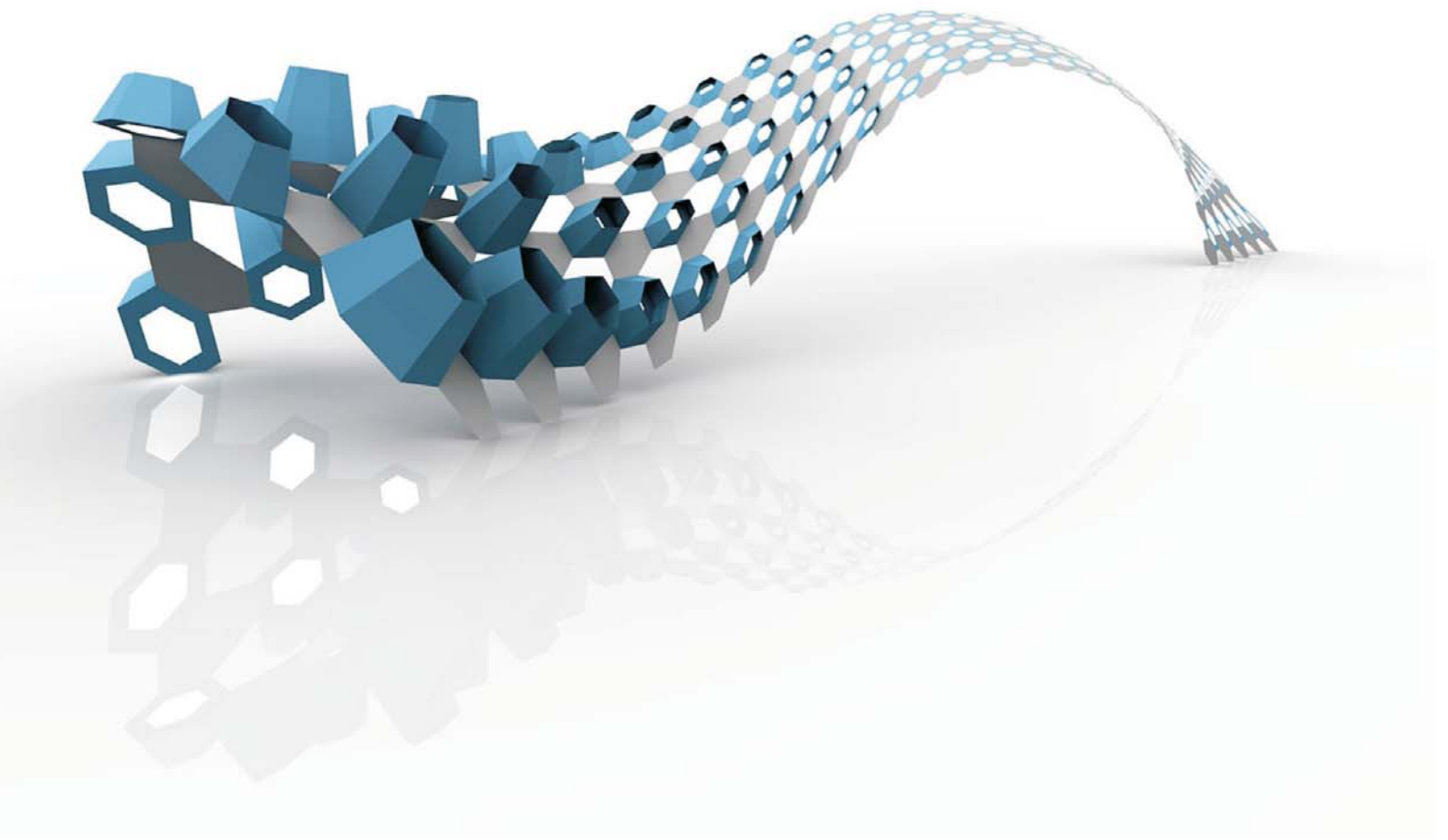


hexisurface

Digital Design Application. Assignment 2. Fabrication Planning. John Leung 178302.

Concept

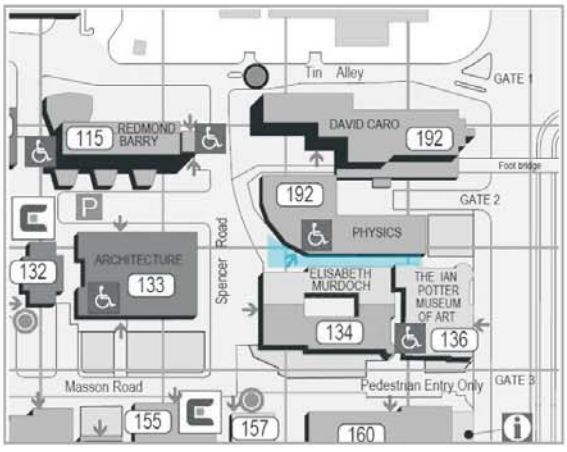
To design a shelter inspired by the geometry and growth of a seashell - to be situated in a laneway of the university campus. the Shelter shall act as an iconic built form the accentuate the stature of the laneway.

The basic form will be of a loft surface which will provide passive shading. Punctures of different sizes controlled by parametric design equations will allow varying degree of light to penetrate the shelter depending on the light requirements.

The form will use hexagon geometry as a basic component to better mimic natural structures. Although common hexagonal tessellation will result in the use of curved hexagonal panels, the challenge here is to find a way of breaking down the form so that flat hexagonal components can be used. This will allow the form to utilize the card cutter for digital fabrication which only produces flat cardboard panels.

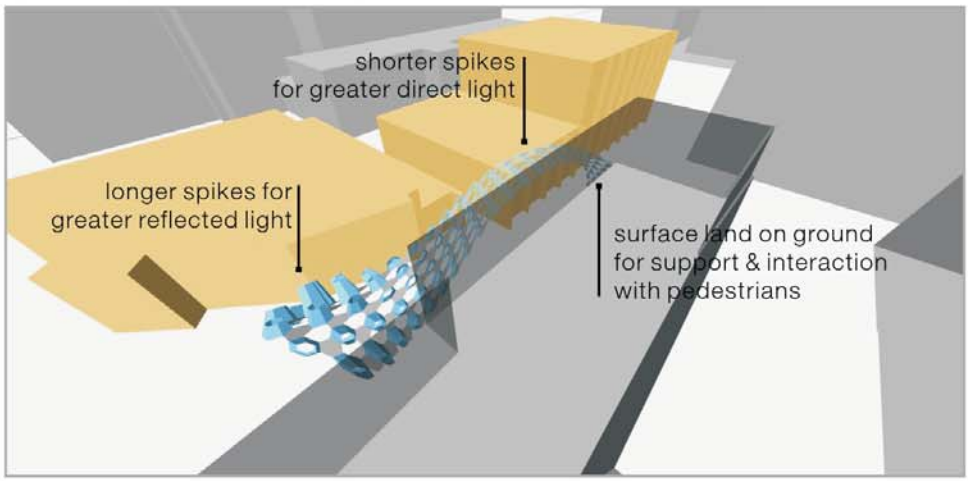
Site

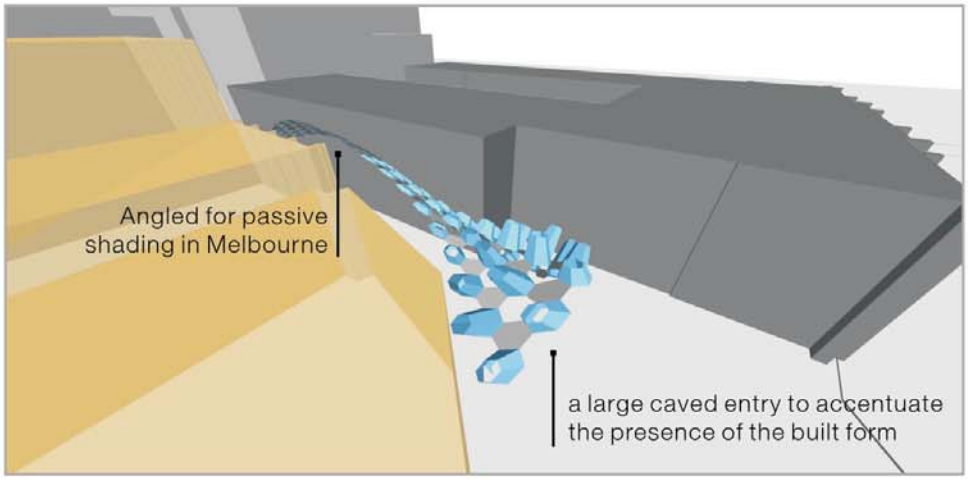
The site is located between the Physics building and Elisabeth Murdoch Building. There is a coffee shop on each end of the laneway.

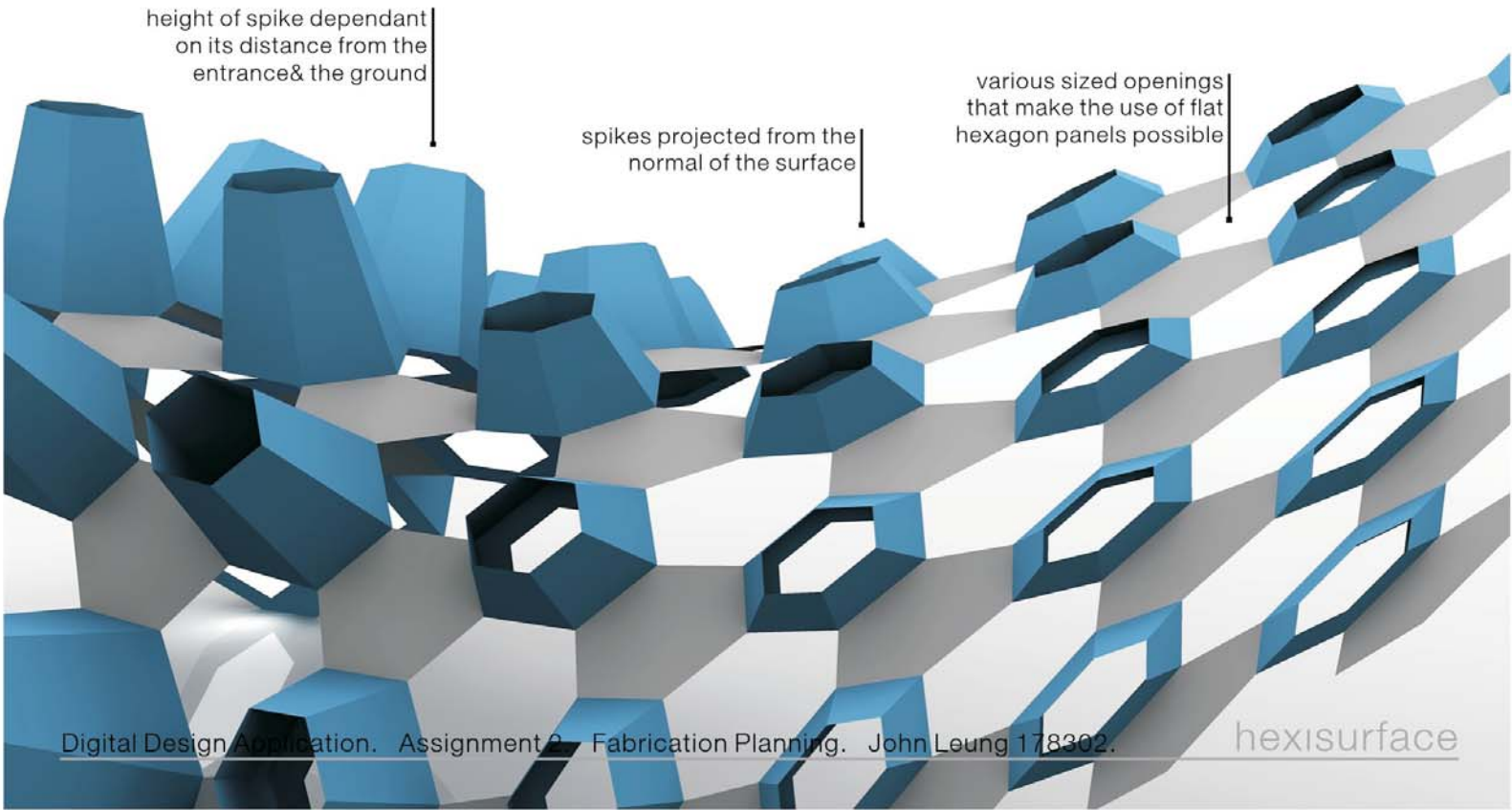


Design

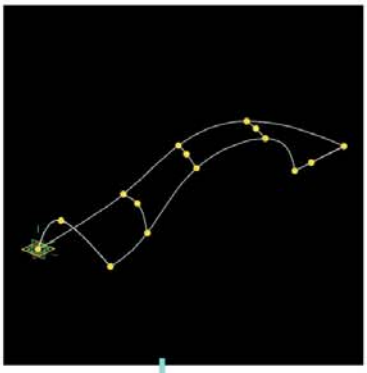
The design consists of components which responds to the site condition. A parametric design approach allows different degrees of direct and reflected light to be penetrated through the surface at various locations.



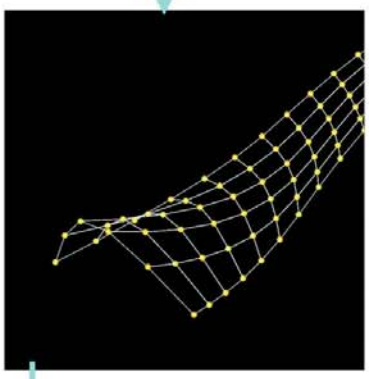




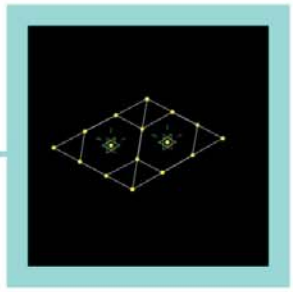
Development



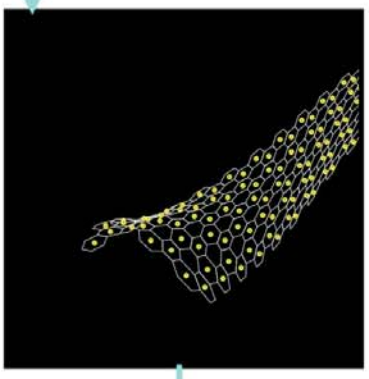
1. Loft Surface
A loft surface is designed to the requirements of support, shelter, passive shading and having a cave form at the entrance. The loft is crated by connecting 5 curves defined in space.



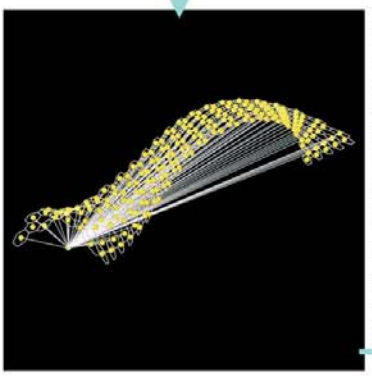
2. Polygon Grid
A polygon grid is created from point grids on the loft surface. This polygon is later used for applying the components. The density of the grid can be adjusted by the **Grid_U** & **Grid_V variable slide bar.**



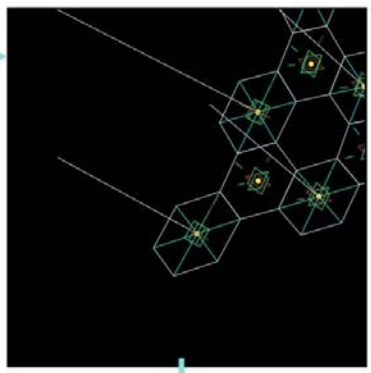
3. Flat Hexagon Component
Each quad polygon is split into 2 hexagons. Since each hexagon will be placed within a triangle, a flat panel can be achieved. A co-ordinate system is also built on each.



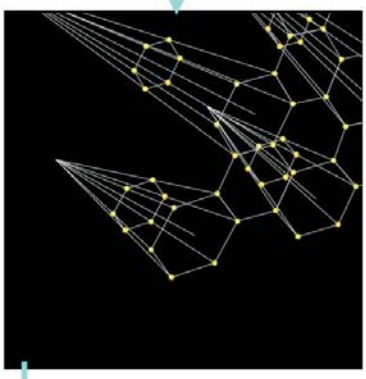
4. Apply Hexagon Component
The surface is now tessellated with flat hexagon panels. Each panel has its own co-ordiate system



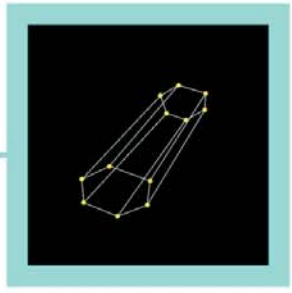
5. Create Control Point
A point is created to control where the Spikes will be longest. A line is connected from each hexagon to the Control Point to determine the distance from the point.



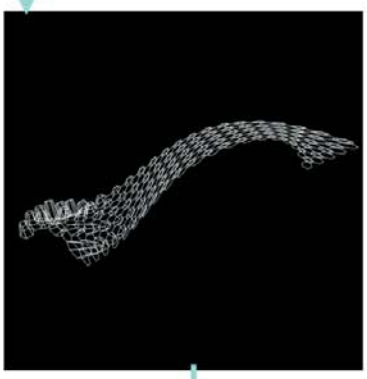
6. Line to Normal
A line is extended from the normal of each Hexagon (determined by its co-odinate system) The length is inversely proportional to the distance from the Control Point & the **Horn_Amp** variable.



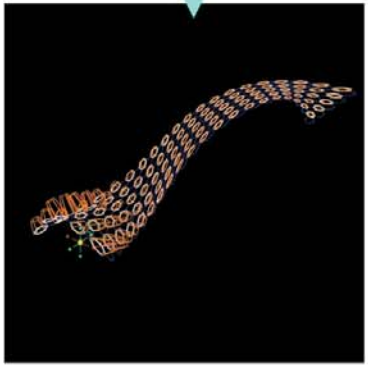
7. Creating the Spikes' Openings
Pyramids are constructed from the lines to the normal. The location for the openings of the spikes are determined by the **Horn_Opening** variable.



8. Spike Component
Spikes with 6 polygonal sides and an opening at the top makes a component.



9. Apply Spikes
Horns Component is applied to the surface. The Control Point created earlier can be moved around for adjusting the heights of the spikes.

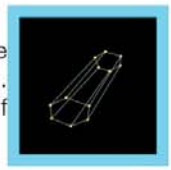


10. Finishing Up
Extra blue hexagons polygons are created to connect each spike to the surface. Each spike is coloured orange for better visualization later for the fabrication process.

Symbolic Representation

Flat Hexagon Components
The input is a quad polygon and the outputs are two flat hexagon panels.

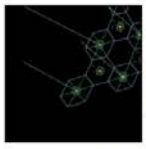
Spike Components
The inputs are the base hexagon and the top hexgon. the outputs are the six sides of the spike.

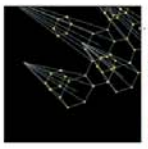


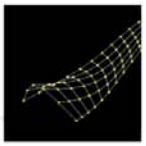
Variables
Each variable can be adjusted on the slide bar. It can affect the density of the hexagons, the height of the spikes, the opening size of the spikes and the amount of filtering.

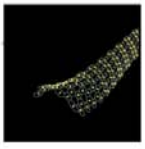
Name	Value	Analog Value
Grid_U	5	
Grid_V	20	
Hex_Opening	1.5	
Horn_Amp	0.4	
Horn_Opening	0.4	

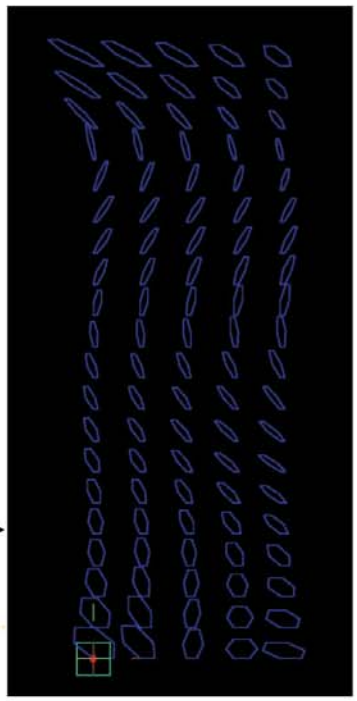
Control Point
Move the point to contral the height of the spikes.









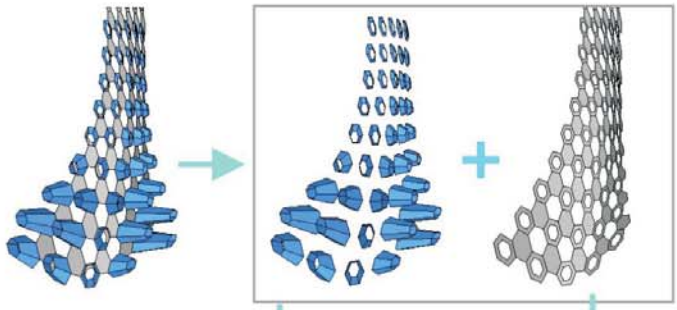


Fabrication Planning Layout
Part of the model was able to be flatted and laid out for CNC cutting. This can be done in GC interactively. Other parts of the model was flattened using more advanced software like Waybe or Pepakura.

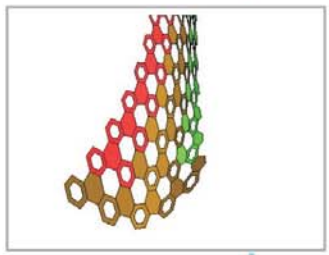
Fabrication Planning

1. Decide on a fabrication specifications
CNC fabrication tool: card cutter
Material: 250GSM Paper (Blue & Grey)
Connection type: Tabs & Glue
Estimated Construction Time: 1-2 days

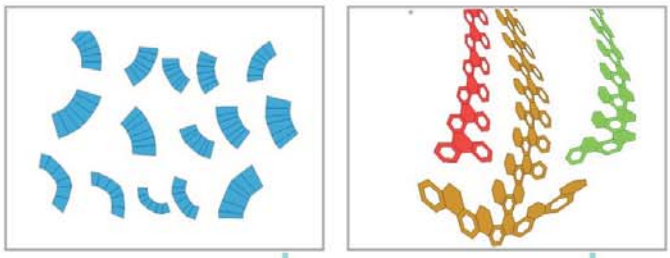
2. Fabrication Preparation
Analyze how to split up the forms into elements for simple and efficient fabrication. The surface and the spikes are separated into two processes.



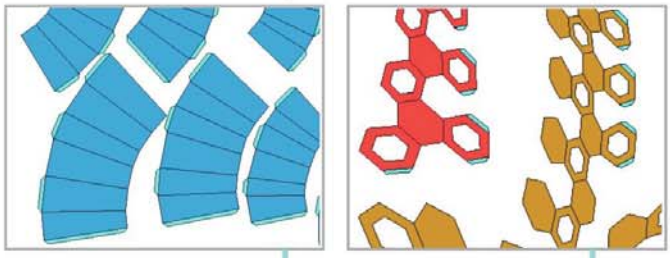
3. Further Split Up
Within the Surface form, it is further analyzed for splitting to maximise work efficiency but minimise material and joints. The original surface is now 3 surfaces- red, yellow, & green.



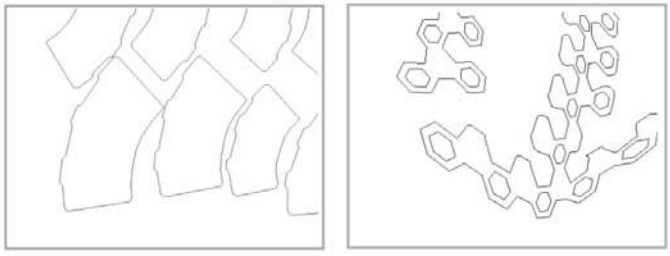
4. Flatten with Software
Waybe (SketchUp Plugin) is used for flattening the 3D forms into flat and connected 2D geometries.



5. Add Tabs
Tabs are added for connections. Waybe has a one-click function to add tabs to any edge instantly. For the Surface, the tabs shall not be added to the filled hexagons because they may show through the holes of the hollow hexagon. Therefore, the tabs are added to the hollow hexagon instead.

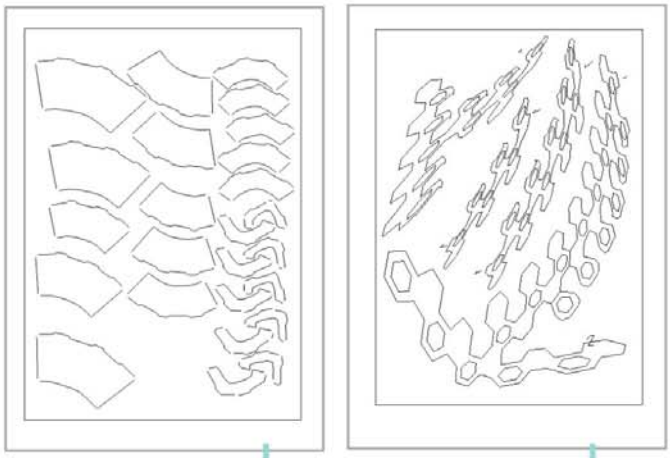


6. Remove unwanted cut lines
Unwanted cute lines in the middle of the shape are removed. If the CNC cutter can do scoring, these lines shall be moved to the layer for scoring.

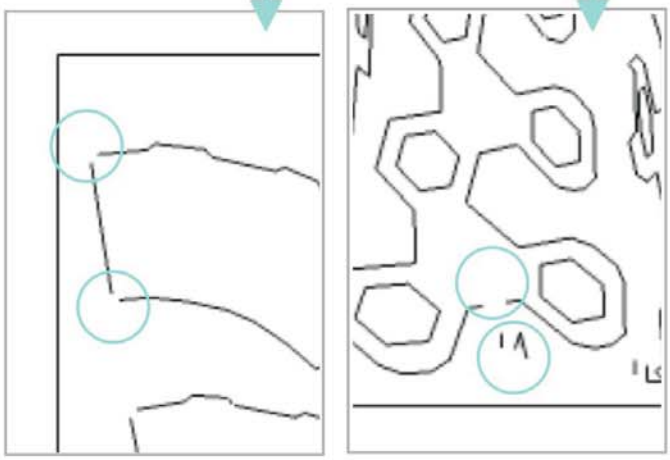


Fabrication Planning

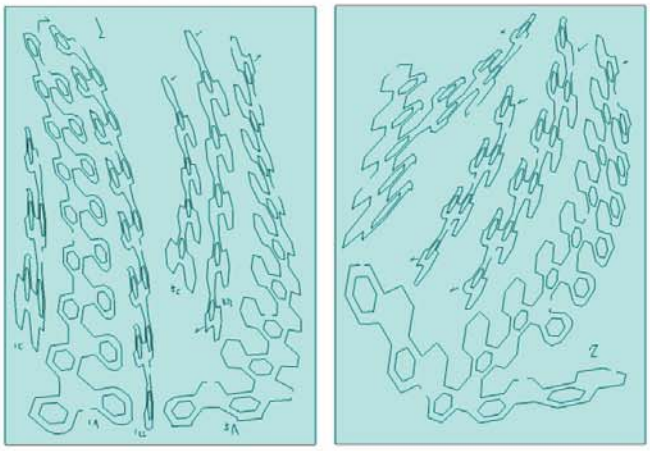
7. Laying out the Shapes to A1 sheet
The shapes are further split and laid out on the A1 sheets that will be feed to the CNC cutter. The laying out of the shape should minimize material use and cutting time.



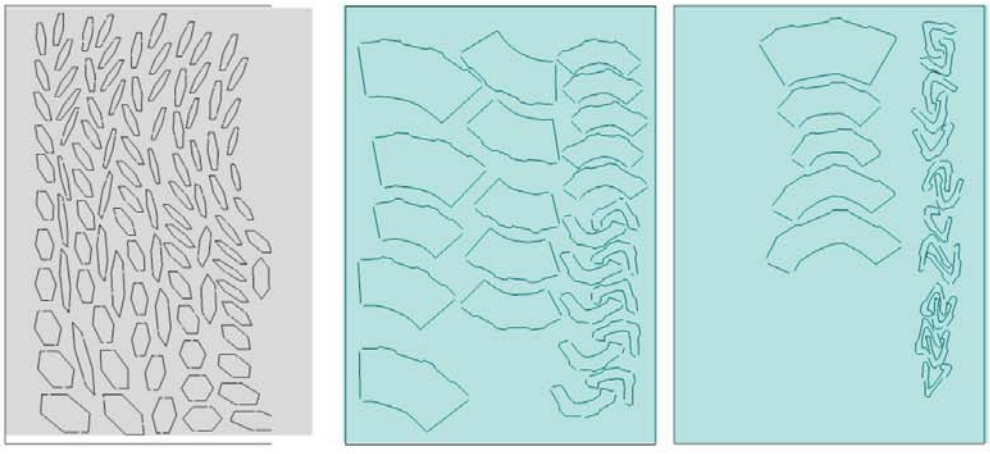
8. Extra Considerations - Notches & Labels
The continuous lines are broken at strategic points so that after the shapes have been cut out they will not be a mess to pick up and remain in place on the A1 sheet. Labels are placed next to shapes for easy identification.



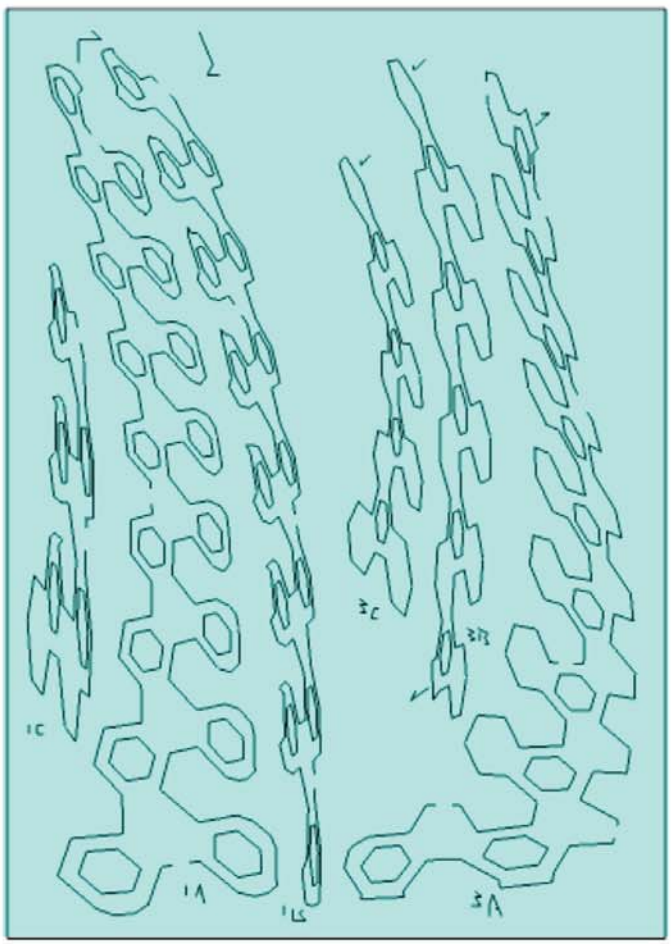
9. Send to CNC Card Cutter.
The completed A1 bards are sent to the cutter specifying card colour. Cut outs are then assembled.

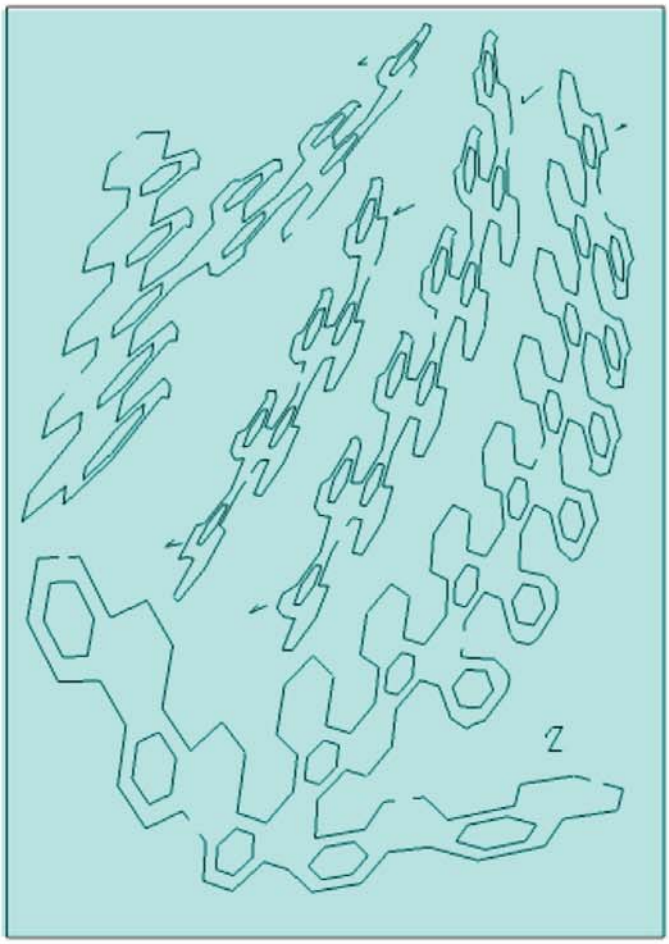


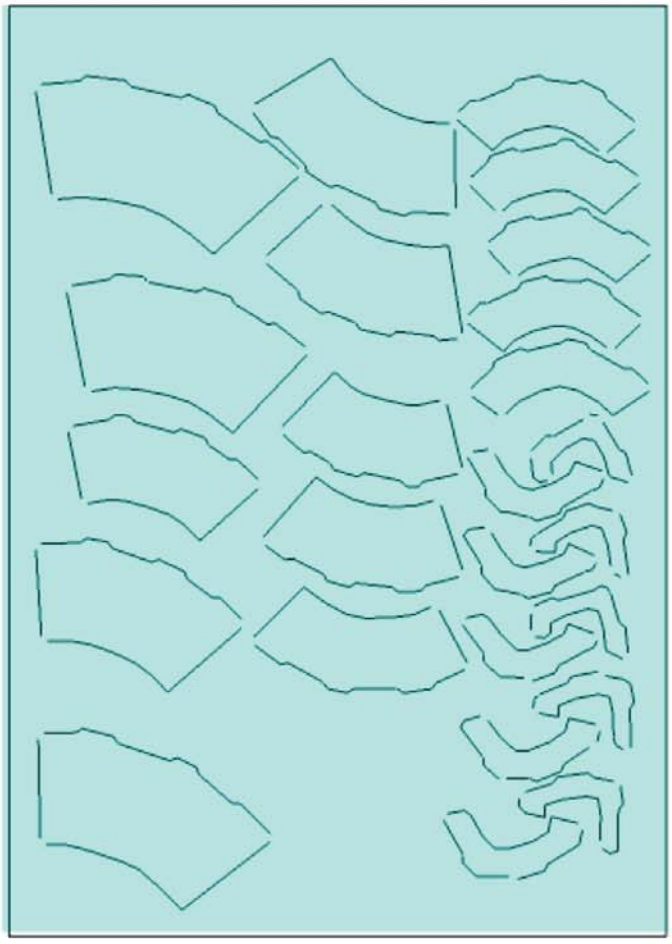
This extra A1 sheet consists of hexagon panels flattened earlier with GC's flatten function. These Hexagons are laid out efficiently to minimize wastage. The panels are for visually defining the hexagonal patterns on the surface.

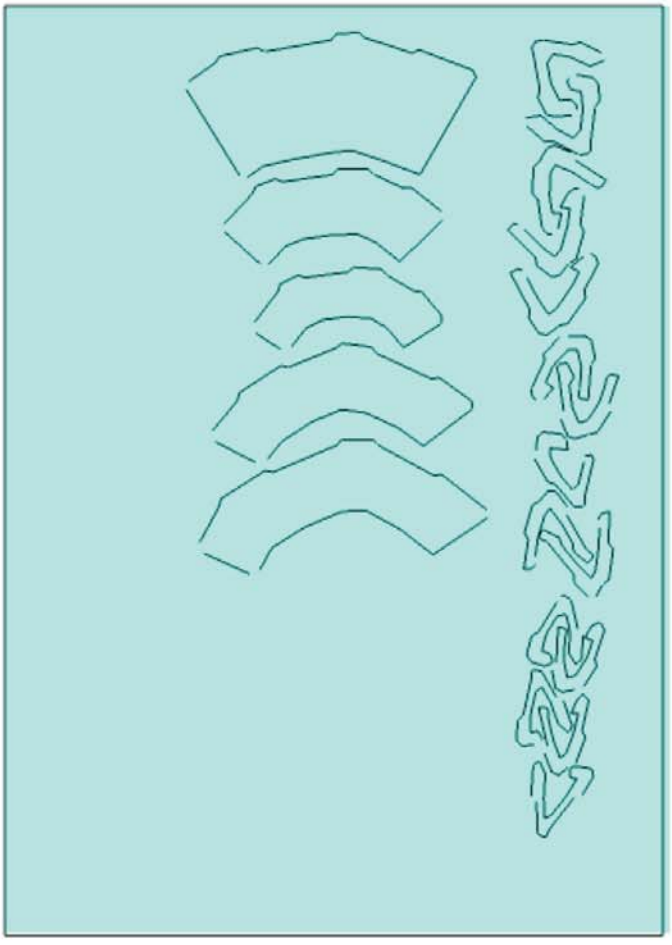


Fabrication Layouts









Fabrication Layouts