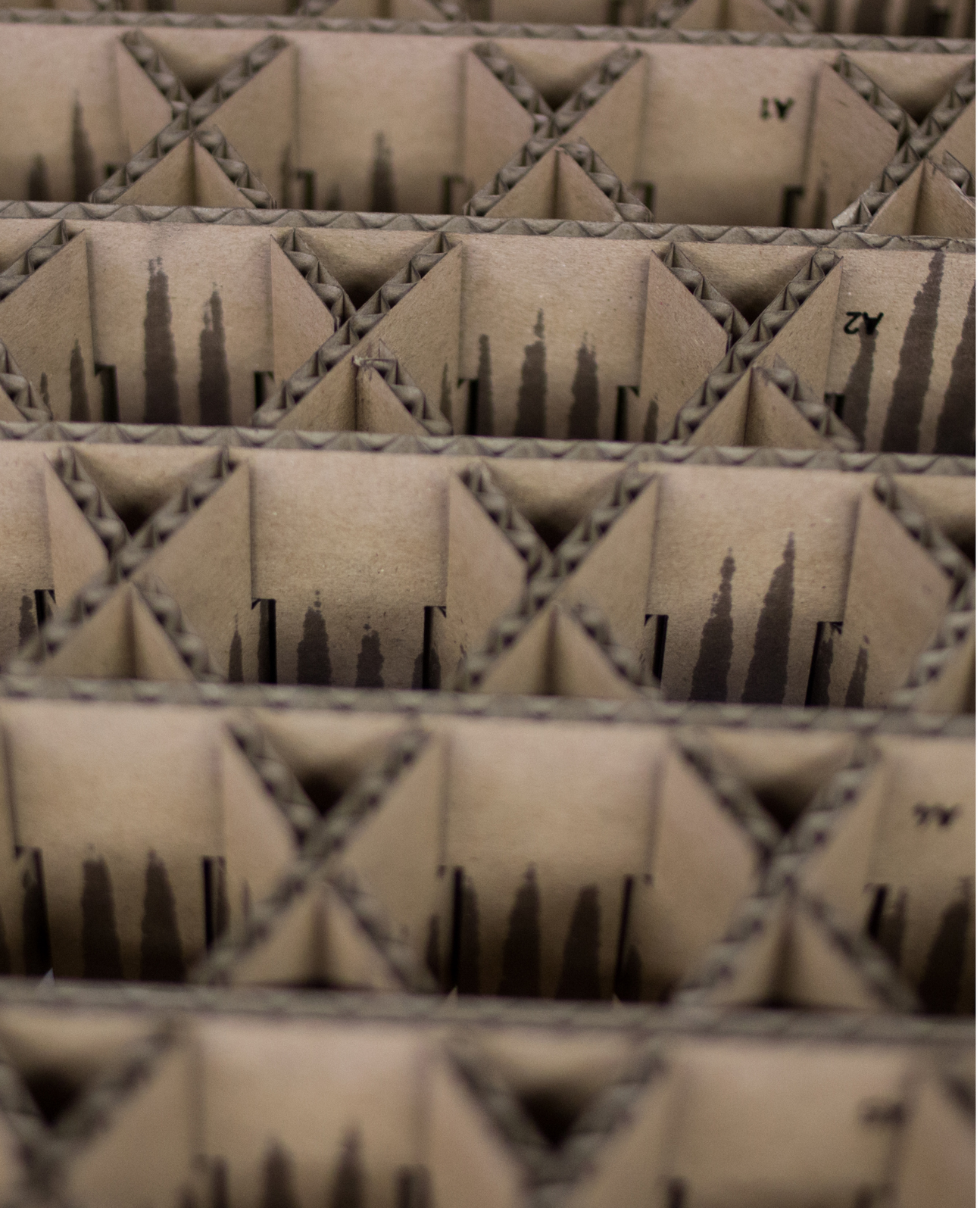
Cardboard and water traditionally are two things that don’t go together very well. When you first think of a surfboard made from cardboard, actually catching a wave may seem really far out. A hollow cardboard core seems unfit in every way to withstand the force of the elements a surfboard is exposed to.

So why would you want to move away from foam based boards? This is a hard question to answer.

Not using the environmentally unfriendly PU and EPS foams definitely is something to consider, but since a cardboard surfboard is still wrapped in fiberglass and resin, it’s hard to really call it ecofriendly. They are also a bit lighter than traditional board and the material coast are a little lower, but overall it’s fair to say that a foam core is superior to a cardboard core on a performance level. But building a high performance board was never the goal with this project. It was all about building your own surfboard, riding a shape that is truly yours and to experiment with unconventional materials along the way.

How does a cardboard surfboard paddle, duck-dive and feel under your feet? Eager to try some new and to answer these questions, we build a cardboard surfboard.



THE IDEA BEHIND SURFING CARDBOARD

We are not the first to surf on cardboard. In fact, we are not even the first at KISD to do it. Finding a cardboard short-board core in one of KISD's workshops is what inspired me to look into the world of cardboard surfboard in the first place.
The first paper surfboard dates back to 1966 when the International Paper Company used it in a TV commercial to promote their new corrugated cardboard. Just watching the commercial it's hard to really make out how this longboard was build and how it surfed. Other than it not being hollow there was not much to take away from this short ad for our project.
Also the second cardboard board we encountered was built by a packaging company to promote their cardboard products.

Unlike the board from the 60's, Ernest's Packaging actually uses a hollow surfboard core made from honeycomb cardboard. Soaking the cardboard in polyester resin they turn the flexible honeycomb into a waterproof and rugged structure that can be shaped with classic surfboard shaping tools and glassed in a traditional way.
But none of these where very influential during our surfboard production.
If you are looking to build a cardboard surfboard you should start with Mike Sheldrake and his Quarter-ISO-Grid surfboards. He was the first (to my knowledge) to use laser cut cardboard to build a surfboard core and luckily he was kind enough to document his work and make it public.

International Paper Company 1966
corrugated cardboard

Ernest's Packaging
honeycomb cardboard

BUILDING A CARDBOARD SURFBOARD

The Digital Part

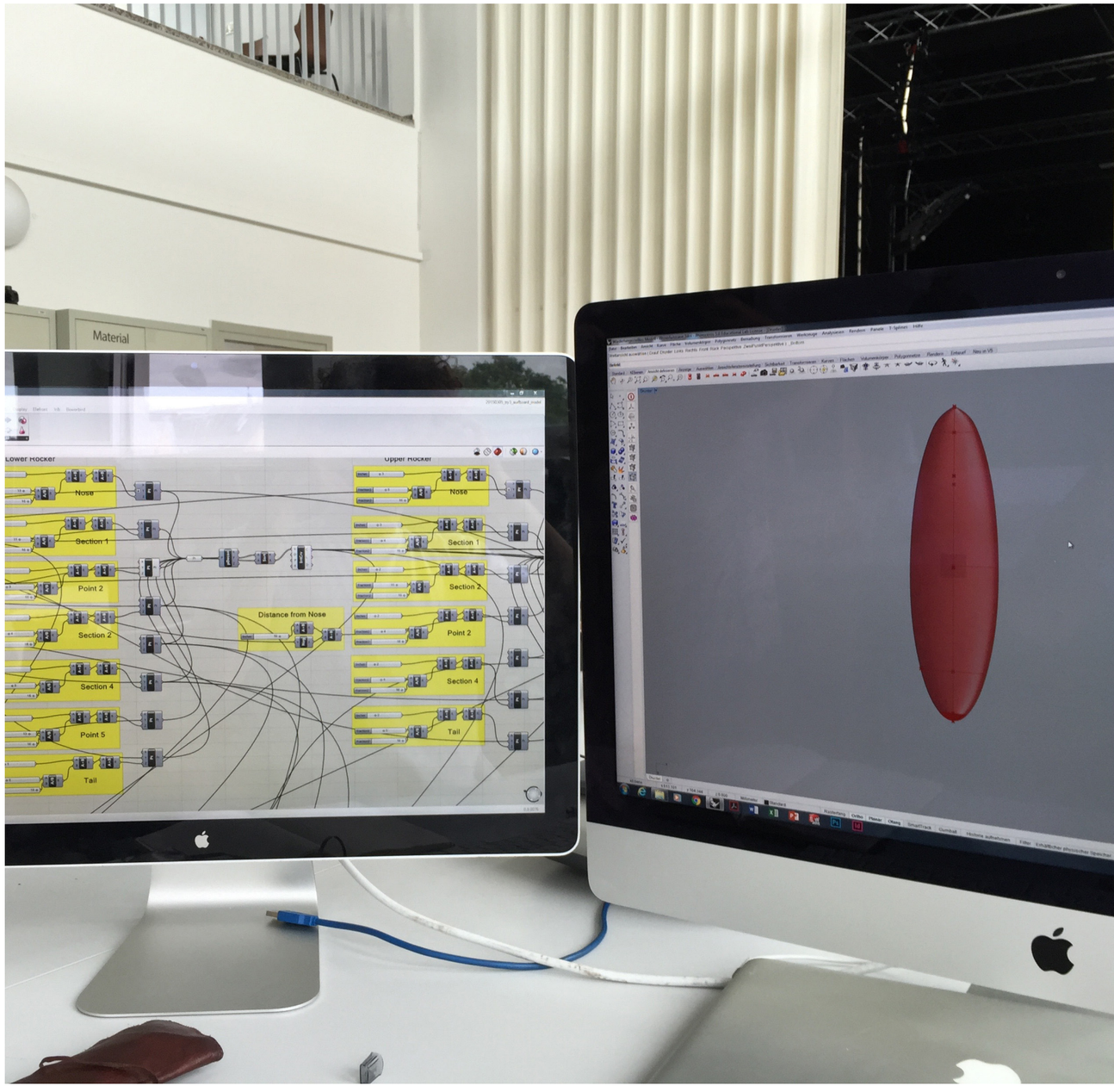
Before you start going out and buying resins, fiberglass and all the other things you'll need, it's a good idea to think of the board you'll want to make. For a surfboard it's all about the shape. Depending on you, your size, weight, skill level and the waves you want to ride you'll have to shape your board.
Those who surf will probably know how a boards shape effects the way you paddle and ride it and there for I won't go into detail on this subject here.
If you never surfed before I wouldn't recommend to start your venture into the sport by building your own board. Start by surfing.

For cardboard surfboards the shaping process is done solely in 3D software and even though CNC milled foam boards are becoming the standard more and more, this still is one of the most importuned things to consider. Once you have laser cut your board it is no longer possible to sand of a little on the rails or the tail of the board. So it's necessary to get your shape just right in software.
To shape your cardboard surfboard there are two options:

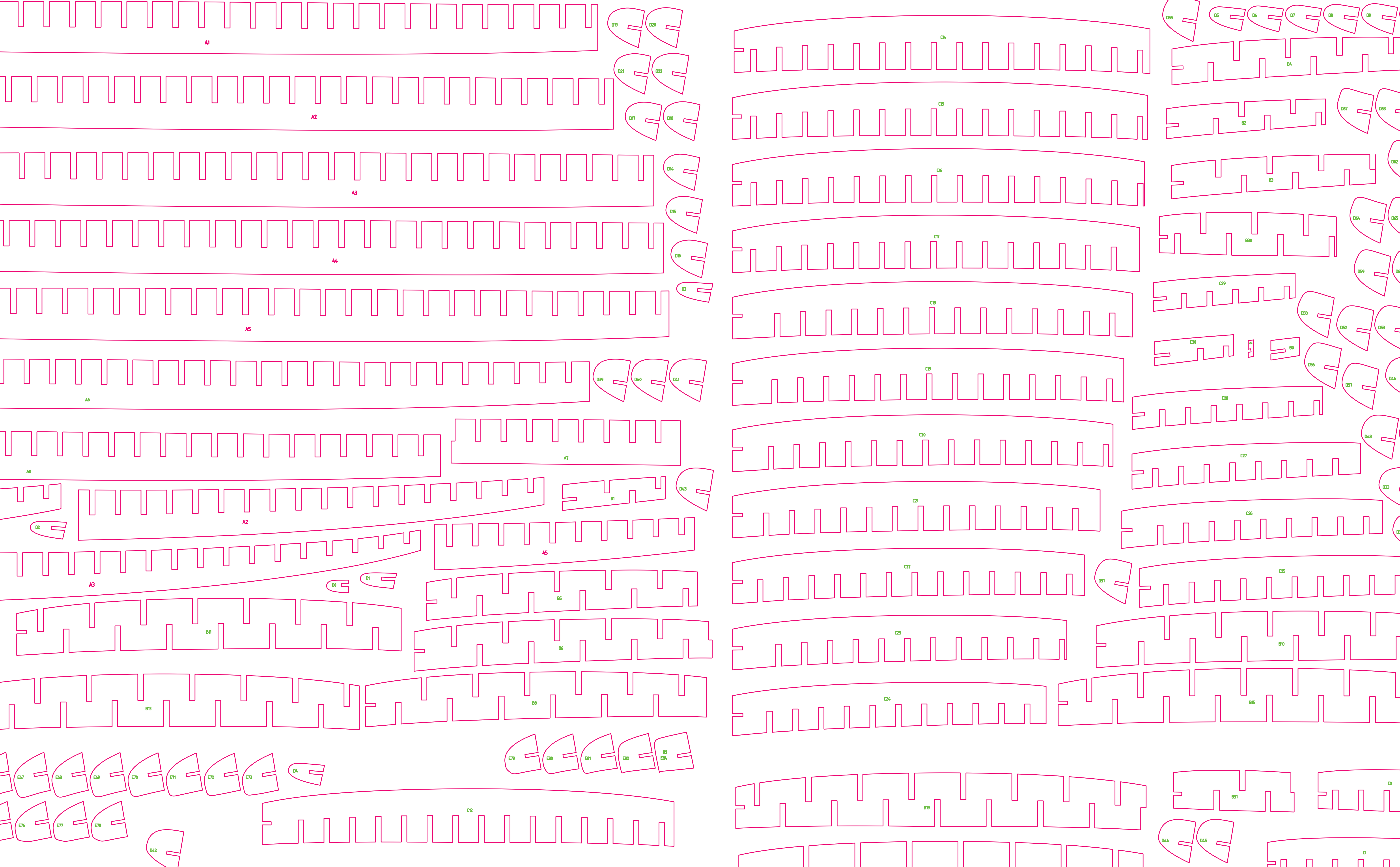
First:
You don't shape! There are a couple board templates designed by Mike Sheldrake available online. If you are not up to shaping your own or if the perfect shape for you is already among theme, you can just download EPS files and start cutting.
We also used altered versions of these shapes for our first boards and if you are building more than one this is defiantly a good place start.

The second option is to shape your board from scratch in 3D software. There are many board-shaping-tools, AKU Shaper or Board CAD just to name a few. These programs are designated for surfboard shaping and provide you with a simple and straight forward shaping processes. Visualizing different board ideas is quick and easy and you can turn a generic short- or longboard into your personal shape in no time. I wouldn't use them to output your final board shape though and here is why.

Board CAD and AKU Shaper are designed for foam cores. The out putted polygon shape is meant to be sent straight to an CNC milling machine. If you want to build a cardboard surfboard you have to process the files you get from these programs further and calculate the cutting patterns by taking a 3D object and braking it down into a 2D shape-grid that you later assemble to create the core. This is very hard to do with files out putted by these two programs.
We tried 123D Make, a software which allows you to break down any 3D shape into a grid structure and create a ESP to laser cut, but unfortunately you aren't able to customize this structure to the degree that is necessary for a surfboard core.
To recreate the quarter-iso-grid structure Mike Sheldrake uses on his boards we used Rhino in combination with Grasshopper and here is where to problem with the AKU Shaper or Board CAD files came into play.
To calculate the gird shape in Grasshopper we used a definition created by Hans Sachs of responsive design. Unfortunately, it is very specific with the board shape you input into it. It only works with a clean closed nurb-structure and not with polygons. Though there are ways to turn a polygon board shape from AKU Shaper or Board CAD into a closed nurb-structure, the result is just too complex and you end up with crashing programs and a headache.
The solution was to shape everything from scratch straight in Rhino, leaving us with ready-to-cut EPS files for our new boards.



Rhino with Grasshopper
shaping process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Before you run to the first laser-cutter in sight, it’s time to you some shopping.
There is more than enough information available on the material equipment you’ll need to build a surfboard and for a cardboard board it’s generally not that different.

Not living next to a big surfboard supplier is not a deal breaker, but it means that you should try to order everything at once before you start with the building process. Waiting three weeks for the air vent to arrive, you forgot to order in the begin, while an almost finished board sits in your workshop is something you should try to avoid.

Shopping

Generally, you’ll need:

Cardboard
We used 4mm c-flute but other options are possible to. Just remember that you have to consider the thickness of the cardboard when you make the 3D model of your board and the cutting files.
Laser cutters also vary in size and so you should consider buying pieces large enough to use up all cutting space your laser provides.

Fiberglass
4oz and 6oz

Resin
When it comes to resins there a many options and for us it was quite hard to choose one. Basically there are epoxy and polyester resins. Traditionally surfboards are made with the cheaper polyester resins, but epoxy is getting a stronger foothold in the industry at the time. Overall epoxy resins are superior to polyester resins because they form a stronger and harder compound with the fiberglass resulting in a sturdier board. Since a cardboard core is a little fragile I would recommend epoxy resin for these kind of boards.

Vents
Since cardboard surfboards are hollow, you will need an air vent that can depressurize the board when it’s out in the sun and the air inside is expanding. Technically a screw that you open when you’re not in the water will do, but I would recommend a self-venting system with a semipermeable membrane. Venting leash-plugs are also a nice option.

Fin Boxes

Leash-Plugs

Respirator
Epoxy resin is not something you want in your lungs. Definitely use a respirator whenever you are sanding, but also when you are working with the resin to filter the fumes. Not all filters do that same thing, so do your research and get one for fumes and particles. For my respirator this was an A2 filter.

Safety glasses

Sander with very soft sanding-pad

Gloves

Scotch tape

Sanding paper

Spreader

Box cutter

Mixing buckets

Brushes

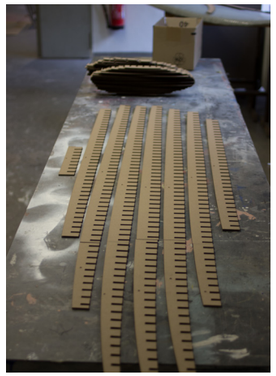
Scissors

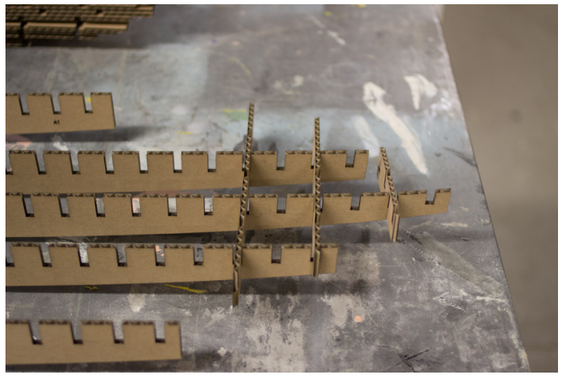
Wax paper

Plastic sheets

Cutting the cardboard

The cutting process in its self is very simple and doesn't really differentiate itself from most other laser cutting applications. Just remember that a plain material level is crucial for the laser to focus, so try to get your cardboard as flat as possible. Tape it down if necessary. To find the right setting I would recommend trail runs. Most laser cutter are powerful enough to ignite cardboard, so always be cautious when using higher settings.



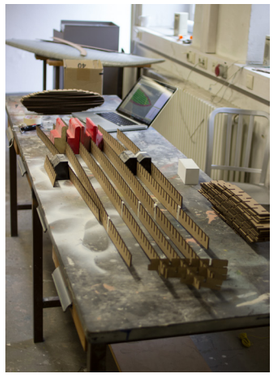


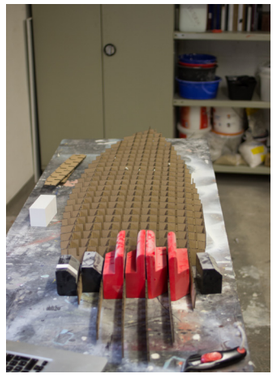
Assembling the core

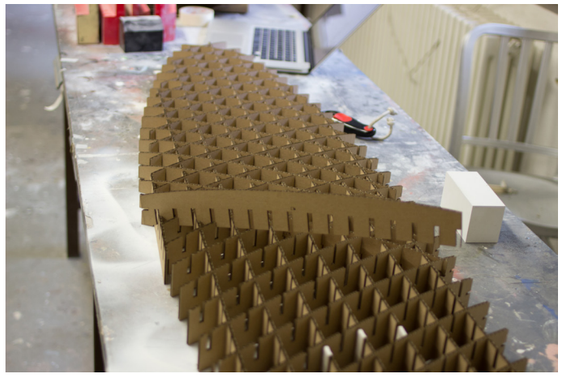
Start by gluing and/or taping the stringer pieces together and lay them out on a table. Since all the pieces are numbered the assembly is pretty straight forward. Before you start take another closer look at the model of the board in Rhino, check where your fist and second piece goes and just finish your surfboard jigsaw puzzle from there.

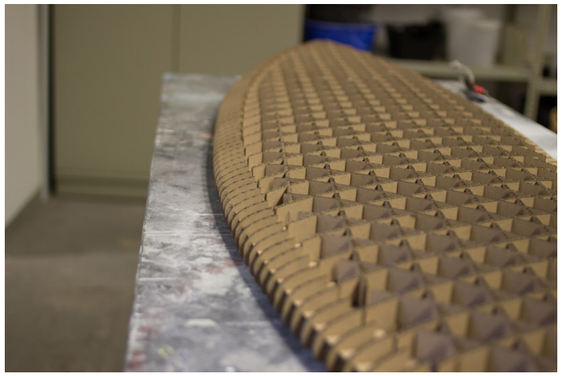
Once assembled the core is still pretty fragile, so handle with care. Make sure that the individual cardboard piece creates an even surface, it best to double check each connection before you apply the first fiberglass layers.

When placing the core on your surfboard stands / racks the core will probably bend a little from the weight of the cardboard. Try to support it by using a third stand or a long piece of wood to minimize this problem. The nose and the rocker will need extra attention here. By placing something under the nose you are now able to influence the shape of the rocker.









Glassing

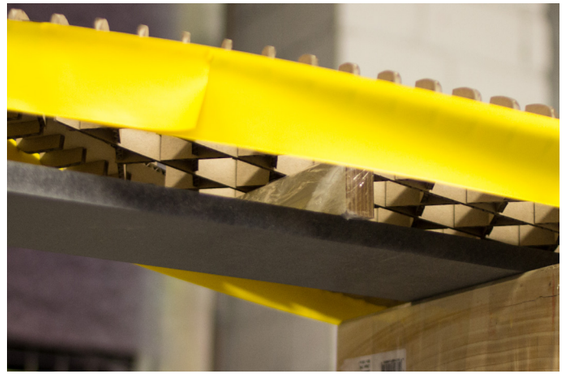
Before you start mixing any resins or cutting up fiberglass, familiarize yourself with standard surfboard glassing processes. If you feel confident, that you can glass a foam board its time to apply those techniques on your cardboard core.

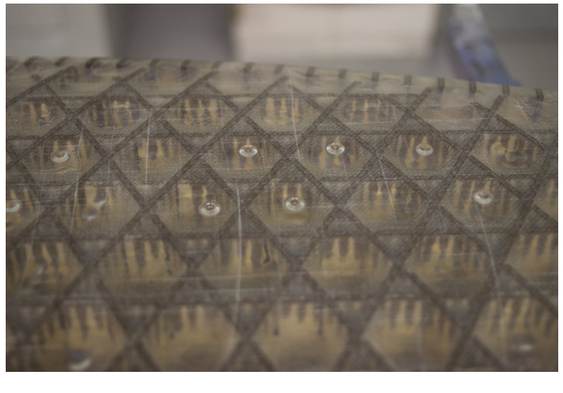
Having a space core or core piece to experiment with is something I would recommend, but if you want to dive in head over heels you can start with your final core straight away.

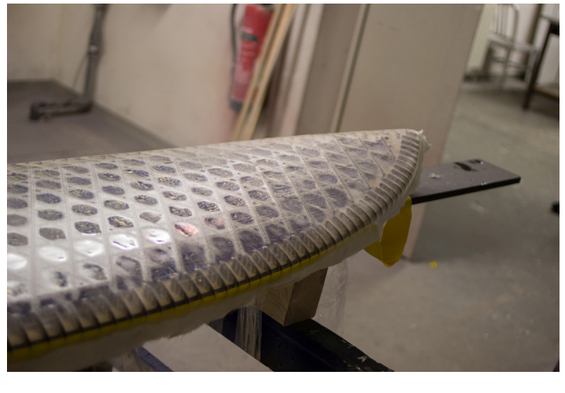
Start by taping around the rails of the board with your heavy duty scotch tape.
Once glass is applied you are going to do a cut lap just above the tape to get a clean edge on your first layer.

Gently pull the first layer (we used 6 oz.) fiberglass over the board. Make sure the surface is smooth and that there are no wrinkles of any kind. Now cut along the side of your board. You want the fiberglass to slightly overlap the scotch tape. Depending on the shape of your board you will have to do some more cuts around the nose and tail. Check glassing videos for this, the process is the same with traditional board.
Once your first layer is perfectly cut and in place do the same for the second.
We use a 4 oz. cloth for the second, but I would recommend trying multiple combinations on a testing core.

Now put on your Respirator and prep your resins.
The big difference between glassing a foam core and a cardboard one is way you apply the resin to the glass. Since your core is hollow you can’t use a spreader and just ‘waterfall’ the board with too much resin. You must prevent the glass from oversaturation, so the best option is to brush the resin on in small amounts at the time.







It will not be possible to glass the howl board with one big batch of epoxy. The resin will get to hot and will stop soaking into the fibers of the cloth and mess up your glass job.
We use small batches of around 50g of resin and 25g hardener (this is for a 1:2 mixing ratio of our epoxy, your mixing ratio might be different so check the canister). Prepare 5 or 6 batches of this size, this way you won't have to spend time weighing the right amount of epoxy and hardener while you work.
Set brushes and a box of gloves in reach and you're ready to start glassing.

We would recommend to always glass with two people, you will have to work quick and having an extra pair of hands that can pull the cloth straight and start mixing the next batch of resin makes it significantly easier get a smooth first layer.

When brushing the resin onto the cloth, start in the middle (where the stringer would be), around the tail and brush the epoxy towards the rails. The other person should lightly pull down the cloth on both side of to board preventing dimples.

If you oversaturate the cloth resin will drip through. This is not necessary a big deal but you should try to keep it to a minimum.

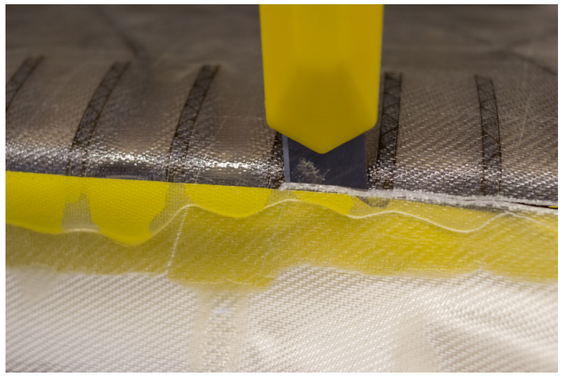
All done? Now it's time to wait and let the resin cure. Depending on your resin time might vary here, so check the resins instructions.
For our epoxy full cure time is 7 days and the flip time is 8 hours. This basically means that you can flip the board after 8 hours and glass the other side.

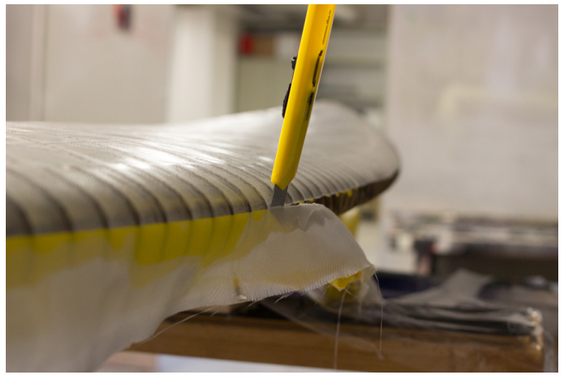
Before you do this though, you need to do the cut lap. Cutting the saturated fiberglass is easiest when the resin is not too hard jet. Cutting after half the flip time is a good indicator, but don't worry if you do it later it will just be a little harder to cut the resin.
Using a box cutter cut just above the scotch tap line, this should leave you with a clean edge on the rails.
Once cured you can laminate the bottom side of the board. This time tape on the top of the board just around the rails. The bottom layers of fiberglass should overlap with the first top layer you just finished.

Overall the process with the bottom layer is the same as the top one. We also use a 4 oz. and a 6 oz. layer of cloth and brush the resin on carefully. The only thing to keep in mind is that you now rap the fiberglass around the rails this time. Cutting the cloth into shape is even more importuned here. If it's to short you won't be able to cover the howl rail, resulting in a not so clean finish. If the cloth is too long gravity will pull the saturated cloth down and it's hard to glue it to the top of the board (that's now on the bottom). Also remember to do some cuts on the nose and tail to prevent wrinkles when folding the cloth.

If done, do the same curing and cut lap process as on the top side.
Always sand of irregularities from the cut lap if necessary before applying the next layer of glass or resin.

Flip the board and laminate one more 4 oz. layer of cloth on the top. This time don't use a brush, just poor the resin on the cloth and use a spreader, like in a traditional foam board glassing process. A cut lap now is optional but I would recommend it.



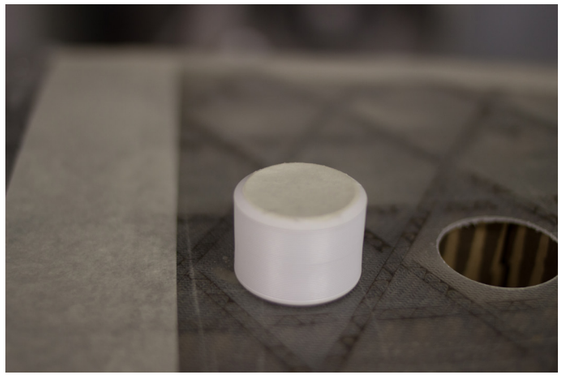


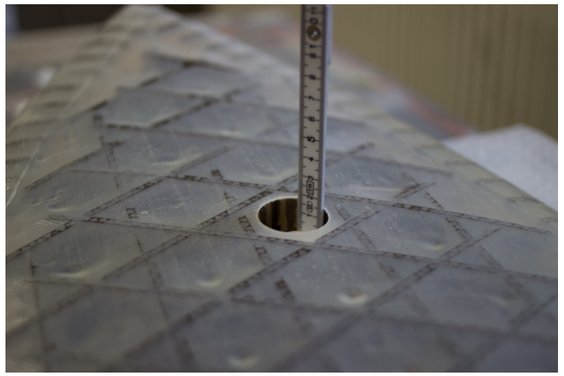
Vent

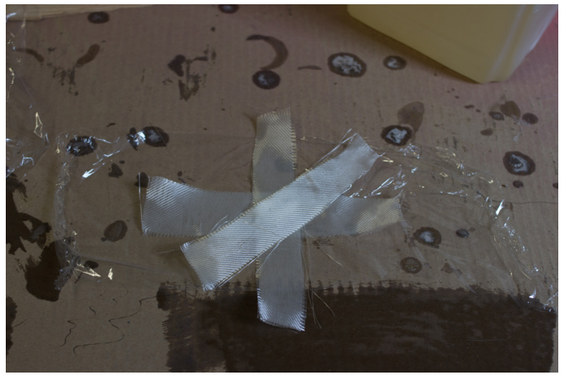
With all the layers of fiberglass applied you should think of where to place your vent. Just like any other hollow board your cardboard surfboard needs a vent do depressurize, when you leave it in the sun and then drop it into cold water.

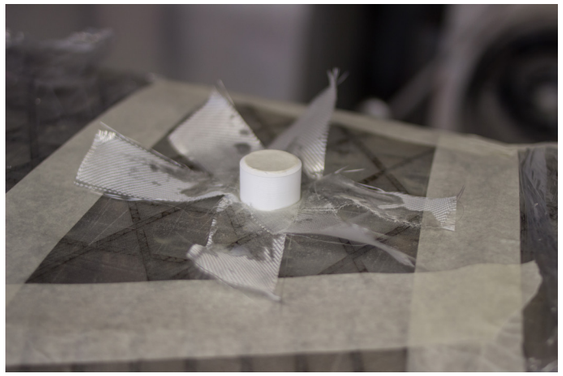
Choose a spot near the nose that is outside the water most of the time and drill a hole the size of the vent there. Measure the depth of the hole and built a support structure that fills the gap between the vent and the bottom of the board. It does not really matter what the structure is made of, it just needs to allow air to pass through. We use a small paper cylinder and punched a bunch of holes into it. Now cut three stripes of fiberglass and lay them out like shown. Glue them together in the middle with a drop of super glue. Tape up the vent and place it on the middle of these stripes. Cut two more pieces of cloth to cover the top of the vent. Before you drop the vent into the hole and onto your support structure soak the cloth stripes with resin and place it under the vent. Then drop both into the hole. The stripes should now stick out on the side, use resin to glue them to the top of the board and place the two cloth patches you cut on top. Saturate everything with resin. To keep the vent in place while the resin is curing you should way them down. Take a piece of wax paper, the resin won't stick to it, place it on top of your newly installed vent and put some weights on top. A bag of sand works perfectly.

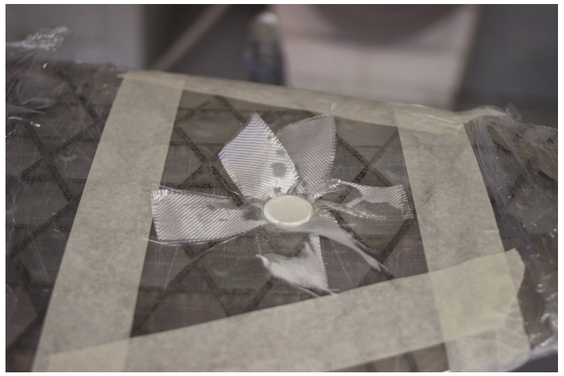
Now let it cure for a least 8 hours.

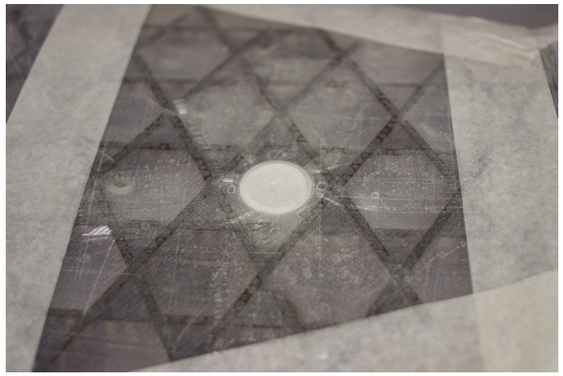


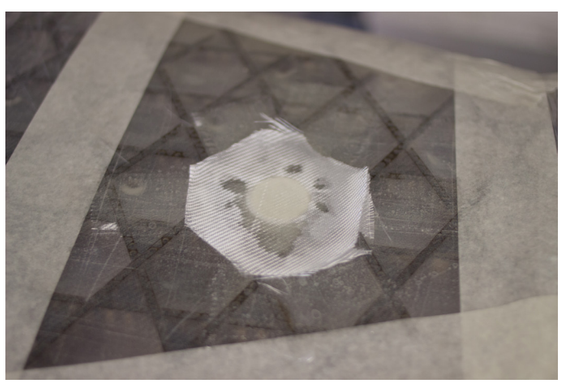


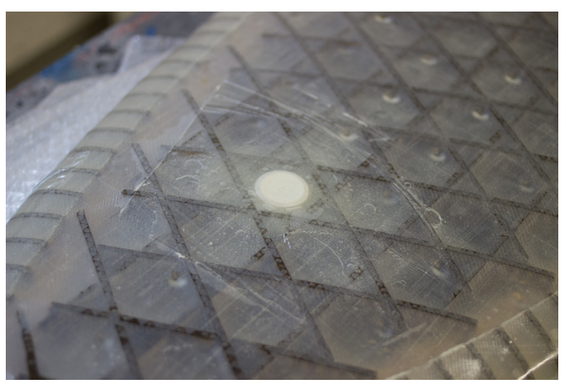






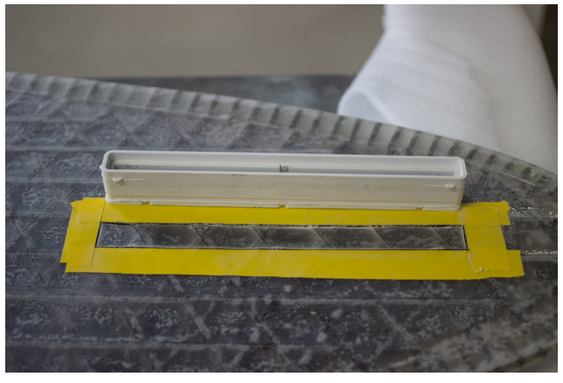




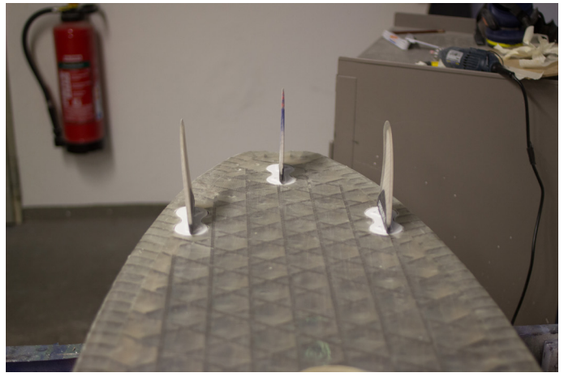


Fin box

Depending on your board setup you might want anything from one to five fins in your new board. We haven't worked with all the fin systems out their jet, but overall the process of installing a fin box of any kind should be fairly similar.
As an example we are going to talk about a single fin US box now.
Right fin placement is crucial, measure the tail of your board to place the center fin in the middle of your board. Depending on your shape the cardboard structure can be asymmetrical without the board itself being asymmetrical. This shouldn't be a problem for your board, but it makes fin placement harder. You might have asymmetrical stringers that will fool your eye so don't just eyeball the fin placement.
Once you are confident that your fin is in the perfect place, mark the position (I used scotch tape) and cut the howl for your fin box. Cut up two pieces of fiberglass to rap the box into, saturate them and push it into the howl you just cut. Have the fin install in the fin box for this process. This way you can check the angles and tape it down to hold it all in place while curing. Just like with the vent installation use wax paper and sand bags to weight it down. Let it cure overnight and sand it to a smooth and even surface the next morning. Very likely you will have a lot of sandthroughs so tape up the box again and add another layer of fiberglass that just covers the arear around the fin box.



Finplacement on the 6,2“ thruster



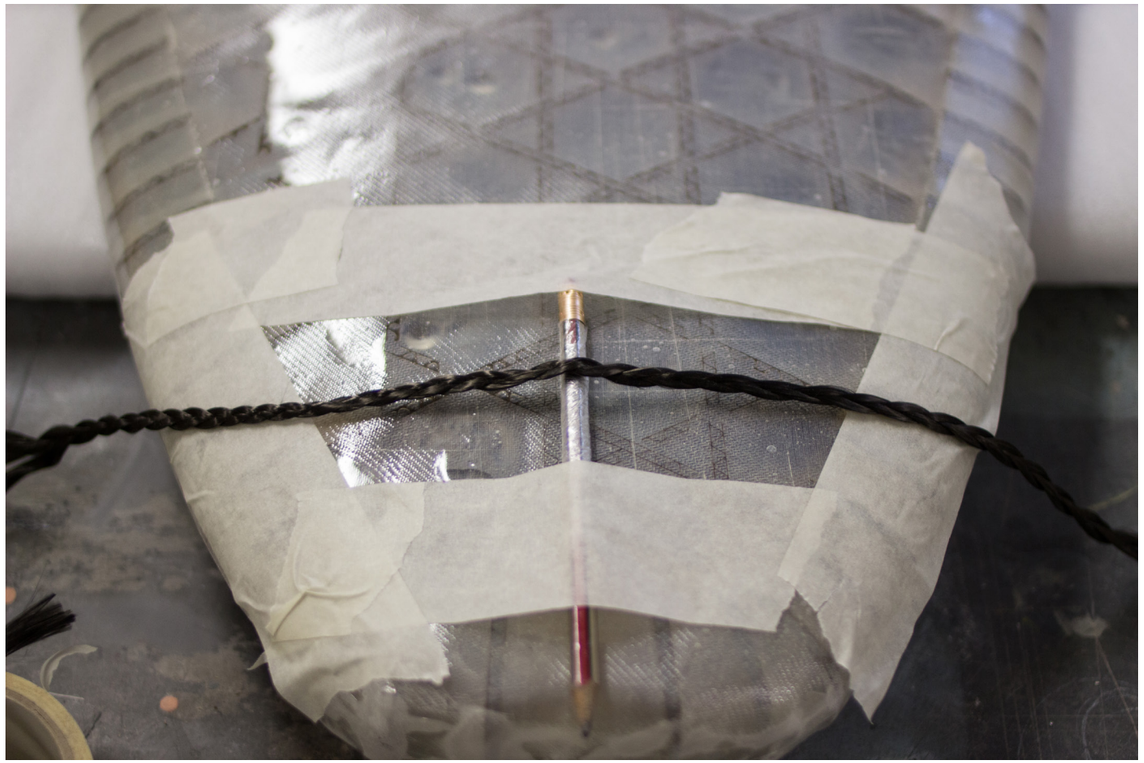
Leash Plugs / Leash Loop

To fix your leash to the board there are multiple option. Most common for most boards a leash plugs. We didn't install leash plugs on our boards, but if you want to, go ahead, the process should be similar to the vent installation.

Since we didn't want to drill more howls into our boards we went for an old school leash loop where you just laminate a loop of fiberglass onto your board.

Instead of fiberglass we used carbon fiber for our leash loops. Its stronger, lighter and we had some left over.

Bread multiple threads together and saturate them with resin. Rap some small stick (pencils are good) in wax paper and tape it to the board. Place the fibers on top and use weights to hold everything in place.



Hot coat

Now it’s time for the hot coat. Tape up the board on the rails and just spread a thin layer of resin over the board. This should build up a little more material and fill in any pin holes that the board might have.

We do two hot coats on top and bottom. This way you can be sure that all the holes are plugged and no water gets in.

Finishing

Now your board is basically finished.
Just cut and drill open the vent and fin box and sand the irregularities.

You might need to post cure your board in the sun for a couple hours and defiantly wait a week or more before taking it to the water.

Surfing Cardboard

Surfing something you build yourself always is a rewarding experience. Paddling out on your Cardboard Board will certainly put a big smile on your face and start numerous conversations with fellow surfers in the lineup. The aesthetics of the board are quite beautiful and whenever there is a ray of sunshine flooding through the board I was amazed by the construction.

The boards themselves are super light and therefore quite nice to paddle. With the 6,2" shortboard catching waves seems a bit easier than with other boards this size, but you do need a solid chest to head high swell to have fun.
Unfortunately, the shape of the board is not quite perfect. The tail is a bit too thick und the rails are a bit too round resulting in slow and sluggish turns. Even in bigger waves its quite hard to generate speed with this board.

In surfing the board, you can tell that we are not experienced shapers and that shaping a board only in software is quite hard.

Building a surfboard is a lot of fun and a lot of work. Looking back, we should have spent more time on the shape of the board and really think about what every single parameter of the board should look like. A few millimeters really make a big difference hear and if you are not an experienced shaper it will be hard to build that ‘magic’ board on your first tries, especial because the cardboard is so unforgiving and you have to do everything right in software.

Building more than one board we could all see big improvements from one version to the other. Working with resins and fiberglass got easier, we got used to the materials, tools and curing times resulting in cleaner, faster and more efficient workflows.
I now feel confident working with fiberglass and resins and also generative structures seem more excess able.