



Half Pipe

Build Manual

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Introduction

Welcome to the Half Pipe build manual. First of all, thank you for choosing the Half Pipe - the debut model of **WingMill RC!** The plane starts by addressing a problem; experienced RC pilots crash, beginner RC pilots crash a lot! The Half Pipe is a simple design that is easy and quick to assemble, so if/when you destroy it, a replacement can be made in a day!

This is not the only aspect that deals with crashes, of course. The smaller airframe makes the flying field feel bigger, allowing for shallower banks and more of the flight spent straight-and-level. Taking the pressure off the pilot to maintain tighter, more difficult manoeuvres to stay within bounds. The light-weight build is able to sustain more crashes and hard landings. And the half pipe shaped under-belly of the craft serves as a shock absorber reducing the impact.

On top of being prepared to hit the deck, this plane has features in the design to make it predictable and easier to fly, hopefully giving its pilots plenty of time in the air before needing to repair or replace it. Design features assist to keep the plane tracking straight and with the wings level. The aircraft is capable of fairly slow flying for a more relaxed experience but carries enough power to throttle out of an uncomfortable situation.

The plane can also be built to have a total weight below 250 grams, making it so most countries will have more lenient regulations on it compared to aircraft weighing 250g or above.



Required Parts

This parts list will cover the parts needed to get your plane into the air.



Transmitter and Receiver

Assuming this is your very first build, you will need the key part for getting into the RC hobby: a Radio Control.

The Halfpipe is a 3-channel aircraft needing only a throttle, aileron and elevator channels to fly. But you may choose a transmitter with more channels for you to 'grow into'.

Pictured is a 6ch transmitter I bought ten years prior to writing this and I have yet to need an upgrade!



Racing Quad Motor

A smaller, light-weight aircraft does not need the larger motors most planes use. The motor this plane uses is a 2300Kv motor made for Racing Quads. Utilising a smaller prop, you definitely want a motor in the 2000+ Kv rating.



20amp ESC

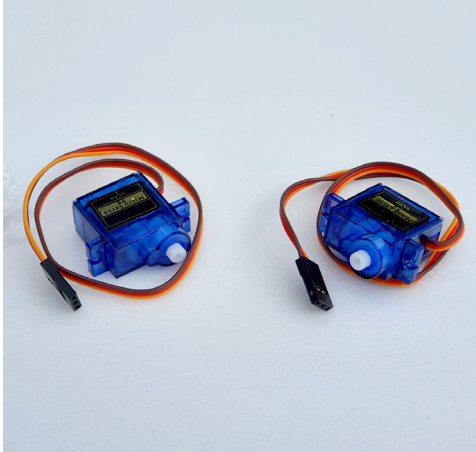
The Electronic Speed Controller (ESC) enables variable throttle input and supplies power to the receiver and servos. The motor on this plane is driven by a 20Amp. With only two servos, an external Battery Eliminator Circuit (BEC) is not needed. This small Turnigy 20Amp ESC sports a Switching Battery Eliminator Circuit (SBEC) and is smaller than ESCs that come with Universal/Ultra Battery Eliminator Circuits (UBEC). This is an ideal choice if you are aiming to make the plane 'Sub-250'.



5x4 Propeller

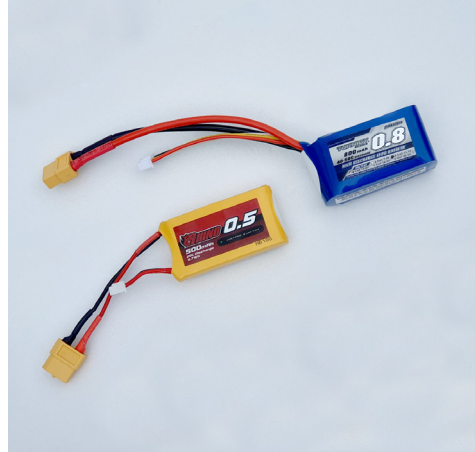
This plane is designed to take a 5-inch prop and has been test-flown mostly with a 2-blade 5x4 APC prop. A clock-wise prop is ideal but the plane can be engineered to use a CCW prop as well. Props are inexpensive and I found I could get a box of both CW and CCW props for less than the motor or ESC price.

Required Parts - continued



A pair of Servos

Servos will control the 'Elevons' (two control surfaces performing as both the elevator and the ailerons). This plane takes two of the typical 9g servos; one for each control surface.



LiPo Battery

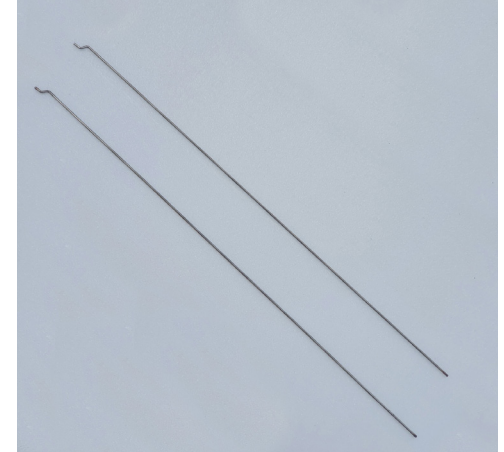
Your plane needs a power supply. This model has been tested with a 500mAh 2S battery (which helps keep the weight under 250 grams) and an 800mAh 3S battery (this puts the weight above 250g but supplies an awesome amount of power. The plane has plenty of power on 2S though and I recommend beginners fly 2S as the throttle is very responsive and the plane can easily get too fast for a beginner on 3S).



Plugs

Most ESCs will come without plugs. A plug on the ESC is a required part for the battery. For connecting the ESC to the motor, however, plugs are very much an optional addition.

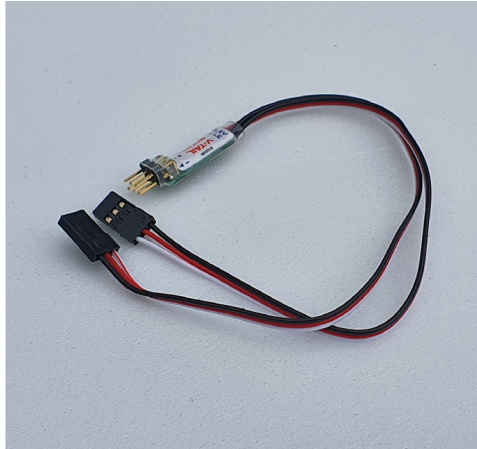
To save weight, I have soldered the wires between the ESC and Motor on this model.



Push Rods

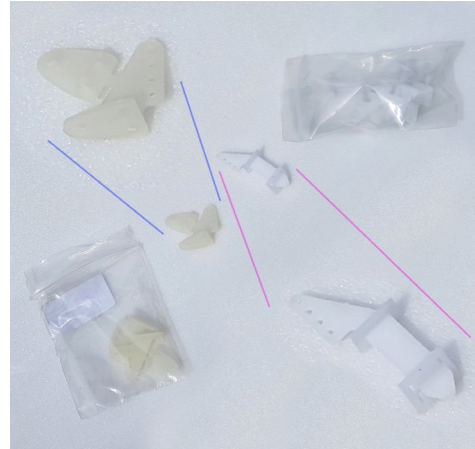
These thin metal rods are what your servos will need to transfer their movement to the control surfaces.

Required Parts - continued



V-Tail Mixer

This is the hardware approach to mixing ailerons and elevator into elevons. Most modern transmitters come with the capability of handling this mixing via programming. But using a hardware mixer is much more simple and has not compromised the ability to get plane weighing under 250g.



Control Horns

I have included templates for making these out of plywood if you don't want to buy a set, but plastic control horns are cheap and buying ready-made ones will save you time.



Velcro

Velcro is the easiest way to secure the battery inside the plane. This aircraft will have plenty of room inside for a battery to move around if not secured, which will result in dramatic changes of the centre of gravity making it hard to control.



Depron Foam and Plywood

This is the material that will make up nearly all the aircraft. It is light, durable and easy to work with. The plans are designed around foamboard that is 6mm thick and has no paper on it.

3mm Plywood will form the 'Firewall' that the motor mounts to. It is also what the control horns will be made from if you are making your own.

Required Tools

This will list all the equipment you will need to get your plane made.



Hot glue gun and glue sticks

This is a simplest and quickest way to stick foam together, mount servos, control horns and fill in scores.

Hot glue can add a lot of weight, so if you are aiming for a sub-250 build, use less of this and more epoxy instead.



Two-part epoxy

This is a lightweight glue that is incredibly strong – the foam is more likely to break in a crash than come loose from the glue joints. Its hardness is required for mounting the motor to the aircraft.

Using epoxy to stick the foam together will make for a strong yet lightweight model.



Strapping Tape/Drywall tape

This super-strong tape is what you will need to work as hinges for the control surfaces and the access hatch. It is also ideal for supporting the glue-joints. For attaching the half-pipe underbelly, I found tape alone is sufficient.



Basic tape

You will need simple tape to stick the paper plans together. A basic tape is also good for lining the foam along folds to reduce the likelihood of it snapping which you can remove afterwards.

Required Tools - continued



Scalpel and/or hobby knife

You will want a sharp blade to make clean cuts through the foam. Hobby knives with long extendable blades are very useful for bevelling and making finishing cuts whereas scalpels are best for doing small intricate cuts.



Soldering iron and solder

Most electronics come without the plugs pre-installed and so you will need to attach them yourself. Or, if you want to save weight, solder the parts to each other directly.

Note: If you destroy the plane, you will find it easy to transfer the parts from the destroyed model to the replacement without needing to disconnect anything.



Thin pliers

Pliers are needed to bend and cut the push-rods to fit in the control horn and servo holes. I find two pairs makes it easier to bend the rod accurately.



A 1-meter metal ruler

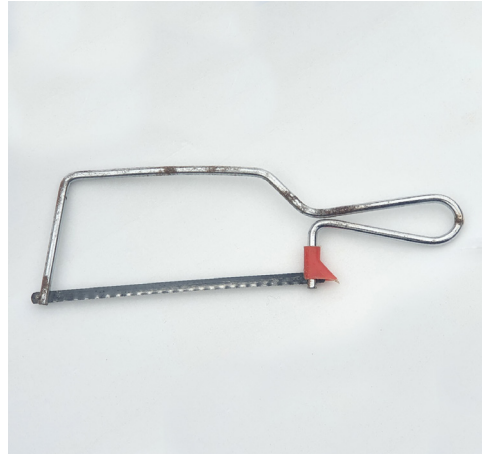
Most of the foam cuts and bevels will demand the use of a metal ruler and a long ruler will be appreciated. A short one is more convenient to work with on most of the cuts but there are some that you will definitely want a metre-long one for.

Required Tools - continued



Spray-Glue

This is the easiest and quickest way to stick your printed plans onto the foam.



Small hacksaw

I found a small hacksaw makes fine cuts in the plywood and is the least likely to cause pieces of ply to splinter off.



Drill

You will need a drill to form holes in the plywood firewall and control horns if you are making them yourself.



Sandpaper

Sanding down the leading edges of the wings and stabilisers will improve flight performance – primarily helping to keep airflow consistent and reduce the plane suddenly shifting its angle of attack in flight. It is also good for smoothing off the edges of the firewall.

Recommended Tools

This will list additional equipment that may ease the build process.



Shrink-tube

Ideal for insulating your soldered sections of wire to prevent them from contacting each other and causing a short-circuit.

Insulation tape can be used instead, but make sure to regularly check that the tape covers have not unravelled.



Heat gun

Though you can make shrink tube shrink with a lighter, a heat gun is a safer and easier tool for the job.



Vice

A vice will come in handy when working on the firewall. Once you have the motor mounted to the firewall you can also clamp it in the vice for safer prop testing.



Scissors

Some cuts will not demand the precision of a scalpel or hobby knife and so cutting with scissors is easier. It is also best for cutting kitchen foil (my material of choice for canopies) as I find scalpels and catch and tear the foil.

Recommended Tools - continued

This will list additional equipment that may ease the build process.



Kitchen Foil

As mentioned; kitchen foil is my material of choice for getting a nice shiney material stuck to the fuselage to resemble a canopy – it always adds a nice finish to any park jet.



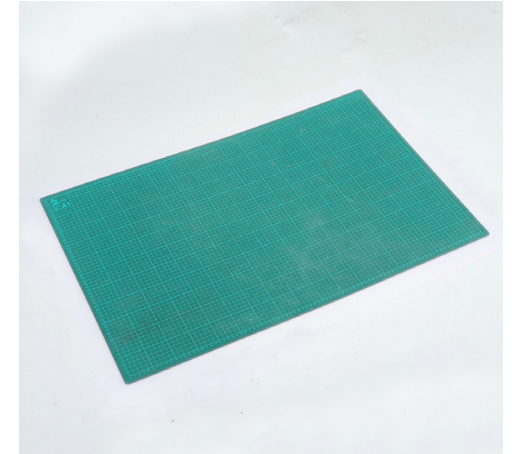
Prop Balancer

Propellers don't always come perfectly balanced. This tool will help you balance your props, reducing vibration which is better for the plane and smoothing the sound of the motor and prop.



Z-Bend tool

This tool makes it easy to put nice right-angled Z-bends into your control rods



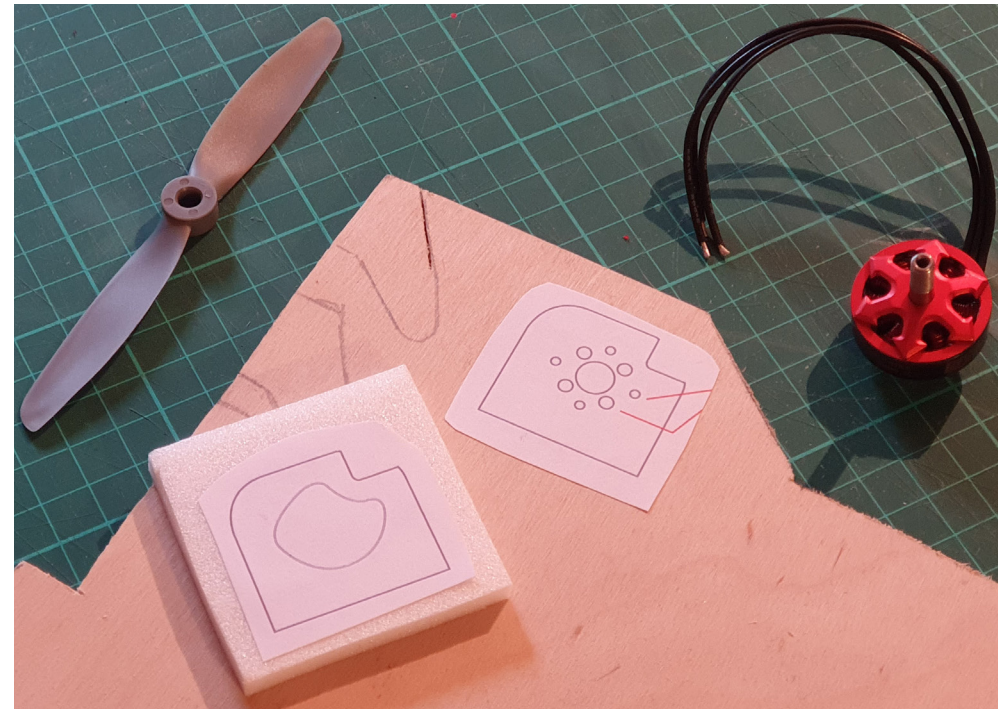
A1 Cutting mat

A way to protect the surface you're cutting on while slowing the rate at which your blades dull with use.

Setting up the power system

We shall begin the build by setting up the power system for the plane - that being the prop, motor, ESC and Battery.

Take the Firewall mount from the printed plans and cut them out – do the same for the control horns if you are making your own. Check that the holes on the firewall template match up with your motor's screw-holes. If you are unsure, cut the central hole out of the template then place it on the back of the motor using the central hole to align the motor with where it should be on the the firewall. Press the paper against the motor mount and find where the holes are located – use a pencil to outline these holes. You want to be able to mount the motor so that its wires are towards the corner with the cut out.



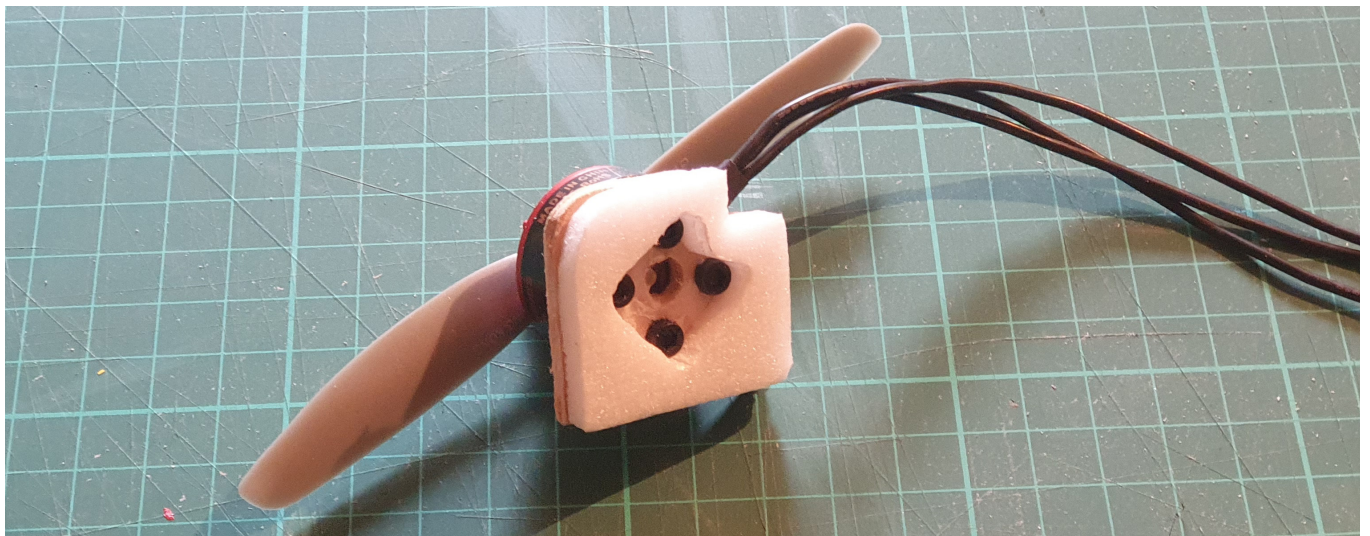
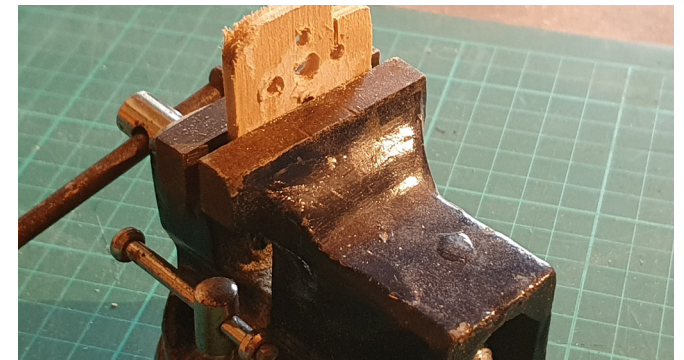
With the correct hole positioning now confirmed, spray glue the firewall (and control horns – again if you are making your own) template to the plywood. Drill the motor screw holes through. If your motor has nuts to hold the bolts, use a drill-bit that matches the diameter of the threading. If your motor is designed to have screws drilled directly into the wood, use a drill-bit that is narrower than the threading.

Setting up the power system - continued

Now that you have bored the screw holes, try to mount the motor to the plywood and see that it is easy and that the motor fits flat against it. With that confirmed, take the motor off and use a hacksaw to cut out the template. Place the template in a vice, sand off the edges and sand off the cut-corner for the motor wires.

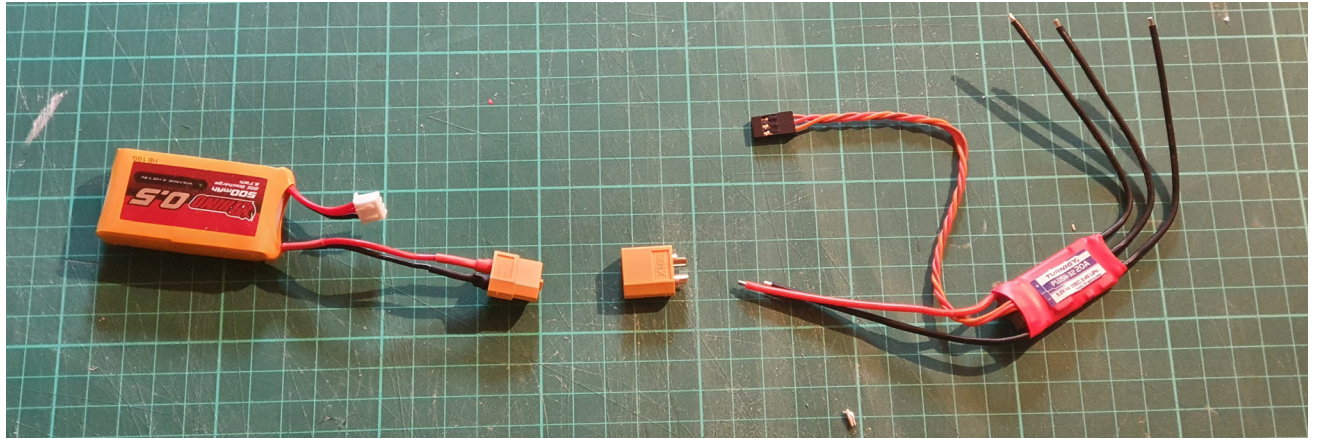
Remove the paper template, mount the motor onto it and cut out the foam padding for the firewall. Test the fit of the foam padding by placing it on the firewall over the motor's bolt-nuts. If your motor screwed directly into the wood, you don't have to cut out the central hole. If the foam fits on nicely (lining up with the wood without being pushed off by the screw heads) remove it and place to one side.

Mount the propeller onto the motor. Propellers usually have writing on the side that faces into the direction of travel. This plane has a 'pusher-prop' configuration, so this writing will face towards the firewall.



Setting up the power system - continued

If your ESC doesn't have a battery plug included, place it next to the battery and match up the red and black wires (DON'T CONNECT THEM) to see which way around the battery plug needs to go on and solder it to the ESC. Note: you might need to strip some of the rubber coating from the wires to do this; gently press your scalpel into the wire so it goes through the rubber and meets resistance at the metal. Rotate the cable to pull this cut around the wire and pull the coating off the wire.



Next, place sections of shrink tube over the ESC wires, if you have some, and solder one of the ESC wires to one of the motor wires. Stick the other two motor wires together temporarily either with clamps or tape (just make sure nothing can cause a short-circuit). Clamp the firewall with motor on in a vice or bolt the motor down to a large piece of wood. Plug the throttle wire from the ESC into the receiver. Set your receiver to bind / plug the bind plug into the 'battery/bind' port on the receiver. Power on the receiver in bind mode and plug the battery into the ESC.

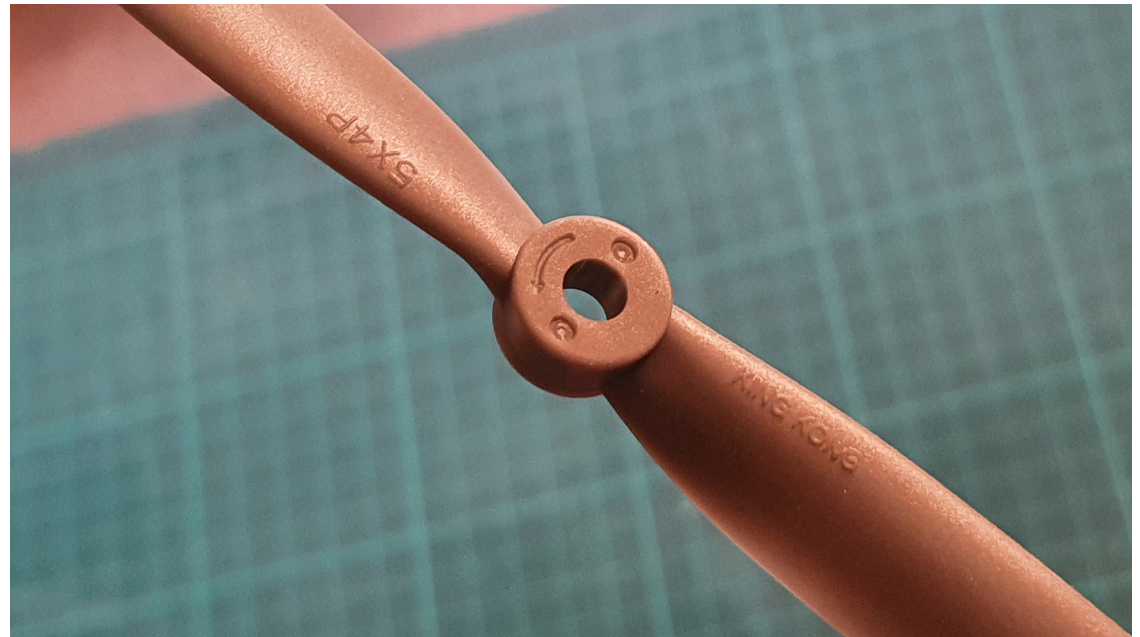


Setting up the power system - continued

A note about propellers - props usually have text embossed on the blades near the core, providing info on the diameter and pitch of the prop. This writing must face the direction of travel. Because this plane uses a pusher-prop, the text will be facing the motor.

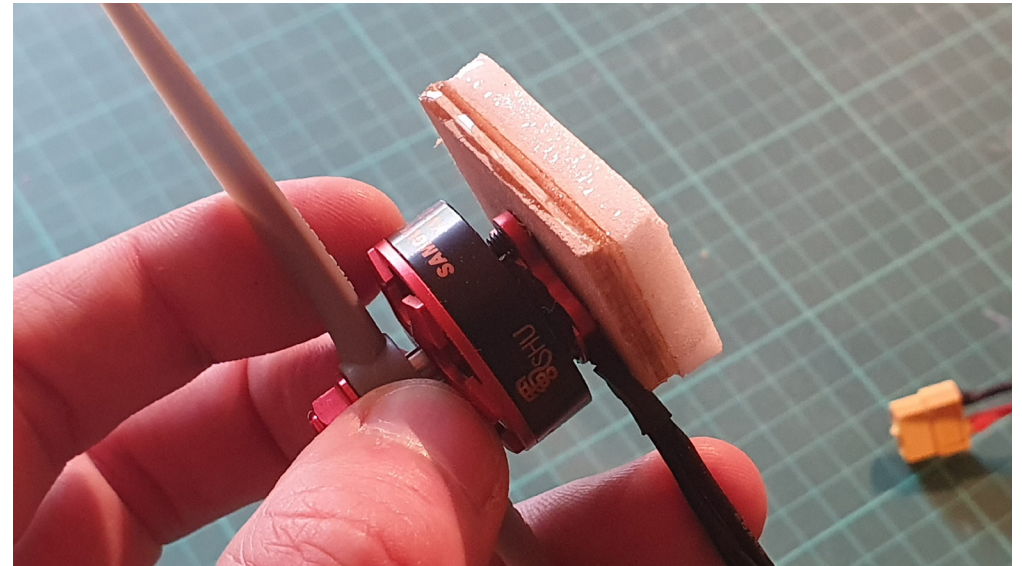
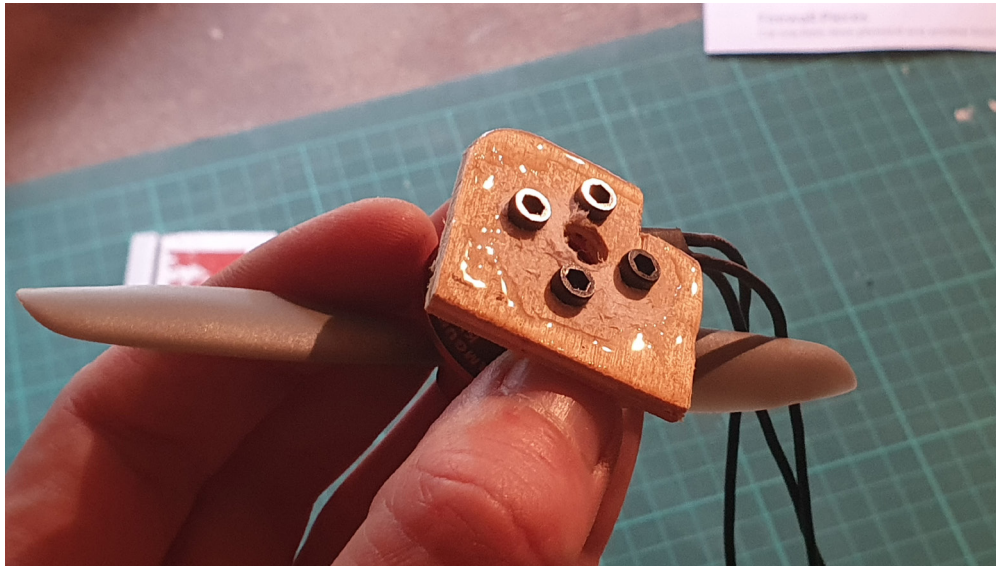
Once bound, raise the throttle just enough to get the prop spinning. To test the thrust direction you can increase the throttle a bit more if that helps you tell, but do not go high on it! Is the propeller blowing air up away from the fire-wall side of the motor? If so, good! It is spinning in the correct direction to provide thrust. If not, switch two of the ESC wires around with the motor wires and it will spin the other way – this is why we only stuck them to each other temporarily!

Before you solder the remaining wires up, look down at the motor prop set up in the vice, with the propeller closer to you and the motor below it – does the propeller spin clockwise? If not you can apply a clockwise propeller and set the motor spin direction accordingly, or you are going to have to bear in mind that the wing plate design will have to be flipped upside down. The prop slot and motor mount areas are angled-off to counter-act the torque roll. The template is set as if you are looking down on the wing from above with a clock-wise prop. If it is counter-clockwise, the motor will need to be angled the other way and so view the template as if you were looking up at the wing from below.



Setting up the power system - continued

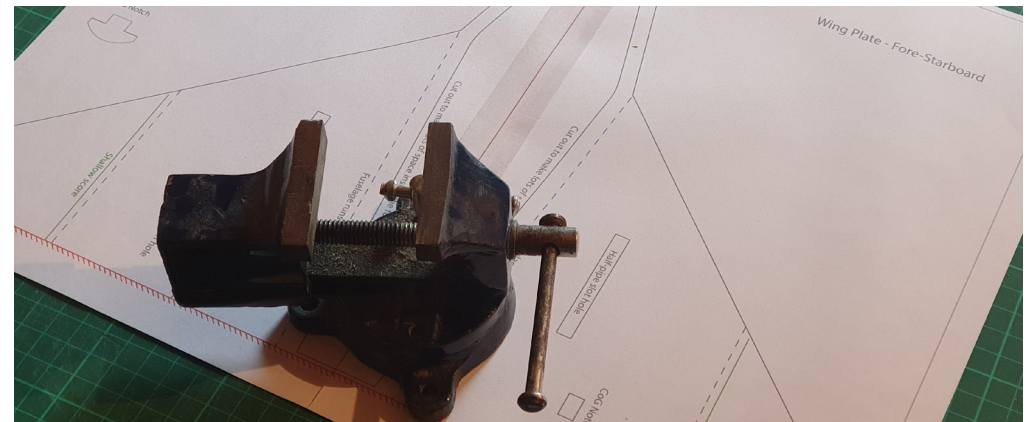
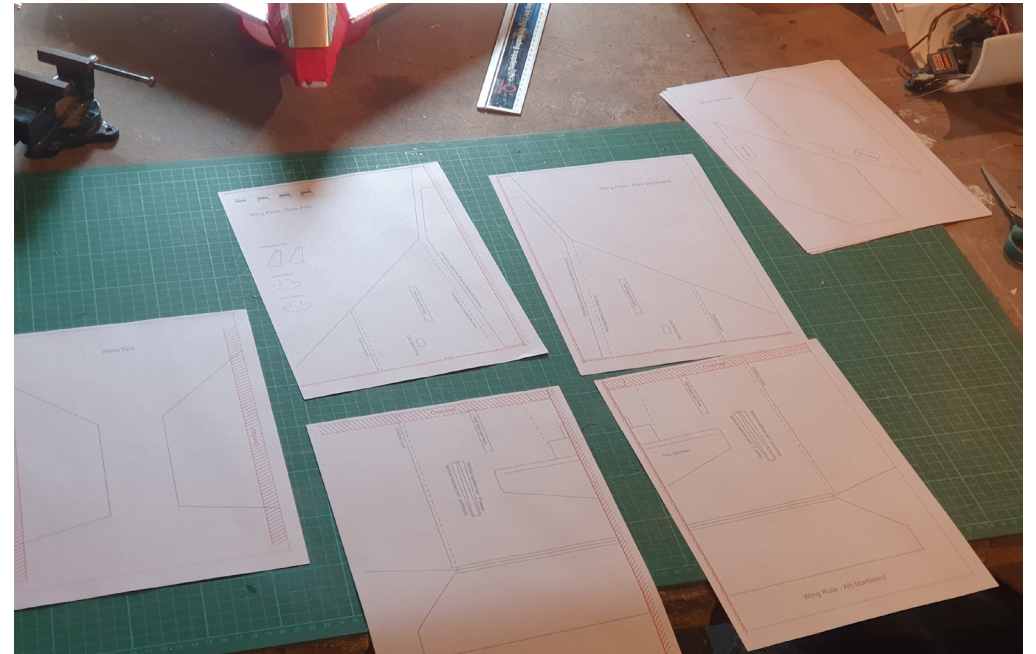
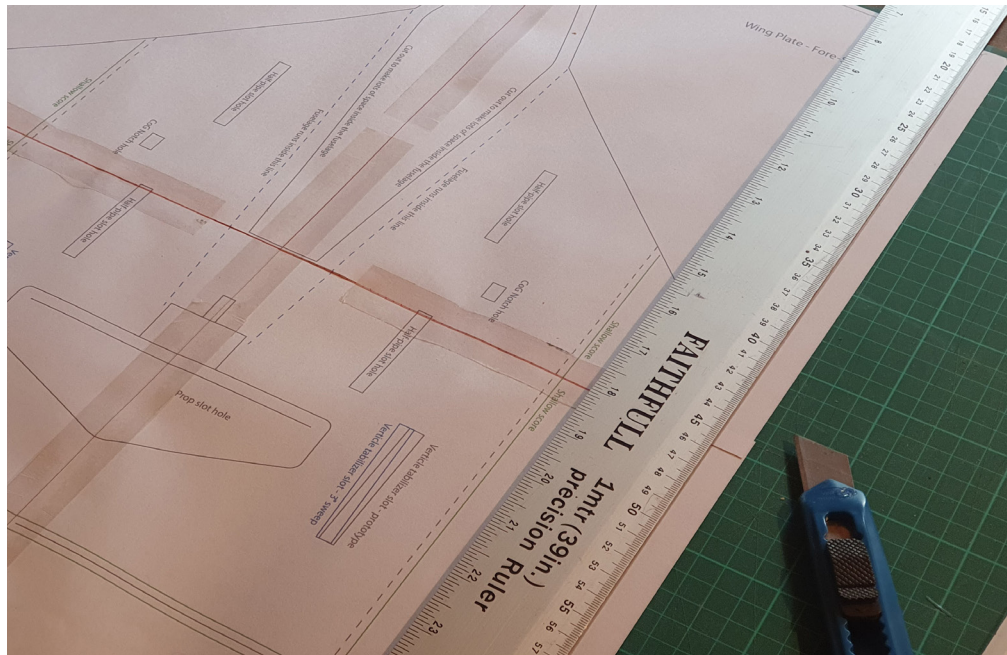
Having confirmed the motor and prop-spin direction, unplug the battery, switch off the transmitter and solder the remaining ESC and Motor wires. Mix up a small amount of epoxy and paste it around the firewall mount near the edges – enough for the foam to tack but not so much that applying the foam will squeeze out epoxy all over the motor screws. Apply the foam padding and smooth off the epoxy that bleeds out around the edges. If the inside is snug against the motor bolts it should be fine to set as it is, if not, wrap a piece of tape around the foam padding and the motor.



The epoxy will need two hours to set, so set it aside. With the prop on, I found it quite easy to just place the motor on a surface and it will hold the firewall up in the air where nothing will make contact with the epoxy.

Setting the plans

Stick the plans together with tape. A ruler can assist with alignment by being placed along a line that goes over two or more sheets. Use a weight to hold the sheets in place while you apply tape to one half then move the weight and tape the other half. Tape needn't run along the whole edge, just enough to keep the sheets in place.

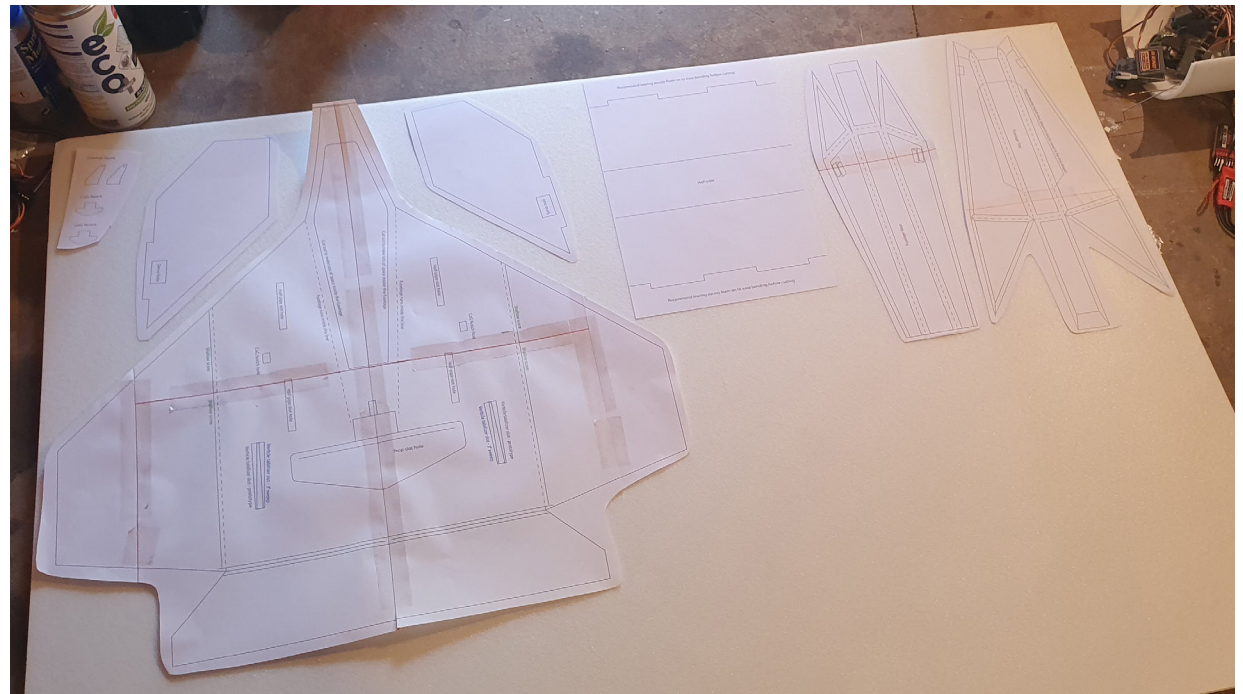


Setting the plans - continued

Once the sheets are taped together, cut the templates out with scissors leaving a cm or two of padding around the black cutting lines, except for on the half pipe template – cut out the edges with the wing-plate notches on with the scalpel – you'll find out why when you go to form the halfpipe.

Place the templates on the foam to find the optimal positioning for minimal off-cut foam. If your foamboard has a slight bend in it, try to get this end running along the wingspan so if the curve has any effect, it will be a dihedral effect that helps keep the plane stable.

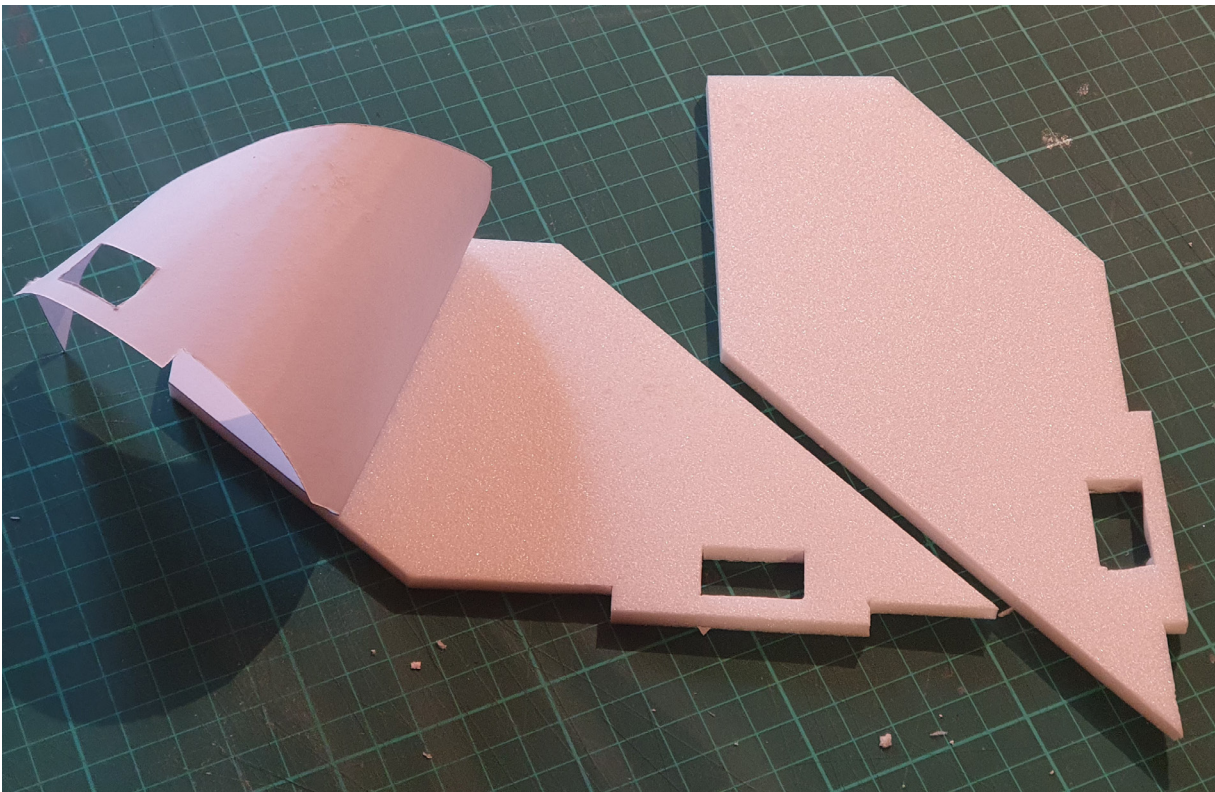
Spray glue the templates to the foam. Do not apply too much glue, we want the paper to be easy to remove after we have cut the shapes.



Cutting the shapes

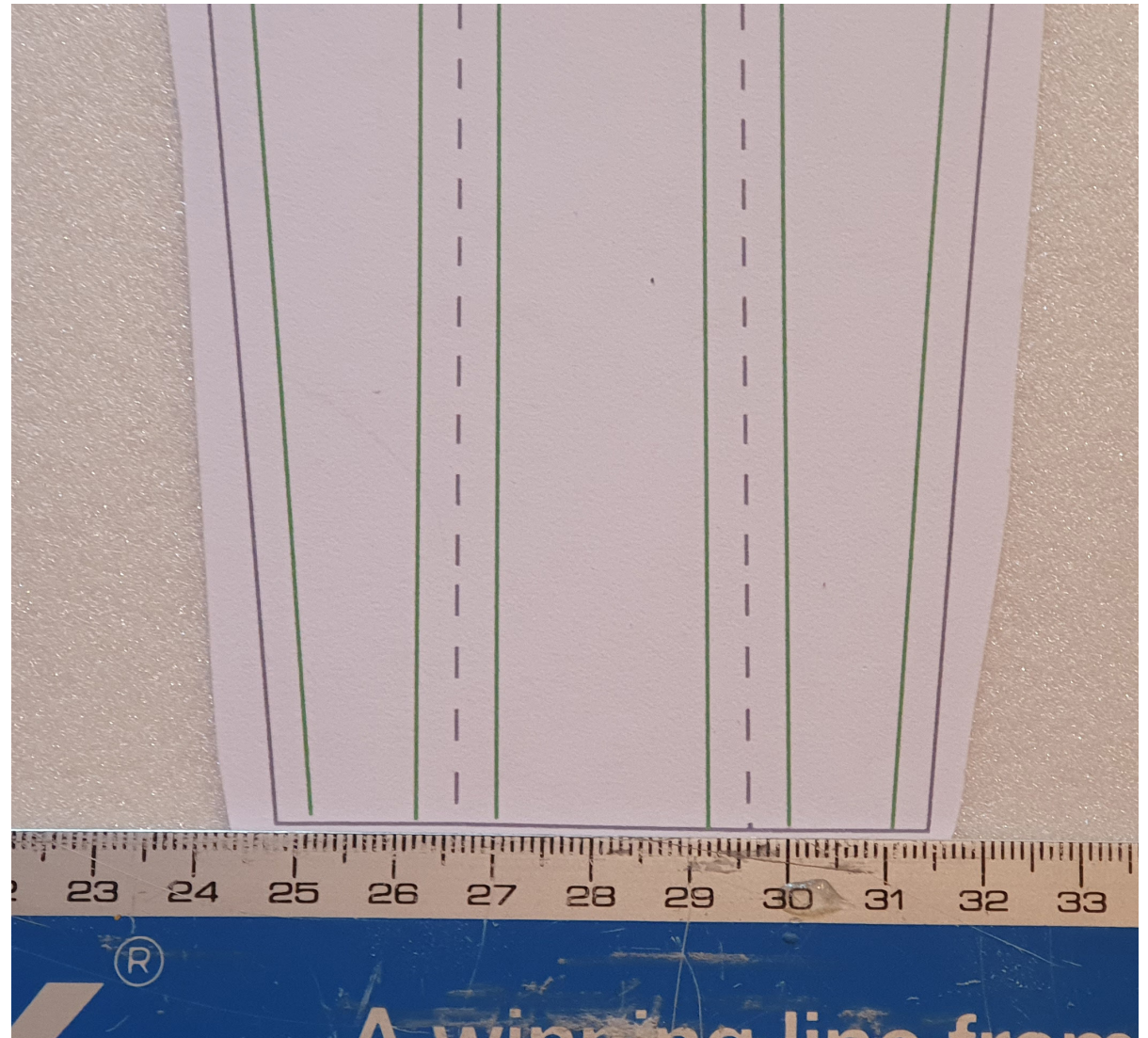
Cut out the shapes following the black outer lines on each one. When cutting the vertical stabilisers, run the ruler along the base-edge and you should see it aligns with the base of the servo hole. Cut the base-edges and with the ruler still in place, cut the base of the servo hole.

Remove the paper on the vertical stabilisers once you've cut out the main shape and servo hole.



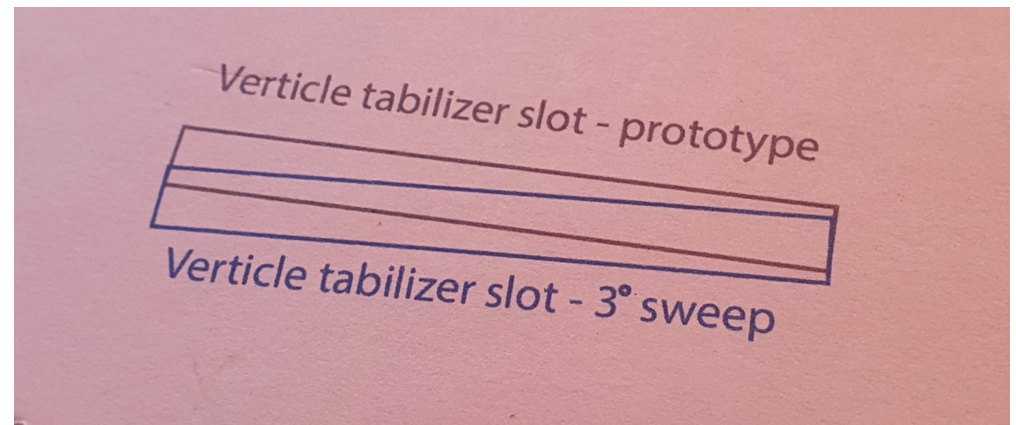
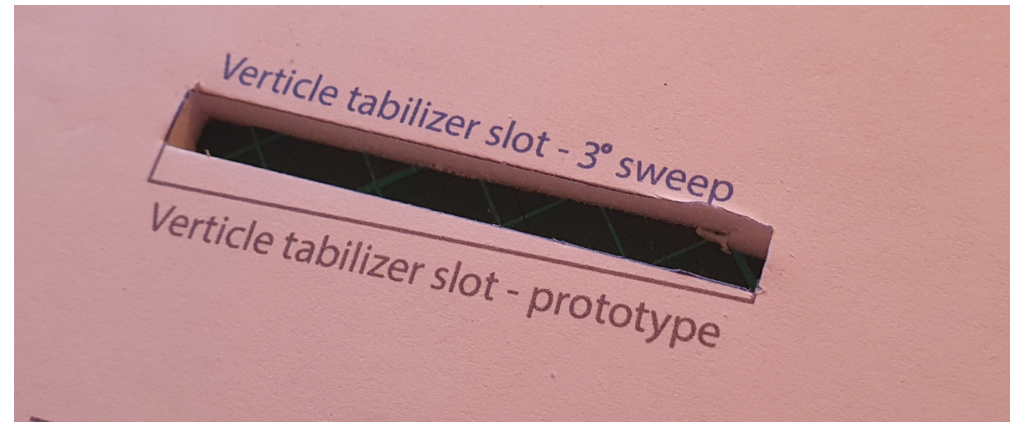
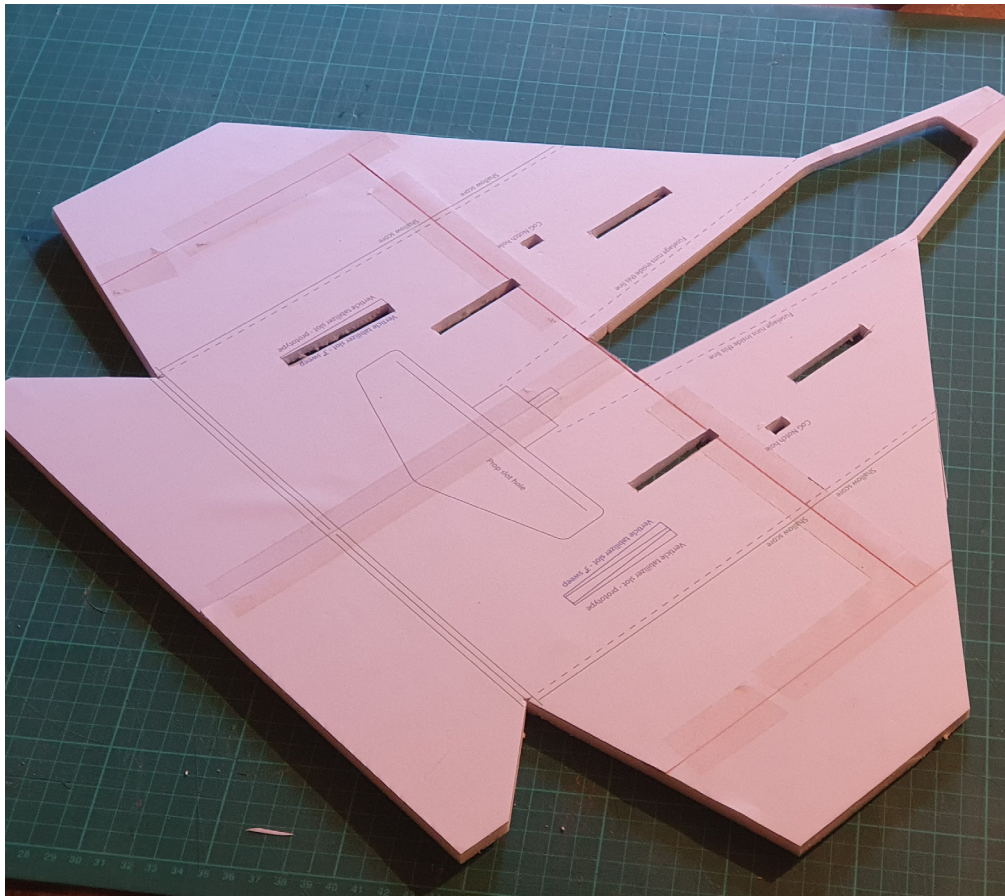
cutting the shapes - continued

You may notice the trailing edge of the bottom fuselage doesn't look like a perfectly straight line – this subtle angle is deliberate. It is to assist the angling off for the firewall.



cutting the shapes - continued

Cut out the wing plate and cut out the slot holes and fuselage area. The vertical stabiliser slots have the option of being parallel or being swept in at the front by 3° . Swept stabilisers will assist the yaw tracking and stabilise it at slower speeds. Parallel stabilisers lose the added stability in exchange for reduced drag.



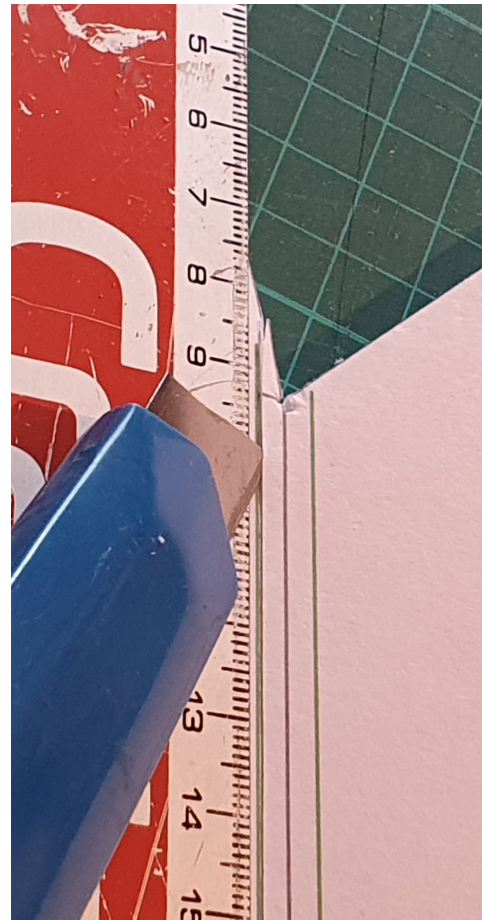
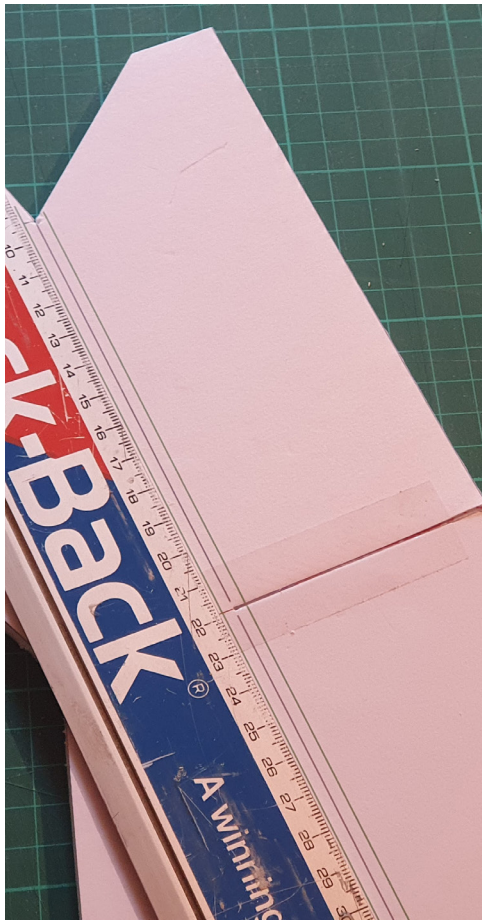
cutting the shapes - continued

Cut out the prop-slot taking care to curve around the corners – this helps keep structural integrity around the slot hole. The motor and firewall mount slots will be 90° corners.



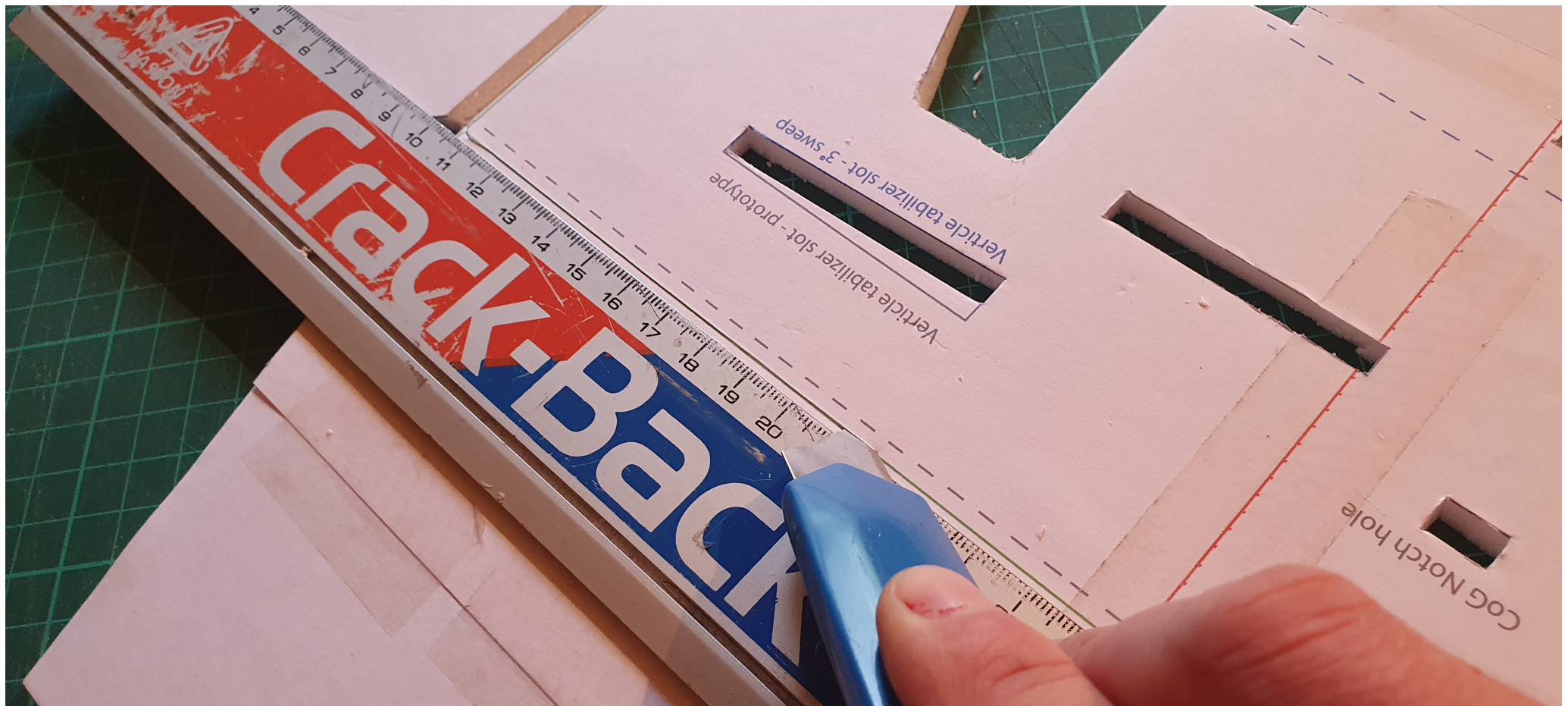
cutting the shapes - continued

Next, cut the bevel for the control surfaces. Enter the blade through the green line and aim to reach the black line at a roughly 45° angle. The cuts down either side should meet and you can remove the strip holding the black centre line in one piece. Cut the black line separating the two control surfaces at the tail and cut the gap just wide enough to keep the two pieces from rubbing.



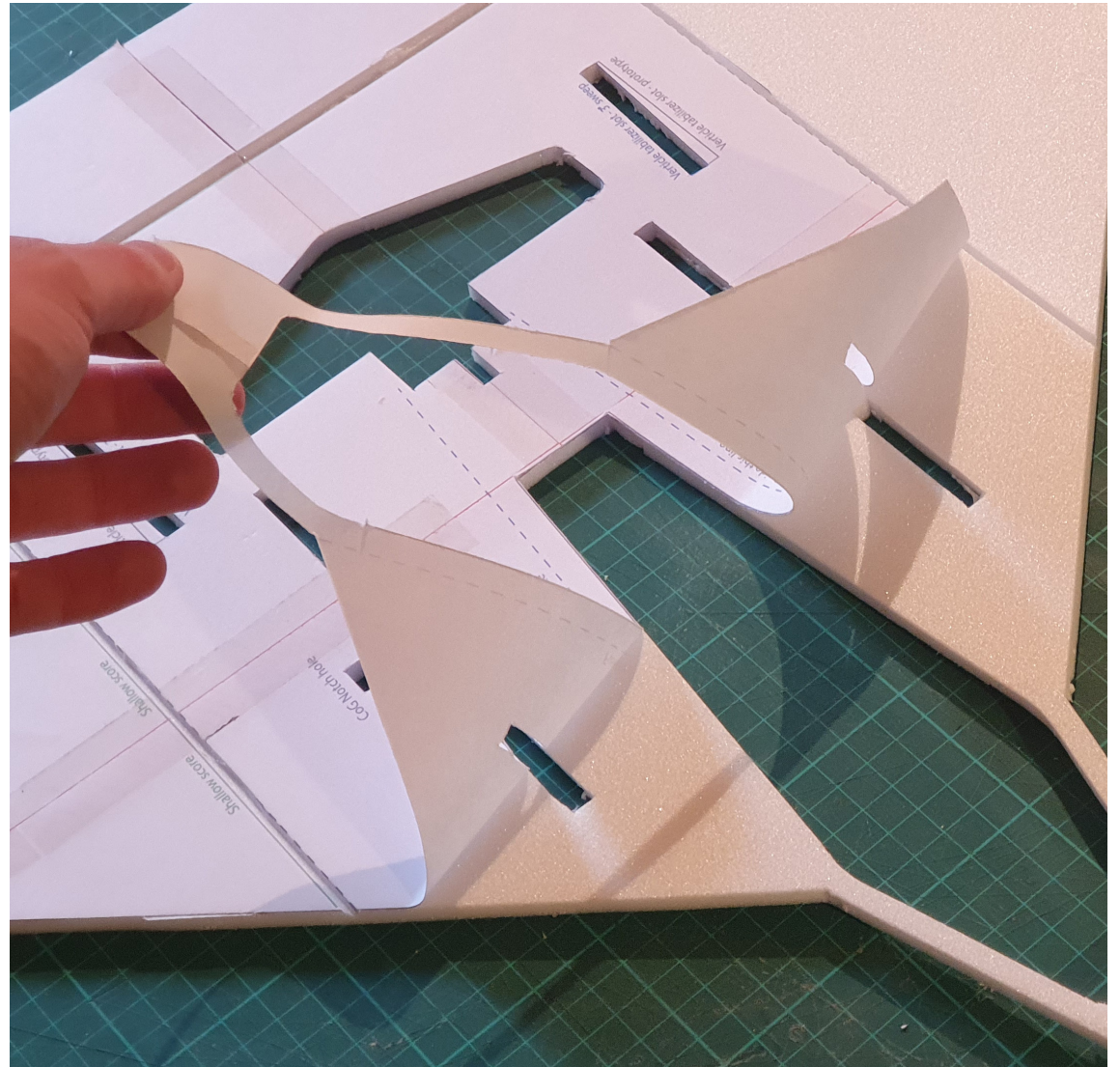
cutting the shapes - continued

Use a similar technique on the dihedral scores. You will notice there is only one green line here. Enter the green line again and aim for the dashed line, but this time you will cut down along the dashed line, being careful not to go all the way through the foam but around half way. I found a technique where my fingers rest on the foam to keep the blade at a fixed height.



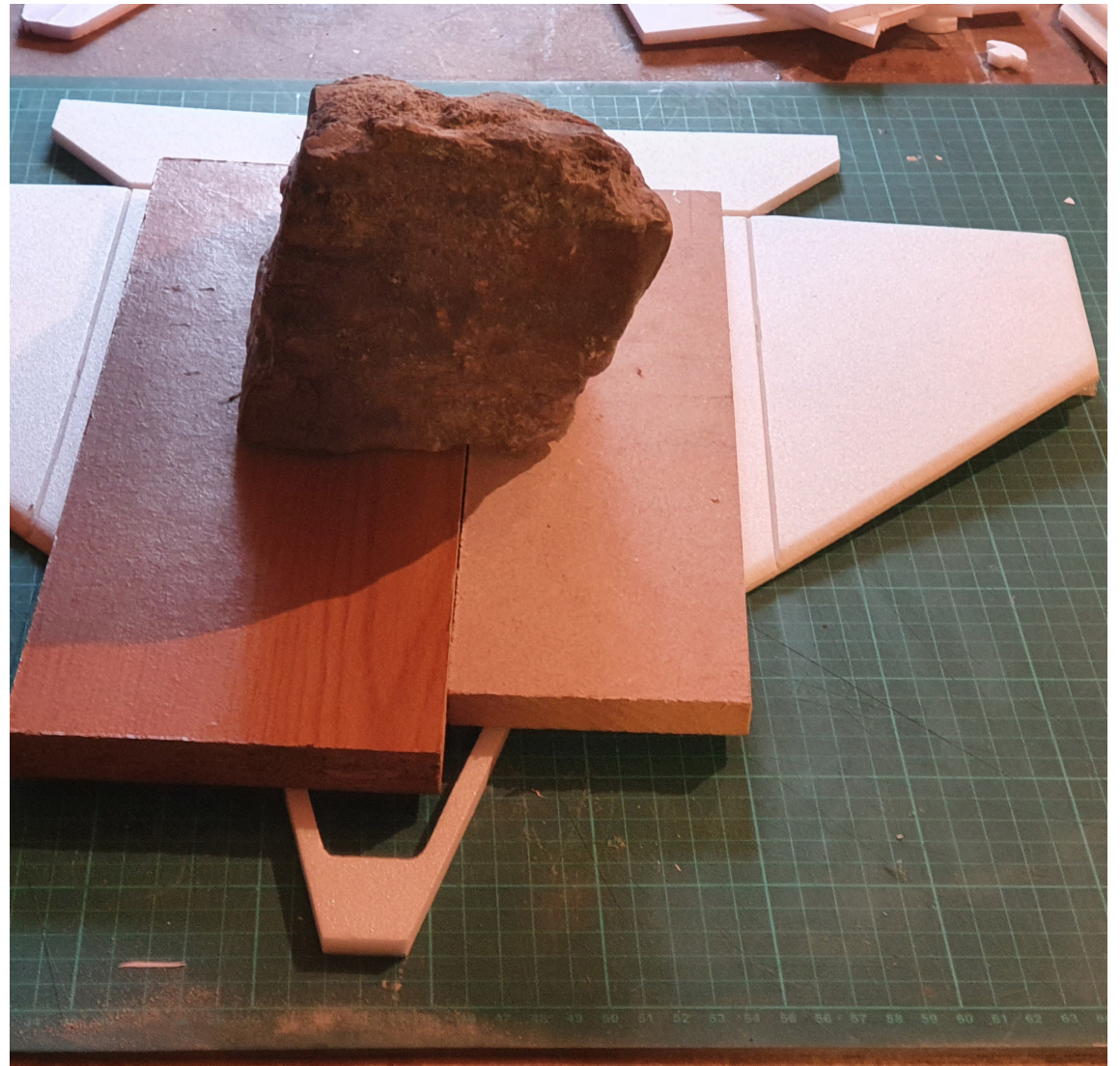
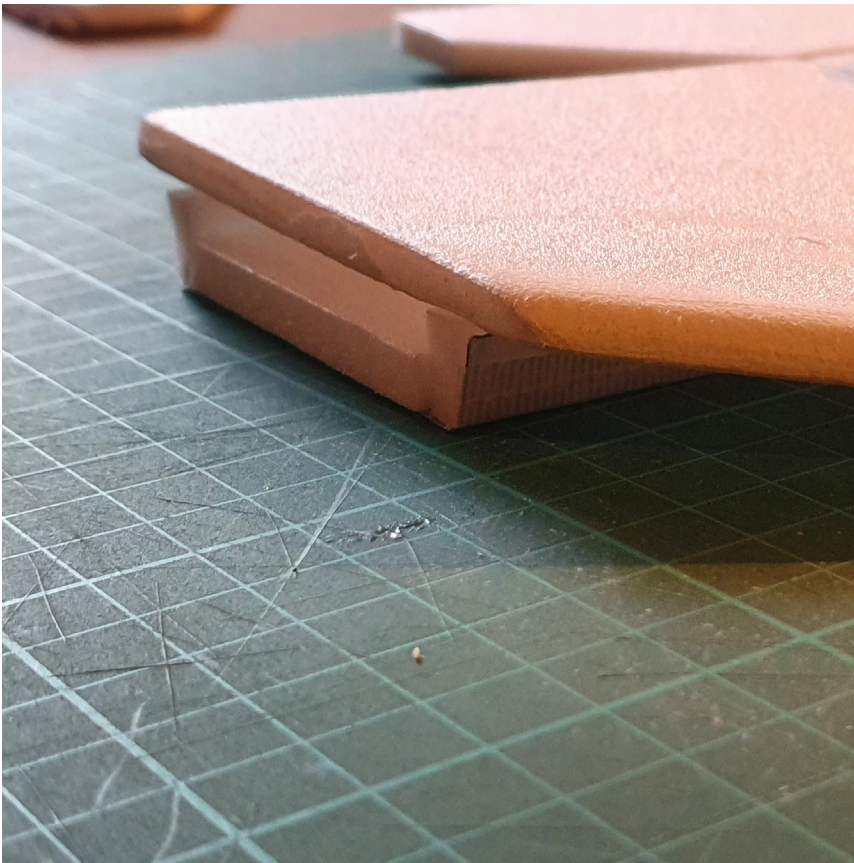
cutting the shapes - continued

That's the last cut made on the main wing plate, remove the paper then sand off the leading edges and trailing edges.



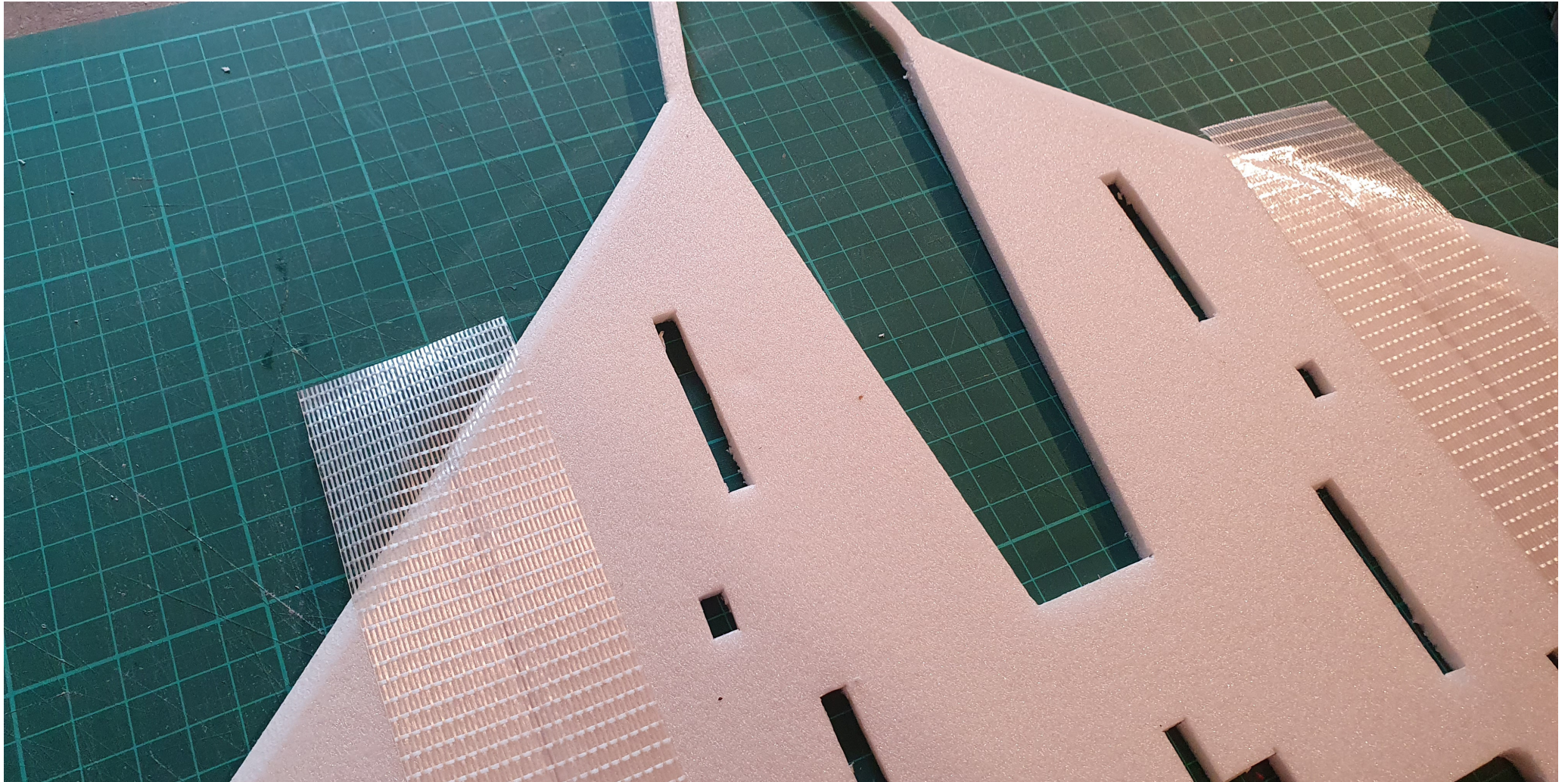
cutting the shapes - continued

Get a board large enough to hold the wing plate down close along the dihedral scores and place a weight on it. Assemble the dihedral guide ramps and wedge one in under the outer edge of each wing.



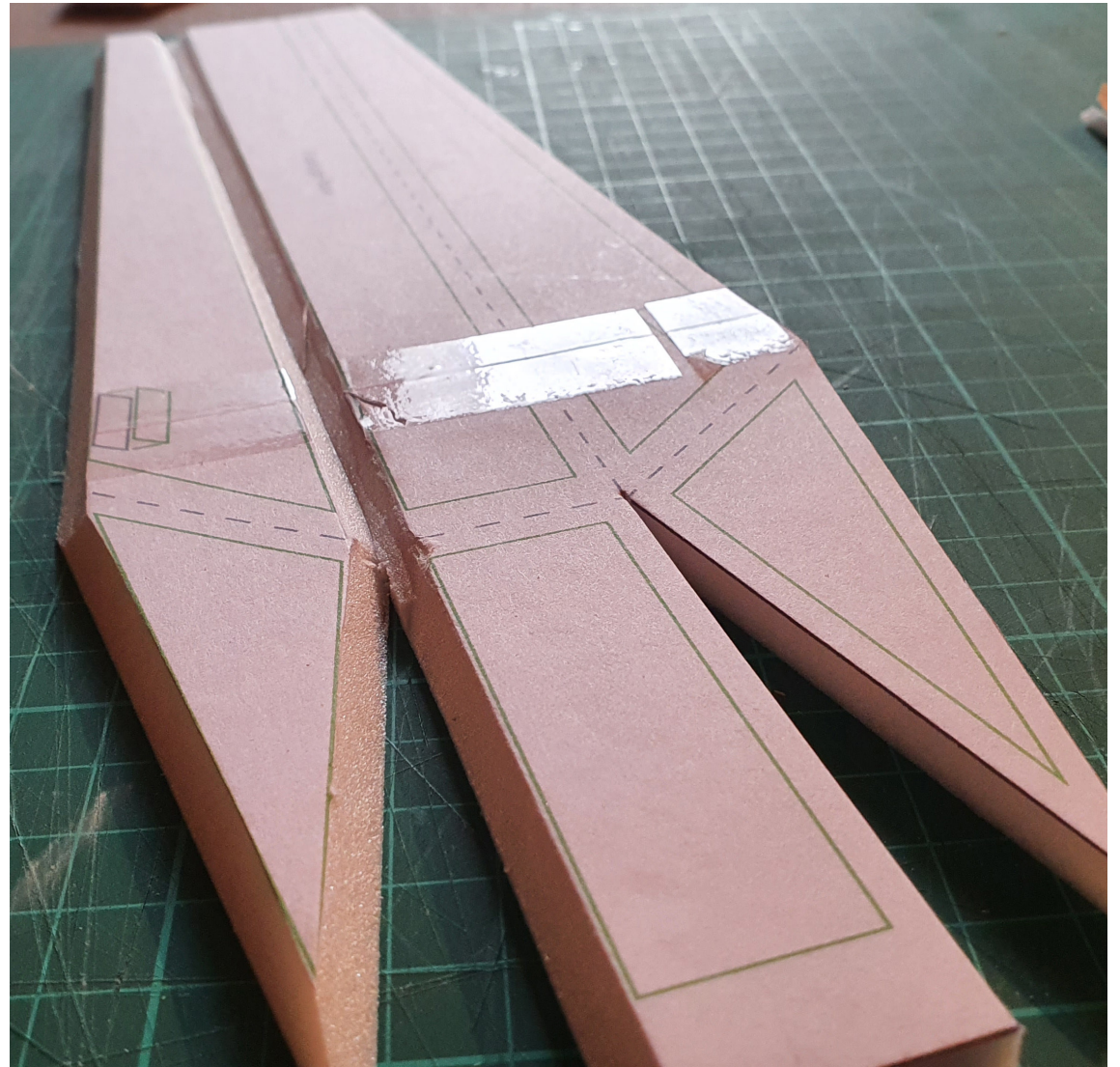
cutting the shapes - continued

Apply a piece of strapping tape along each score to help hold the shape.



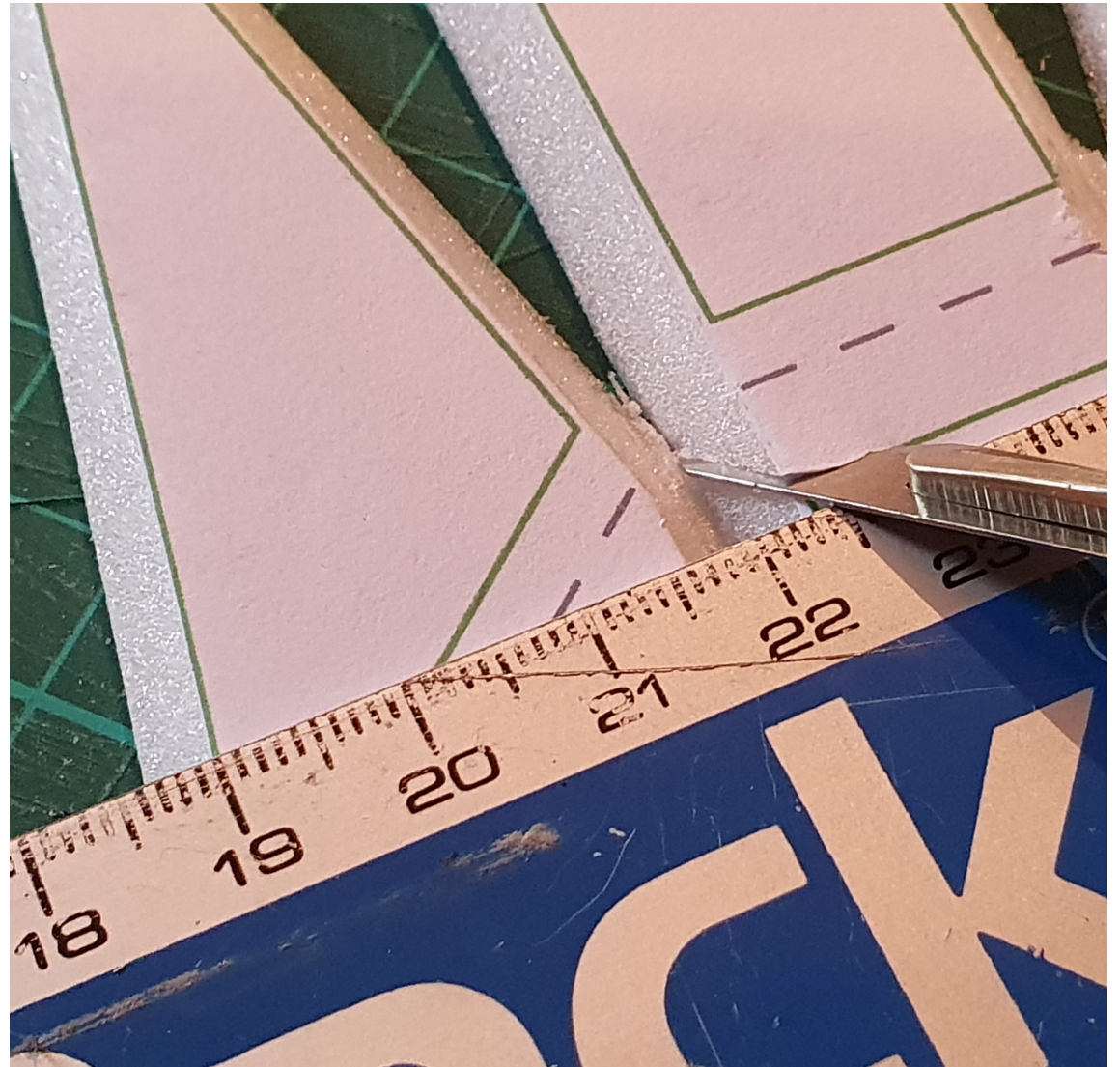
Forming the fuselage

Next, cut out the top and base fuselage templates. Again, the green lines will assist with bevel cutting the edges and scores.



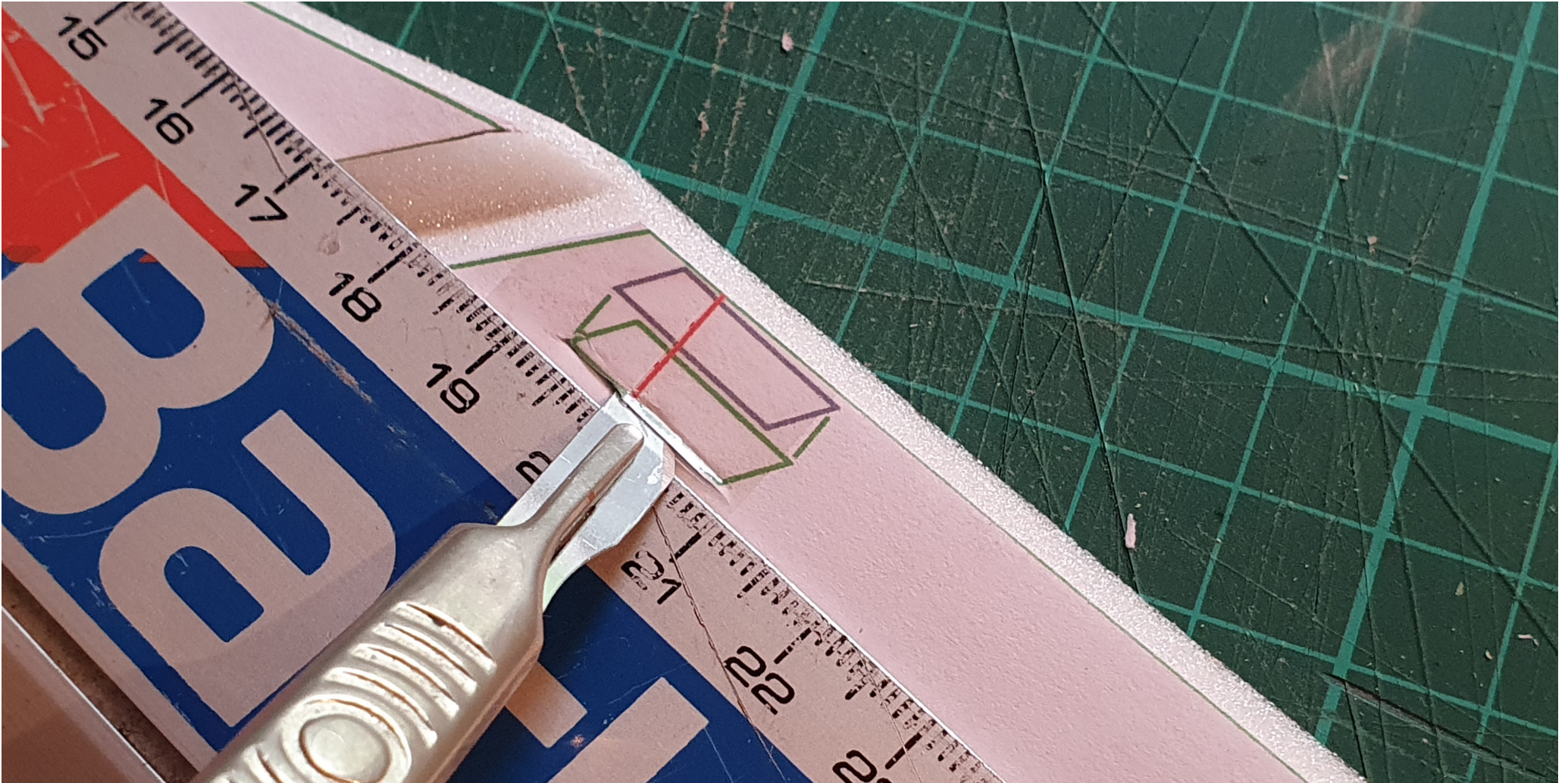
Forming the fuselage - continued

Make sure not to cut all the way through the foam where the dashed lines are when cutting the internal bevel scores.



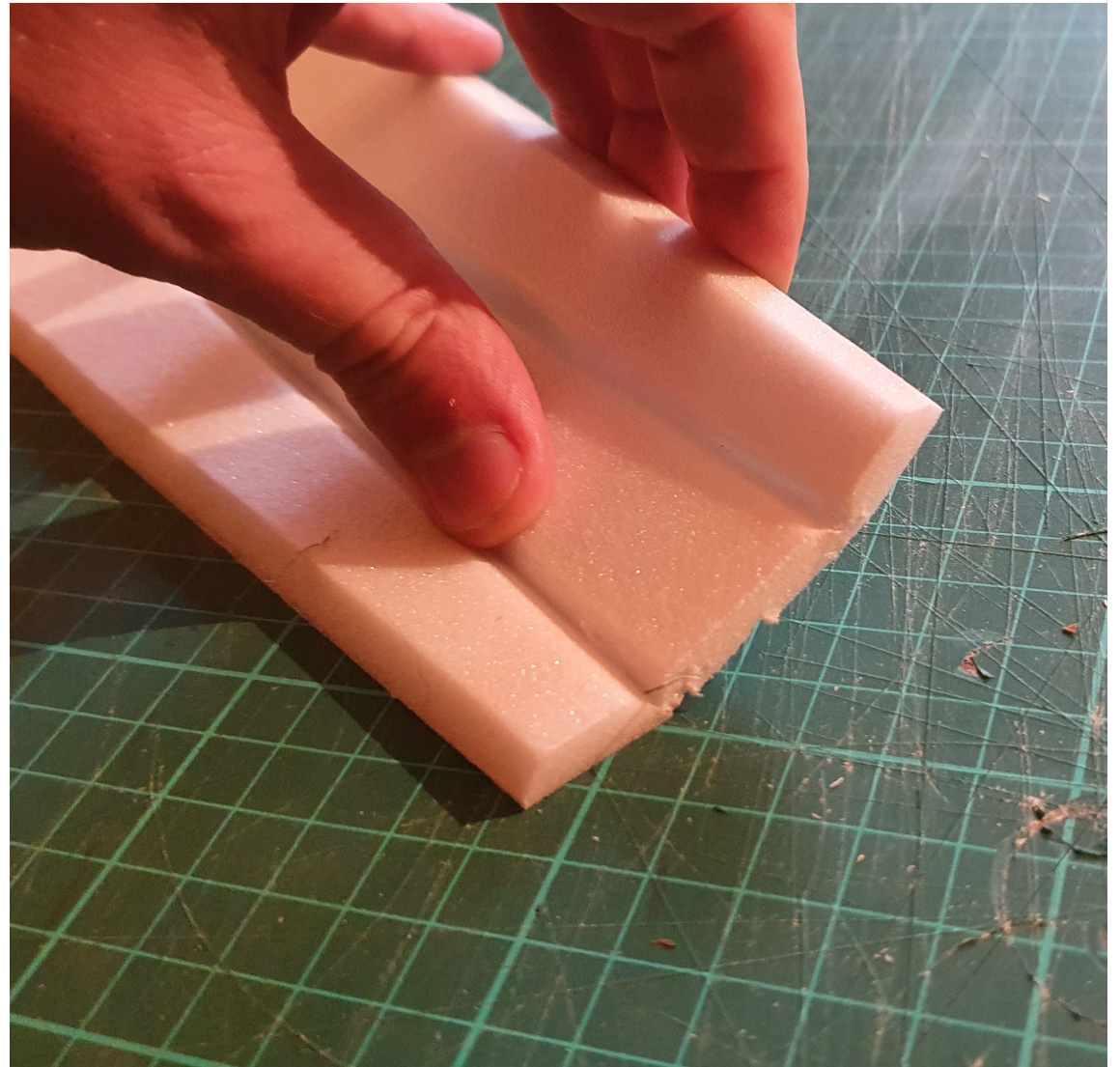
Forming the fuselage - continued

The air intake holes will be tricky and may need finishing off from the other side.



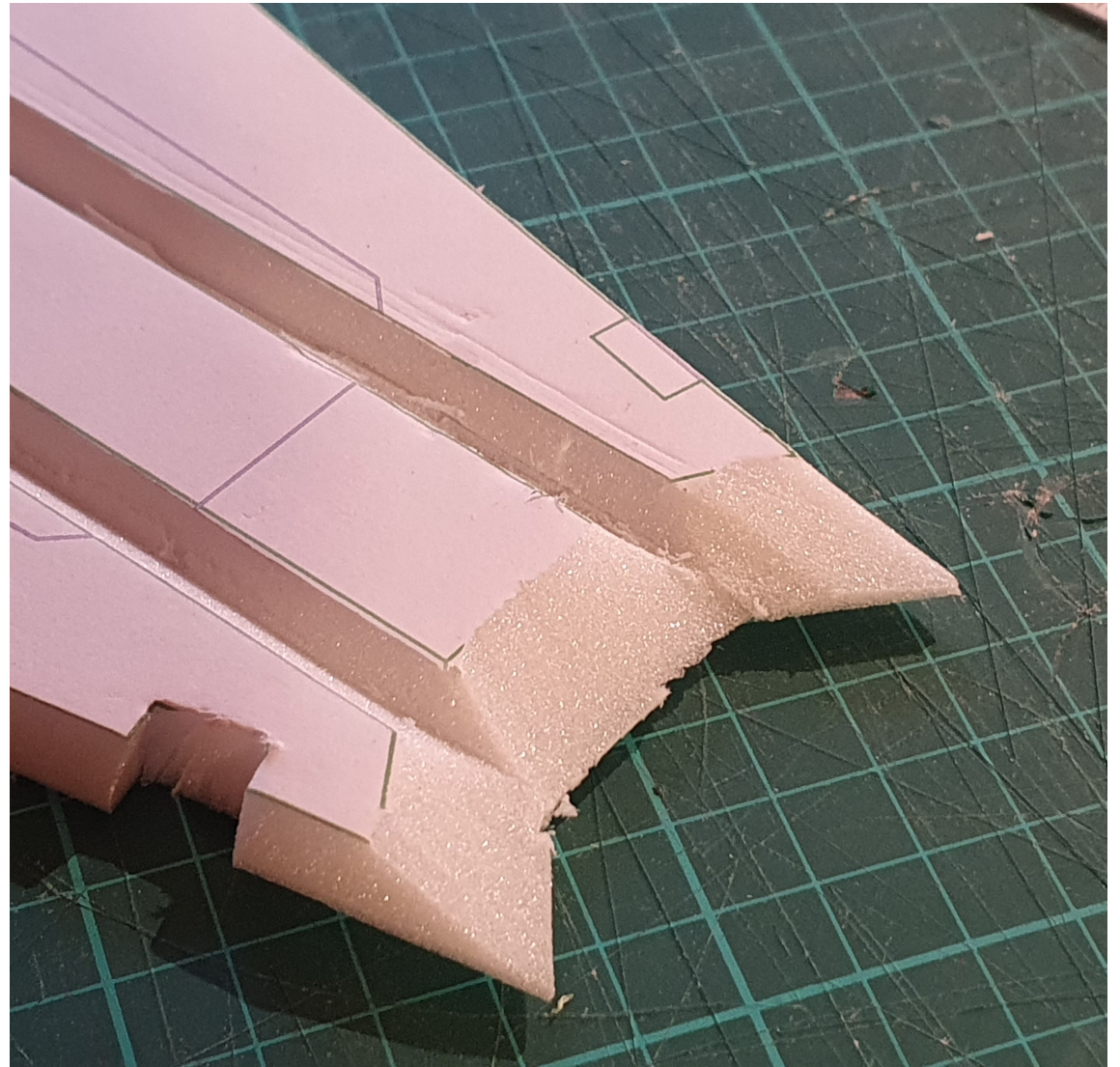
Forming the fuselage - continued

Apply tape outside along the scores on the fuselage base and form the bends.



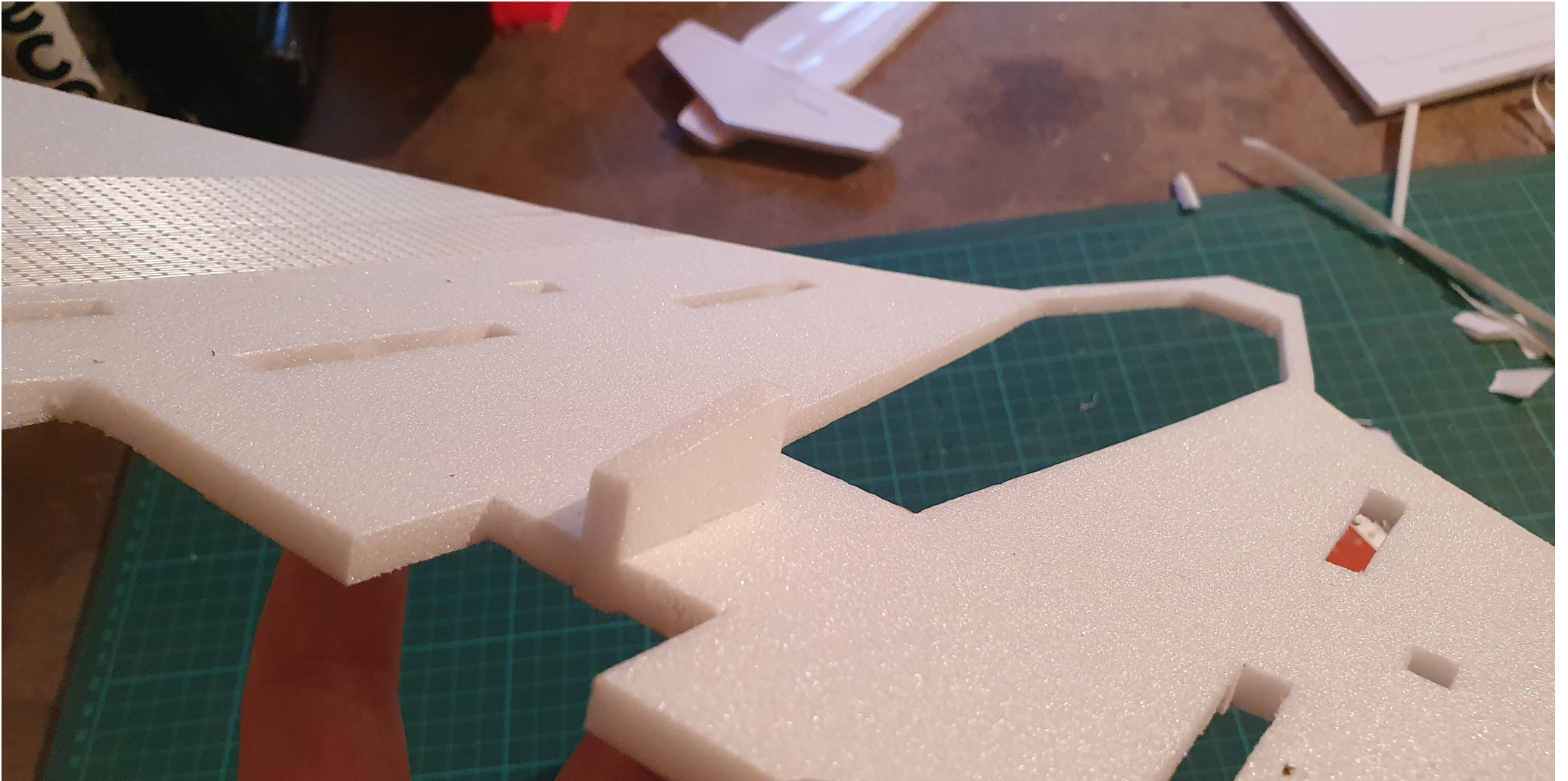
Forming the fuselage - continued

The top fuselage is just like the base except for a wide bevel on the inside of the trailing edge (this is to make room for the motor mount and wires).



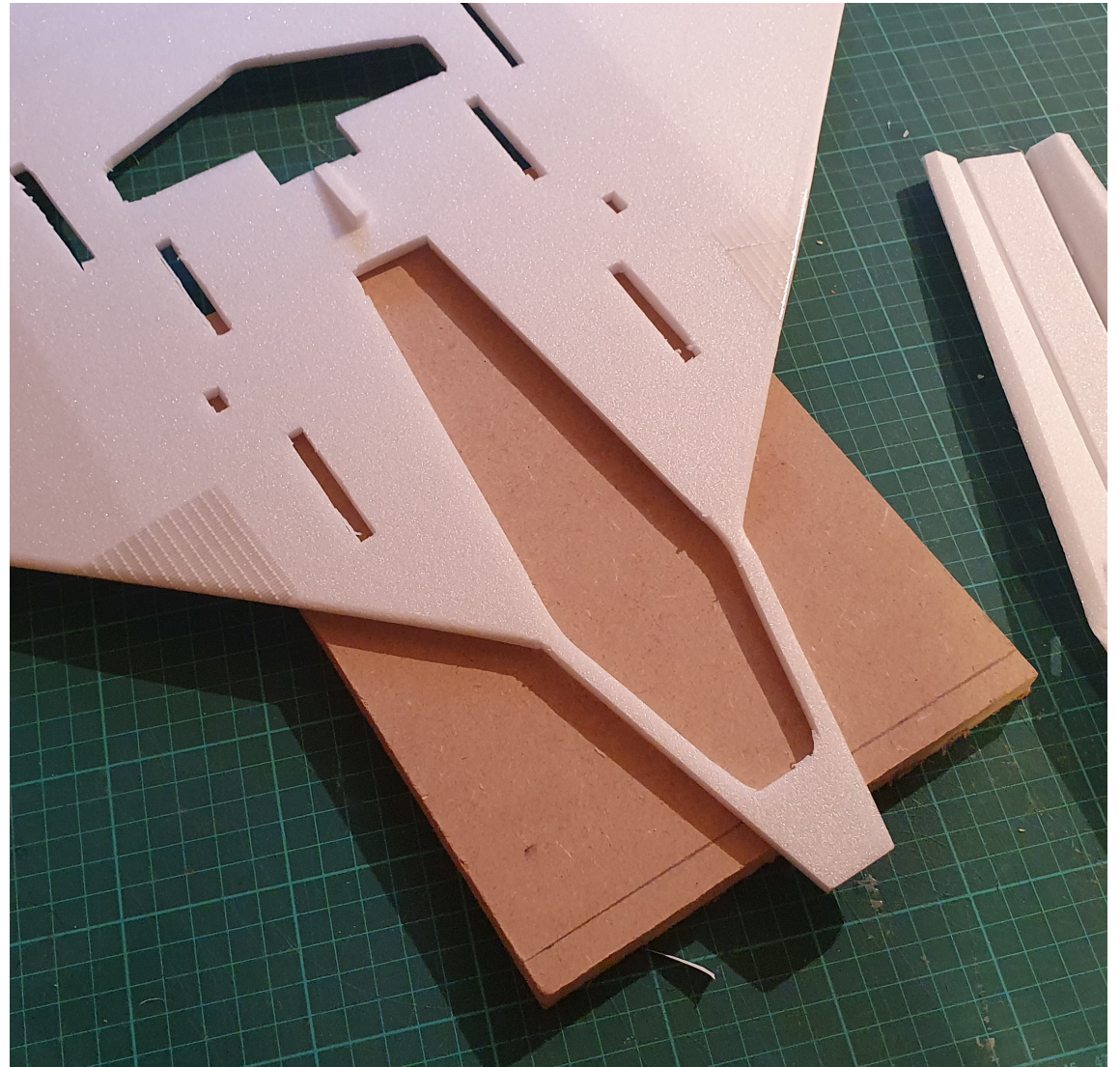
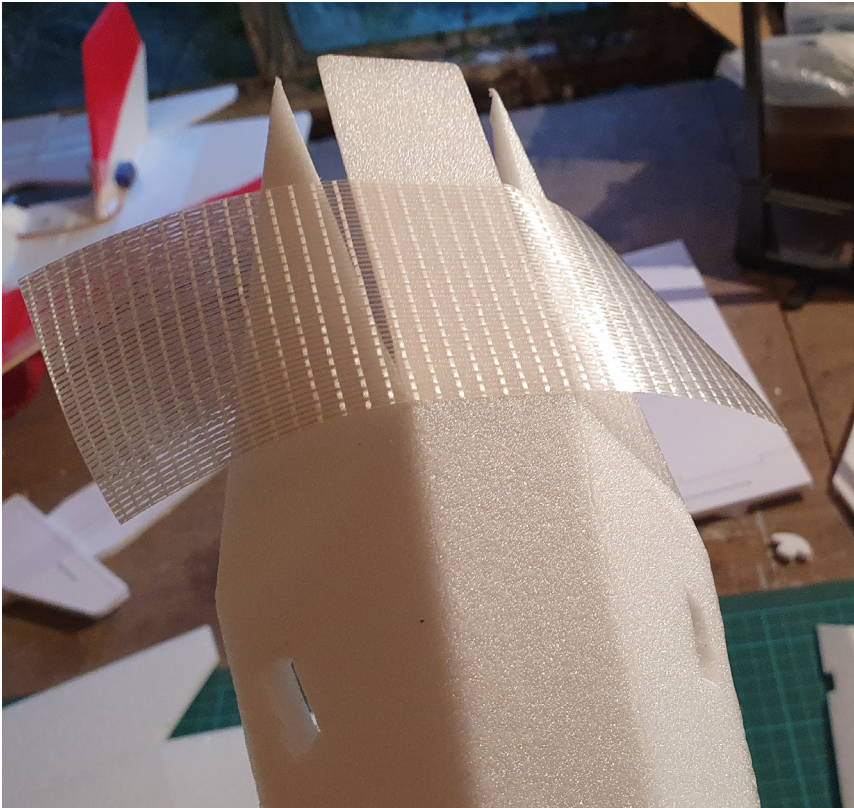
Mounting the motor and fuselage

Remove the paper from the fuselage pieces. Mix up some epoxy and stick the firewall mount onto the wing plate.



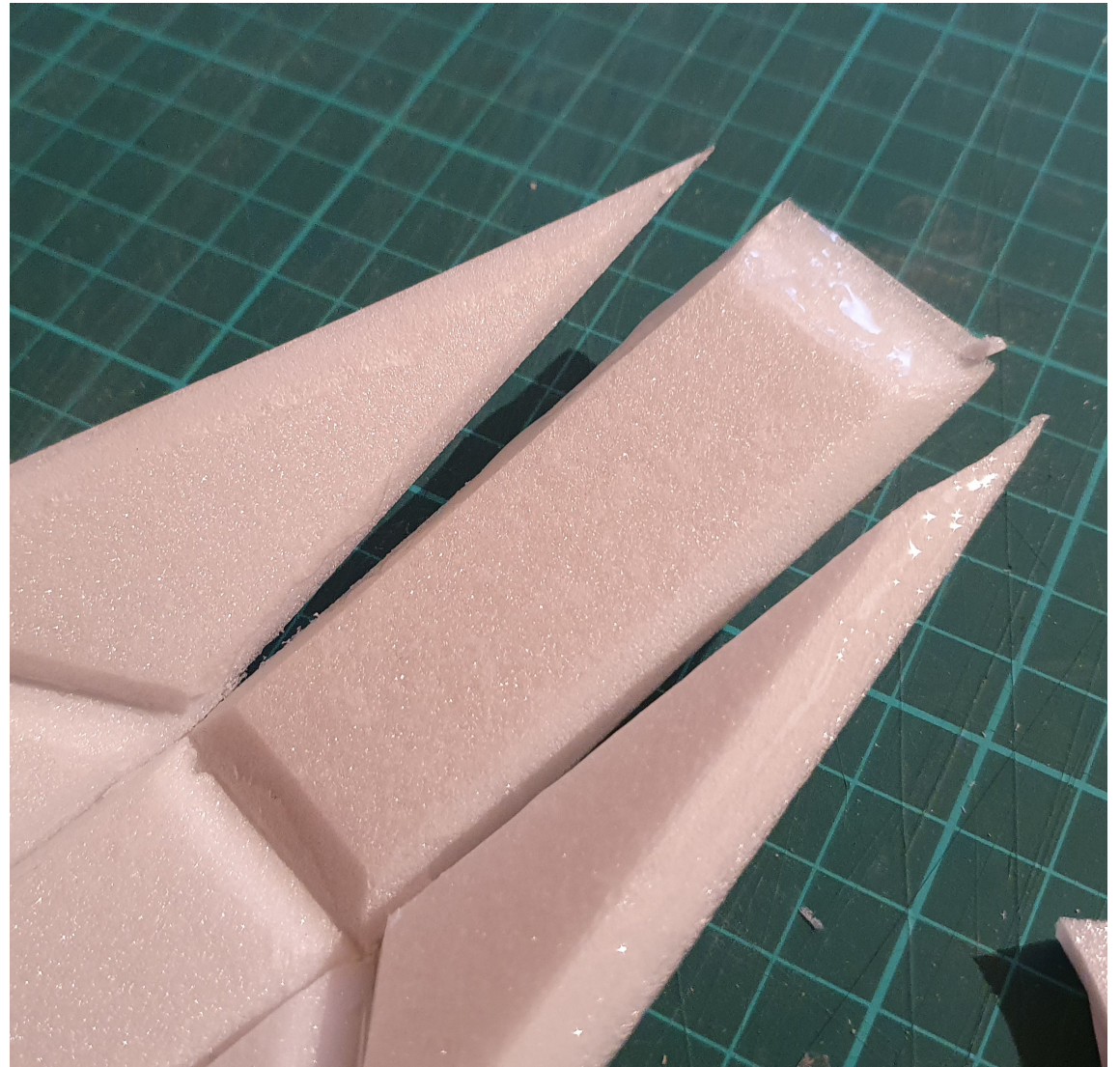
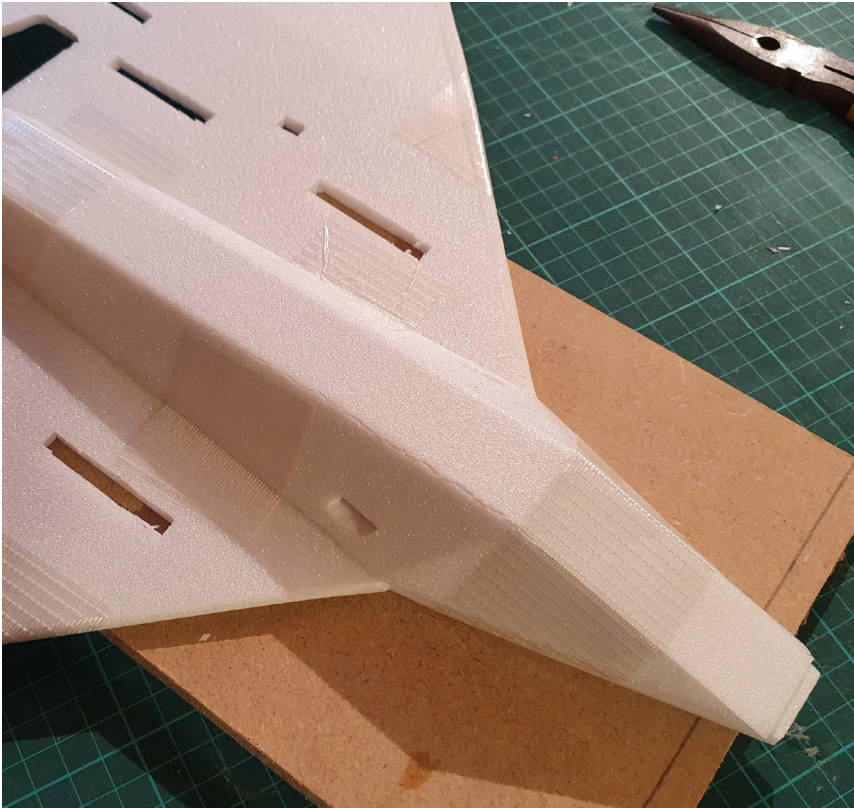
Mounting the motor and fusealge - continued

Find a board to support the wing-plate ahead of the firewall mount, keeping it off the surface. Remove the simple tape from the fuselage pieces and apply a piece of strapping tape to the centre of the nose section of the fuselage base so that it overhangs, but does not properly stick to, the triangular parts either side of it.



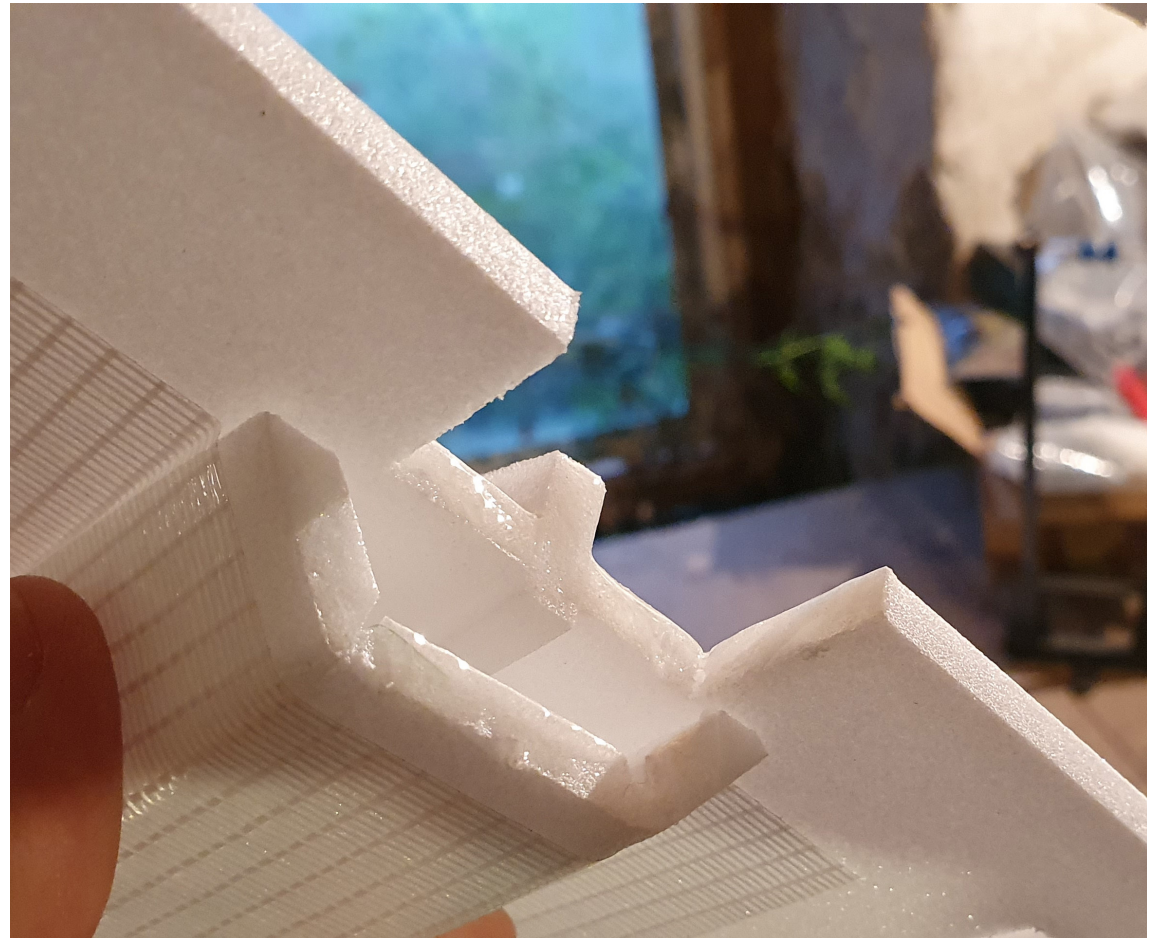
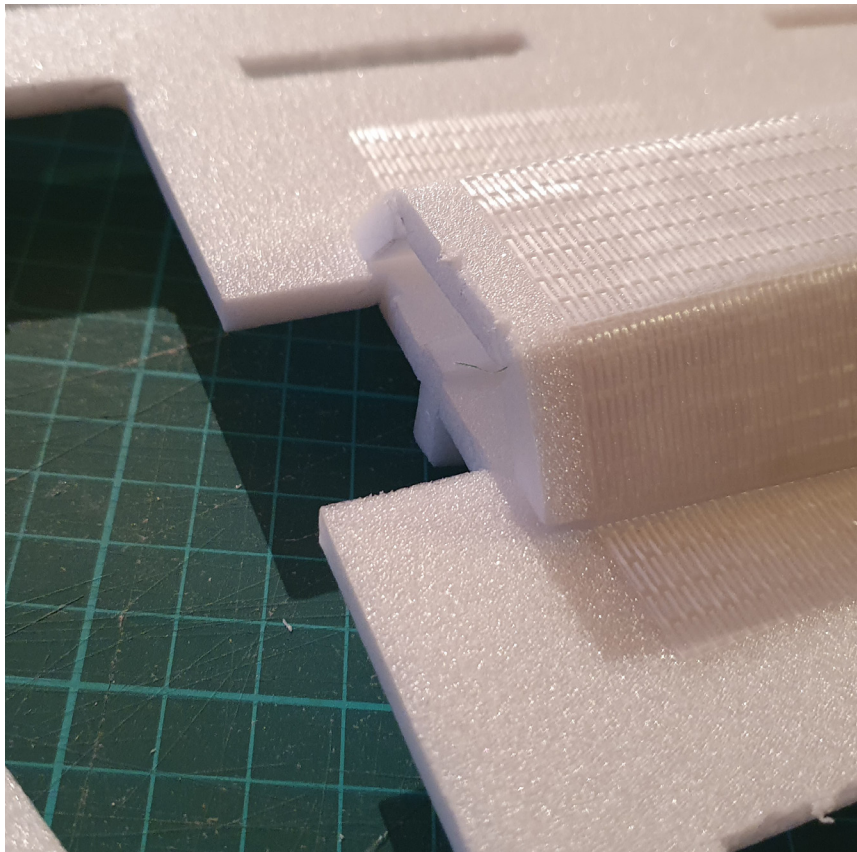
Mounting the motor and fusealge - continued

Apply epoxy (or hot glue, if you're not aiming for sub-250) along the outer edges of the bottom fuselage as pictured, ignoring the trailing edge. Place it down on the wing-plate. Place the nose-edges of the fuselage along the nose-edges of the wing-plate to find the form.



Mounting the motor and fusealge - continued

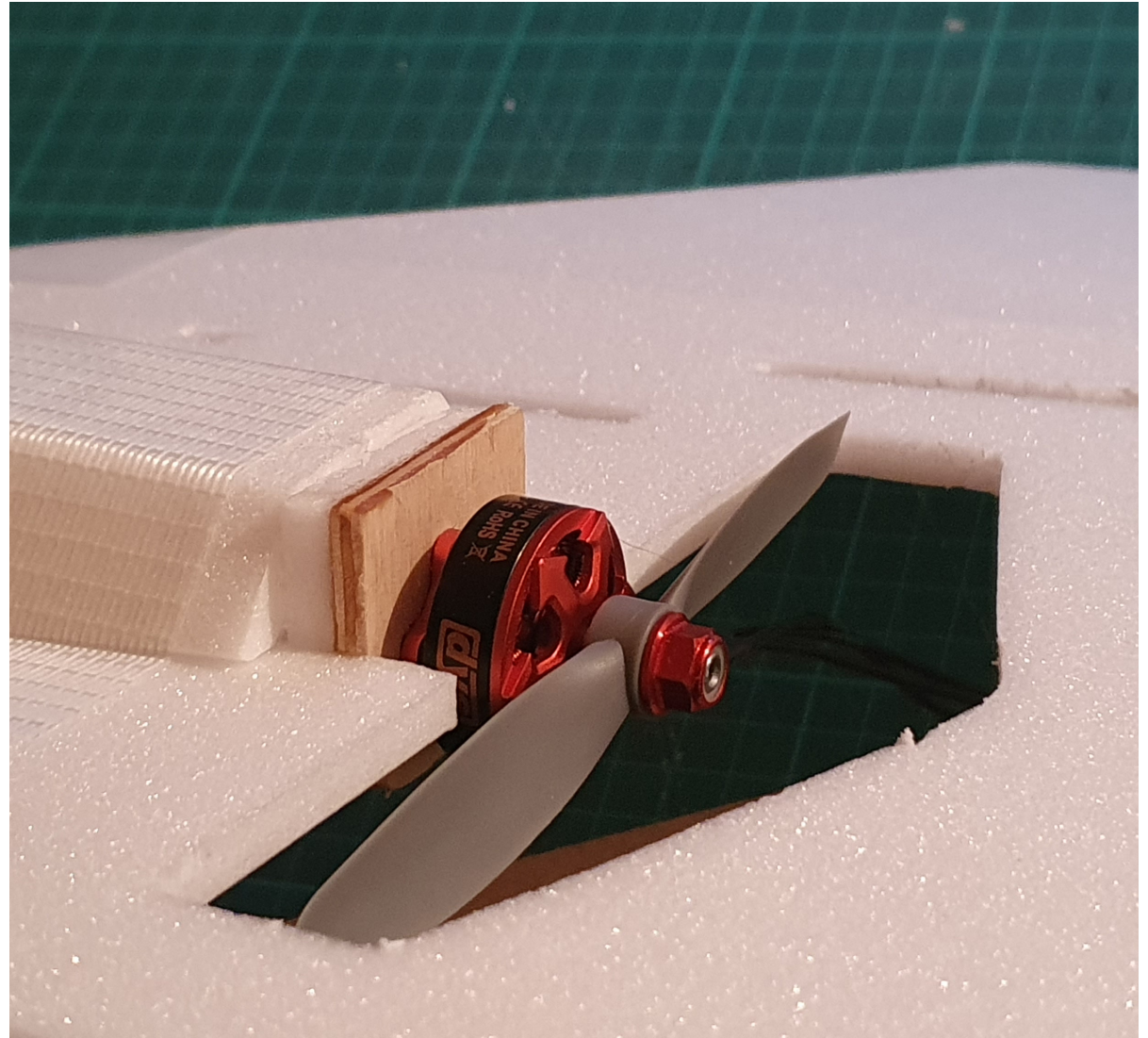
Have the trailing edge coming in so that the internal space just about matches the motor slot. Press the tape you had on the fuselage nose down against the rest of the fuselage and around the nose section of the wing-plate.



Use more strapping tape to hold down the middle and rear parts of the fuselage as well. This will allow you to continue working while the epoxy sets.

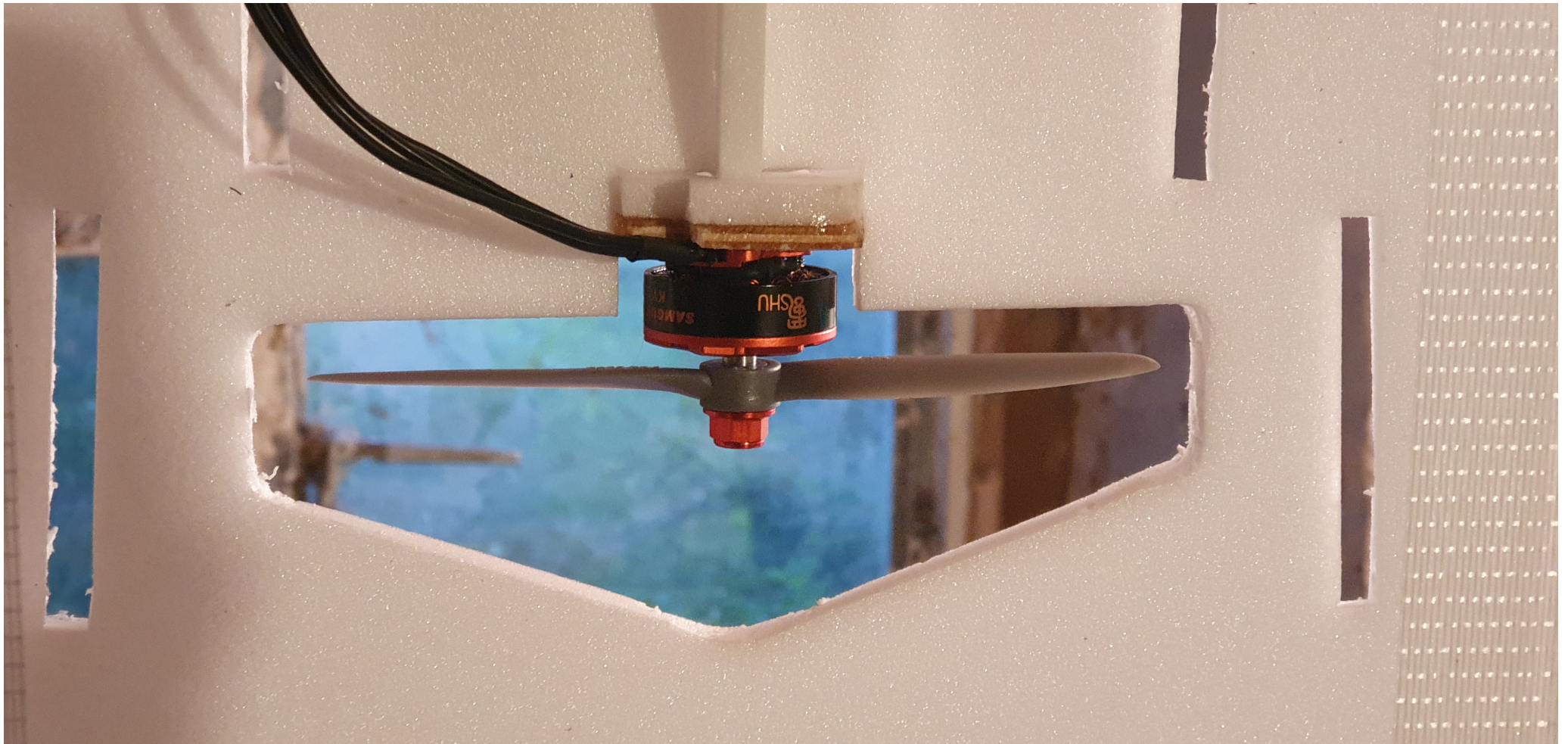
Mounting the motor and fusealge - continued

Get the glue gun heating up and apply epoxy to the trailing side of the bottom fuselage and firewall mount. Place the motor mount into the slot taking care to make sure the centre of the prop lines up with the wing-plate. If it should be on either side it would ideally be down towards the fuselage base.



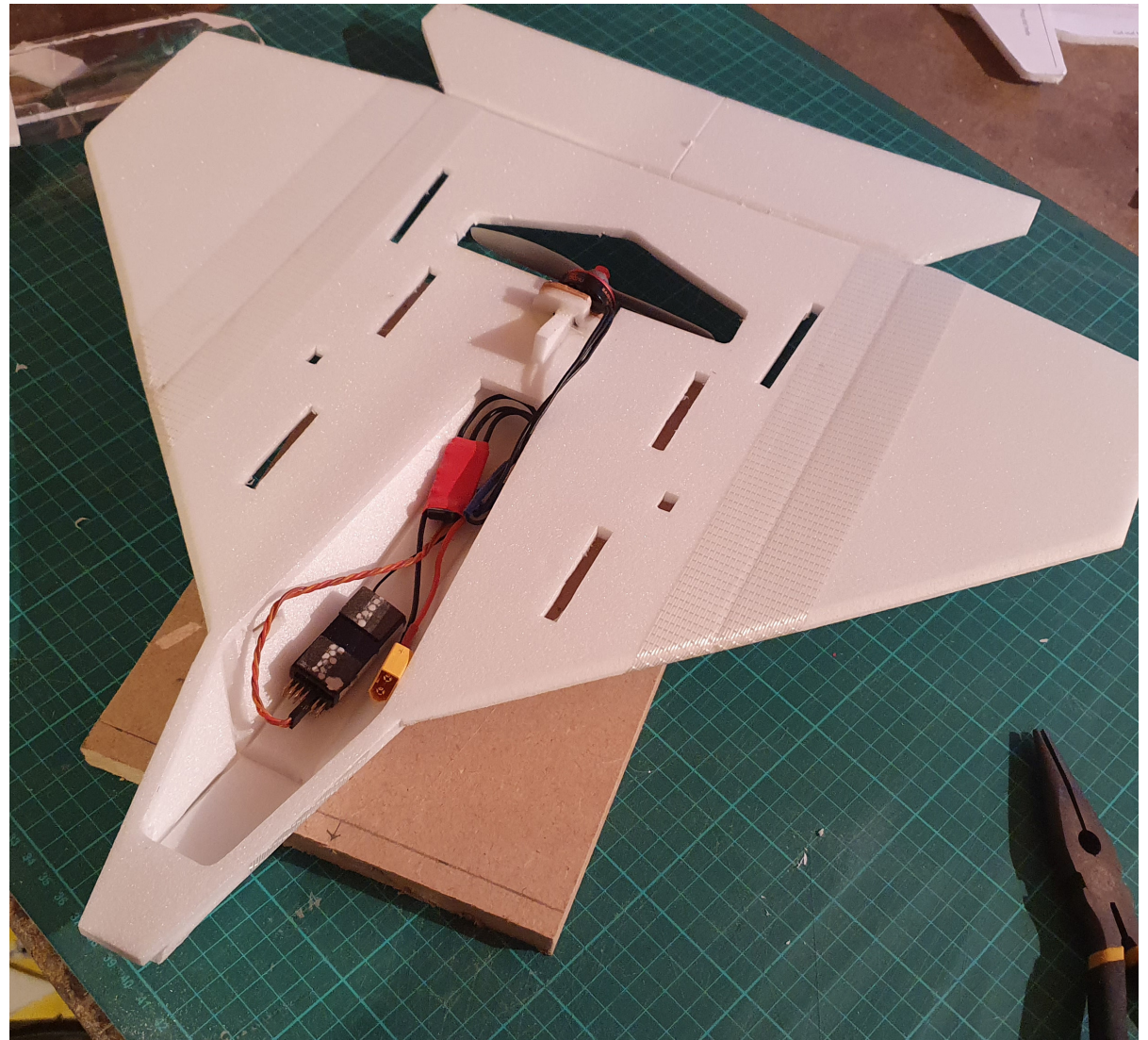
Mounting the motor and fusealge - continued

Make sure the horizontal alignment of the prop is parallel with the leading part of the prop slot. Apply some hot glue around the motor mount to reinforce the epoxy and also hold it in place while it sets.



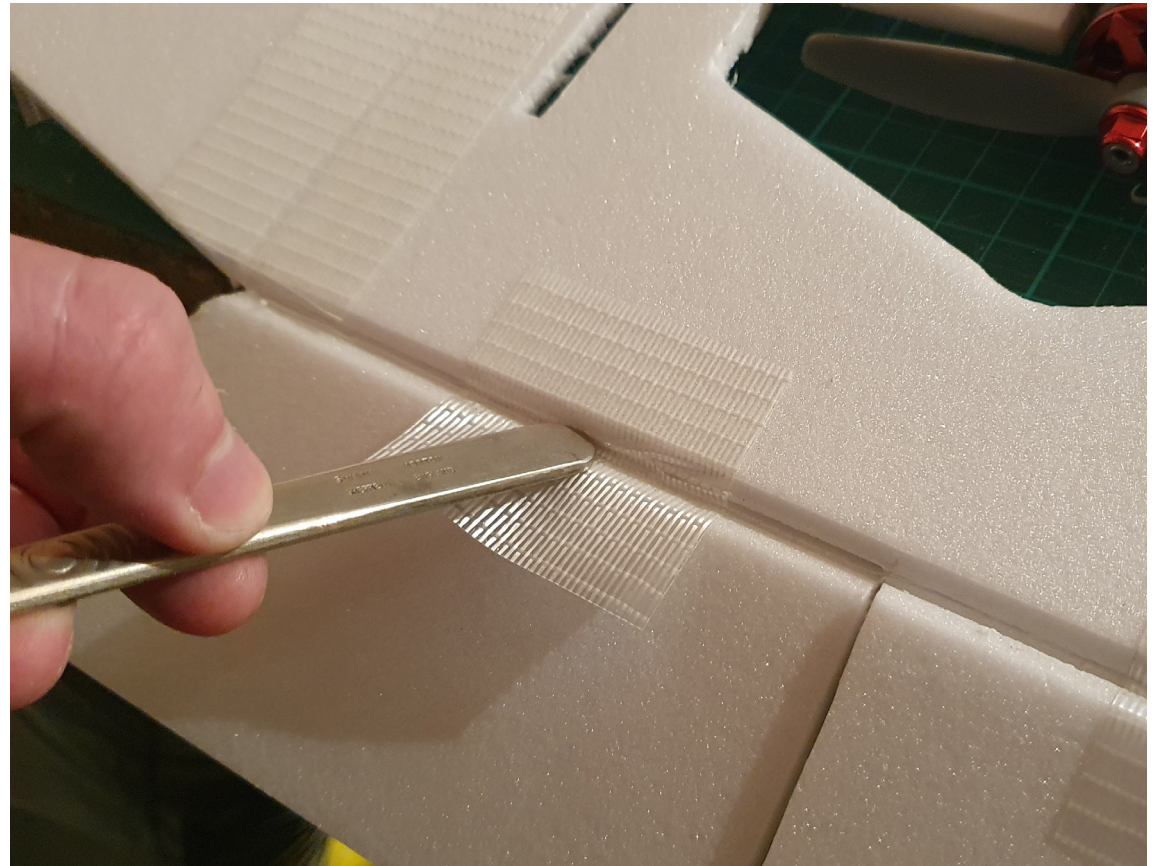
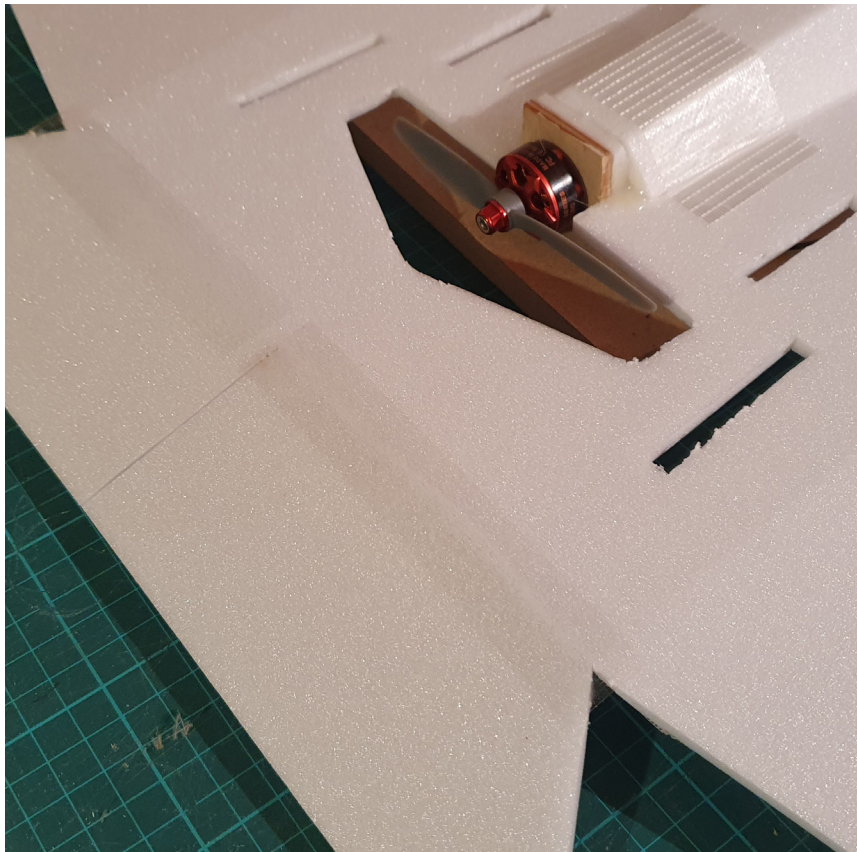
Mounting the motor and fusealge - continued

Using epoxy as opposed to hot glue will reduce the nose-weight so if you're aiming for sub 250, now may be a good time to think about sticking down internal parts. But make sure the servo wires are long enough and test that you're getting the V-tail mixer in the right way around – you will be less able to reach the receiver if its up in the nose after the top fuselage is attached. The wires on the V-tail mixer should reach well into the access area so the servos needn't be plugged in when attaching the fuselage top.



Applying control surface hinges

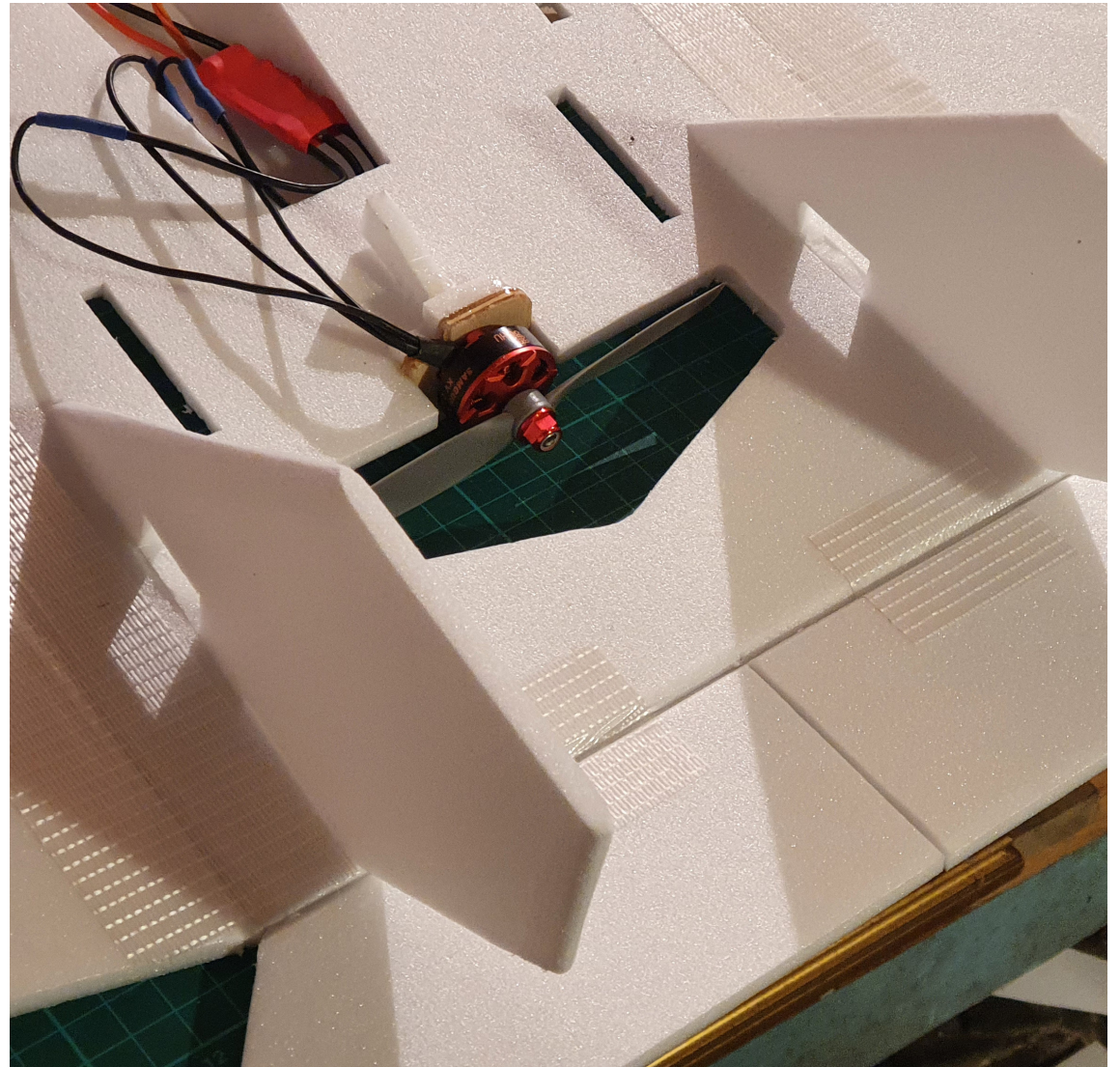
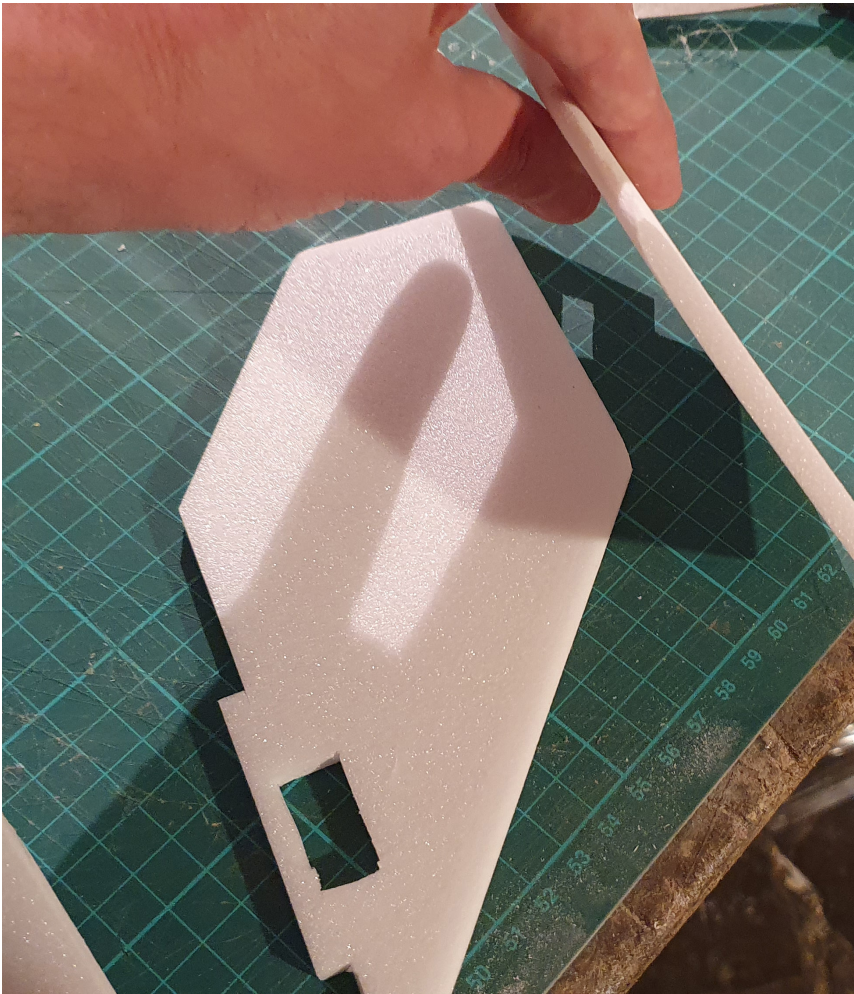
Apply simple tape along the elevon joins (opposite side from the score) and bend them down. Then remove the tape and apply a couple two-inch strips (doesn't have to be exactly 2 inches) of strapping tape to work as hinges.



Flip the plane over, push down the control surfaces again and apply a two-inch strip of strapping tape along the centre of each join using a blunt item to press the tape into the corners. With the plane now the right way up, cut off the overhanging tape from the nose.

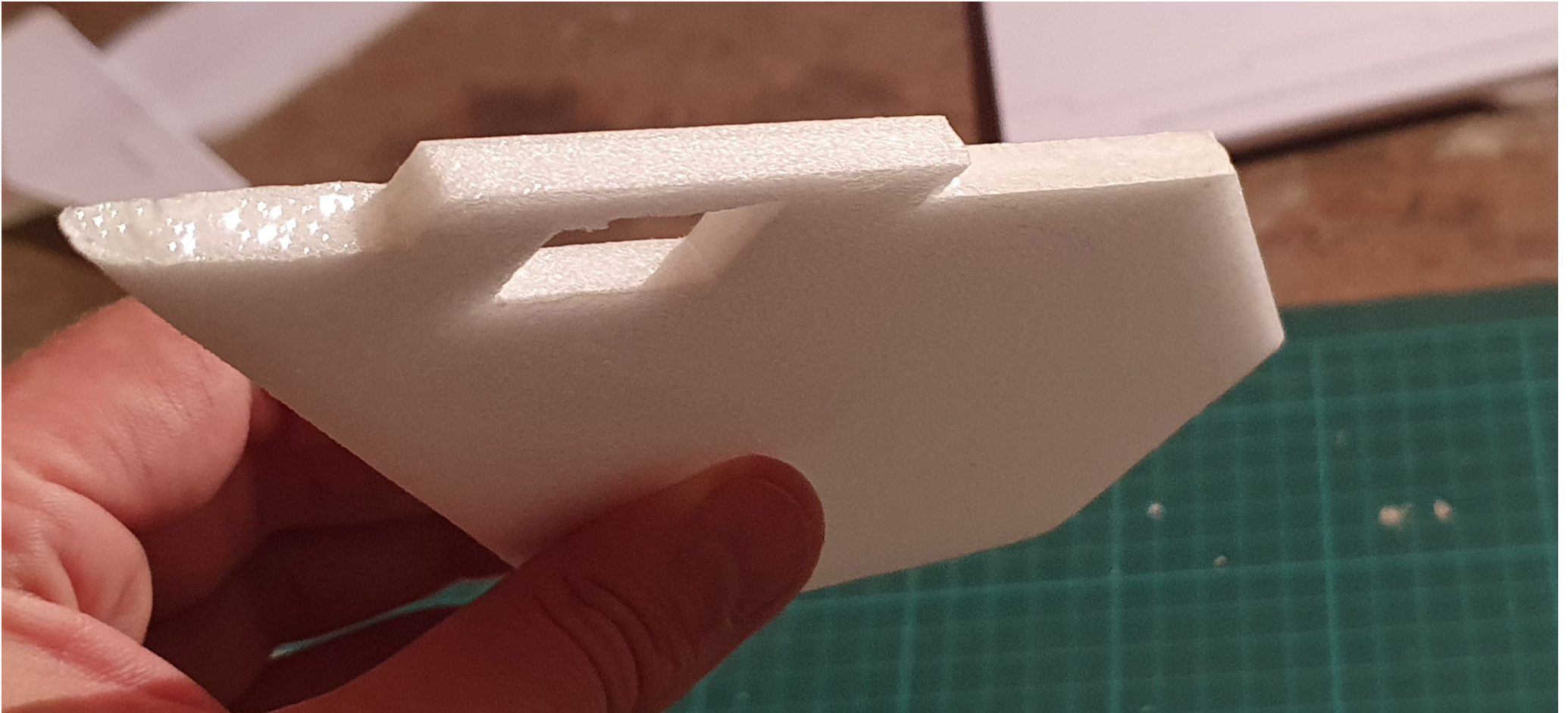
Mounting the vertical stabilisers

Sand off the leading and trailing edges of the vertical stabilisers and test the slot holes on the wing-plate.



Mounting the vertical stabilisers - continued

If they slot in easily, remove them and apply epoxy along the base edges except for the base edge of the notch. Apply epoxy around the sides of the notch. If they slotted in tight when you tested them, you can simply slot them in they will set in place while you build the rest of the plane.



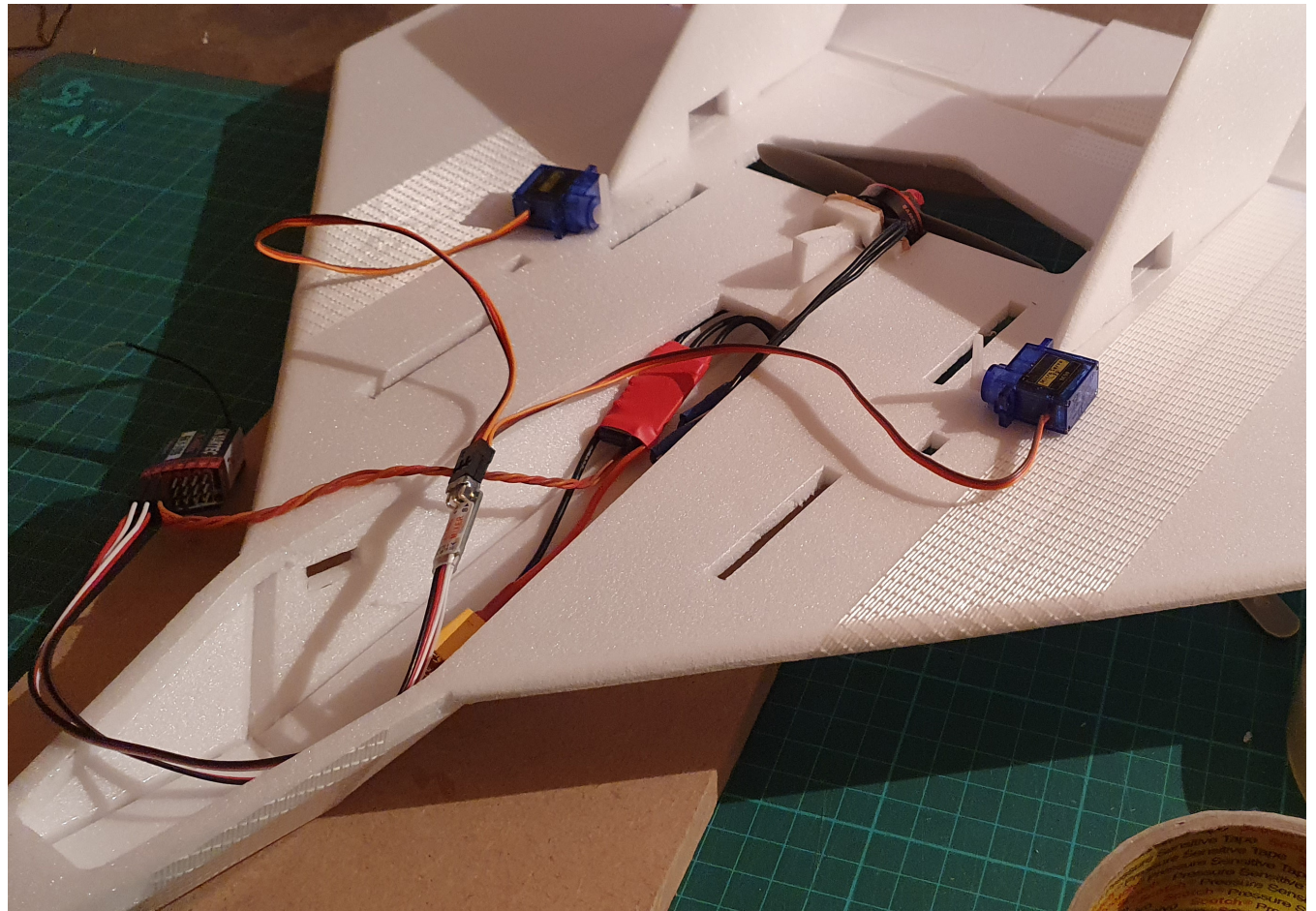
Setting up the servos

Plug your V-tail mixer into the receiver and plug the servos into that. Switch your transmitter on and power up the plane – careful not to touch the throttle. Lay out the servos with their arms on the inside and their wires going outside and test the direction. If you pull back on the stick they should both move their arms forward. Push forward on the stick and both should move backwards.

Pushing left on the stick should move the starboard arm backward and the port arm forward. Pushing right on the stick should move the starboard arm forward and the port arm backward.

If arms aren't going forward and backwards together with forward/backward movement of the stick and invert on each other on sideways movement of the stick, the aileron and elevator plugs are the wrong way around.

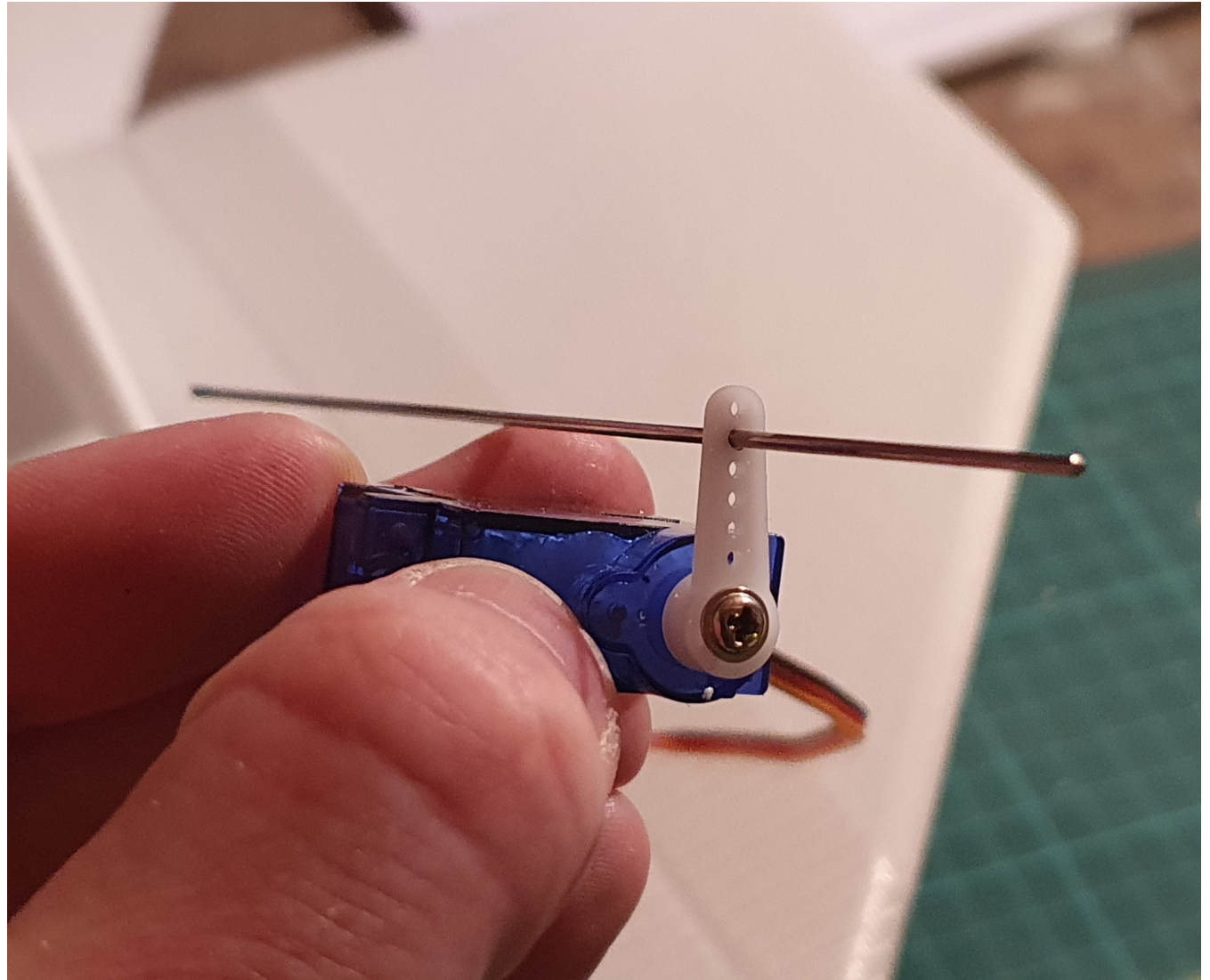
If servo arms are doing the correct movements together with the stick input but moving the arms the wrong way, you can reverse the inputs in your transmitter.



Mounting the vertical stabilisers - continued

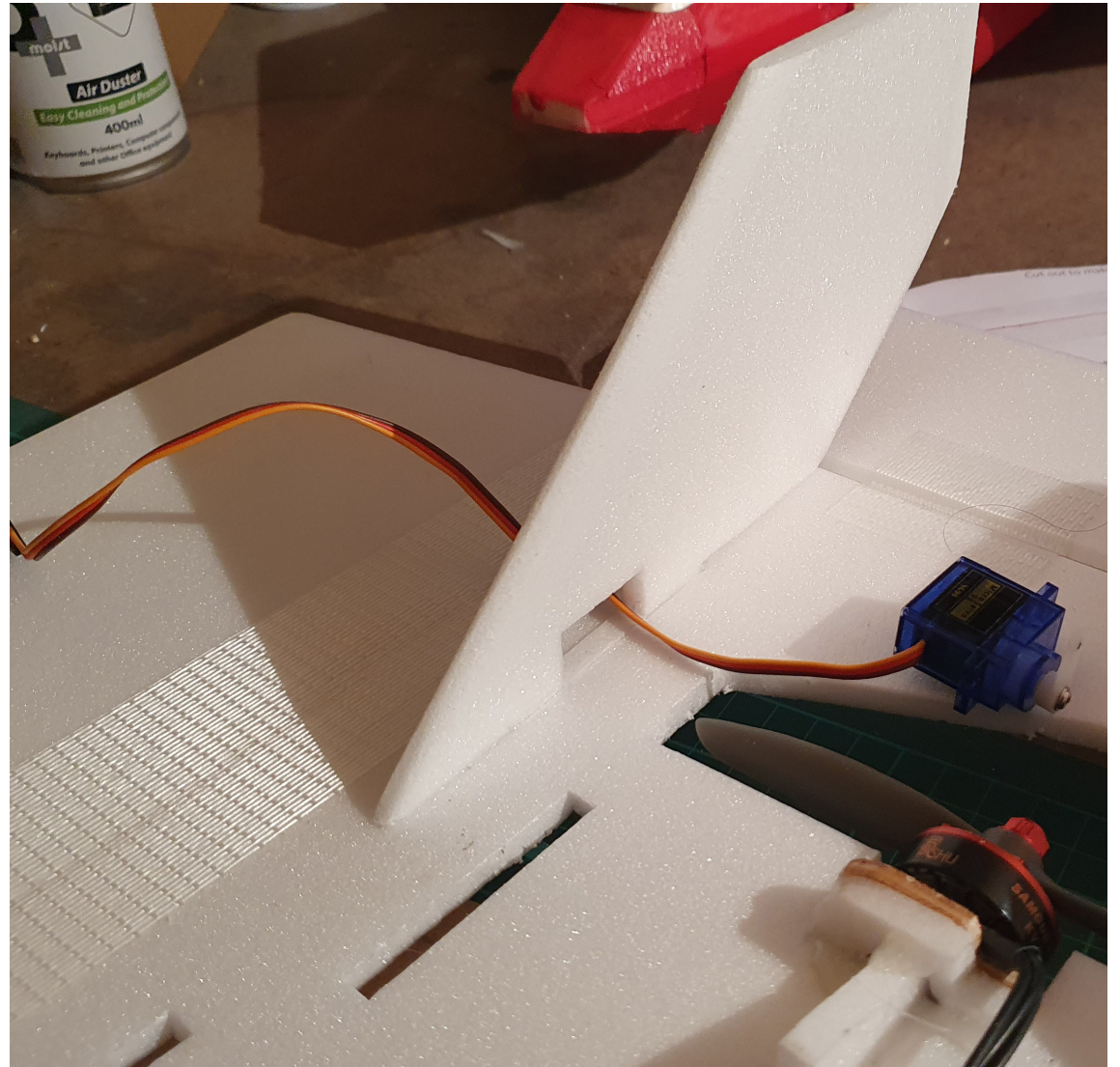
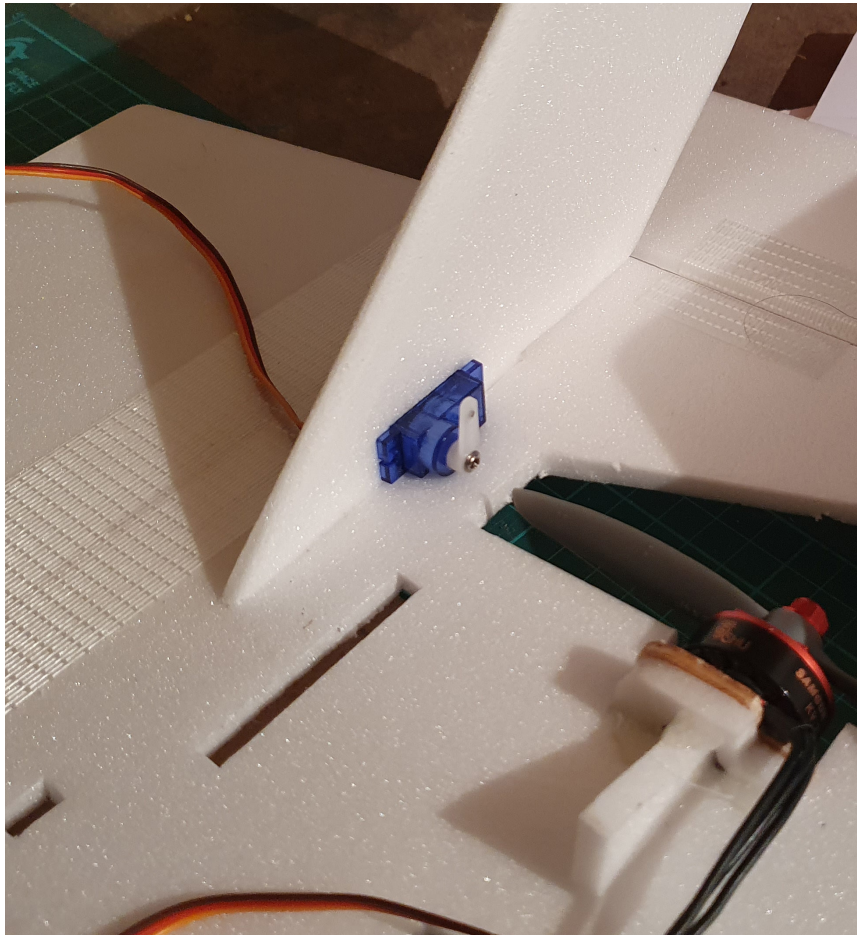
With the servo direction confirmed, power off the plane, the transmitter and unplug the servos. Before setting them in, make sure the push-rods you have fit the servo arms. If they don't fit through the holes, you can heat up the rod over a flame and melt it through the hole. Alternatively you can grind the hole with a scalpel to widen it.

If the hole seems just slightly too small for the push-rod, a heated rod should be easy to push through. Once through, work the hole a little loose (moving the push-rod back and forth in the hole achieves this) and remove the push-rod.



Mounting the vertical stabilisers - continued

Thread the servo wire through the servo hole on the vertical stabiliser from inside to out, slot the servo into the servo hole and apply hot glue to hold it in place.



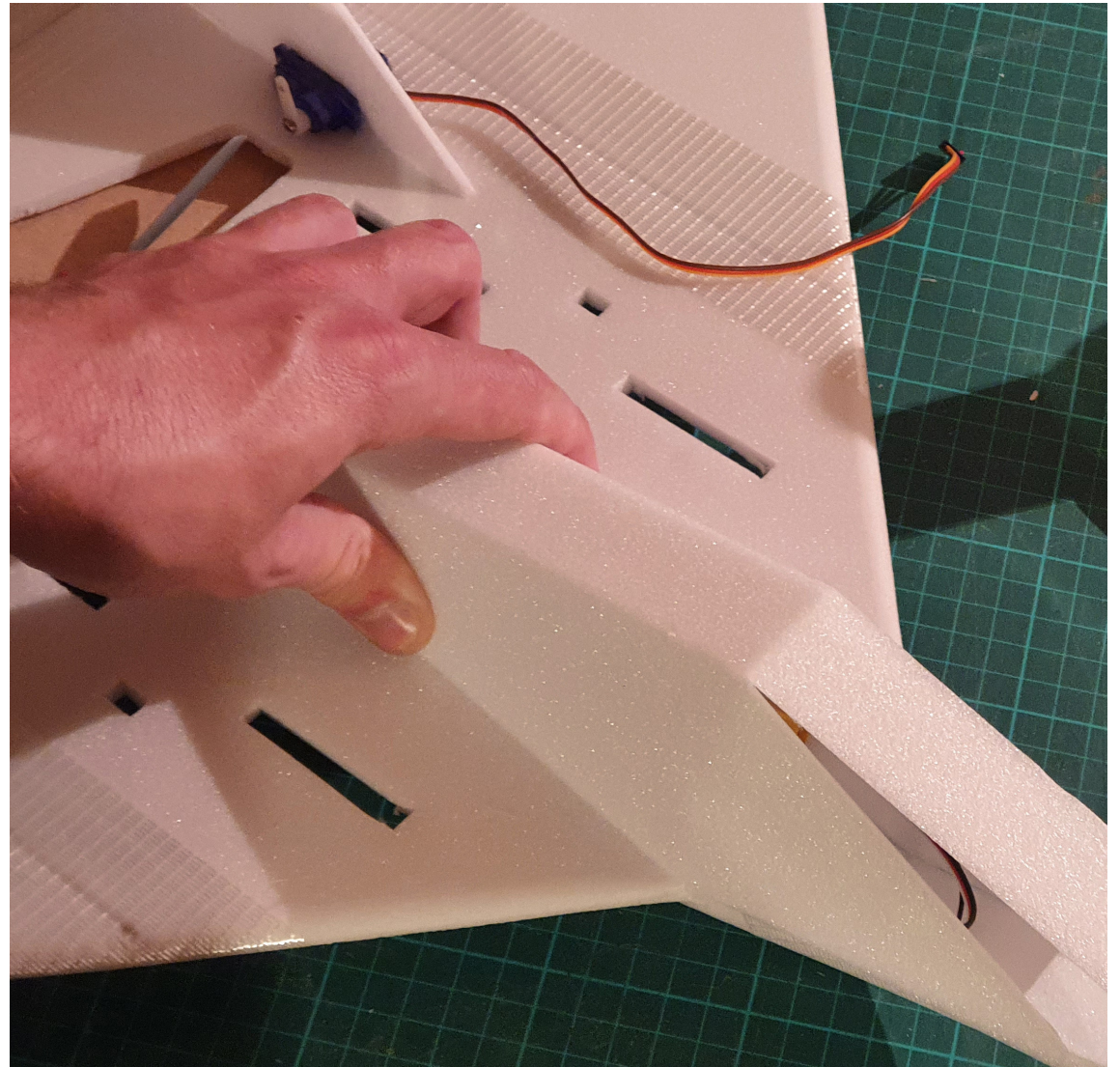
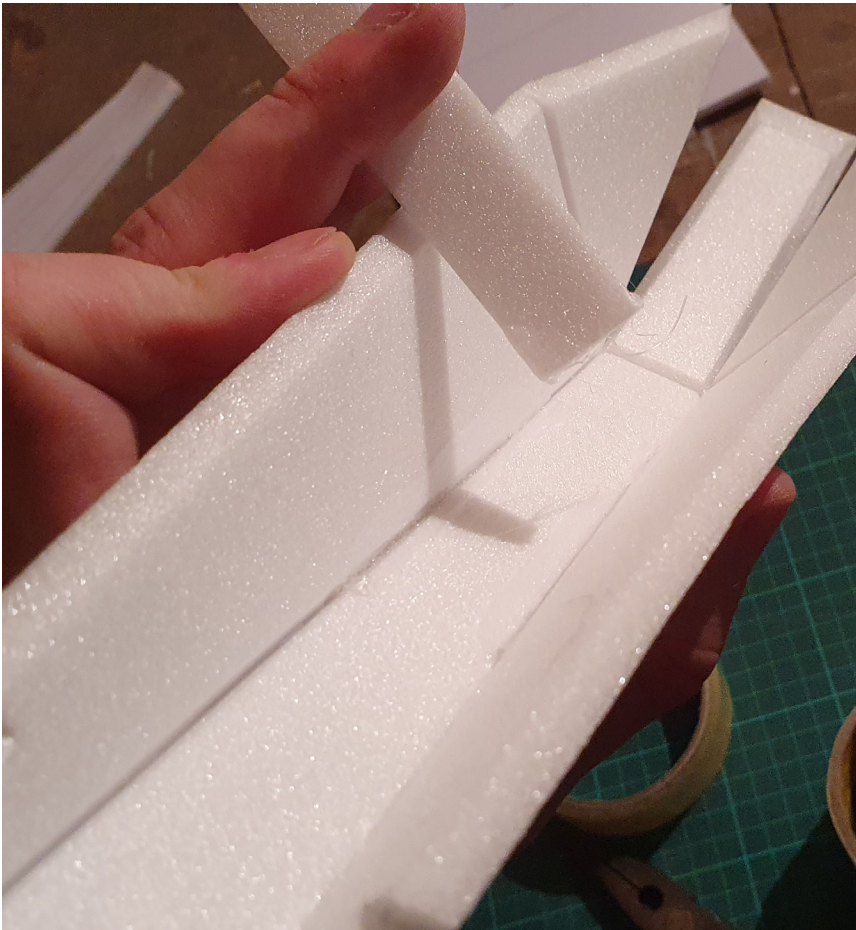
Forming the top fuselage

Now it is time to set on the fuselage top. You will want to apply hot glue to the interior dorsal scores of the fuselage top along where you want to have the hatch formed. Leave gaps in the glue where you think you are going to cut the hatch.



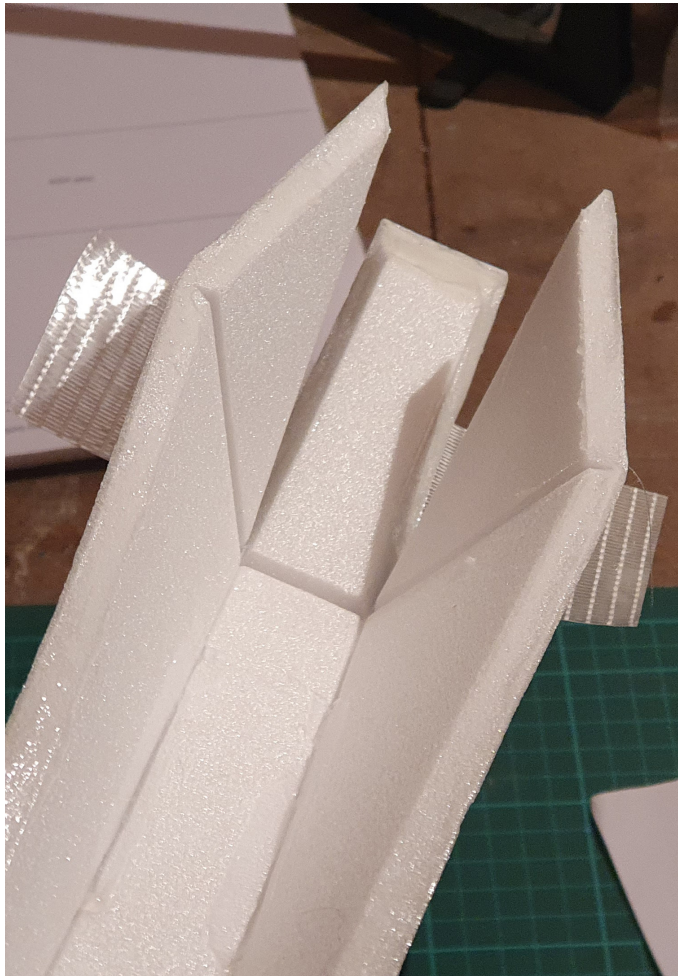
forming the top fuselage - continued

Bend the fuselage top to form and smooth out the hot glue with a piece of foam. Press the fuselage top to the wing plate and hold its form while the glue sets



forming the top fuselage - continued

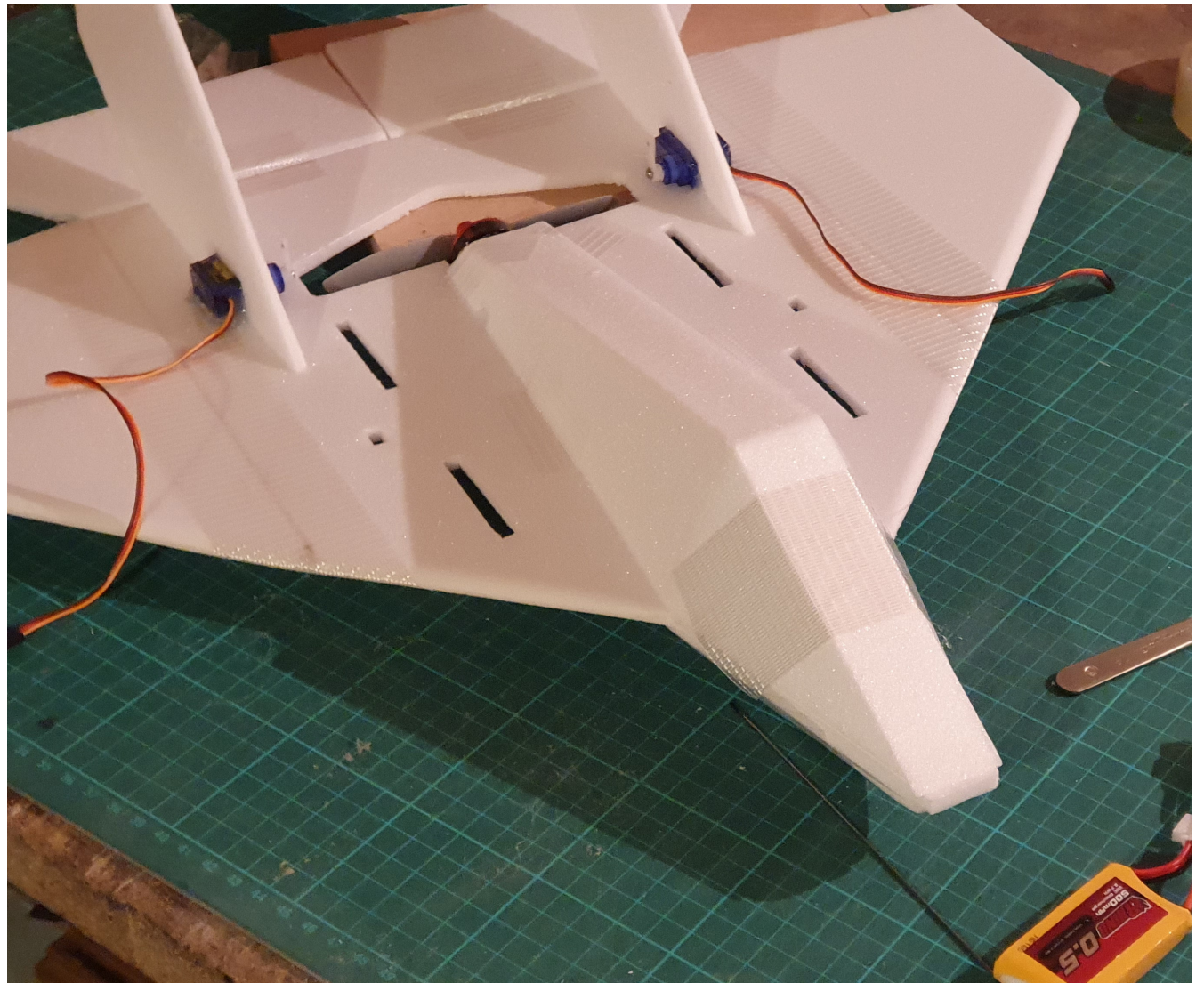
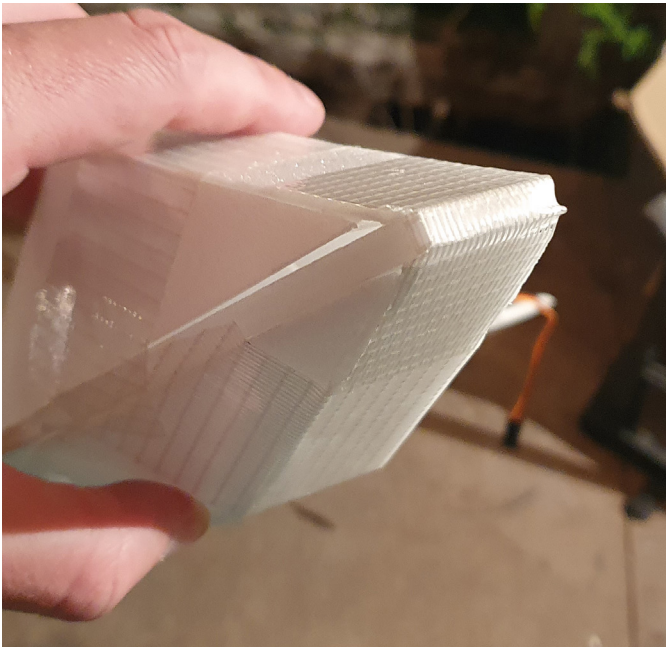
Next, place a piece of strapping tape along the central nose panel like you did with the fuselage-base. Apply epoxy to the sides that will contact the wing plate. If you want a little bit of extra nose-weight, use hot glue for the nose section, as well as on the joins.



forming the top fuselage - continued

Place the fuselage down on the wing-plate, and form the nose, again to the nose section of the wing-plate and press the tape down of the entire nose.

Apply a strip of strapping tape over the front of the nose to give it a smoother edge and reinforce it for when it inevitably takes a bump.



Adding CoG Notches

Cut out the CoG notches, apply epoxy and set them into the CoG notch-holes on the wing plate. These will help you find the correct battery position to balance the weight correctly.



Forming the half-pipe

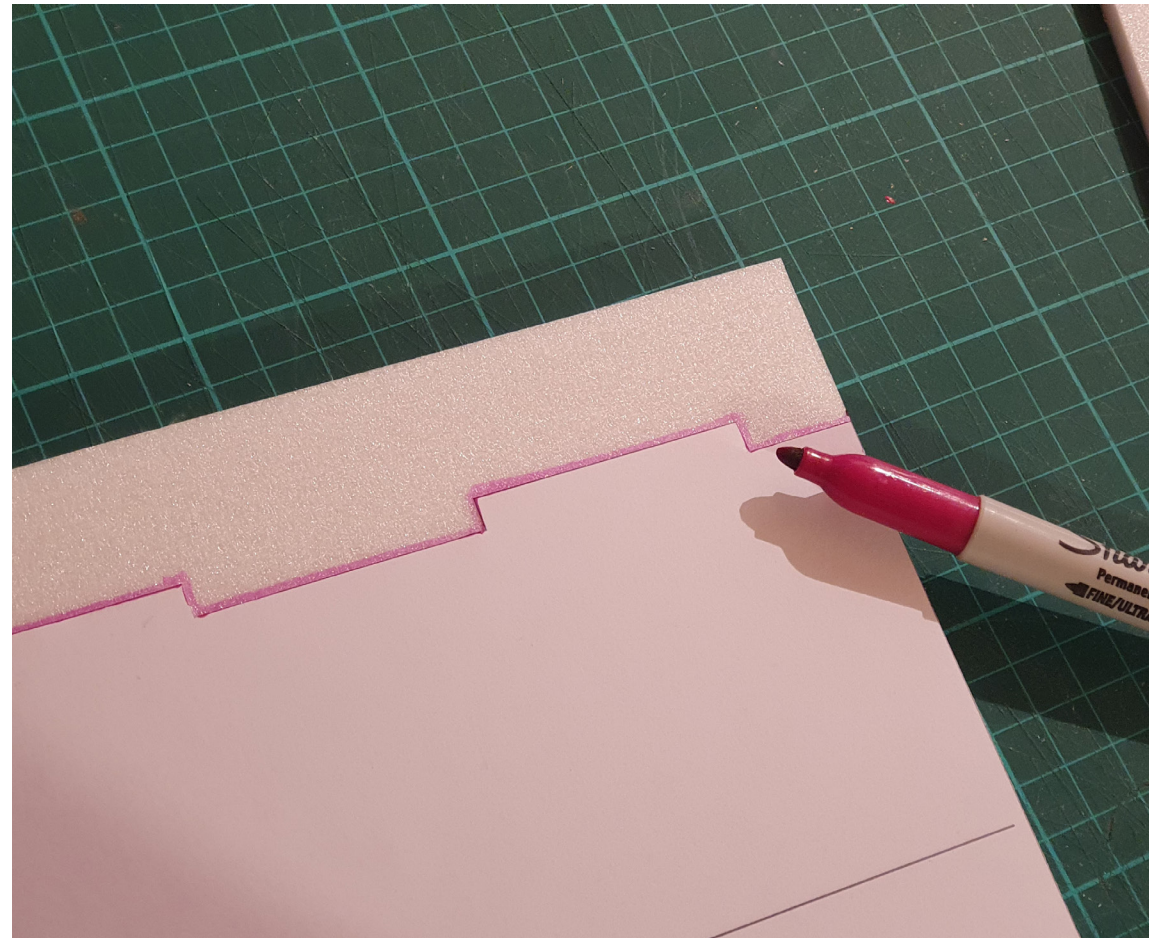
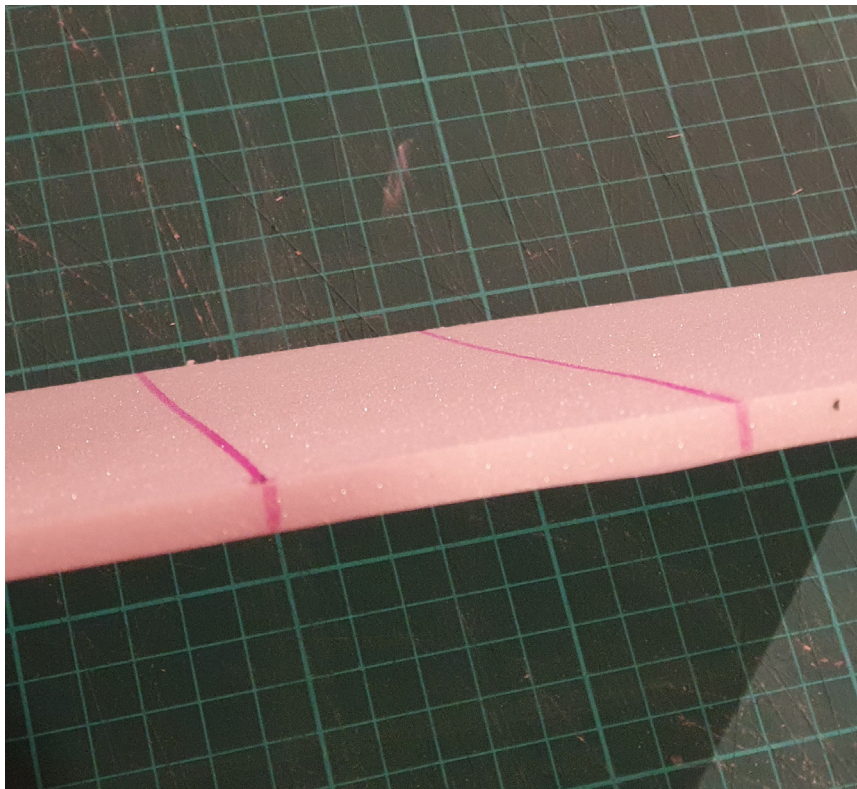
Now for the final piece on the model; the half-pipe underbelly. This is the one piece you will need to cut clean from the paper with no extra paper going beyond the cutting lines.



When gluing to the foam and cutting, make sure to leave an extra couple inches of foam beyond the notched edges. The extra foam will make this piece easier to bend to shape.

Forming the half-pipe - continued

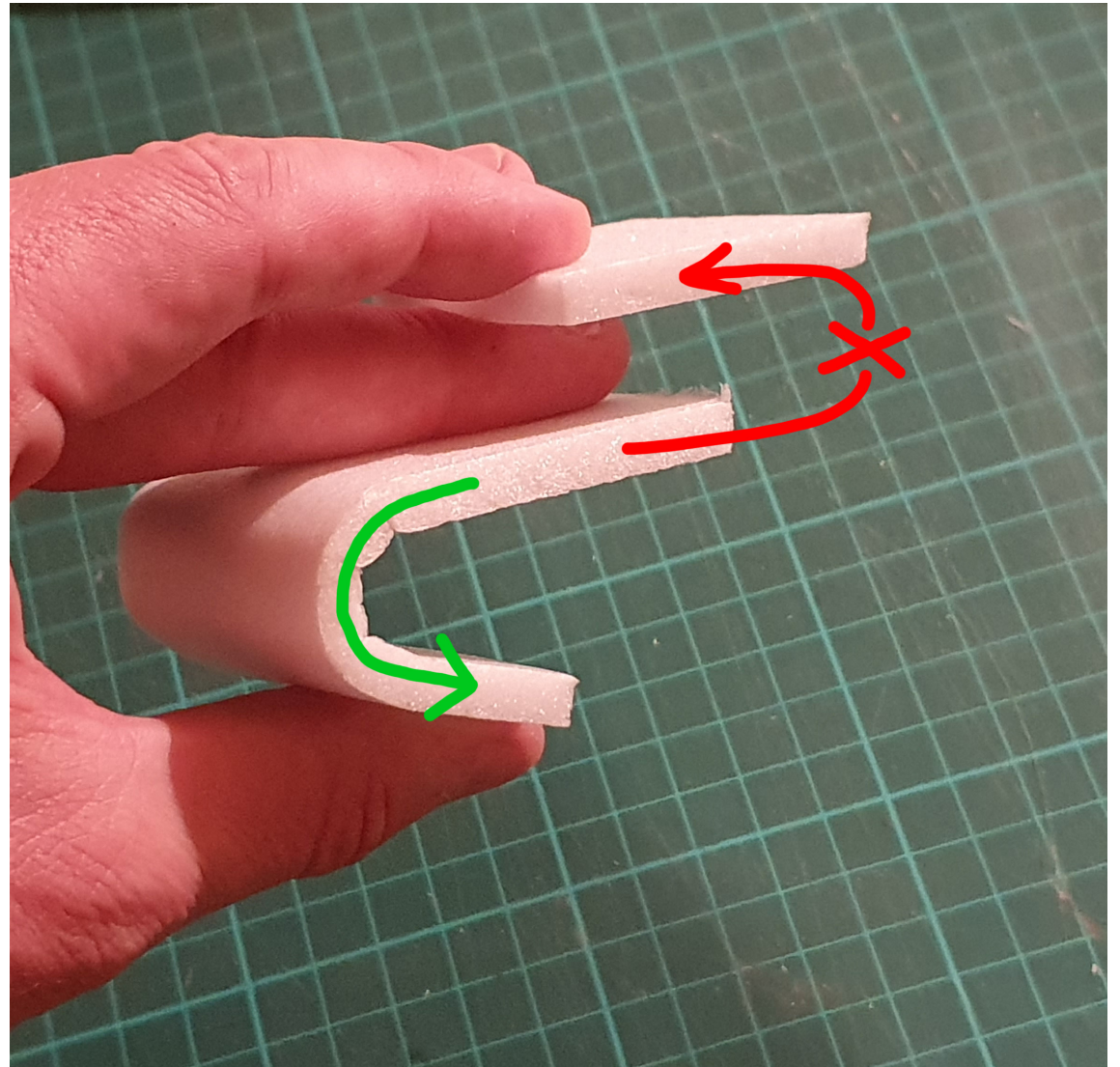
Now here's why I had you cut the notch edges from the paper earlier. Use a felt-tip pen or sharpie and trace along the edges to stain the foam with ink without scoring it. Any score, even one left by a ball-point pen can cause the foam to snap when you're trying to bend it.



Draw lines down to stain the leading and trailing straight edges where the black lines start and finish. Remove the paper and use a ruler to stain lines along where the black lines were.

Forming the half-pipe - continued

For bending the foam you will likely find the foam board is easier to bend one way without snapping than it is the other. You may also find that your foam has a slightly different texture on each side. Use these to identify which way the foam bends more easily.



Forming the half-pipe - continued

There are various ways to bend foam. When building the prototype I moved it back and forth along the smooth edge of a kitchen work surface, pressing down on the overhanging edge. This is a slow process that takes patience to bend the foam without snapping it, but it can be done.

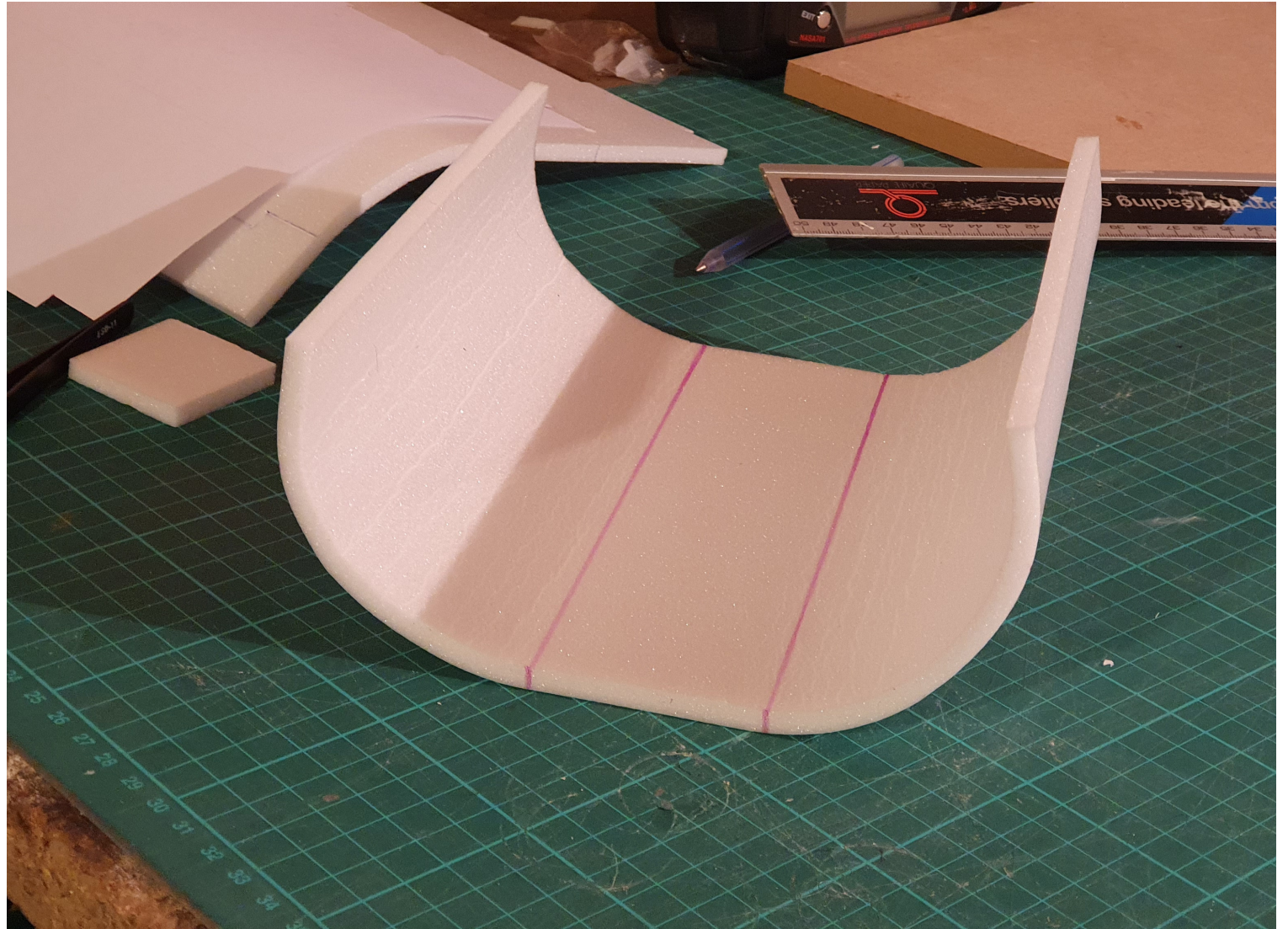


It is easier and faster to roll the foam over two pipes with the third pipe pressing down from above. This is of course made even easier if you find a way to keep the bottom two pipes from moving while you roll them.

Tip: applying tape to the outer side of the foam will help prevent accidentally snapping it when bending.

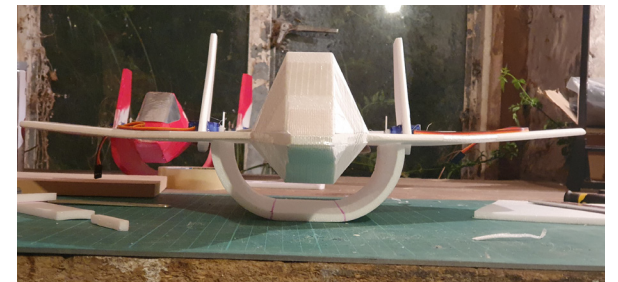
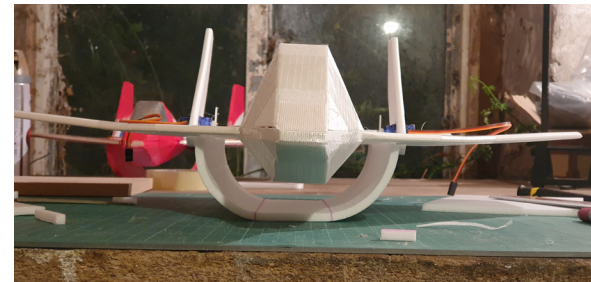
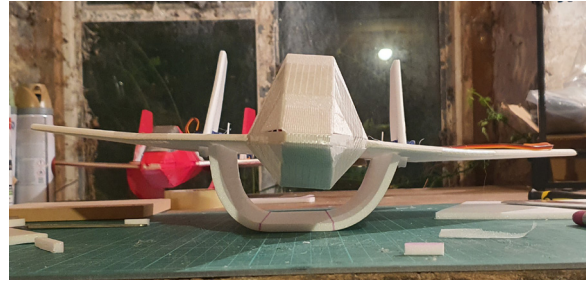
Forming the half-pipe - continued

Aim to bend up to the lines you stained nearer the middle – we want the central section of the half pipe to be flat, so the plane sits level on it.



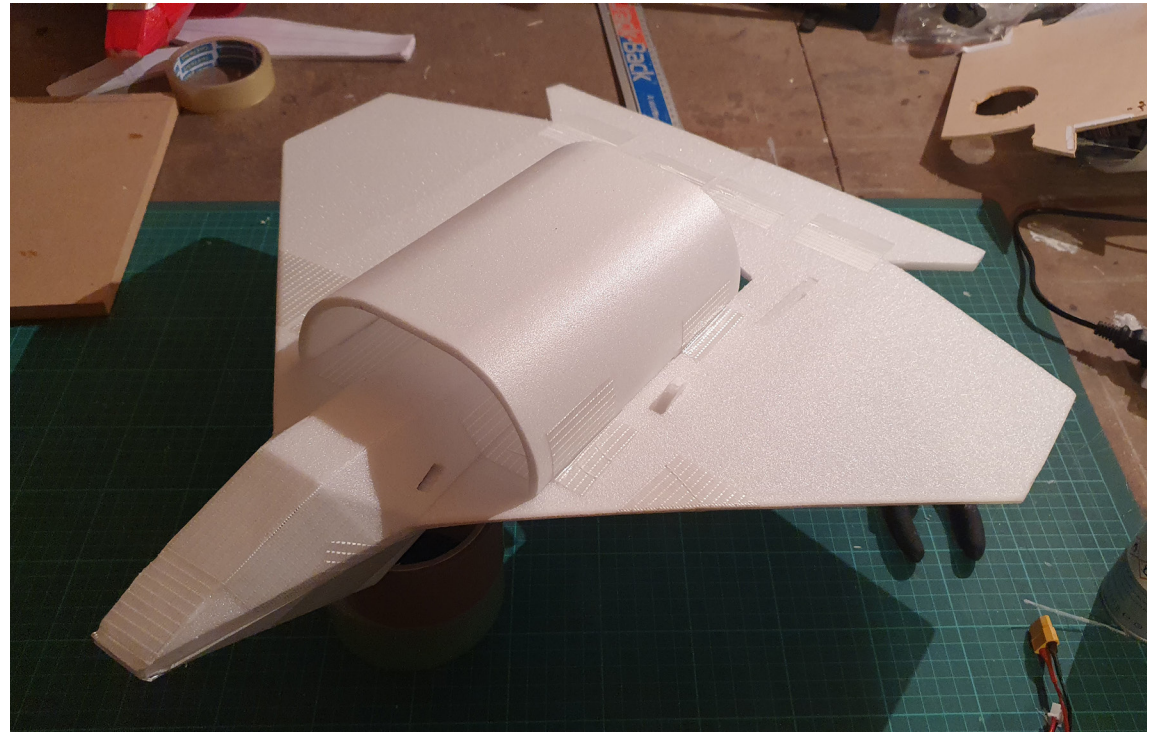
Forming the half-pipe - continued

Once you have the half pipe formed, cut out the notch edges and slot the halfpipe into the wing plate. You may find you haven't bent the pipe evenly on each side – that's okay, at this point it will be easier to press it into shape by hand and make adjustments until the shape is right.



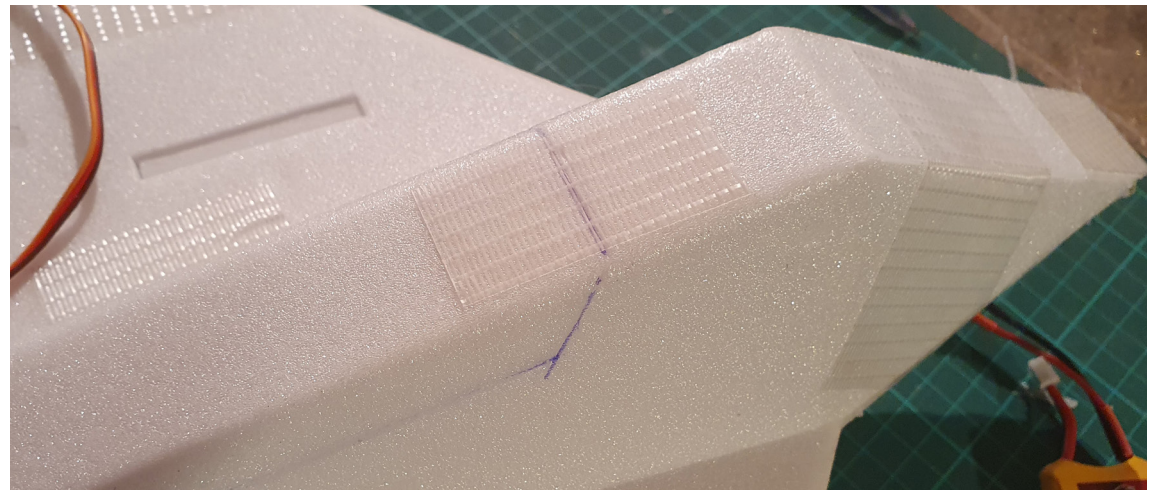
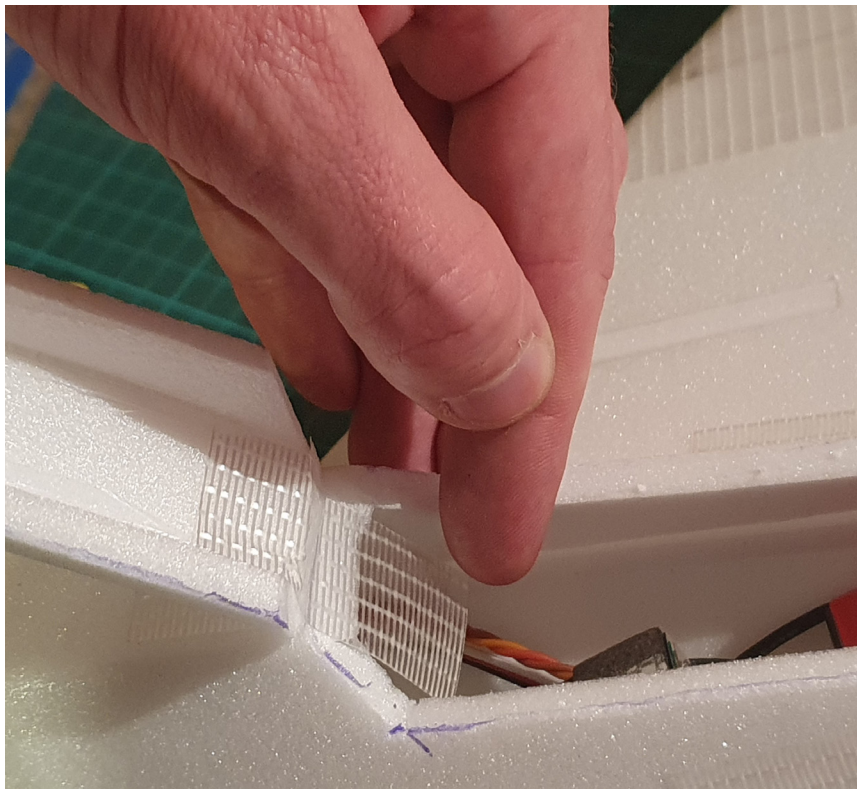
Mounting the half-pipe

With the shape formed, sand off the leading edge of the half pipe to help keep the inlet air stable. I have found that pieces of tape fixing the front and rear thirds of the halfpipe to the wing-plate has been sufficient to hold it in place.



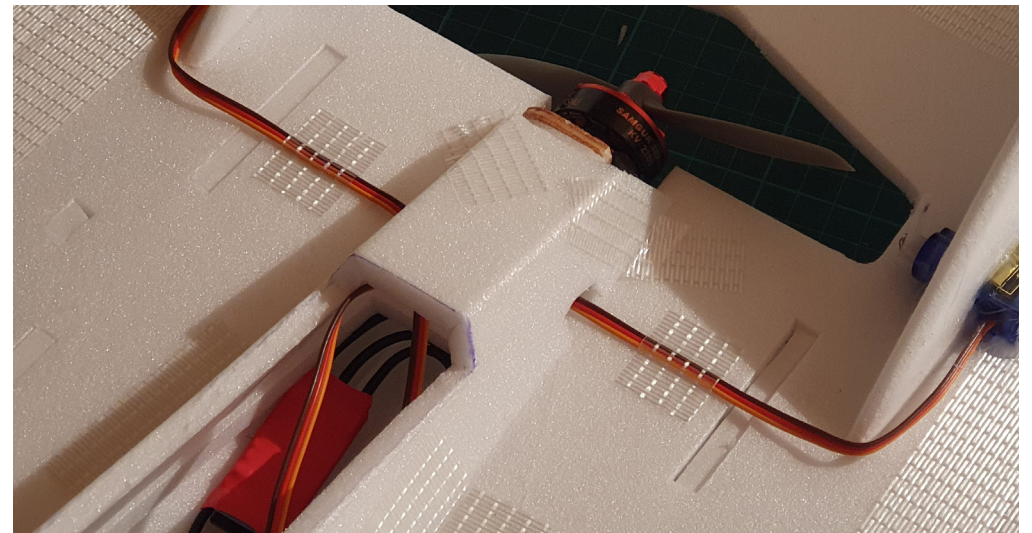
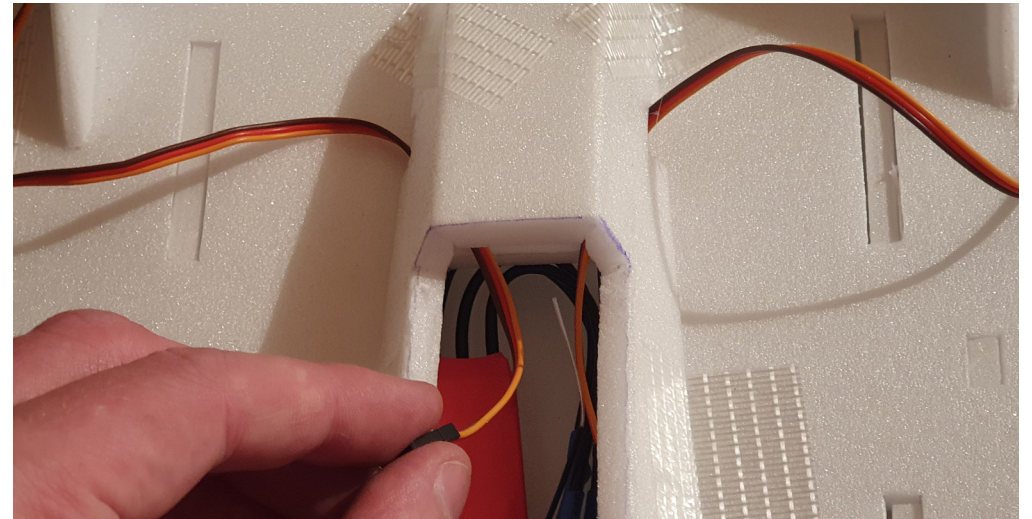
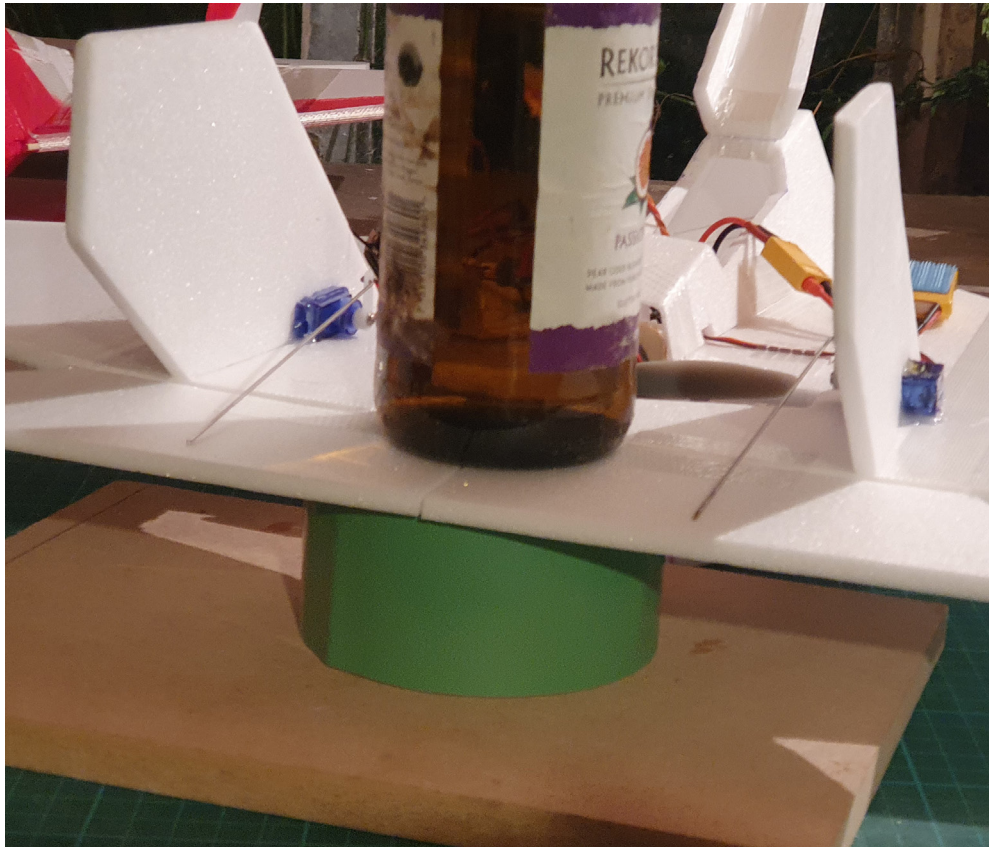
Cutting the hatch

Use a ruler and pen to mark out where you want the hatch to be. Carefully cut the hatch out with your knife – the hot glue you applied earlier should keep it in one piece. Apply some tape near the front to be the hinge and place tape along the inside of this hinge like you did with the control surfaces.



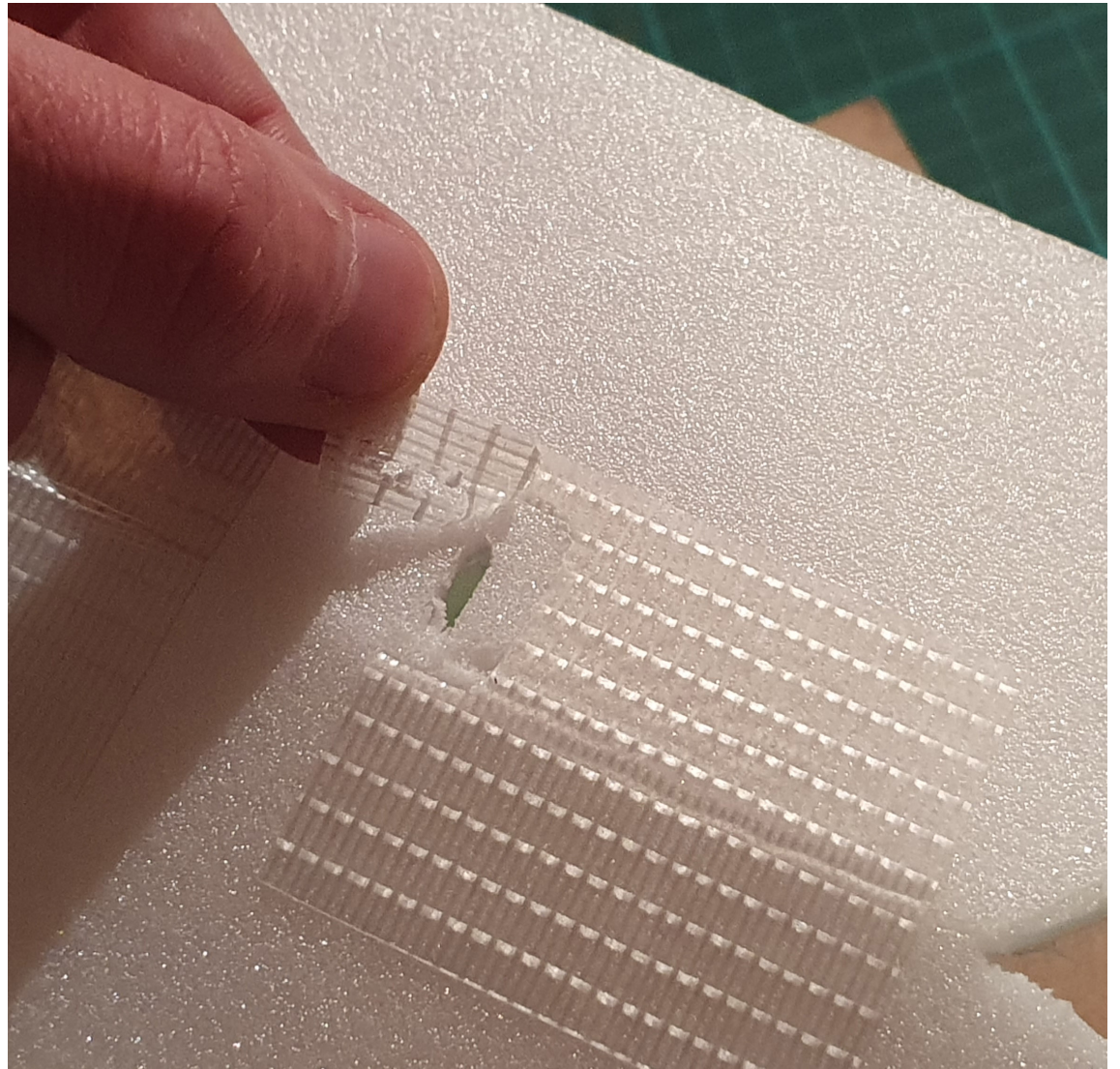
Setting the elevons

Pull the servo wires through the holes in the fuselage and tape the wires down. Find a block that can go under the elevons and hold them flat and level with the wing plate and each other when a flat-bottomed weight is placed on top.



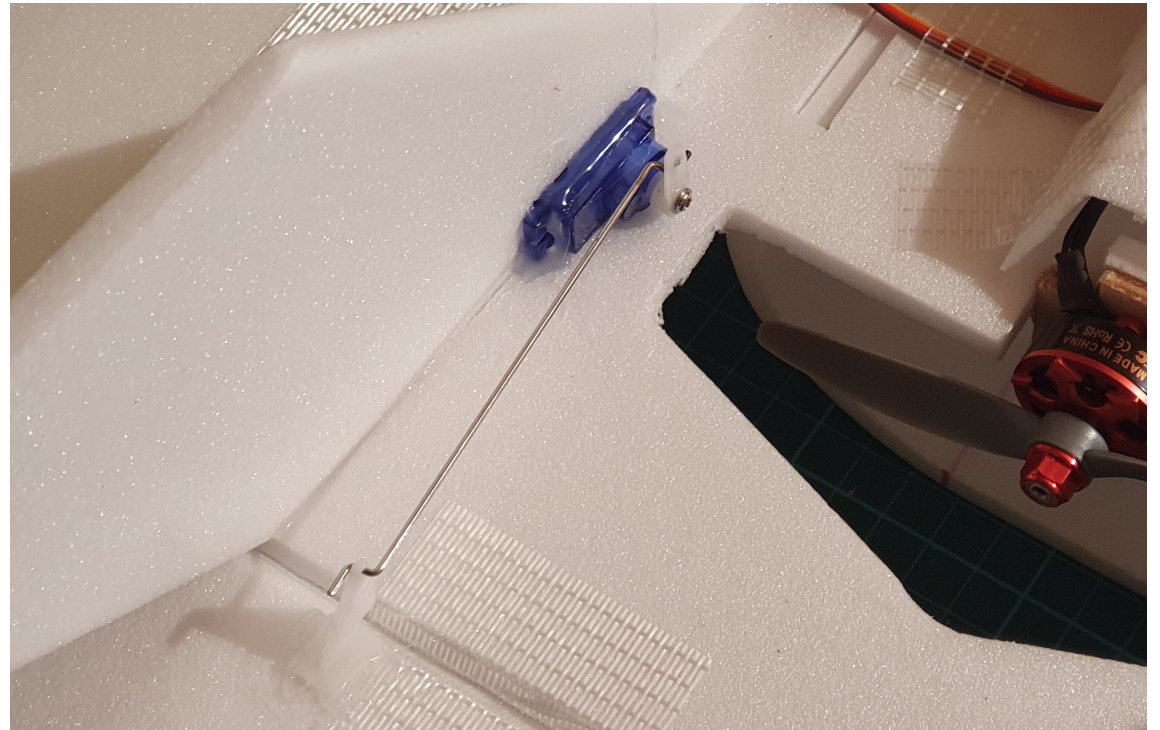
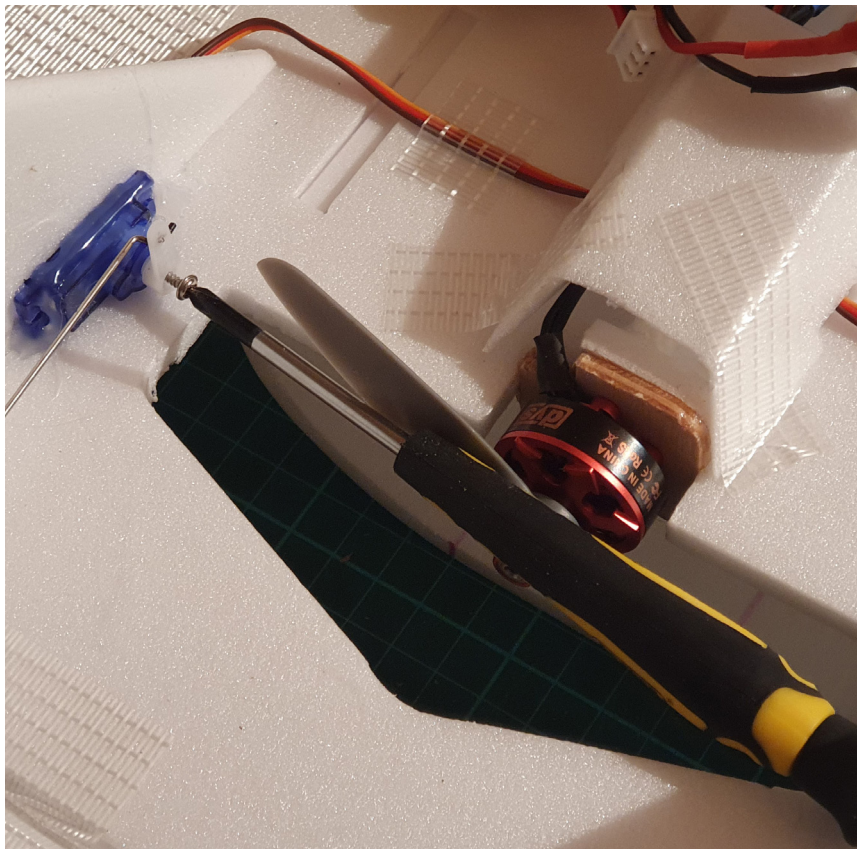
Setting the elevons - continued

Cut holes in the hinge tape for the control horns, then cut holes through the foam for the control horns if needed and set in the control horns. You ideally want the hole in the control horn for the push-rod to be directly over the hinge line. Use hot glue to stick them down and hold them in place.



Setting the elevons - continued

Bend the pushrods so bends are in the right places to connect the control horns to the centred servo arms. You can remove the weight holding the elevons level when you have the bends set.

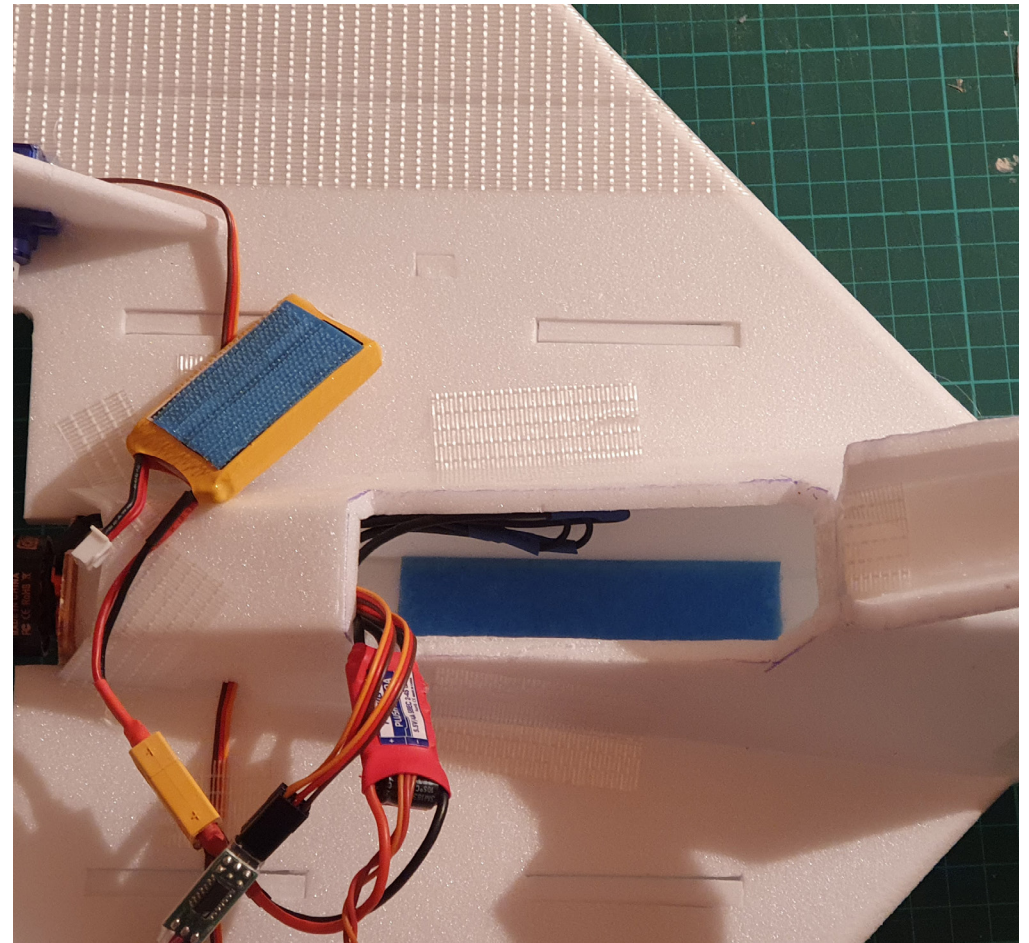
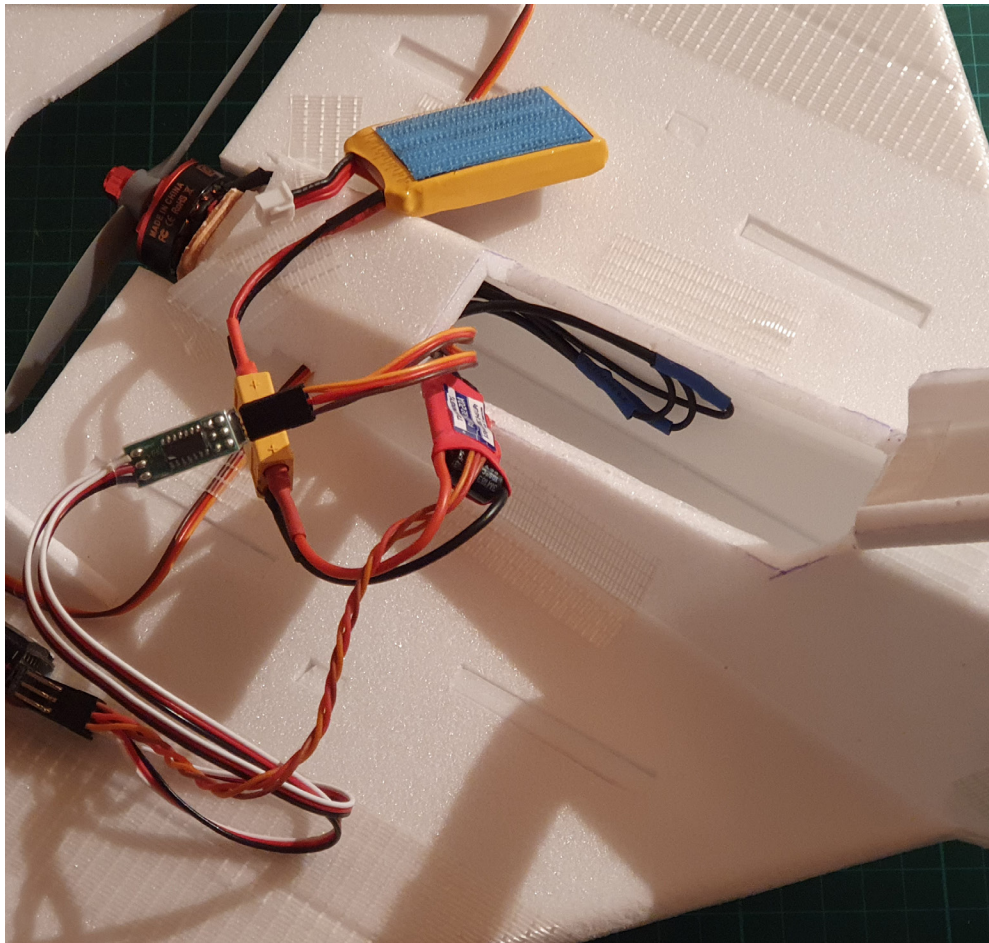


If they aren't quite exact enough to hold the control surfaces even, you can remove the servo arm and place it back on one notch backwards or forwards. The rest can be levelled out with trim.

There should be enough space between the vertical stabilisers to fit a screw driver between them and fasten the screw on the servo arm.

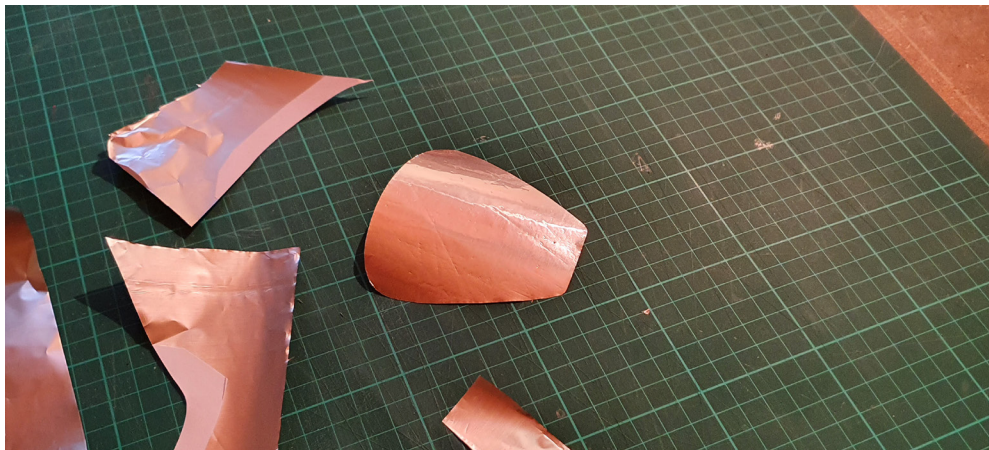
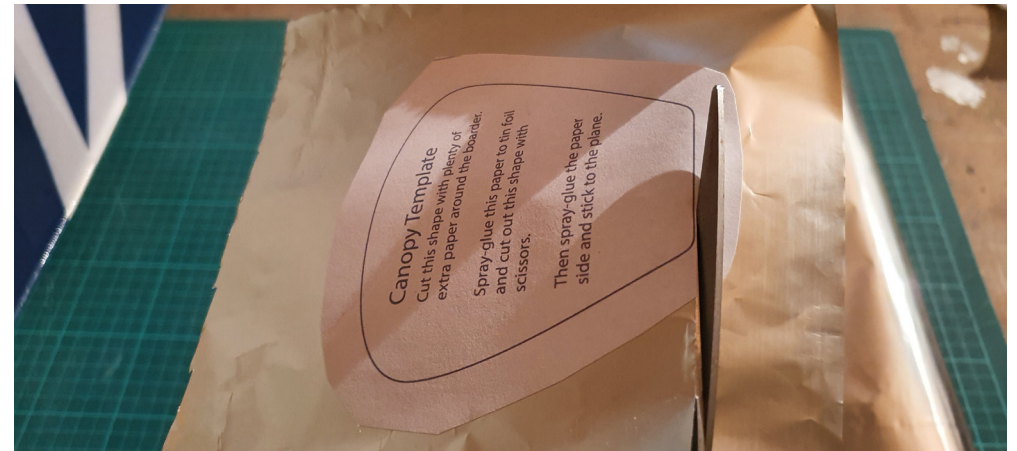
Adding the velcro

Open the hatch and set a Velcro strip inside to hold the battery. Have the strip running from the CoG up towards the nose. If you have used less hot glue in favour of the plane being sub-250, you definitely want the Velcro to go as far forward as the where the wing leading edges meet the fuselage.



Adding the canopy decal

And finally, after you have painted the plane, spray-glue the canopy template to kitchen foil (this time you can use plenty) carefully cut it out with scissors as to not send creases down the foil. Then spray-glue the paper side down onto the fuselage top as pictured. Take care to make sure it is even on both sides before the glue sets.



Finish!

And that concludes the build! Best of luck on the maiden. I found with a 500MaH 2S Battery the weight came in at 216 grams (180 without the battery) after painting, so with a 2S you have plenty of head room to layer the paint on.

