

**CONTEMPORARY
FABRICATION
TECHNIQUES**

BENV7813

JAMES HARGRAVE

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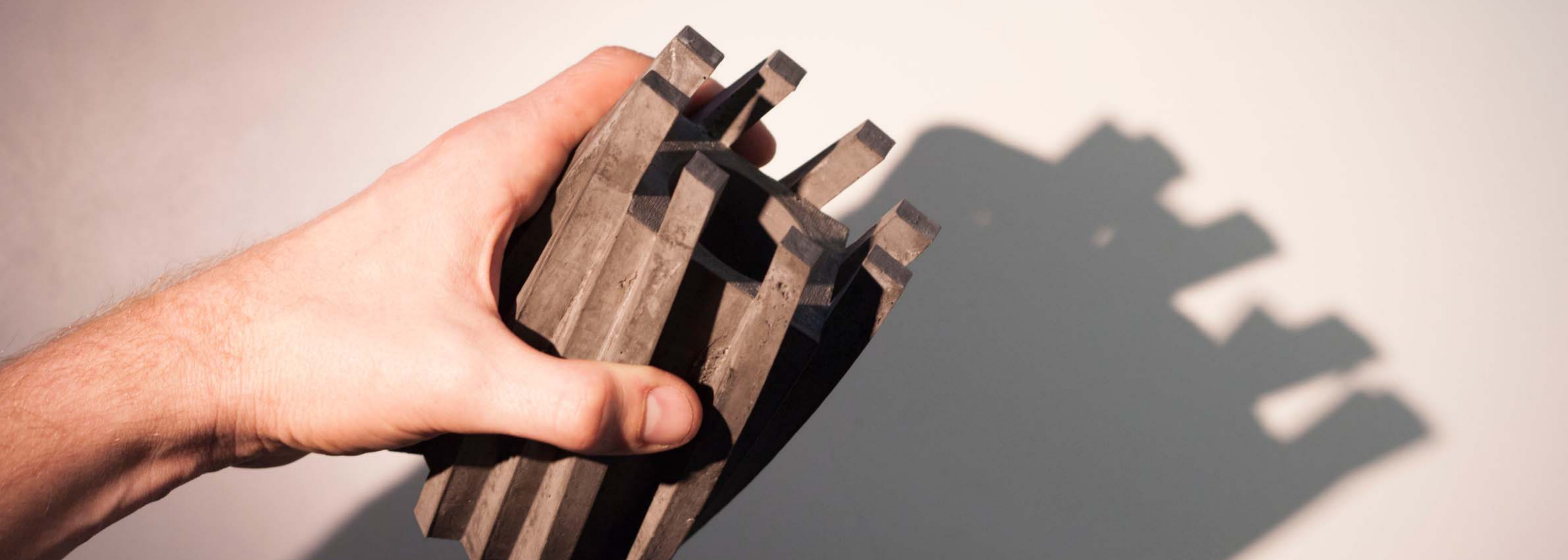
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TIMBER LAMINATION



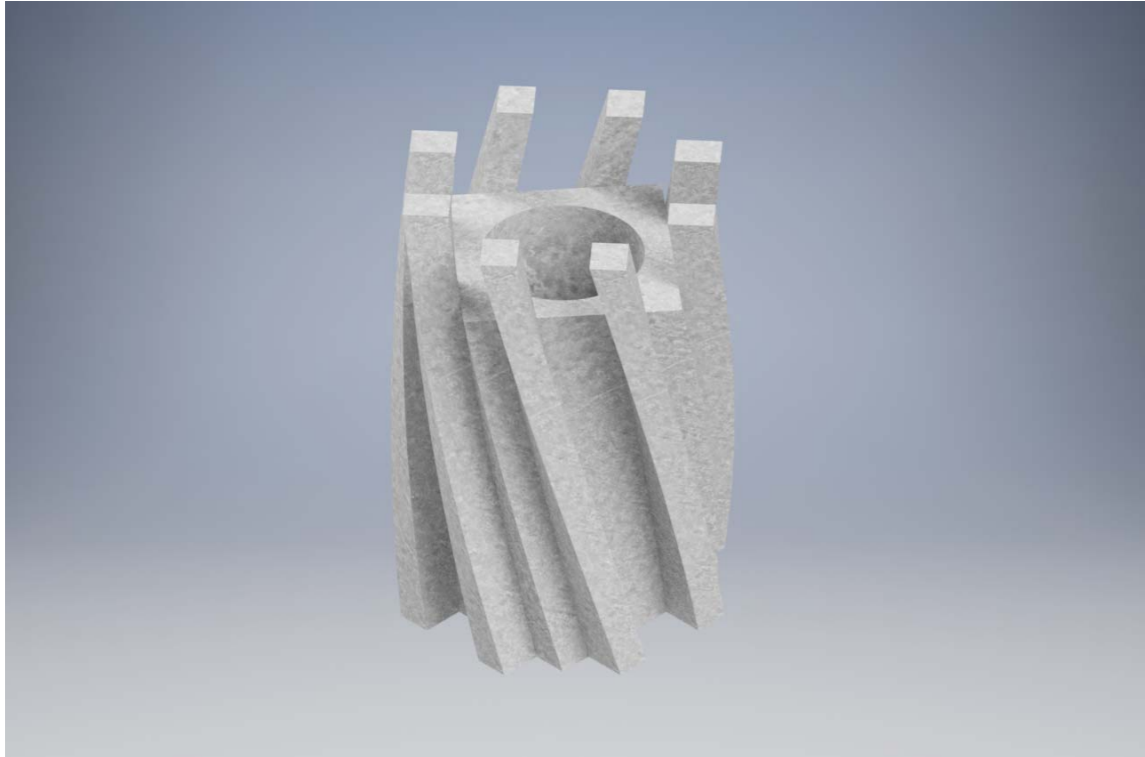
COMPONENT #1

3D MODELING , 3D PRINTING, AND
HYDRASTONE CASTING



*Six components were built before
arriving at the final object*

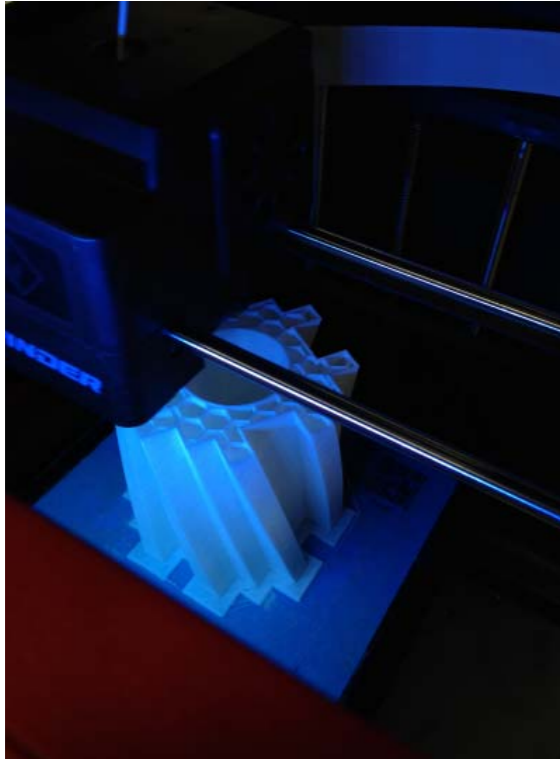
1. 3D model
2. 3D print
3. A casting box
4. Silicone mould
5. Half concrete/ half hydrastone casting
6. Hydrastone with black oxide casting



I drew inspiration from my three precedents to arrive at this final form. I used Autodesk inventor to create my desired shape. This was achieved using extrusions, profiles, coils, tweens and many other tools to achieve this form. I exported the form as .STL file in preparation for 3D printing. I ensured when exporting that the highest detail settings were selected so there would be no geometric stepping in the final print.

1. 3D model

2. 3D print
3. A casting box
4. Silicone mould
5. Half concrete/ half hydrastone casting
6. Hydrastone with black oxide casting



The .STL file was imported into the Flashforge software where the I selected the maximum layer heights / lowest print quality. I made this selection as it prints a lot faster and I would be sanding the final print to be smooth so extra layers were unnessisary. I used white PLA filament to print the object on the Flashfourge (finder) printer. It too around 8 hours to complete. I printed it with the typical structural infill and with a raft to ensure the print got off to a good start. There was almost not cleanup required after the print completed.

1. 3D model

2. 3D print

3. A casting box

4. Silicone mould

5. Half concrete/ half hydrastone casting

6. Hydrastone with black oxide casting



The box was made in a modular way so it could be unscrewed and the silicon mould easily removed. It was made just big enough to provide enough cover but too big that I would run out of silicone. In preparation for the pouring the end of the 3D print was blocked up with blue-Tack to prevent the 3D it from becoming stuck in the mould once the silicone was poured.

1. 3D model

2. 3D print

3. A casting box

4. Silicone mould

5. Half concrete/ half hydrastone casting

6. Hydrastone with black oxide casting



The 3D print was sanded smooth and then sprayed with a plastic primer to strengthen its surface while also creating a smoother surface to take a mould off. The plastic primer also protects the 3D print from being damaged when being removed from the silicone mould.

1. 3D model

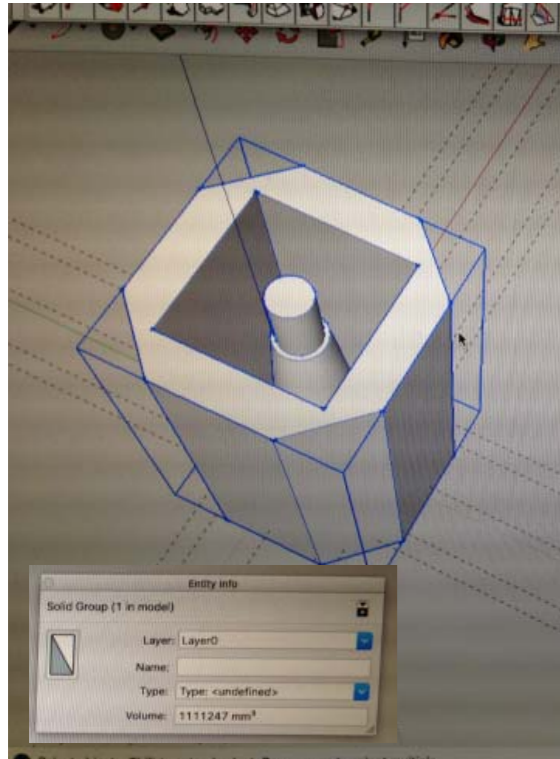
2. 3D print

3. A casting box

4. Silicone mould

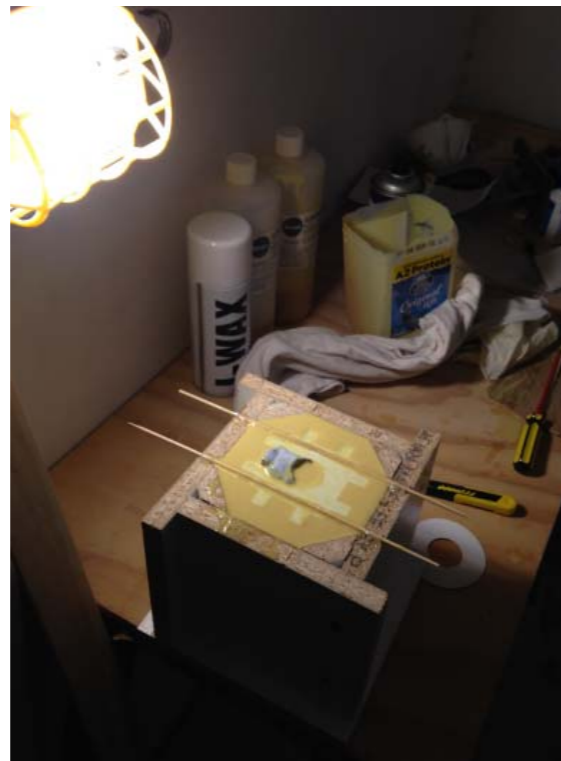
5. Half concrete/ half hydrastone casting

6. Hydrastone with black oxide casting



The 3D print was sanded smooth and then sprayed with a plastic primer to strengthen its surface while also creating a smoother surface to take a mould off. The plastic primer also protects the 3D print from being damaged when being removed from the silicone mould.

1. 3D model
2. 3D print
3. A casting box
- 4. Silicone mould**
5. Half concrete/ half hydrastone casting
6. Hydrastone with black oxide casting



Prior to working with the silicone I sprayed the inside of the casting box and the 3D print with J-WAX to make de-moulding easier. Equal parts of "1" and "2" were mixed together before being poured in and around the casting box and 3D print. I made sure the 3D print was hung from the top by gluing two skewers to so there would be a good cover around the top of the print.

1. 3D model
2. 3D print
- ~~3. A casting box~~
- 4. Silicone mould**
5. Half concrete/ half hydrastone casting
6. Hydrastone with black oxide casting



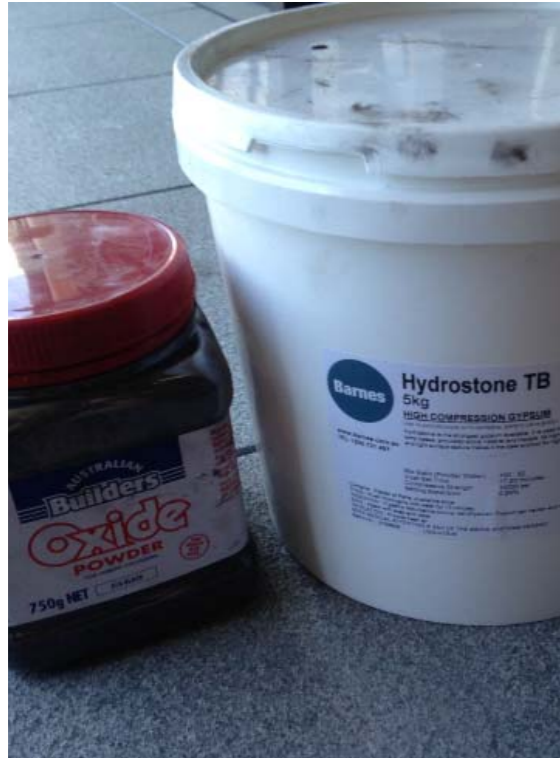
This silicone I used was a higher strength silicon. This meant that it took around a week to fully cure as opposed to more flexible moulding silicone. From the research I did, 75 degrees Celsius was the optimum speed to speed up curing time. After allowing the mould to cure outside for approximately 6 days I put the mould in the oven for a final cure prior to removing the 3D print. I had to cut the mould on four sides in order to remove the 3D print but once placed back in the casting box it returned to its former shape.

1. 3D model
2. 3D print
3. A casting box
- 4. Silicone mould**
5. Half concrete/ half hydrastone casting
6. Hydrastone with black oxide casting



I was experimenting with different mixtures to get the colour and texture I was looking for. The first experiment was with half hydrastone and half concrete. The mix works relatively well, the only issue being the mixture was thicker and it did not flow well into all of the areas of the mould.

1. 3D model
2. 3D print
3. A casting box
4. Silicone mould
- 5. Half concrete/ half hydrastone casting**
6. Hydrastone with black oxide casting



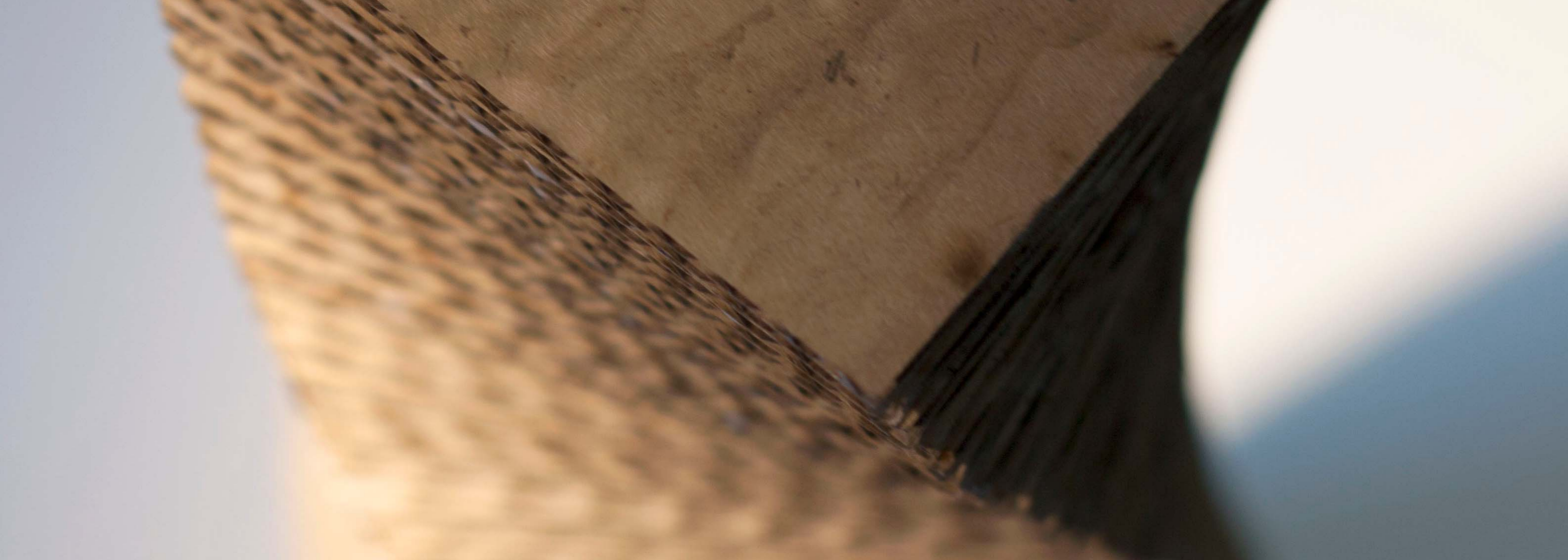
On my second trial used 100% hydrastone with around one teaspoon of black oxide powder to give the hydrastone the stone or concrete like colouration. Prior to casting the part I sprayed the inside of the mould with some J-WAX which makes it easier to remove the casting. The mix portions were 10 parts hydrastone, 3 parts water. This mix worked really well as it flowed into all areas of the mould and produced a really smooth and accurate result. I also used the body of a pen to leave a small hole in the base so a power cord may be easily run to a light fitting inside.

1. 3D model
2. 3D print
3. A casting box
4. Silicone mould
5. Half concrete/ half hydrastone casting
- 6. Hydrastone with black oxide casting**

The final models



From the left: 3D print, Half hydrastone / half concrete, and the 100% hydrastone with oxide additive.



COMPONENT #2

3D MODELING, LASERCUTTING, AND
GLUED ASSEMBLY



*Four key stages were undertaken
before arriving at the final object*

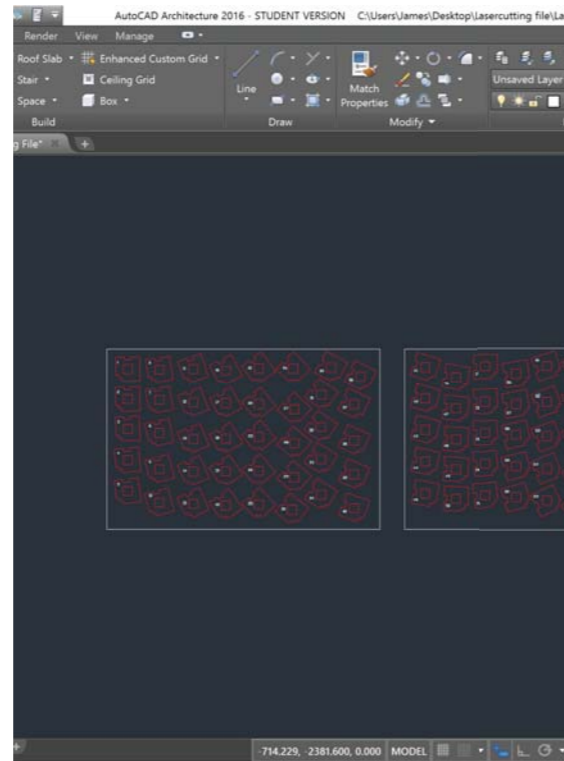
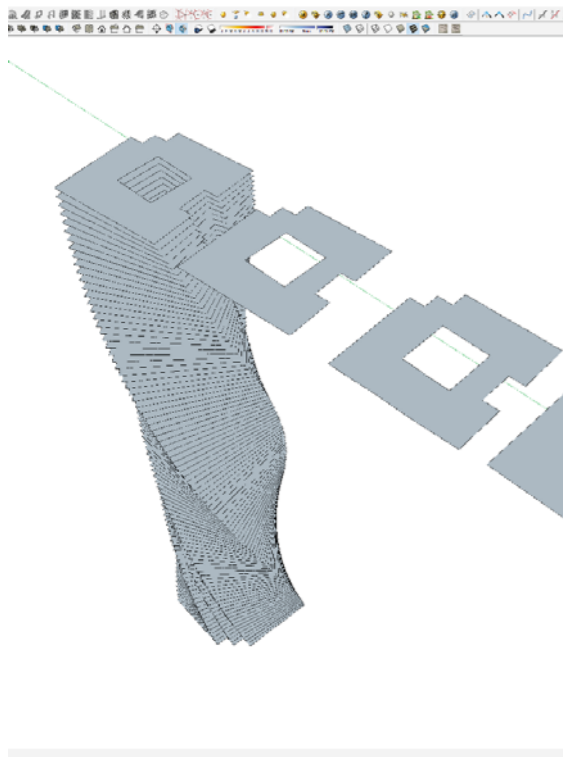
1. 3D model
2. Lasercut drawings
3. Lasercut cardboard
4. Glued assembly



I used Autodesk Inventor and the existing files I had created to generate this form. The initial form was a culmination of three precedents brought together to create a unifying structure that embraced multiple fabrication techniques and pushed the perception of what was possible. This form was initially created as a "jig" to aid in the construction of the timber laminated components. It later became a model in itself as it possessed all of the qualities of a contemporary fabricated component. It uses contemporary materials (cardboard) and contemporary techniques (lasercutting) to achieve a sculptural and beautiful result.

1. 3D model

2. Lasercut drawings
3. Lasercut cardboard
4. Glued assembly



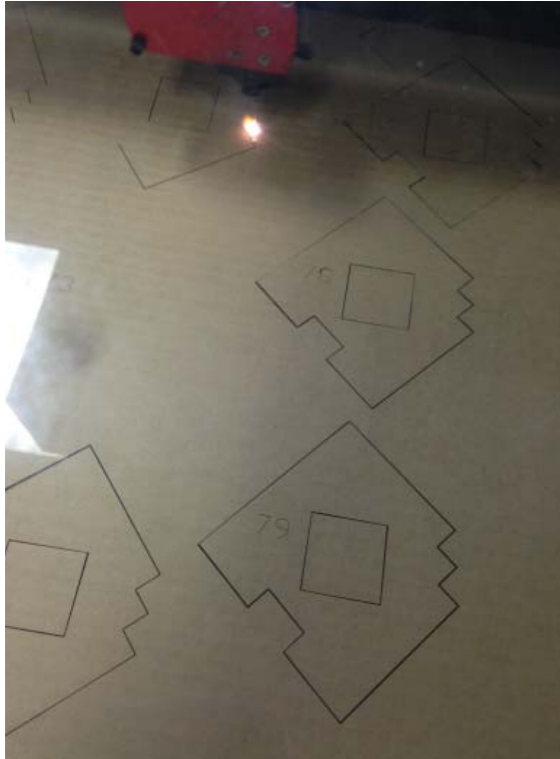
I exported my model from Autodesk Inventor as an .OBJ file. I imported this file into Sketchup where I cut it up to create a series of slices that had a central core to ensuring all slices aligned correctly. The slices were exported and edited in Autocad in preparation for lasercutting.

1. 3D model

2. Lasercut drawings

3. Lasercut cardboard

4. Glued assembly



I initially was going to make the model out of MDF. It seemed a little unnecessary to as other cheaper materials could achieve the same result. I trialled a number of test with layers of cardboard and the compressive strength when sandwiched together was more than enough required for my jig. I lasercut the pieces and taped them to keep them all held together for transportation.

1. 3D model

2. Lasercut drawings

3. Lasercut cardboard

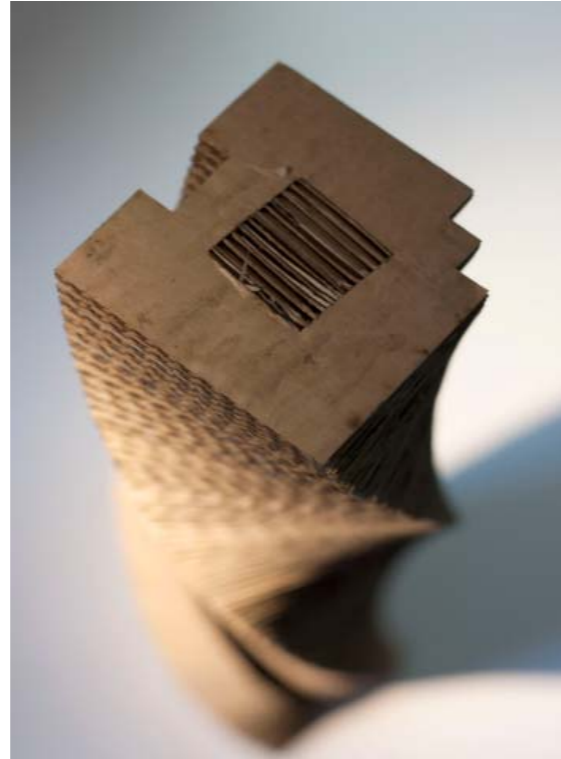
4. Glued assembly



I first assembled the core of the structure. All of the pieces were numbered so it was a process of gluing them in order, sliding them down and holding for a short while to achieve the desired compression. After gluing all of the pieces the correct height I cut off the remaining core and the jig was complete and ready for work.

1. 3D model
2. Lasercut drawings
3. Lasercut cardboard
- 4. Glued assembly**

The cardboard spiral in its final sculptural state. The compressive state was incredible and it was more than suitable to work as a laminating framework.



The final model



COMPONENT #3

3D MODELING, LASERCUTTING, AND
TIMBER LAMINATION



*Five key stages were undertaken
before arriving at the final object*

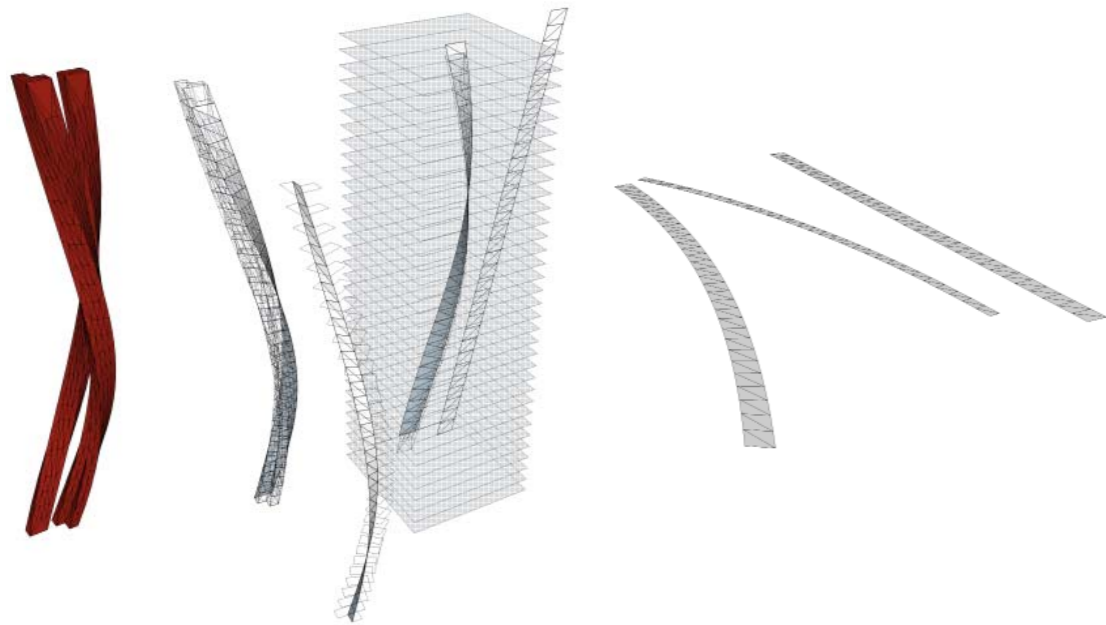
1. 3D model
2. Flattening geometry
3. Lasercutting + drawings
4. Gluing and the Jig
5. Finishing



the form and inspiration for the timber components was drawn directly from my timber laminating precedent. The model I created for the timber component tied in directly with component #1. I used Autodesk Inventor to model the components up and then import the individual components into an assembly drawing to see how they interacted with each other.

1. 3D model

2. Flattening geometry
3. Lasercutting + drawings
4. Gluing and the Jig
5. Finishing



I started by exporting the Inventor component as a .OBJ file. I imported this file into Sketchup and proceeded to slice and simplify the curved geometry. This allowed me to extract the complex face created in Inventor and simplify it to a series of twisting triangles. I ran a flattening command that aligned all of the faces I created to the X and Y axis. I then exported these drawings as a .DWG.

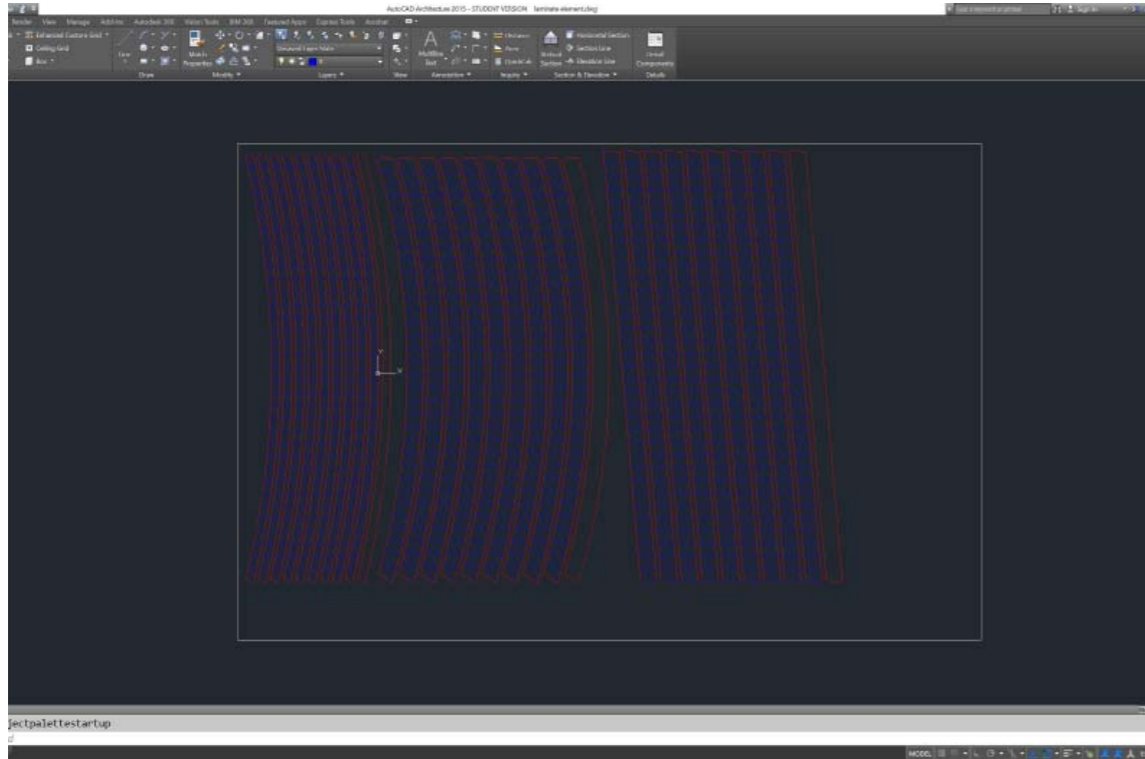
1. 3D model

2. Flattening geometry

3. Lasercutting + drawings

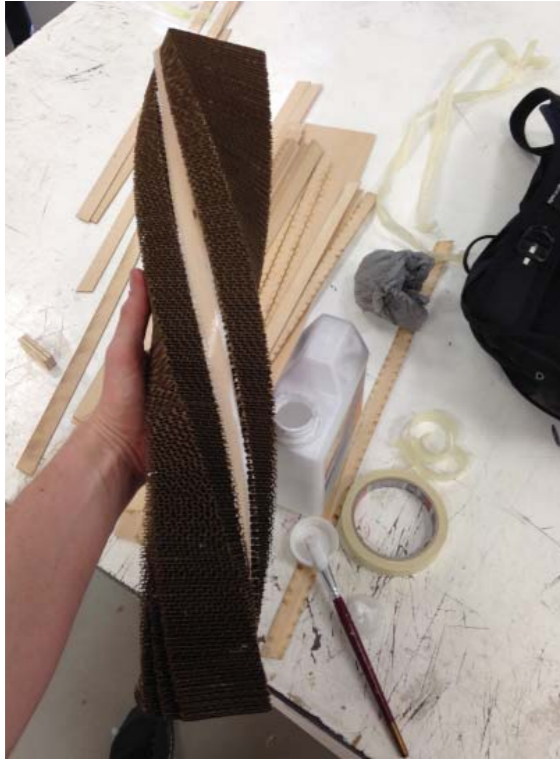
4. Gluing and the Jig

5. Finishing



I made sure to join all of the cut lines together as a continuous line so that the lasercutting would be smooth and would not burn my thing timber strips. I initially trialed etching small fold lines into the surface but it was unnecessary as the strips were so thin they bent easy enough.

1. 3D model
2. Flattening geometry
- 3. Lasercutting + drawings**
4. Gluing and the Jig
5. Finishing



I started by lining the inside of the cardboard jig with layers of masking tape to ensure the glue does not fuse the two together. One by one I inserted the strips into the jig's groove - gluing as I went. After layering up 10 strips I used three clamps and some small plywood chocks I made to compress all of the layers together.

1. 3D model
2. Flattening geometry
3. Lasercutting + drawings
- 4. Gluing and the Jig**
5. Finishing



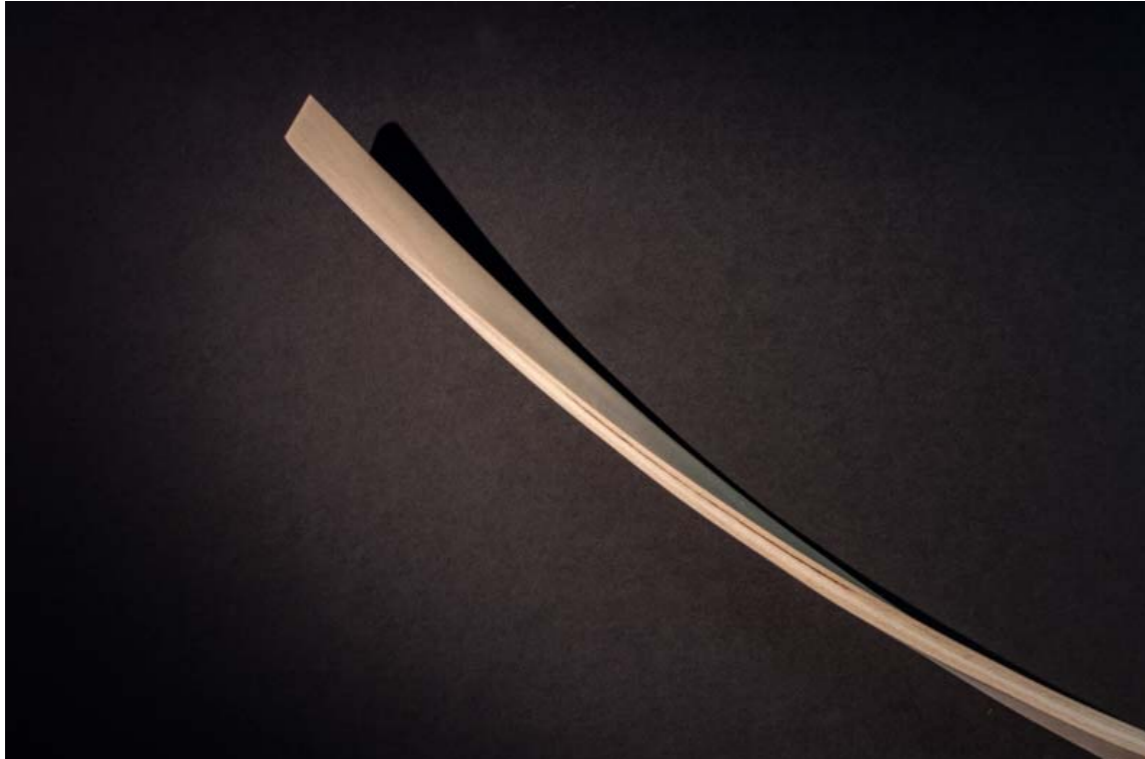
I only used three clamps on the jig and as a result the twist in the finished piece was not as smooth and i had anticipated. I also found that the glue had made its way past the masking tape and stuck itself to the cardboard. I had to continue trialling other methods.

1. 3D model
2. Flattening geometry
3. Lasercutting + drawings
- 4. Gluing and the Jig**
5. Finishing



On my second try I used glad-wrap instead of masking tape. The glad-wrap was thinner and prevented bunching up and a narrowing of the jigs groove. I also used 7 clamps as opposed to the 3 I had used previously. Using more clamps pressed the laminations together much more uniformly. The clamps were easy grips which made it much easier to clap the pieced one handed.

1. 3D model
2. Flattening geometry
3. Lasercutting + drawings
- 4. Gluing and the Jig**
5. Finishing



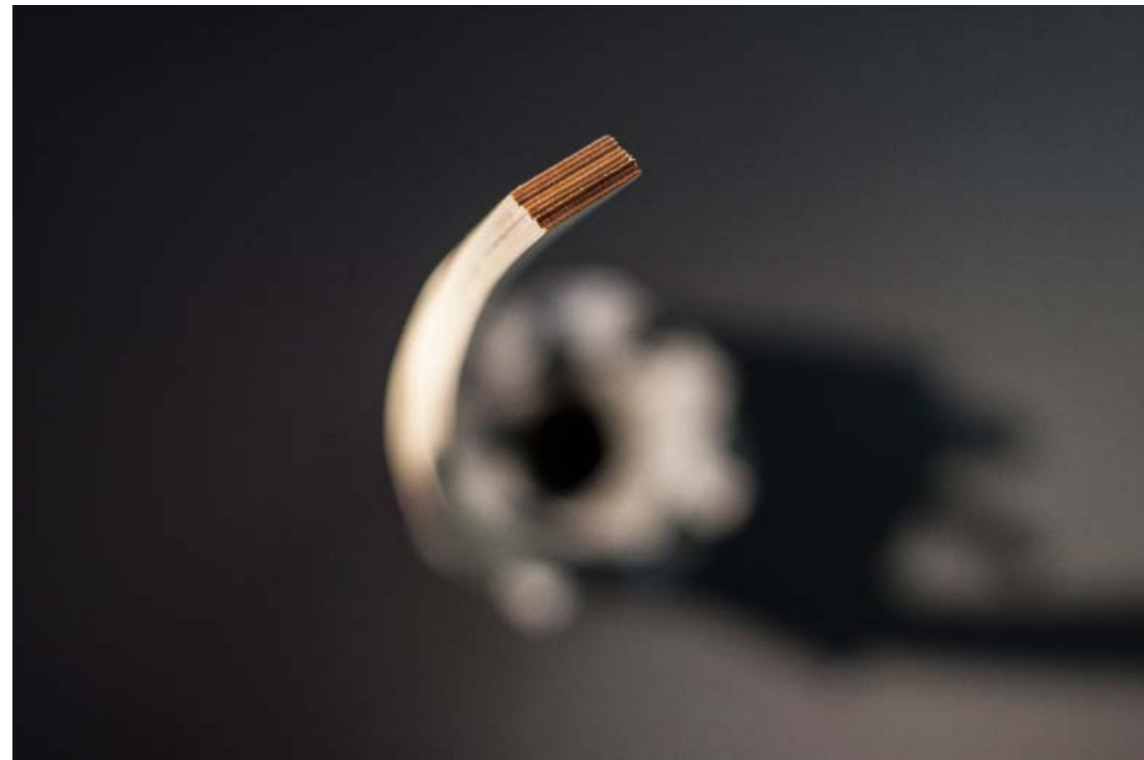
After easily removing the laminated strips from the jig I was able to use a belt sander mounted upside down to refine the edges of the lamination. I then used a fine grit sandpaper to relieve any imperfections.

1. 3D model
2. Flattening geometry
3. Lasercut drawings
4. Gluing and the Jig
- 5. Finishing**



My experimentation has continued and I have been working on a the complex corner timber components. They require a fair bit more work than the other timber components. I have been laminating small strips and then building up layers of larger strips over the top of the smaller strips. the bend on the corner pieces is much more severe and it requires more clamps and precise gluing. This is ongoing.

The laminated timber can be seen perfectly sliding into the groove in the cast hydrastone base.



The laminated timber in its final resting place



OTHER FABRICATIONS

BOWL #1
BEAT METAL

CHILLIDA #3
WOOD CUTTING

TEST PRINT #3
3D PRINTING

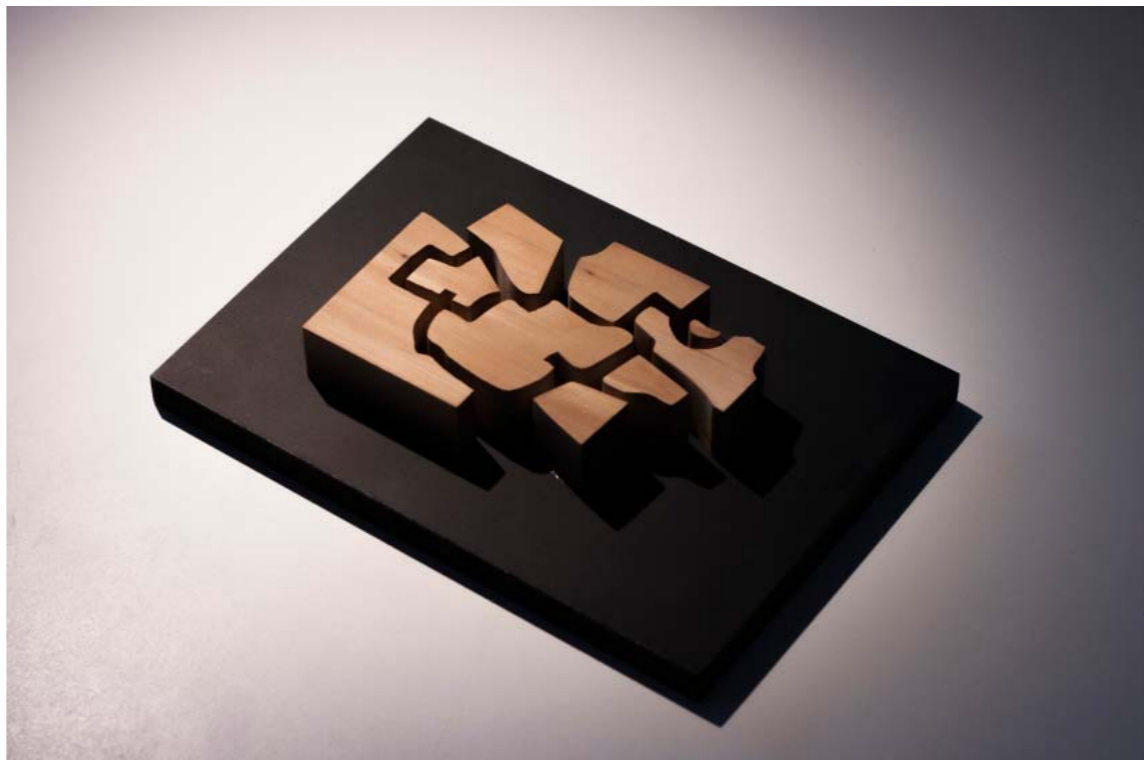
STAND #4
WOOD CUTTING

BOWL #5
CASTING

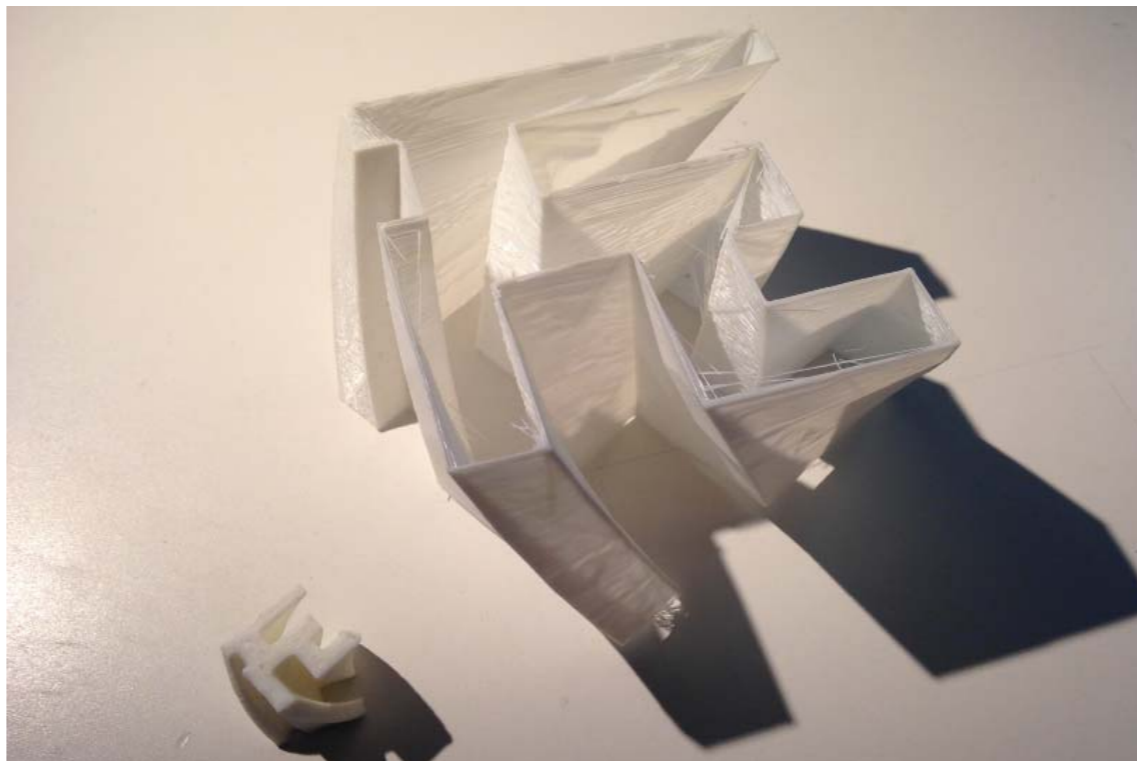
BOWL #6
LASERCUTTING AND WOOD CUTTING



A hand worked aluminium bowl. Originally 3mm sheet aluminium. This was the first time I had ever beaten anything from metal.



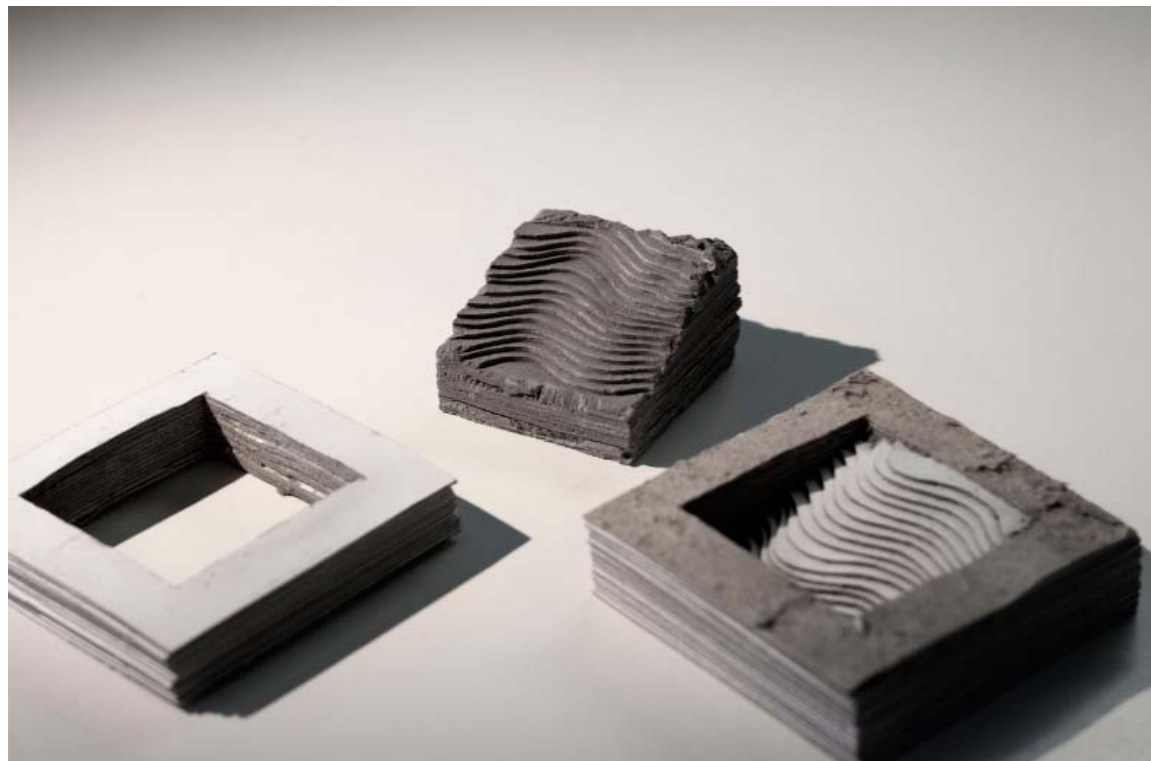
This was a test to see what kind of shaped I could create. I used a Eduard Chillida print as the base shapes for this model.



These were test prints for what became Component #1. I was experimenting with wall thicknesses on the 3D printer.



This was one of the first experiments I made in the workshop. I was looking at how different materials may intersect and layer to create an interesting composition



After originally working with hydrastone on Component #1 I decided to use it for my final year Masters of Architecture design studio site model. This is a small 30mm x 30mm test to see what I can expect for the final result.



This is the first lasercut model I have ever made. All of the new techniques I learned in contemporary fab gave me the confidence to bring this model together. I fabricated this model during the contemporary fab classes as an additional model to complement my scheme in my final year M.Arch Studio.



