‘JACOMB SPECIAL V’ S4 Boost Glider

Introduction:

The S4 class of boost glider is a challenging discipline that requires a model to be launched as high as possible and descend as a fixed wing glider, after jettisoning the motor. Many attempts at ‘bending’ the rules have allowed models to be developed that jettison everything but a polystyrene triangle, purported to be a ‘glider’. In the UK we have very much built models within the spirit of the rules but have been disadvantaged because launch heights are compromised with the flapped and folder type of models due to the high drag of the assembled parts in launch mode.

In 2006 John Jacomb, a member of the British Spacemodelling team, had a brain wave and the ‘Jacomb Special’ was born. “Why not rotate the wing through ninety degrees and fold it, full length, around the boom and launch the thing as a regular rocket with the motor at the back?” John is neither an aerodynamicist nor an aeromodeller, in the strictest sense, and it is probably just as well. A genuine aeromodeller would never dream of taking a pristine wing and proceed to cut it into nine pieces and then expect it to go back together accurately, yet this is precisely what he did.

A prototype was built that was held together with 41 pieces of elastic that enabled the folded wing to metamorphose from rocket to glider, at ejection. It was first flown at Heckington at the 2006 British Nationals where it failed to open. However, others there saw the potential because, despite its weight of over 30g, the launch height of the prototype was prodigious, when compared with the folders and flappers that weighed in at a mere 17 to 20g. Nigel Bathe, another member of the British Spacemodelling team, took the original model and developed the opening mechanism. The geometry was not changed but Nigel managed to get the elastic count down from 41 to 2!!!! This had a dramatic effect on the overall weight and surface drag of the opened model. However, there were still problems with the opening at ejection. Adding another piece of elastic across the wing, at the centre, eventually solved this problem.

Third stage, development models were taken to Baikonur, Kazakhstan, for the 2006 World Championships. Two flights were made; the first deployed properly but was out of trim and flew in a straight line. The second attempt with a re-trimmed model failed to open. On inspection, it was found that the ‘Blue Tack’ added to the tip of one wing, to give it a turn, had stuck to the boom when the wing was folded; - something that should have been foreseen.

Unperturbed, development continued and two of the main aims were to reduce weight and increase performance. The second stage models weighed in at 27g and at this weight they flew very well but launch height was not as good as it could have been. What was needed was to get the weight down as close to the 18g, minimum launch weight, as we could. An increase in performance could also be achieved by using an airfoil section designed specifically for the glide. With the ‘Jacomb’s’ method of boosting there is no need to make any compromises on wing section as the wing is totally non-functional in launch mode, unlike some models.

2007 saw the ‘Jacomb Special’ reach adolescence. It now boasted a moulded wing, moulded tailplanes/fins, moulded incidence/pivot piece and a choice of burning fuse or viscous button de-thermaliser. The weight of the wing, using four layers of glass cloth, moulded onto 32k/M^3 Rohacell, was between 9 and 10 grams with the total weight around the 18 to 20 gram mark. These models were taken to Kosice, Slovakia, for the 2007 European Championships where they did not perform well. However, on the reserve day, the models were flown without a problem at all. The fact was, they performed excellently provided they opened at or slightly before apogee: still some work to be done.

In May of 2008, during our Spacemodelling National Championships, a couple of suggestions were made. One, lose one of the fins during motor ejection and fly the glider as a ‘V’ tail. Two, use a launch cradle to hold everything together during launch.

After a few sessions on the drawing board, a combination of the two emerged. Using the Kosice wing, a new and shorter fuselage was made that engaged with the motor tube that was attached to a cradle that ran the length of the fuselage. The cradle served three purposes; one, it held the third fin in alignment for launch; two, it held the wings folded during the launch and three, it held the de-thermaliser timer in the off position during launch. At ejection, the whole cradle, motor tube and third fin are ejected and descend with a streamer, and the de-thermaliser is released. The metamorphosis was now complete and the ‘Jacomb Special’ had come of age.

It was with this model that Nigel Bathe won silver at the Spanish World Championships in August 2008. The only reason he did not win gold was that his model was white and in the failing light, the timekeepers lost sight of the model while it was still at altitude. The new models are much more brightly coloured!

Still progress went on and by the World Cup in Ljubljana, 2008 the model sported another wing. This is now fully elliptical, has more undercamber and is lighter than the previous wing yet has more area. It is this wing that is shown in the photos. In Ljubljana it gained a creditable fourth place behind three flying wings.

It may be interesting to note that there is not a scrap of wood anywhere to be seen on these models with everything being of carbon or glass composite. It is not the lightest of S4 models and it still weighs in at 20g+ and whilst we are striving to make the model lighter, the main thrust of development was to make the model as efficient as possible in the gliding mode and we seem to have achieved this. One huge advantage of a fully moulded model is that each one performs in an identical manner with only a minimal amount of trimming required.

The ‘Jacomb Special’ is truly a team model and owes much to a number of contributors but without that original out of the box moment, by John Jacomb, none of this would have happened.

Further developments? – That would be telling ☺

The three culprits: John Jacomb, Nigel Bathe and Mike Francies

Instructions:

Checklist of components for full kit:

1 x Moulded Wing
1 x Motor tube
1 x Cradle Fin
1 x Incidence piece
1 x 60mm x 1mm Carbon Rod
1 x 50mm 0.9mm piano wire
2 x Elastic bands

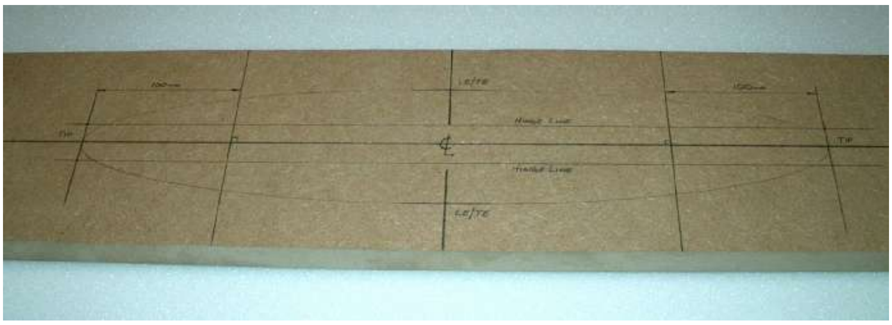
1 x Fuselage boom
1 x Set of two fins
1 x Cradle Flat Carbon Strip
1 x 70mm Fishing elastic
1 x 40mm x 10mm x 0.5mm carbon sheet
1 x 3mm nylon nut, bolt and washer

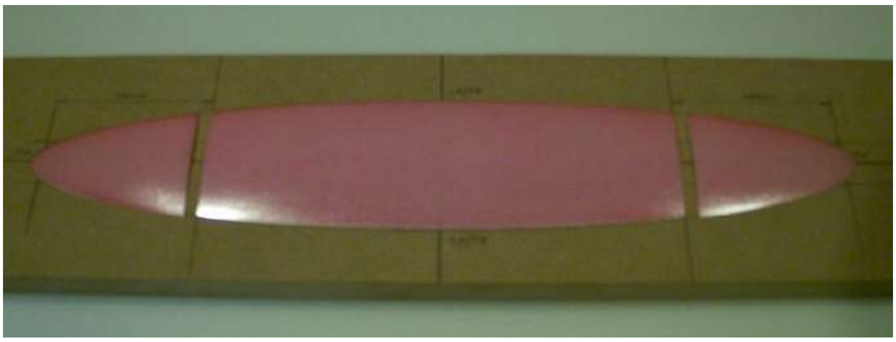
1/ **Fuselage:** Start by sanding the boom using 600 wet and dry paper. The sanding removes the ridges and makes the boom slightly lighter. It is possible to save up to half a gram by judicious sanding. You will notice the colour of the residue change from white (*resin*) to black (*carbon*) as soon as you see the black, stop sanding. The boom is only 0.08mm thick!

2/ **Tail Group:** Trim all three fins by carefully sanding the leading and trailing edges using no more than 400 grit paper. Attach the two larger fins to the thicker end of the boom using medium super glue, leaving 10mm clear at the end. To make a better fit, wrap a piece of 400 grit wet & dry round the boom and lightly sand the root of the fin. Do make sure you keep the fin aligned with the boom. The fins should be 120 degrees apart. (*The angle is not super critical*)

Finish the fitting by running some medium thickness super glue along the joints, on both sides of the fins, to make a miniscule fillet. There is no need to use epoxy if the fit is good.

3/ **Wing:** Start by removing the slight flash, left from the manufacturing, from the leading and trailing edges. Some of the carbon leading edge may well be removed in the process. Aim to have a very smooth leading edge with no discontinuity from underside to top. **Be very careful, as you get close, as the glass skins are very thin.**



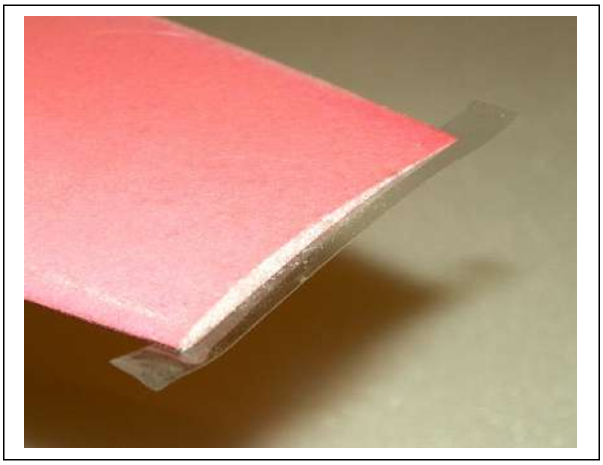


Accurately cut the tips off 100mm from the ends. Do make sure the cut is square to the wing. It is worth making up a cutting/marking jig. By drawing around the wing and marking the various cuts.

Sand the dihedral angle on both sides of the cut, both the tip and the centre section.

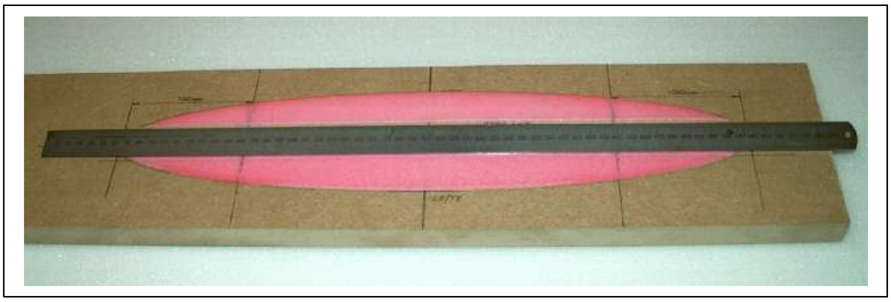
The sanding jig shown here is simply a piece of 400 wet and dry glued to a piece of bent aluminium. The angle should be around 12.5 degrees from the vertical, which will give a total dihedral angle of 25 degrees. Again, make sure you sand the ends square with the centre line of the wing.

Once sanded, seal the ends with some medium super glue, smeared on and smoothed with a finger. Use a latex glove if you do not like super glued fingers! **Leave to dry thoroughly.**



Hinge the underside of the tips. Stick a 100mm strip of standard, 25mm wide sellotape (*or similar*) to a sheet of glass then slice it down the middle to give two strips, 12.5mm wide. Turn the centre section of the wing over to have the underside uppermost and carefully place the tape in position, halfway across the join. In the photo to the left, you can just make out the tape.

Turn the centre section back, the right way up, on a piece of glass or known, flat surface, and offer up the corresponding wing tip. Try to keep the wing tip as close to its proper section as possible and as close to the centre section as possible. This is difficult with the undercambered section but you do not want a gap between centre section and tip. Turn the wing back over and press the tape down firmly with your fingers. Do not forget, the section is undercambered so just pressing down on the flat surface will not necessarily stick the tape all the way across.
Repeat for the other wing tip.



Now the wing is back in one piece, it is time to slice it into three along its length. Right at the centre of the wing the chord is 85mm and the wing is sliced into 28.3mm wide strips (*two 28mm strips and a 29mm centre piece is perfectly OK*). Mark where the two cuts will be. Take a straight edge, long enough to cut the whole length of the wing, and place it accurately on one of the marks. Make sure the straight edge is parallel to the centre line of the wing. This is relatively easy to do if you made the jig in the earlier stages.

One way to ensure the straight edge does not slip is to put some small pieces of double-sided tape between the straight edge and the wing. If you do this, do make sure you de-tack the tape, particularly on the side that is going to stick to the wing.

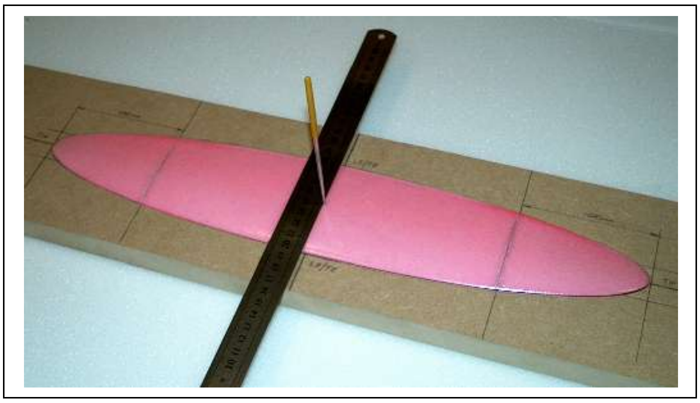
Use the thinnest blade you have to make these cuts. An old style razor blade is ideal, as you do not want to compress the foam. **These two cuts are the most important part of the operation so far. It is essential the cuts be made with blade held at the same angle for each stroke. It is better to take two or three strokes rather than try and cut all the way through in one go.**

<u>DO NOT BE TEMPTED TO SAND THESE CUTS</u>

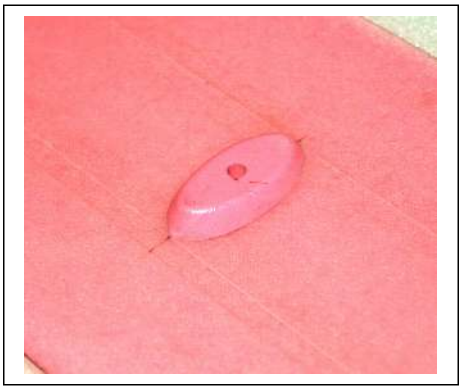
The leading edge cut is a little more difficult as you need to cut through the carbon at the leading edge. It cuts through relatively easily if you just keep repeating the cuts

Photo on the left shows a sliced wing.

Hinge the pieces in much the same way as for the tips. Again, it is imperative there is no gap between the pieces otherwise you will not get an accurate airfoil section when the wing is deployed. You will notice that once the whole wing is hinged and it is held with the tips pulled up, the wing is remarkably stiff and holds its shape well, even without elastic.



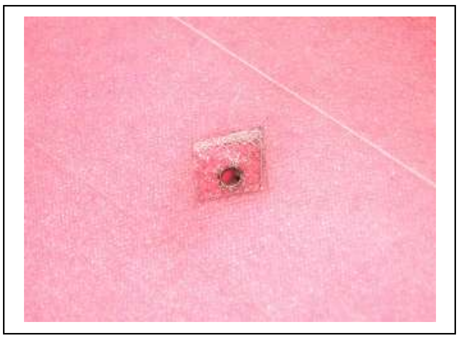
Wing pivot: Find the centre of the wing and drill a 1mm hole right through the wing. **This hole should be perpendicular to the underside wing skin.** Alternatively, use a needle file to accomplish the same result.



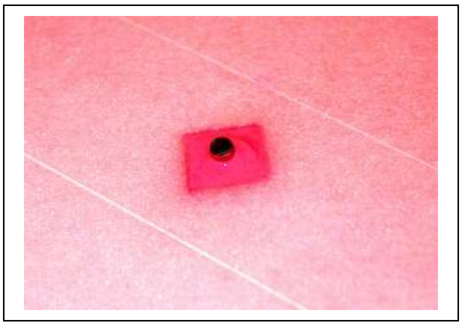
Take the wing incidence saddle and note the protrusion that indicates the very front of the saddle that must be aligned accurately on the wing. Locate the saddle on the underside of the wing using the previously drilled hole as a guide. **You must make sure the saddle fits between the two hinge lines without overlapping either.** The 1mm hole may well be toward the front of the saddle hole. This does not matter.

Cyano the saddle into place.

Using a round needle file or a 3mm drill, carefully drill right through the wing, from the bottom, ensuring the file or drill remains square and perpendicular to the bottom of the saddle.



Pivot reinforcement: On the top of the wing make a small cutout, approximately 10mm square, and remove all the Rohacell, right down to the bottom skin. Wax or Vaseline a 3mm rod or drill shank and push it through the incidence saddle from the bottom. Mix up some epoxy and microballoons (*add just a bit of Kevlar pulp too, if you have*



it) into a consistency of thick porridge and pack this into the hole, around the 3mm rod. Use the slowest setting epoxy you have, the best is laminating epoxy but 30minute epoxy will do the job. **Be patient and let it cure completely before removing the rod.**

On removal of the rod you should have a neat, 3mm hole right through the reinforcement, accurately aligned with the incidence saddle. This hole is the pivot point for the wing.

4/ Fuselage (*continued*): Place the wing alongside the fuselage, hold the tips flat and mark the boom in line with the centre of the wing when the wing tip is 5mm away from the fins. You must allow clearance for the wing to swing past the fins, at deployment.

Carefully make a 3mm hole for the nylon bolt, right through the boom at the marked point, taking care to ensure it is perpendicular to the boom axis and vertical with respect to the two fins. You will find that a round needle file does a much better job than a drill bit, as the boom walls are so thin, though it is reinforced at this point.

Take the 3mm nylon bolt and make sure it is a good fit in the previously drilled hole. **Do not fit it permanently yet.**

The head of the nylon bolt needs thinning so that just 1mm or less remains. This is to allow the launch cradle to pass over it easily. This is best achieved in a lathe but it can be done with a file.

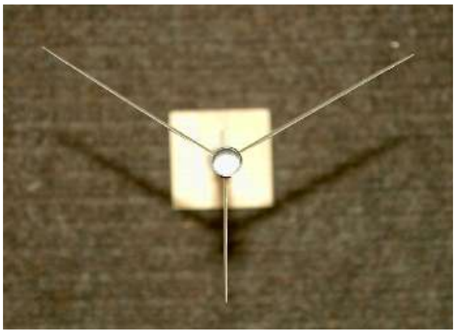
Once thinned, use thick cyano to permanently fix the bolt in place. **Do ensure the bolt remains vertical to the fins while the cyano cures.**

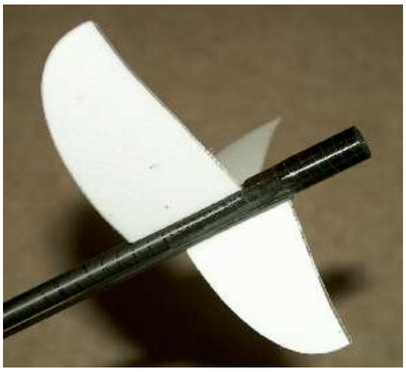
5/ Launch cradle: Take the motor tube and cut away the thinner end similar to the photographs, right and below. There should be approximately 10mm of the smaller diameter left complete, and the total length should be around 65mm.

Use medium cyano to attach the motor tube to the length of 4 x 1mm carbon strip. The end of the strip should be up against the step in the motor tube. **Sight through the motor tube to ensure it is aligned accurately with the carbon strip.**

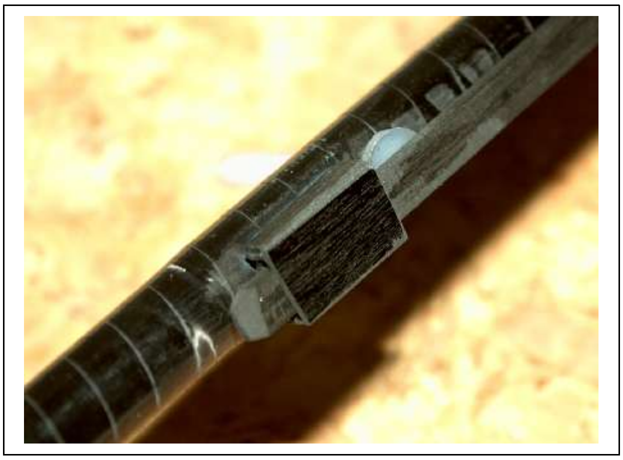
Take the small fin, sand the end flat and cyano this to the other side of the flat, carbon strip. **Make sure it is central and aligned with the length of the carbon strip.**

6/ Launch cradle retention box: Cut an 8mm length from the end of the launch cradle carbon strip, that is now the spine of the cradle; cyano this onto the boom just in **front** of the nylon bolt. To ensure this is correctly aligned, place the motor tube over the end of the fuselage boom and slide the end of the boom into the motor tube. The alignment is correct if the axis of the small fin bisects the angle of the other two fins as in middle photo below.





Cut two further 8mm pieces from the cradle spine, chamfer one edge slightly to match the angle of the boom and cyano them into place as in the photos below.



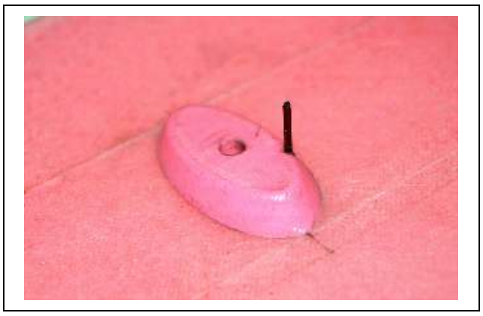
Lay the cradle into position and file the two side pieces until they are flush with the cradle strip. This can be seen in the photo above right.

Cut a small piece of thin, carbon fibre sheet to make the top of the box. Cyano it in place then file the edges flush with the sides and ends.

The launch cradle spine should slide easily into and out of the box with little or no slop. If it is too tight, lightly sand the spine with 600 grit wet & dry till the correct fit is achieved.

Trim the end of the spine until just 2mm protrudes through the box when the cradle is fully engaged. Chamfer the end to make insertion easier

7/ Wing retention and pivot: If at all possible, counterbore the wing reinforcement epoxy with an 8mm end mill so that the bottom of the counterbore is parallel with the bottom of the incidence saddle. If this is not possible, try to build a flat on the top of the reinforcement that is parallel to the bottom of the incidence saddle. The photo to the right shows the reinforcement counterbored and a nut and washer retaining the wing.



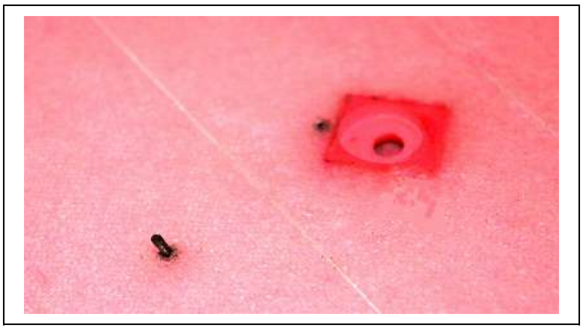
Fixing the pivot elastic: Establish the position, on the incidence saddle, for the elastic retainer and swing stop peg. This should be a place 45 degrees from the pivot hole, forward of the hole and on either side, depending on which way you want to swing the wing. The photo on the left shows the position. And the photo on the right shows how it looks when assembled.

Drill a 1mm hole through the incidence saddle and right through the top skin of the wing. Cut a length of 1mm carbon rod so that 6mm extends below the incidence saddle when flush with the top surface of the wing. Cyano in place.

Put another 1mm carbon peg through the boom 50mm in front of the wing pivot, and slightly above the centre line of the boom. **Do make sure this is on the same side of the boom as the stop peg on the wing saddle.** Angle this slightly forward so that the elastic has no tendency to slip off. Make sure the front peg does not foul the wing as it is rotated and folded – shorten if necessary.

8/ Wing deployment elastic: To aid the correct deployment of the wing it is necessary to put an elastic band on the top surface of the wing. Measure a point 25mm forward of the nylon pivot bolt, on top of the wing, and drill a 1mm hole right through the wing at a slight angle to keep the elastic in place.

Cut a piece of 1mm carbon rod so it goes all the way through the wing and extends just 5mm above the wing. Cyano the rod in place.



Use the smaller, stronger elastic and stretch it over the pin and the nylon pivot bolt. **The wing holding nut should be fastened just enough to allow free movement of the wing without any excessive slop.**

Fitting the wing tip elastics: Remove the wing and mark the positions for the tip elastic, 12mm from the hinge line and in the middle of the centre section. See photo. The elastic is 1mm diameter so drill a 1mm hole right through the wing at both positions. Push one end of the elastic through one of the holes, from the top side, until it is flush with the bottom skin. Apply a spot of thin cyano to the end of the elastic. Also apply a spot to the upper side, where the elastic comes through the surface. Now pull the elastic quite hard and thread it through the other hole and pull it through from the underside. **The elastic should have a high-pitched 'ping' when flicked.** Once you are happy with the tension, cyano the underside, while still holding tension on the elastic. Cyano the top also.

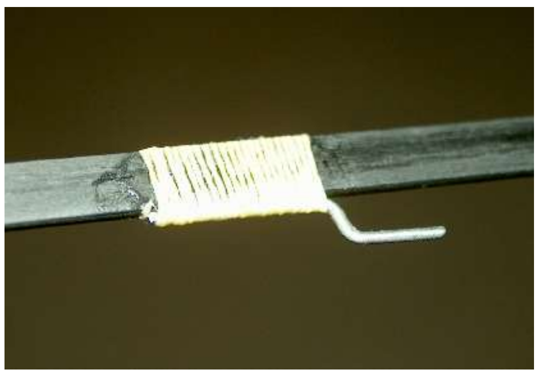
Finally, trim the elastic flush with the skin. Be careful, the elastic is tough!

Repeat for the other wing tip.

To hold the wing in the folded position for launch, it is necessary to make a couple of pins from 0.9mm piano wire. This is one of the best improvements over earlier models that relied on pieces of cotton to hold the wing closed.

9/ Closure Pin: Bend a small pin similar to the one in the photo on the left. The longer arm should be approximately 10mm long and the smaller one 6mm, try to keep the bends sharp and at 90 degrees though this is not super critical.

Assemble the model and attach the launch cradle, making sure the front end is engaged fully into the box. Tack the longer arm of the closure pin to the edge of the cradle spine using cyano. **Note the position in the photo. The shorter arm should run alongside the nylon bolt head.**

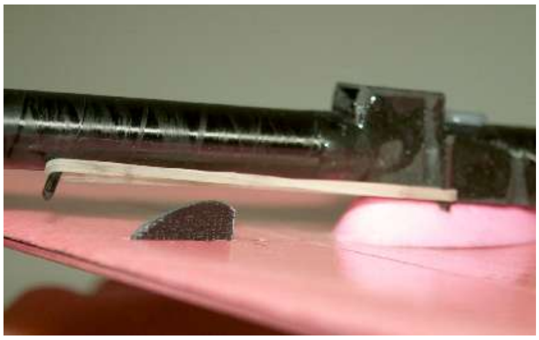


Use cotton or fine Kevlar thread to bind the pin to the spine. Wipe cyano into the binding to secure it.

Re-assemble the model, complete with the two elastic bands and launch cradle, turn the wing through 90 degrees and fold the leading edge down till it touches the closure pin. **Mark where it touches the wing.**

Take a small piece of 0.5mm carbon sheet approximately 10mm x 7mm and shape it similar to the photo on the right to make the wing closure web.

Using a sharp knife, make a cut through the bottom skin of the wing leading edge 10mm long, 5mm either side of the mark made previously. This cut should be in line with the centre of the wing. Push the closure web through the cut till it meets the top skin of the wing. The rohacell foam will compress easily. **Do not glue into place.**



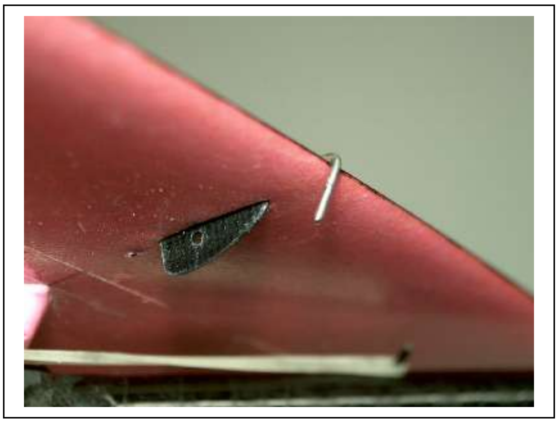
Assemble the model again and swing the wing through 90 degrees and check that the wing closure web clears the swing elastic. Adjust the web if necessary.

Mark the position, on the web, where the closure pin on the cradle will enter the web. Remove the web and drill a 1mm hole in the marked position.

Push the web back into place **but do not glue it.** Assemble the model again, on the cradle, fold the wing, slide the cradle back slightly so the pin clears the web, fully fold the leading edge and slide the cradle forward. The pin should enter the hole. If it does not, adjust the web position till it does. Once happy with the position of the web, cyano it into the wing.

10/

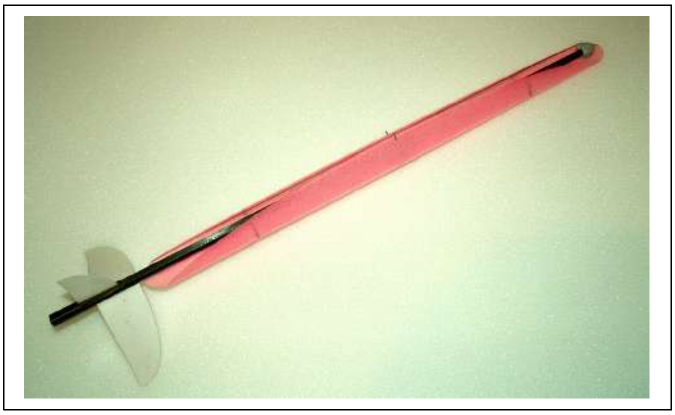
Trailing edge closure pin: Take another length of 0.9mm piano wire and bed it through approximately 55 degrees as in the photo. Make the long leg about 12mm long and the short leg 6mm.



Simply push the long leg through the leading edge of the wing, just above the carbon leading edge, trying to keep the leg just under the top skin. If you get this right, it should just slide down one side of the closure web. This does not need gluing in place but can be done if it works itself loose. It is advantageous to be able to swing this pin sideways when folding the wing.

It should now be possible to completely fold the model, hold it in its launch position and test the deployment.

Start by attaching the launch cradle, and then rotate the wing through 90 degrees. Flatten the tips and fold the leading edge down. Pull the cradle back slightly and engage the closure pin by sliding the launch cradle fully forward. Rotate the trailing edge closure pin through 90 degrees, fold down the trailing edge till it meets the leading edge then rotate the pin back again. You should now be able to hold the model vertically, in its launch position with everything remaining closed.



To check deployment, hold the cradle fin in one hand and the glider fins in the other. Slowly separate the two and as you do so, the wing should disengage the pin, unfold and swing into its flying position pretty quickly. If you continue separating your two hands, the launch cradle should separate entirely from the glider.

11/ Trimming: Without the launch cradle, add something like plasticene or blue tack to the front of the boom till the model balances just on the front hinge line of the wing. Test glide and add or subtract weight until happy with the performance, neither stalling nor diving. The overall weight of the glider only, should be in the region of 16 - 18 grams.

The instructions above describe the making of the basic model without a de-thermaliser. It is beyond the scope of these instructions to describe the many variations on de-thermalising and the following describes the finalising of a basic, non de-thermalising model.

Remove the weight and weigh it. Mix up some 5 or 30 minute epoxy, with micro balloons and some micro fibres, to the same weight. It is better to use more fibre than micro balloons, to keep the volume down, and make it really thick so it can be moulded by hand without flowing. Mould the weight around the front of the fuselage boom and leave to cure thoroughly.

Once cured, smooth the surface if necessary and re-test the model's glide. Provided you mixed the same weight of epoxy as the test weight, your model should perform in exactly the same way. Slight adjustment may be needed.