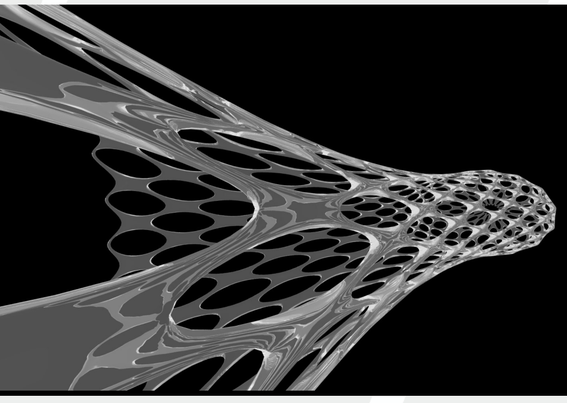

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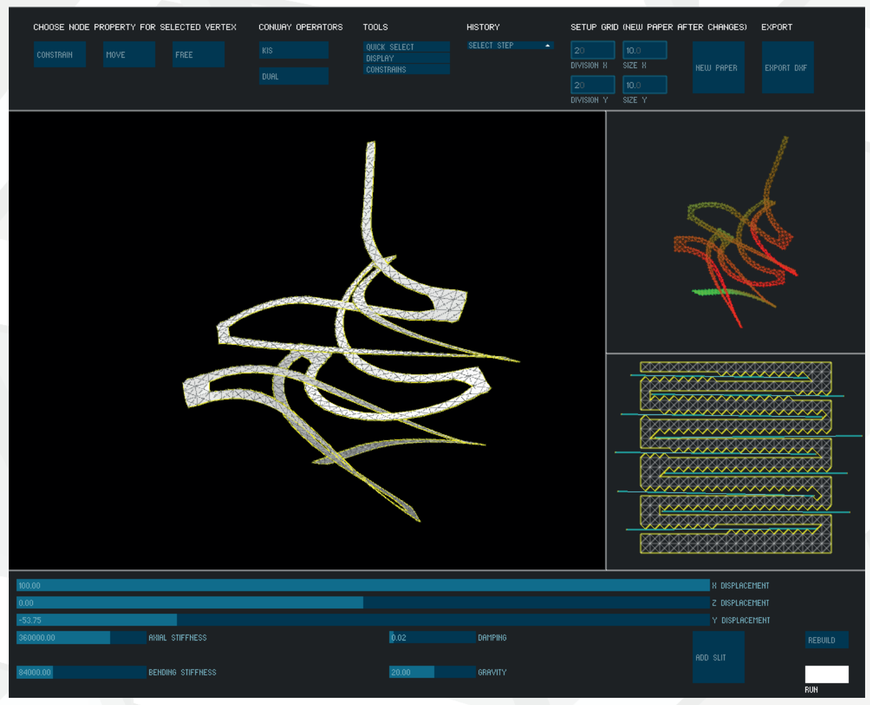
_Simulating bending

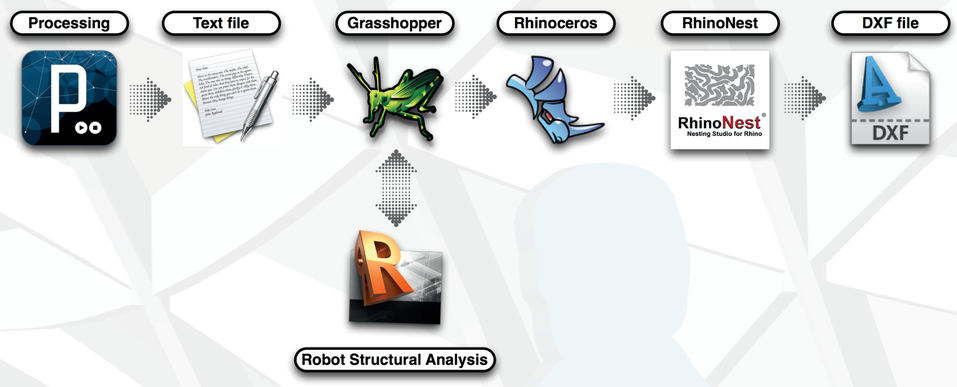
A design tool to **simulate bending stiffness of a thin shell** created using the programming language Processing. By using **verlet integration**, usually used in 3D-graphics engines to simulate real-time movement of fabric, this software simulates the movement of a piece of paper in real-time. The software allows **real-time user interaction** to define constrains, deformations, axial/bending stiffness and gravity. The project also involved different meshing algorithms and the implementation of slits in the shell.



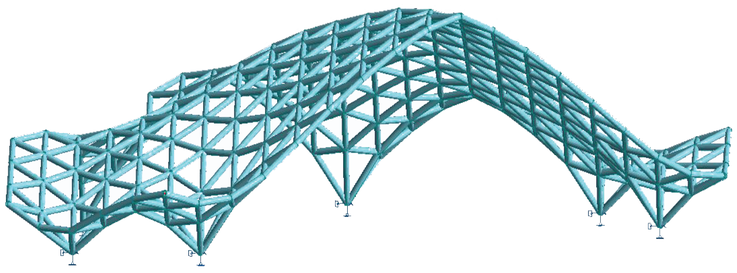
Processing application interface

_Formfinding, analysis and manufacture

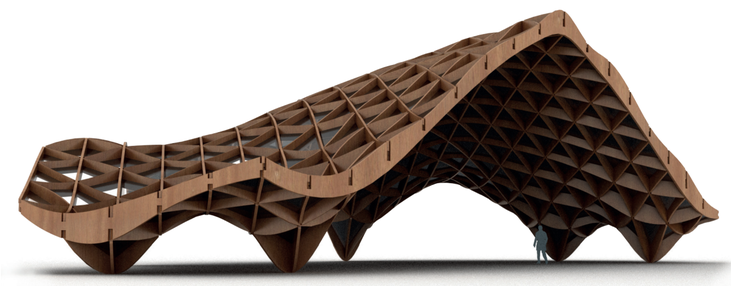
This project covers the span from the initial **form-finding of a lightweight structure** to the manufacture of a **physical scale model**. Verlet integration was used to find the optimal shape of the structure given a certain load and boundary conditions. The topology and the spacial coordinates was exported from the Processing script to the parametric modelling tool Grasshopper for Rhinoceros. Grasshopper linked the geometry to Robot Structural Analysis and optimised the cross-sections based on the finite element results and geometrical constraints. The cutting patterns for the scale model was the output of the Grasshopper definition. This approach allows for **quick and often design changes at each stage** of the project thus giving the designer more freedom to expiriment.



Software links from form-finding to cutting patterns.



Finite element model from Autodesk Robot Structural Analysis.

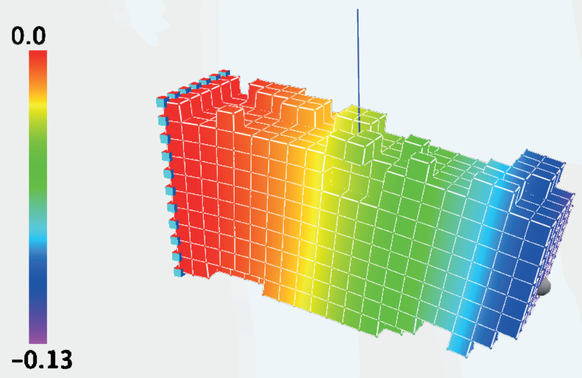


Render of model from Rhinoceros.

1 : 40 scale model made of laser-cut MDF sheets.

_Manufacture of topology optimised concrete slabs

In my ongoing project I seek to **optimise the topology of fibre-reinforced concrete slabs cast in fabric formwork**. The aim of the project is to use knowledge of structural analysis and dynamic relaxation to create an application with the goal of finding optimised shapes that can be cast using fabric formwork.
Topology optimisation is used widely in the aeronautics an automobile industry because of the ability to save weight without losing stiffness or strength. But it has never gained ground in the building industry. One of the reasons is that topology optimisation often produces organic looking shapes which can't be manufactured at an affordable price with the manufactoring methods available today. This project tries to **bridge the gap between the optimisation of a concrete slab and the actual production of one.**
The output of the finished product will be **how to constrain the fabric** during the casting to achieve the optimised shape.



Finite element analysis of arbitrary shape

Photos by courtesy of John Orr