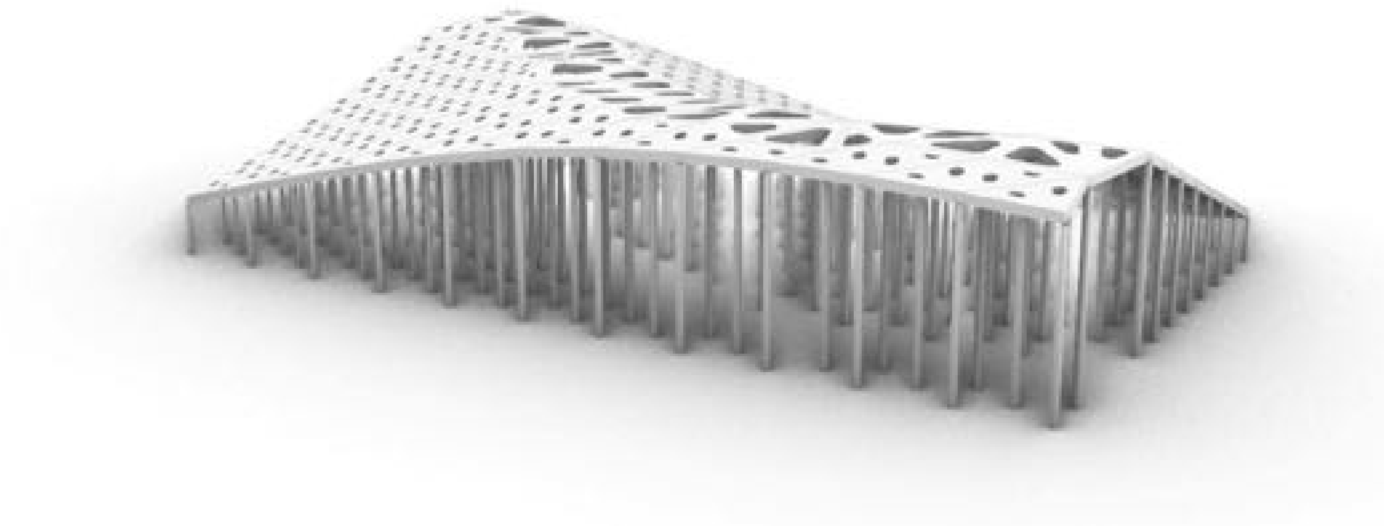
The second week of the course was the first contact that we had with the Grasshopper plug-in. Through the tutoril of Andrés González, we focused on different themes that are essencial to GH, like lists, trees, branches, items, and much more.

Week 3

Diego García Cuevas

Columns Forest

Still working on GH's core components, we rapidly evolved to more complex concepts, including the usage of magnets for the creation of certain shapes.

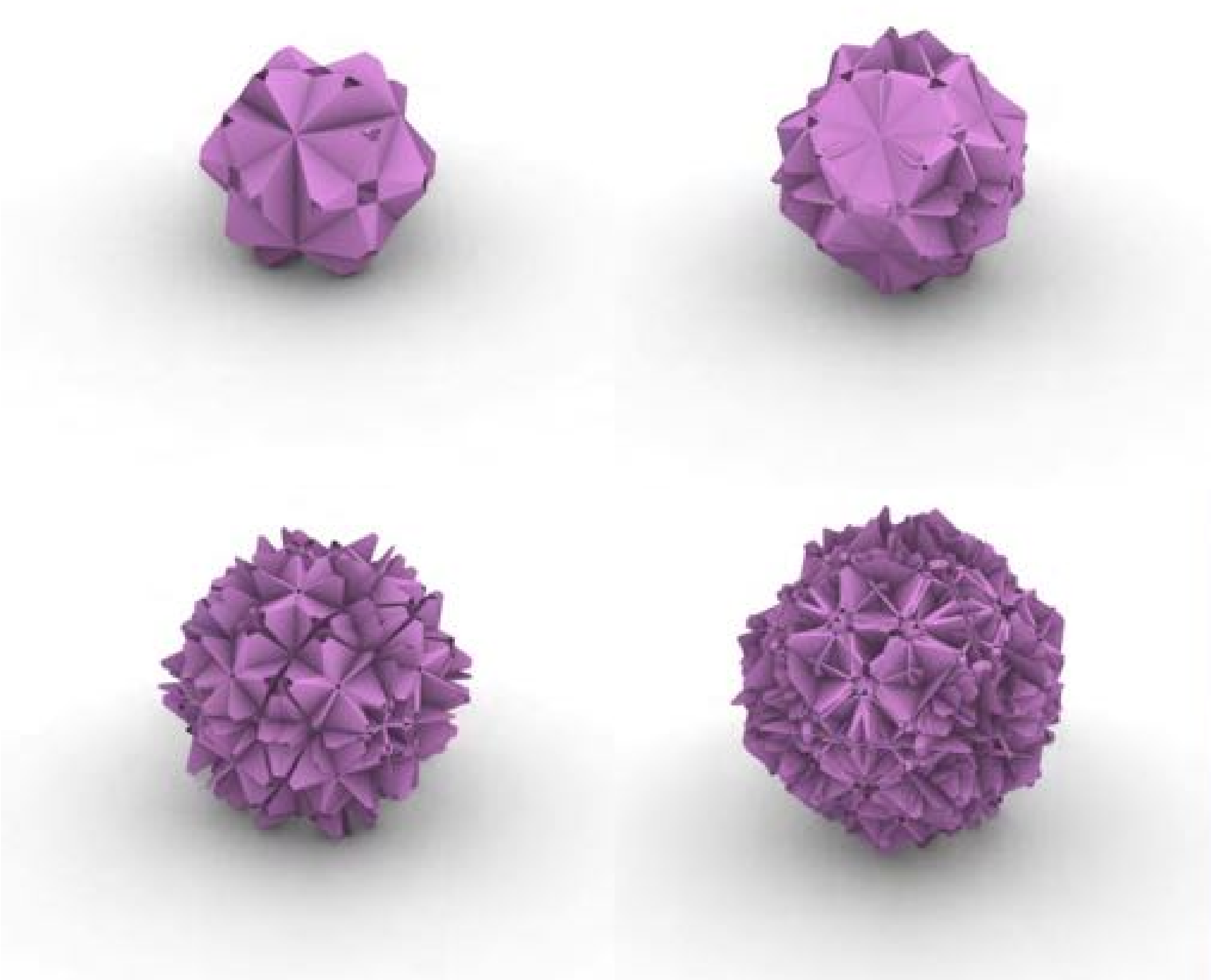


Week 4

Aman Agrawal

Origami

Under the tutoring of Aman, we started exploring different GH plug-ins, in which are included Kangaroo, Galapagos, Biomorpher and Anemone, this last one used to develop these flower like origamis.



Week 5

Arturo Tedeschi

Midjorney Rice Terraces

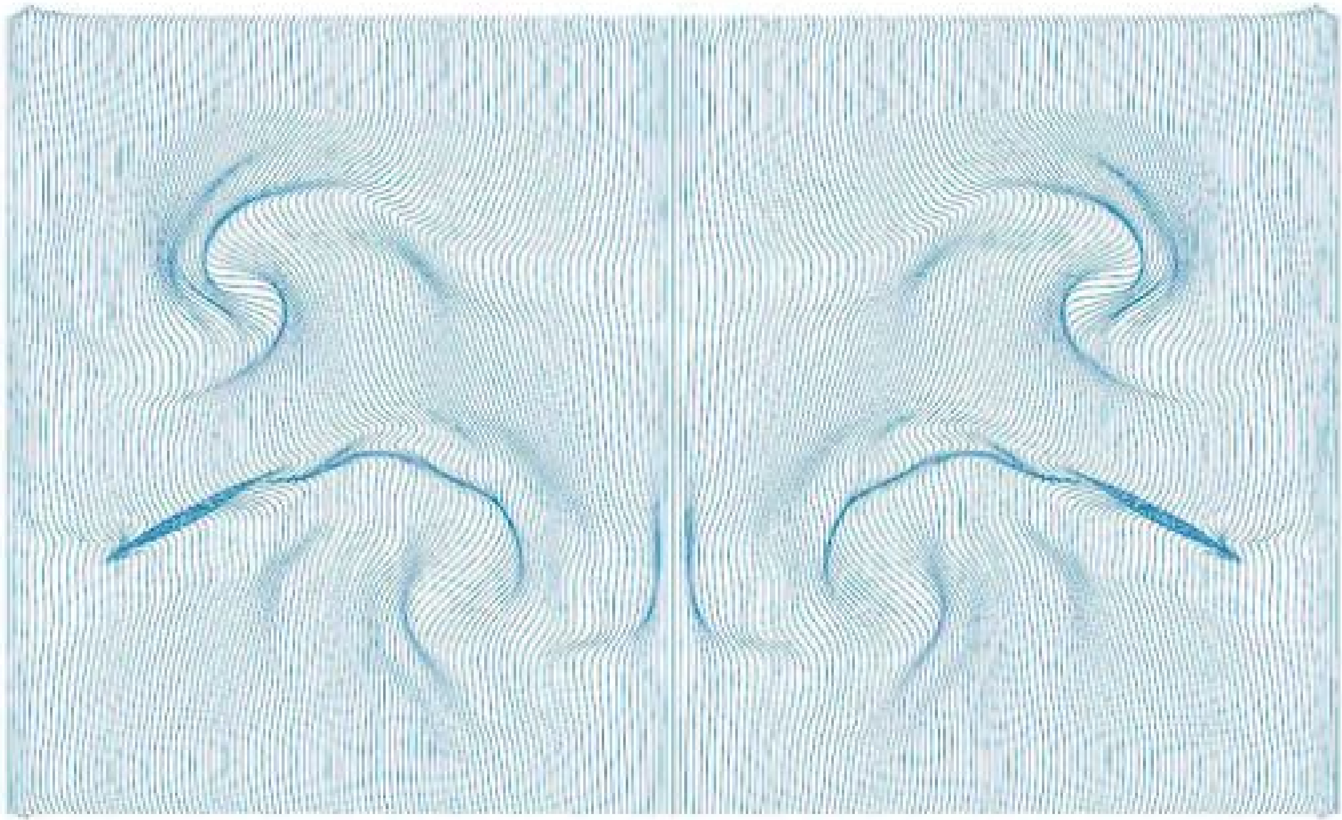
Arturo Tedeschi gave us our first introduction to AI, how to use its settings and prompts, in order to generate pictures that we can use for creative purposes. The two main AIs explored were Midjourney and Stable Diffusion.

Week 5

Heba Eiz

Mirror

During Heba's class, we explored a bit more the core properties of GH and how to use magnets and trees in a more advanced way, resulting in shapes that seem out of a dream world.

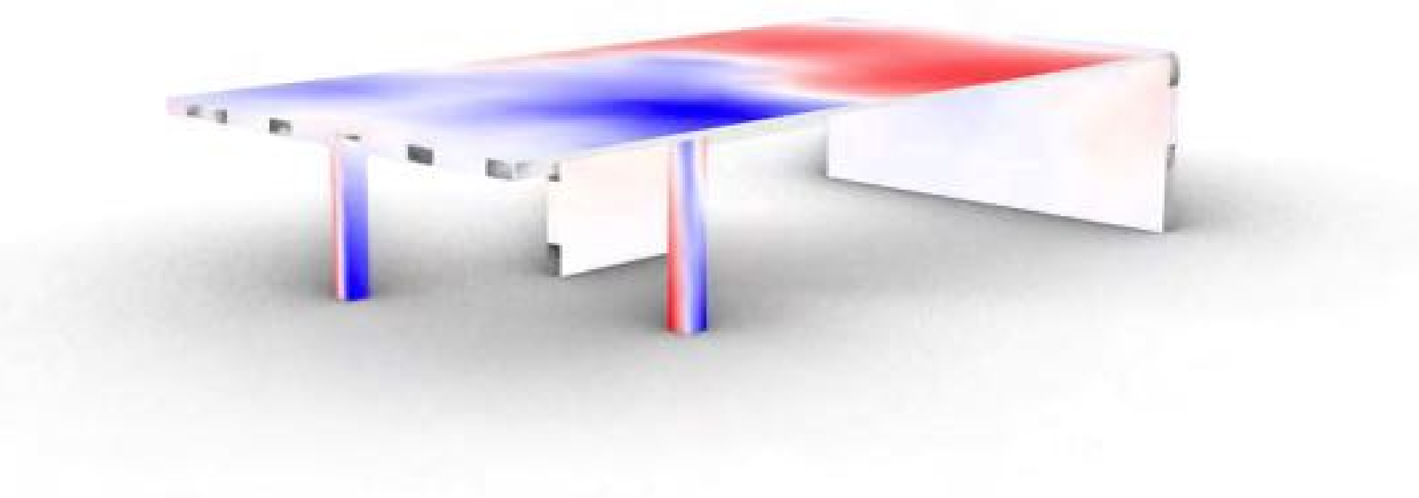


Week 6

Matthew & Adam

Pavilion

With Matthew and Adam we learned how to work with GH's plug-in Karamba3D and how to use it in order to better optimize our buildings through their structure and its analysis.



Week 7

Francisco Pérez

Wave

The last week of the first time of the course was spent learning Python for GH. It was our first ever approach to a coding engine, which represented some challenges. However, the benefit of knowing this plug-in in the long run makes it worth learning it.

controlmad

Helena Riesenberger

DIGITAL FABRICATION

M A S T E R _ P A R A M E T R I C _ D E S I G N
18th Edition. Final Project. Part II
January 2024-February 2024

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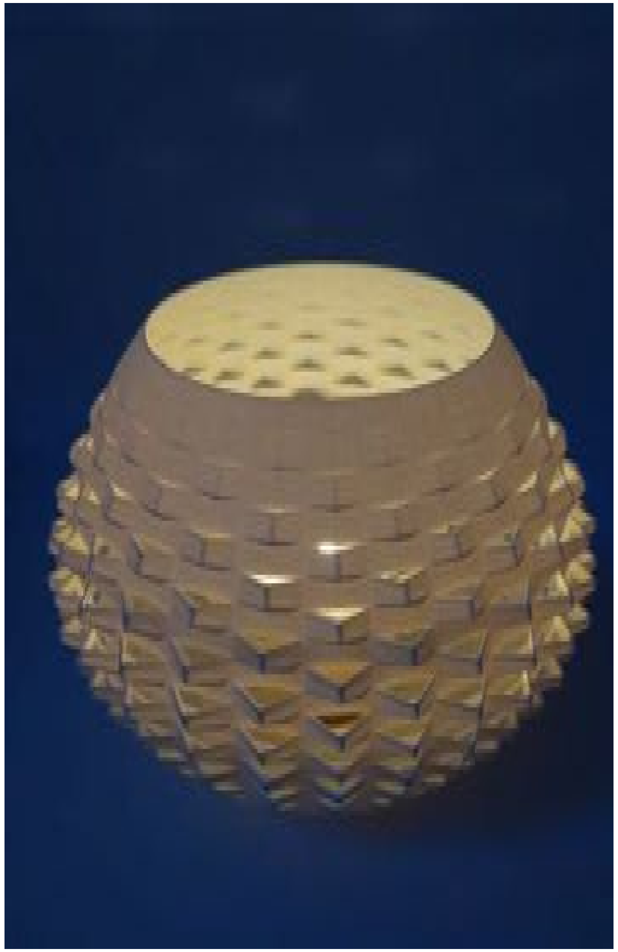
INTRODUCTION

Using the traditional Japanese lantern as an inspiration and reinterpreting it into new shapes, different Digital Fabrication techniques were put into practice to create a PLA, a clay and a laser cut lantern.

As for the final project, a colaboration with Assaad Awad was developed in order to design some pieces that could be integrated into his leather handbags.

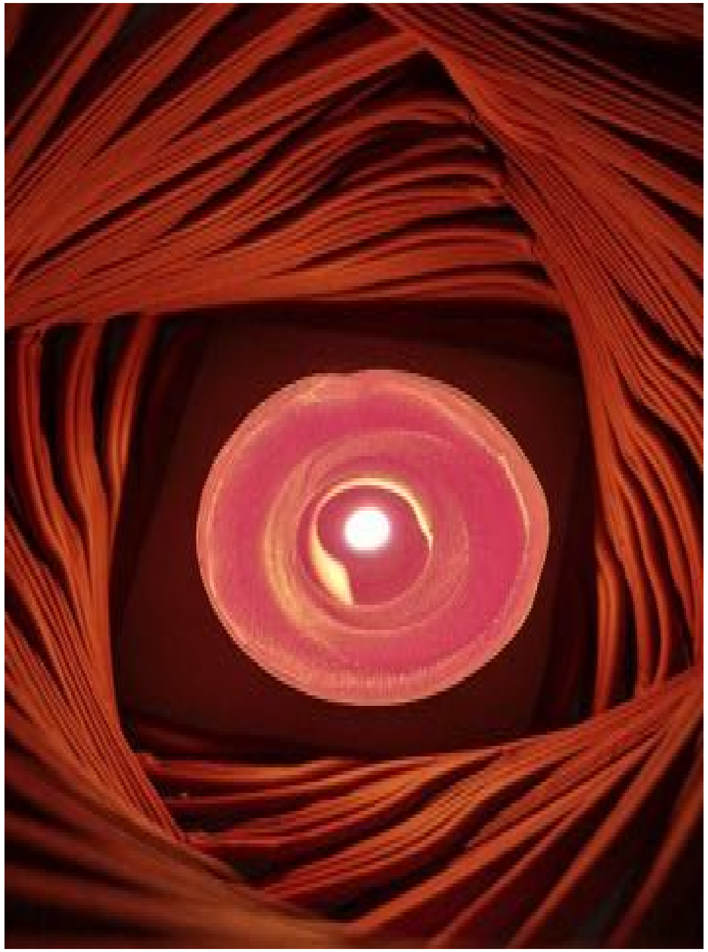
UNIT A

PLA Lantern



UNIT A

Clay Lantern



UNIT B

Laser Lantern

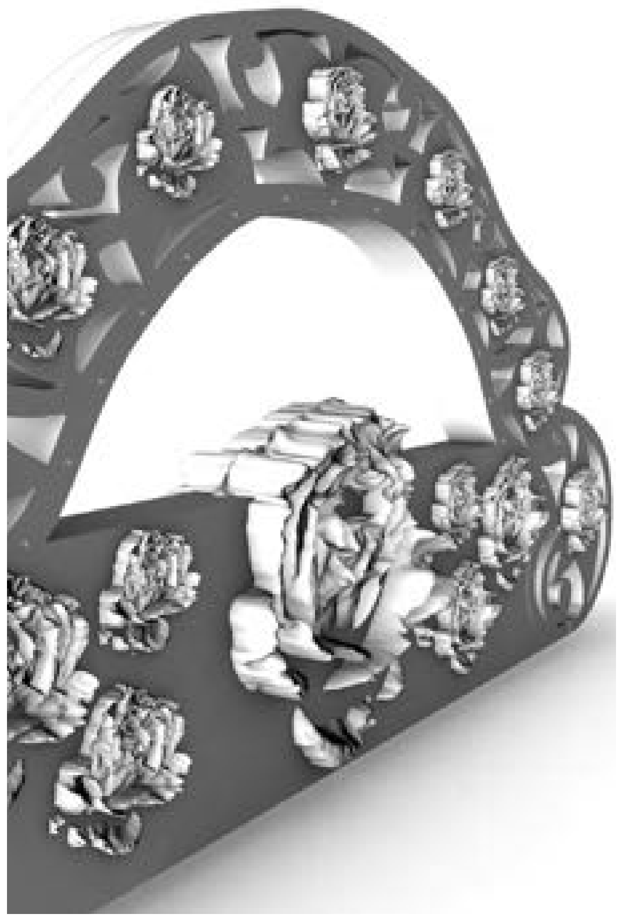
Principal Moment + Principal Stress

UNIT C

CNC Bust Prototype

Final Project

Rose Garden

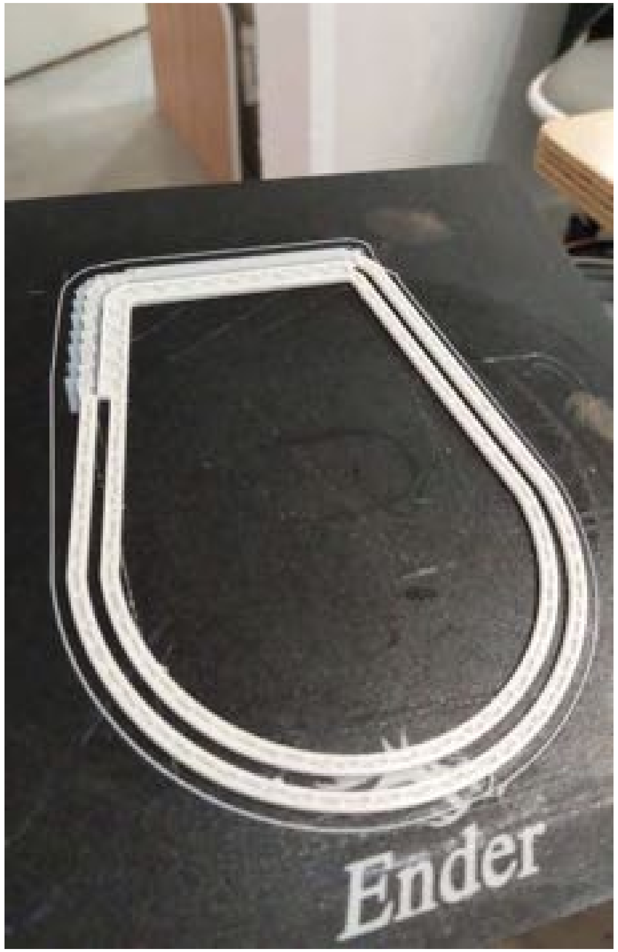


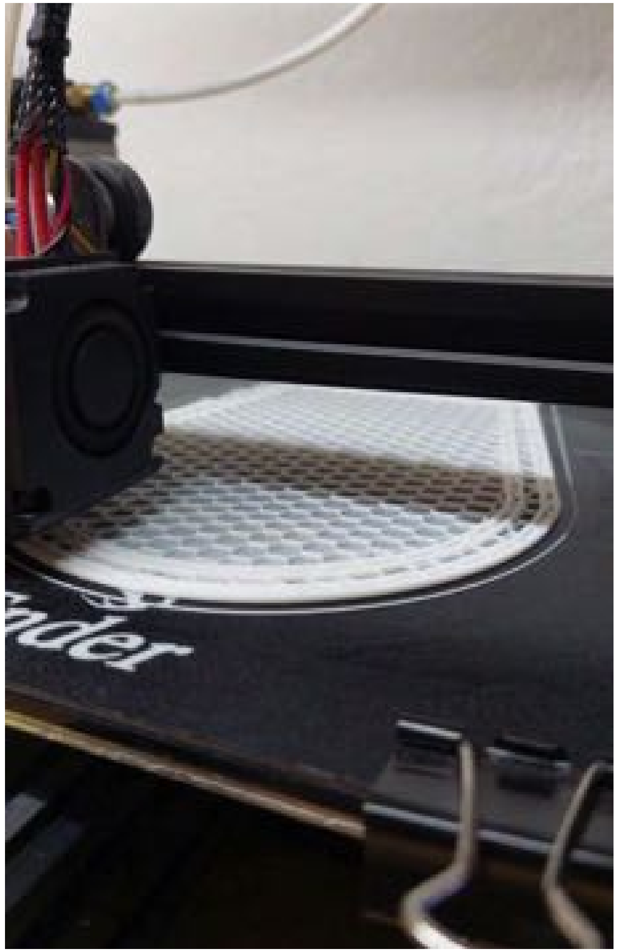
Handle

PETG Filament

Side Piece

PLA Filament





AutoVisualizer

Dan Kenerson

M A S T E R _ P A R A M E T R I C _ D E S I G N
18th Edition. Final Project. Part I
October 2023 - January 2024

Acknowledgements

Thanks to @ParametricCamp for their Youtube tutorial series on creating grasshopper components and asynchronous requests in C#.

The Ladybug devs for their imageviewer component, which provided inspiration for the one included in this plugin, as well as the BitmapPlus plugin by @interopxyz on Github.

Abstract

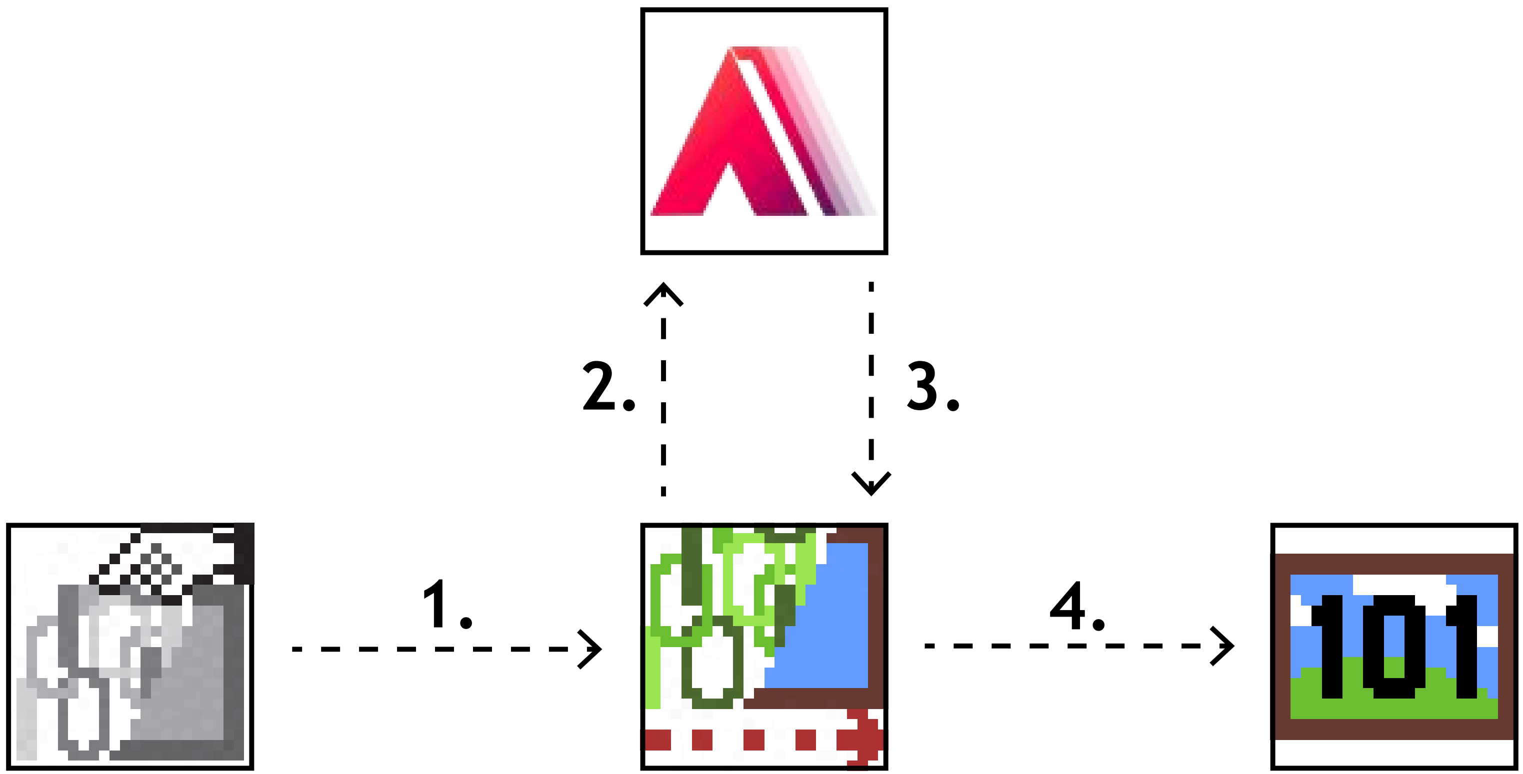
What?

AutoVisualizer is a plugin designed for Grasshopper, providing seamless integration with the Automatic1111 Stable Diffusion API. This powerful combination enables users to generate captivating images directly within the Grasshopper environment, harnessing the capabilities of the Automatic1111 API for stable diffusion processes.

Why?

After the sessions taught by Arturo Tedeschi I looked into support for AI generation inside of Grasshopper. There was really only one solution, and it was in a much larger plugin with a general focus on all types of AI. There were no image AI pugins geared to entry level users, with simple and easy to understand controls.

How AutoVisualizer Works



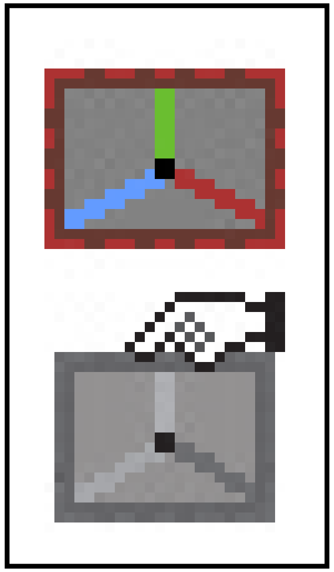
1. User input is gathered and sent to a generation component.

2. User input is formatted correctly and sent to Automatic1111 from the generation component.

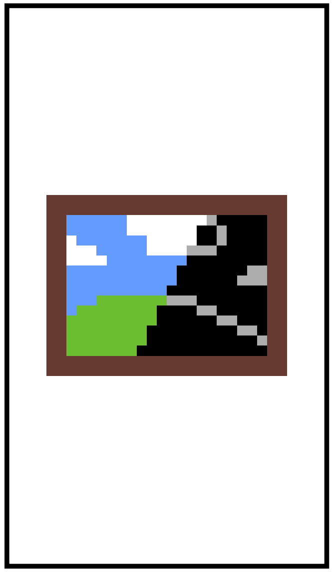
3. Automatic1111 generates an image using Stable Diffusion, and sends it back to the generation component.

4. The image save location or raw data is sent to be modified as seen fit.

The (Current) Components



Capture View Components



ControlNet Components

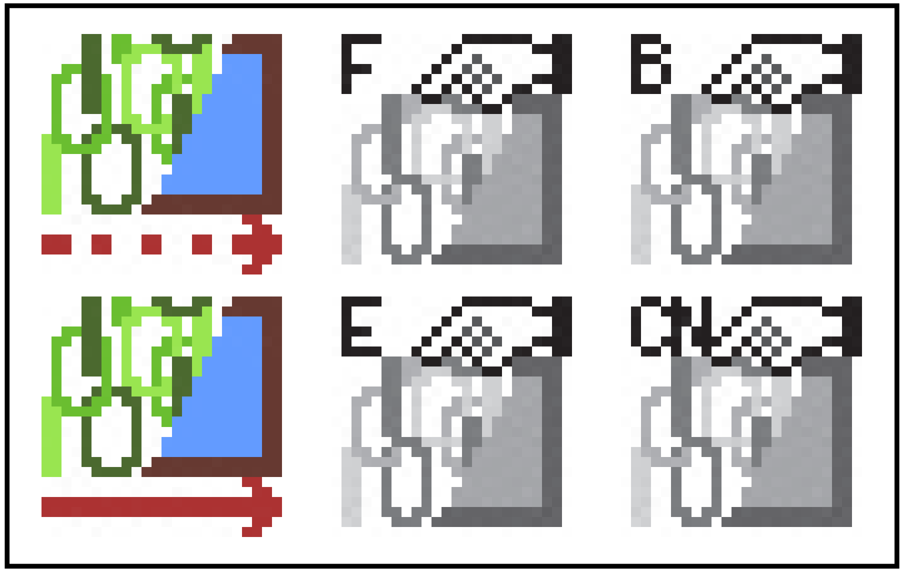


Image Generation Components

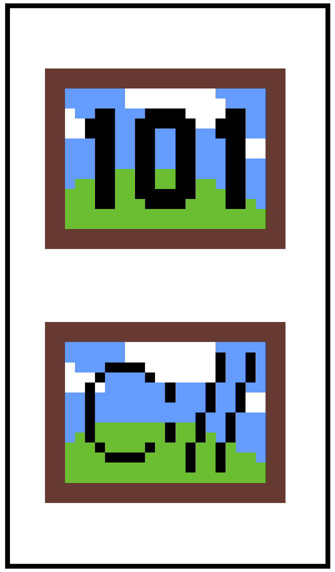
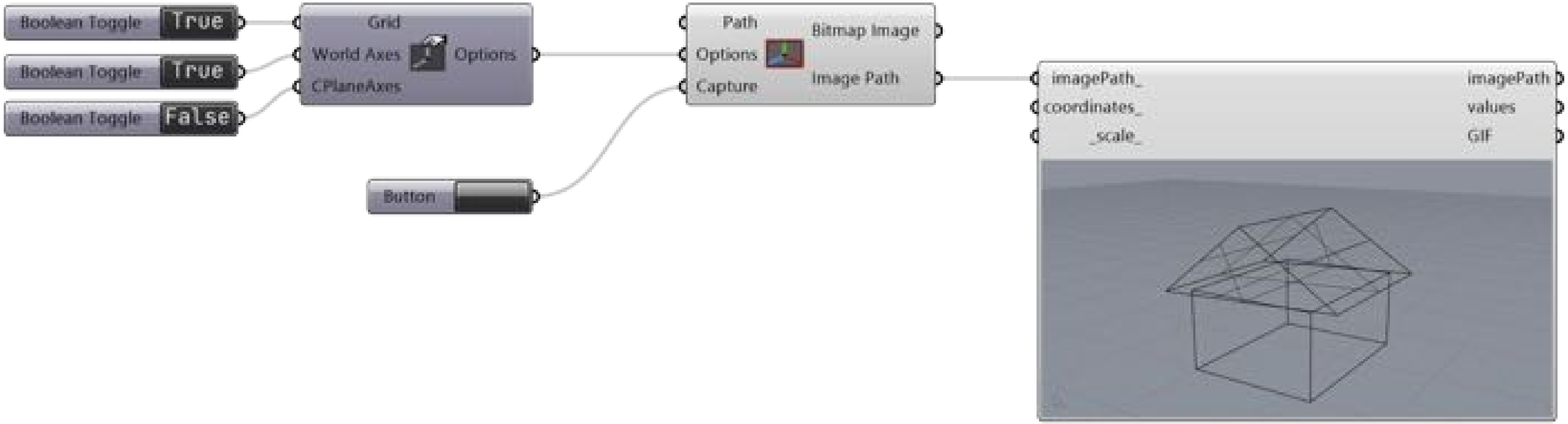


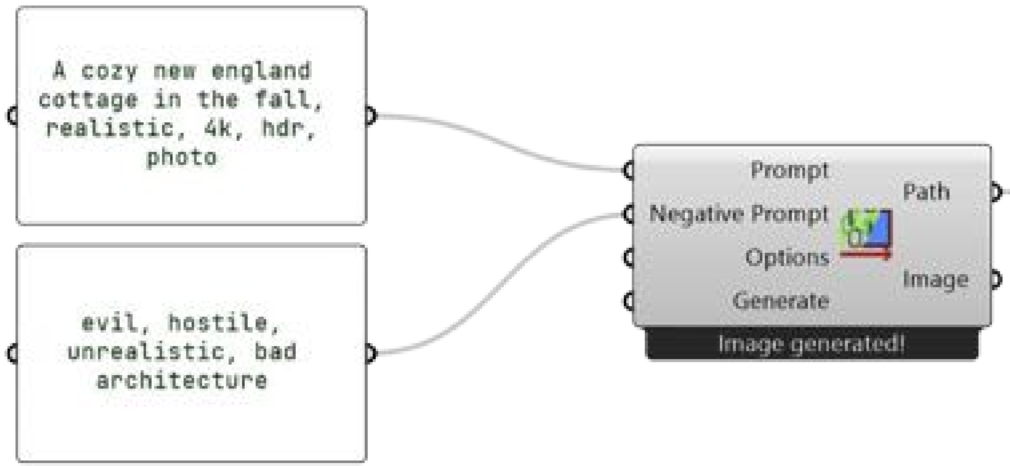
Image Viewing Components

Capture View Component

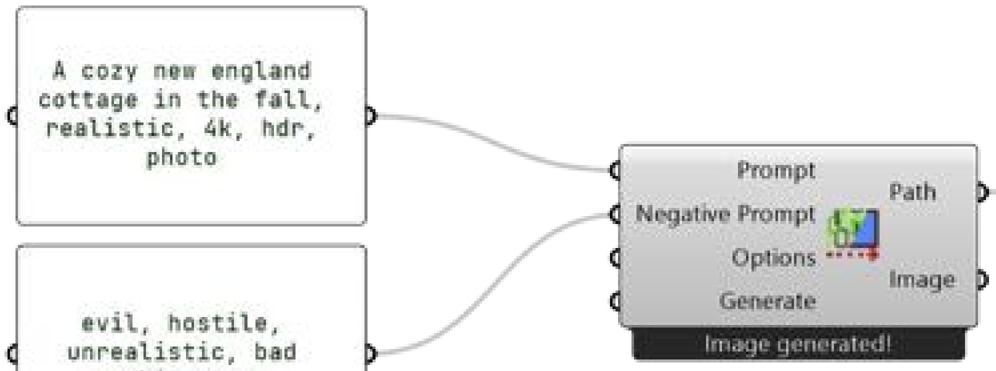


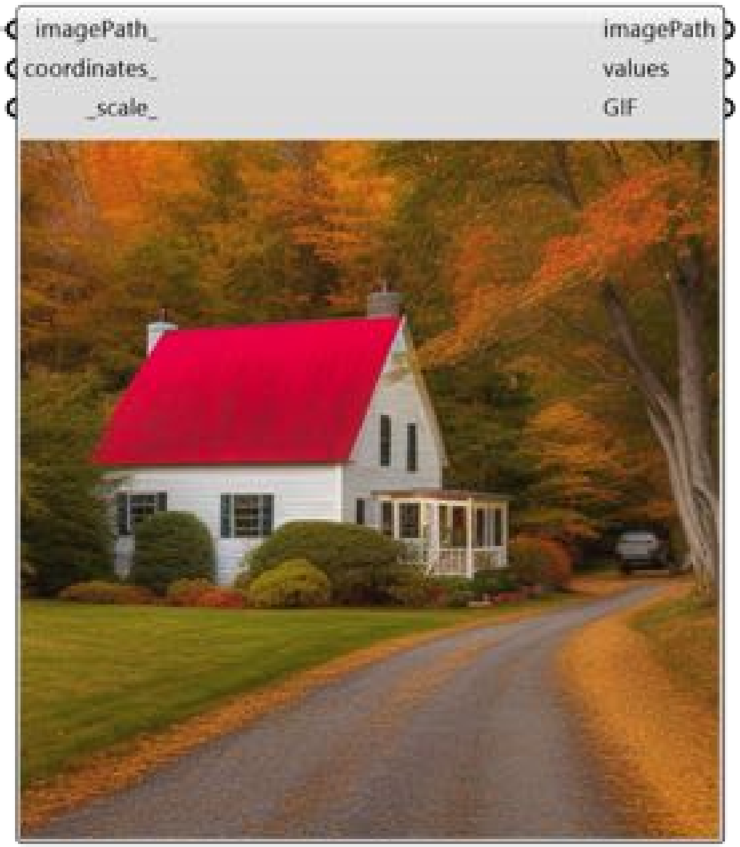
The Capture View component allows for a user to capture the current active Rhino 3D viewport directlz into the current Grasshopper document. An optional settings component allows for visual modifications, such as hiding and showing the grid, world axes and cplane axes.

Image Generation Components

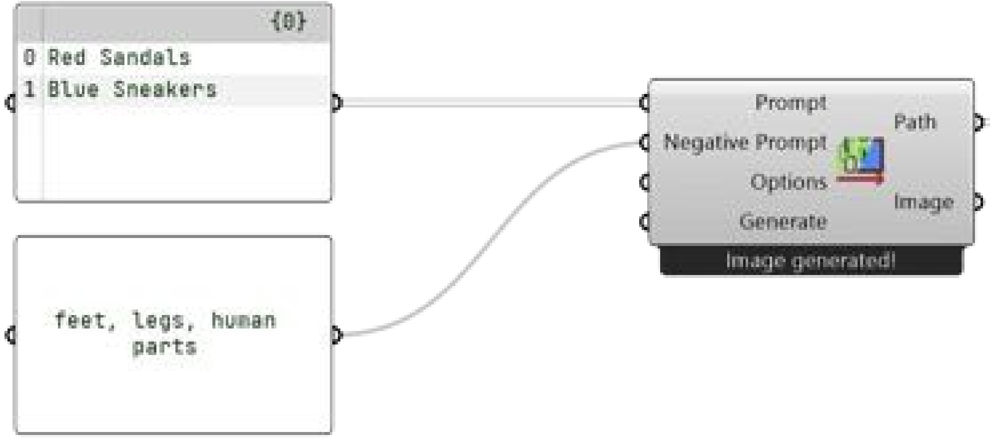


The GenerateSync Component is the first of two ways to communicate with the Automatic1111 API. This component works “Synchronously” with the API, so it only sends an image after generation is complete. This makes Grasshopper “hang” as it waits for this component to complete, however if generating images in an Anemone loop the Synchronous component is required. (Similar to needing ZombieSolver in Kangaroo)





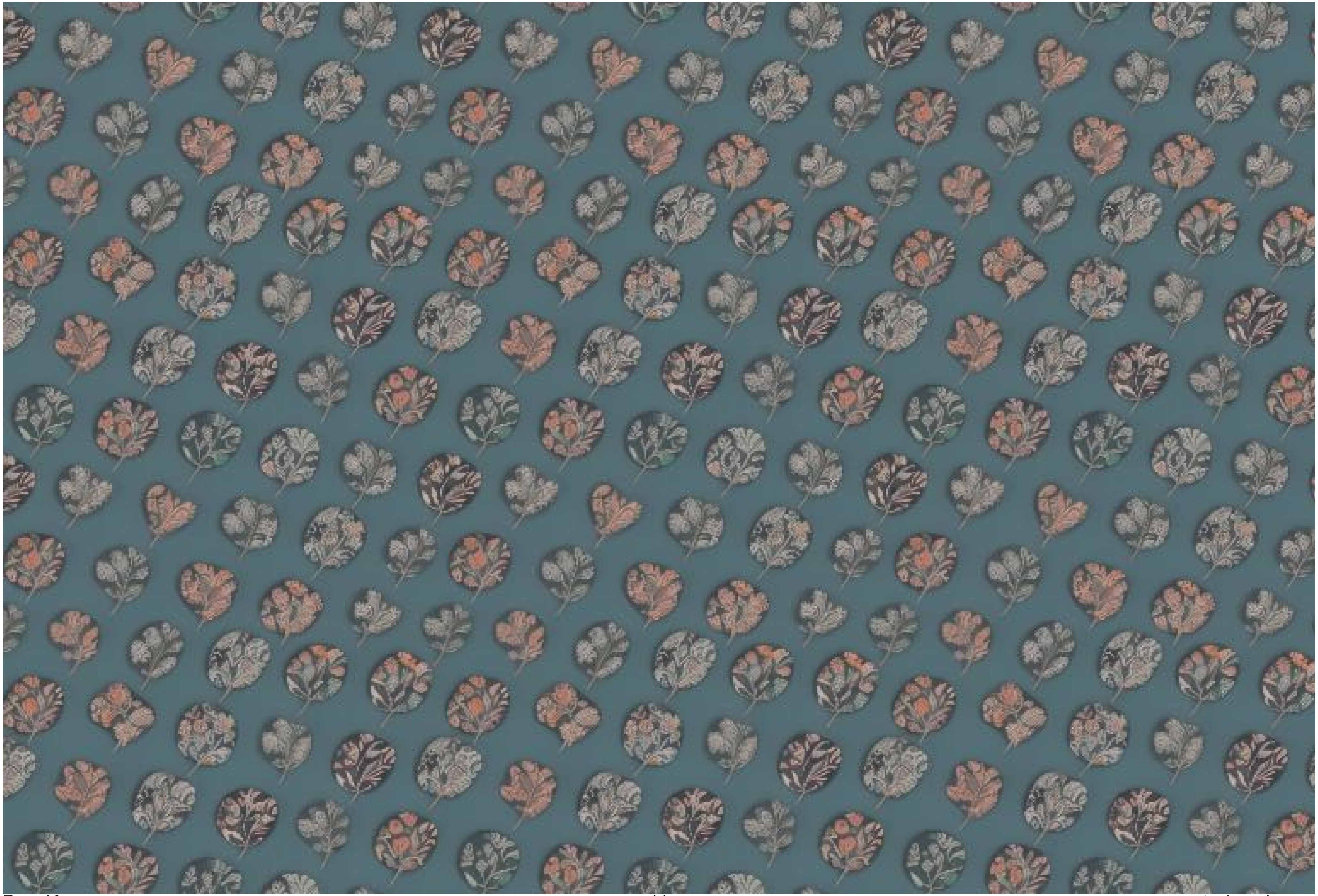
The GenerateASync Component looks the same as GenerateSync, but it doesn't wait for an API response to have an output. The component output is updated when the API finishes. Because the component does not wait for the API response, Grasshopper does not hang, and this node is thus better for normal use.



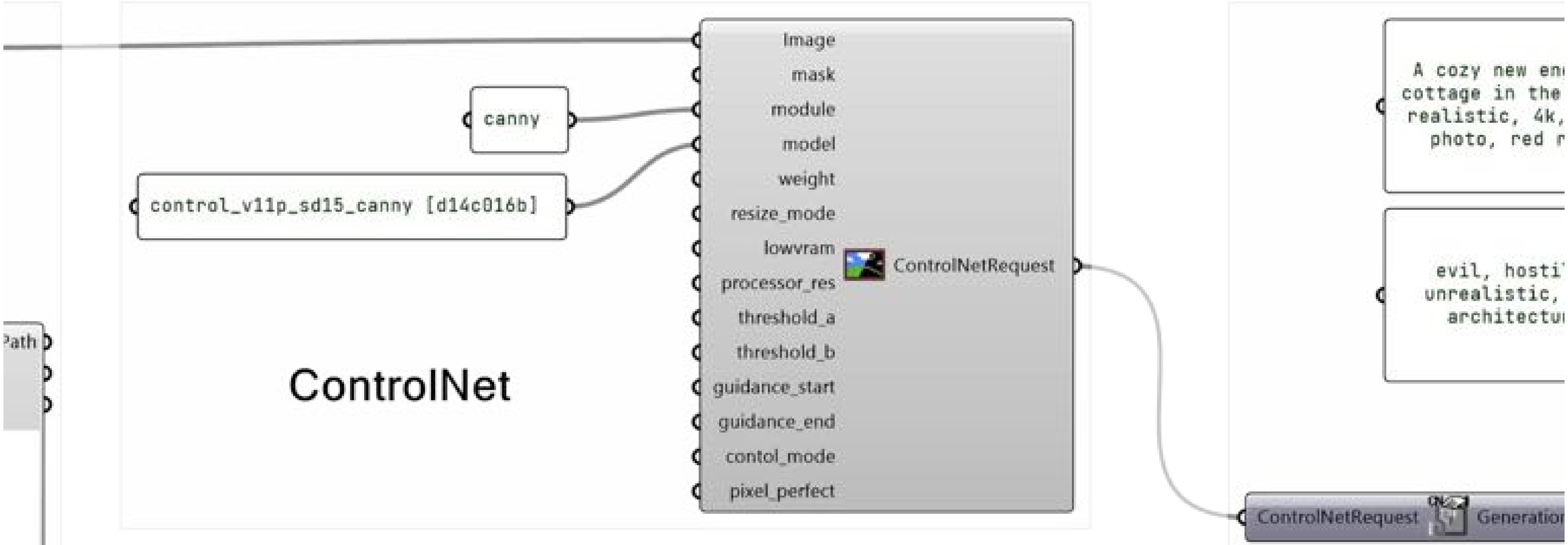
Lists can be used as inputs to the generate components, whichs creates an image for each possible combination. Here there are two images; one of red sandals, and one of blue sneakers (not shown).

Generation Options

4 options components allow varying levels of customization to the generation settings. This one, with a batch size of four, provides us with 4 images to pick between. Now lets preview the tiling (set to true) capabilities in the next two slides.

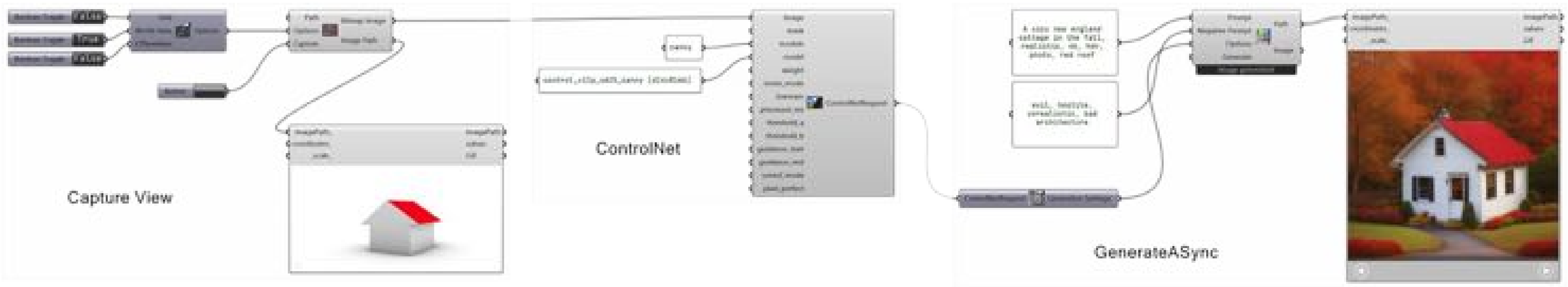


ControlNet Component



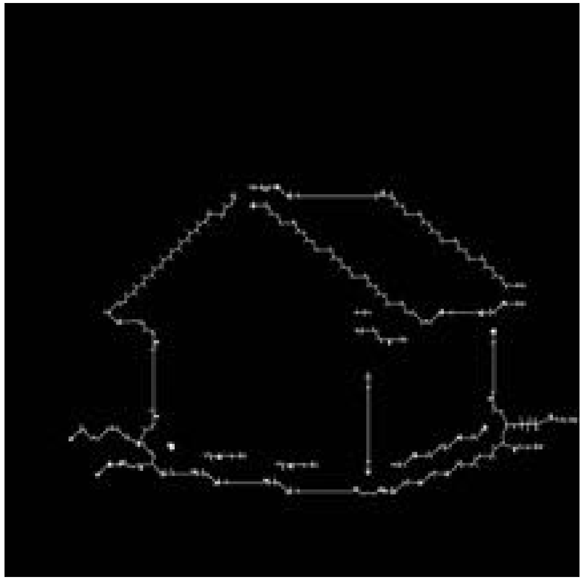
ControlNet is a way of influencing a final image based on an input image. A method of image interpretation is needed, in this example Canny is used. Generation options allow for finer control of the final image.

ControlNet Component



The ControlNetRequest output must be passed into a SD_GenerationOptions_ControlNet node, or the alwayson_scripts input in another options node to be converted to the proper.

The viewport as captured by the component, and what is passed into the ControlNet component.



ControlNet processed image.
The processor used, Canny, finds the edges of items and colors in an image and uses those as influence points.

Final output image, based on the ControlNet influence, and the prompts provided.

Sources

Automatic1111 Logo: https://github.com/AUTOMATIC1111/stable-diffusion-webui/discussions/2901

Shoe Sketch by Lin Shi on Behance (Appendix): https://www.behance.net/gallery/50951153/Some-doodles

Part II - Fabricaiton

Dan Kenerson

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October 2023 - January 2024

Acknowledgements

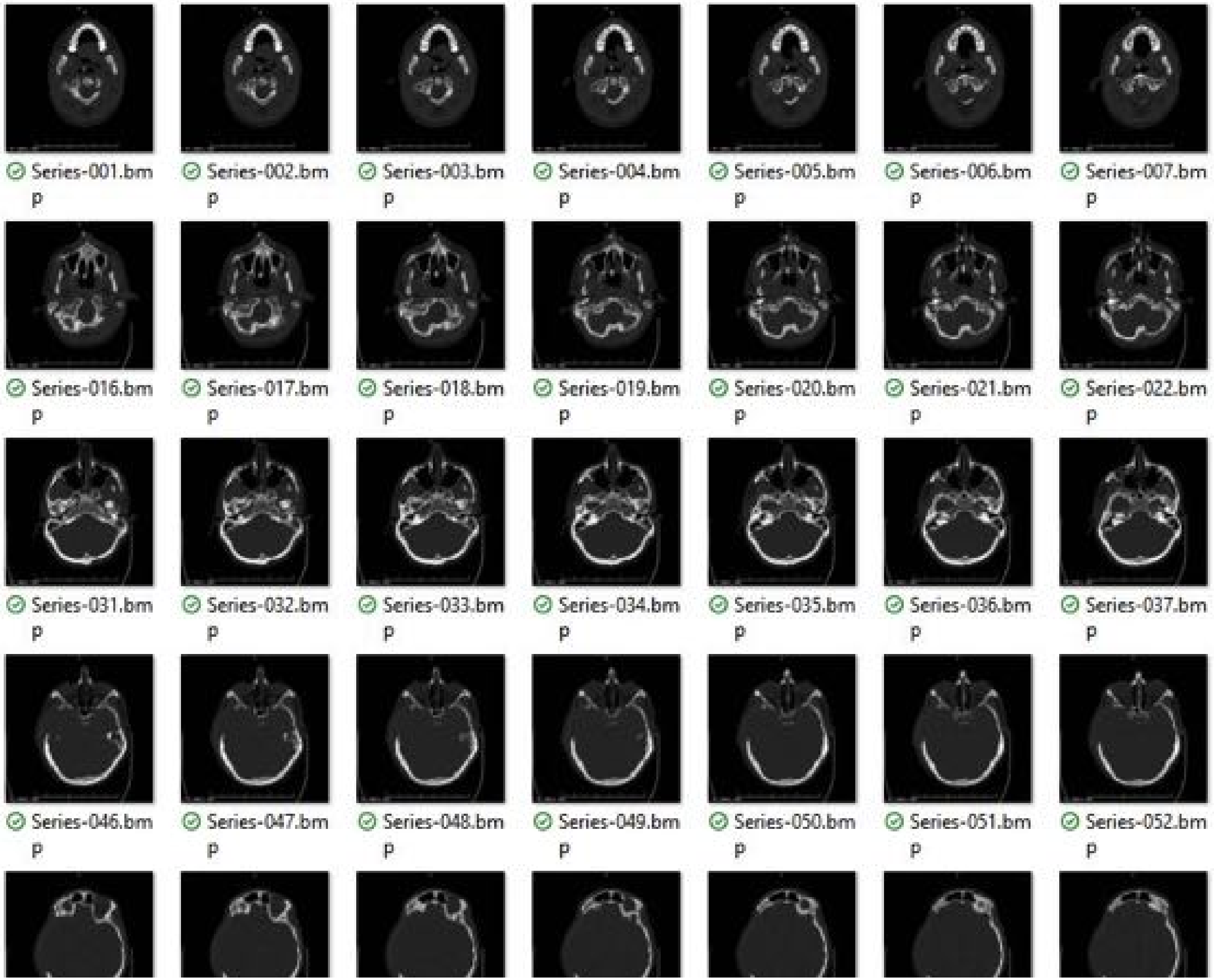
Thank you to Diego for many hours of studio help and questioning.

Also thanks to Assaad, LowPoly and Nagami for studio/ workshop tours.

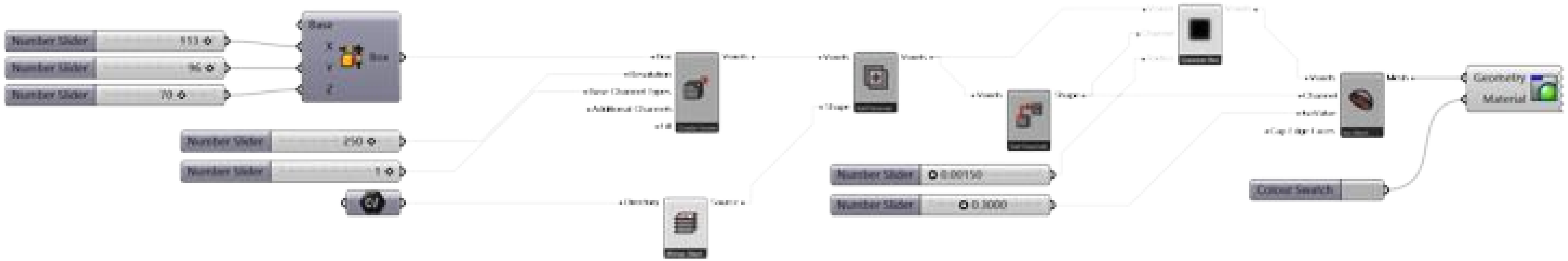
Plastic 3D Printing

Project Goals:

Using medical CAT scans, create and 3D print my brother's skull.




A
R
L
P
1 of 2: W: 1500 L: 500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Base
Box
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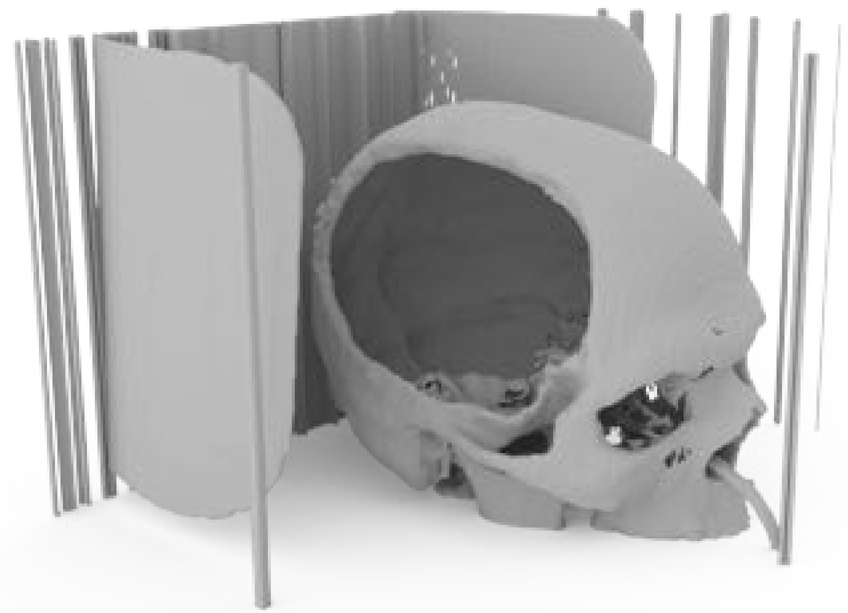
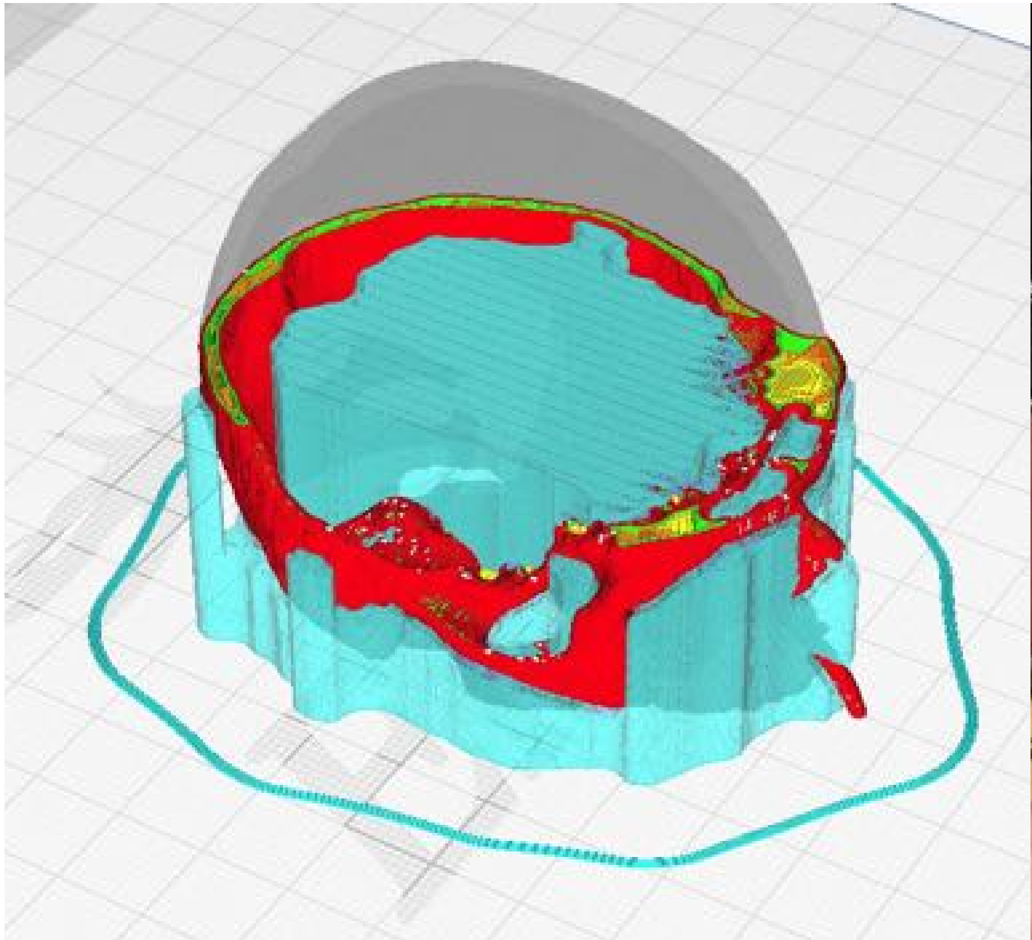
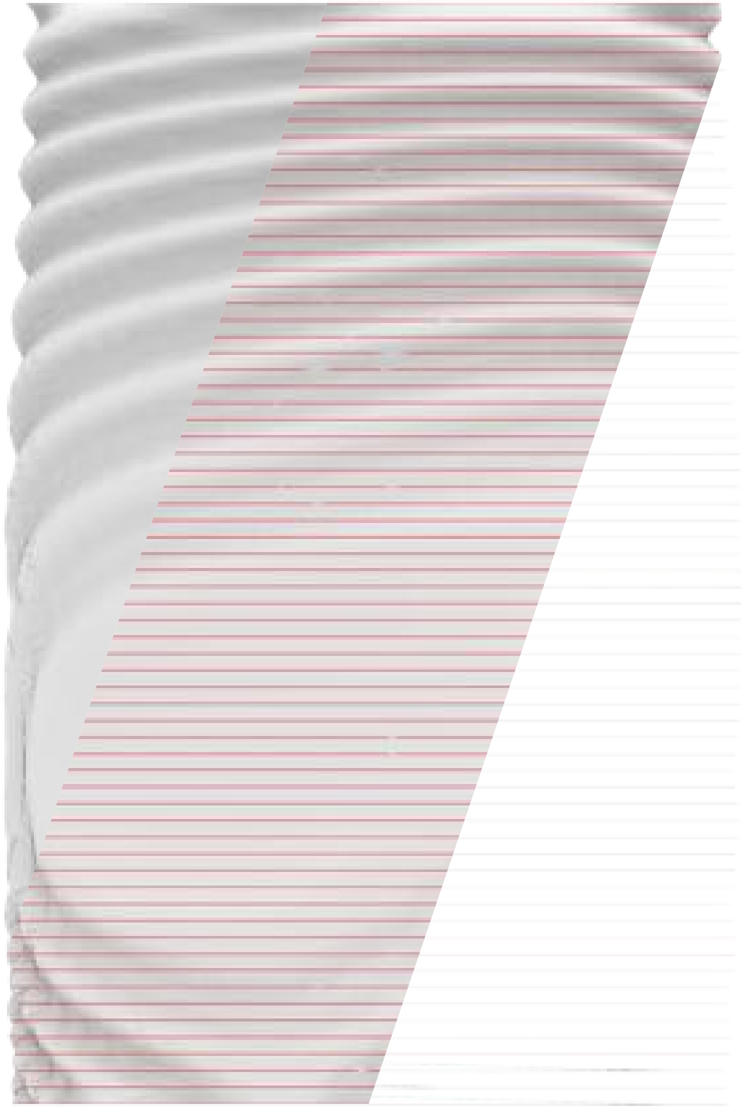
Number Slider
Number Slider
Number Slider
Colour Swatch
Geometry
Material





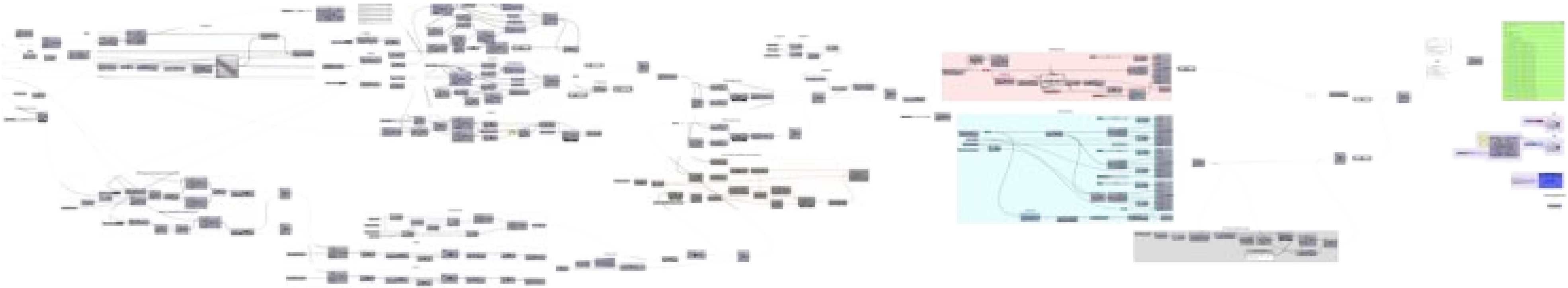

Ender

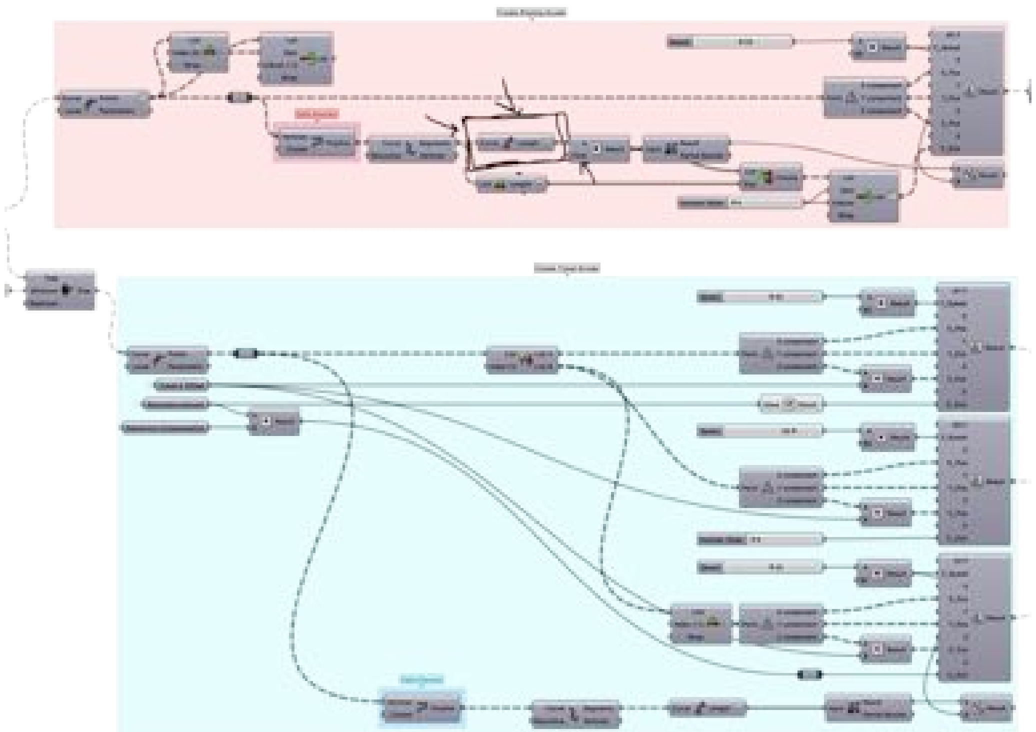
Clay GCode Creation

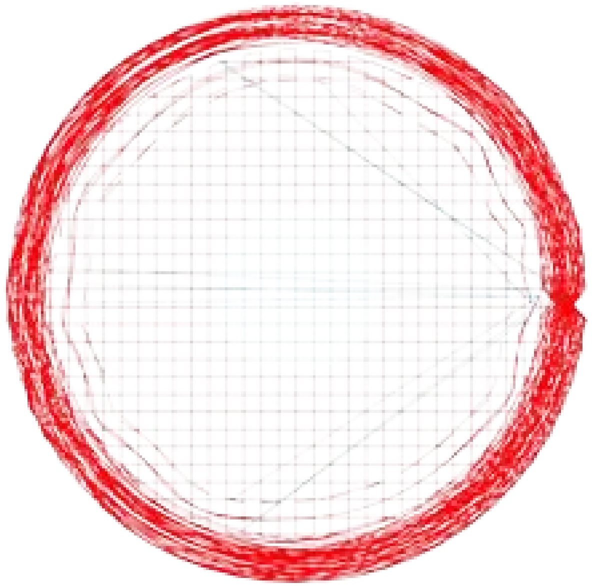


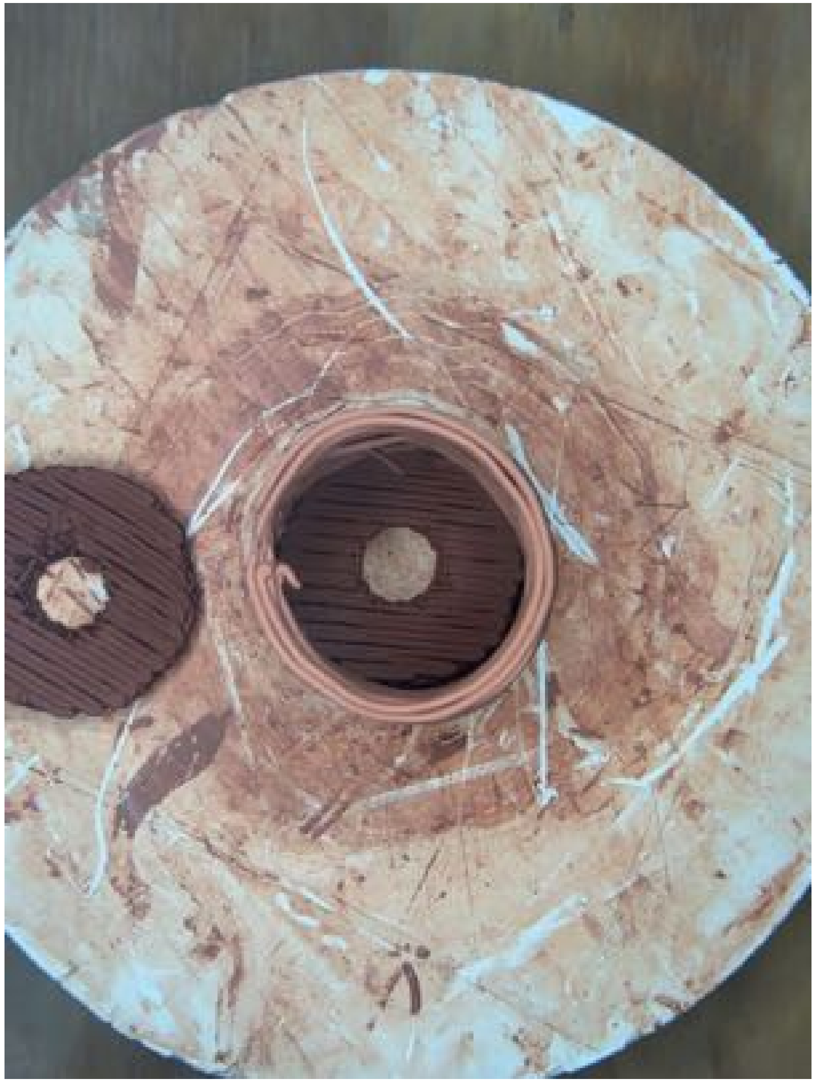
Project Goals:

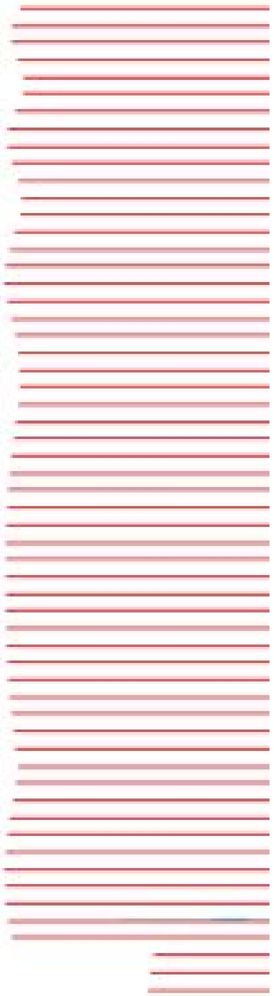
Create a pot for a plant out of clay that contains two parts: A water catch, and the pot for soil and plant. The exterior of the pot will have attractor field designs.

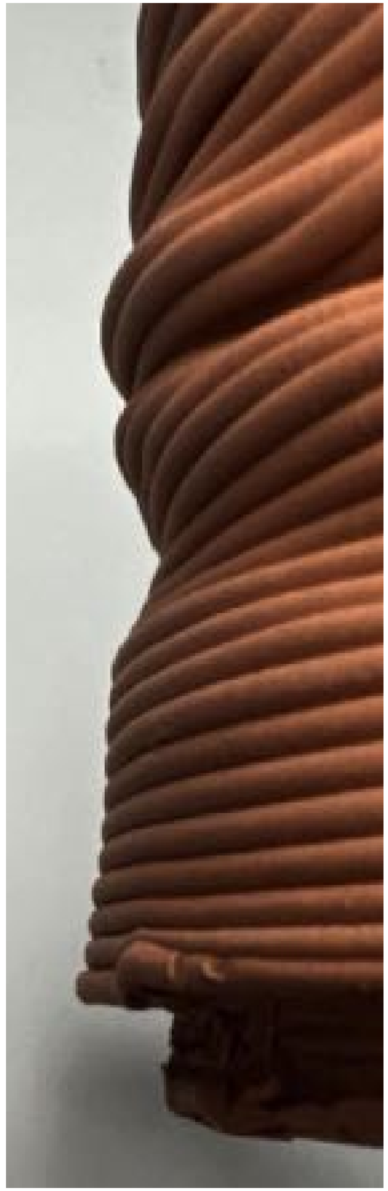








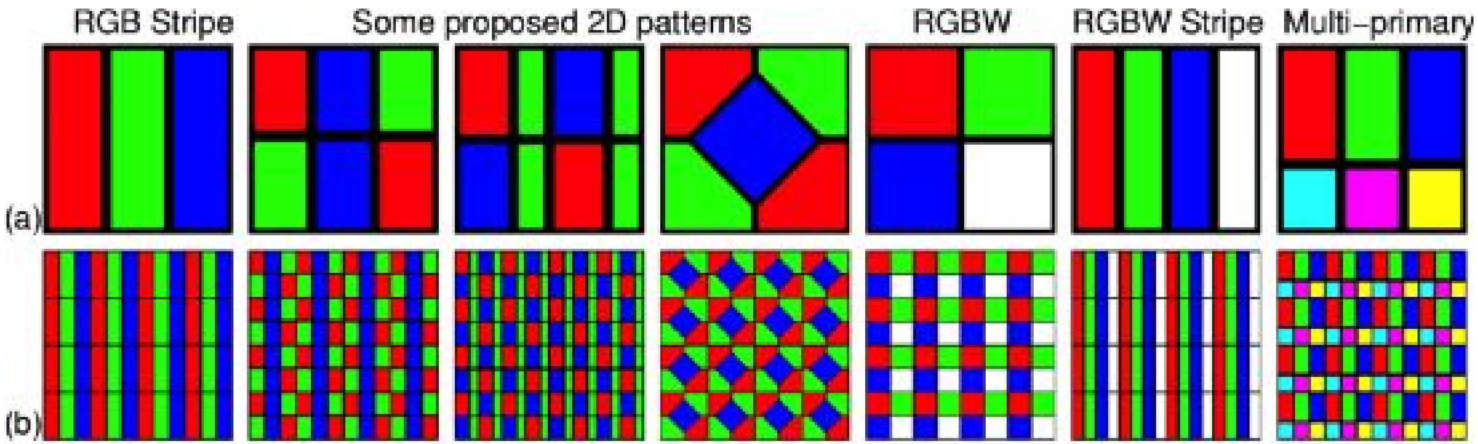




LED Acrylic Display

Project Theory (Sub-Pixels)

A sub-pixel is the orientation of light emitters that are within one pixel on a display. LED displays use a variety of sub-pixel layouts to shine light out into the world. Below are a few examples, what I chose for this project is “RGB Stripe”.

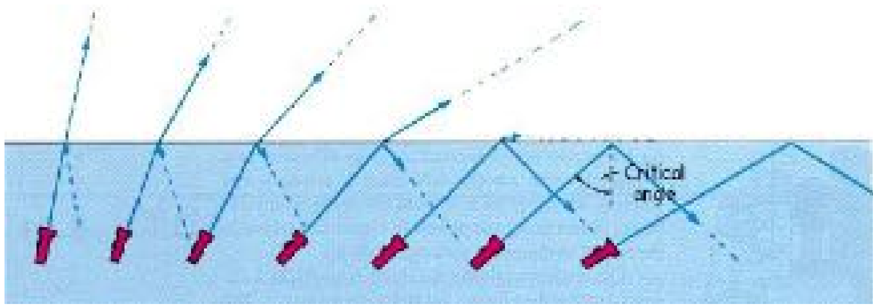


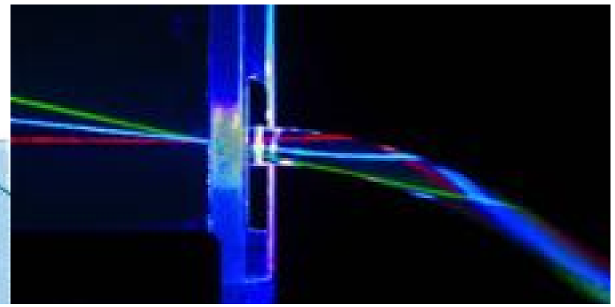
Project Goals:

Combine the concept of edge-lit displays and the pixel packing of LED displays to make an image display. Creating a base with CNC milling and LASER, and the image panels with LASER.

Project Theory (Total Internal Reflection)

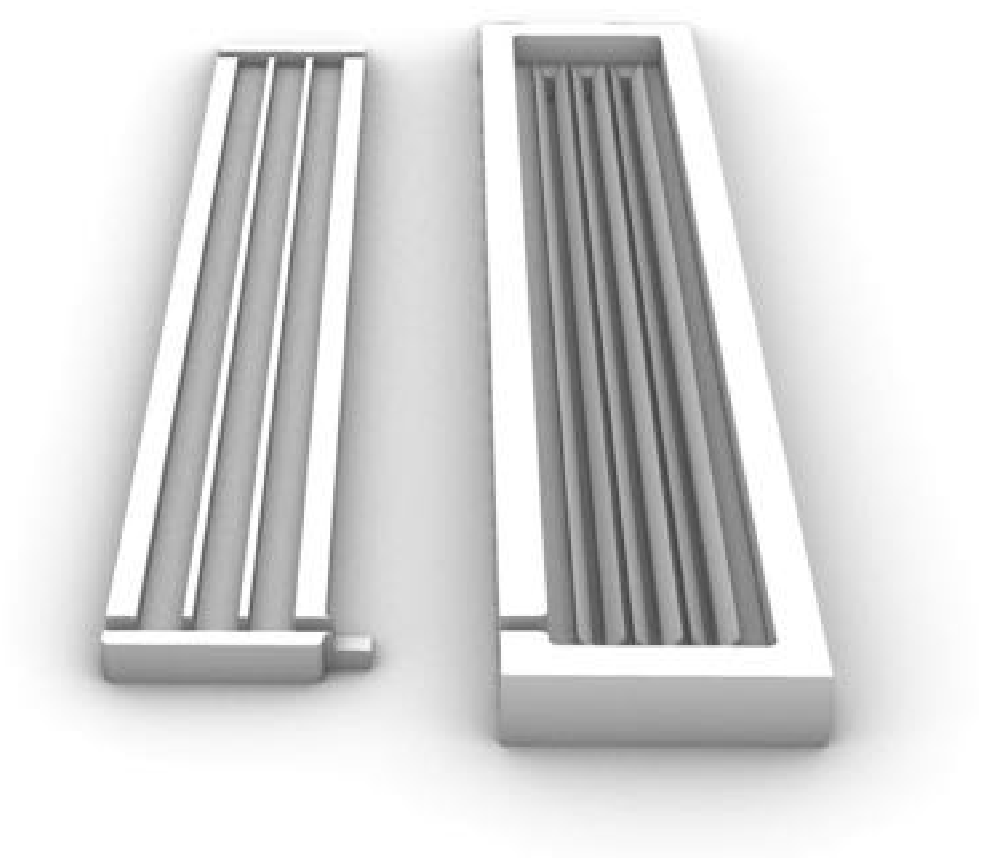
Total internal reflection occurs when the angle of light is acute enough that it bounces off of a change in material instead of shining through.





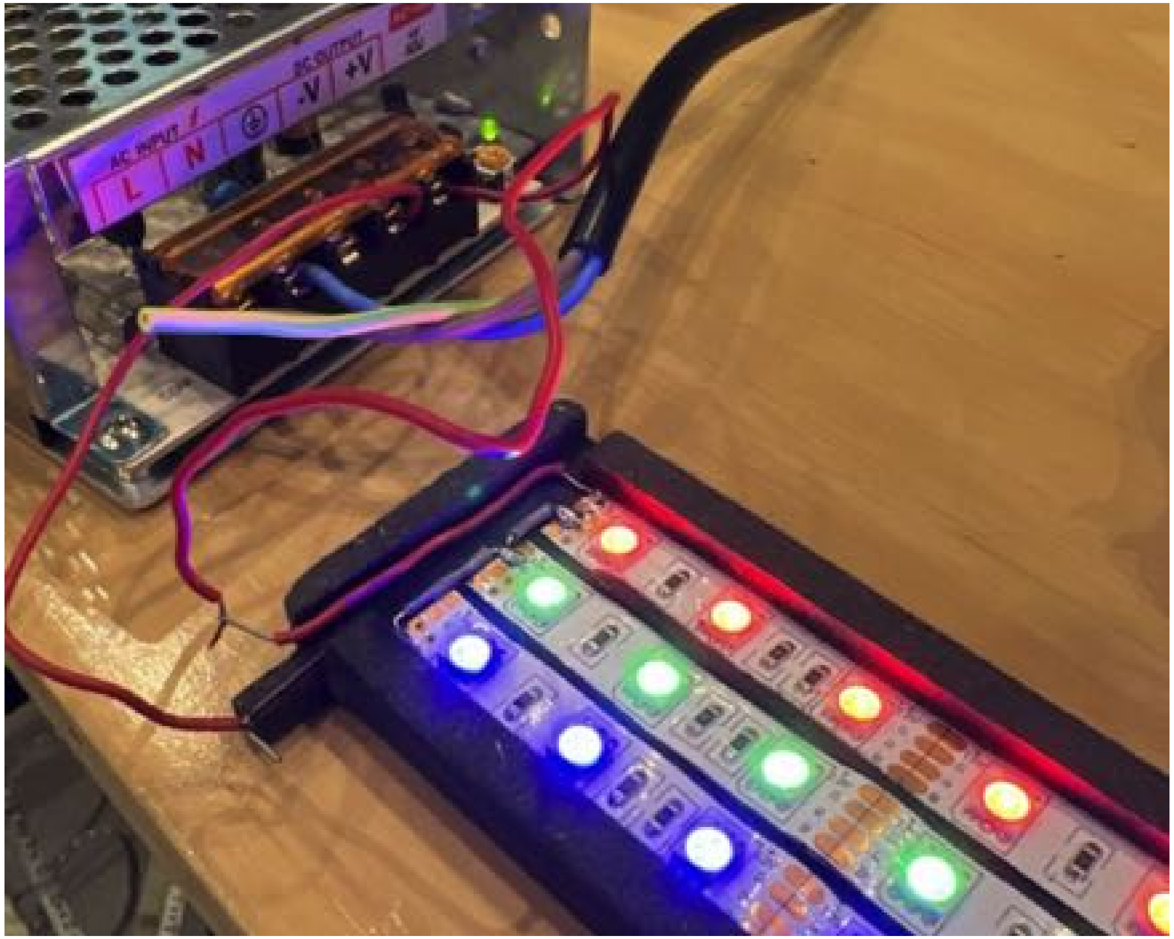
Base Designed In Grasshopper

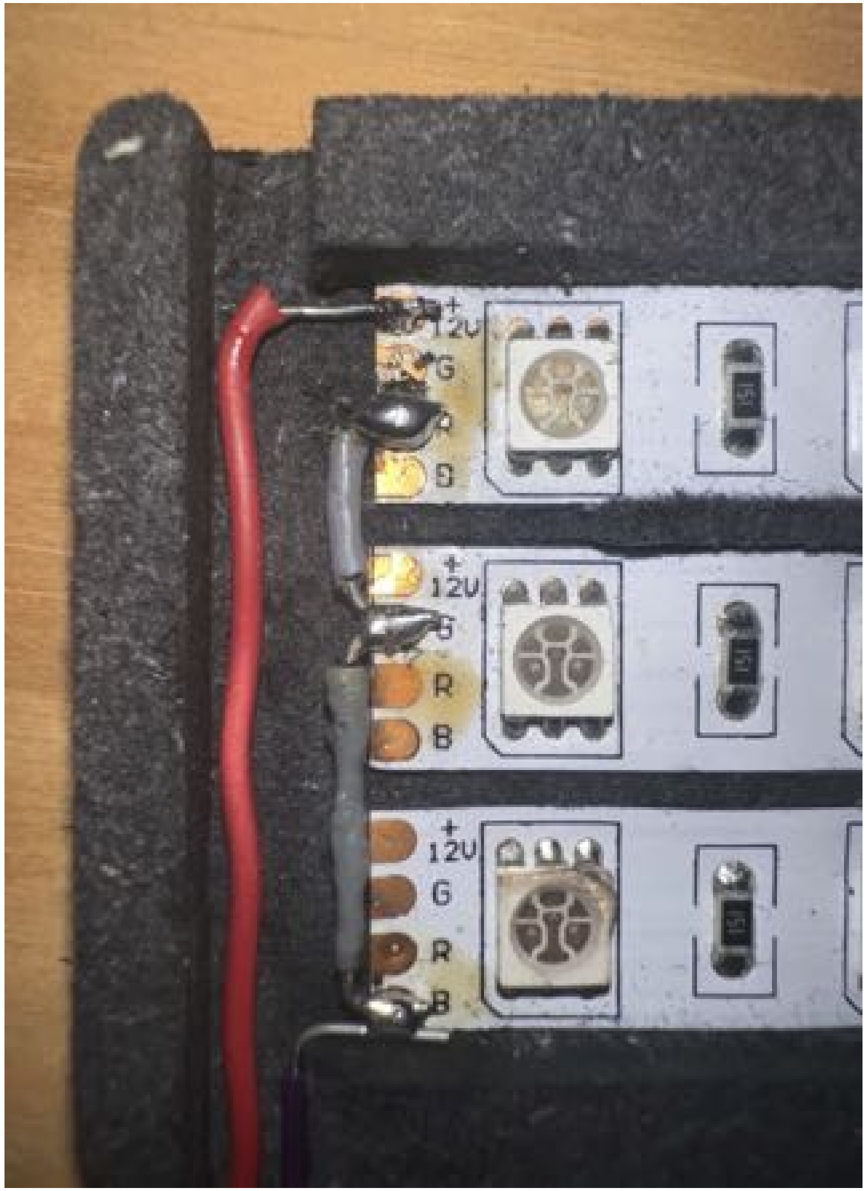
The top and bottom parts of the base were CNC milled, with the finishing of acrylic panel holes done in LASER.

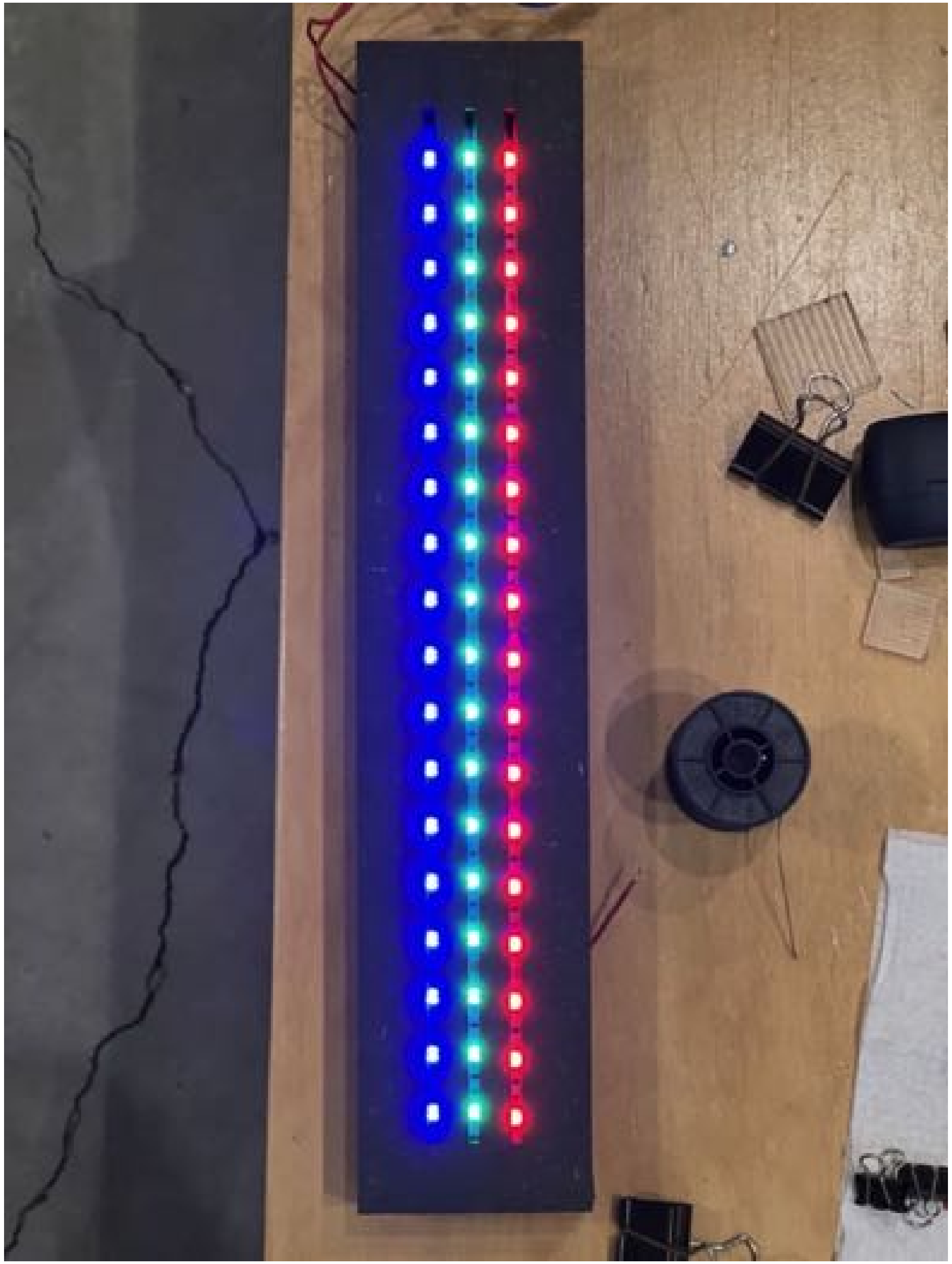


Electronics

Since one channel of each color is needed, and those colors will not change the circuit can be hardwired.



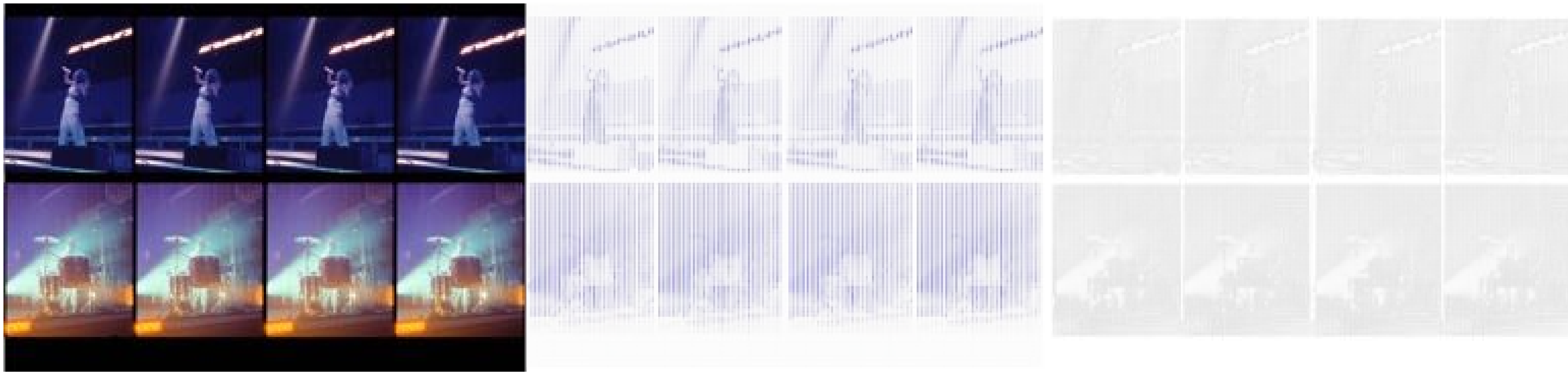


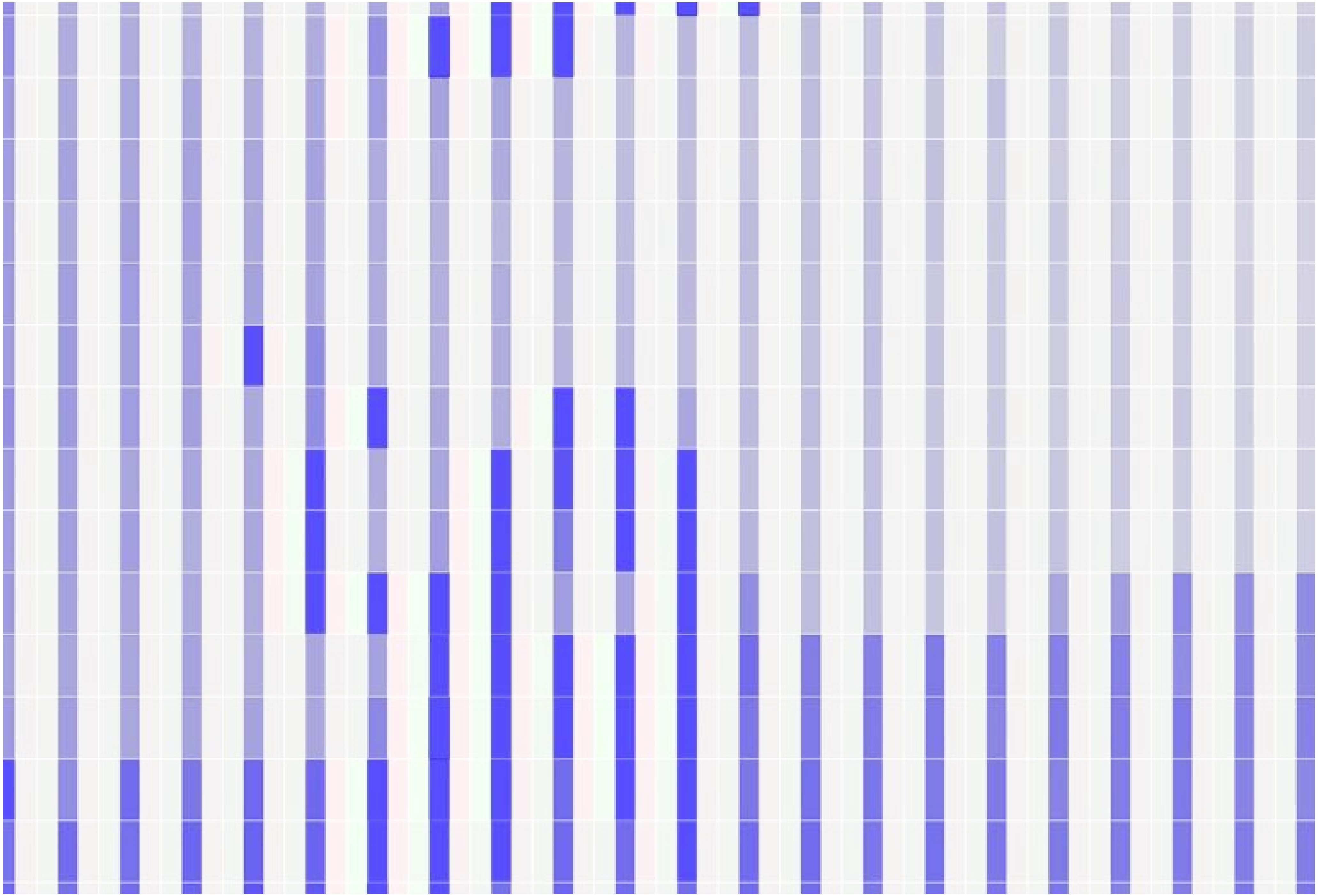


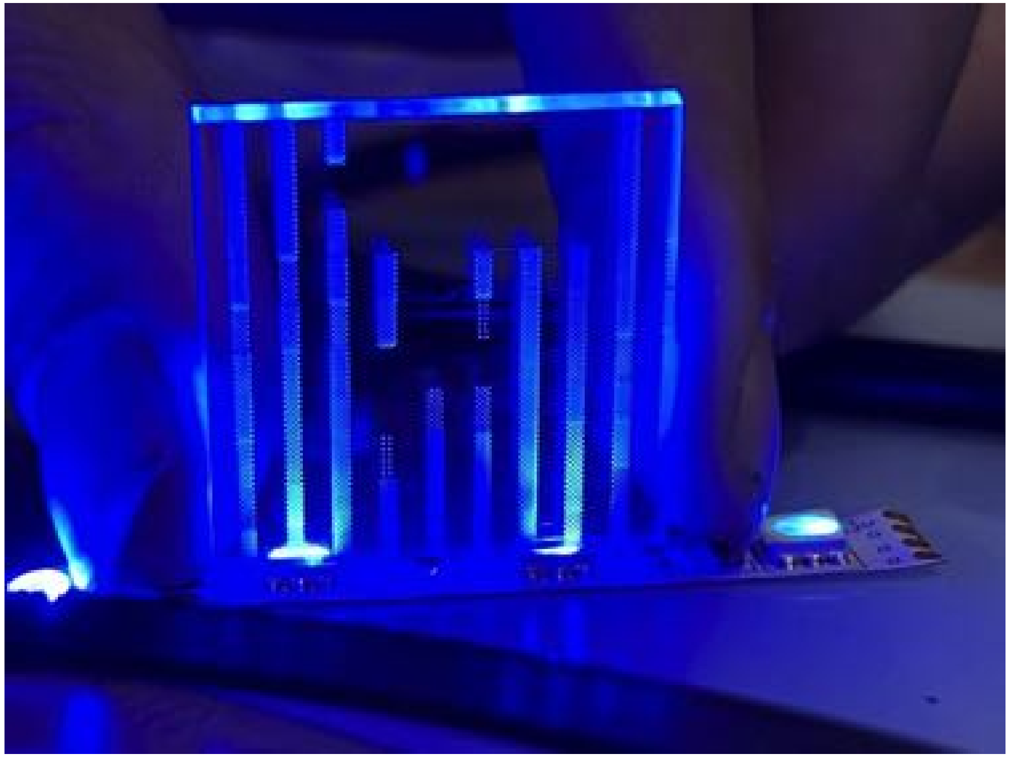
Panels Designed in Grasshopper

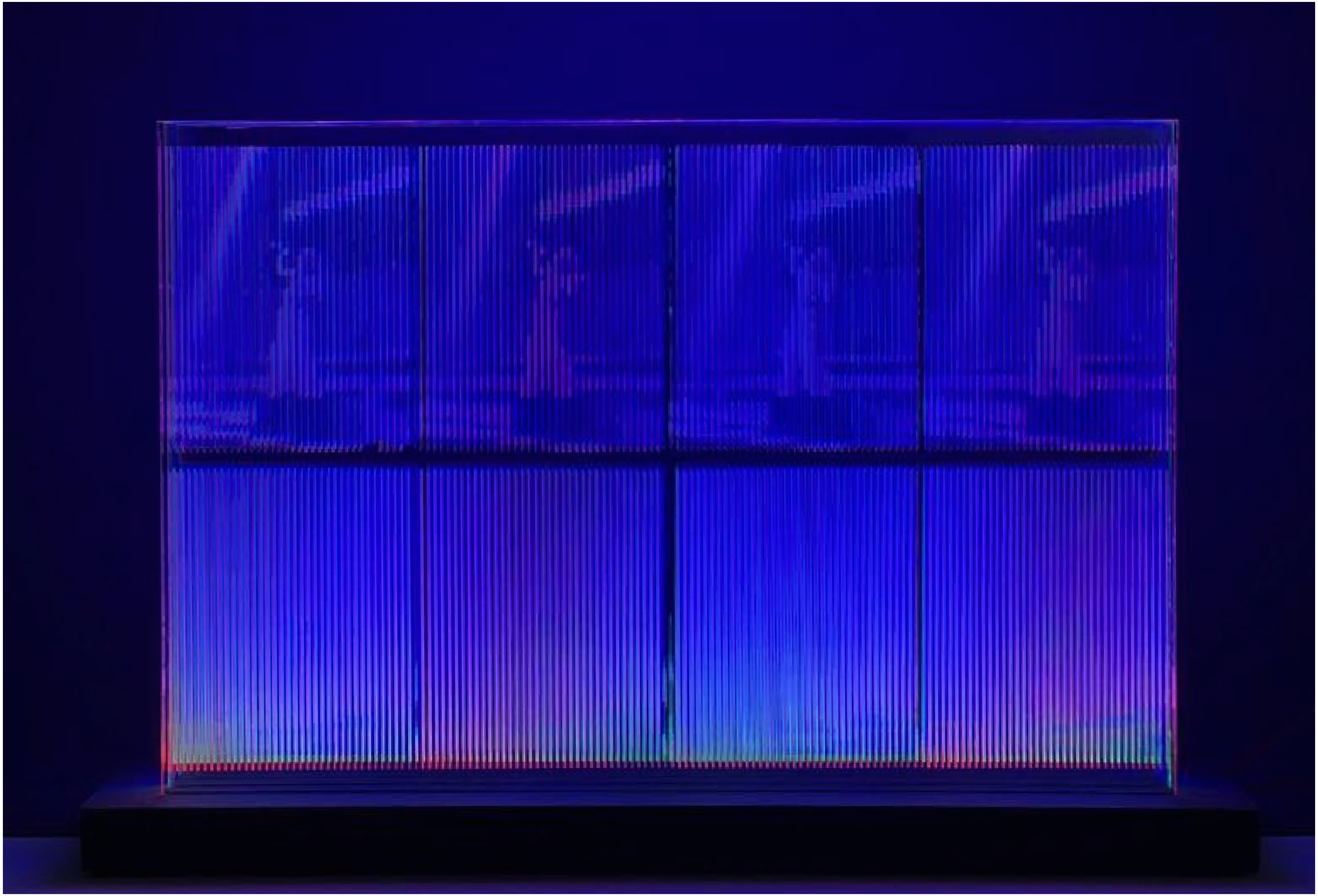
The display panels were cut and engraved with the LASER according to subpixels designed in Grasshopper.

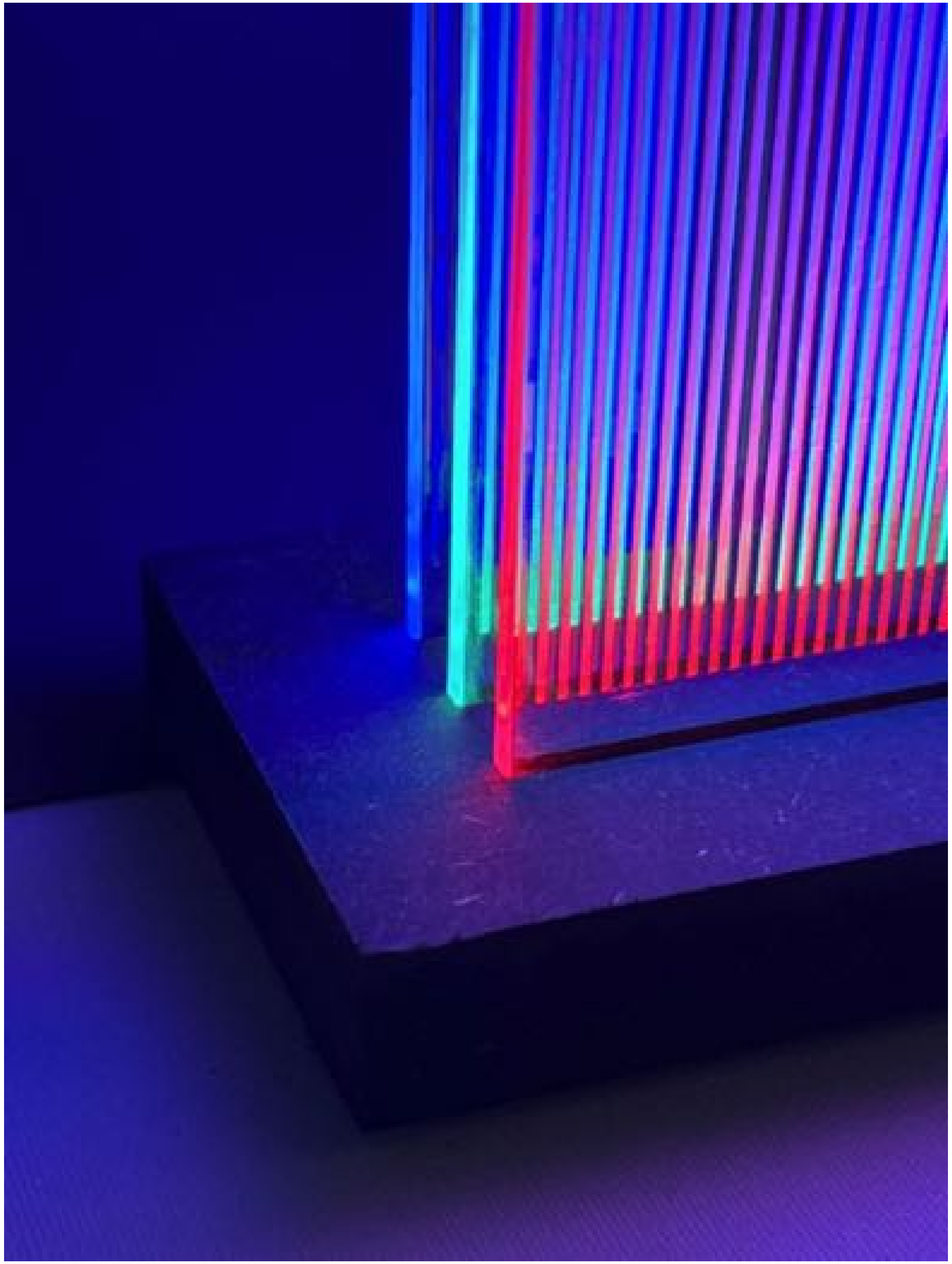
Image -> RGB Subpixels -> Greyscale

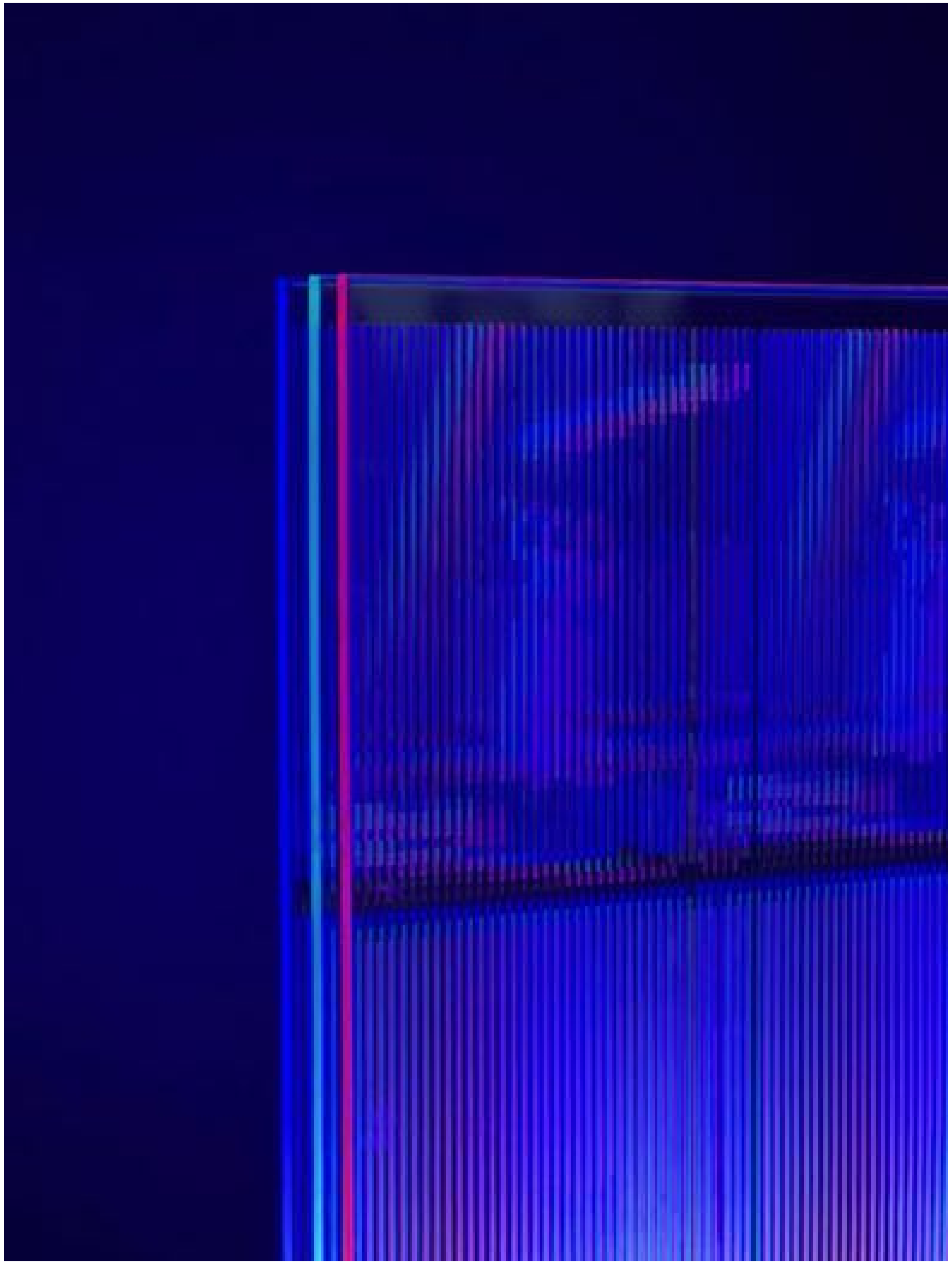












Sources

7 Subpixel Configurations: https://www.researchgate.net/figure/a-Seven-subpixel-configurations-traditional-1D-RGB-stripe-three-different-proposed_fig1_295905125

Internal Reflection Example: https://labs.phys.utk.edu/mbreinig/phys222core/modules/m7/internal-reflection.html

TIR Water Photo: https://www.flowvis.org/2013/05/09/total-internal-reflection-in-a-water-stream-traps-three-lasers/

JORGE MATAS AGUADO
COLUMNS IN THE AIR

M A S T E R _ P A R A M E T R I C _ D E S I G N

18th Edition. Final Project. Part I

October 2023 - January 2024

ABSTRACT

Structural model have been, since ages, a great tool for trial and error method. The 20th century has a rich development of models. This model have influence architects and designer until nowadays.

Geometry modelling programmas, like Rhinoceros, with its extension, Grasshopper give us now the chance to replicate many of the models from the past in a reliable way. Kangaroo2 is a solver that simulates forces on a given geometry and outputs a geometry in equilibrium under the presence of those forces.

The aim of this thesis is to check whether this simulator are correspondant to the physical models from the french engineer Robert Le Ricolais.

RESUMEN

Las maquetas de estructuras han sido desde tiempo inmemorial una adecuada herramienta para el método de ensayo y error. El siglo XX ha sido testigo de un rico desarrollo de las maquetas en este sentido. Estas piezas han influido en arquitectos y diseñadores hasta el día de hoy.

Programas de modelado como Rhinoceros y Grasshopper nos dan la oportunidad de imitar muchas de las maquetas del pasado de una manera fidedigna. Kangaroo2 es un solver que simula fuerzas en una geometría específica y da como resultado la misma geometría en equilibrio bajo esas fuerzas.

El objetivo de la tesina es comprobar la correspondencia de la geometría simulada con los modelos reales del ingeniero francés Robert Le Ricolais.

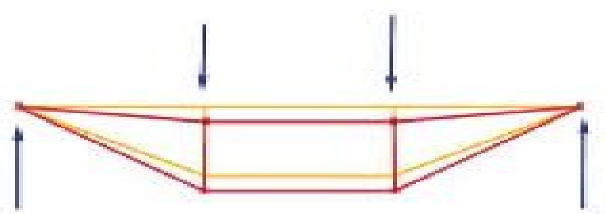
INDEX

2. Polyten Truss - “Polyten Unit” in Kangaroo2

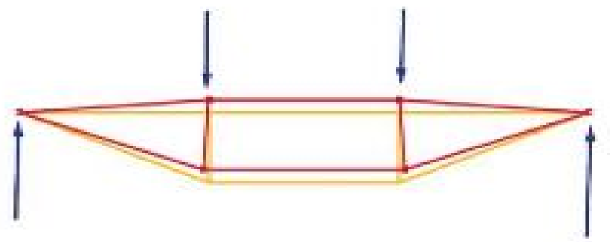
The components that at first will be used will be *Load, Anchor and Length(Lline).* The Strength parameter from the “Columns in the air” is set to a very high number, so it simulates a solid being under compresion forces.

After running the simulation, the equilibrium result does not match the expected result: the displacement in the middle point is in the negative Z direction. In the physical model of Le Ricolais one could easily see that the displacement is in the Z direction, giving the piece a light-weighted appeareance.

We now try to get that appeareance throught adding a Kangaroo2 component called *ConstantTension.* This component has the aim to replicate the cable tensioner Le Ricolais used to have in his physical models

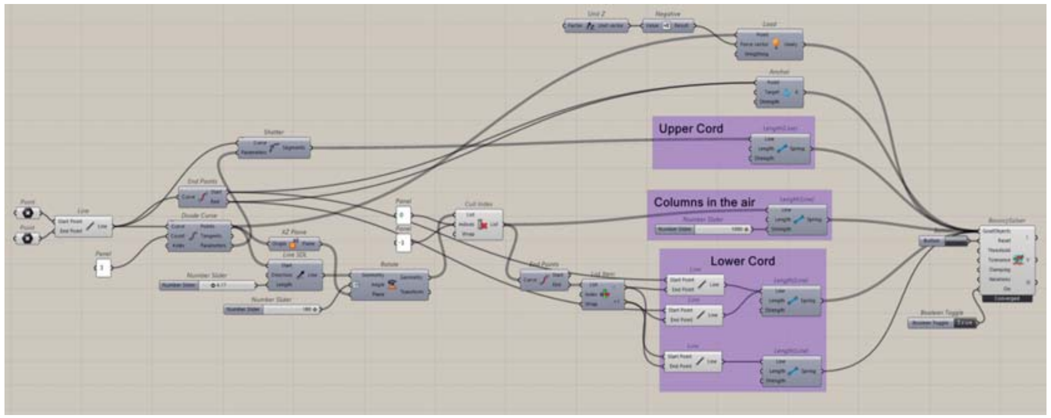


Kangaroo output

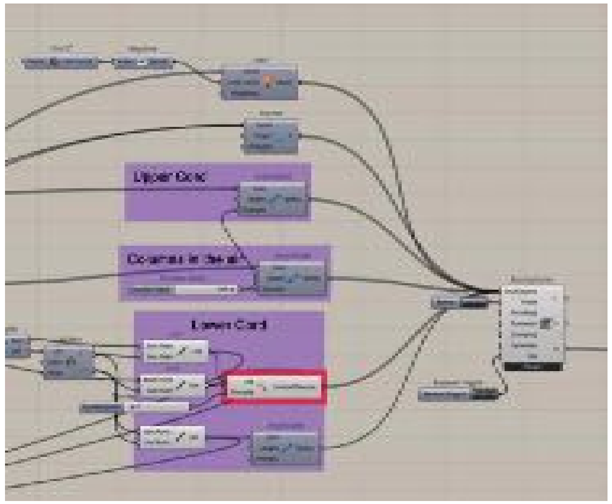


Kangaroo output

Kangaroo definition of a “Polyten unit”

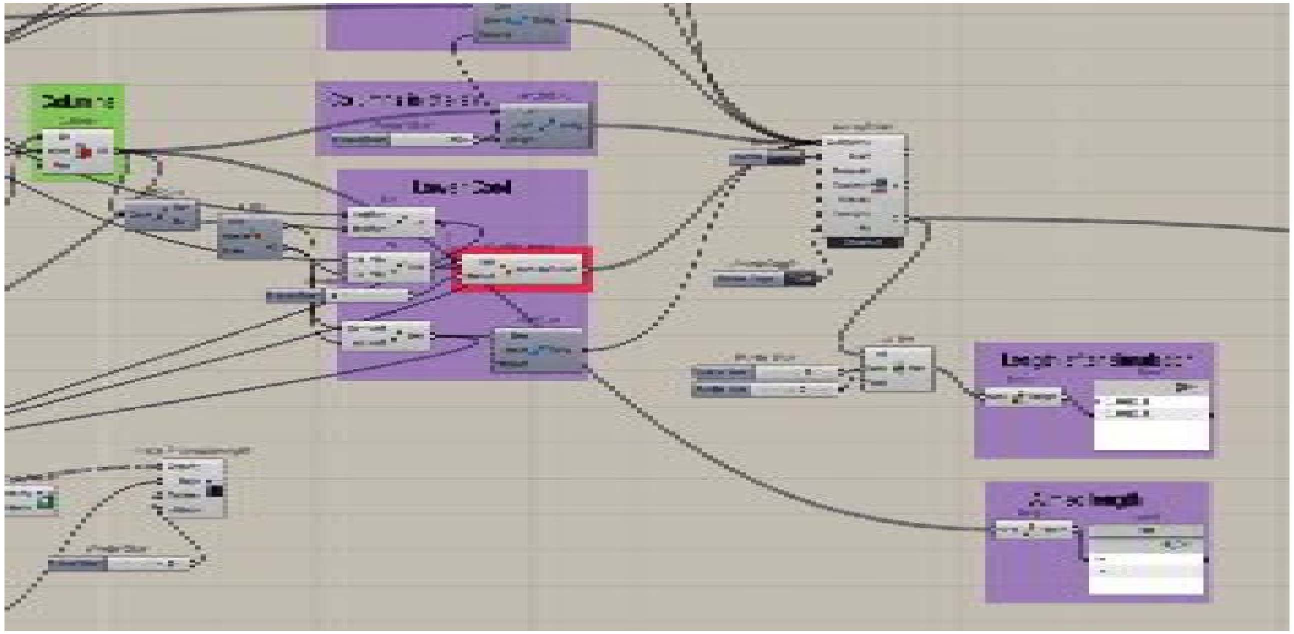


Kangaroo definition with Constant Tension

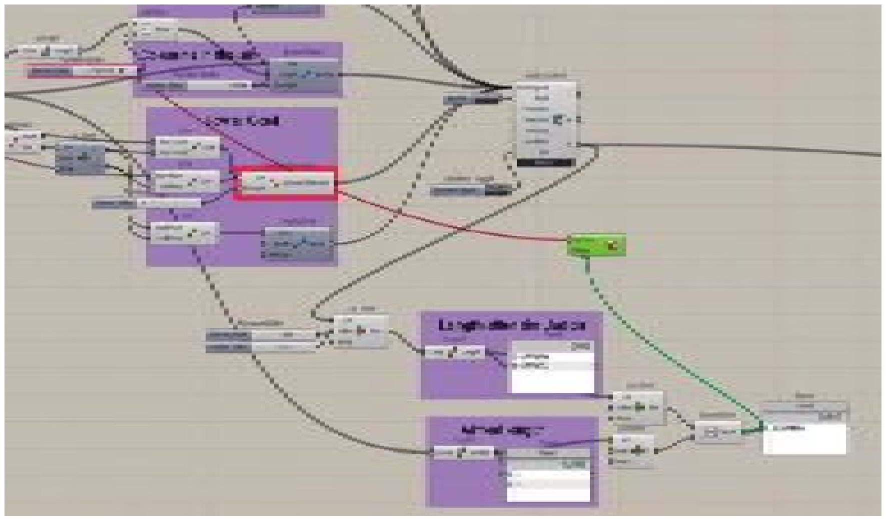


The Length(Line) component applies the Hooke’s Law. It is mean, that the greater is the strength parameter, the closer to the original size will be. Even if the strenght parameter is very very high, it will have a diferent lenght as output. This is critical when trying to replicate solid-compresion elements in Kangaroo2.

We try now, thanks to Galapagos, to change the Length parameter in the Lenght(Line) component. We will make it artificially bigger, in order to get as a final output the real length.



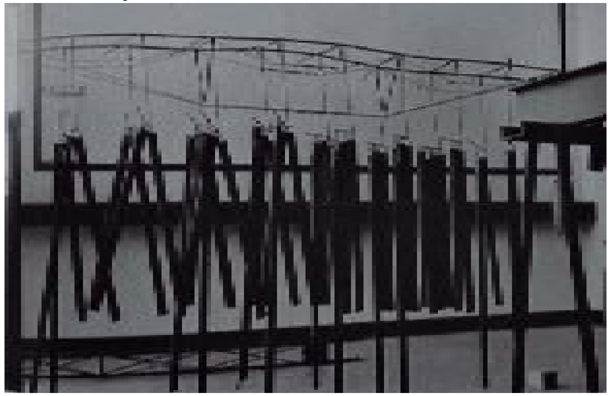
Results are not satisfactory due to the essence of both Kangaroo and the sincretized geometry. This geometry is in equilibrium, but is not a stable one. Any change in its geometry (length) applied to the solver (kangaroo) can make it colapse. The Galapagos component changes a huge amount of times the slider of the length during the simulation. it takes no time for the virtual model to colapse (as it would do in real world).



The previous example was a 2D example. Models in real life are never 2D. Even when talking about models made out of paper, that paper has a thicknes, a grammage.

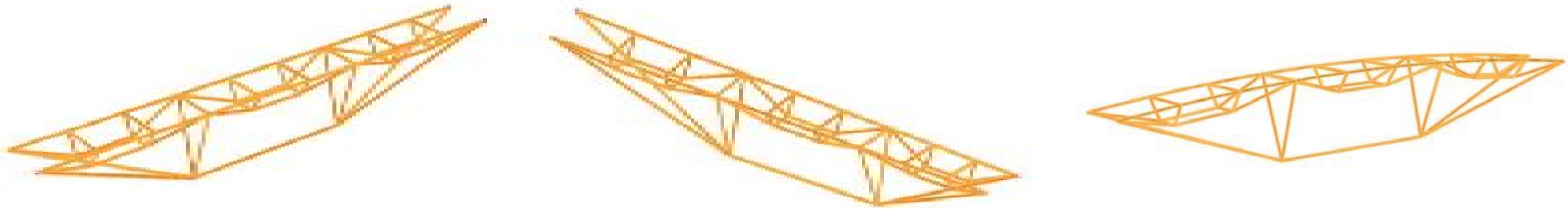
Le Ricolais said about the picture below: This photo was taken just before the model failed, under a load of about 108 kg, or 60 times its own weight. You could see from the ondulation what kind of fight was going on, pushing against bending: instead of a simple deflection, we had somthing like sine waves, these curves showing that the thing was working and that one could begin to control the system and its deformations, possibly by adjusting the pre-cambering and tension or by further repetitions of the queen post.

Preliminary model of a Polyten truss, 182 cm de largo, barras de acero de 5mm y 6.3 mm de diámetro y cable de avión de 1.5mm. 1968-69



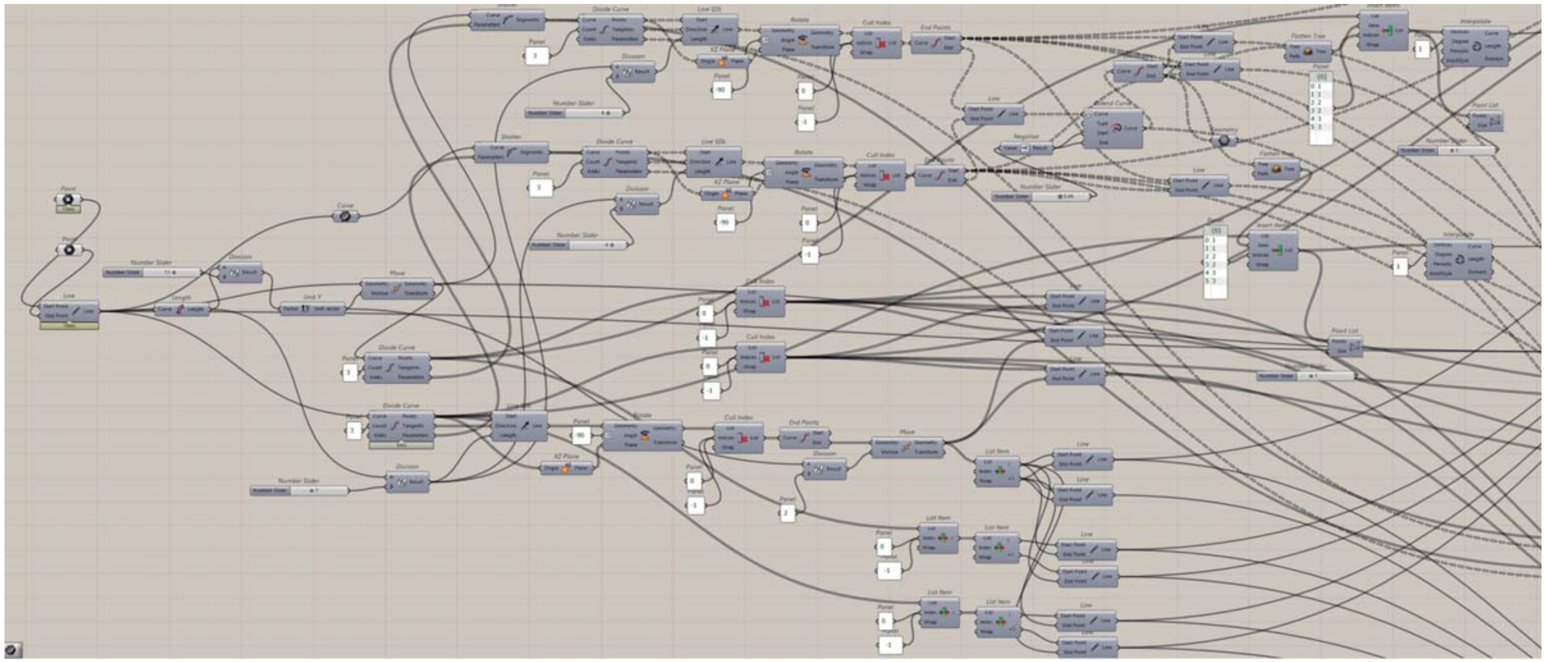
Polyten Bridge (Model #078) 1968 12.5x94x32.5cm. Centre Pompidou

2. Polyten Truss - A “physical” Model



Rhinoceros model generated through a Grasshopper definition and two points

Grasshopper definition



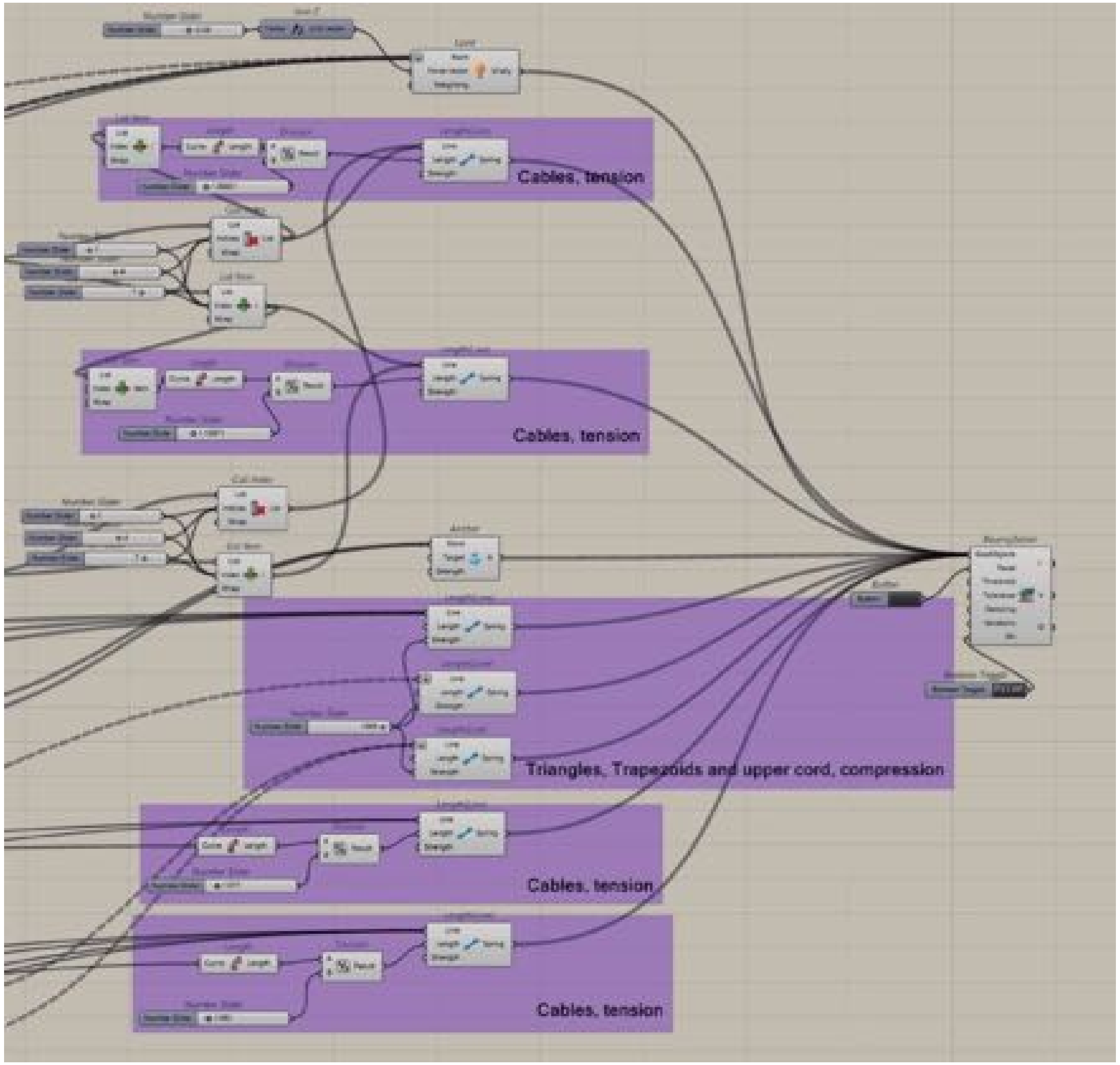
Constructing the geometry in Grasshopper takes some time, but a wide knowledge is not needed. List and Cullpattern components are the most difficults ones that have been used. We first chose a straight line, but we can change it to a new curve. This new curve could have some counter-deflection (picture on the right). This aspect may give us a different aproach when dealing with Kangaroo2

2. Polyten Truss - A “physical” Model

As soon as we apply the previously used goals, things start to happen. It turns out that the ConstantTension component is not suitable. It makes the model to turn around itself.

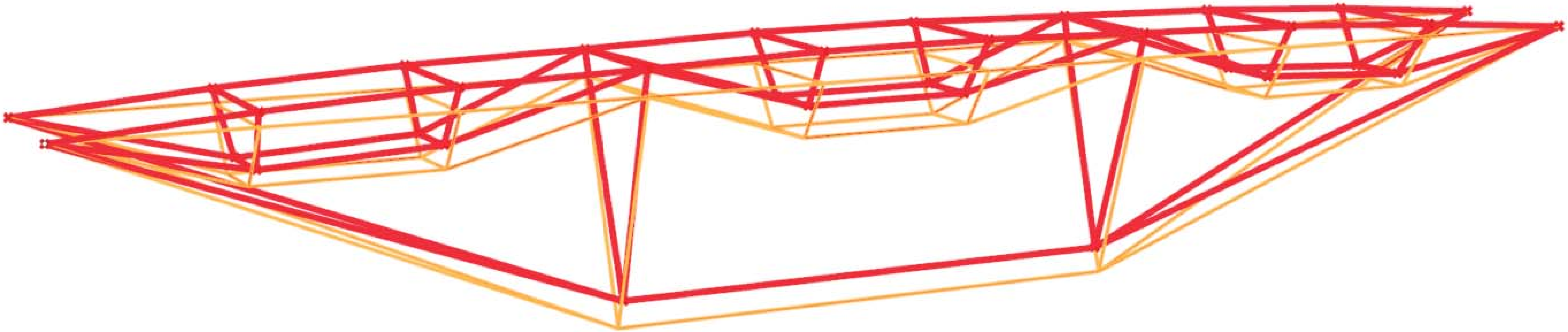
Another aproach is made this time back with the Length(Line) component. In the “Polyten Unit” part we did not change the Length parameter, however, we can change now these parameter in order to simulate this elements (cables) to be tensioned.

Simulation shows that even with a straight line as base, the curvature that we can be seen in the pictures from the 60s is posible to be emulated through Kangaroo



Kangaroo Goals - Polyten Truss

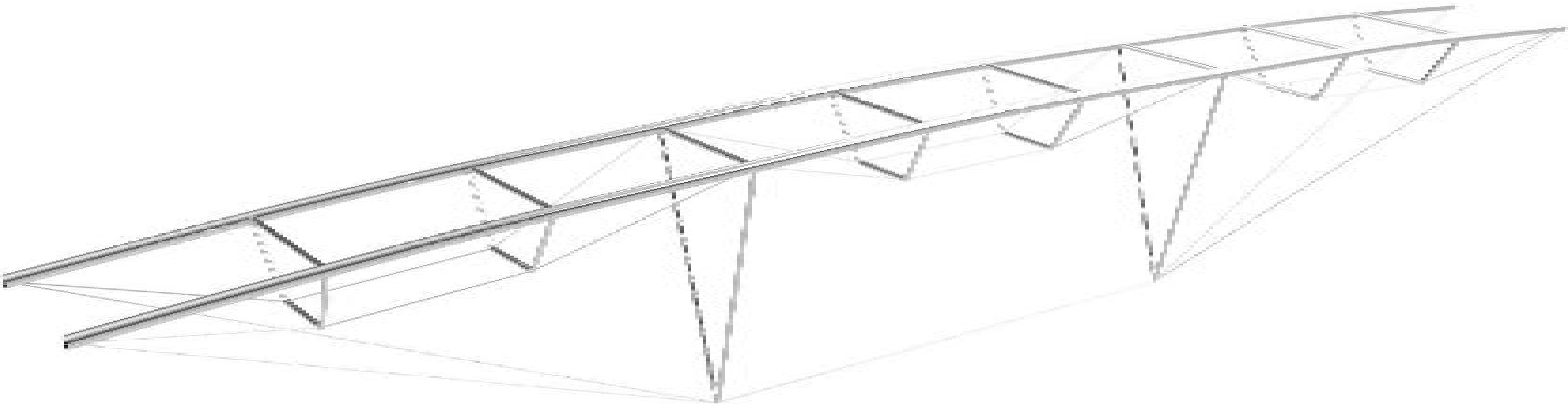
2. Polyten Truss - A “physical” Model



Red = geometry after simulation

Yellow = base geometry

2. Polyten Truss - A “physical” Model



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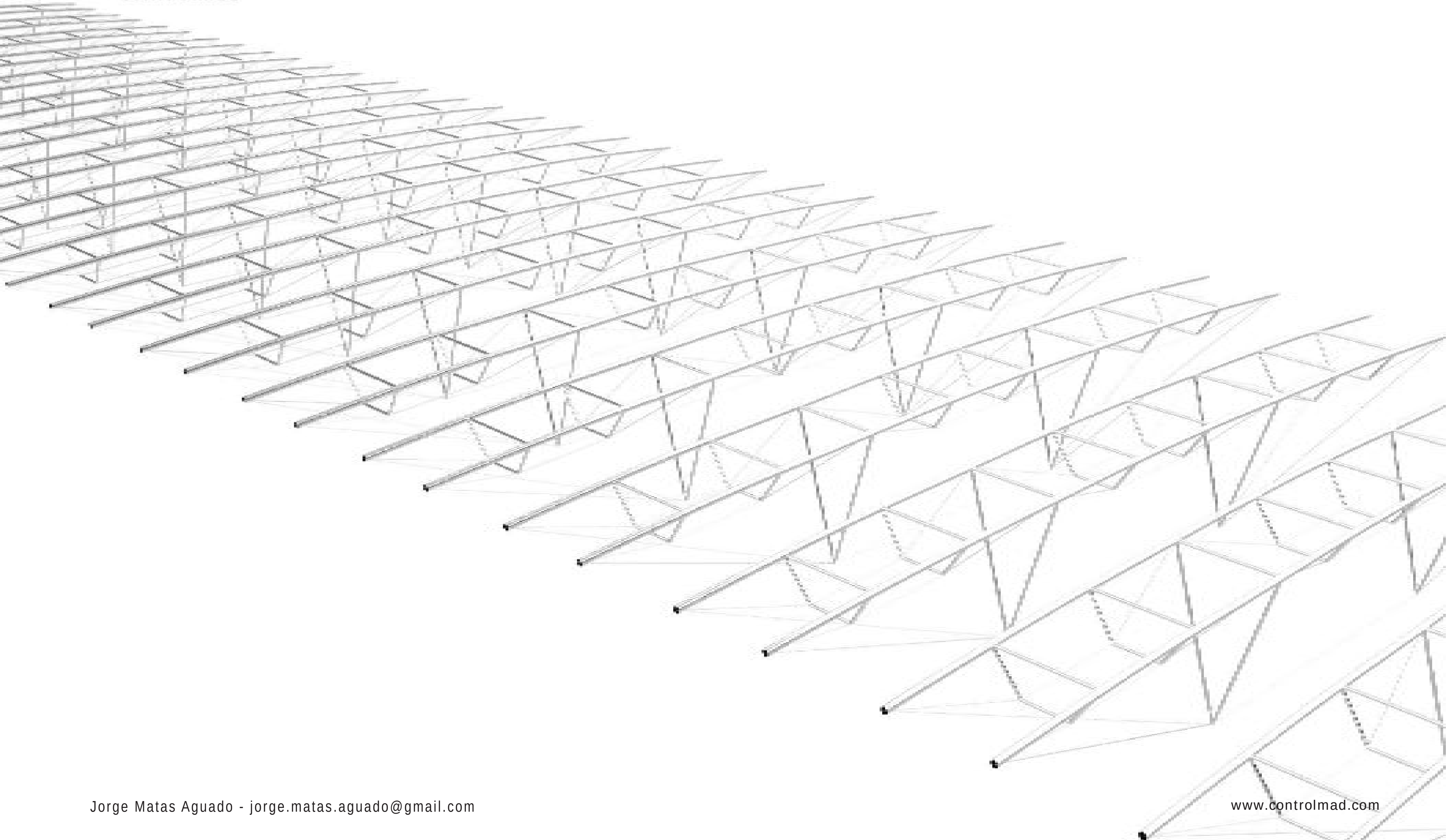
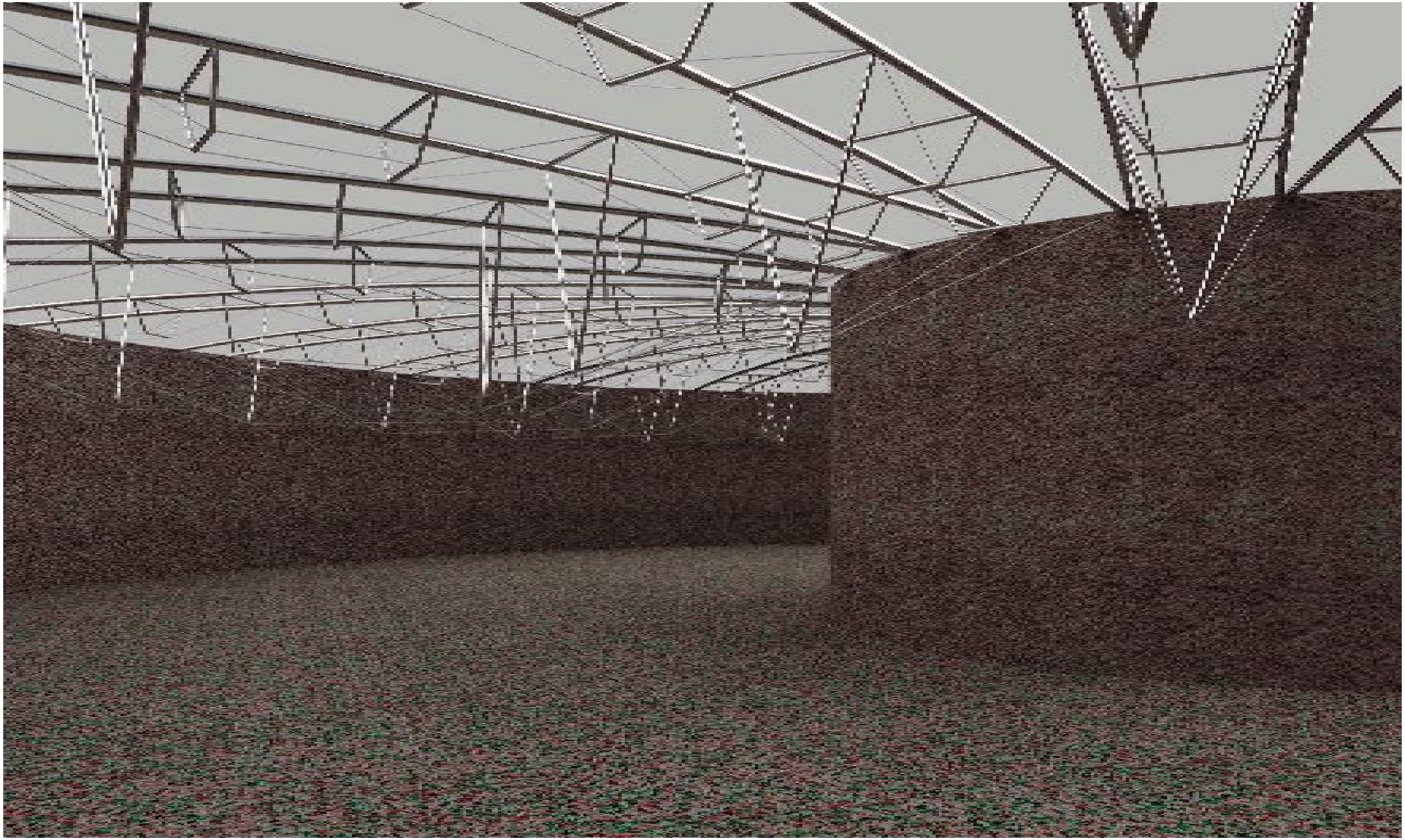
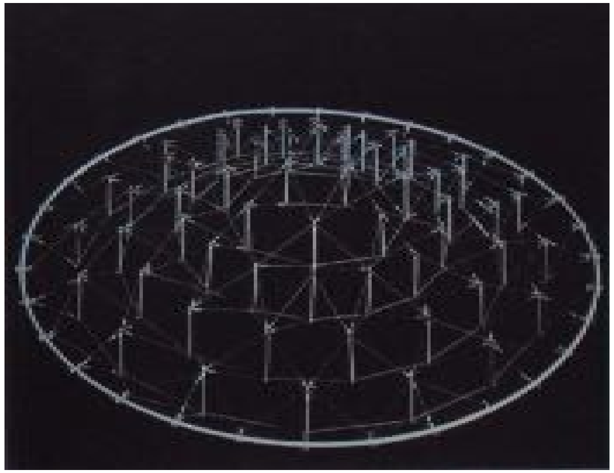


2. Polyten Truss - A “physical” Model

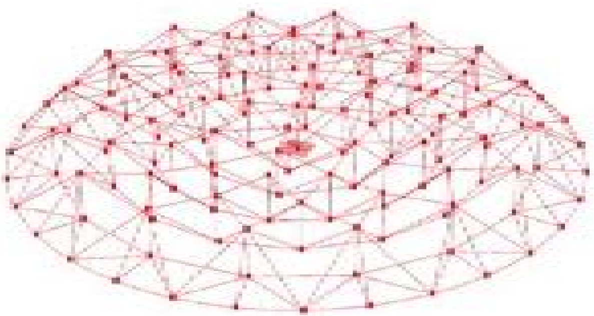


In the publication *Robert Le Ricolais: visions an paradox* a nice and misterious picture can be found. It depicts a model of a dome. Same, tension or comprension elements. A ring which supports compresion forces acts as anchor. Then, little columns, columns in the air, act as persons carriyng the loads to each other.

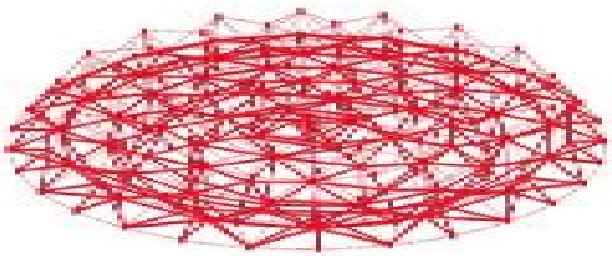
First, like with the "Polyten-Truss" we sincretize the geometry so we can run it in Kangaroo



As soon as it was finished, I wondered whether all inner rings should be placed on the same plane. I run the simulation anyway.

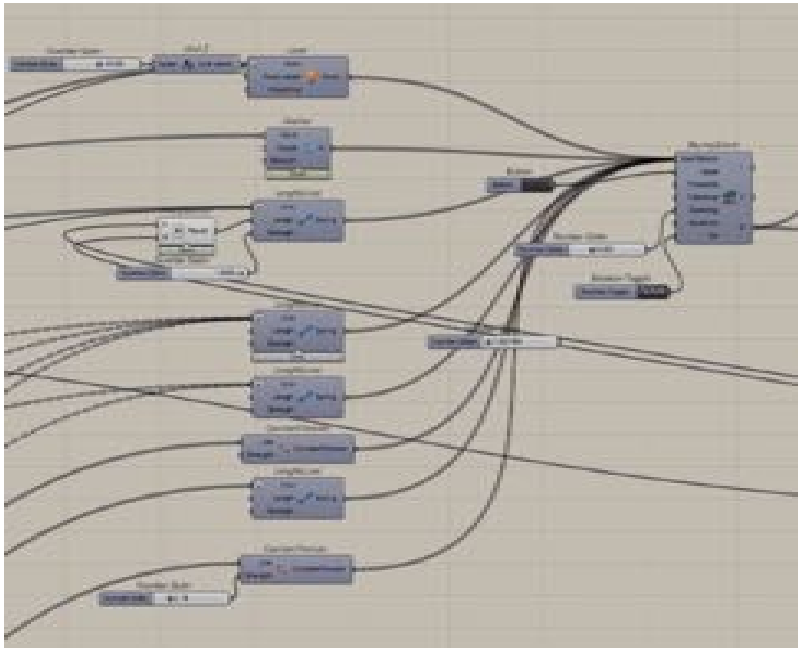


Structure does not behave as expected.



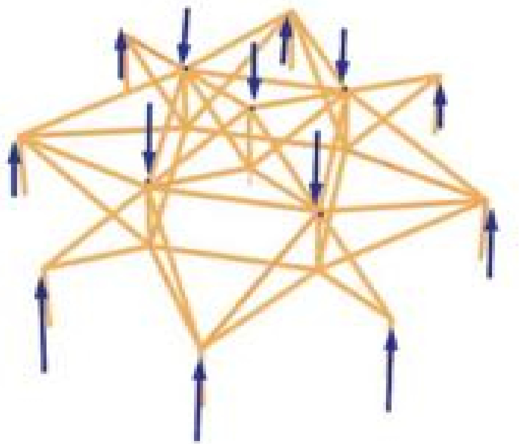
A part of the complete dome is used to run a simulation and play with the goals, so than we can understand how can the dome has its shape even when having gravitational forces on it.

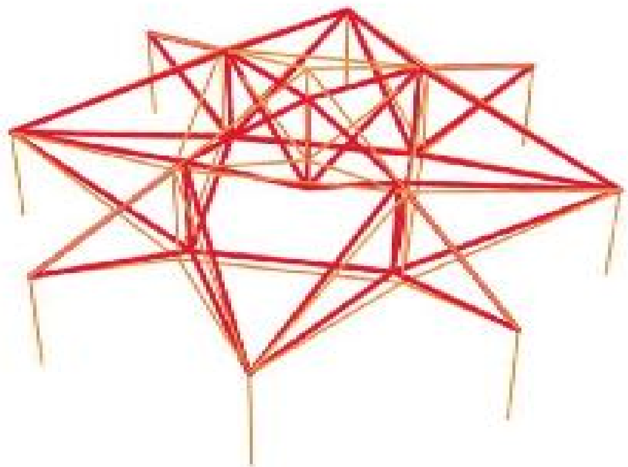
This is the uppermost part of the dome, with its exactly equal geometry. We take the minimun part so we can run the simulation properly.



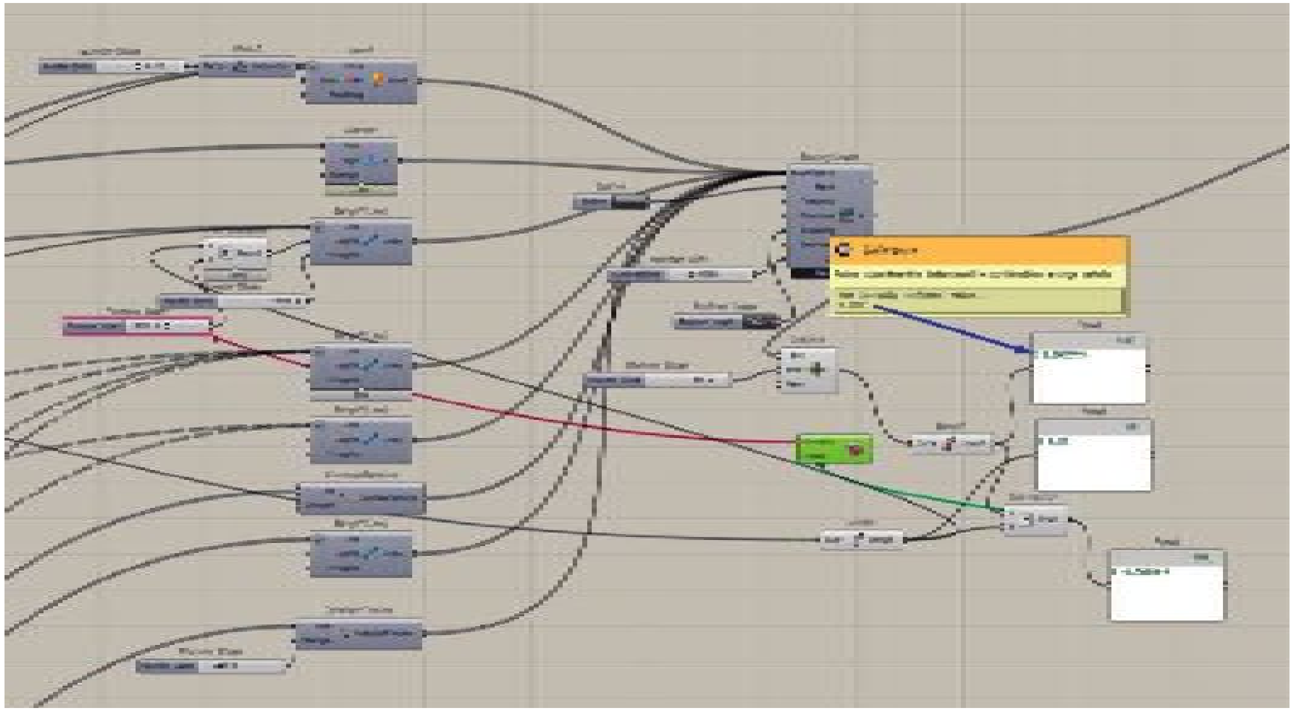
Constant Tension goal seams to be enough to have a positive displacement. After playing with the structure, it comes out clear that the inner rings, need to be tensioned.

Further simulations with the whole dome will show us that this is not always the case, neither for ConstantTension goal or for just the inner rings.

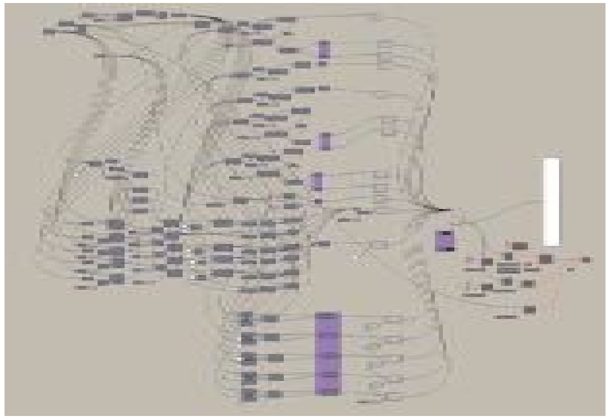


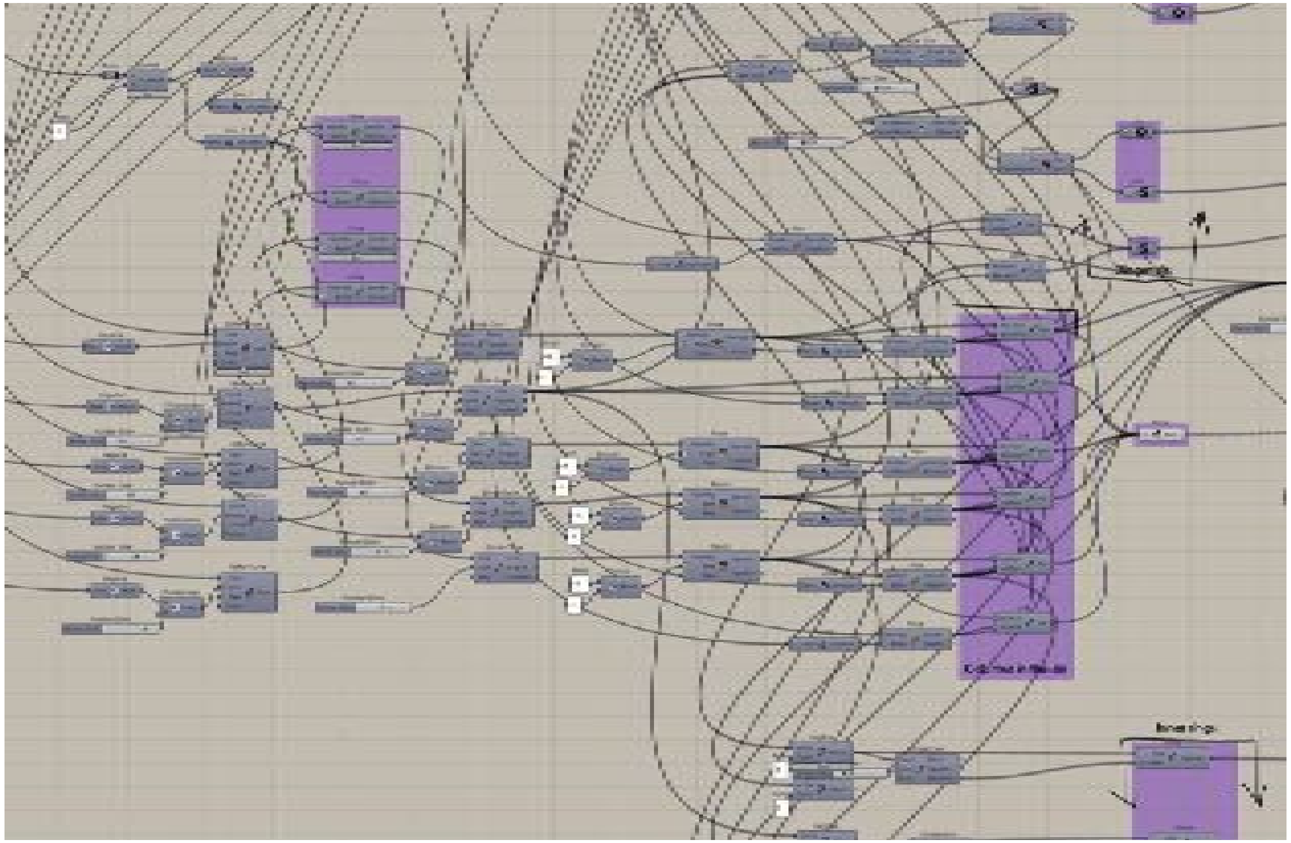


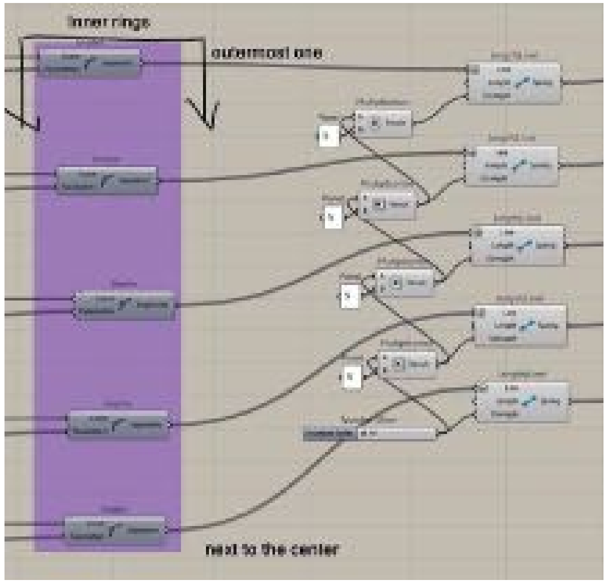
With this well-controlled geometry simulation a Galapagos component genetic algorithm will be set. As we know, after the simulation in Kangaroo, every element or line enlarge when being tensioned or decrease when it is being compressed. We'll now "fake" the Length paramenter in the Length(Line) component so that the output, which is the length of the simulated element, would match the base element's length.



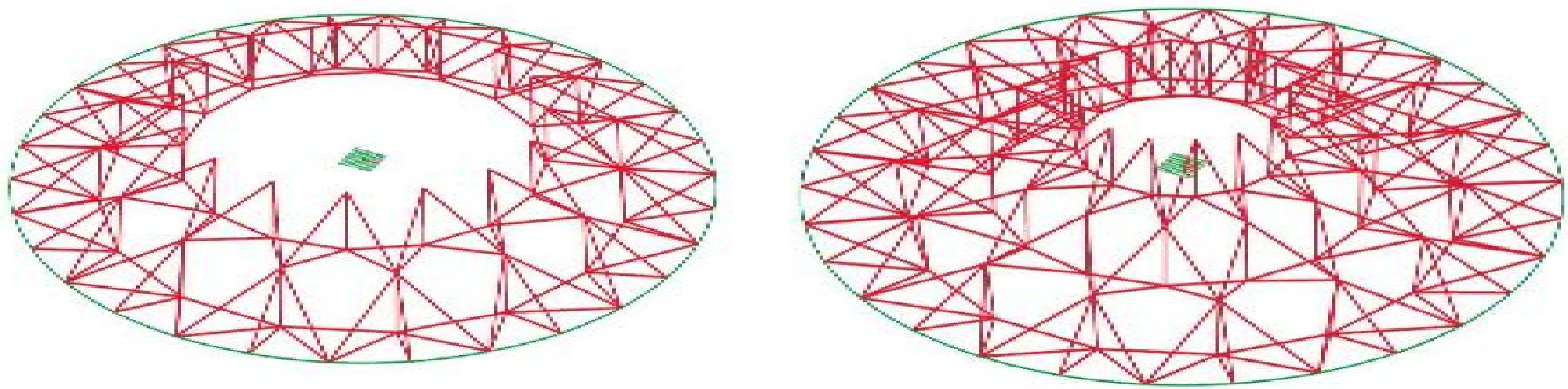
3. Dome - From Picture to GH



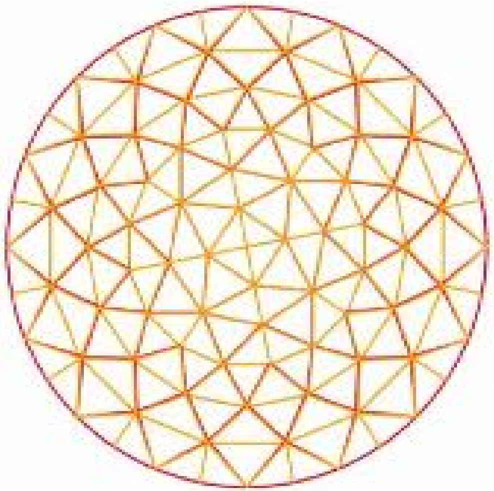


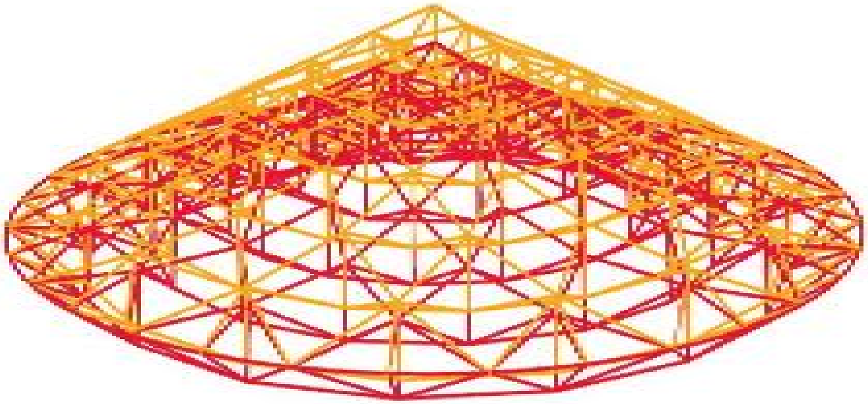


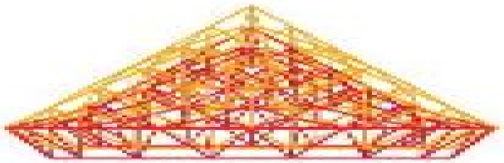
This is the dome-definition follows the planes concept from the previous, which is to have the next inner ring higher (1/2 a column). This arrangment will help find an equilibrium as all pairs of diagonal have the same length. We'll apply a supperior stiffness to the inner ring's cable. The outer one will have a many times higher stiffness.



The dome can be built from the outer ring inwards, as this pictures show. It can be seen already how the columns in the air already turn as it receives compresion forces. These two phases can withstand mainly because of the tensioned ring.

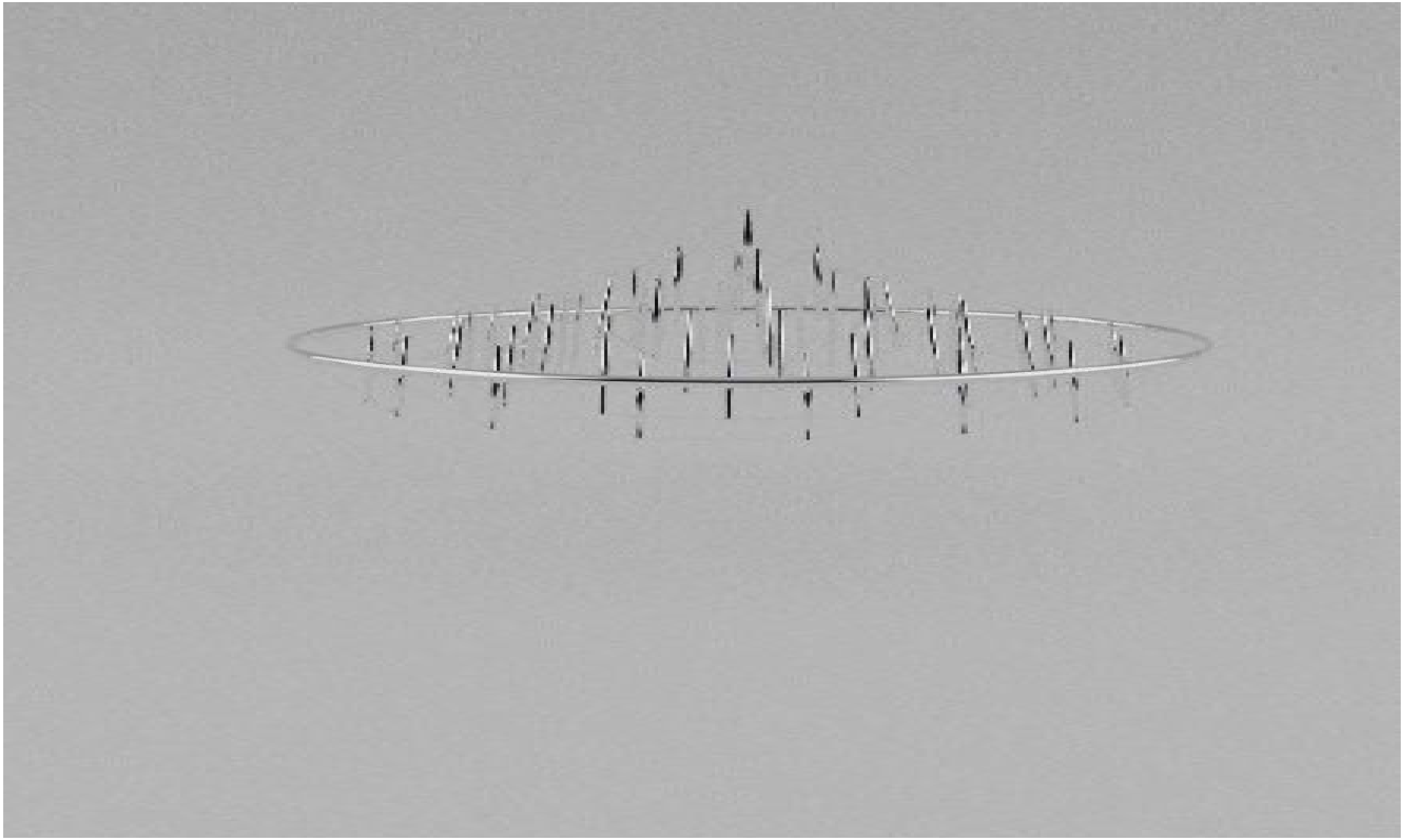




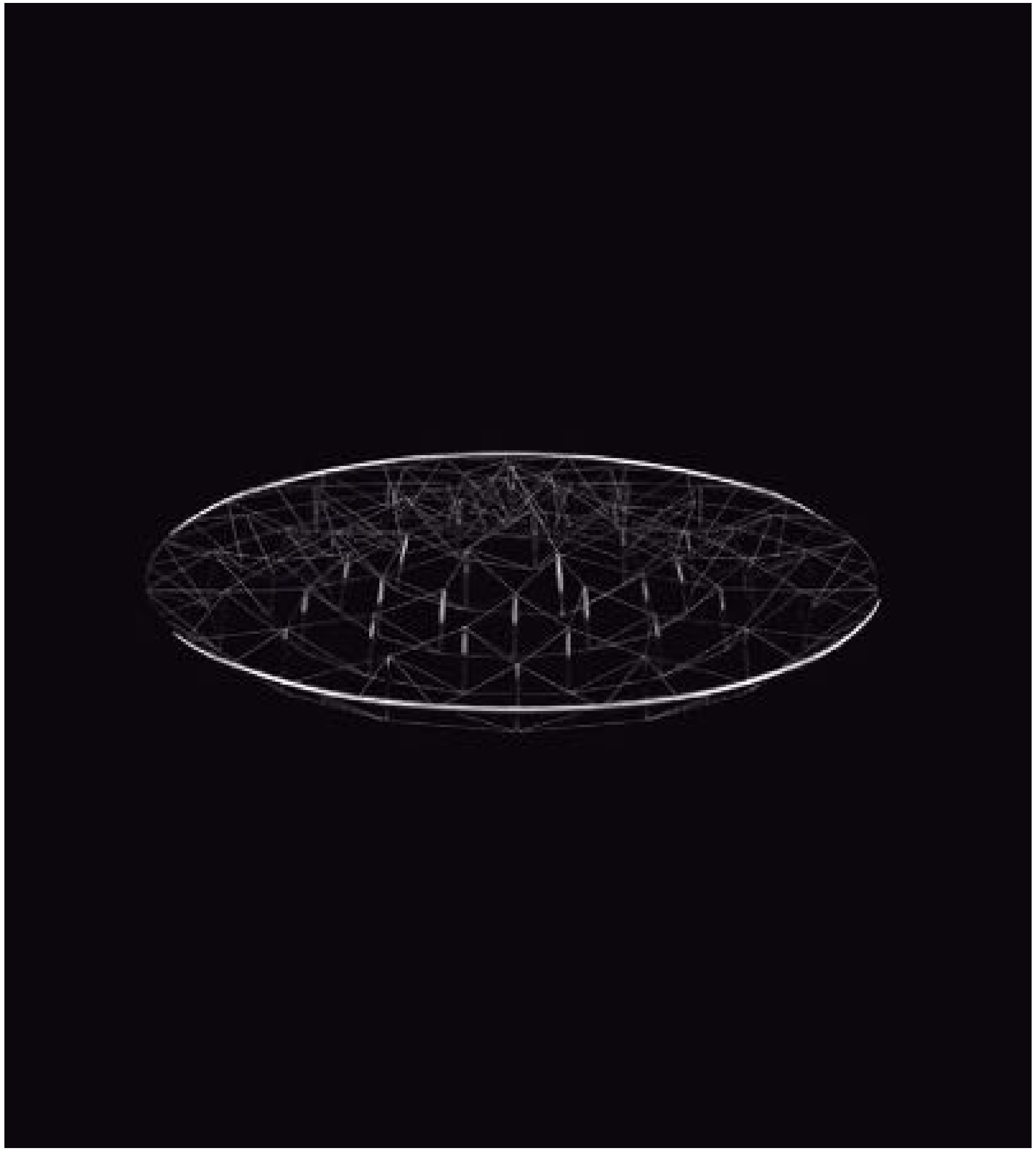


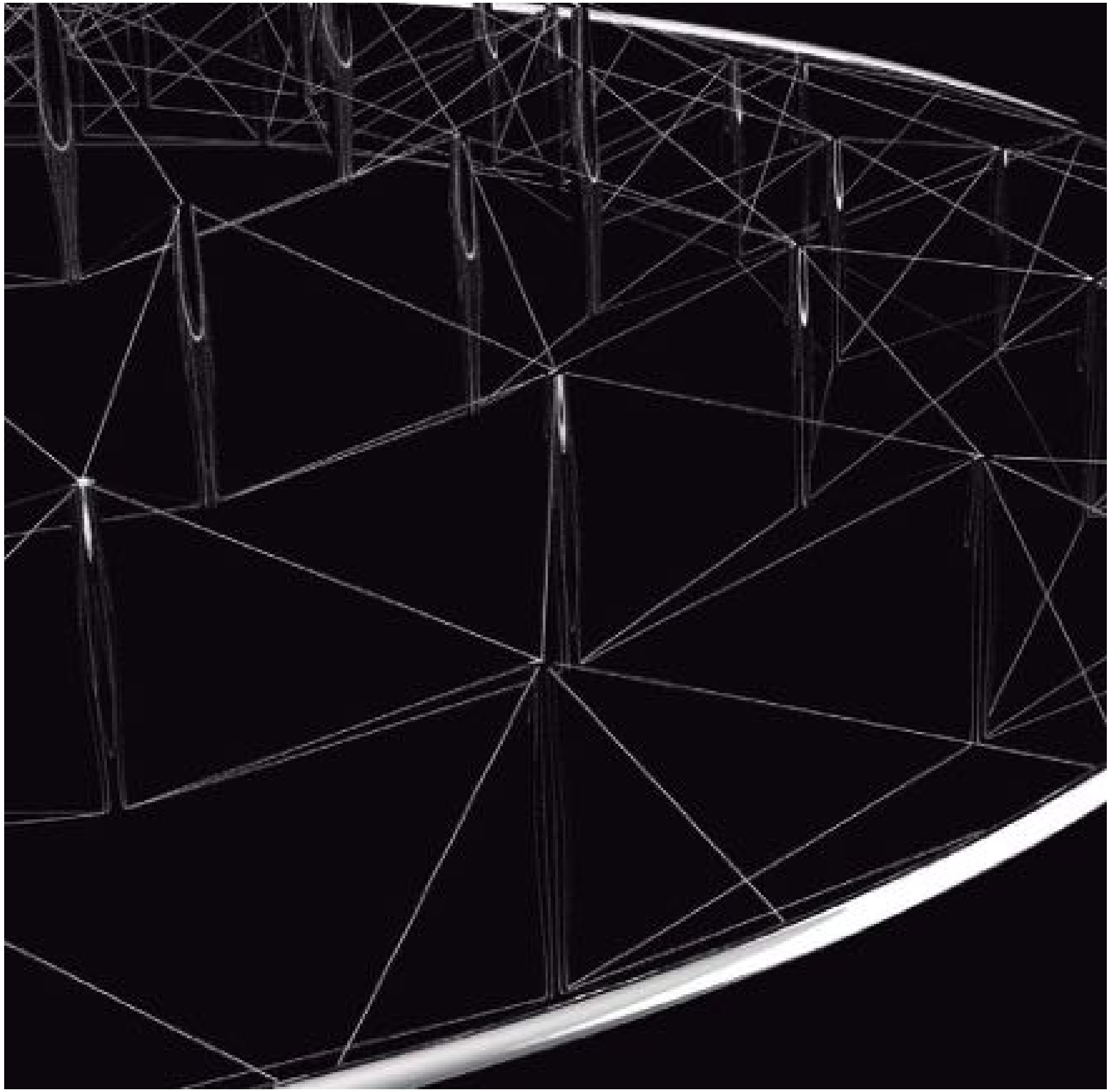
Yellow = base geometry

Red= simulated model



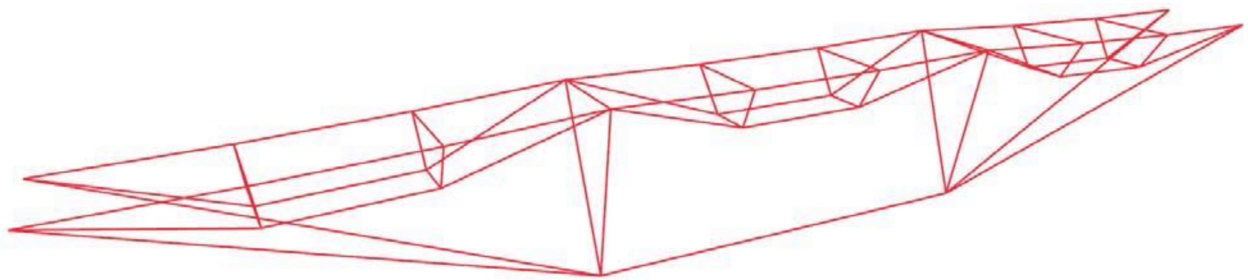
3. Dome - From Picture to GH

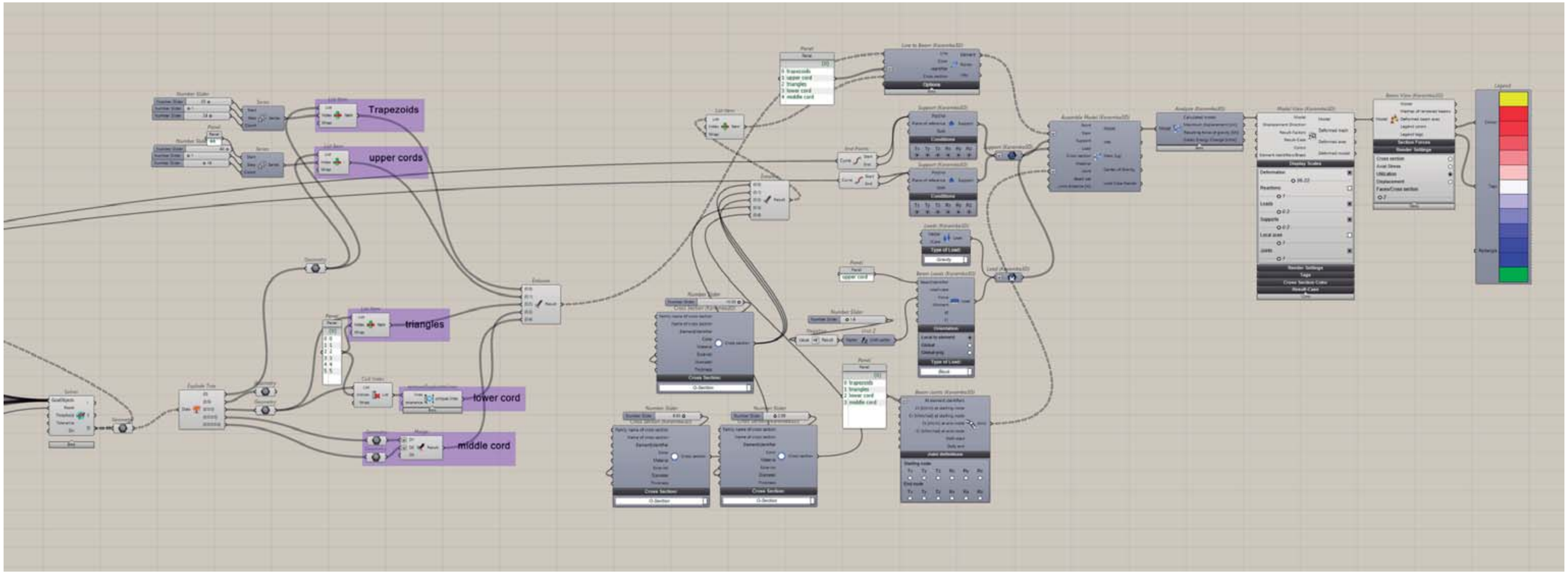




4. Polyten-Truss in a FEM software - Karamba3D

Once we have a geometry that has been under a simulation, that geometry can be isolated in its elements by groups.





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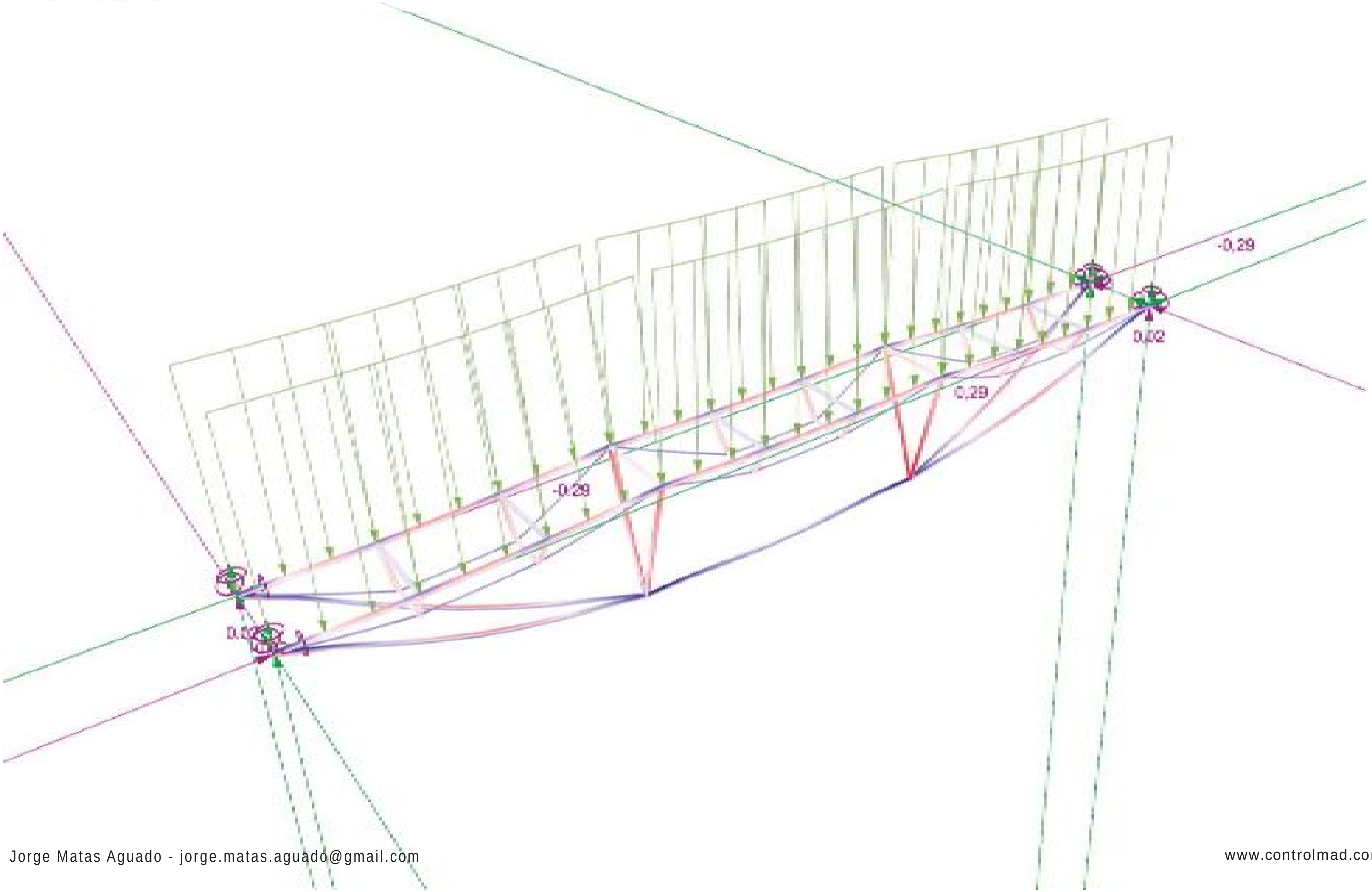
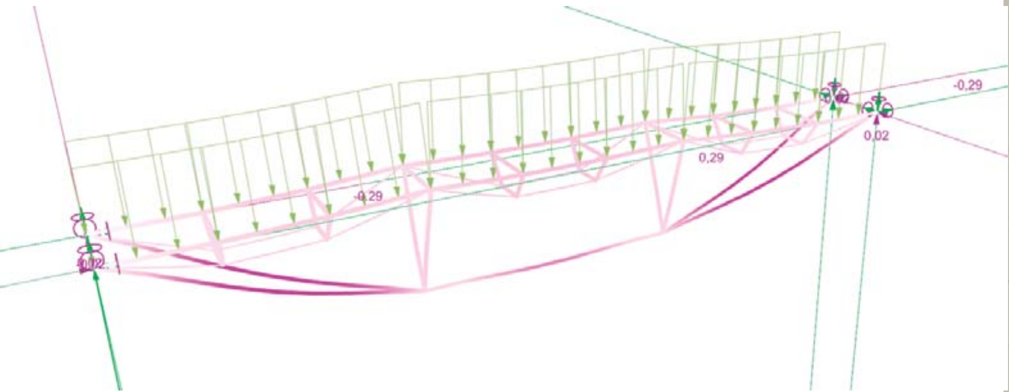
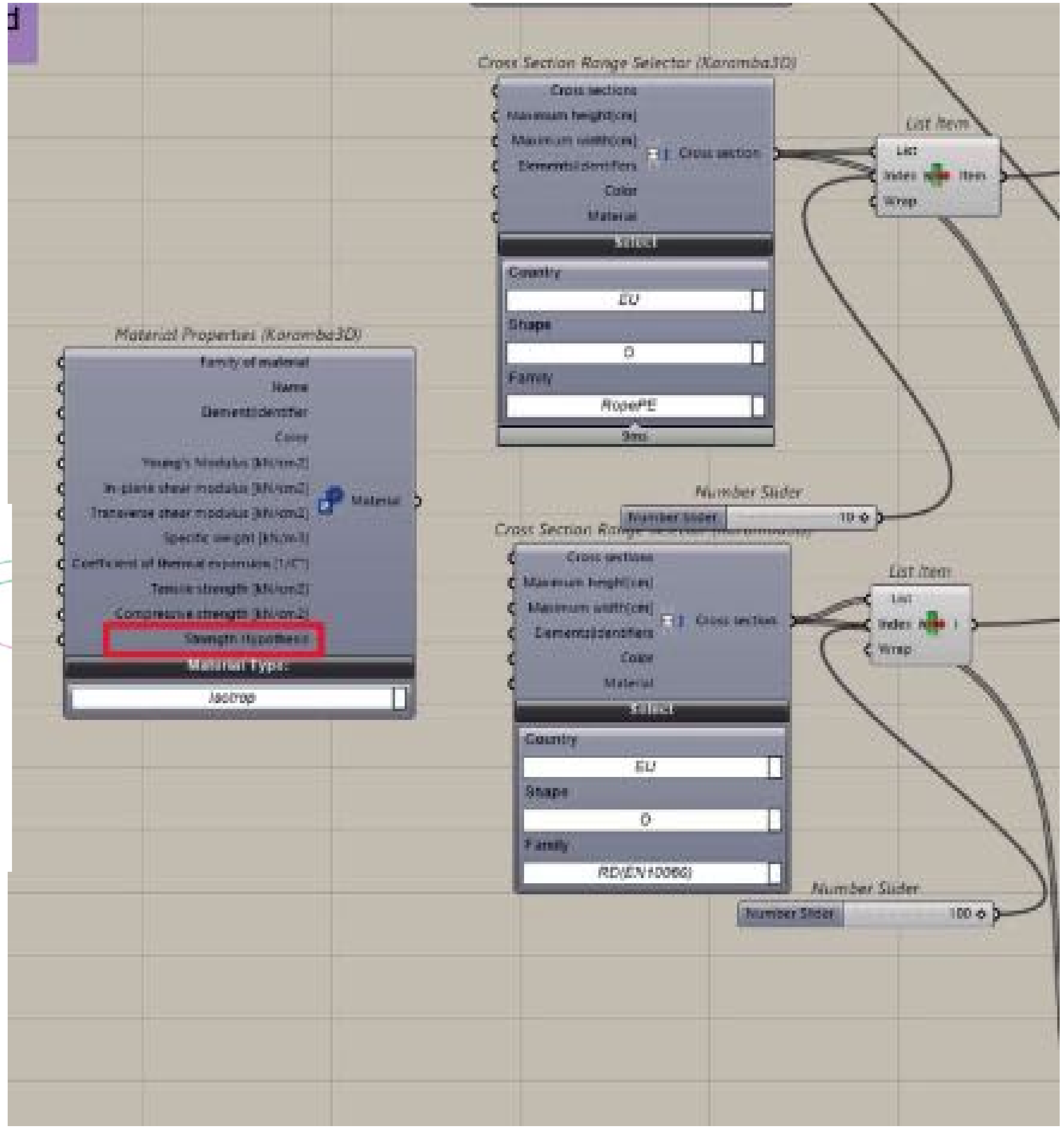


4. Polyten-Truss in a FEM software - Karamba3D

To simulate a tensioner in Karamba, we should create a material with an specific Strength Hypotesis. In order to make an fast exercise, we have chosen two of cross sections provided by Karamba. Rope is a cable cross section and RD is a rod cross section. These two elements were also used by Le Ricolais team.





5. Conclusion

Models for structures are heavy, need to be big enough to measure some displacement and are difficult to store.

Kangaroo solver offers a reliable way of replicating this models, specially the ones that have to be tensioned. Tension can be aplied many ways and many times without having to bild up again the physical model from scratch.

Simulations that have been conducted in this processes have been satisfactory. I would add also that the Kangaroo solver can be “hacked” in order to imput actual forces so we can have real displacements.

Karamba3D plug-in should consider adding elements whose lenght could be optimize, simulating a cable tensioner in real life.

6. Bibliography

Robert Le Ricolais: Visions and Paradox, V.A., Fundación Cultural COAM, 1997

AAD_Algorithms-Aided Design: Parametric Strategies using Grasshopper, Arturo Tedeschi, Le Penseur, 2014

Estructuras 2, José Luís de Miguel Rodríguez, Munilla-Lería, 2019

Maria Genevieve Bezzone

Final Project_Aggregate explorations

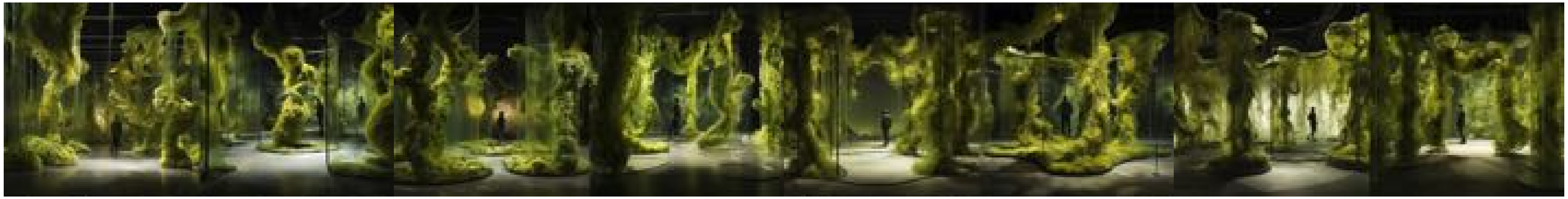
M A S T E R _ P A R A M E T R I C _ D E S I G N
18th Edition. Final Project. Part I
October 2023-January 2024

INTRODUCTION

The aim of the project is to explore different configurations of aggregates in the formation of an architectural element.
The aggregate shape has been simplified and reduced to a spherical element. The granulometry of the elements has been broken down according to a predefined range, allowing an optimized distribution of those when populating a geometry. The exploration of this case scenario is intended to be the base for a more complex studies which can involve aggregate variations and meet criteria different than structural optimization or morphological explorations.

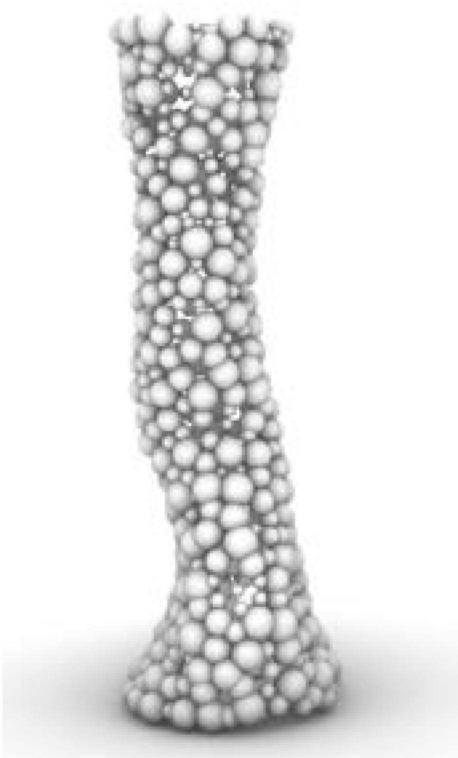
Brainstorming with AI

To kick off the project, the AI Tool Midjourney was consulted. The use of this kind of tools in the concept phase broadens the horizon of possibilities, allowing to consider different paths or to deviate from the original purpose, enlarging the aim fo the research.
The generation of images through prompt typing have projected different scenarios, progressively refined and selected, in order to get a visual overview of what might be achieved and considered.



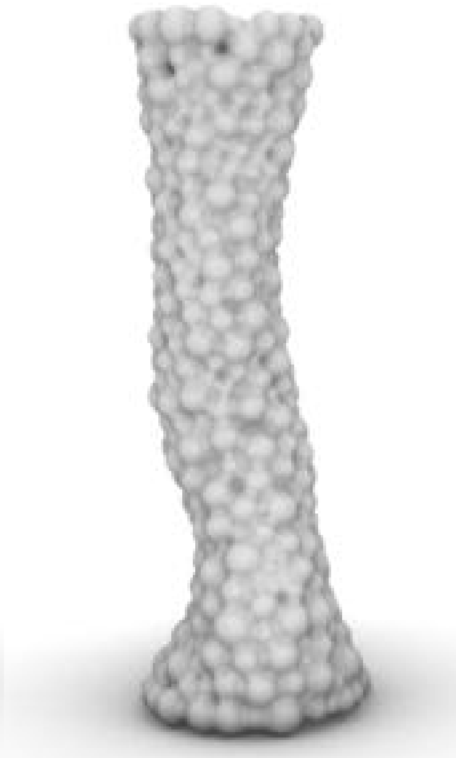
Population and dynamic simulation

A simplified freeform element has been considered as host geometry for the aggregate.
The aggregate shape has been also simplified and reduced to a spherical element. The granulometry of the elements has been broken down according to a predefined range, allowing an optimized distribution of those when populating the geometry. Kangaroo plugin has been used to optimize the aggregates distribution on the host element.
In the final stage of the simulation, the aggregates efficiently populate the whole element. In the final stage, Dendro has been used to give solidity to the element.



Kangaroo simulation_100 iterations

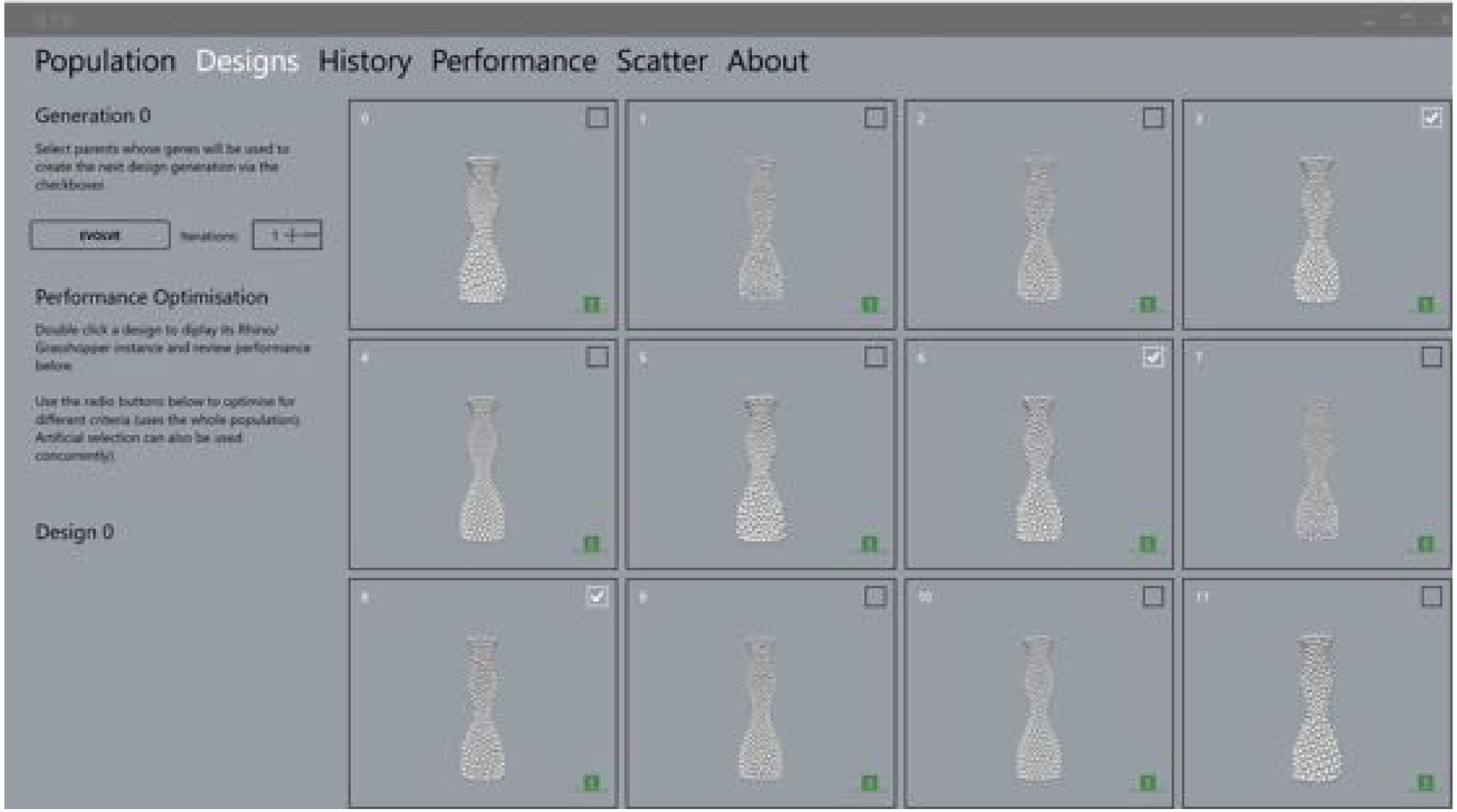
Kangaroo simulation_1700 iterations



Final stage_Dendro mesh

Biomorpher exploration

Different combinations of aggregate configurations have been explored through the use of Biomorpher together with Kangaroo. The aggregates have been distributed initially according to a gradient on the host element.
After a range has been set to determine the granulometry of the spherical elements, Kangaroo has been applied to populate the host element.
The evolution of the generations has been brought up to the third generation, after which have been observed a very reduced mutation in shape.

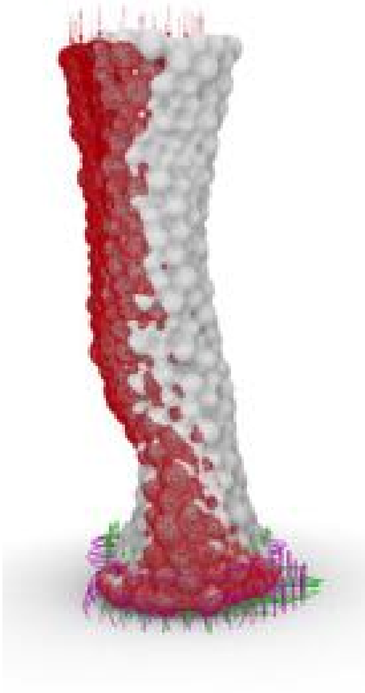


Biomorpher optimisation

As a second step, the volume optimization variable has been introduced in the process.
The process shows how to combine the aggregates distribution together with the performance. The performance definition has been linked to the volume parameter.
The results of the first generation illustrate how the parameters are combined considering both of the optimization criteria- minimize and maximize.

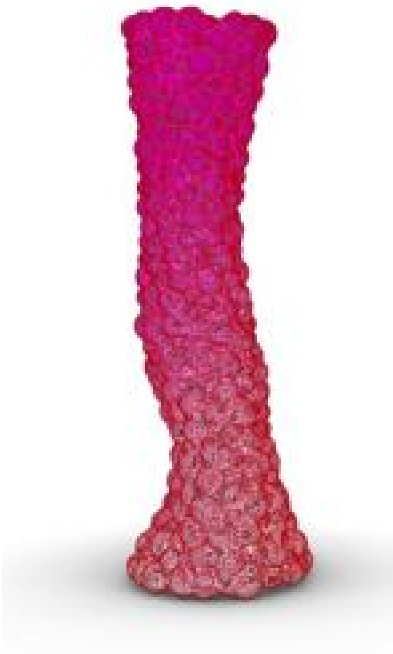
Structural Analysis

One single combination, deduced from Kangaroo simulation, has been analysed with Karamba.
The element, supposed to be an architectural column, has been imported in Karamba as a mesh shell. This has allowed the software to analyse the element considering the whole complexity of the shape in the calculation process.
The results obtained by the software should be taken as symbolic though, for this initial evaluation, as the element lacks the complexity of a surrounding context and appropriate variables applied. The results are shown as graphic schemes, mostly highlighting the fact that such results can be achieved also in a reiterative computational process inside GH.



Karamba deformation graphic-compared to original mesh.

Karamba deformation, load and support diagram



Karamba displacement diagram

Karamba utilizazion diagram

Conclusions

The project offers a wide range of further explorations, particularly in the field of aggregate shaped elements.
The potential of aggregates population and simulation supported by a computational approach, may lead to explore significant scenarios, from form finding to structural optimization. Increasing the complexity of the shape of the aggregates would have a significant impact on those two last aspects.
The aim and outcome of the research has been strongly limited by lack of time, which has narrowed down the approach to a simplified single element. The project research and exploration potential has been also limited by the computational capabilities of the means.

ESTEBAN PÉREZ DE LEÓN
PERSONAL PROJECT
3D PRINTED ARCHITECTURE: THE WIXÁRIKA RAIN HARVESTING TANK
ARQUITECTURA IMPRESA EN 3D: TANQUE WIXÁRIKA DE CAPTACIÓN PLUVIAL

M A S T E R _ P A R A M E T R I C _ D E S I G N
18th Edition. Final Project. Part I
October 2023-January 2024

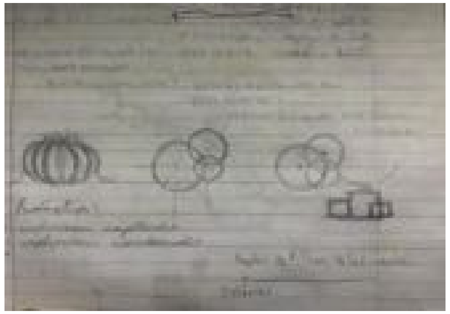
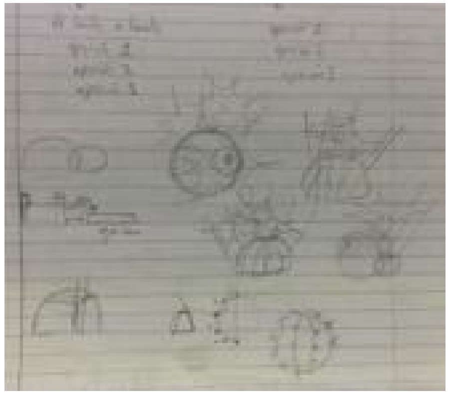
INDEX

ABSTRACT

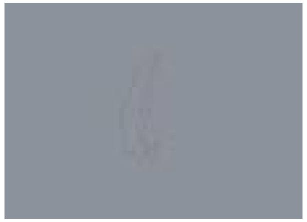
The adoption of 3D printing with earth-based materials presents a promising path for sustainable construction and manufacturing since it offers a multifaceted approach; blending environmental consciousness, economic viability, design flexibility, community empowerment, and technological advancement. As this technology continues to evolve, it holds the potential to revolutionize the way we build, providing a more sustainable and resilient future.

The implementation of 3D printed rain harvesting tanks holds tremendous potential to address water scarcity challenges in the Huichol community of Mexico. By utilizing locally sourced materials through 3D printing technology, these tanks can be customized to suit the unique environmental and cultural needs of the Huichol people, fostering resilience in the face of changing climatic conditions.

WORKFLOW

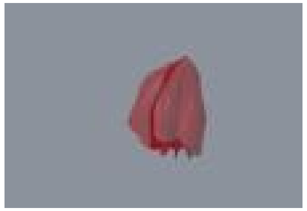



STEP 1:
Landing the idea using paper and pencil.

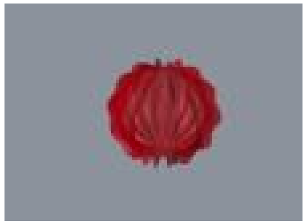


STEP 2:
First 3 and most important lines, the ones carrying the loft pattern I want for my container.

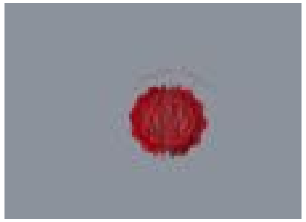
STEP 3:
Lofting the 3 principal curves of the design.



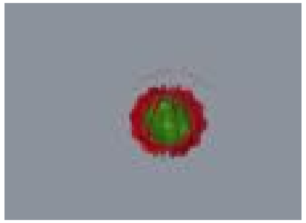
STEP 4:
Mirroring the module.



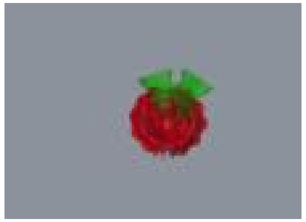
STEP 5:
Circular array of the module.



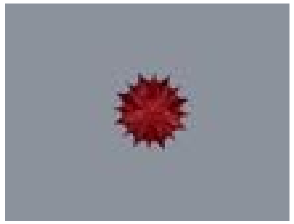
STEP 6:
Creating the conic entrances, line from the center of the model to populated surface.



STEP 7:
Creating the inner part of the tank.

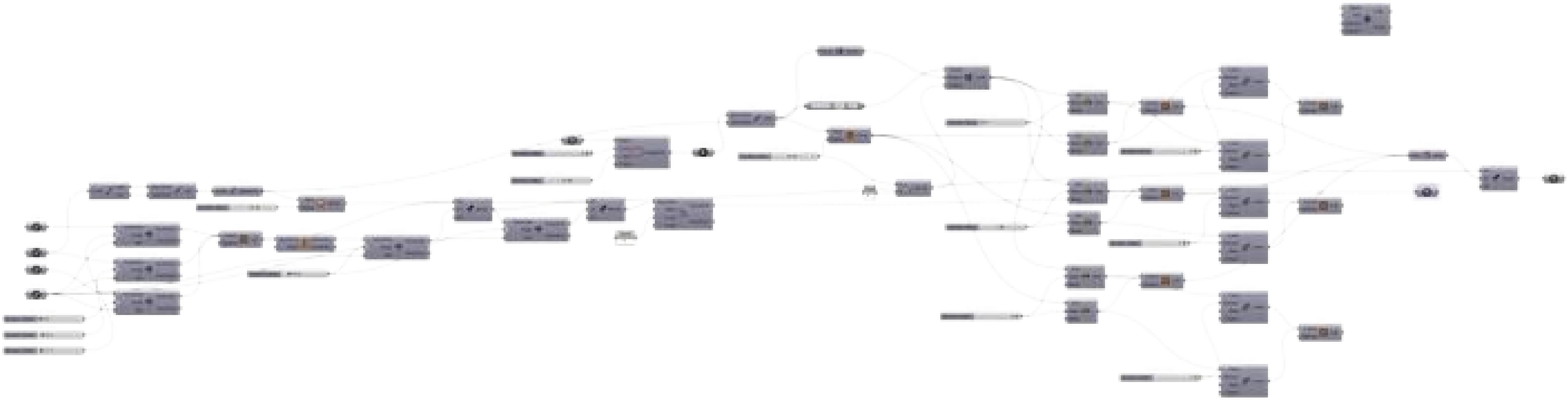


STEP 8:
Making a solid out of the entrance cones.

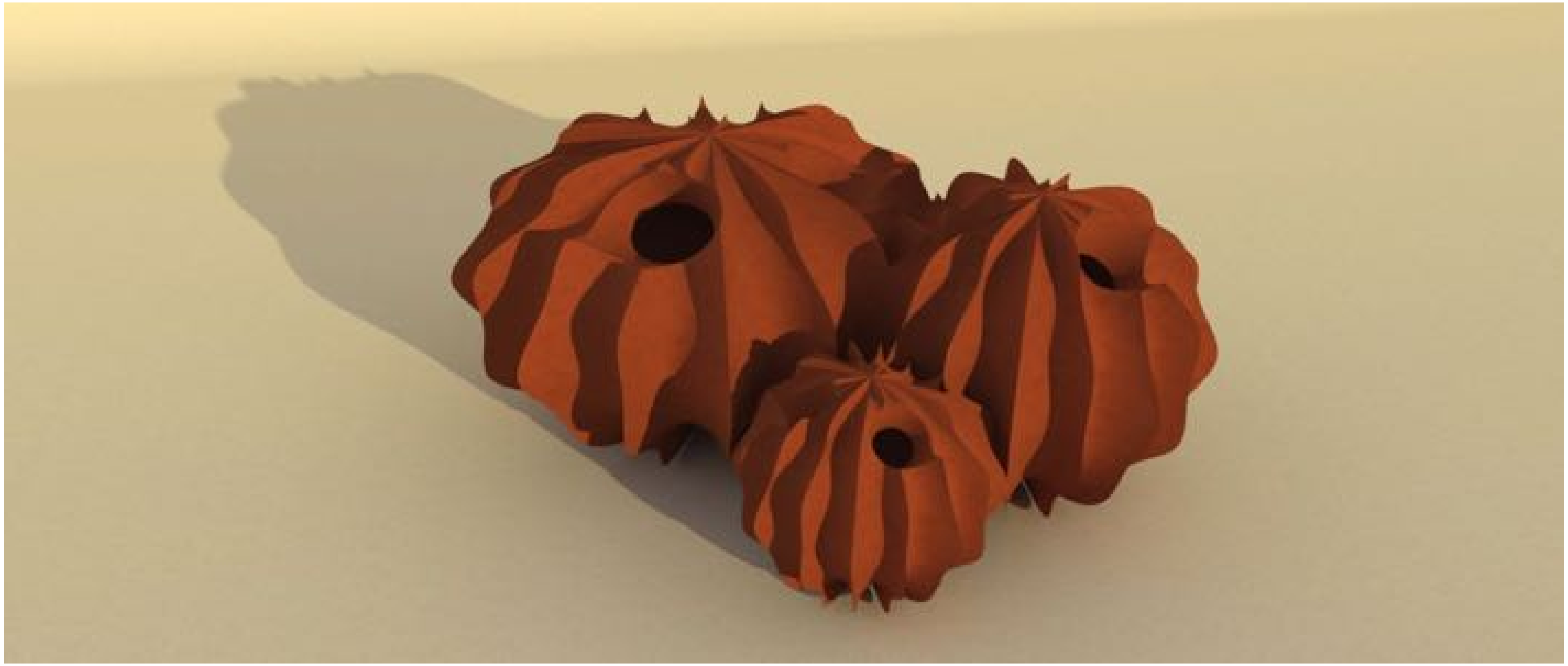



STEP 9:
Solidifying model and substracting entrance cones.

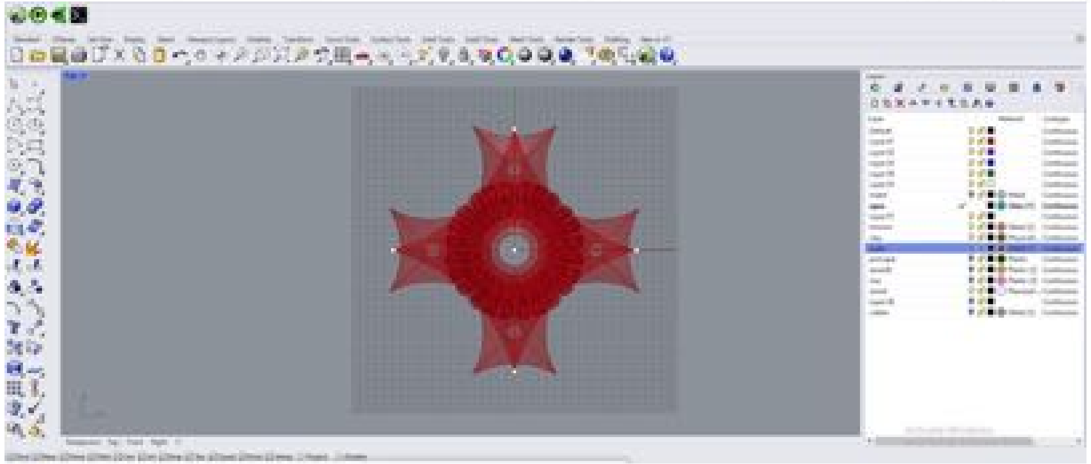
THE FINAL DEFINITION AND MODEL:

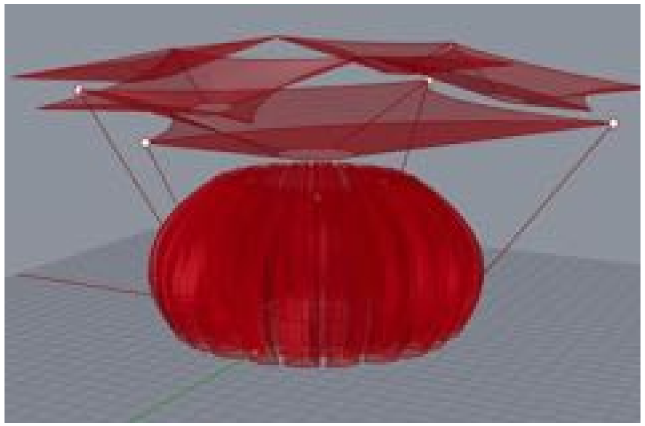


VISUALIZATION



THE FINAL DEFINITION AND MODEL:

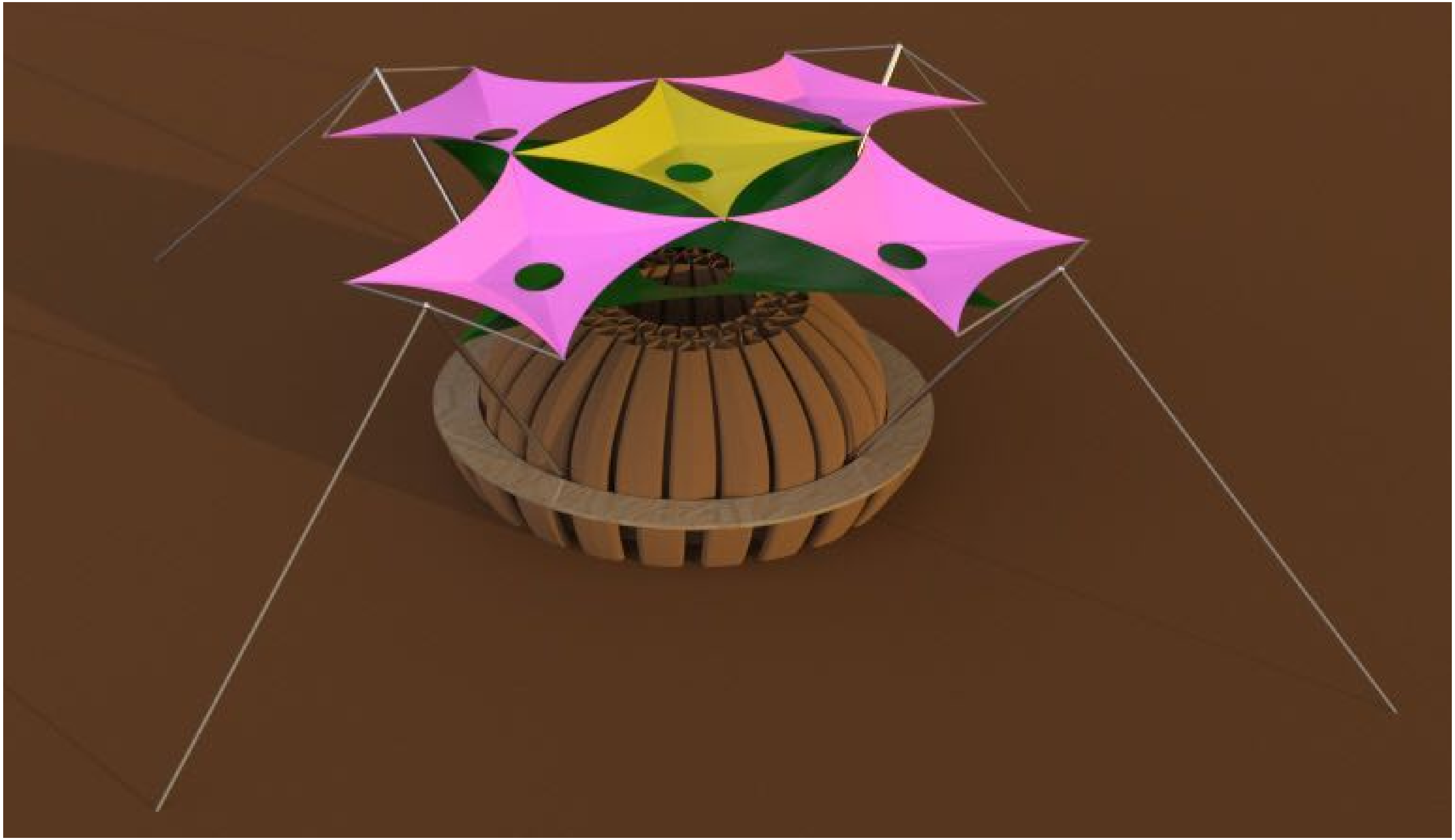


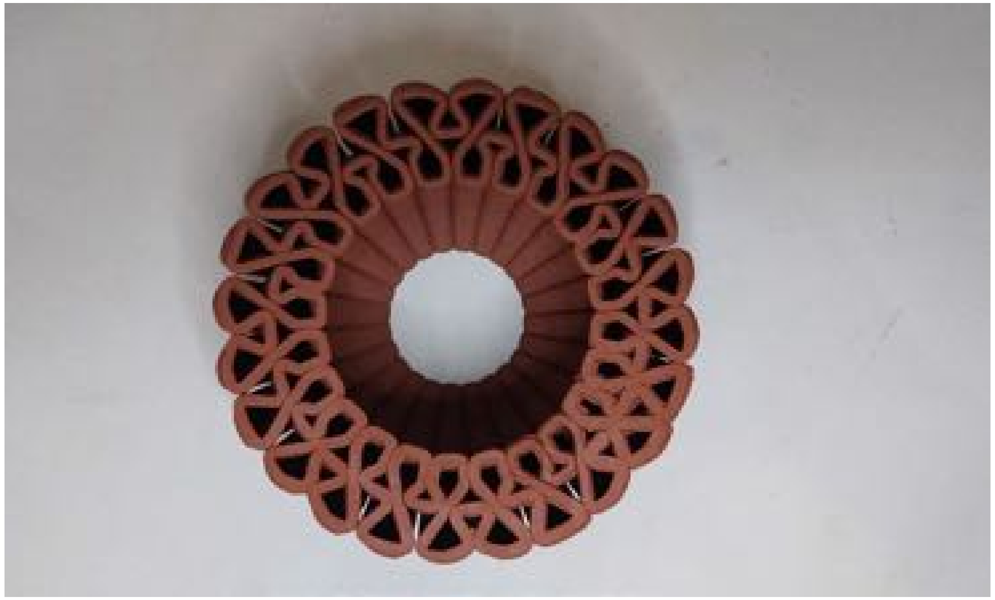


VISUALIZATION









CONCLUSIONS

The use of parametric modelling changed my design process completely. I come from an extremely "manual" way of designing and modeling, using Sketchup most of the time. Once I got started with Rhino I found out how much I was actually missing. Simple operations like lofting or finding exact points on a curve take less than 5 seconds. The large amount of time I spent creating simple stuff will now be time I can use for fabrication or other projects.

I must admit I had a lot of fun creating my model. Even though it is quite simple, I tried my best building it from "memory" without the use of saved files or replays. I wanted to test myself and practice my memory at the same time, I think I didn´t do that bad.
I would like to complete this project on the next part of the course. I am missing the .gcode generation part and I am really looking forward to implement it on my tank design. I would like to add I´d really love to make this tank a reality so I will work hard in order to achieve it.

As of now I have some points I know I have to get better with this project:
- Try and parametrize more data.
- Get better at visualization.
- Reconect with my internal designer, I am getting way too technical.

Jason Daniel

Design optimization for minimum heat gain

MASTER_PARAMETRIC_DESIGN

18th edition. Final Project. Part 1

October 2023 – January 2024

ABSTRACT

In modern urban development, skyscrapers are not just architectural icons but also key players in the urban environmental landscape. As global attention shifts towards sustainable development in response to climate change, the design of these towering structures, particularly in terms of orientation and the interplay of aesthetics and functionality, has become a focal point. This study zeroes in on the critical task of optimizing skyscraper orientation to minimize heat gain, a significant factor influencing energy consumption and overall building efficiency.

The traditional design approach for skyscrapers often heavily emphasizes visual impact and structural innovation. However, as environmental sustainability becomes increasingly imperative, the architectural focus is shifting towards designs that also prioritize energy efficiency. This study explores this shift by investigating how the orientation of a skyscraper can be optimized to reduce heat gain while maintaining the building's aesthetic appeal and functional integrity.

The integration of computational analysis tools like Ladybug and Galapagos in this process marks a progressive stride in architectural design. Ladybug offers detailed environmental analysis capabilities, allowing designers to simulate and assess the impact of different building orientations on heat gain. This analysis is crucial for understanding how orientation influences a building's energy performance and indoor comfort levels.

ABSTRACT

Galapagos, with its evolutionary algorithm, serves as a complementary tool by facilitating the iterative optimization of building orientation. It evaluates numerous orientation scenarios, aligning them with energy efficiency objectives while ensuring that aesthetic and functional aspects of the skyscraper design are not compromised. This optimization process is vital in striking a balance between creating visually stunning structures and meeting the functional needs of the building's occupants, all within the framework of environmental sustainability.

Through this focused approach, the study aims to contribute to the evolution of skyscraper design, guiding it towards a harmonious blend of aesthetic elegance, functional excellence, and environmental responsibility, fundamentally impacting the way urban spaces are designed and inhabited.

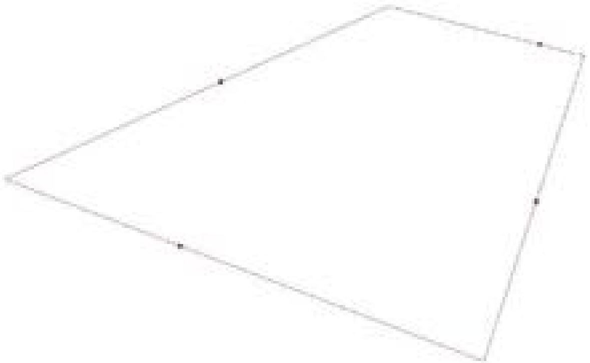
CONTENTS

IMAGES

1. Initial geometry with points
2. NURBS curve based on the geometry
3. Initial form by curve stacking
4. Form twisting
5. Two surfaces
6. Loft
7. BREP and Mesh BREP
8. Initial orientation
9. Comparison of orientations
10. Twisted tower
11. Curtain wall
12. Handle
13. Panel size determination based on radiation
14. Panel clustering and rationalization
15. Simply supported beam

DESIGN PROCESS

- The Design process starts with the drawing of an initial shape. In this case, a trapezium was chosen.
- Then four parameters (points) are set up on the individual curves (lines) making up the trapezium.
- These parameters would later be linked to the Galapagos component (genome) to be a part of the optimization process.
- The number sliders controlling these points run from varying ranges to get a varied form.



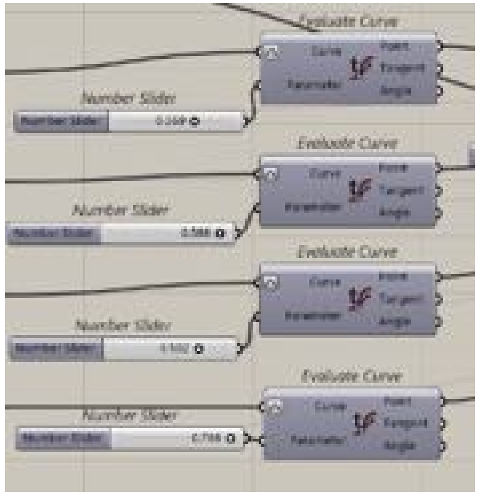
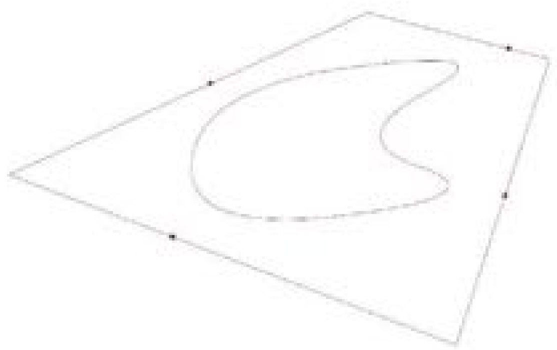


Image 1

DESIGN PROCESS

- Then a NURBS curve is generated based on the points and this curve can be changed based on a certain degree.
- Then the NURBS curve is generated along the z direction to get the initial form for the skyscraper.
- Then an element of twist is introduced to the form generated.
- This twist is later introduced to the Galapagos component to be a part of the optimization process.
- Then two surfaces are generated based on the initial and final curve.
- Then a loft is generated between the two surfaces.
- Then the surfaces and loft are combined into a BREP.
- Then a mesh is generated for the BREP.



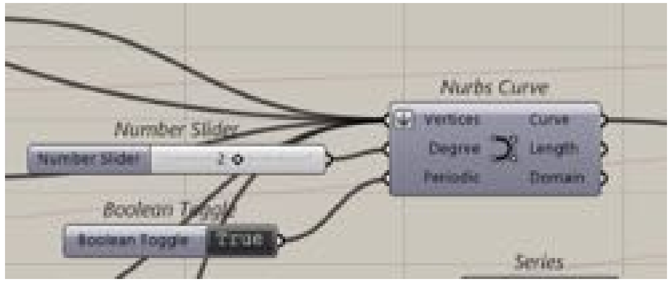


Image 2

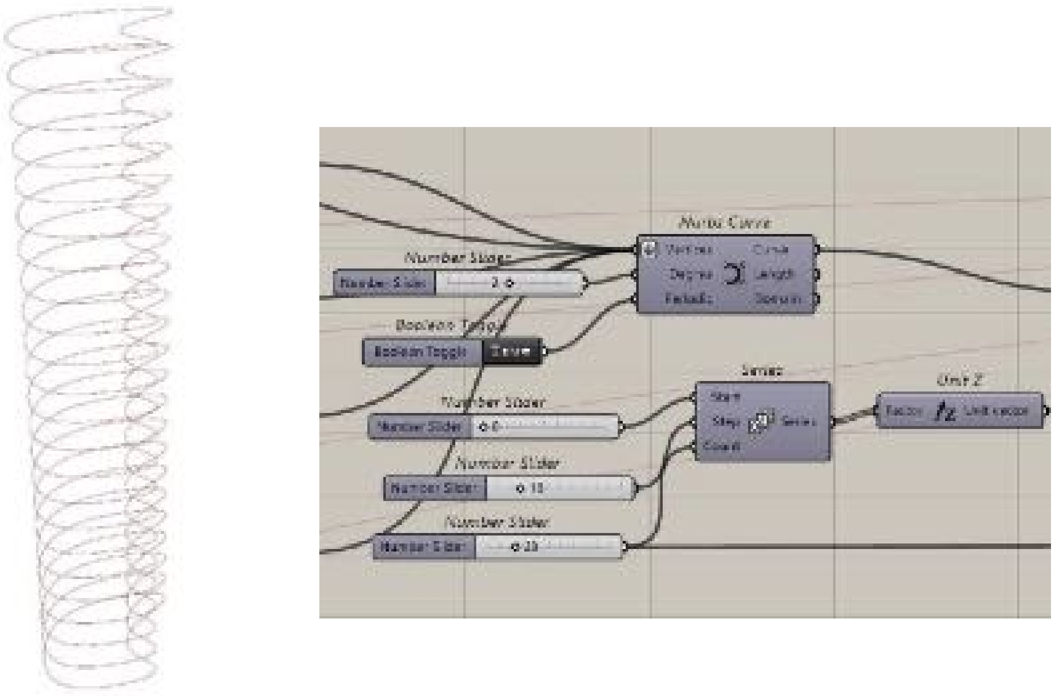


Image 3

Image 4

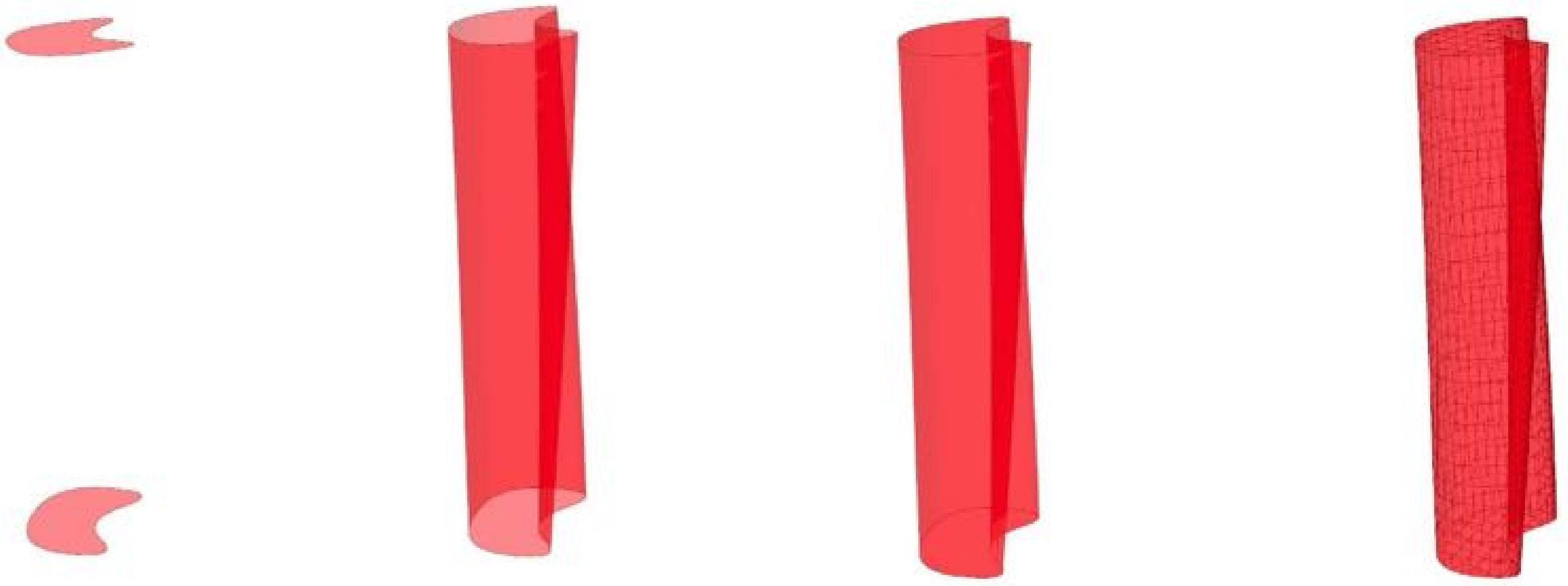


Image 5 to 7

DESIGN PROCESS

- The ladybug plugin is then introduced at this point and the epw weather file is selected for a city of choice.
- Then the radiation is then simulated based on the existing form.
- The various parameters discussed previously like the control points, twist are then introduced into Galapagos.
- Then an optimization is set for minimum heat gain and the results are tabulated.

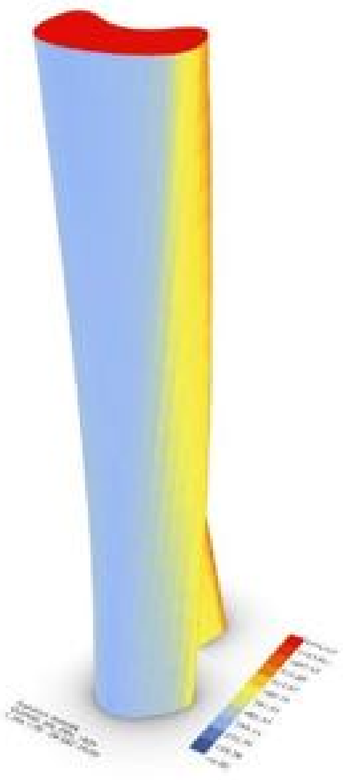


Image 8

RESULTS AND CONCLUSION

- As we can see from the results on the right hand side, the orientation of the skyscraper seems to have changed entirely based on the inputs given for minimum heat gain.
- This ensures that the ideal form for the set criteria is determined.
- Simulations like these when used in the early design stages help architects and designers to make informed decisions to ensure an increasingly sustainable design.
- It helps to minimize the energy required for cooling in warm areas by minimizing the heat gain in the buildings.
- This can further be coupled with the facade panel size determination based on the radiation analysis to further complement the approach to an increasingly sustainable design.

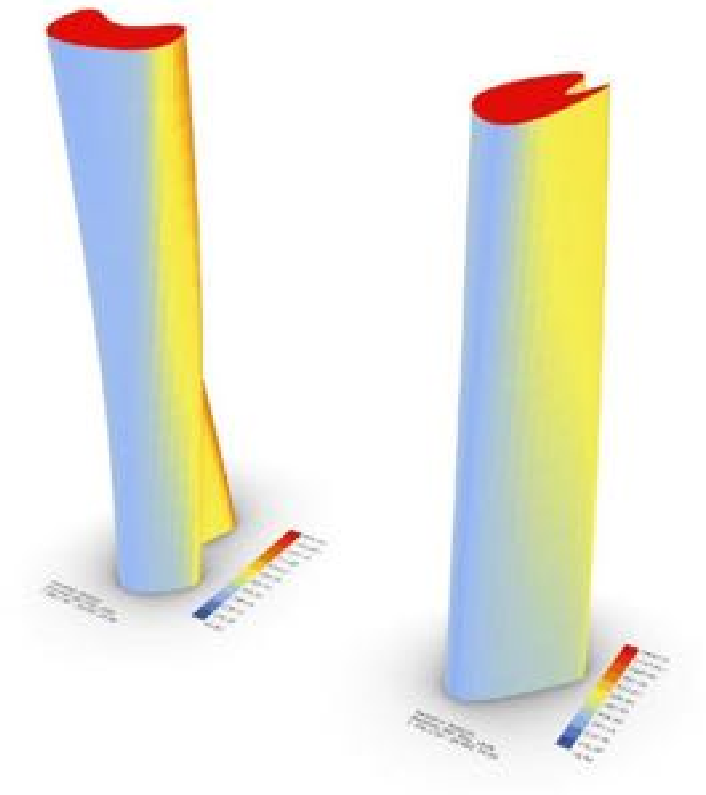


Image 9

Chen, I - Chieh

Inspiration of Toledo, Avila

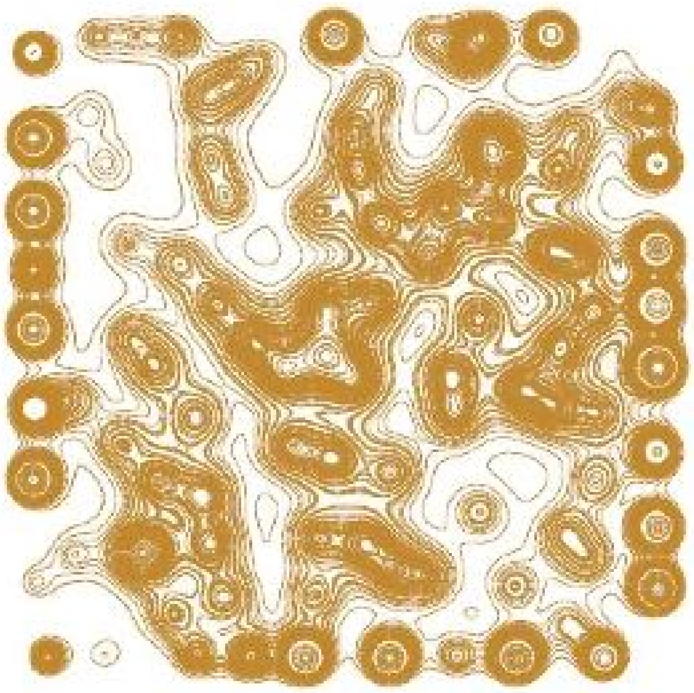
M A S T E R _ P A R A M E T R I C _ D E S I G N

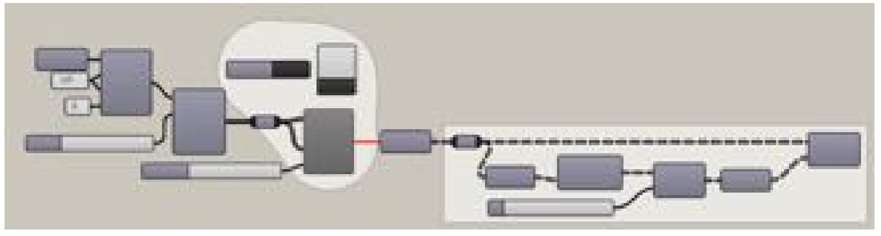
18th Edition. Final Project. Part II

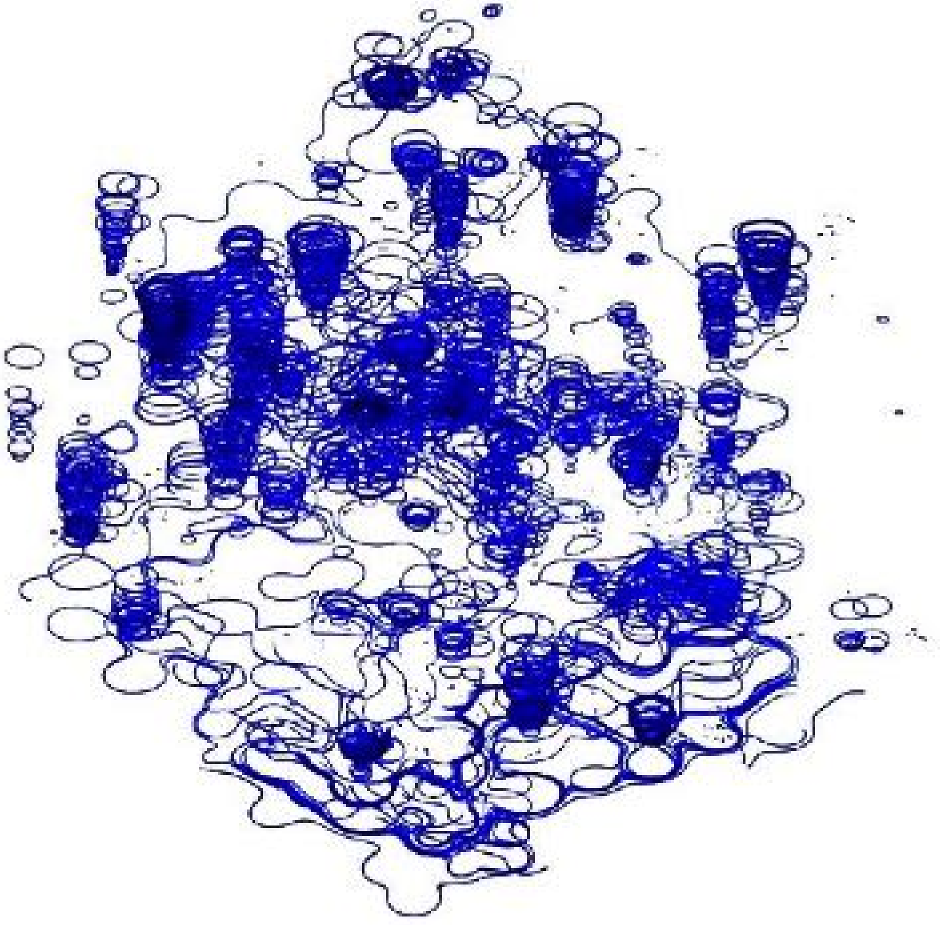
October 2023 - January 2024

Index

1. (Metaballs as landscape expression)

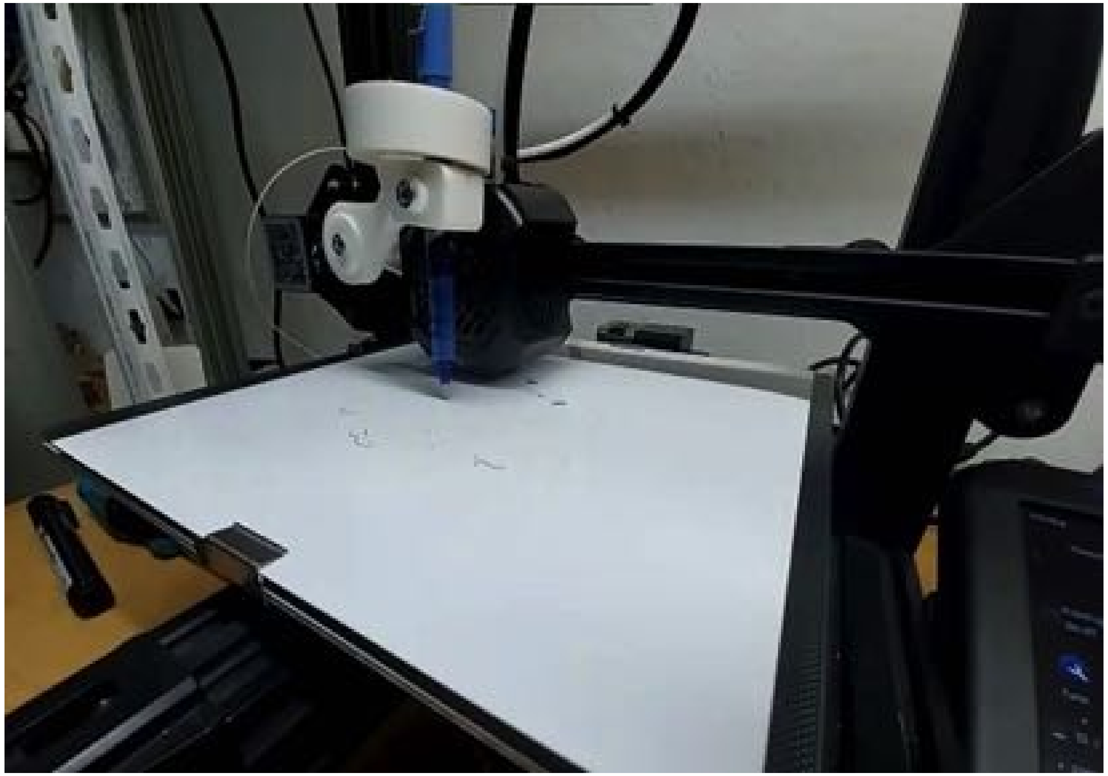


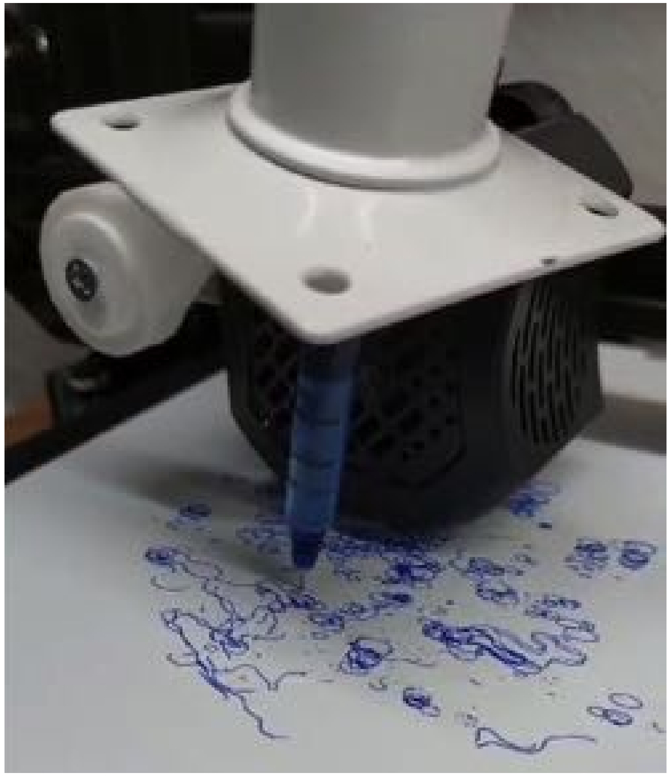




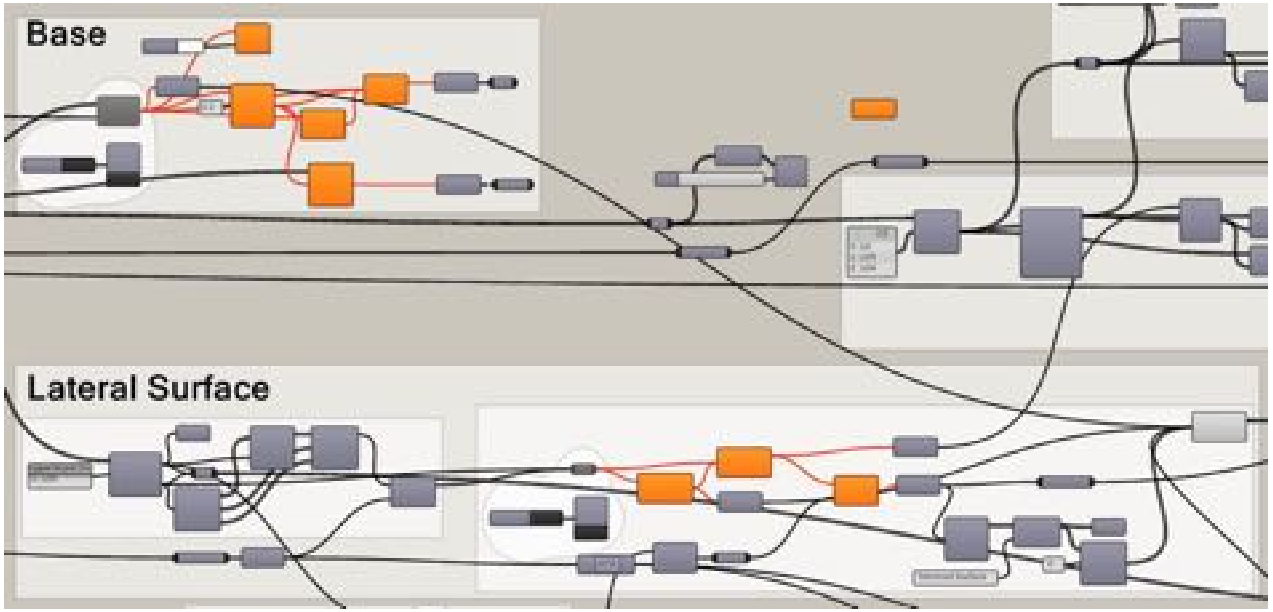
3D Printing Drawing

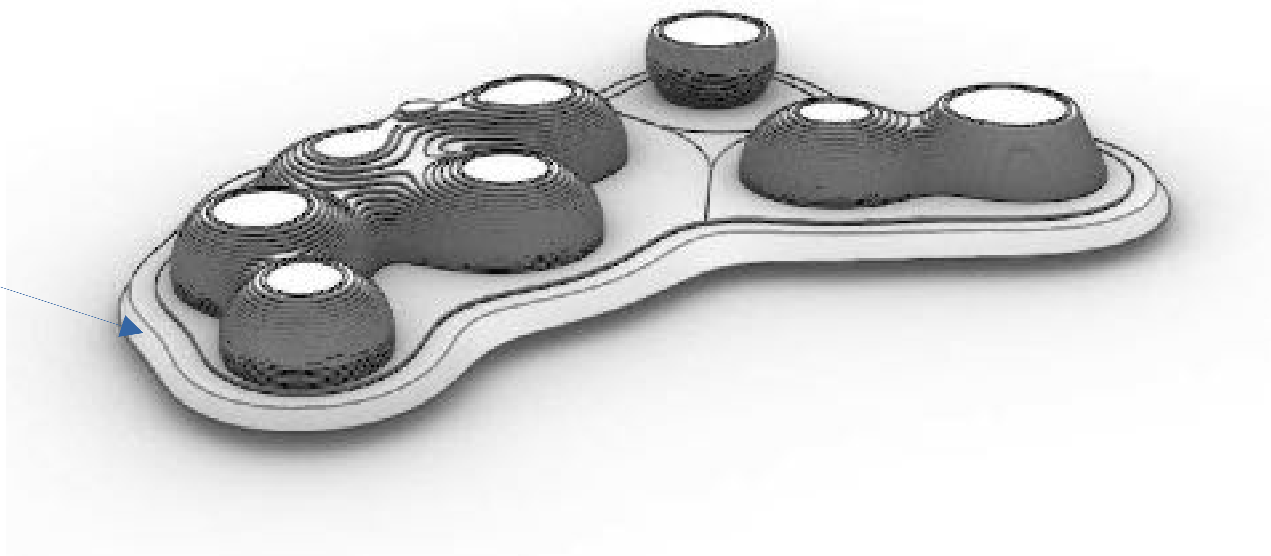
Fabrication

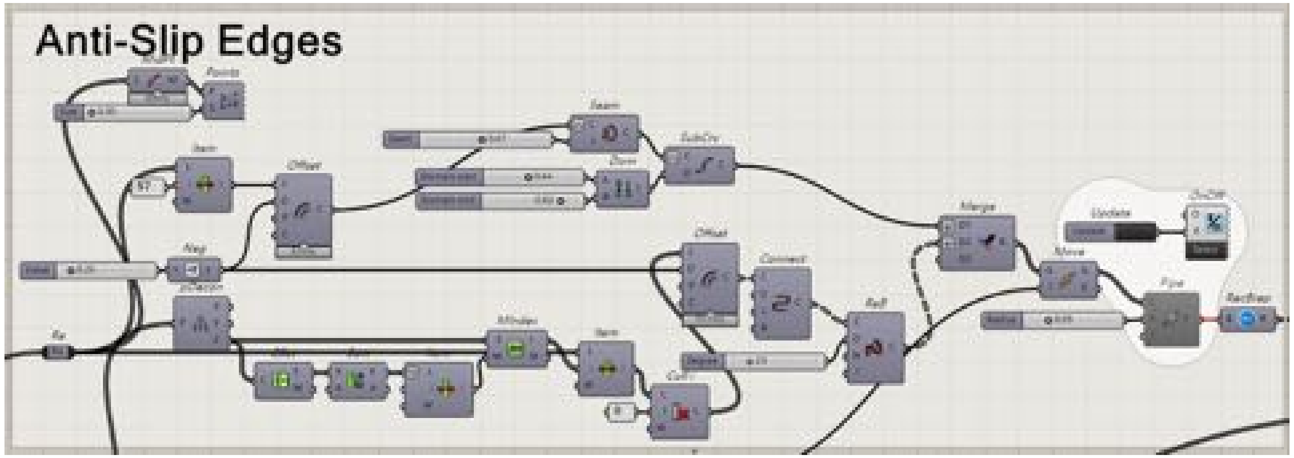


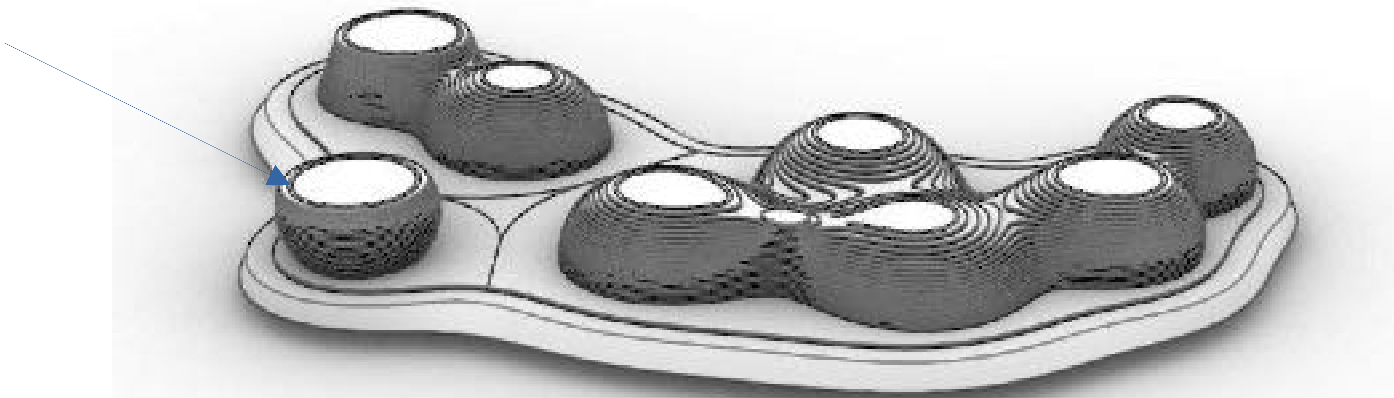


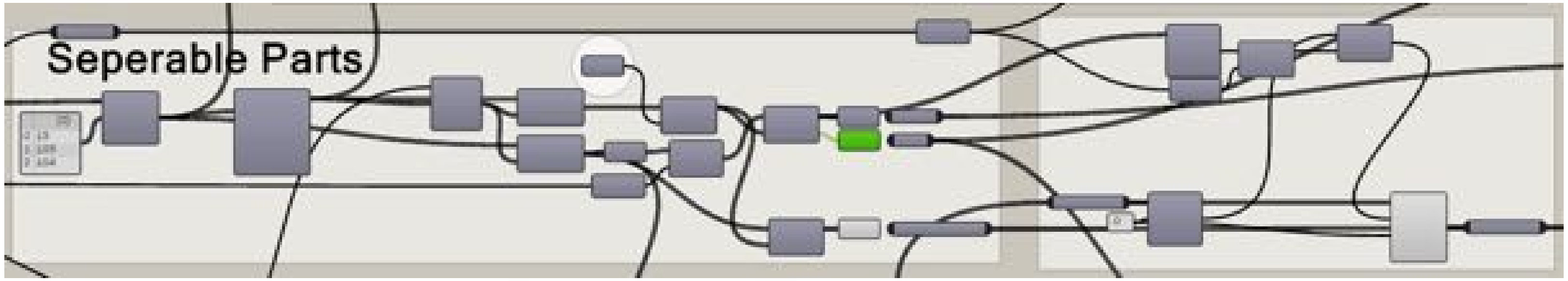
Geometry






Anti-Slip Edges

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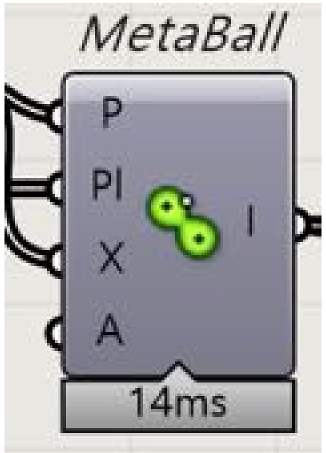
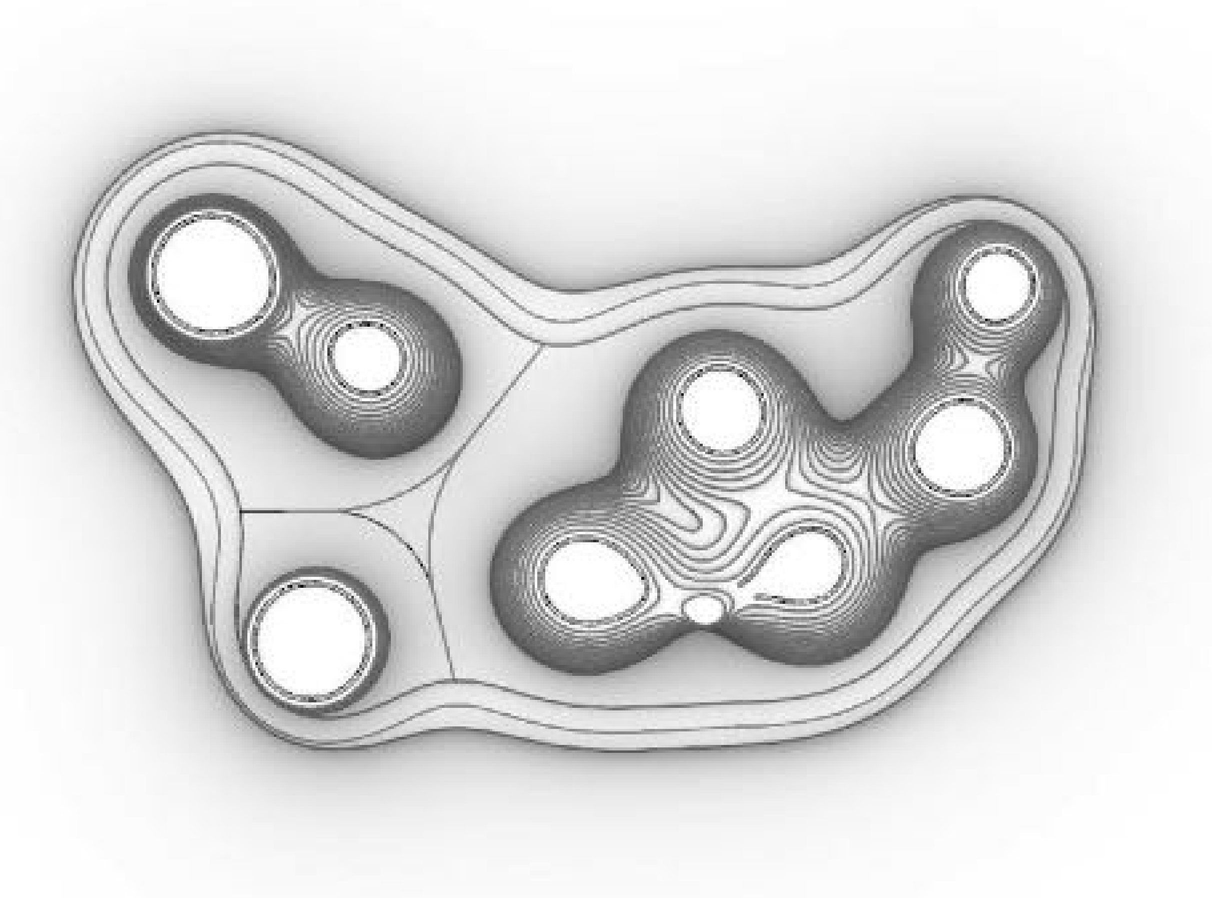
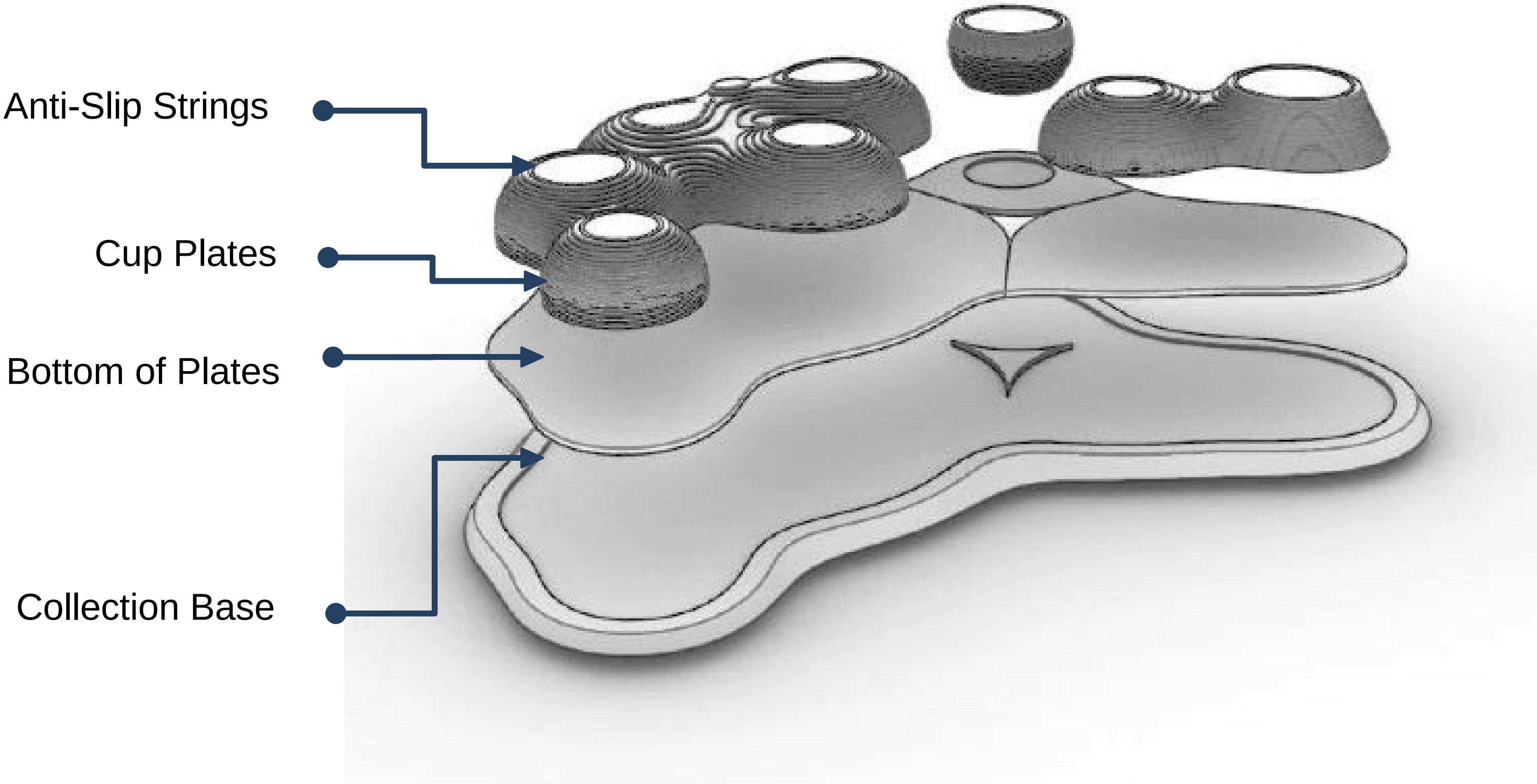

MetaBall
P
Pl
X
A
I
14ms

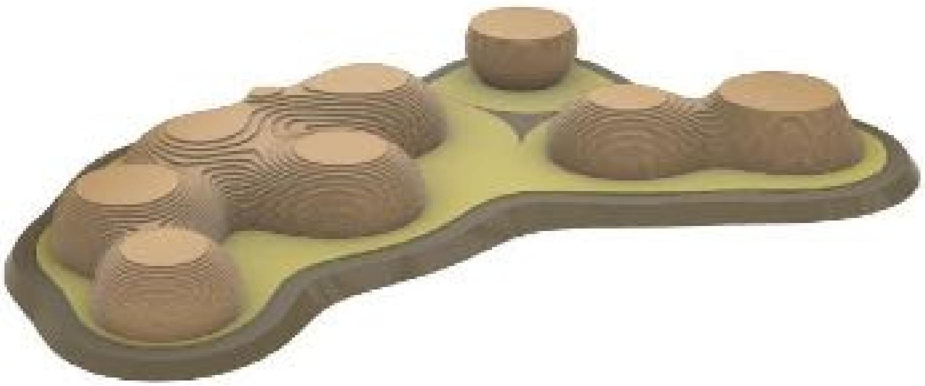


Explosion


Anti-Slip Strings
Cup Plates
Bottom of Plates
Collection Base

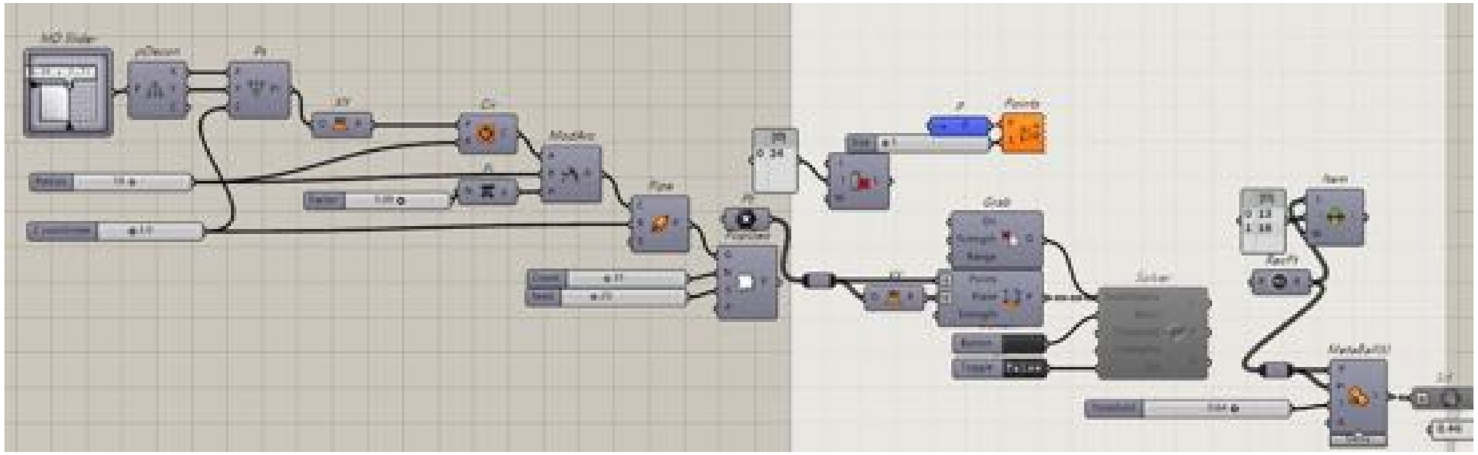
Fabrication

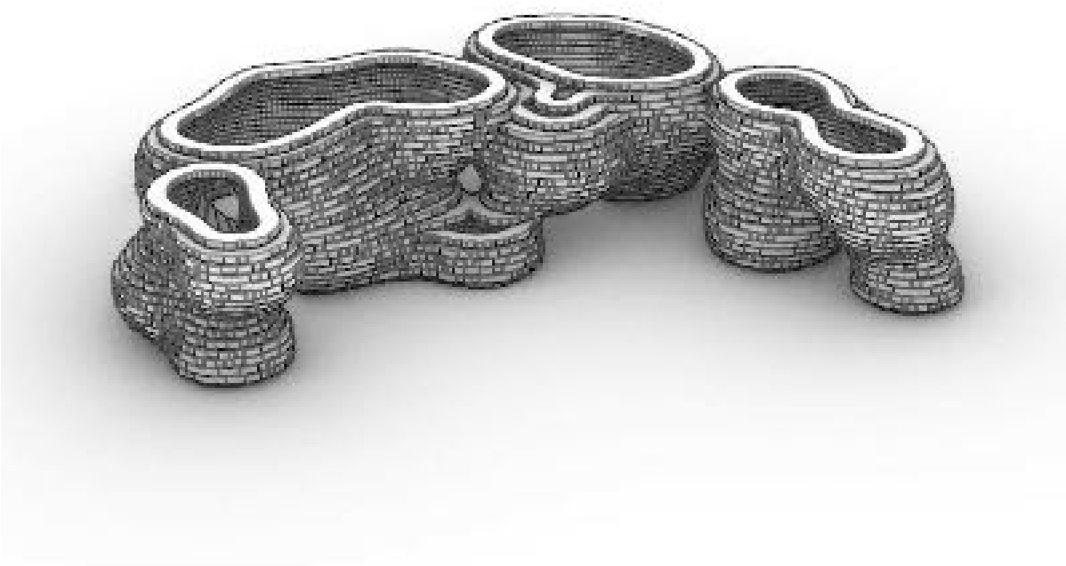
Function of use: (Tea table)

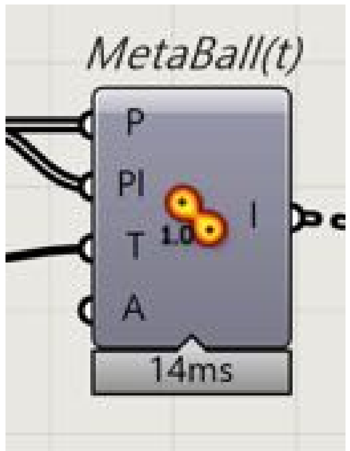


controlmad

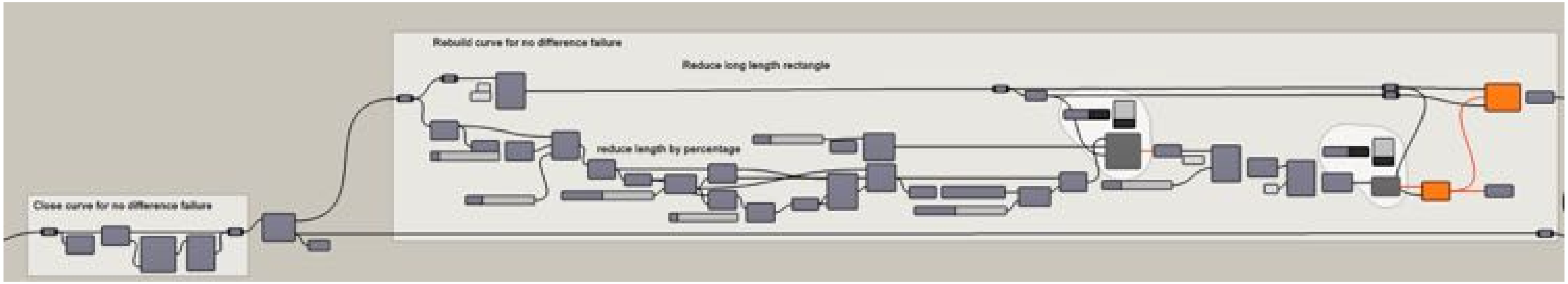
Geometry:



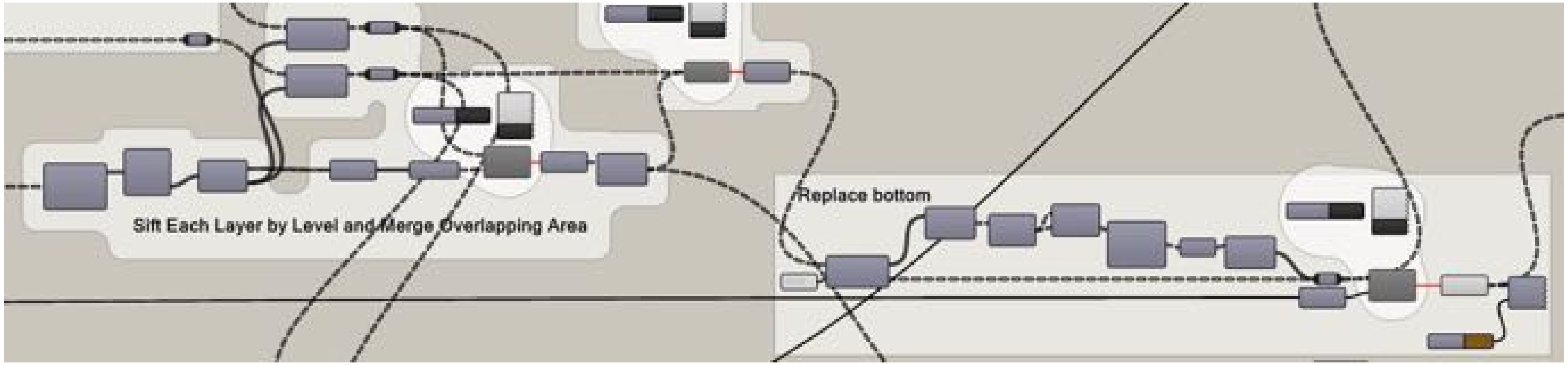




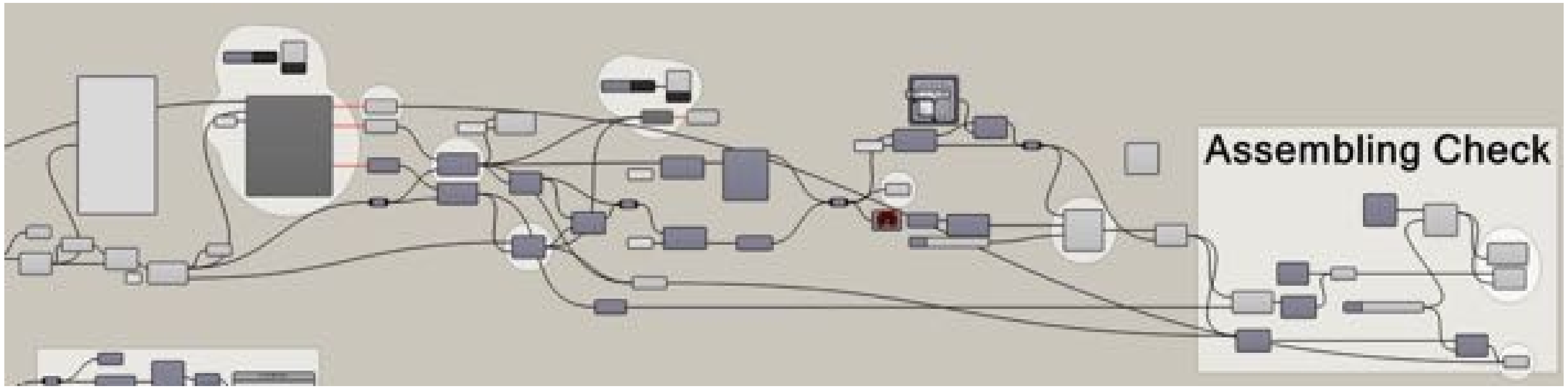
(Rough Pattern)

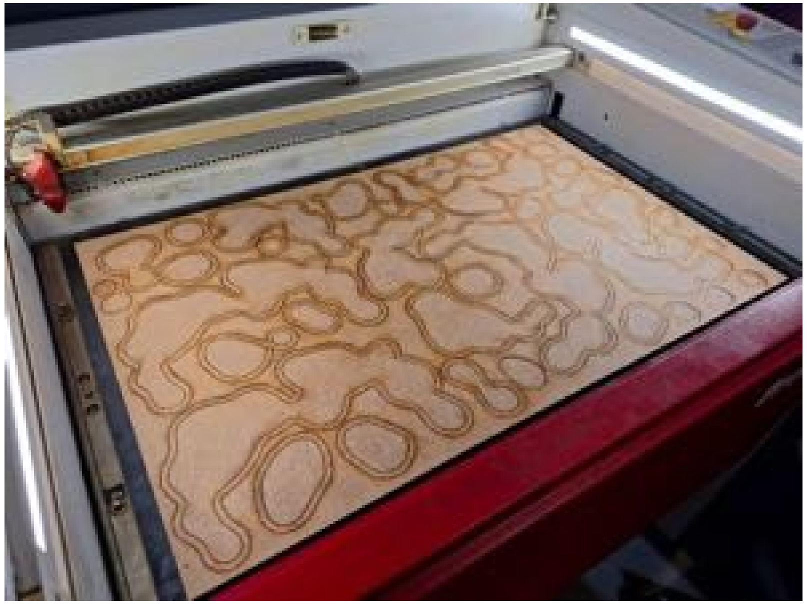


(Sorting Levels)

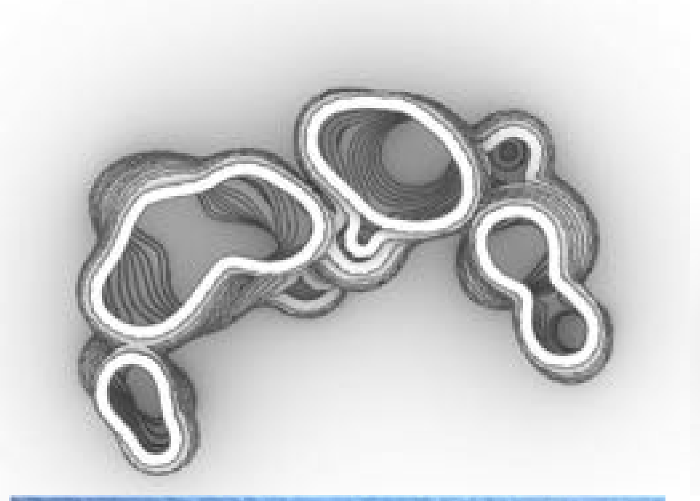


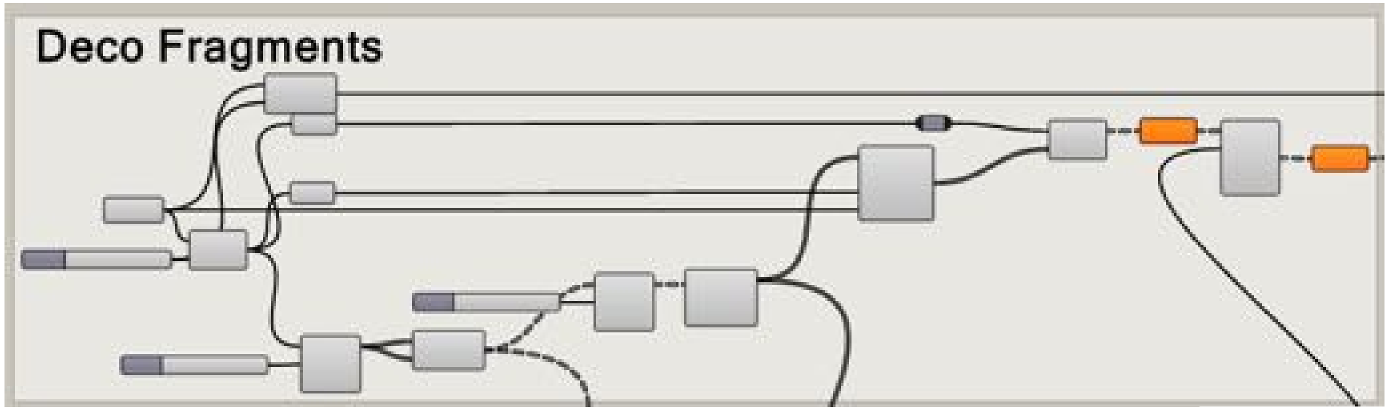
Fabrication

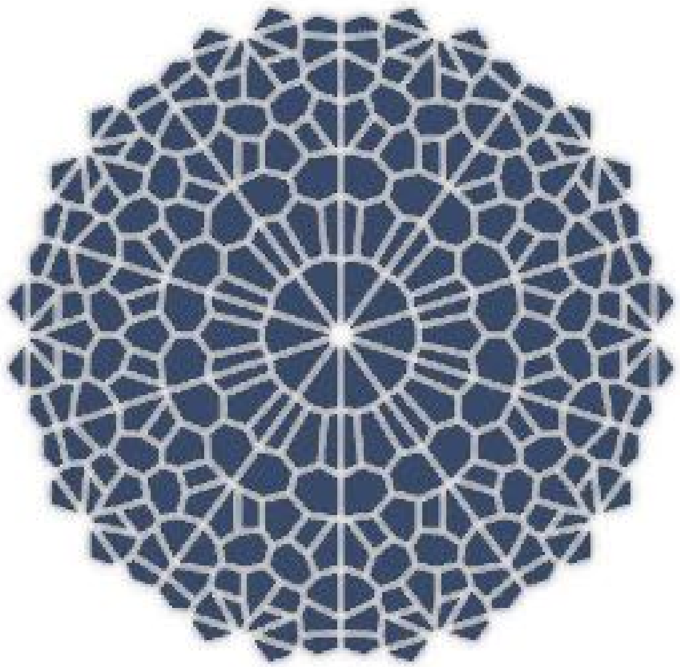


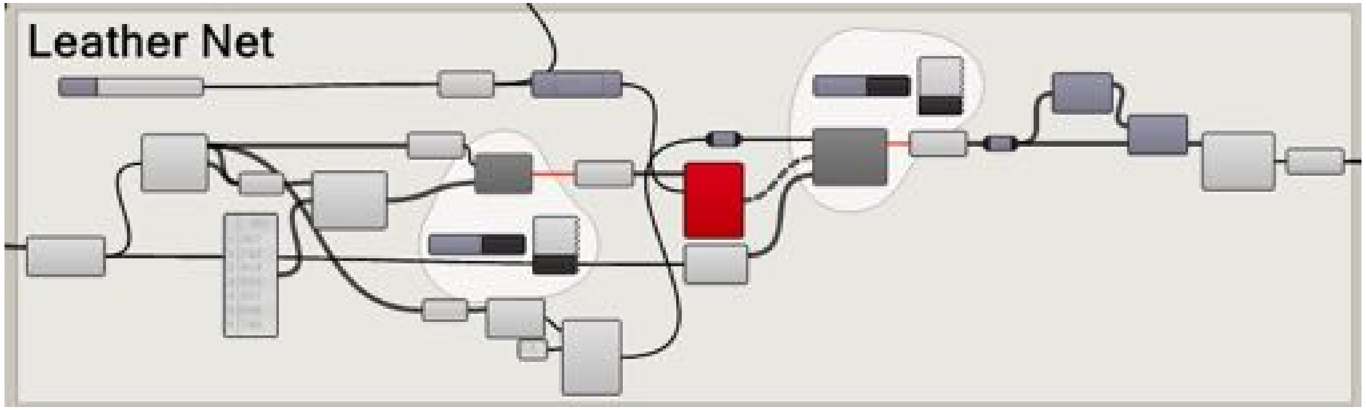


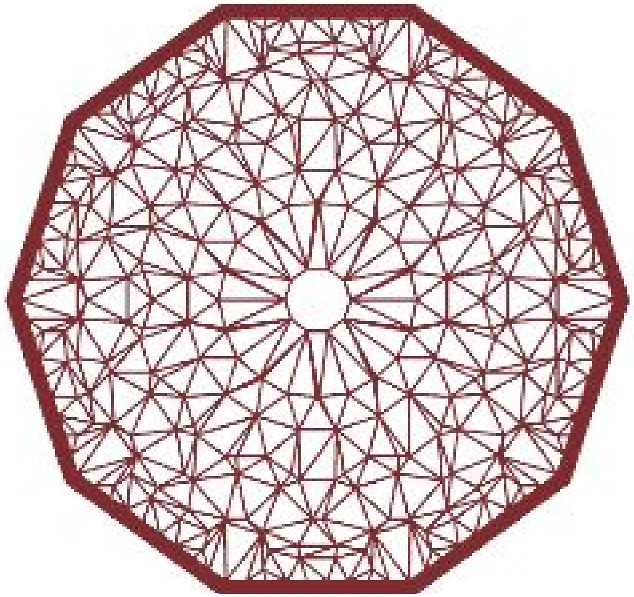
Function of use: Stationary Flowerpot

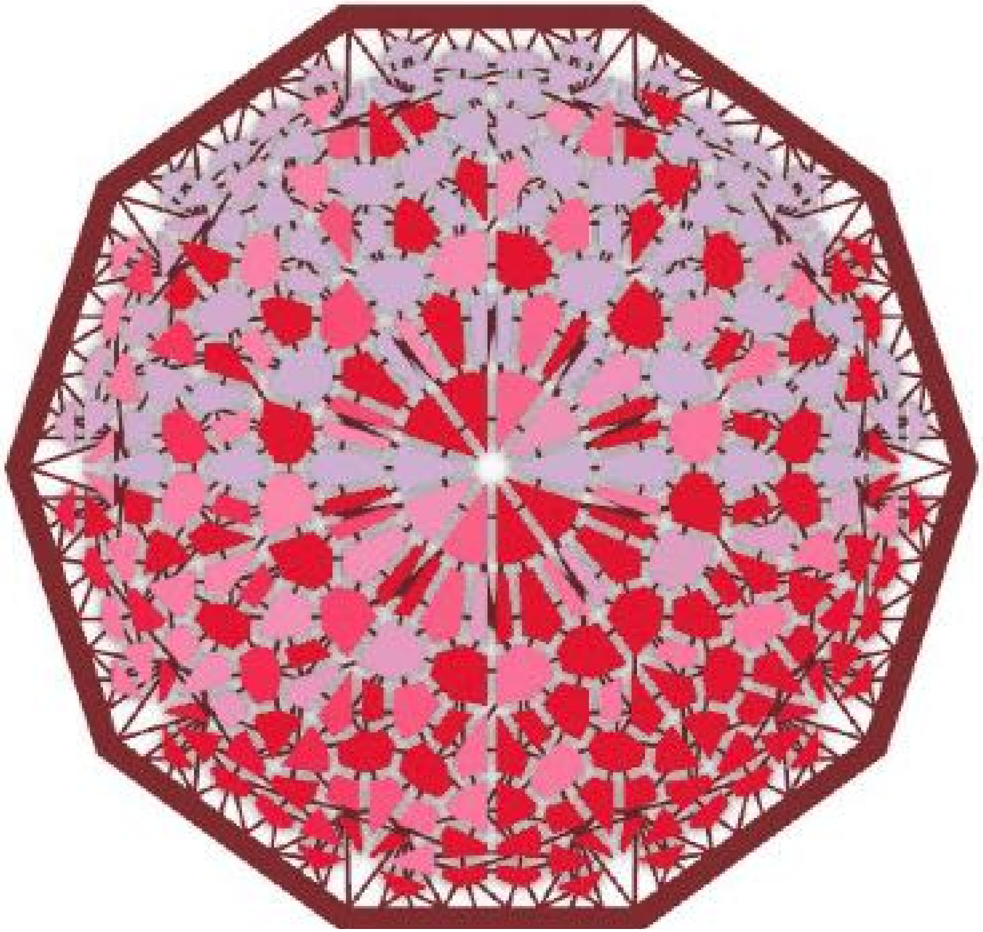



Deco Fragments




Leather Net





Fragmental ceramics

Leather for attachment

Original chestnut wood