

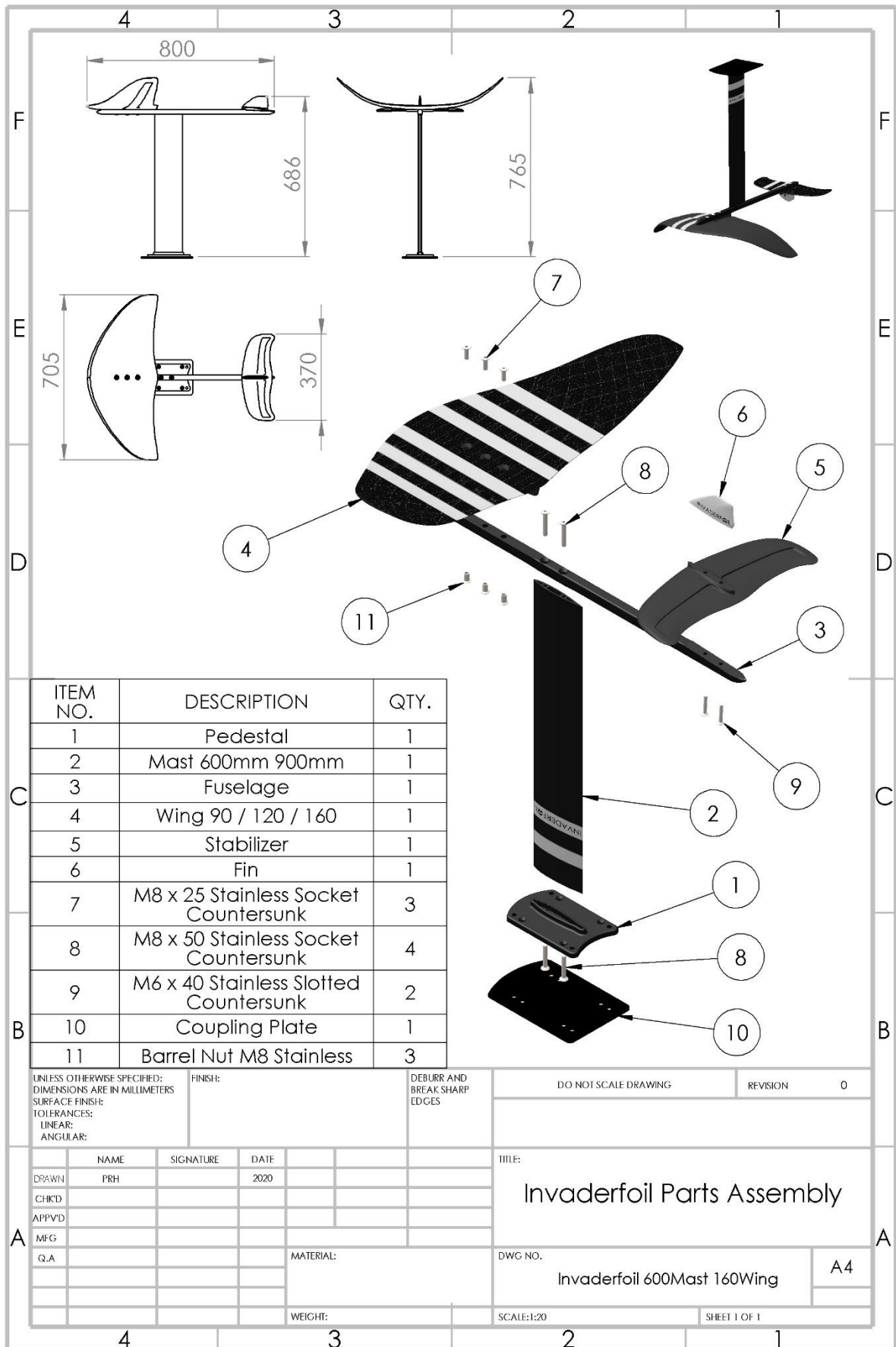
INVADERFOIL

DIY FOIL KIT

Weekend Projects – How to Complete Your Hydrofoil Kit



INVADERFOIL HYDROFOILS INSTRUCTIONALS



ITEM NO.	DESCRIPTION	QTY.
1	Pedestal	1
2	Mast 600mm 900mm	1
3	Fuselage	1
4	Wing 90 / 120 / 160	1
5	Stabilizer	1
6	Fin	1
7	M8 x 25 Stainless Socket Countersunk	3
8	M8 x 50 Stainless Socket Countersunk	4
9	M6 x 40 Stainless Slotted Countersunk	2
10	Coupling Plate	1
11	Barrel Nut M8 Stainless	3

UNLESS OTHERWISE SPECIFIED:
 DIMENSIONS ARE IN MILLIMETERS
 SURFACE FINISH:
 TOLERANCES:
 LINEAR:
 ANGULAR:

FINISH:

DEBURR AND
 BREAK SHARP
 EDGES

DO NOT SCALE DRAWING

REVISION 0

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DRAWN	PRH		2020
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TITLE:
Invaderfoil Parts Assembly

DWG. NO.
Invaderfoil 600Mast 160Wing

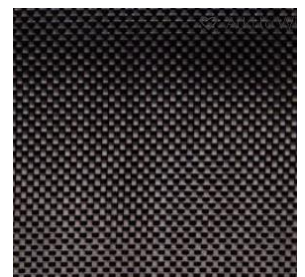
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SHEET 1 OF 1

How To Complete Your Invader Hydrofoil Kit

What You Will Need

1. Sandpaper - 60 grit dry and 100 grit dry paper.
2. Hand sanding block for easy sanding with uniform pressure.
3. Wet sandpaper 150 grit, 400 grit and 800 (or higher for polishing). Can use the sponge blocks or sheets.
4. A box of non-powdered nitrile medical gloves.
5. Some empty (clean and dry) yoghurt tubs or paper cups - this is for mixing the epoxy. Your composites store will also sell measuring cups but I prefer to use what I can from home.
6. Yoghurt tub lids to make some squeegee spatulas to spread the epoxy evenly.
7. Wooden tongue depressors to mix epoxy or any item you are happy to throw away after use.
8. Liquid epoxy and hardener (slow cure) I use SP106 resin with slow hardener from Gurit Composites. You can buy UV resistant to prevent yellowing but with the black finish you won't notice discoloration over time anyway. As long as your resin is marine grade for spending lots of time in the water, that's all you need. Your local composites shop will be best to advise.
9. Carbon cloth. 200gsm. I recommend the plain weave, stock standard carbon cloth. Depending on your wing size and the width of the cloth, 1 - 2m cloth should be sufficient.
10. Acetone.
11. Cotton wool.
12. Kitchen paper roll.
13. Measuring cups and spoons.
14. Rubbing alcohol or if you are unable to purchase this easily, surgical spirits from the pharmacy works well (to remove any dirt or oil residue on the wings before lay-up). Just be sure it doesn't have any tea tree or some other oil added.

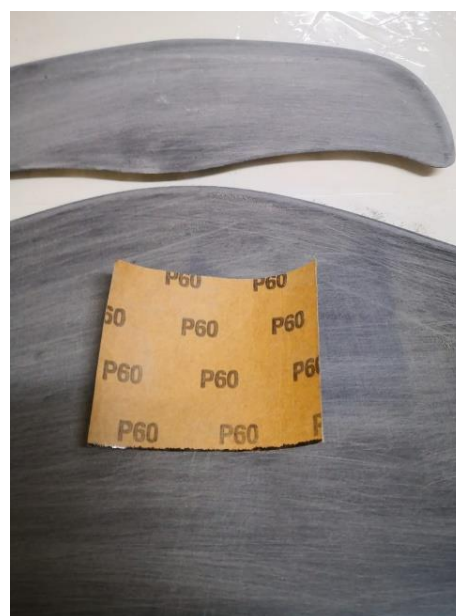


15. Sharp scissors to cut out the carbon or a sharp cutting roller blade. Do not steal your partner's sewing scissors unless you want to die! Carbon will make the scissors blunt.
16. Mini angle grinder with thin grinder disc.
17. Drill with 9mm and 7mm drill bit (for drilling steel not wood).
18. Countersink drill bit 16mm.
19. We recommend a simple single or double organic filter respirator mask from your local hardware store to avoid any fumes.
20. A clean and dry area to work in, free from dust and humidity, hence the need for the mask as outdoors is not ideal (note that bugs seem to love epoxy and any humidity ruins the finish!)

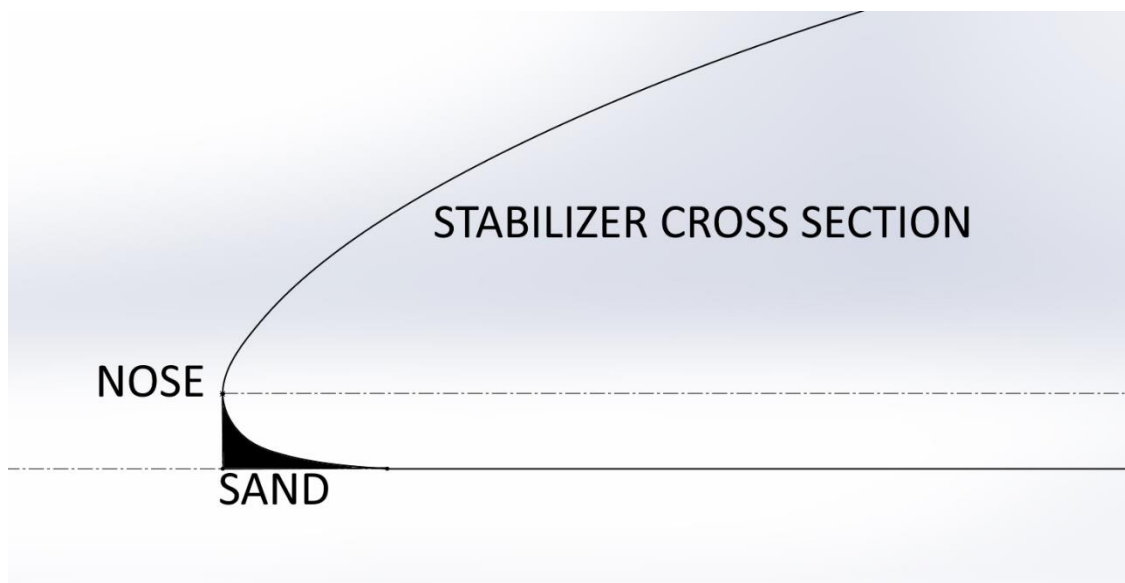
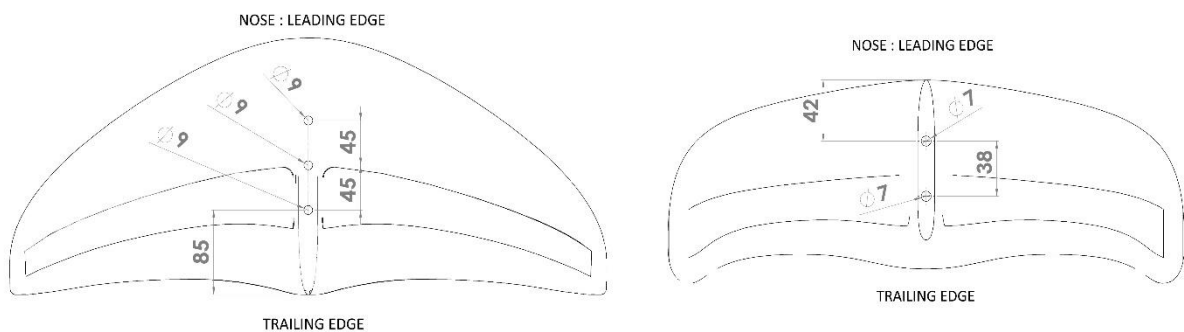
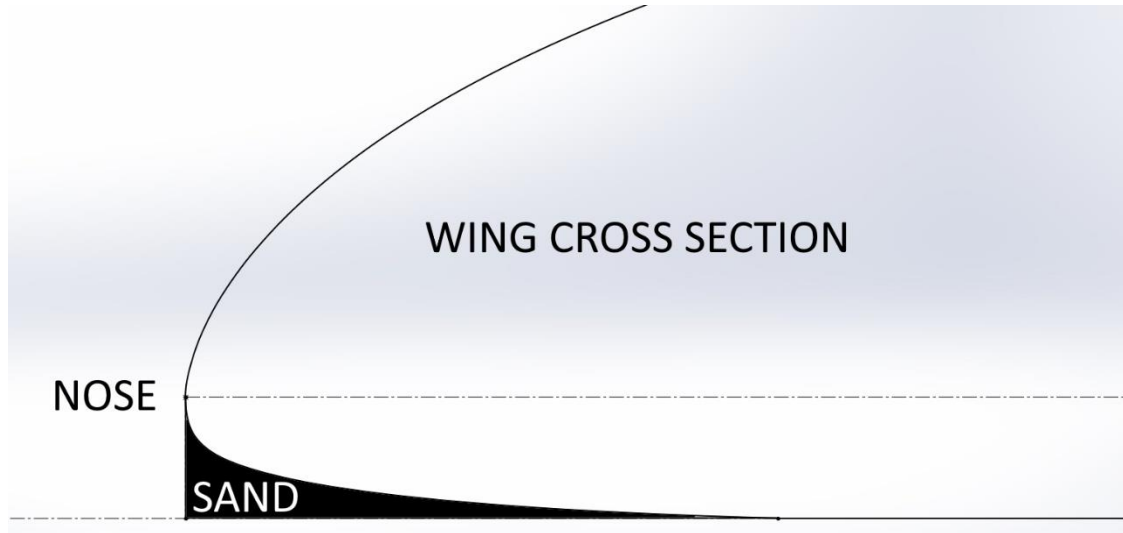


Wing Lay Up Method

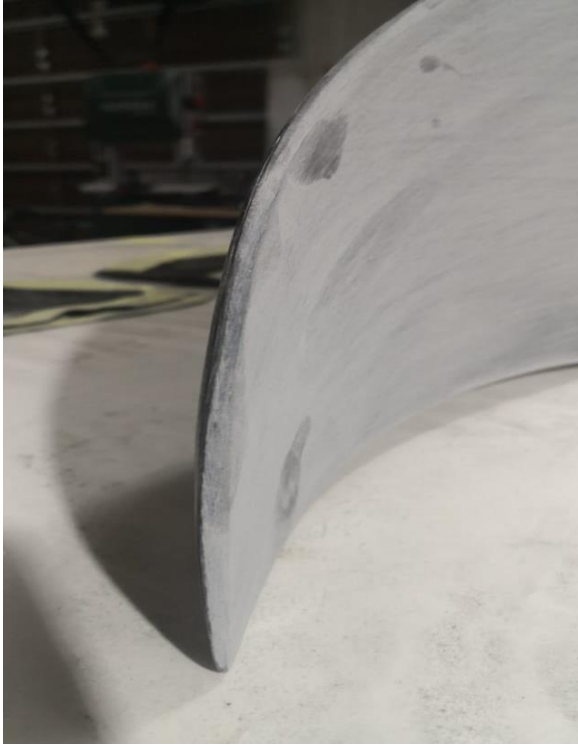
1. Use the 100 grit dry sandpaper and carefully remove any excess plastic beading left from the mould. Don't worry too much about the leading edge yet but be sure the edges cannot cut you, they can be super sharp.
2. Cut some 60 grit dry sandpaper to fit your hand block, or a piece big enough for your hand to easily scrub the underside. Sand the underside as rough as you can without breaking any edges off the actual wing profile. Rinse the wing off in water when it gets too dusty, and be sure there are **no shiny spots left at all** on the surface. The rougher the sand, the better the epoxy will adhere.



3. Using this 60 grit paper, shape the leading edge to match the profile template shape as best you can. It doesn't have to be exact but as you can see from the templates below, both the wing and stabilizer need the underside of the leading edge sanded down to attain an aerofoil shape. As the wing gets thinner toward the wing tips, this shape will get proportionally smaller. Eye ball it and make it your own.



4. You are now completing the shape of the aerofoil on your wing and stabilizer. Spend a little time on this part to get the leading edge looking good. It still needs a rough finish (only on the underside) since your carbon is going to wrap onto this.
5. Wash the wing when you're happy with the scratched finish and shape of your leading edge.



6. Do steps 1 - 5 for your stabiliser.
7. Let them dry in the shade.

Tip: Hot sunshine for an extended period will warp the shape of your plastic wings.

7. Using your wing and stabilizer as templates, make a pattern of the outline for each with brown paper or pattern paper. Your pattern should be larger than the wing by approximately 3 fingers width around the perimeter. Remember that you need to



accommodate the curve in your wing so lay the paper into the curve before tracing your outline. Rather have it too big than too little. The pattern is for your carbon.

8. Cut out your carbon cloth using the applicable templates and carefully set them aside. Using masking tape to outline your cloth helps prevent threads from fraying and keeps the carbon in the correct shape for your layup. Cut through the centre of the tape so the left over cloth also stays intact.



9. You need 2 layers of carbon cloth for the 90 wing, 3 layers for the 120 wing and 4 layers for the 160 wing. You need 2 layers for the stabilizer.

Keep the layers separate from each other by folding them in half and then stacking them.

This makes it easy to pick them up when you start to lay up. Keep the pile free from dust or fluff and be careful not to snag the threads. I place mine on top of a plastic sheet or a rubbish bin liner.

9. Cover your work surface with newspaper or plastic to protect it from any drips and spills.



10. Have your paper towel ready with a sheet or two folded on your work surface so you can place your measuring spoons and cups down on separate sheets (you must not mix up the spoons or cups with the resin and hardener as you will be reusing them throughout this project).
11. Clean your sanded surfaces thoroughly with alcohol and cotton wool until the cotton ball doesn't wipe off black. Your wing surfaces should now be dust free and dry with a scratched, grey finish. Make sure there is no fluff left from the cotton ball.
12. Place your wings on your work surface with enough space between them not to get your carbon cloth draping onto the other wing, scratched side facing up.
13. Time to put your nitrile gloves and mask on . . . Measure out 50ml epoxy resin into your mixing cup/cream cheese tub/yoghurt tub. Place your measuring cup on your folded paper towel (you will be using it again shortly). Close the bottles properly after each use.

14. Measure the applicable ratio for the hardener and add it to your 50ml resin. SP106 has a 100:20 mixing ratio so in my case I add 10ml hardener to my 50ml resin.

15. Place your measuring spoon on the other paper towel ready for another use and close the hardener bottle.

16. With a tongue depressor mix your resin thoroughly. You have time so be sure to stir for a



decent duration. For this job it does not matter if you whip air into the mixture so do what you need to, in order to mix it properly. Mix it for a minute or so. The pot life on SP106 is around 15 minutes but each resin brand will vary, and the temperature on the day will also affect your cure rate. (For more accurate guidelines refer to your epoxy product properties.)

17. Pour a little mixture out onto your wing and spread it over your entire sanded surface using your hands (like finger painting), be sure to run your fingers along the sanded portion of your leading edge that you have shaped, to ensure the carbon sticks. You don't want resin running off the edges, just a thin smear so the wing is sticky for your carbon. Don't worry if the resin on the wing starts to separate, that's normal. Just try to be quick so it does not separate too much.



18. Grab 1 layer of carbon and lay it onto the wing with the edges draping all sides.



19. Pat it down with your hands and then pour some more epoxy mix on top.
20. Use your hands to smear it over the wing. You want the carbon to be completely soaked through. Spread the epoxy slightly beyond all the wing edges. And remember to run your hands along the leading edge to wrap the carbon around your sanded leading edge. (You still need to wet the carbon beyond the wrap of the leading edge).

Note: Do not wrap the cloth under the wings. You want it stuck to your sanded surface, with the excess cloth forming a frill around your wing. Remember that once it cures it is rock hard and you need to still be able to trim the excess off without cutting into your wing. The trailing edge in particular must not hang vertically down. As long as it is stuck to the surface, the remaining frill can jut out. The leading edge is the only portion you need to ensure drapes down enough to cover your sanded portion.

21. Use your squeegee now to spread and apply pressure over the wet cloth in uniform strokes across the wing. Side to side, diagonal and up and down. This ensures the cloth gets properly soaked and helps to push excess resin out... you can use the excess to wet the perimeter since it will be pushed to the edges.

Tip: Make sure your squeegee has no burs. The edge must be perfectly smooth to avoid pulling any carbon threads.



22. You will find the carbon doesn't want to drape off the edges and tends to lift up at the wing tips. Cut darts through your masking tape, more around the wing tips and leading edge where it needs to shape to your sanded surface, and cut a few along the trailing edge. Do this for each layer to ensure the cloth fits your surface perfectly. Be careful not to cut right to the plastic, just beyond the tape should be fine.



23. Add another layer of carbon and repeat steps 16 -22. You will need to mix a new batch of resin during this process. The resin mix has a pot life which you must not exceed. SP106 is around 15 minutes working time before it starts to thicken. If you are quick, you may find you have time to use some of the left over resin mix, but be sure to squeegee it into the carbon before it starts to thicken. A fresh batch is always best if you are unsure.

For the purposes of creating this instructional, we asked a friend to do the lay up over a weekend. He had a few extra commitments so he spread the project out a little longer, doing the stabilizer a day after the wing... the temperature increased a few degrees from one day to the next and his pot life reduced his working time with the epoxy, making his mixing and working times shorter. If you can do both wing and stabilizer on the same day it is easier to gauge the working time.

Note: *You will need to change your gloves between layers so that you handle a new epoxy batch without sticky paws. The epoxy also eats through the gloves after a bit of use. If you get sticky hands it's a very good indication that you are having too much fun playing with the wing.*

24. Depending on your wing size, this layering process is repeated 2, 3 or 4 times
25. After your final cloth layer and squeegee, give your wing a once over with your hands again. Make sure it's wrapped nicely around the leading edge and that the cloth is wet beyond the border of the wing by approx. 10 - 20mm.

Note: *There should not be any resin pooling on the wing, just a nice glossy shine.*



The Stabiliser won't need as much time due to its smaller size and only needing 2 layers of cloth. 50ml may be sufficient for both layers and you should have time to do both with one mix, but you can always mix more resin if you need. The Stabiliser is flat. You do not need to try and wrap the cloth down the leading edge as you did with the wing, just follow the slight slope of your sanded edge and spread the resin and layers as per steps 16 - 19.



1. Leave the wings for an hour (if the weather is very hot try 45 minutes). Lightly stroke the epoxy just off the edge of the wing with a fresh gloved hand (don't apply pressure). If it's sticky, come back in another half hour or so. The resin in your mixing cup will also be hard. You have a max of around 3 hours, after which time you cannot add a new layer of resin. (**** refer below regarding product properties information*).
2. When touch dry, place another thin layer of resin onto your wings with your squeegee or gloved hands, but the wing cannot be tacky when you do it. (You can do the stabiliser at



the same time and only need to mix a small amount of epoxy at a time. My SP106 uses 10ml resin : 2ml hardener).

3. Repeat these thin layers every 45 minutes to an hour (as soon as the wing is not tacky to touch. Usually you need 3 or 4 layers until the surface looks smooth).
4. Once you are happy, leave them overnight to cure completely.

**** Your particular brand of epoxy should come with instructions regarding its properties. This will include the temperature vs curing time, what the pot life should be and how long you have until you can no longer add additional resin overcoats. Note that when I refer to "touch dry" I am not referring to the cured time, I am referring only to when it is no longer sticky. You would still be able to leave an impression in it with a fingernail when it is touch dry. Epoxy is exothermic when curing and the extra layers of resin each help the previous layer to cure further by generating additional heat.*

Tip: *If you wish to speed up the curing time or your weather is cold, a heater in the room will work wonders to speed up the process. It also helps keep the air dry.*

Trouble shooting:

If your resin layers start to separate like oil and water, you did not mix the epoxy well, and you may likely have also allowed humidity into the room. It's almost impossible to fix this separation without standing over your wings and constantly spreading your resin layer around.

Worst case, your wing will cure with little mini craters on the surface (looking like the moon) but you can sand and polish the finish once cured so it won't be too noticeable. Any major imperfections can also be filled with spot putty before painting so don't stress too much if you see this happening.



Tip to avoid this: *do not do your wings outside or by an open window, and mix your epoxy thoroughly before every application. Always stir and stir some more.*

1. Once cured overnight, trim the excess carbon edges as close to the plastic as you can. (Use a mini angle grinder cutter or diamond blade cutter on a Dremel or sand off the excess if you have a permagrit file.
2. Sand off the balance of the excess with 60 grit until you are flush with the plastic wing.
3. Refine the edges of your wings with 150 grit wet sand so that the trailing edge is almost sharp



and the leading edge resembles your original profile as per the template (just as it did before you put the carbon on). Your trailing edge ideal shape should resemble that of number 8 on this drawing. This shape has the lowest vibration amplitude whilst keeping the carbon side of the wing flat. If you find your wings hum or whistle when you ride, the cause is most likely from your trailing edges of the wing and/or the stabiliser. Sometimes they need a little more refinement.

Case	Geometry	Relative vibration amplitude
1		1
2		1.9
3		3.8
4		0.43
5		0
6		0.38
7		0.03
8		0

Tip: Sand the trailing edge from the plastic side down toward the carbon so you have approx. 0.5mm thickness. Do not finish it like a knife edge or it will whistle when you ride.

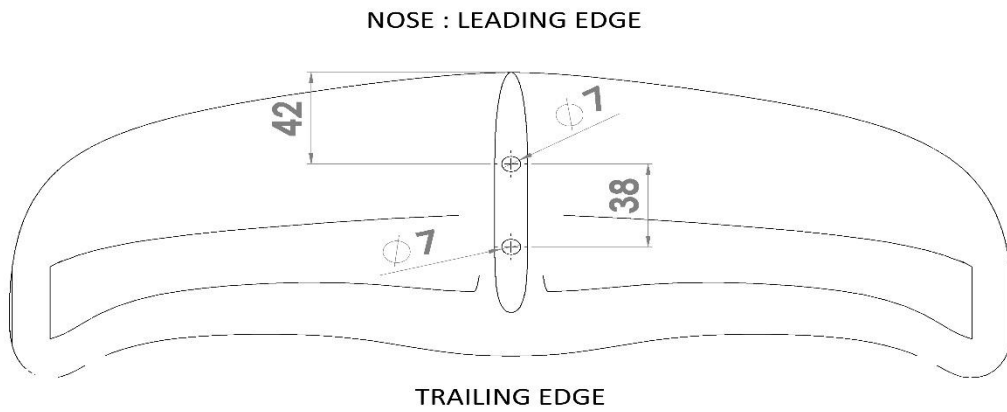
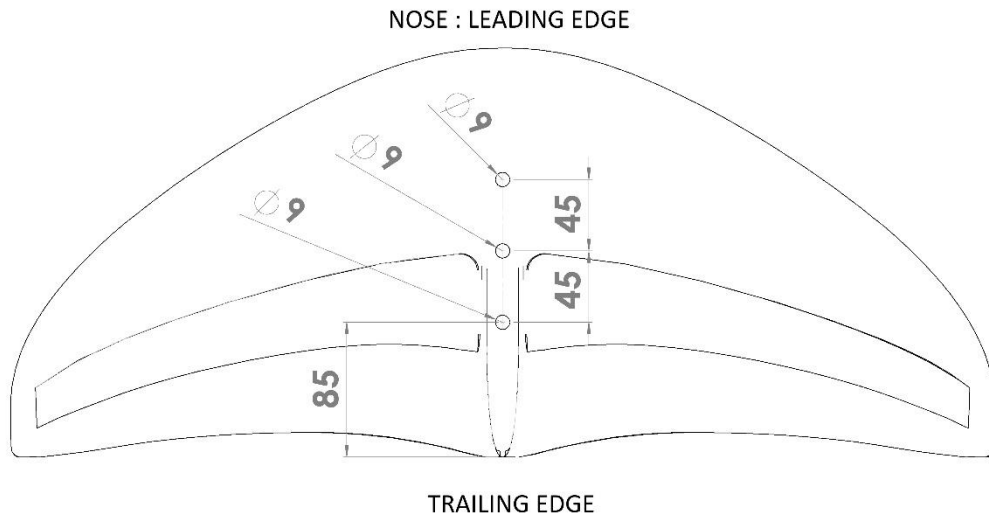
Tip: Sand and shape the leading edge from the carbon side so you don't accidentally sand the

shape of the plastic portion away. The shape of the leading edge affects performance.



4. Water Sand and polish the underside so your resin carbon finish is smooth to touch and look at. Start with 150 water paper if you have imperfections, followed by 400 to refine and 800

upwards to polish. Using a block helps keep the water paper uniform for a smoother finish in the underside, and using the sponge on the leading edge creates a smooth curve.



5. Polish off any resin which may have run onto the non-sanded side (it should lift off easily with a craft knife blade).
6. Once you are happy, wash and dry your wings.
7. Drill out your holes as per the template dimensions. Start with the centre hole and then remeasure to ensure accuracy in the spacing. You can start with a smaller pilot hole if you prefer, before drilling the actual size hole. After drilling the 9mm holes in the wing, use the countersink bit on the carbon underside.
(Note that the stabilizer does **NOT** need the countersunk holes).



Be careful not to bore too deep on the countersink, stop where the drill bit angle is level with your wing and then test the depth with one of your M8 countersunk wing bolts. The head of the bolt should sit flush with your carbon surface.

8. You may find at this point that that the countersunk edges are a little fluffy. Take some 400 wet sand paper, but don't wet it. Sand off the fluff with a small piece of this 400 grit.
9. Mix a 5ml batch of your SP106, dip a gloved fingertip in it and smear a thin seal around each countersink hole. You need a tiny bit, just enough to gloss the rim without any drips or excess running down the hole.



10. The Stabilizer holes need a smaller drill bit (7mm) and no countersink. You also do not need to seal anything with epoxy after drilling. Drill slowly so as not to tear the carbon with excess pressure as you break through the other side.



Since you don't use a countersink, you do not want to have any damage on the carbon layer. Measure from the nose backwards to the first hole and drill, then remeasure the distance to



the rear hole before drilling to ensure accuracy. Ideally it's best to use a drill press with clamps and mark the holes out with some masking tape.



11. Wait 24 - 48 hours if possible before taking your foil into water or painting it... The resin will go milky opaque if soaked too soon (but it won't affect performance if you are desperate.)
12. Use the 400 or 800 water paper on the top of the wing before painting to ensure the paint adheres well. Whilst sanding the top, you can also buff off the shine of the countersink seal on the wing's underside.
13. Dry your wings and wipe down with some rubbing alcohol to clean any grease or dust.
14. Give your wings a spray paint with your favourite colours. You can use a thermoplastic outdoor aerosol paint from the local hardware store. This fills up any pin holes and gives a final seal.





15. Assemble your flying surfaces to your foil, attach to your board and you are ready to fly!

