Slipso400

August 17, 2006

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Chapter 1

Introduction

Designed as an introduction to the fun sport of club racing, the Slipso400 can accomodate speed-400 sized motors and battery packs up to 7 cell 2/3A configurations.

The Slipso400 has a 6mm (1/4”) solid balsa wing covered with laminating film or fiberglass. The fuselage is made of balsa sheet, triangular stock and balsa-ply formers, subsequently covered in fiberglass using water-based polyurethane clear varnish. The tail feathers are made from solid sheet balsa.

In no way is the Slipso400 a beginners plane. The Slipso400 is a low cost entry level *racing* plane however it’s assumed that the builder/pilot has had at least three other planes and is comfortable with ailerons. With speeds in excess of 160km/hr (100mph) possible this plane is most certainly not a toy.

Specifications

- Wingspan: 750mm (30”)
- Length: 555mm (22.5”)
- Flying weight: 340˜400g (12˜14oz)
- Motor: 6V Speed 400 brushed can motor or Hacker B20-40-15L for serious speed.
- Suggested Prop: APC 4.5x4.2 - 4.75 x 4.75
- Suggested Battery: 2S1800 - 2S2200mA lipo
- Controls: Ailerons, Elevator and Throttle
- Construction: Solid balsa wing with laminating film covering. Shaped sheet-box fuselage partially covered with 2oz fiberglass cloth, sealed with water based polyurethane.

Chapter 2

Preparation

To make building the Slipso400 as efficient as possible, it's recommended you have the following resources and tools at your disposal

- Workbench of at least 1500 x 500mm (5' x 2.5') in size (for general building)
- Fast CA glue
- Whiteglue (PVA, Aquahere, Weldbond etc)
- Epoxy (may be supplanted by Polyureathane/Gorilla glue etc)
- Balsa Plane (not essential but makes building a lot more plesant)
- Xacto type No.11 blade knife
- Assortment of clamps and pegs
- Straight-edge rule
- Patience (yes, seriously, patience, your plane will turn out a lot nicer if you don't rush it)

Throughout this manual there will be references to using various tools to do certain tasks, you are not obliged to follow strictly what is done in the manual, everyone has their own preferred methods. Gluing of items is additionally a rather subjective affair, the selection of glues in this manual is based on anticipated loads and stresses that a particular join may be required to take, if you feel that you prefer another selection of glue then certainly go ahead, it is after all a personal judgement call. It is of my personal opinion that using PVA/Whiteglue such as Weldbond or Alphiatic resin will result in a much better model than using CA, not to mention the health problems that CA can potentially induce.

Some people may laugh at the requirement of patience, the truth is that after years of building, it would appear that patience can actually speed up a build and result in a better quality finished item, this is because there will be less accidents due to rushing an item (CA is a wonderful glue that bonds fast and strong but it can commit mistakes equally as well).

Examine your kit and make sure that all the parts are included and none of the items are missing from the laser cut out sheets. Also check that none of the parts in the kit are broken. It helps at times if you mark off the parts on the plan as this gives your mind a chance to associate where things go.

All dimensions and weights are specified in metric.

Chapter 3

Wing

3.1 Preface

The Slipso400 wing will be taking the greater portion of all the forced felt by the plane while it's wipping around the sky low and fast. The only other part on the Slipso400 that will feel the pressure in the same magnatude is the wing-mount bolt holders in the fuselage.

There are ten (10) pieces to make up the Slipso400 wing;

- 2 x Leading half quarters.
- 2 x Trailing half quarters.
- 2 x 100x20mm (4" x 4/5") center join blocks.
- 2 x Wingtips
- 2 x Trailing Edge strips

Please note - Due to the nature of laser cutting you will need to flip over various pieces in order to make the kerfing angle match up to provide a nearly seamless join.

Decide up front how you're going to cover your wing. We find that using 80 micron (3.0mil) laminating film on the bottom and 40 micron (1.5mil) on the top in combination with a single strip of CF tow on the wing underside is more than ample for most power configurations up to 100W.

For higher powered applications you may consider totally glassing the wing.

3.2 Building

3.2.1 Assembly

- Carefully examine all 10 parts used to build the wing and remove any excess balsa notches with the knife (Figure 3.1)
- Assemble the parts making sure that you invert one panel on each side so that the kerfing from the laser cutting process match up.

- If required, trim the width of the two reinforcement balsa pieces to ensure that both halves of the wing match up accurately.
- Glue and assemble the wing together, leaving it to rest on a sheet of plastic or laminating film and weigh down with books or other suitable weights to ensure that the wing does not warp while drying. (Figures 3.2,3.3 and 3.4)

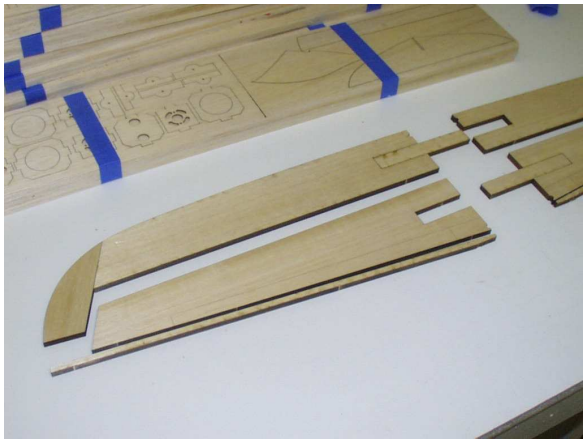

Figure 3.1: Dry fitting of parts

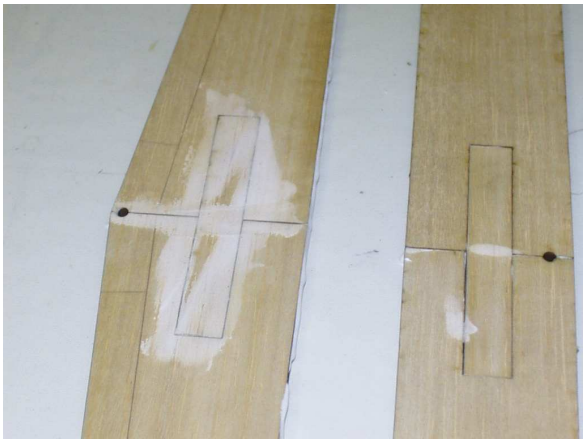

Figure 3.2: Bringing the wing halves together

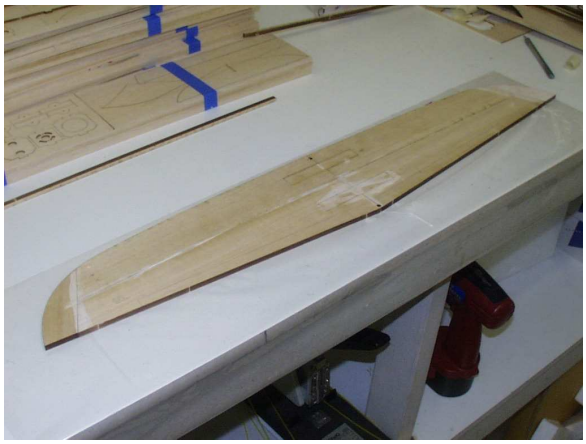

Figure 3.3: Wing glued

Figure 3.4: Keep the wing flat

3.2.2 Shaping

Despite being only 6mm thick, the wing section (Airfoil) of the Slipso400 wing can make a considerable difference in flight, however even if you do not obtain a near ideal wing section the Slipso400 will still fly. The quality of the wing section will certainly be something which can separate winners and almost-winners. As an example, if you can manage to make a good wing section that allows you to pull an extra one degree of attack without having the airflow detach from the wing (high drag, rapid speed loss) it means you will be able to turn tighter and maintain speed. We will not be discussing how to make an ideal section here, rather we'll describe how to start out and let you, the builder take it from there.

- As a basic starting point, shave down the LE (Leading Edge) to just below mid thickness (4mm ˜ 1/5") and sloping back to the top 25˜30mm (1˜1.25") in from the LE.

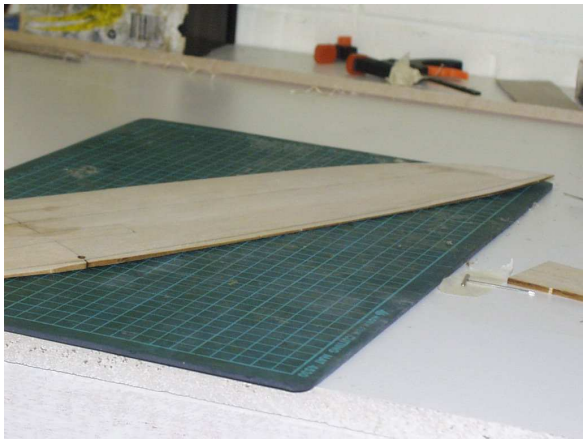

Figure 3.5: Wing with sanded profile - note the upward curved tips

- Shave the TE (Trailing Edge) down to 1.5mm (1/16”) and 45˜55mm (2”) in from the TE.
- Sand the wing down to provide a nice smooth surface and curvature. Take special note of the LE section to ensure that it has a nice egg profile. Do NOT attempt to round the LE to a circular profile as this will cause a considerable amount of drag.
  - A sharp egg-point nose will produce less drag but stall sooner (faster).
  - A blunt egg-point nose will produce more drag but stall later (easier).

3.2.3 Reinforcements

The basic balsa Slipso400 wing covered with film will most likely suffice for normal speed-400 racing. For the purpose of safety and peace of mind, you may wish to consider applying a strip of CF tow or cloth along the underside of the wing across the span. Standard 12,000 strand tow bonded down with epoxy, CA or hotglue will provide ample wing tensile strength for those extra tight turns or emergency “Oh dear” moments.

Figure 3.6: Masking tape applied for hotglue tips

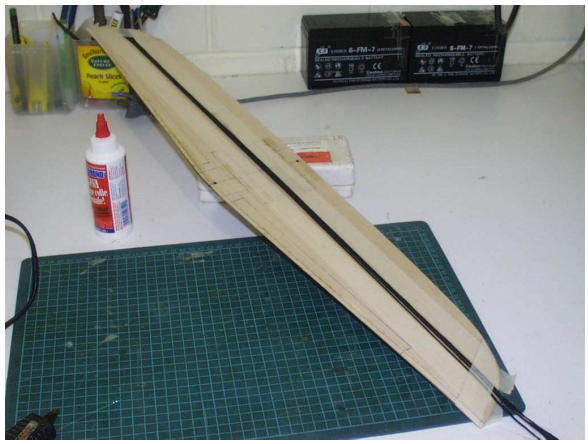

Figure 3.7: CF positioned and taped down

3.2.4 Covering

There's many choices of potential coverings that can be used for the Slipso400 wing. We have found the simplest and cheapest is to use a combination of 80 micron (3.0mil) and 40 micron (1.5mil) laminating film.

The 80 micron film is used on the underside of the wing and provides yet more tensile strength for handling tight turns. The topside 40 micron film provides a light, strong and low drag finish. One could us 40 micron film on both sides, especially when combined with the CF tow/cloth reinforcements - however using the heavier 80 micron film does give additional peace of mind from mid-turn wing clapping events (and subsequent clapping from the peanut gallery).

Figure 3.8: Wing being covered

3.2.5 Ailerons

By default the Slipso400 comes with ailerons marked out by the laser cutting. These ailerons are sufficiently effective at medium deflection rates for general purpose. If you wish to have extremely agressive roll rates you may consider making the ailerons an additional 6mm (1/4") deeper.

Ailerons can be cut cleanly from the covered airframe and hinged according to preference. The simplest of hinging methods is to bevel the underside of the aileron and use tape or 40 micron laminating film hinges on the topside.

When bevelling the ailerons make sure you do not cut away any balsa from the top otherwise it will result in an ugly gap in the top-hinge. If you do accidently cut away too much balsa it would be best to make a new aileron from fresh material.

Chapter 4

Fuselage

4.1 Preface

Building the fuselage isn't a complex task however you'd be wise to take your time and it's strongly recommended to use PVA or Alphiatic, this gives you the time to setup the join as well as providing a flexible bond that can tollerate less than perfect landings as well as high stresses.

4.2 Making the Formers

To provide an extra level of strength, the formers for the fuselage are made by creating a balsa plywood from 3 layers of 1.5mm (1/16") balsa. Of the three (3) pieces there is one that has the grain at 90 degrees to the other two, this piece is the *middle* piece.

Use PVA glue and assemble all the formers together and place under pressure until dry. Using two glass sheets with books or old batteries works well.

Figure 4.1: Fuselage formers under glass

4.3 Building the Fuselage

- Join the two fuselage sides, F2 and F3 with PVA glue and clamp. F2 and F3 are symetrical so you can insert them either way up. (Figure 4.2)

- Insert, glue and clamp F1. (Figure 4.3)
- Insert but *DO NOT GLUE* BD1 and BD2 (Bottom Deck 2). They are used to ensure the airframe is correctly aligned at this point. We do not glue them in yet because we have to add the triangular stock first.

Figure 4.2: F2 and F3 glued

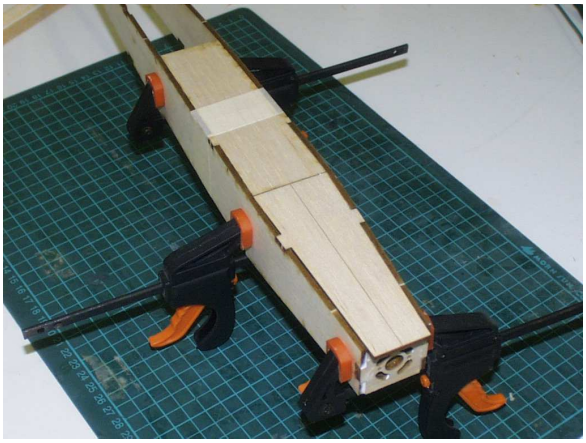

Figure 4.3: F1 added with bottom deck

- Glue in the fuselage tail alignment former. (Figures 4.4, 4.5 and 4.6)

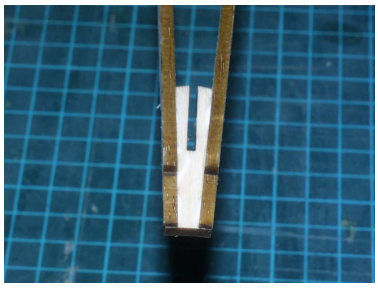

Figure 4.4: Tail alignment former

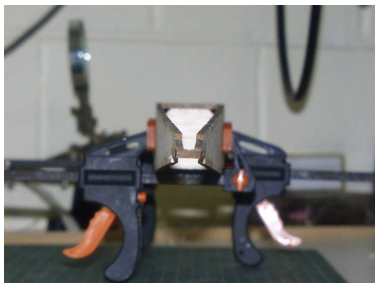

Figure 4.5: Check alignment (rear)

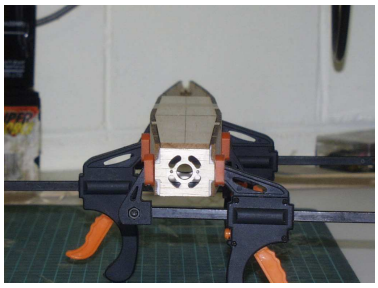

Figure 4.6: Check alignment (front)

- Remove BD1 and BD2 once the glue for the formers has dried.
- Cut to length and glue in 6mm triangular stock along the length of the bottom of the fuselage.
  - The reason we did not do this before putting the formers in is because if we tried to do that the triangular stock would resist the bending of the fuselage sides and crush the balsa causing it to be weaker.
- Take notes that the triangular stock has to sit flush with the notches in the fuselage sides. (Figure 4.7)
- Insert panels BD1, BD2 and BD3 with their laser marked center lines on the outside (this is used later to ensure proper alignment. Ensure that the tristock glues and sits flush with the bottom panels.
- Install the wing bolt hold-downs. Be aware that they are of different sizes for the front and the back. (Figures 4.8 and 4.9)

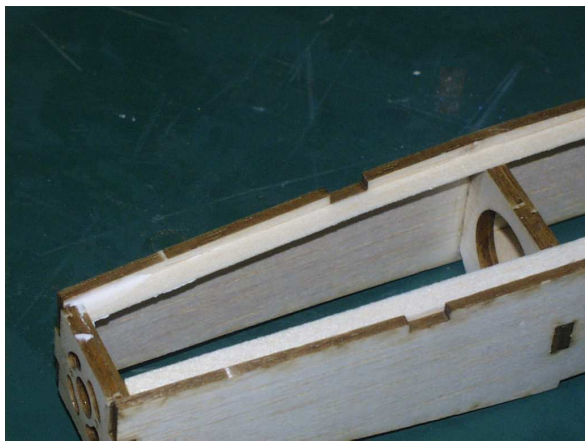

Figure 4.7: Triangular stock glued in

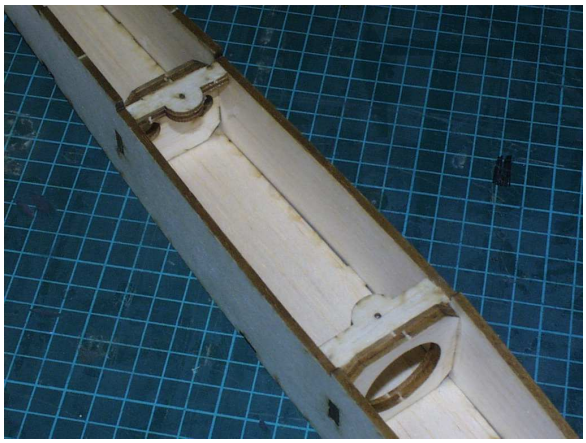

Figure 4.8: Wing mount formers installed

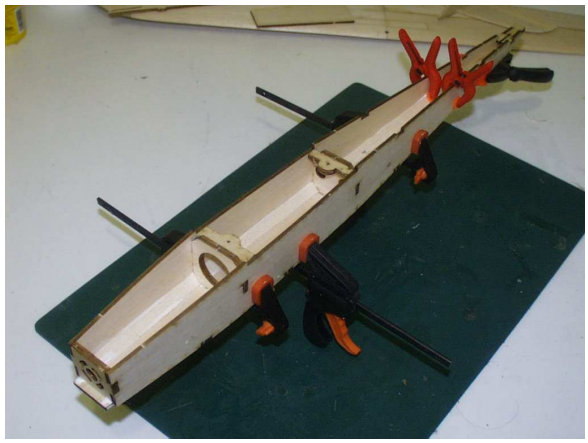

Figure 4.9: Bottom decking and tristock installed

- At this point you need to commit yourself to installing the elevator servo. A typical 9g (0.3oz) class servo provides ample strength for a brushed speed-400 setup. Tape and hot-glue in the servo to the rear side of F3. (Figure 4.10)
- Install cable guide and an ample length of control wire to extend all the way to beyond the underside of the tail former. (Figure 4.11)
- Install triangular stock to the top side of the fuselage. (Figures 4.12 and 4.13)
- Install the rear top-deck (TD2) with the laser-marked center line facing up.
- Using a razor plane, shave down the fuselage to a round profile and finish off with sand paper. (Figures 4.14 and 4.15)
- At this point you may wish to temporarily install the motor/spinner to give a guide for how far to shape down the nose section. (Figures 4.16 and 4.17)
- Finish the fuselage according to preference. We find that applying 2oz glass up to F3 (wing TE former) is sufficient for most applications. (Figure 4.18)

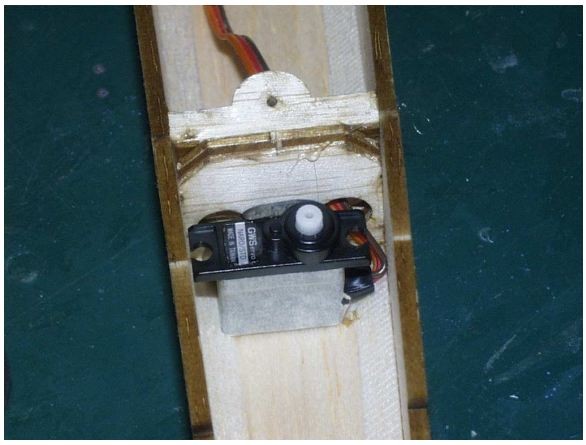

Figure 4.10: Elevator servo installed

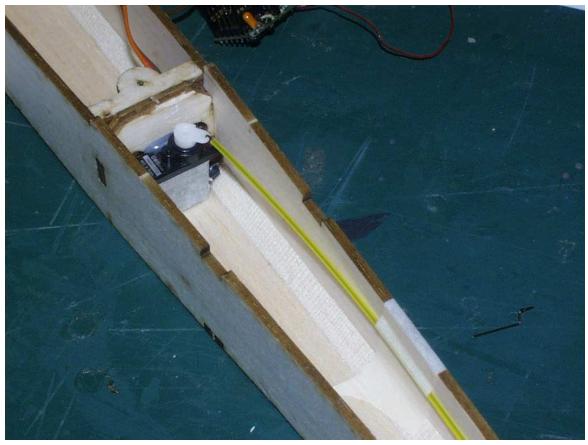

Figure 4.11: Control guide installed

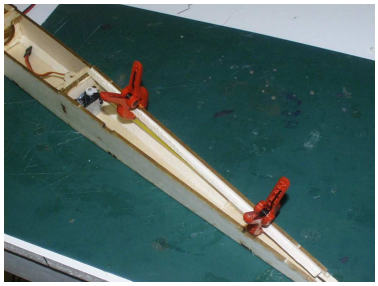

Figure 4.12: Appling tristock to top-rear

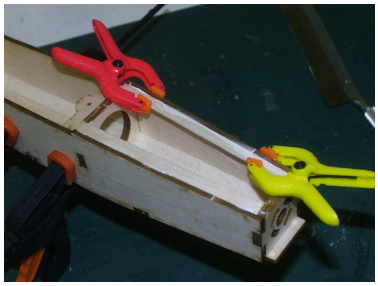

Figure 4.13: Top-front tristock

Figure 4.14: Front of fuselage shaved to shape

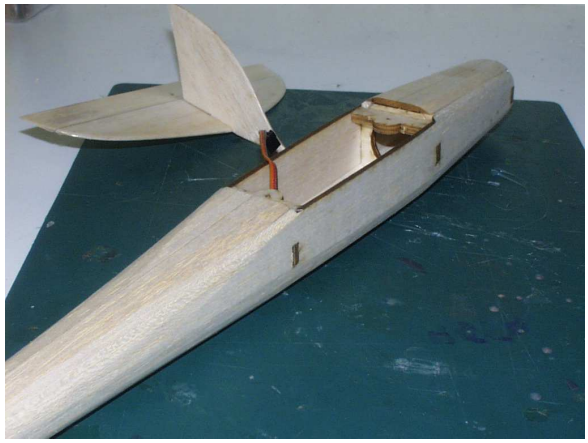

Figure 4.15: Rear of fuselage shaved to shape

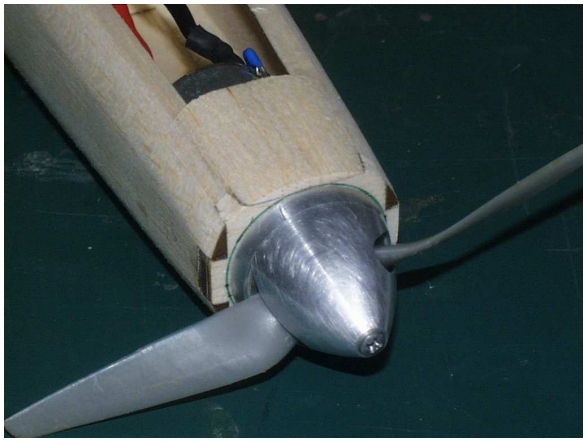

Figure 4.16: Spinner fitted and marked

Figure 4.17: Nose sanded to smooth profile

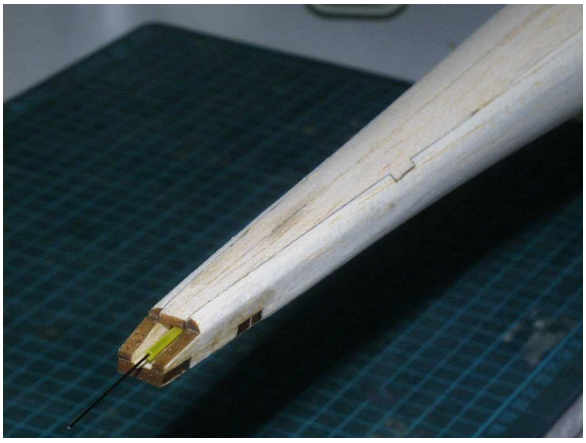

Figure 4.18: 2oz glass cloth on fuselage

Chapter 5

Tail

Building the tail for the Slipso400 is a fairly simple affair but it is very important to ensure that you build it square and keep the elevator hinge as slop free as possible (not too difficult).

- Join the elevator to the horizontal stab with masking tape (Figure 5.1)
- Turn over and shave down the shave down the TE as much as practical, try to get to at least 1mm (1/25”) thin, preferably closer to 0.5mm (1/50”) (Figure 5.2)

Figure 5.1: Horizontal stab and elevator joined with masking tape

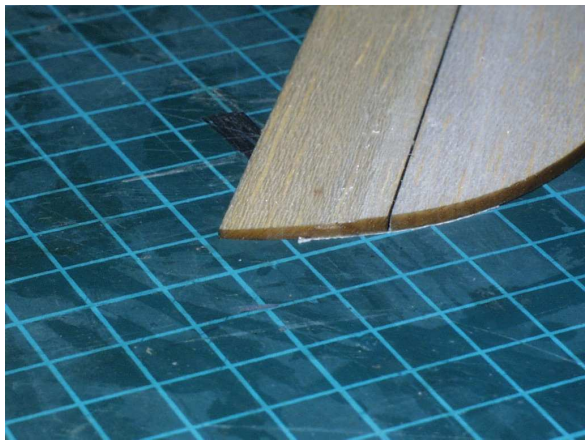

Figure 5.2: Elevator shaved down

- Fold up the elevator and shave in the bevel for the hinge. As with the ailerons, do not over cut the bevel else you’ll have ugly gaps in your hinge. (Figures 5.3 on the following page and 5.4 on the next page)
- Sand down the horizontal and vertical stab to a smooth profile and test fit. (Figure 5.6 on the following page)
- Cover tail surfaces with 40 micron laminating film to provide a very low drag surface. You can use the top-covering of the horizontal-stab as a live hinge and use 12mm (1/2”) wide clear scotch tape on the underside of the hinge.

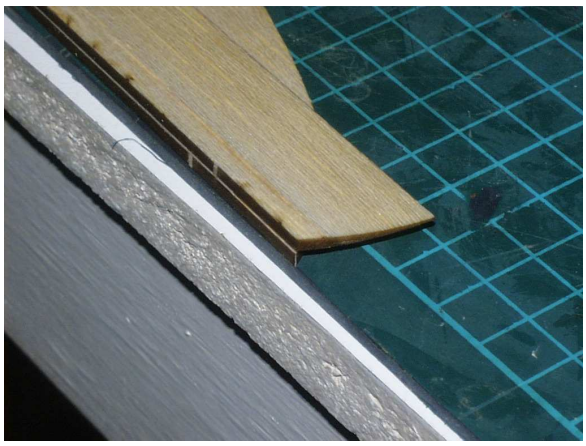

Figure 5.3: Elevator folded over

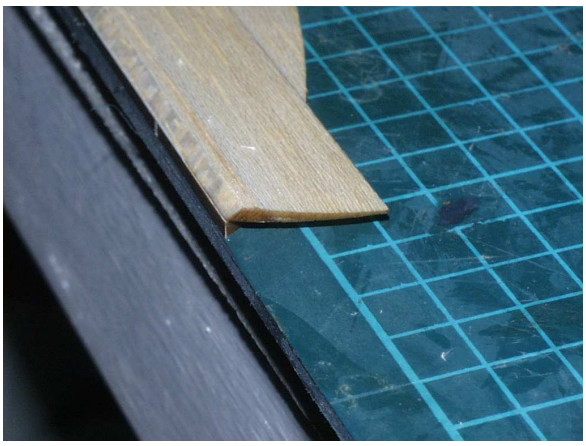

Figure 5.4: Beveled elevator

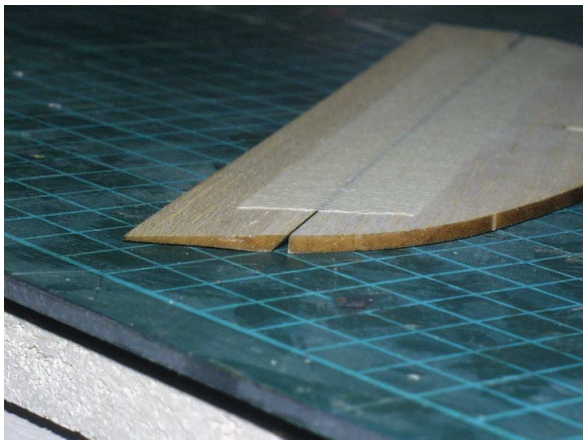

Figure 5.5: Elevator after shaping

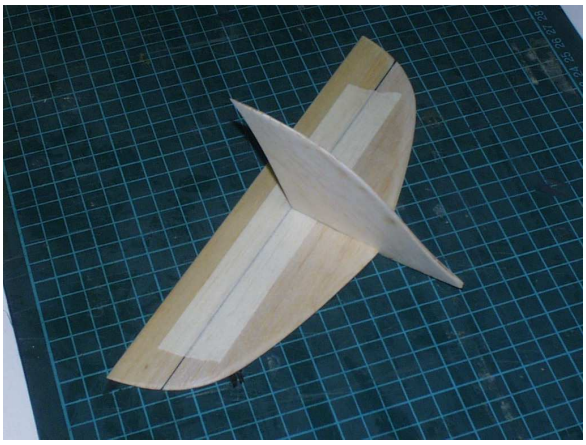

Figure 5.6: Test fitting the tail

- Glue the tail together and keep it flat and square.
- Glue the tail unit together after the fuselage has been glassed and sealed.

Chapter 6

Final Assembly

When the tail, fuselage and wing have all been finished you can finally bring them together to create the complete Slipso400 airframe.

6.1 Wing fixation to the fuselage

The Slipso400 wing comes with 4mm (1/6”) bolt holes already laser cut into it with the subsequent wing mount receptors in the fuselage having a pilot hole cut. A blind nut mounted onto the underside of the fuselage receptors will provide for a suitable hold-down. When installing the fuselage wing hold-downs make sure that you provide ample gluing, these are the only items holding the wing to the fuselage. You may wish to install triangular stock around the underside of the hold-downs to increase their strength. Make sure when you install the wing bolts that the center line of the wing (where the two halves join) is kept in alignment with the center lines marked on the top deck panel sheets.

6.2 Tail fixation to the fuselage

Once the wing has been mounted onto the fuselage, the tail can be fitted. Before gluing the tail to the fuselage check that the laminating film on the underside of the tail has been removed as required to ensure that a balsa-balsa bond occurs. Triple check the tail horizontal stab alignment to ensure that it’s parallel to the wing.

6.3 Motor installation

Depending on the motor used different installation methods will be required.

- Use 5.5˜6mm x 2.3mm metric screws directly through F1 for the Speed-400. Make sure you strengthen the balsa supporting the screws by CA’ing them and allowing to soak for 15 minutes.
- Use a double-wrapped 1.5mm balsa holder and glue with PVA. Sand the front edges of the holder down to fit snugly into the nose of the fuselage before gluing.

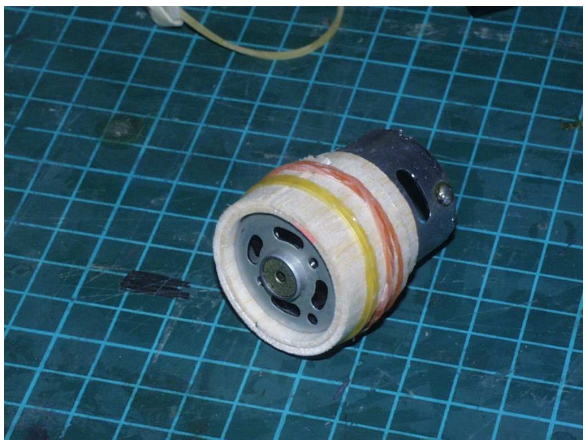

Figure 6.1: Motor mount made from two layers of 1.5mm (1/16”) balsa

Chapter 7

Flying

7.1 Control surface setup

7.1.1 Elevator

If you have the ability on the transmitter, it's recommended to have either dual-rates or expo-rates setup for the Slipso400 elevator. During normal flight there is very little movement required, however on landing approach with power off it's often useful to have a lot more elevator movement to facilitate washing off speed.

In-flight movement range is +/-3mm (1/8") of deflection (yes, a very small amount).

Landing movement range is +/-6mm (1/4")

7.1.2 Ailerons

As with the elevator, the ailerons do not need a lot of deflection. In fact, with excessive deflection you risk adverse stability issues including spontaneously snaps and flat spins. If you need greater roll rates it's suggested that you increase the average width of the Slipso400 ailerons rather than attempting to increase the deflection.

Medium Aileron deflection: +/-6mm (1/4")

7.1.3 Flaps

If you've decided to use a two servo aileron setup you can program your TX to provide a flap/reflex facility which can be useful for landing approaches. With flaps you can consider increasing your lower deflection maximum to 6mm but it's not recommended that you go beyond 6mm (1/4") for the upper deflection.

7.2 Battery Selection

7.2.1 NiMH

The standard battery for most club racing is a 7 cell (8.4V) 1000˜1400mA 2/3A NiMH pack. At the time of writing the highest capacity cells are from Intellect IB1200 and IB1400 cells. Other popular cells are the GP1100's.

7.2.2 Li-poly

For starting out, a 2S1800 to 2S2200mA with 10˜15C average discharge rate works very well with speed-400 can motors. Despite having a lower nominal voltage of 7.4V versus the 8.4V of a 7 cell pack the lipo can actually end up having a higher real voltage during the flight due to the internal resistance differences. The great thing about using a lipo pack is that the AUW for the plane can be lower for the same flight times or you can choose to keep the same AUW and have longer flight times.

7.3 Prop selection

7.3.1 6V Speed-400 can motor

Ideal prop selection will vary dramatically based on your battery selection and prevailing atmospheric conditions to obtain optimal performance.

- On 7 cell NiMh or 2S lipo configurations an APC 4.75x4.75 is a good starting point.
- On 3S lipo an APC 4.2 x 4.5 would be more ideal, be aware though that nearly all brushed speed 400 motors are not really designed to withstand such voltages.

7.3.2 Brushless in-runner

There is such a massive range of in-runners that it's difficult to suggest a prop for them, however, starting with a 7cell-2S configuration on a 3000kV 20x40mm in-runner an APC 4.5x4.7 could be a good start. For higher kV or 3S configurations an APC 4.1 x 4.1 may be more idea so as not to overly stress the motor in the much higher rpm (30,000rpm+) environments.

7.4 Center of Gravity (CoG, CG)

The CG is located between 28 and 32mm (1" ˜ 1.25") from the LE (Leading edge) as measured at the sides of the fuselage. Deviations from this can be based on personal flying preferences.

7.5 Launching

For Speed-400 brushed installations, launch at full throttle over the shoulder with a horizontal angle (don't try to launch upwards aggressively, the plane will only stall and crash). The Slipso400 will sink about 1 meter before it has picked up enough speed to start flying. Allow it fly straight at a very slight upward angle to gain more speed before commencing the first turn and climb.

7.6 Landing

The Slipso400 is a surprisingly fast plane when it comes to landing but with a few tips you can make it easier.

- Approach the landing from at least 15m (45’) high as you perform the final turn from about 50˜70m (150’) down wind.
- Kill the throttle just as you commence the final turn to line up with the landing strip. As you turn the high attack angle on the turn will cause the Slipso400 to wash off a lot of its speed. WARNING - do not turn if you are already quite slow or lower than 5m. As with most racing planes of this type they are quite susceptible to tip stall at lower speeds. Without sufficient height or speed a crash may result.
- The Slipso400 should come into contact, or be very close to contact with the ground as it passes your position, if you’re too high and fast then power up and go around again.
- Do not use excessive aileron movements on landing, remember you do not have a rudder so you cannot correct a misaligned approach too easily - better go around and do it again.
- If you find that the landings are too hot then try leaving the throttle at 10˜15%, this has a very aggressive air-brake type effect, so much so that you may find the Slipso400 will want to land well short of your position.

Chapter 8

Beyond here...

After you have mastered the Slipso400 you may well be looking for more performance, moving up from a standard brushed speed-400 motor to a Brushless in-runner will provide the single most dramatic improvement in performance. Take care when upgrading to brushless to ensure that your airframe has been built to handle the extra stresses.

Thank you again for building and flying the Slipso400.

Chapter 9

Web sites containing further details on various build processes.

- Using laminating film to cover wings.
  - http://www.pldaniels.com/flying/balsa/using-laminating-film-for-models.html
- Using laminating film to cover tails.
  - http://www.pldaniels.com/flying/balsa/laminating-model-aircraft-tails.html
- Video demonstrating covering with laminating film
  - http://www.pldaniels.com/flying/balsa/videos/playflash.html?video=laminating-film-covering&pp=balsa
- Using hotglue and carbon fiber tow for reinforcements
  - http://pldaniels.com/flying/balsa/howtos/carbonfiber-hotglue-composite
- Using water based polyurethane and fiberglass
  - http://pldaniels.com/flying/balsa/fiberglassing-model-aircraft-with-water-based-polyurethane.html
- Video demonstrating glassing with water based polyurethane
  - http://www.pldaniels.com/flying/videos/flash/playflash.html?video=glassing-with-wbpu-360x288&pp=balsa


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