FOILING SuMoth CHALLENGE

Team Solent SuMoth
Representing Solent
University UK

IRIDIUM V2

JGT Projects

Foiling SuMoth Challenge Stage 1 – 2024
Design, Manufacturing & Sustainability

sponsored by

11TH HOUR RACING

Bcomp PERSICO

MARINESHIFT360

Contents Page

Introduction

Off the back of the team having built and completed the 2023 Sumoth it was not certain what would happen next. But after a few months James and Linus discussed the highs and lows of the 2023 project and after a while we came up with an entirely new concept. The concept very much revolves around a thought process of what could we do to make the sumoth as eco as possible. This is quite different to last year; last year we wanted to do something eco but still modern and attract the interest of people in the moth class to show that just because the material is not carbon it can still work. So the concept for this year changes as we switch to making as much effort to make the build as sustainable as possible.

To achieve this we had to pick a strategy of material and build that would reflect this concept. We have committed and built our main hull using timber (wood). Then to minimise the materials and components we are decommissioning our moth from last year (Iridium V1) and will reuse the wingbars, foils, mast, sail, boom and hardware. That is until we find a more sustainable alternative for any of these components which we have been able to do in some areas.

This is the breakdown of our second entry to the SuMoth challenge, we hope to capture your interest!

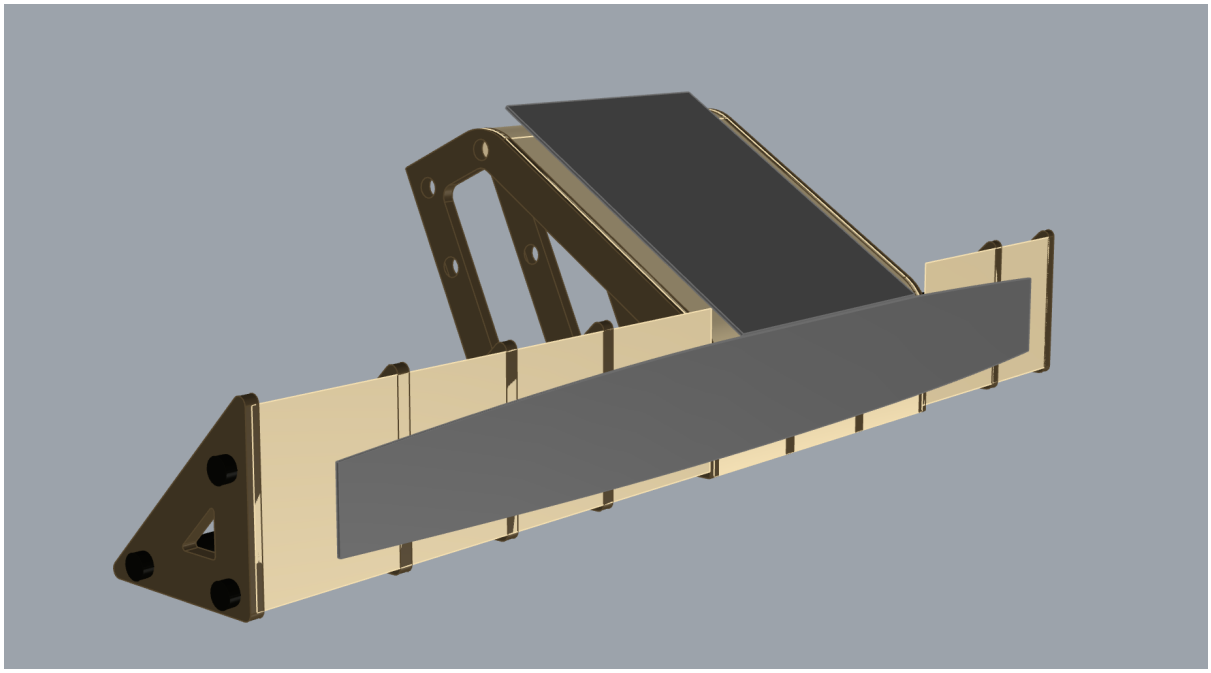
Engineering and Design

Concept.

The aim of the 2024 SuMoth for us is to create a concept which has the potential to win the competition. As mentioned before to do so we set the main material of the project as timber. The real engineering realisation is understanding how to optimise the material to achieve the specification of a moth while not making the structure too heavy.

For us the process started with sketches and discussion. Off the back of last year we took a break and then in November we started to cMonsider what we could do. For our team captain James, the aim to compete again was always the plan it was just a matter of deciding if we used the same concept refined or come up with a fresh approach. With more time on our hands we started to explore options for how we might achieve a more sustainable project.

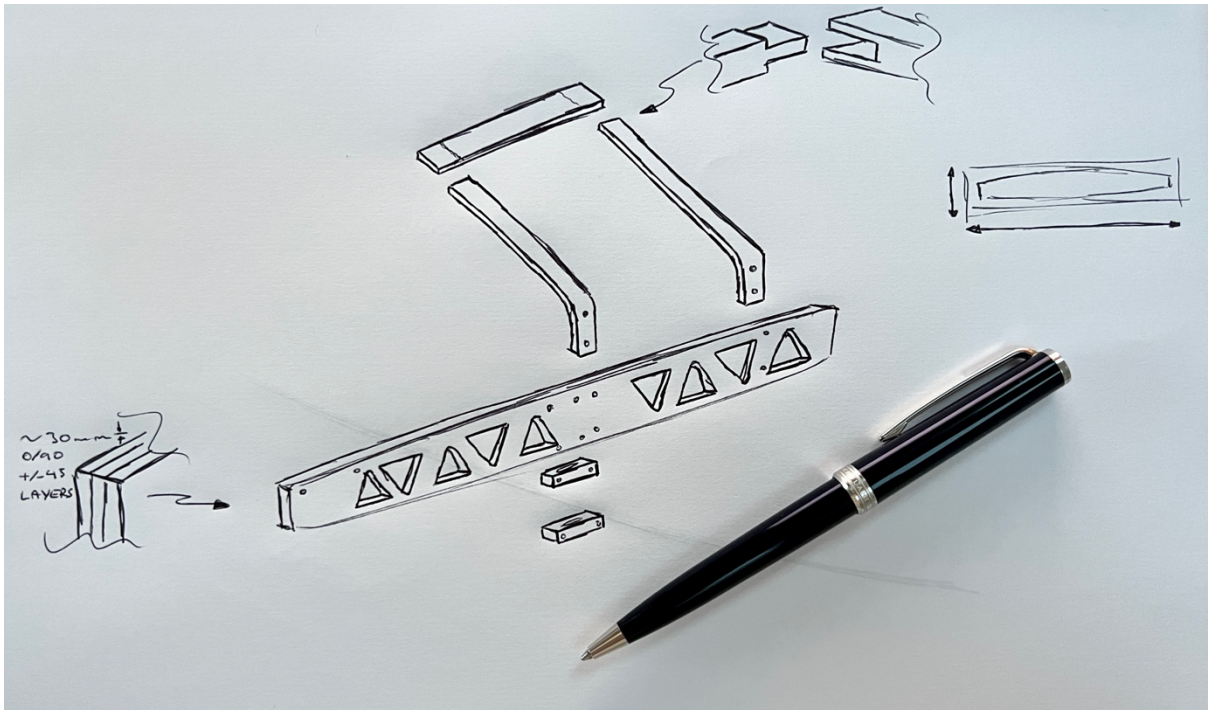
While we are extremely proud of our project in 2023 there were two aspects that we wanted to improve in the new project. The first was to make it more sustainable and the second was simplify the concept. These two factors for us go hand in hand, where by making the project more simple the theory is the less material and processes are required thereby making the project more sustainable.



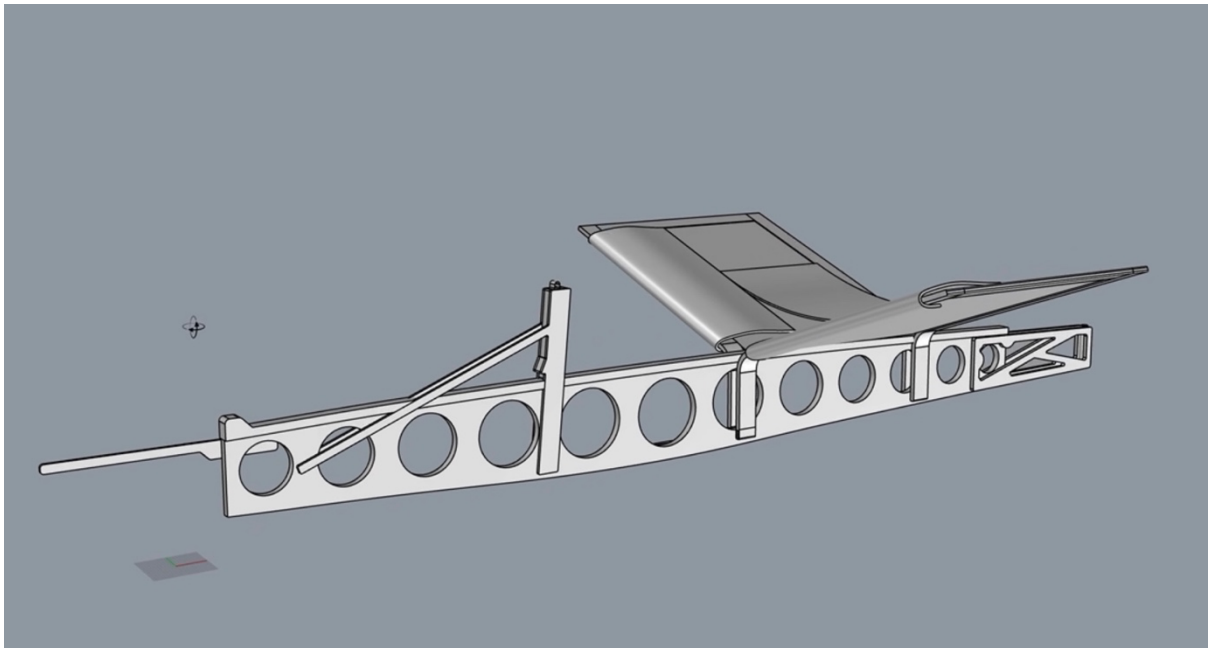
Initially our first concept was quite inventive. The idea here was to take a simplify by taking a single sheet of plywood and using a mould, cold-mould bend part of the plywood over. Then cut away excess material and this would leave the hull outline and a wing, then repeat the process and bond the two hull outlines together creating the 'hull'. This then developed to the wing part of the mould being reduced in size during the process. The render above is the most effective way we can show this process. The idea we feel was clever because we could take a plywood sheet and mould it to our shape.

The challenges from this idea was achieving the strength in the build required and floatation. These factors have not necessarily changed to where we are now, however what became apparent about this idea was it would require a lot of space to be able to perform this moulding and there would be a significant amount of material going into the mould and some being cut away.

After some critical thinking we decided that parts of this concept could work and we could simplify the process of manufacture. What we liked was the idea of the hull outline being two dimensional and a wooden laminate. So the challenge in the design team became, how to achieve a two dimensional outline of the hull that would be able to handle the loading of the moth rig and foils.



Essentially this concept uses a single central longitudinal two dimensional frame, to which all of the components such as wingbars and mast post will attach to uses a very simple attachment of nuts and bolts. Enter then the “flat pack moth concept”. The central frame would have cut outs in areas to reduce weight and we first designed it with some shape to make it more interesting and eye capturing to the moth community. At this stage we wanted to create new wingbars, which would be a simple wood laminate. As can be seen they area where the sailor would sit would be flat and then a single curve would change the angle of the timber and allow it to connect to the frame. There would be a port and starboard wing and all screwing together.

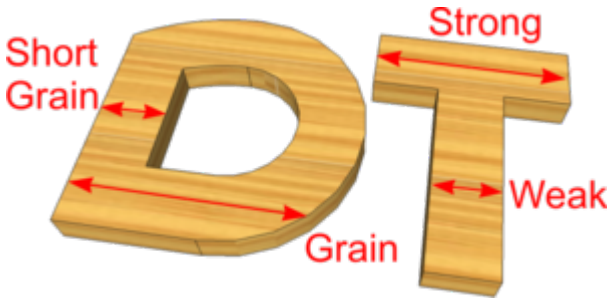


This is a 3D model the team built in Rhino CAD/CAM. Hopefully this gives a more accurate visual aid to what we are trying to describe. As can be seen in this iteration we discussed having

circular cut outs rather than triangles. In add addition are a few more of our ideas emerging into the design, the mast post for instance. The post follows the same design as other modern moths, except it as compression arms forward of it to.

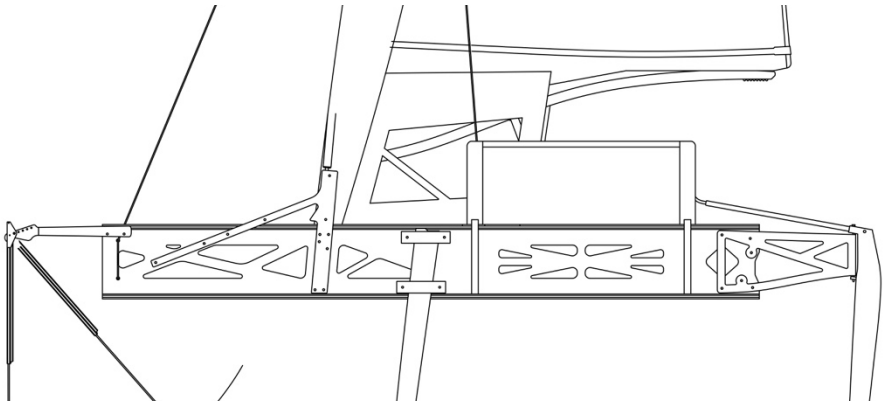
At this stage the design became more finalised. Through the various discussions and different ideas this concept of design is what we will focus on to proceed in a positive direction. Some changes we made. Here can be seen the frame has curvature top and bottom. To simplify the manufacturing stage we decided to make the outline shape a rectangle. Then we needed to asses what the most effective weight saving cut outs would be.

Initially we sketched the design with triangular cut outs. After some research we made this design above with circles. Then after further research with local industry we decided circles would not be suitable. This is because when using timber there would be areas where the short grain of the wood would be positioned between the two circles. This could lead to a weak point when the timber is subjected to loading. We decided to look at the load paths on the moth and where most of the loads are, and then build our cut outs around these.



The final design.

Here is our final design on which the project is built from. As can be seen the hull outline is now a rectangular box. The cut outs are varied in shape and are situated around the load paths of the hull. Then there are hints at other parts of the design which we will go into more detail about.



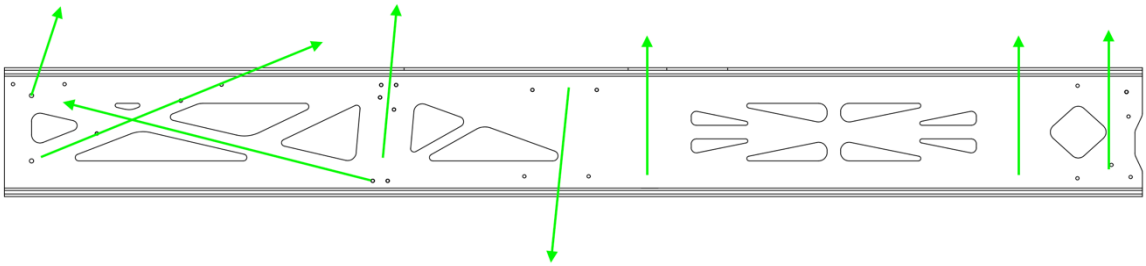
The frame.

The central piece that ties the whole project together. Unlike almost any other moth this design will not have a buoyant hull as we know it. Instead it is essentially a longitudinal bulkhead, which we are referring to as a space-frame. This frame will allow all the components to attach onto it using nuts and bolts. Initially we designed the concept with a single sheet wood material that could be cut to make this frame, after some thought are approach now will be to laminate a couple of layers together to increase the strength of the frame.

The lay up of the frame will consist of 3 layers plywood as described below:

SuMoth Spaceframe Laminate			
Layer	Material	Thickness	Orientation
1	Poplar Plywood	12mm	0/90
2	Poplar Plywood	12mm	+-45
3	Poplar Plywood	12mm	0/90

The idea here is by adding the middle layer at an opposing angle it will help increase the strength of the overall laminate. We are opting to Poplar plywood because it is a very uniformed plywood and has good characteristics for machining. We considered using marine Gaboon plywood which is a stronger plywood, but from a budget point of view we could not go down this route. A typical piece of 12mm thick Poplar contains 8 layers of veneer. Each of these layers are laminated perpendicular and so the sheet itself is already a 0/90 orientation. Therefor when we cut the middle sheet at 45 degrees, half the layers will be orientated at -45 degrees. This is quite useful as it increases the strength of the laminate. It also means our concern for areas that might have short grain is greatly reduced.

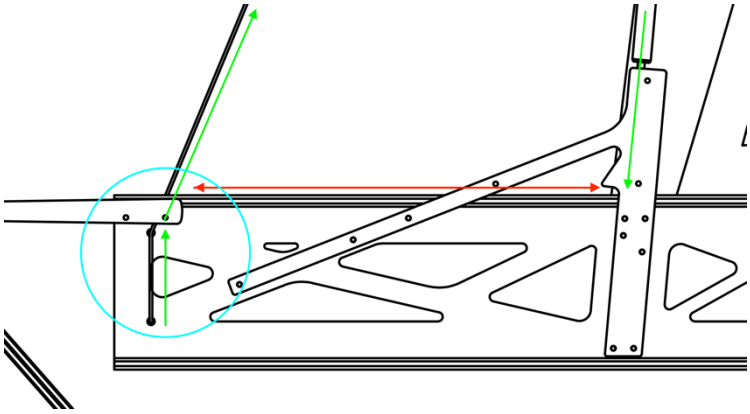


Following the load paths we have come up with this design for the cut outs, which we hope will reduce as much material as possible which maintaining the strength of the frame. The key areas of load (from front to back) are the forestay, the mast post. The subsequent loading between these two components. Where the mainfoil is attached. Where the wings attach and the shroud that attaches to the wing. And finally the gantry which holds the rudder foil. From consulting with Rob Greenhalgh we know the loading the rig puts of the forestay, shrouds and vang are significant.

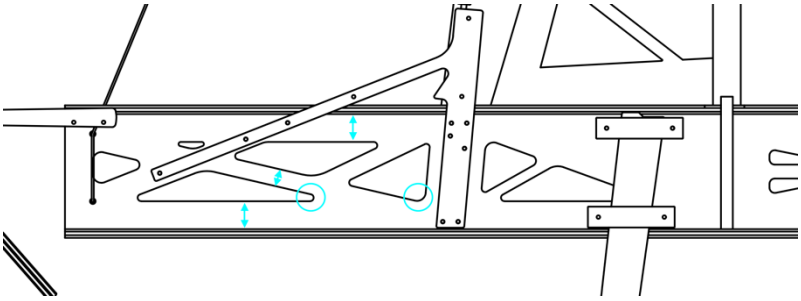
Rig Loads On Modern Moth		
Area	Load	Unit
Forestay	350	Kilogram
Shroud x1	250	Kilogram
Vang	1000	Kilogram

From our SuMoth last year we are reusing our wingbar frame. This is change from our initial concept where we wanted to make new wingbars. After much consideration we concluded there is no good reason not to use these wingbars again. From an eco point of view we made them and we should use them again, and from the moth point of view we know they worked last year and could handle the loads from the shrouds and the sailor. It also will save time in the build.

While the shrouds are not connected to the hull frame, their load is going onto the wingbar and thus pulling the wingbar in an upwards direction. This then put loading on the frame. The vang we know on the SuMoth is not as high as it is on a production moth but nonetheless the mast post will require support. This is why the post has compression arm going forward, and as a result the cut outs are around the strut giving it support. Lastly the forestay bears a lot of and combined with the forestay creates a compression load between the two. We have therefor left more material here and created effective diagonal lines to deal with this load.

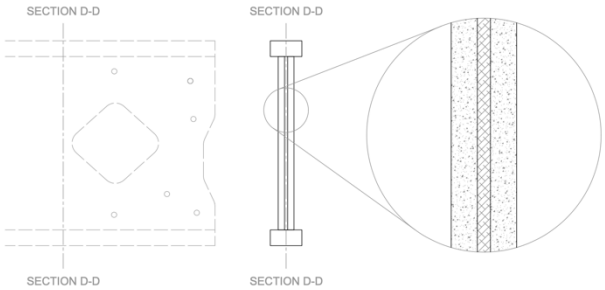


Our design team also came up with an idea we hope will deflect some of the load on the forestay. The idea is to have the forestay attachment point low down on the bow and have a second point above it where the forestay will pass through, thereby deflecting the forestay through an angle and thereby reducing the load.



Deciding how large to make our cut outs was undefined too. We had concerns about cutting away too much material. We discussed this with some local boat builders and decided that the distance between a cut out and the edge of the frame would be 80mm and the distance between cut outs would be 40mm. Then to avoid point loading we added large radiuses to the cut outs.

Lastly on the frame we decided to add a feature that would ensure its stability. To make it into and I Beam. This we feel is a really clever thing to do as in theory it can deal with torsional loading. Initially we designed it as a T section and then after some discussion it made more sense to add the stiffener top and bottom making the whole piece an I beam. This concludes the design of the frame.



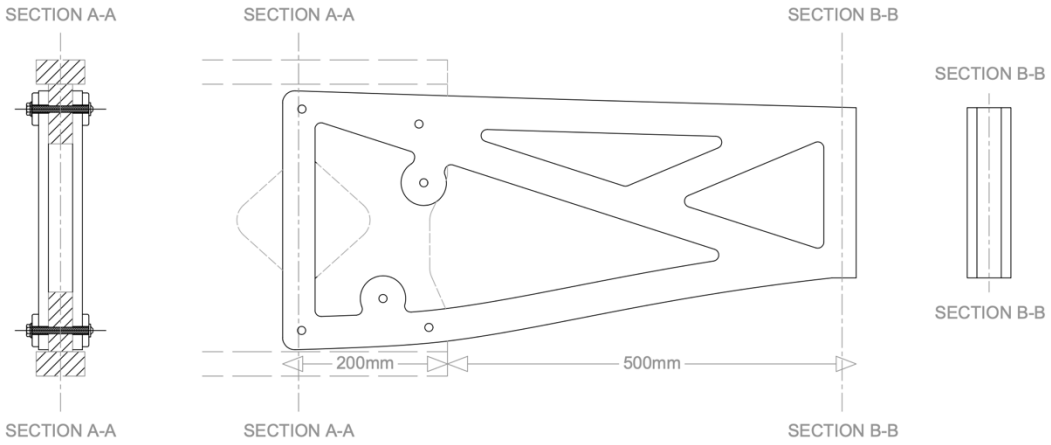
The mast post.

The design of the mast brings together new and old moth design. Earlier moths had foredecks which supported the mast post, and then if we look at the Assassin Moth it had struts instead of a foredeck. Fast forward to a Bieker and the post is supported by internal structure and protrudes above the deck level. This is the same as how we made it on our SuMoth last year. However given that our design has no hull there isn't any space for the structure around the mast post to be attached, therefor we decided to add the compression struts.

These will and the post itself will slot over the top of the frame and bolt through to attach. To make this possible we will make the mast post the same layup as the frame and then add an outer layer to each side so that it slots over the frame.

The Gantry.

In addition to the final design we reveal the gantry design which is not present in previous sketches. We found that by using the design of the frame we think we can quite easily make the gantry attach, unlike last year which was challenging. Between the aft wingbar and the transom is around 350mm. The gantry itself as per the class rules can extend aft of the hull by 500mm and must be detachable. We realised we could make the gantry 700mm long, and the excess 200mm would slot over the frame and be bolted on to contain the gantry.



The cut outs in the gantry also reflect the loading we expect to see. With a large upwards load the gantry needs support in the lower corner where the rudder pin slides through. We also gave it six attachment points to avoid rotation around the bolt fitting.

Foil and Wand.

Because the design is a central frame it presents a challenge for mounting the foil. We therefor decided to simplify the concept again, why not just mount the foil on one side of the frame in an external foil casing? So this is what we plan to do. Create two foil casing bearings which can be attached to the side of the frame and have the mainfoil slide into these. This actually helped because we can then mount the bowsprit to the same side of the frame as the casing and the push rod can run on the side of the frame rather than going through the mast post.

We are very happy with our idea for the bowsprit, as might be seen in the drawing it resembles a guitar neck…which is exactly what we plan to use! In our team we discussed different ideas for the bowsprit, last year for instance we used a broken C Tech batten from a Maxi72 which was the right shape and profile. Initially we were looking at racing bicycle forks but the issue was they were below 500mm in length. When we thought of the guitar neck idea we needed to check the length and we were in luck so the idea was ticked off as something we wanted to design around and make a reality.

Summary.

In this part of our report most of the attention is regarding the design of the “hull” / frame. This is because we plan to reuse almost all components from last years SuMoth expect for the hull. This makes our challenge for this year creating a more sustainable platform to race with!

We also acknowledge that there is little content in the way of “calculations and results” or CFD going into this project. We want to highlight that the type of project we are attempting to complete is not straight forward for making calculations of CFD due largely to the material choice. Part of the team attempted to do a load calculation and analysis based on our material choice. In the end we stopped this approach. The issue is the material. Because wood is a natural material its properties are not defined. Depending on the type, the storage and processing the properties of strength can vary. Despite this we wanted to do two calculations based on a minimum and maximum value, however then ran into issues because we can not

accurately define the strength of the glue line between the layers. At this point we decided for the type of project we are doing our best approach would be to consult with local industry who have helped last year and go off advice from experienced wooden boat builders. We admit there is a chance the moth could be break or be too heavy and strong. We hope that with our research, safety margin and design towards dealing with the loading we can achieve our goal!

Manufacturing and Cost Analysis

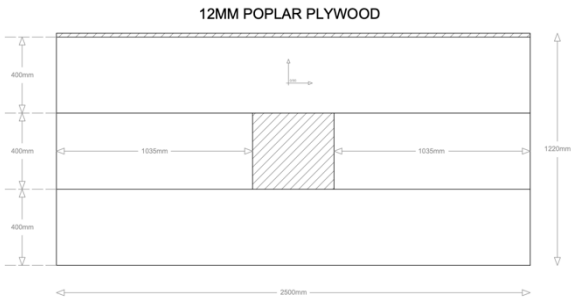
For the manufacture of this moth project we were able to reduce our jobs list because we plan to reuse many of the components from last years project. This meant our priorities for manufacture would be:

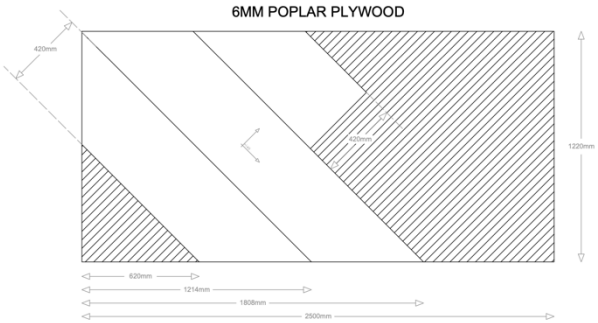
- The hull
- Refining the wand mechanisms
- Adapting our wings to fit the new design
- Servicing all other components

We also want to acknowledge and thank one of our main sponsors and supporters of this project, Yachting Sports ltd, who's advice and access to their workshop have made it possible for us to have a space to build our project. We are proud to be able to work alongside local companies and they have helped us more than they know.

The hull frame.

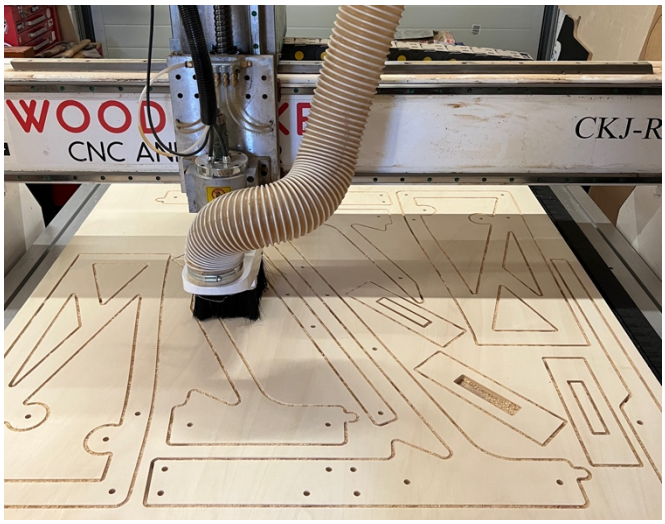
While our design concept was essentially to take a 3 layers of sheet plywood and laminate them together we immediately hit a real world realisation. In the moth class rules the moth hull is 3.355 meters long. We had selected plywood as our main build material as it is readily available in sheet material and straight forward to process. The issue we realised is standard sheet plywood is available in 8x4", or 2440 x 1220 mm. This meant that the sheet would be 915mm short. Nothing we can so about this, so we decided to proceed, cut the sheet to size the max length and then using a lapping join and extend the length of the plank.





We were able to design the cuts on CAD and then run the sheet through a table saw at the wood shop to get our planks. At this point we hit another small unexpected issue, when we bought our material the shop assistant made and error and one of the sheets of plywood was not the same thickness as the others. This we noticed after the cutting and decided to continue. The same principle for the laminate remains but the middle layer will be thinner.

Back in the workshop we used a router to reduce the ends of the sheet to half thickness to create the lapping joinery. We broke the gluing together part into two stages to reduce error. First we glued the joins together for each of the three planks, and then the planks on top of each other. This left us with a plank of plywood, three layers thick, laminated together 3500mm long and 500mm wide. The final thickness of the frame is 30mm.



Locally we found a company with a CNC machine called Woodpecker CNC and Laser Cutting. They very kindly offered us a heavily discounted rate and we decided to use this approach to cut our frame out from the oversized plywood laminate. One challenge here was that the bed of the CNC was designed to fit the standard size of plywood. Using two reference points we were able to cut half the shape with part of the frame overhanging the CNC, then rotate the frame and cut the rest out. This process made a lot of sense to use as it is much more accurate than us cutting and the time much quicker. We kept the offcuts for future use in the project. We also cut the mast post and gantry parts out with the CNC machine. This involved cutting five of the same component and later we will laminate them together.

This was a really interesting moment because at this stage a lot of work is suddenly completed. After a lot of time designing the shape in AutoCAD everything was cut in the space of an hour. We were able to send our AutoCAD file and this was directly inputted into the machines software. We spent hours double checking all the screw holes were in the right places and they matched on the external parts such as the mast post and gantry.

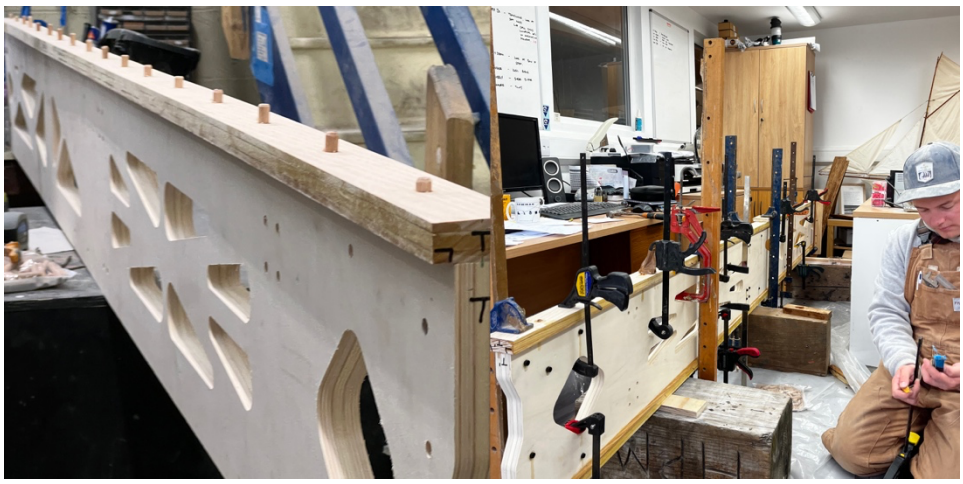
I Beam.

With the frame cut out the next stage was to make the whole piece into an I beam. The purpose of adding the plank top and bottom of the frame is that the grain of the plank will be 90 degrees to that of the frame, thereby stiffening the frame in side to side or torsional loading.

At this stage we changed the type of wood we were using in favour of something to add more strength to the frame. On a local farm we bought a large piece of live edge Ash. The plank was four meters long and 55mm thick. It was extremely heavy but has the potential to provide a lot of material to be used in the project.

Instead of cutting the plank into two beams we added an extra step. Our concern was that over time and temperature change the wood might warp. Our local wooden boat builder recommended a method to counter this. The process was to cut the plank to the width we want. The thickness was set, then when cut we rotated the new plank 90 degrees and cut it into 3 equal thicknesses, giving us three strips of 70mm x 15mm and 4000mm in length. We used a thickness plane to make sure all three strips are the same thickness. Paying close attention to the planks we cut we glued them back together, the difference being we rotated the middle plank 180 degrees. The idea here is counter any warp by having the middle plank upside-down. Once glued back together we made sure the edges are square and the overall thickness is the same. From the dimensions written above, the final plank is smaller. We repeated this twice since we are adding two planks to the frame. The process takes a bit more time but should ensure that the boat will last longer.

To attach the planks to the frame we use a combination of glue and dowels. The dowels are used both to locate the planks for attachment and add some strength. Using lots clamps we could secure the planks to the frame in one hit.



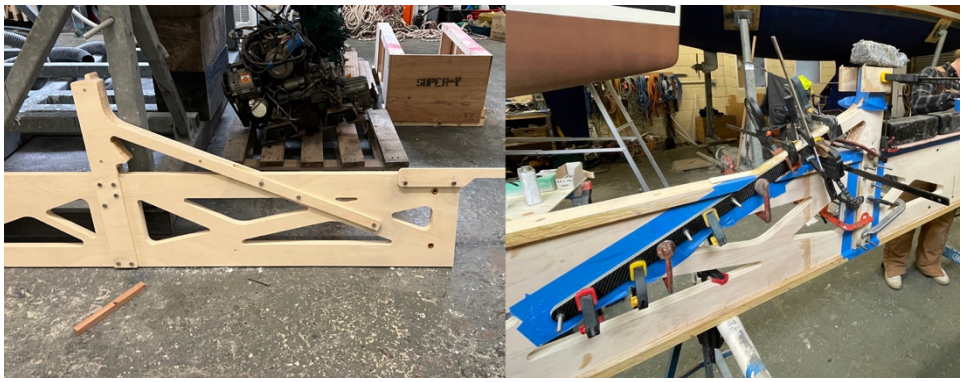
Finishing the Frame.

The frame at this point as unit is complete, then there are following processes required to finish it. These include:

- Attaching the mast post
- Rounding off edges
- Adding the “deck”
- Making knees for the wingbar frame
- Sealing the frame

Mast Post.

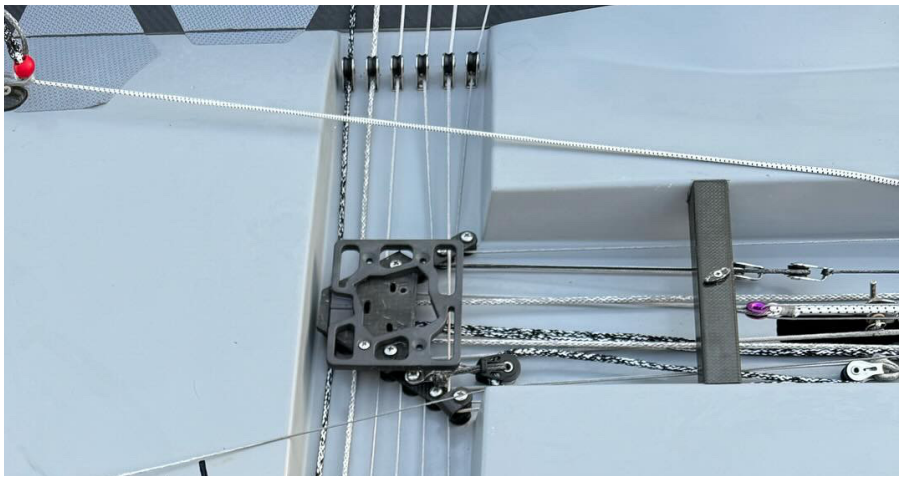
The mast post was its own project, but not complicated. Following the design of the post we had cut on the CNC. We cut three layers to match the thickness of the frame and two additional pieces on the outside. These were then glued together. On the frame the plank on top is wider than the frame, so where mast post slots on we had to cut a channel for the post to fit into.



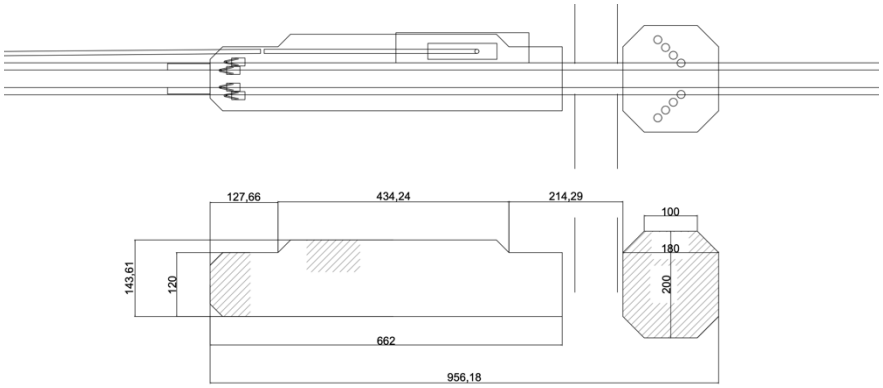
After much debate we decided to bond the mast post and the arms to the frame. Initially the plan had been that the piece could be detachable, however we were concerned about the strength of the post. For this, the initial concept of the idea, we decided it would be sensible to bond it and make the piece permanent and then be able to test it and review if that is necessary or if the post could be detachable.

The Deck.

One issue with the width of the frame being so narrow is there is no deck space. The design team reviewed this and we decided to add a wider area of wood that would be the deck area. The design reflect the width required for the ropes to sit on, and where they need to run to between the mast and deck organiser.

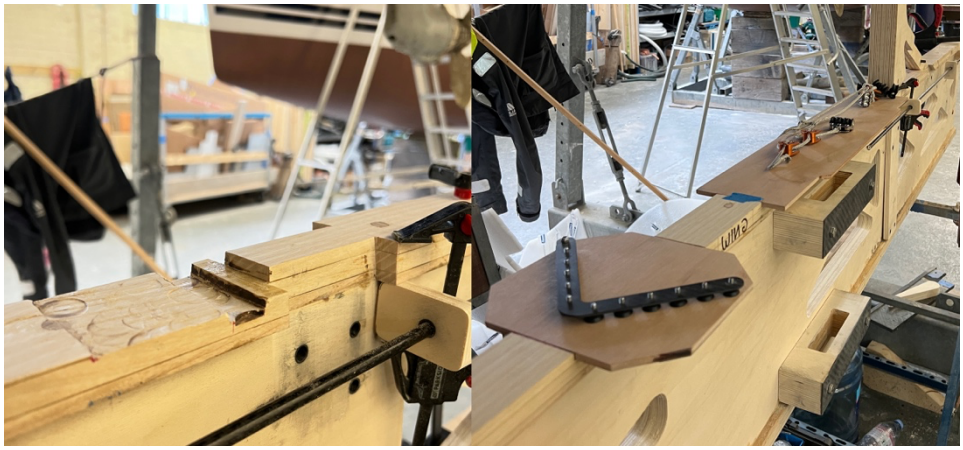


We reviewed different existing moth designs and decided to follow the design principle of the Aerocet. Last year we designed our own system completely, where the ropes cam down from the mast, along the deck to a deck organiser, up to the wing, then back to the organiser and aft in a take up system. This idea was really innovative and even now we can see the V3 Bieker is using a similar design and some of the SuMoth teams! This time though we wanted to do something different, and with the parameters of the design we could apply our previous design but it would create knock on issues. Therefor we favoured following what Maguire have done on the Aerocet, where there is a deck organiser and the take up system runs inside the wing. The only difference is the because we are using our wings from last year we have to adapt how they attach to the hull.



Because the design of the boat has no deck, there are no recesses for the wings to sit in. they are supported by knees, which will be covered later. Essentially the challenge here is to get the ropes to run along the deck to the deck organiser but somehow get around the wingbar which also sits on deck level, effectively blocking the ropes getting past. Our solution is very simple, we have made a port and starboard shim to sit under the wingbar. This raises the front wingbar 10mm and the middle is a gap for the ropes to run through, underneath the wingbar.

To make the deck we decided to use sheet plywood of 4mm thickness, and in the areas where the blocks and deck organiser attach we added a carbon plate backing to support the load. To attach this to the hull we used a router and reduced the thickness of the top plank by 4mm and then bonded the deck onto the frame. Before bonding we had to attach the turn blocks at the base of the mast because this would not be doable afterwards. Linus spliced the blocks through the plywood and carbon plate and then it was ready.



The deck organiser itself is very similar to the design of the Aerocet. We have six sheaves on each side, with the potential to fit all the systems such as:

- Vang
- Cunningham
- Wand Length
- Gearing
- Wand Elastic
- Ride Height

A lot of controls and we are not sure we will do all the wands controls, but still nice to have the option and not need to retrofit things. Through the plywood we drilled holes in a template,

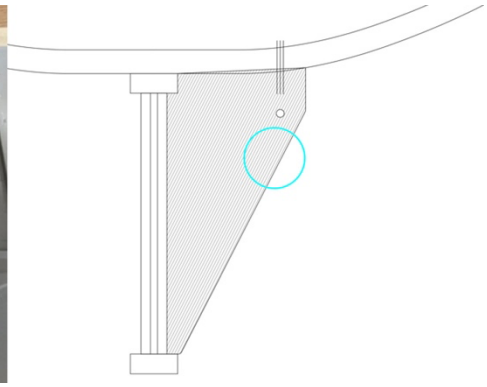
then the sheaves simply sit on M3 bolts which go through the top piece and the nuts hold it together. The sheaves we were able to reuse from last years SuMoth.

As a later addition, when rigging, we realised we needed a better lead for the rope going from the deck organiser to the wingbar. Again the design team had to think of the challenge because we lacked space on the deck we cut to add any fittings. The solution was to add additional area that we could attach some leads onto. Under this part of the deck is a carbon plate, using more plate we could bond carbon to carbon and maintain strength and then attach the lead to this. This worked very well in the end and the ropes run with little friction. This largely completes the process of making the deck area.

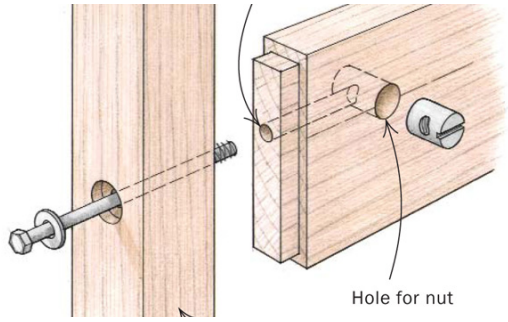
Wingbar Knees.

The wingbar attachment is briefly mentioned above and here we can explain a bit more detail about what we have done. Initially we planned to have the attachment of the wingbar vertical, then once we decided to reuse our wingbars we needed to come up with a solution to attach them because they attach horizontally.

The solution involves using traditional wooden boat building methods with some modern adaptation. In wooden boat building it is very common to see a “knee” being used to support two perpendicular beams. The knee is easiest to liken to a right angled shelf bracket. We decided we could use this approach to have the knee attached to the side of the frame, and on the top of it allow the wingbar to attach. Effectively increasing the beam of the hull.



Again there is a potential here that short grain of the wood could become a weak point. So instead of taking a piece of wood and cutting at 0/90 degrees, we designed our cuts so that the long grain of the wood follows the longest edge of the knee. Therefor where the wingbar attaches at the top of the knee, the grain will support the knee when under pressure.



Last year we followed the Bieker design, where the wing attached at deck level with a carbon shim that goes over the wing and is held down either end with a bolt. This year again material thickness is a constraint. To attach our wing the knee we decide to use barrel nuts in the knee and have one central bolt going through the wing into the knee (on port and starboard side of each wing). The barrel nut is usually found in Ikea furniture for example. What it is a rod of steel that slide into a drilled hole, and in the rod is a thread. The bolt then goes down through the surfaces and screws into the thread. When loaded the barrel nut pulls against the material it is captured in, somewhat similar to a sailing dog-bone. For the wing this is perfect as the wing pulls upwards and the barrel nuts pulls against the material of the knee.

Four knees were made. We marked out carefully on the frame where they would go and used dowels to position them and bonded them on with glue.

Preparation for Varnish.

Given that this is a largely wooden project it will need sealing before it can enter the water. Before doing this the team took on a lot of work to ensure readiness. Last year we varnished our wooden wingbar frame with six coats of varnish and even with this, by the end of summer the varnish was cracking after significant UV exposure. One of the key things we needed to do to ensure the varnish would bond well to the wood and not crack was to round off all the edges. The process is straight forward enough with using a palm router and a radius bearing bit, however it still took a long time to complete the process. Then in addition we had to complete a secondary finishing process as the bit was not 100% sharp and left burn marks on the wood.

Sanding the whole frame was good to do because at this stage it gained marks and dust during other processes. We sanding off the burn marks and got the frame to a level we feel would provide an aesthetic finish.

Next we taped up areas we did not want Varnish and then chose our varnish system. At this stage the frame is completed.

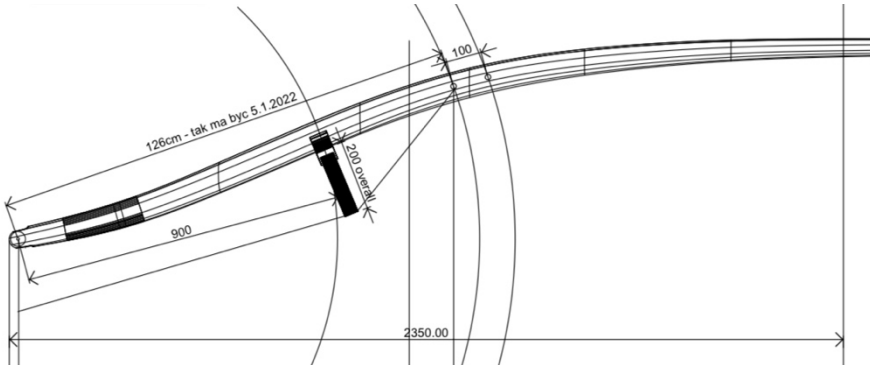
Additional components.

A moth is not just the hull. There are lots of components that are essential to making a moth work. We were fortunate to be able to reuse a lot of components from our project last year, most of which were still all good and some which needed refining. These include mainly two:

- The wand
- The boom

The boom.

When we started the project we set out to complete the concept as described above. We had our rig from last year which we know worked. Then during the build we started to critically think about some of our components and analysing what we could make more sustainable to make the project more viable. The boom became a new project we decided to make better than what we had last year.



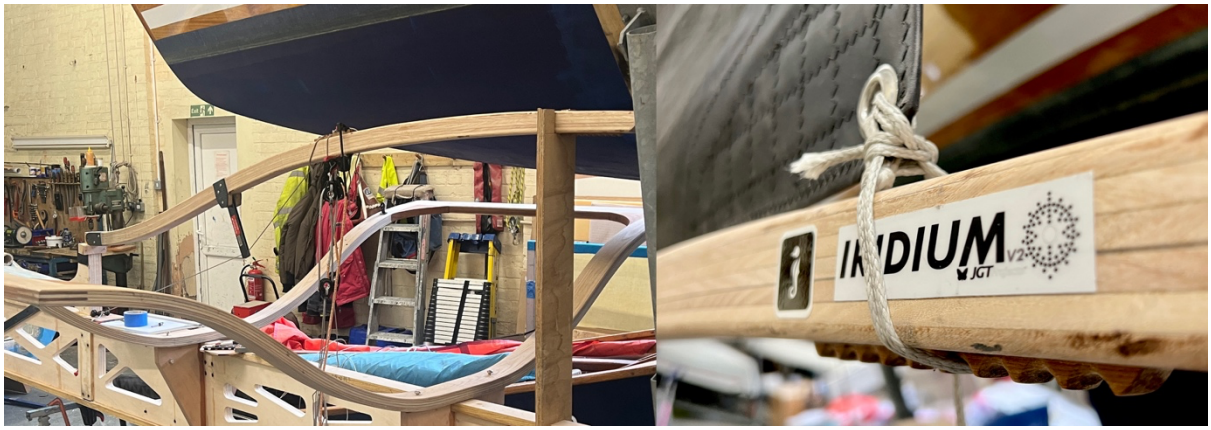
Very similar to the wingbars, we realised we could make a boom by laminating strips of wood together. We still had left over material from the ash plank and this is what we used. We made the boom in five days. First the design team designed the shape. Moths have the kinked boom which usually is two straight edges connected by a 12 degree curve. The producer called Exploder make a boom that is a sweeping curve, and we decided this shape was more organic for the method of bending wood laminate. Exploder provided us with a drawing and we were able to follow the shape in AutoCAD and cut our mould to the curve.

The mould is a simple male mould, and the method of production is to cold mould bond the layers of ash together on top of the mould. Similar to the planks on the frame, we cut the width of the strips we wanted from the ash plank. Then rotated it 90 degrees and cut it into 6mm thick planks. We then planned them and got a final thickness of 4mm per plank.

We aligned the mould to the edge of the workbench and began laying up the laminate. Then with a great many clamps secured the laminate leaving it to cure. When we demoulded the piece there was a tiny bit of spring-back but not noticeable. Unlike our wingbars, which have a carbon layer between each plank, this boom is just timber layers. Once demoulded we put the boom through the planer again to get flat parallel edges. Then we routered a radius to the edges.

To finish the boom we needed to adding fittings such as the gooseneck, vang strut, mainsheet hanger and clew attachment. The gooseneck would require something stronger than timber to allow the boom to fit the mast. Here we had offcut carbon plate from Jason Carrington which we could use. We used the router again to reduce the thickness of the sides of the boom so the carbon plates can be attached. The plate then extends 50mm forward of the end of the boom which allows for the boom pin to attach to the mast. In addition to bonding these plates on we added two bolts going through to lock it in place and have a mechanical backup if things don't go well.

For the vang strut we were able to reuse an offcut we had from last year, the Maxi72 Batten. This is perfect for the strut. To attach it to the boom again we used offcut carbon plate, this time attached on the outside of the boom. The mainsheet hanger and clew attachment were both attached by laying them into the boom. The clew piece was made from hardwood and can be described as "knuckles". The ideal is simple, on the clew of the mainsail it can be lashed to the boom and just sit in the groove of the knuckle.

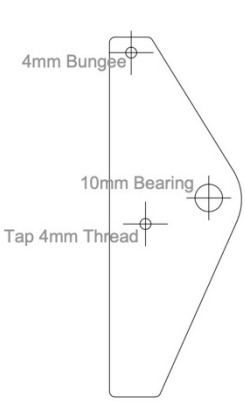


We have been able to rig the boat up and the boom has so far held. We will keep the carbon boom as a backup. However while the wooden boom hasn't broken, it does flex when under tension. Under tension the boom at the moment is flattening out. This boom is a first iteration so it is experimental. Going forward we will aim to add a spreader on top of the boom that will sit inside the double skin of the mainsail. The idea of this will be triangulate the load and tension the areas bending flat.

The wand.

Our wand cassette from last year was innovative. It used a broken carbon batten, which had two holes running through it allowing the wand to slide inside it. While this was good we had issues at the top of the wand cassette where the push rod attaches to it and articulates the pivoting movement which in turn trims the mainfoil flap. This was a "must fix" after reviewing how our project went last year.

Fortunately we were able to reuse the entire piece. We started by cutting off the top. Essentially we rebuilt the part just using much larger amounts of material and thereby making it stronger. We designed the offsets we needed for the two pivot points. Then using more carbon plate offcuts we could cut two large shims which we bonded to the wand cassette. These are substantial and the whole piece is now much more robust.



At the other end of the wand system we were not happy with the bias adjuster from last year. The issue we found was our rod last year had a bend in it and so when it rotated there was a lot of friction in the system. One of the supporters of our project is a post graduate of Solent University. He has spent the past 15 years working in motorsport. Through him we got hold of

two out of date “pull rod” from the steering system of an F2 car. This is essentially a titanium tube with a thick wall and a thread at each end. This we are in the process of adapting to become our new bias adjuster.

Final manufacturing status.

At this point now we have a complete hull and rig. We have also rigged the whole thing up and tested that it is capable of dealing with the loads. We felt this was an important stage to complete before advancing into sealing all the wood. It was a great moment to see it together and it works. Some areas required a bit more reinforcement and these are being addressed. Now we have completed varnishing the frame and are in the process of finalising the wand systems and the gantry, before hopefully having time to test it on the water before driving to Lake Garda later in June.

Cost Analysis.

As per the rules we have conducted an analysis of the cost of the project following the format of the SU$ and allocations for material and machining costs. We hope we have understood the rules and interpreted the cost per item in our project correctly. Because of the concept of the project the main material is wood with no moulds which lowers our cost significantly. We are reusing a lot of components from last year but have included the costs for these. We also are using a high specification block package that was sponsored to us, this cost nearly contributes half of our overall cost. Here is the breakdown overleaf:

Cost Analysis				
Item	Breakdown	Unit/Quantity	SM$	Notes
Hull	Plywood Sheet		$ -	Wood and no mould
	Ash Plank		$ -	
	Bio Epoxy	2 KG	$ 30.00	
	CNC Machining	1 Hour	$ 40.00	
Wings	Ash and Carbon Build		$ -	Upcycled from last years project
Gantry	Plywood Sheet		$ -	
	Bio Epoxy	400g	$ 7.00	
	CNC Machining	20 Minutes	$ 20.00	
Mast Post	Plywood Sheet		$ -	
	Bio Epoxy	500g	$ 7.50	
	CNC Machining	20 Minutes	$ 20.00	
Foil casing	Plywood Sheet		$ -	
	Bio Epoxy	200g	$ 4.00	
	CNC Machining	20 Minutes	$ 20.00	
Mainfoil Vertical	Upcycled Carbon Mast		$ -	Upcycled from last years project
Mainfoil Horizontal	Broken Maguire 2014		$ -	Upcycled from last years project
Rudder Vertical	Upcycled Carbon Mast		$ -	Upcycled from last years project
Rudder Horizontal	Exploder		$ 500.00	Upcycled from last years project
Deck Hardware	Allen 20mm Double	3 x £26.52	$ 79.56	Sponsored free of cost to us. Used last year
	Allen 20mm Triple	3 x £38.51	$ 115.53	
	Allen 20mm Single	10 x £10.43	$ 104.30	
	Allen 20mm Double HL	2 x £58.76	$ 117.52	
	Allen 20mm Swivel	2 x £41.76	$ 83.52	
	Allen 40mm Single	3 x £29.45	$ 88.35	
	Allen 45mm Ratchet	1 x £62.74	$ 62.74	
	Allen 6mm Low Friction Ring	15 x £7.81	$ 117.15	
	Allen 30mm XHL	2 x £118.92	$ 237.84	
	Allen 40mm XHL	1 x £140.90	$ 140.90	
	Allen 20mm XHL Double	1 x £129.17	$ 129.17	
	Mafioli Rope Vang	14 meters @ £2.50/m	$ 35.00	
	Mafioli Rope Cunno	15 meters @ £2.50/m	$ 35.00	
	Control Lines 3mm Dyneema	30 meters @£1.50 / m	$ 45.00	
	Bungee 3mm	15 meters @ £1 / m	$ 15.00	
Rig	Mast	Mach2 2009	$ -	
	Ash laminte Boom	Ash and 1kg Bio Resin	$ 15.00	
	Spreader team built	3m2 Carbon @150g = 450g	$ 72.50	
	Sail	Onesails new build	$ 750.00	
	Shrouds	5m 3mm SK99, £3/m	$ 15.00	
Tramp	Recycled Sail		$ -	
Tiller	Shock Tiller	Made 2018	$ 400.00	
Wand Area	Bowsprit	Upcycled Guitar Neck	$ -	
	Wand	Carbon rod	$ 15.00	
	Wand Cassette	Upcycled Batten	$ -	
	Bearings		$ 30.00	
Total			$ 3,352.58	

Sustainability Analysis

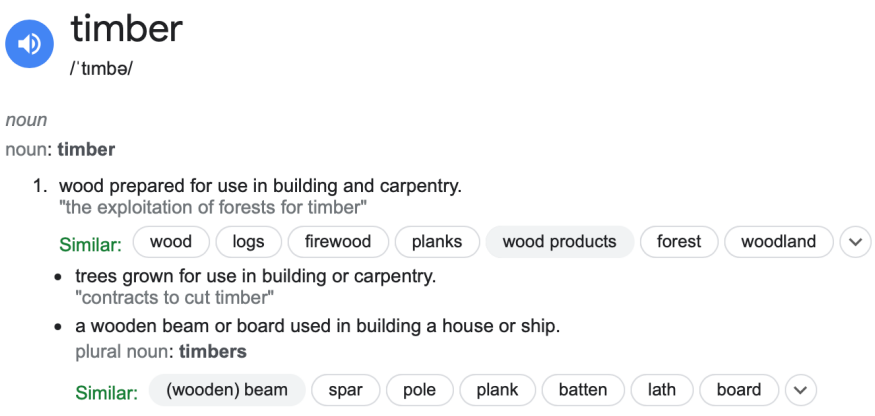
Summary.

To be a team who has done one cycle of the SuMoth event puts us in a really interesting position. Part of the team were part of that project last year. The concept that we designed and built we were very happy with and proud of what it achieved. At the end of that project it left us in a position to review what we made. The project last year followed a philosophy where we can use sustainability to build a moth, but we wanted to make something that was current and would capture interest of the moth community to see that sustainability and performance can go together. In aspects we achieved this and in other ways we fell a bit short. By making this our goal we limited something of the sustainable aspects.

Ultimately then our conclusion from last year is that going forward what if we went in the completely opposite direction? The goal this time has been to push the goal towards creating a platform that embraces sustainability and showcases what can be achieved. This year we really want to win the SuMoth. How do we do it? Change the way its done!

Strategy to make an impact!

Our material selection for the project is very different. We like being different.



timber

/ˈtimbə/

noun

noun: **timber**

1. wood prepared for use in building and carpentry.
   "the exploitation of forests for timber"

   Similar: wood | logs | firewood | planks | wood products | forest | woodland

   - trees grown for use in building or carpentry.
     "contracts to cut timber"
   - a wooden beam or board used in building a house or ship.
     plural noun: **timbers**

     Similar: (wooden) beam | spar | pole | plank | batten | lath | board

Traditionally the original British Moth was a wooden boat build, and in some ways we pay homage to this method. Using wood opens up many possibilities that work in our favour for making a sustainable moth, or as the definition states- our ship!

A natural material that is 100% renewable and sustainably sourced, then bonded together using the very latest generation bio based epoxy. And the best part is we didn't even need a mould to make our hull. This reflects greatly in our SuMoth budget estimate, as suddenly there is ZERO cost for the hull or the mould.

Then adopting boat building methods that have been around since 8000BC we are able to implement clever methods to get the most strength out of our material while reducing weight where possible. This, and the very class the project is being built, really brings together old and new.

Our components.

Completing our hull we have wooden wingbars, mast post and gantry. Then we have been able to take onboard other components we made in our project last year that we feel have strong sustainable credit.

Our foils were a great example, built taking material out of a broken TP52 mast. We matched the foil section to the interior curvature of the mast and were able to cut a rectangle from the port and starboard side of the mast. Adding a core built up the inside of the section, allowing us to bond the two halves together to create our vertical foils. Using this mast means our vertical foils are 3mm thick made from ultra high modulus uni directional prepreg carbon- what better material is there? The horizontal mainfoil is an Exocet foil which we sourced on Facebook moth market place, from a German seller. The foil had been laminated to his vertical and his laminate had come undone so the foil was a bit of a mess, but perfect for us!

We also must mention the wooden boom which we will be testing this year. While it may weigh a bit more than a normal moth boom but the principle for making it is method that has been done for many years and follows the same approach as our wingbars. Yes here we made a mould for the boom to be layered on top of, and we have kept this mould should our prototype fail we have the option to make another version or indeed make more for other people.

Improvements and changes.

This project for us ticks a lot of boxes. One of the biggest compromises is the weight which comes with using this material in the way we are using it. We see this as a compromise but not a factor that de-values the project because we are going to achieve our target weight and the mainfoil has enough lift to lift 70-80 KG.

In terms of manufacture there is not much we would change. Yes through the processes we have done to get to this point we can take forward lessons and next time we could possibly streamline the process but this is not the point. The fact we do not need a mould underlines the fact there is not much to improve upon because what more can you do.

Of course a bi-product of our manufacturing is saw dust. The dust from the plywood has zero potential for future use, but the dust from the ash could be used in biodegradable composte. This is not something we were able to do in our project since we were operating in a commercial workshop where the extraction contains a mixture of cutting dusts and we simply could not interfere with their workshop. But going forward it is something we could look to do in a future project.

Ultimately we hope that our project can resonate with the moth class and spread ideas towards sustainability and help promote change.

LCA.

The task of the LCA is to be completed. The task was delegated and not completed. Now we are trying to do so, however we are having trouble inputting values into the LCA tool when we have no plug or mould or indeed any laminate fibre in our hull. At this time we are talking to the contact there, Tim, but need to submit the report. So we hope to complete the LCA and be able to add the content to S2.

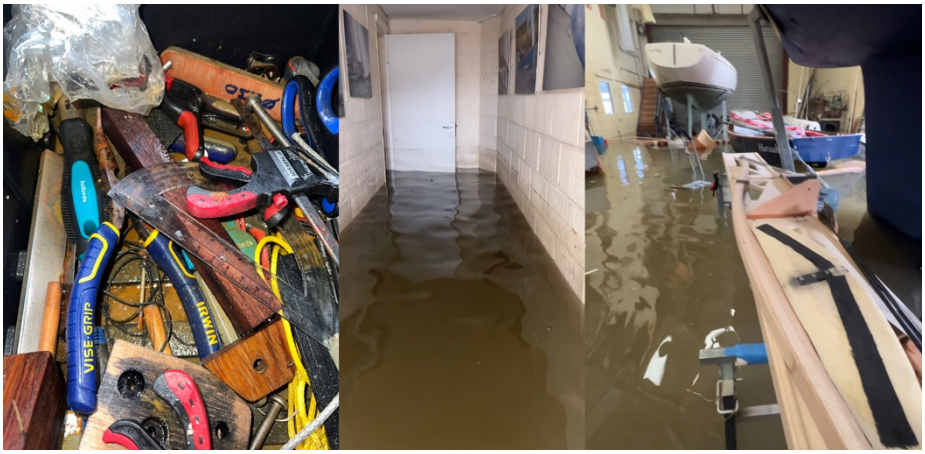
Challenges faced and overcome

Throughout the project things have generally gone well. Our research and assumptions have proven to be logical and when testing everything has held. Unfortunately during our build there has been an event that occurred which has hindered the project threatened to end it.

On the 9th April (2024) the workshop flooded. Our supporters, Yachting Sports, who allow us to operate in their workshop are based at Hamble Point in a marina. In this marina their facility and others are located on a level that sits below sea level. On the night of the 8th there was a storm and extra high tide and the lower level of the marina was flooded to a depth of 1050mm.

This was a mixed day of emotions. Disbelief for the most part, sadness and then resilience as we and our other supporters OneSails came together to move and save what we could. In our case we were extremely lucky.

Just the day before we had done a final rig up to test some final ideas and be happy everything is working and holding. Then later we took the boat apart to just the bare frame in preparation for varnish. It was left laying on its side on top of trestles. At this orientation the knees on the port side were protruding out under the frame. As an indication of the water level the frame stayed just above the level that the flood water came to. Infact we can see on the knees that the water came within 50mm of the frame. If the flood water had covered the frame it would be game over as the plywood was untreated. Amazingly it didn't.



We were able to rescue the frame and the wings from the workshop. Our tools and spares were not so lucky and we have lost about half of our equipment to rust or floating away yet to be found. A mixture of luck and some things lost. Since then we dried the frame out for a week to be sure there was no moisture content in the plywood. Then we did the final sanding and have been able to varnish it.

We only share this because it was a very unexpected and sad moment where our project nearly stopped. Now we hope everything will work despite this setback!

The Team

Going into 2024 the core the team remains the same. We are five people this time with some familiar faces from last year and some new ones. James and Linus who were at Foiling Week Sumoth last year again make up the core team and both will be at Foiling Week this June. Meanwhile the rest of the team members, Andrew, James (2) and Hamish are all pitching in during the design and build stages.

The structure of the team looks like this:

- James Tomlinson is our team captain for the second time in a row.
- Linus Rindsfuser is also on the team from last year and this time takes up the role of co-captain and primary sailor.
- Andrew Pimm comes into the team with input on the design development and manufacturing team.
- James Oxenham is again with the team from last year and this year is our communications officer. He is also taking lead on the MarineShift360 report.
- Hamish Pimm is our final team member who is new to the team and will be assisting with build and production.

All the team are students of the Yacht Design and Production courses at Solent University. Our team leader university representative is Jack Cunningham-Burley. The team has been meeting once a week to discuss the progress made, decisions to be made and set out a plan for that week.

In addition to this building progress we have also been making a conscious effort to be more active on our social media channels, and are posting multiple times a week. We are yet to do a post about the team members but this will be up soon!

Thanks to our supporters