Microseether

A PLDaniels Design

February 9, 2007

Contents

Part I

Introduction

After the success of the Seether, there was a strong desire to create another version but of a different scale. The Microseether was originally intended to be a 500mm span (approximate 50% scale) however this was found to be an impractical scale for holding current R/C electronics without having to resort to more expensive ultra micro equipment and exotic lipo battery sizes.

Amazingly (terribly?) the Microseether also required a couple of frustrating attempts to finally come good in flight. Being a smaller wing the CG was found to be a lot less forgiving than the original Seether.

The power plant for the Microseether is the same as the Seether, the GWS 2205 outrunner though it's coupled with a 6x3 prop rather than the 7x6 of the full Seether. Obviously the battery used is a lot smaller, the current versions using an Elegance 2S450mA-15C.

The Microseether is flown in a manner that's somewhat different to the Seether, it's a plane that you find enjoyment with by keeping it within 50m of yourself and playing games with mother Earth (be forewarned, Earth sometimes wins).

Microseether's durability

When people think of balsa planes they tend to imagine large structures of stick and tissue that have taken many meticulous hours to build and look so fragile that one is hesitant to even sneeze around them. For the Microseether nothing could be further from the truth. During development and testing of the Microseether it endured no less than 6 distinct crashes as items such as the CG and control throws were determined. Crashes that involved cartwheeling (normally incredibly destructive), lawn-darting and playing chicken with trees (We never managed to win those).

The Microseether is made of solid sheet balsa, there's very few delicate structures in the Microseether build. The typical failure mode of the Microseether was to split or break off the nose boom from a hard impact. Sometimes the landing skids would shear off though we've adjusted the laser cutting to greatly prevent this (notice the grain orientation of the balsa). more often though it was just a case of wiping off the dirt on its nose and launching again

Who should fly a Microseether?

First up, just because the Microseether is a smaller version of the Seether does not make it a plane more suited to a person starting out with pusher wings. The Microseether is actually more fickle, less forgiving and relatively faster than the full size Seether, for this reason it's recommended that the Microseether is not chosen as a first flying wing / pusher jet. If you're starting out rather look at the full size Seether which is bigger, glides better and less hyperactive. On the other hand, if you've had the full size Seether or similar and you're looking for something that will almost fit in your glove box and provide you with a good lunchtime flight fix in a very small flying field, the Microseether is a great plane that's durable to boot.

Enjoy!

Part II

Building

Chapter 1

Preparation

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

- Workbench of at least 1500 x 600 (5 x 2') mm in size (for general building)
- White-glue (PVA, Aquahere, Weldbond, Aliphatic etc). CA can be used but isn't required.
- Epoxy (may be supplanted by Polyurethane/Gorilla glue etc)
- Balsa Plane (not essential but makes building a lot more pleasant)
- Xacto type No.11 blade knife
- Assortment of clamps and pegs
- Weights (sandbags, old Gel-cells, metal blocks)
- 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 judgment call. It is of my personal opinion that using PVA/White-glue such as Weldbond or Aliphatic 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 can be a wonderful glue that bonds fast but it can commit mistakes equally as quickly).

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 2

Booms

The tail booms and the nose spike do not require a lot of work but they do need to be prepared beforehand so as to facilitate faster building later.

2.1 Tail booms

1. Take the two parts of each tail boom and glue together. Make sure the two parts are orientated correctly. The slot of the horizontal stabilizer should be parallel to the bottom of the front stabilizer.
2. Set aside the tail booms under weights until they are dry

(See figure 2.1)

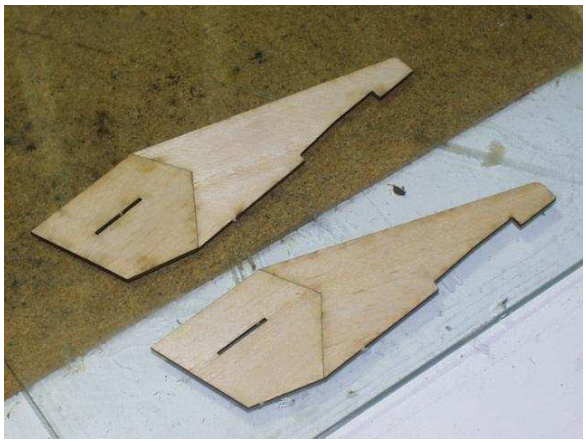

Figure 2.1: Booms glued and drying.

2.2 Horizontal Stabilizer

NOTE - the horizontal stabilizer is installed pointing away from the main body of the plane.

1. Sand down the leading and trailing edges of the horizontal stabilizer to an egg-nose profile
2. Seal or cover the horizontal stabilizer

Chapter 3

Wing

With the *Microseether*, everything is centered around the wing, the wing is the major portion of the entire plane. How well you build the wing will directly dictate the performance of your *Microseether* as well as its limits. A wing with a well shaped airfoil section will be able to greatly exceed the performance limits of a simpler flat-plate version.

The Microseether wing is composed of two distinct halves that are comprised of 3 pieces each, tip, main wing and rear segment.

3.1 Creating of wing halves

1. Join the main and rear segment parts together with a high flex, high lap-shear strength glue such as PVA/White-glue. Fast CA is not highly recommended due to its brittle nature.
2. Do NOT attach the wing-tip yet.
3. Do NOT attach the aileron yet.
4. Weigh down and clamp the two halves so that the join between them does not open up. (See figures 3.3,3.2)

Figure 3.1: Joining rear wing segments to main.

Figure 3.2: Notice the limited amount of glue.

3.2 Joining wing halves

1. If required, *very* lightly sand the centers of the wing half segments to ensure a good match, check that the fuselage spine can still be inserted without excessive pressure
2. Bring the two wing segments together and glue

Figure 3.3: Joining of the wing halves.

3.3 Shaping the wing

Once the wing has been glued, we can proceed to create an airfoil section for it. While this airfoil section is not super critical it does always help the performance if you can do a smooth and consistent job of it.

1. At the tail boom slot, 20mm from the LE down to 10mm from the LE at the wing tip
2. At the tail boom slot, mark where the tail boom ’kinks’ down to 40mm from the LE at the wing tip (See figure 3.5)
3. Mark off where the nose-spike will sit on the wing, make sure you don’t sand or plane down this area as it’s required to remain flat to ensure a good fit later. (See figure 3.4)
4. Shave or sand down the leading edge portion to approximately 2mm (1/10”) from the bottom of the wing. (See figure 3.5)
5. Shave or sand down the trailing edge portion to approximately 2.5˜3.0mm (See figure 3.8)
6. Sand down the wing to produce a smooth transition between the LE, center and TE portions (See figure 3.9)
7. The vertical tail booms have a shaped notch in them that you should try to closely match (See figure 3.12)

Figure 3.4: Marking off the nose spike area

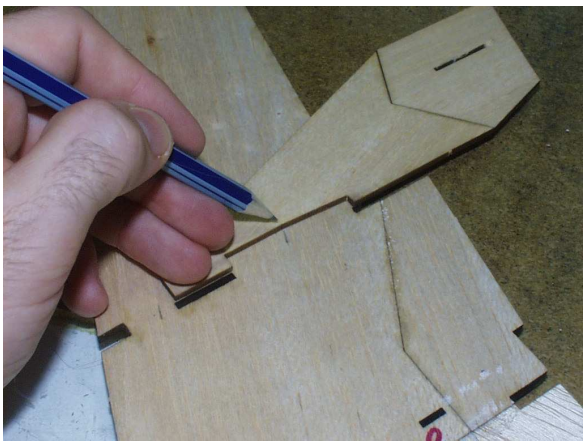

Figure 3.5: Marking the point where the wing starts tapering

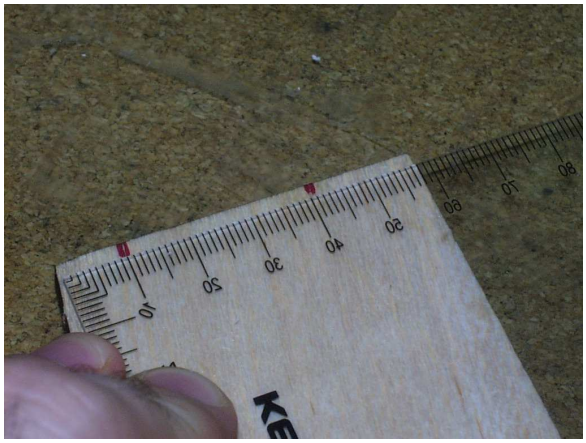

Figure 3.6: Marking the wing tip

Figure 3.7: Joining the lines for the shaving limits

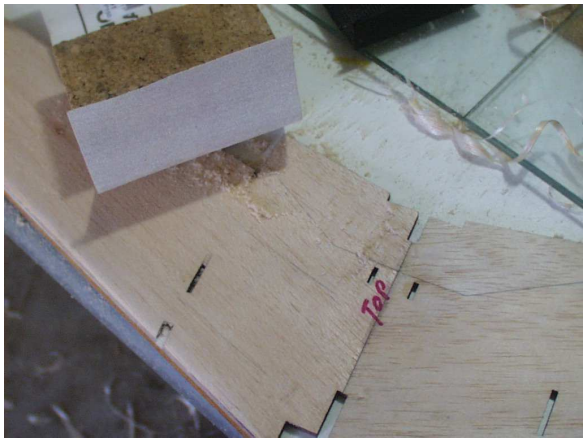

Figure 3.8: Sand or plane down TE

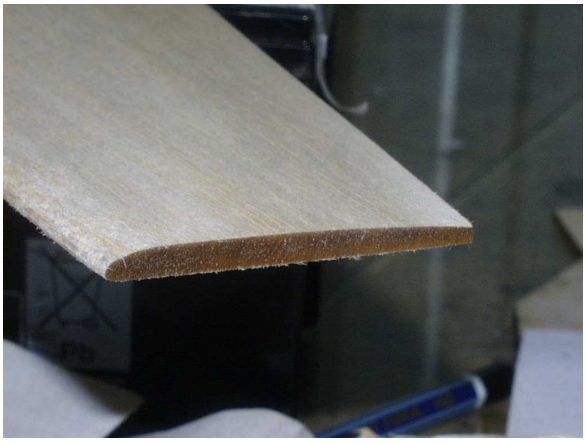

Figure 3.9: Wing section at tip after shaping

Figure 3.10: Trailing edge detail at wing center

Figure 3.11: Leading edge detail, note wedge area untouched

Figure 3.12: Try to match wing section to boom taper

3.4 Attaching the wing tip

Now that the primary part of the wing is shaped, we can attach the wing tip. By applying the wingtip on after the primary shaping we avoided having use the hand planer across the grain on the tip (which would cause it to typically become very messy).

1. Glue the wingtip onto the wing, align the tip with the leading edge of the wing
2. When the glue is dry, use a sanding block to bring the tip down to the same profile as the wing.

(Figures 3.13 and 3.14)

Figure 3.13: Wingtip glued on

Figure 3.14: Wingtip sanded down to shape

3.5 Shaping the Elevons / Ailerons

1. Place the elevon along side the shaped wing and score a line on the elevon indicating the amount of stock to shave or sand off.
2. Shave / sand off the excess elevon stock and keep comparing it against the wing until there's a smooth transition from the wing to the elevon (Figures3.15, 3.16)
3. It's recommended that you cover your elevons, 30 micron laminating film works very well and adds only minimal weight
4. After covering, insert and glue the control horns (Figure 3.19)
5. For hinging of the elevons, the easiest way is to bevel the underside of the elevon at approximately 45 degrees and use tape on the topside and bottom side. Clear tape hinges are amazingly robust and certainly very easy to apply. (Figures 3.17, 3.18)

Take note, the elevons aren't actually attached to the airframe until we've completed everything else.

Figure 3.15: Elevon lined up before shaping

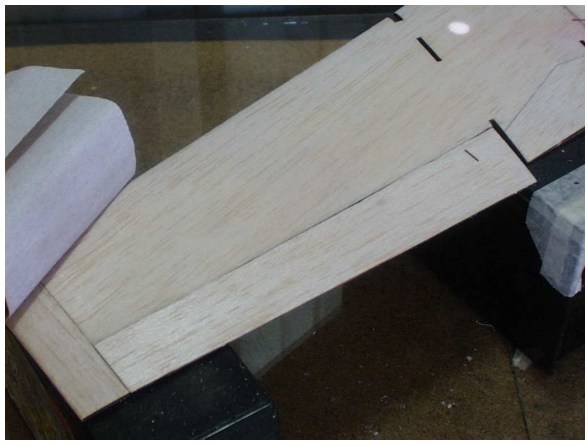

Figure 3.16: Elevon after planing down

Figure 3.17: Elevon before beveling

Figure 3.18: Elevon after beveling

Figure 3.19: Elevon control horns installed

3.6 Wing Sanding, and Covering

The choice of covering is left to the builder but we find that laminating film makes for an excellent low cost covering material that is exceptionally tough.

When covering, make sure that you cut out allowances for the fuselage, tail booms, triangle stock and landing skids in the covering after it is complete.

Chapter 4

Fuselage and Tail

4.1 Wing, Nose and Spine Assembly

1. Turn the wing over onto its back
2. Insert and test fit the fuselage spine into the wing
3. Insert and test fit the nose spike onto the spine. If the sides of the spine do not touch the wing then trim a little bit of extra clearance from the inside location notch (Figure 4.2)
4. Glue wing, nose spike and fuselage spine together
5. Set to dry on a flat plate. Check that the nose spike sides are in contact with the wing

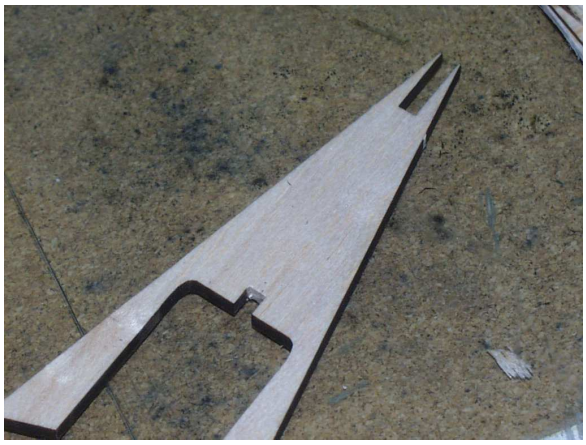

Figure 4.1: Small recess cut away in spike

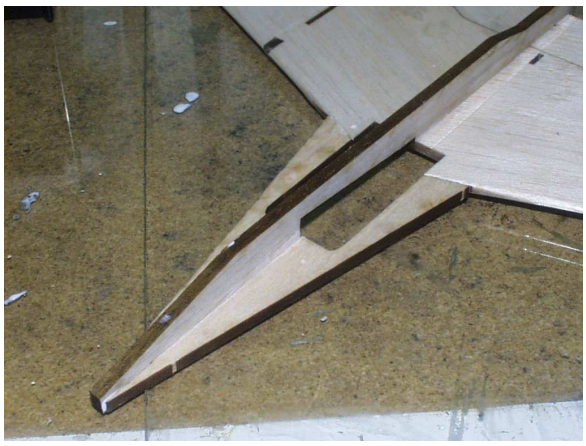

Figure 4.2: Assembled nose spike, fuselage and wing.

Figure 4.3: Fuselage spine in wing

4.2 Tail Assembly

It's important to note that because there's no trim facility build into the tail assembly you need to ensure that the tail booms rest properly into the wing.

1. Glue and insert one tail boom into the wing, make sure that the base of the boom is flush with the underside of the wing (Figure 4.4)
2. Insert and glue the horizontal stabilizer, remembering that it is installed backwards.
3. Insert and glue the second tail boom (Figure 4.5)
4. Check that the booms are parallel to each other and that the horizontal stabilizer is parallel to the wing (Figures 4.6,4.7)

Figure 4.4: First tail boom installed

Figure 4.5: Tail assembly completed

Figure 4.6: Check booms are parallel

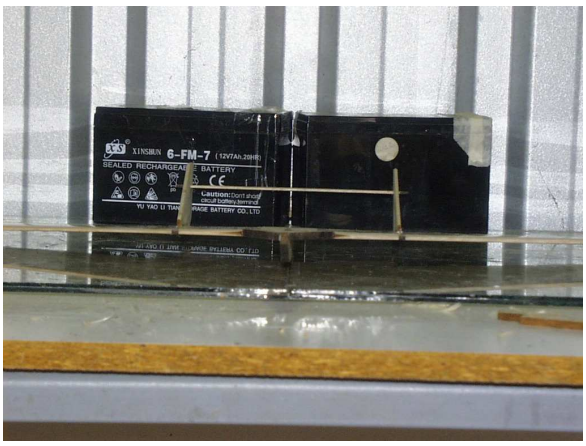

Figure 4.7: Check stabilizer is parallel to wing

4.3 Fuselage Assembly

Rear segment

1. Glue and insert formers F1 and F2, making sure both are square to the top-surface of the wing. (Figure 4.8)
2. Glue fuselage sides only between F1 and F2 (Figure 4.9)
3. Clamp sides to fuselage
4. Insert reinforcement plates, check the alignment of the cable holes with those in the wing (Figures 4.10,4.11)
5. Wait for glue to dry

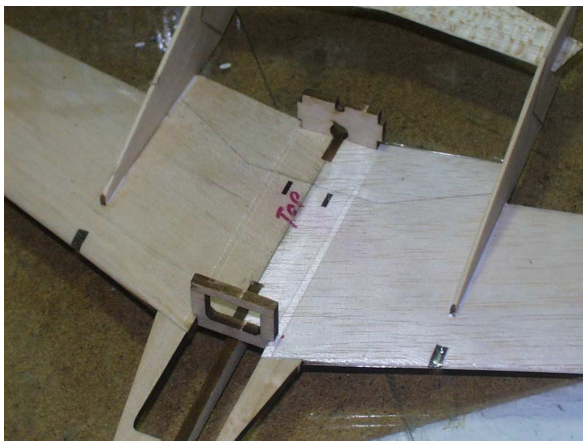

Figure 4.8: F1 and F2 installed

Figure 4.9: Fuselage side installed

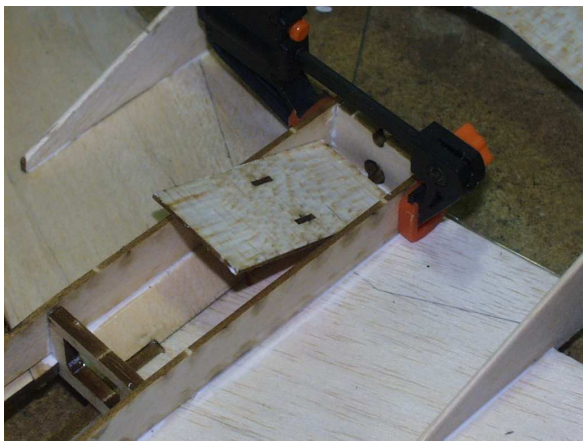

Figure 4.10: Inserting reinforcement plate

Figure 4.11: Both reinforcement plates installed

Front segment

1. Glue and insert battery bay plate (Figures 4.12, 4.13)
2. Glue and insert 6mm triangle stock reinforcement along the length of the spine between F1 and F2 and the battery plate (Figure 4.16)
3. Glue and insert F1 top-doubler (Figures 4.14, 4.15)
4. Glue and clamp the fuselage sides from F1 to the nose spike. At this stage it's useful to test fit your battery so that you can bend the sides of the fuselage to match. You can use a small block of wood to help keep the sides out (Figure 4.17)

Figure 4.12: Battery bay plate installed

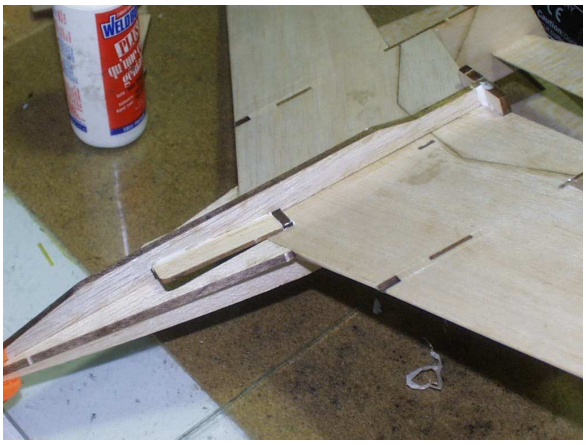

Figure 4.13: Viewed from the side

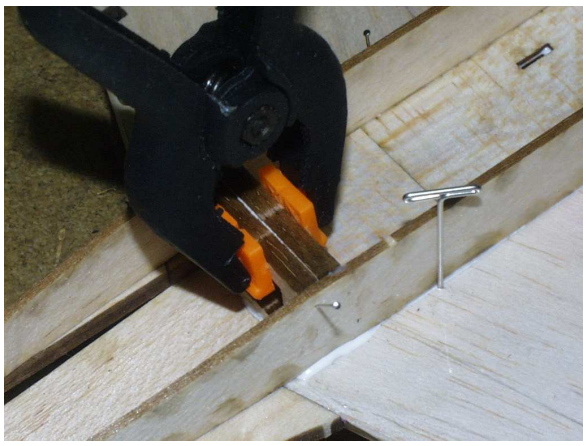

Figure 4.14: F1 top doubler being installed

Figure 4.15: F1 doubler installed

Figure 4.16: Installing the triangle stock

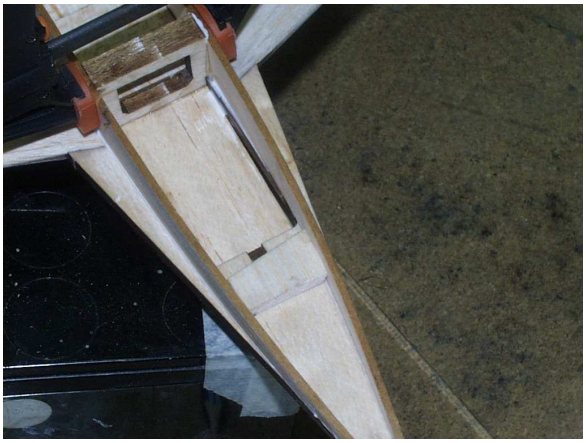

Figure 4.17: Fuselage sides glued with small wood block for spacing

Fuselage hatch

To make building easier, the Microseether incorporates a dual-hatch system. By using two separate hatches we don't need to make a specially shaped long hatch, it also means that our fuselage can be made stronger as we can rely on strength contributed by the fixed top hatch plates at F1.

The hatch is made of six (6) pieces.

- 1 of Leading removable curved deck
- 1 of Leading fixed curved deck
- 1 of alignment tongue
- 1 of Rear, rectangular deck
- 1 of Rear fixed deck
- 1 of alignment tongue

Rear deck installation

1. Place and glue the Rear fixed deck sheet such that its leading edge is aligned with the front of F1 (Figure 4.18)
2. Insert the Rear alignment tongue underneath the fixed deck and insert as far as possible, mark with pencil or pen where the deck ends (where you can see the alignment tongue emerge) (Figure 4.19)
3. Slide tongue back towards the rear of the fuselage and glue on the rear rectangular deck ensuring that it is aligned correct (minor misalignment's aren't a big problem as we can always sand/adjust the tongue later) (Figures 4.20, 4.21)
4. Apply glue to the top of the doubler and gently install the removable front hatch (don't push it too far down, just apply enough pressure to make the glue work. If you have problems with the doubler sliding down then insert a pin on either side of the fuselage side to hold it in place) Figure 4.22

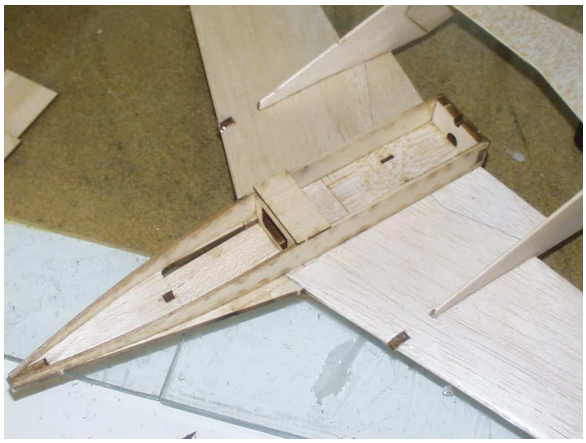

Figure 4.18: Rear fixed deck installed

Figure 4.19: Rear tongue installed for alignment

Figure 4.20: Rear tongue and rectangular hatch lined up

Figure 4.21: Glued and clamped

Figure 4.22: Gluing rear hatch locator block

Front deck installation

1. Place leading removable deck piece such that its rear is aligned with the front of F1
2. Place and glue leading fixed deck to match (Figures 4.23, 4.24)
3. Insert leading tongue underneath fixed deck as far as possible, you may need a small piece of scrap wood to hold the tongue up flush with the front fixed hatch (Figure 4.25)
4. Glue tongue to removable leading deck making sure it's aligned carefully (Figure 4.26)
5. Insert a piece of 32mm x 4.8mm doubler in front of F1 and leave it slightly proud of the fuselage sides
6. Apply glue to the top of the doubler and gently install the removable front hatch (don't push it too far down, just apply enough pressure to make the glue work. If you have problems with the doubler sliding down then insert a pin on either side of the fuselage side to hold it in place) Figure 4.27

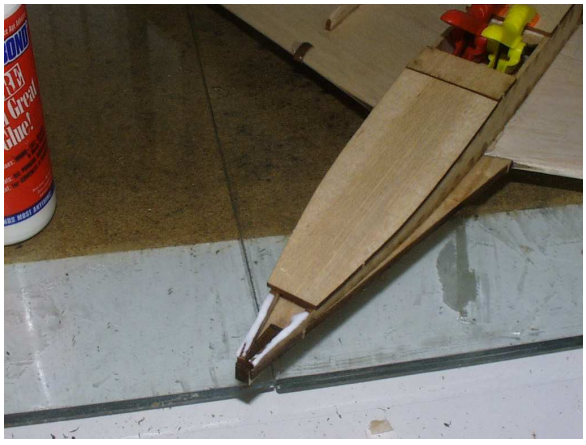

Figure 4.23: Gluing the front fixed hatch

Figure 4.24: Glued front hatch. Rear portion is used to align

Figure 4.25: Front tongue in place

Figure 4.26: Gluing hatch to tongue

Figure 4.27: Gluing front hatch locator block

Figure 4.28: Completed hatches

Firewall doubler

To aid in motor holding ability as well as preventing wood splitting, a 1.6mm firewall doubler should be installed. The motor wire notch and motor shaft hole should line up.

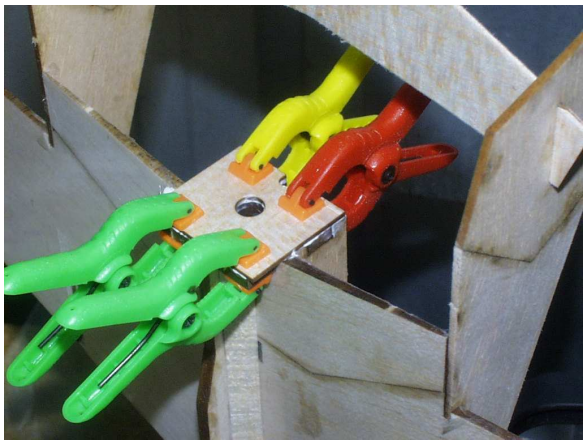

Figure 4.29: Firewall doubler glued and clamped

Chapter 5

Finishing up

5.1 Wing skids

- For the protection of the wing aileron/elevon servos, there are two wing-skids that must be applied to the underside of the wing.
- Make sure when you apply these skids that you remove the covering from underneath.
- The skids should slot cleanly into the leading edge of the wing.

See figure 5.1

Figure 5.1: Wing skid

5.2 Completed assembly views

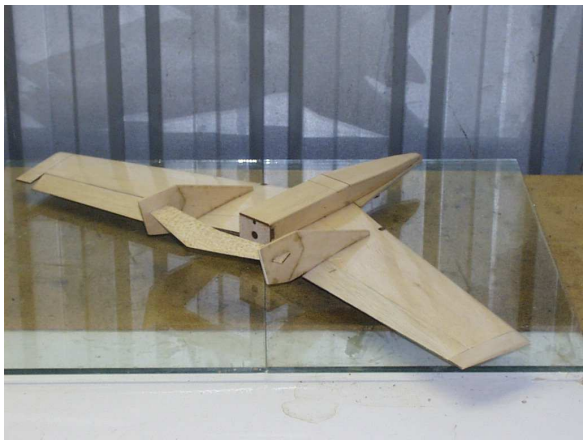

Figure 5.2: Completed Assembly View 1

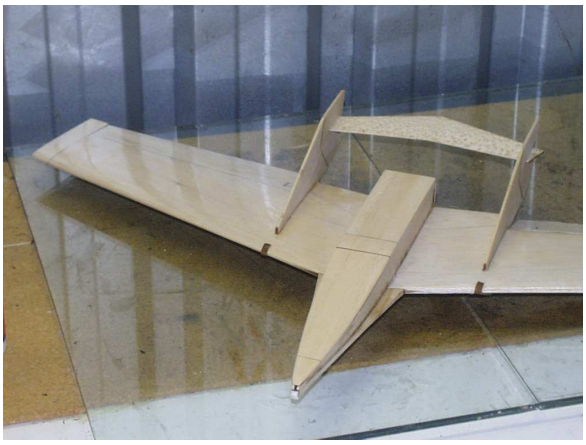

Figure 5.3: Completed Assembly View 2

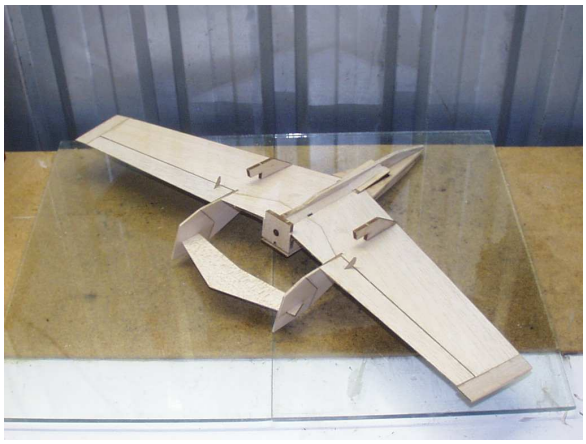

Figure 5.4: Completed Assembly View 3

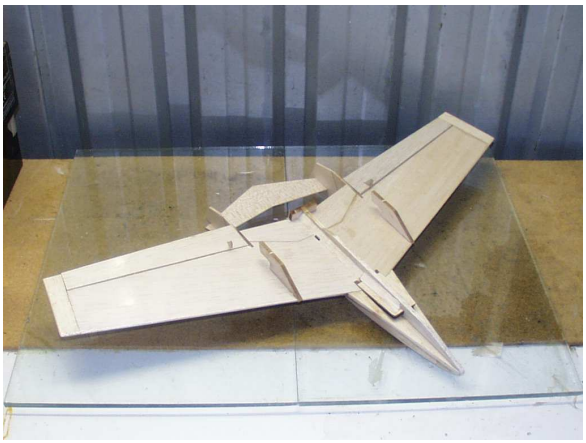

Figure 5.5: Completed Assembly View 4

5.3 Servo installation

The Microseether was designed around a pico class servo (5˜6g). The easiest way to setup a permanent linkage is to create two double Z-bend lengths of wire, both the same length.

1. Lock your elevon in place by putting a small clamp on the outer edge and clamping the elevon to the wing tip
2. Insert the wire into both the servo and elevon horn
3. Adjust the position of the servo such that both the horns, wire and servo body are all parallel (and perpendicular to the elevon edge)

See figures 5.7 and 5.7

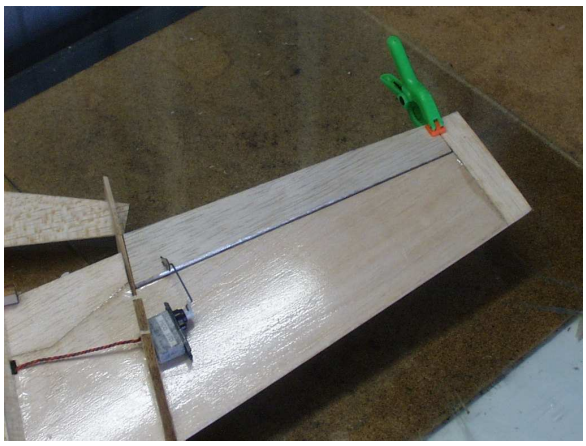

Figure 5.6: Elevon servo installation

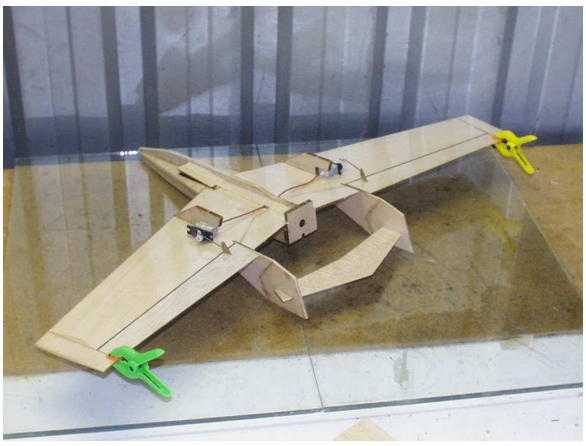

Figure 5.7: Both servos installed

Chapter 6

Flying

6.1 Control surface setup

6.1.1 Elevons

The Microseether has only elevons for directional control and thus requires either a computer transmitter or a V-tail mixer on-board. It is preferred to have a computer mixer so that you can adjust the rates individually of the elevator and aileron inputs as they require distinctly different amounts of travel to be mixed.

For aileron control the elevons should deflect +/- 4mm

For elevator control the elevons should deflect +/-8mm

Expo rates at 50˜60% for the ailerons is strongly recommended.

The reason why the elevator control requires so much more input is because the elevons are not displaced a great distance relative to the CG the elevons.

Be very careful not to try and apply too much deflection on the elevons. Excessive deflection on the elevons during flight will result in a wing-stall which can often result in a crash. The Microseether has had various aspects of its design adjusted to help reduce the severity of a wing stall, including larger wing tips and larger central area between the booms, however ultimately it's still your responsibility to make sure you don't provide excessive deflections.

6.2 Power System

6.2.1 Li-poly

The Microseether was designed specifically around a 2S450-15C or 3S450-15C pack of size 52 x 30 x 11mm (2S) or x 17mm (3S). Slightly larger packs can be made to fit if required. Smaller packs can be used though at the expense of flight times and without any significant weight loss due to requiring extra ballast in the nose to compensate and keep the CG correct.

6.2.2 Motor Selection

The basis of the Microseether sizing and CG was the GWS 2205 outrunner motor. This is a relatively high kV motor which can work on 2S and 3S lipo configurations. Other similar motors can of course be used including popular CDR build motors. The rear firewall on the Microseether is designed to handle a X plate mount.

6.2.3 Prop selection

Depending on the kV of the motor used and lipo selected, a GWS 6030 (6x3”) or GWS 5043 (5x4.3”) would make an appropriate starting point. The 6030 provides a considerable amount of thrust even on a 2S lipo however it’s limited in top speed by the fine pitch. For more pitch speed but less thrust the 5043 or even an APC4.75x4.75 would be more appropriate.

6.3 Center of Gravity (CoG, CG)

The CG is located between 190mm (7.5”) and 195mm (7.7”) from the tip of the nose.

6.4 Launching

DO NOT LAUNCH WITH THE MOTOR RUNNING.

IF YOU LAUNCH WITH THE MOTOR RUNNING YOU WILL BE STRUCK BY THE PROPELLER.

DO NOT LAUNCH WITH THE MOTOR RUNNING.

- Launch the Microseether from over your shoulder with a firm throw horizontally forward (don’t try to launch upwards aggressively, the plane will only stall and crash)
- Don’t panic about throttling up immediately, the Microseether can glide for a reasonable distance.
- Gently throttle up over a period 0.5˜1 second (rapidly opening the throttle will potentially cause a torque roll effect which could cause you to crash if not corrected).
- With a 2205 outrunner motor and 6x3” prop you should be able to climb out at 30 degrees attack without any trouble.
- Let the Microseether gain speed and height until it is about 50m (150’) away from you and then commence your first gentle turn - be strongly aware that with the default throws the Microseether can roll at a rapid rate (2˜3 rolls per second).

6.5 Landing

The Microseether is a light plane with a minimally performing airfoil section and fairly minimal wing surface area. As such the Microseether does not have a lot of momentum in flight and thus does not glide very well when speed drops off. It is not recommended that you chop the throttle until the last moments of the landing. The Microseether is actually so light that often you can get away with a near crash landing with no damage.

- Approach the landing from at least 5m (15') high as you perform the final turn from about 25˜30m (75') down wind.
- Reduce the throttle to 50% 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 Microseether to wash off a lot of its speed.
  - WARNING - DO NOT TURN IF YOU ARE ALREADY QUITE SLOW OR LOWER THAN 5M OTHERWISE YOU MIGHT INDUCE A TIP STALL (SUDDEN DROPPING OF ONE WING AND LOSS OF CONTROL).
- The Microseether 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 or let it carry on further and simply walk over to retrieve it.
- 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.
- Remember to kill the throttle before the plane touches the ground. Failure to stop the motor can result in damaged electrics or model.

Chapter 7

Web sites containing further details on various build processes.

- Microseether WWW site
  - http://www.pldaniels.com/flying/models/microseether
- 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