FEI BAO

MIRAGE 2000

ASSEMBLY MANUAL

APRIL 2014

Written by Peter Love

Thanks to Richard Spreadbury for his build tips and reference photos.

DISCLAIMER

THIS IS NOT A TOY. This is a high-performance miniature aircraft, capable of high speeds and damage to life, limb, and property. The manufacturer and its distributors cannot control how you assemble this model, what equipment you use to fit it out, or how you fly it, and can assume no liability whatsoever for any damages that may occur when you fly your aircraft. By assembling this model, you are agreeing to indemnify and hold blameless the manufacturer and/or his agents from any and all torts and liability associated with the use of this product.

Please inspect all parts before beginning assembly. If any parts appear to be suspect, contact your dealer or the manufacturer for repair or replacement BEFORE you begin. Once you have assembled the aircraft, you are the pilot in command and assume any and all responsibility for the use of the model and any damages that might occur by flying or attempting to fly this aircraft. R/C model jets require a high level of skill in both their assembly and their flying. If you do not feel confident in either your building or flying skills, PLEASE seek assistance from more experienced modellers.

It is a wise idea, no matter what level of skills you possess, to have a second experienced modeller go over your installation after assembly. A second set of eyes may spot a problem you have missed. If you have not flown a model like this before, it is HIGHLY recommended that you get an experienced turbine pilot to do your maiden flight. Very often, the first few seconds of a maiden flight are critical until the aircraft is trimmed out, and having an experienced pilot at the controls can make the difference between a wrecked aircraft and once that enjoys many hundreds of flights. Be sure to select a suitable field for flying...take the time to find a large paved runway if at all possible, especially for test flights, until you feel comfortable getting the aircraft in and out of smaller grass fields.

BEFORE YOU BEGIN

Keep this in mind as you proceed:
Look at EVERY assembly step you finish, and ask yourself "*Is this going to crash my airplane?*" A chain is only as strong as its weakest link, and this is a high performance aircraft that will be very intolerant of sloppy assembly techniques. Even the smallest component is important and can cause the loss of your Mirage, so take the time to do things right, or Redo them if they are wrong. Careful work will result in a long lasting plane that gives you years of pleasure, one loose component could result in the complete loss of the aircraft and all the components inside it, and someone can even get hurt. So pause every once in a while when building it and double-check your workmanship.

INTRODUCTION

You have chosen a model that represents the pinnacle of ARF technology. While there is not a lot of building to do, there is enough to keep you busy for a few evenings. Even if you have assembled maybe other ARF jets, we highly recommend

following our assembly sequence and procedures anyway. Chances are it will save you a lot of time, prevent you from running down dead ends, and perhaps remind you of a few small things that might end up saving your aircraft. We have tried to arrange a construction sequence that will allow you to keep moving forward, rather than waiting for glue to dry before you can proceed to the next step.

Just because the model is almost completely built does not mean you can rush through the final assembly. You need to employ fine craftsmanship every step of the way, turbine models are critical. Keep this in mind with everything you do, every part you install...look at the work you just did, evaluate it critically, and ask yourself "is this going to potentially crash my airplane?" If there is any doubt about the work you have done, back up, and re-do it properly.

ADHESIVES

The correct adhesive to use for all procedures is Loctite Hysol 9462. This is a very strong white epoxy that is thixotropic. "Thixotropic" means it does not run at all, but stays only where you put it. It is infinitely superior to regular epoxy, even slow-setting epoxy, for our purposes, because of this characteristic. Regular epoxy will run downhill with gravity as it dries, taking it away from where it is supposed to be. A good example is in the hinges...using regular epoxy, a good portion of the glue will migrate down away from the hinge into the inside of the wing as it dries, and you won't even know it is happening. Hysol stays where you put it. The downside of Hysol is it takes overnight to dry properly, but we have tried to arrange things to keep you busy while waiting for glue to dry.

We also highly recommend that you only use a proper Hysol dispensing gun, and only the long-type mixing nozzles. The short nozzles do not mix this glue enough, and only a thin nozzle and gun will let you fill the hinge and control horn holes properly with glue, you can't do it mixing your Hysol on a flat surface and trying to get the glue in the proper place by a brush or stick. You can buy a complete Hysol setup with a gun, nozzles, and two cartridges of glue from your dealer.

WORKING WITH PNEUMATIC SYSTEMS

The Mirage uses pneumatic brakes and retracts. If you follow a few tips, you should have very reliable, leak-free operation. Neatness counts. All airlines should be secured to the airframe to keep them from flopping around or getting kinked, use tie wraps and clips for this. The other very important thing is to cut off the end of each airline dead square before installing it on the nipple. This is VITAL. You can either purchase a professional tubing cutter from your dealer or you can make up a little jig to hold the airline and keep a sharp, new razor blade perfectly upright as you cut. Either one works, just ensure that all ends of all airlines are cut off dead square. Make sure all airlines are pushed ALL THE WAY onto their nipples.

They should not need to be secured otherwise, but you can add fine wire safety wraps if you like. Make sure all left and right matching airlines are the same length, particularly the brake lines, or you will get uneven retraction or braking action.

It's worth taking the time to get everything pneumatic right the first time, as having your landing gear fail to retract is not THAT bad, but having it fail to deploy can really ruin you day and the paint on the bottom of your model.

Specifications

Length:	96 ¾ In (2460mm)
Wingspan	64 ¼ In (1635mm)
Weight	37.4 to 39.6lbs (17 to 18 Kg)
Radio	Min 8 servos
Power Req	30 to 40 lbs (14Kg to 18 Kg)

Additional Component List

Your kit is very comprehensive but additional items will be required to complete the Mirage. The following are additional items required and the items used for this test model.

Servos

Elevons	Minimum 24 Kg/cm	(Futaba BLS 152 – 31 Kg used)
Rudder	Minimum 12 Kg/cm	(Hitec HS5585 – 17 Kg used)
LE Slats	Minimum 9 Kg/cm	(Hitec HS 645 – 9.6 Kg used)
Steering	Minimum 9 Kg/cm	(Hitec HS 645 – 9.6 Kg used)
Air System	Minimum 3Kg/cm mini servos	

Other items

UAT or alike highly recommended (Hanson Super Trap used)
Lock wire (optional) but highly recommended
Loctite
Velcro
Festo shutoff valve
Tygon Ffel tubing
Glues: Medium CA with accelerator, 30 minute epoxy, Aeropoxy or Hysol kit
Electronic gear sequencer
Brake valve
Matchbox, Powerbox, Smartfly EQ10 or Spektrum Power Safe receiver (JR matchbox, I-Gyro, Booma RC Regulator and Spektrum 12ch receiver used)
Turbine (Kingtech K180G used)
Servo extensions (length may vary, depending on receiver placement)

CONSTRUCTION

The following is a suggested construction sequence but isn't mandatory. Carefully unpack your new Mirage and inspect all parts for damage and fit prior to construction.

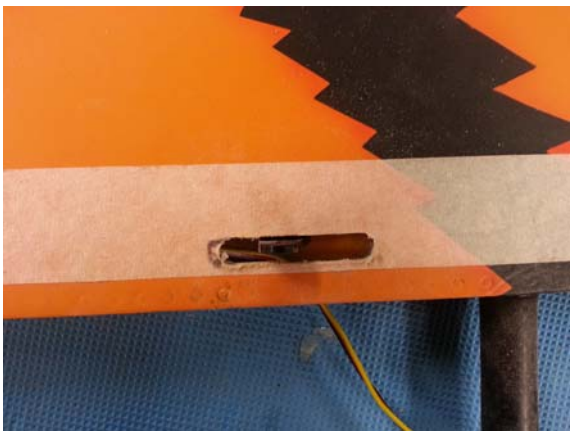
Fin & Rudder

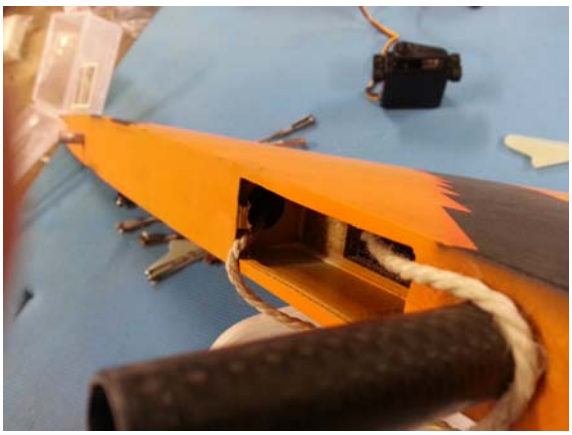
Your fin and rudder come pre-hinged, first check that you have sufficient movement without the rudder binding on the sides of the fin.

The rudder can easily be removed by unscrewing the hinge pin at the bottom of the rudder and removing it. The fin then can then be trimmed to ensure that sufficient movement is gained without binding.

Temporarily fit your chosen rudder servo in the bottom of the fin and mark the opening for the servo arm.

Remove the servo and carefully cut a slot in the fin for the arm to protrude. Refit your servo and use a small weight on a bit of fishing line or string to guide your servo wire through the fin.

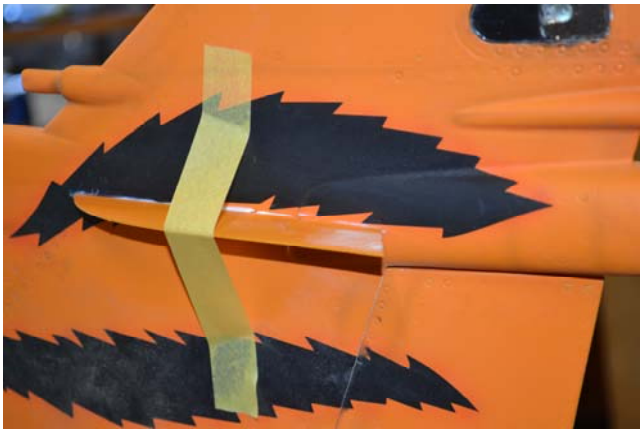




Using a straight edge line up the servo arm with the intended position of the rudder horn. Once marked carefully cut a slot in the rudder to accept the horn, ensure that the horn is in line with the servo arm and that the hole in the horn is positioned over the hinge line. Using a high strength glue like Hysol or Aeropoxy glue the horn into the rudder.

(Note: The photos show two horns used, only one is supplied and is sufficient for this task.)

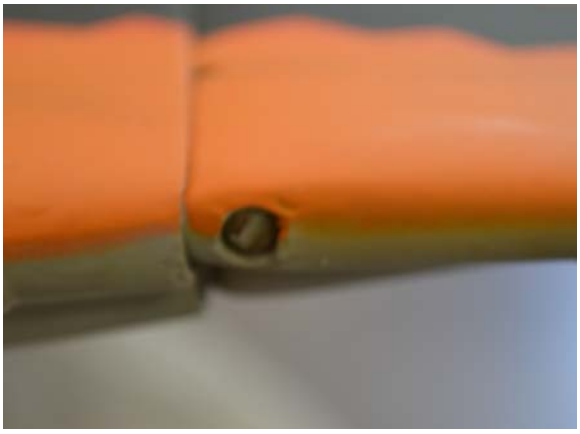
Connect all linkages and check for smooth operation with no binding.

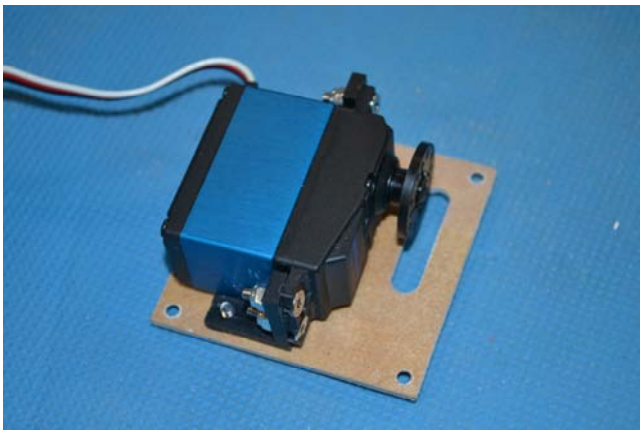


Carefully mark the position of the fences on the top of the fin and cut a small slot. Using hysol or similar glue the fences to the top of the fin.

Wings

As for the Rudder, check for adequate movement of the elevon with no binding and if insufficient remove the hinge pin, located at the wing tip, and shape the rear of the wing to ensure adequate movement of the control surface, refit the hinge pin once satisfied.

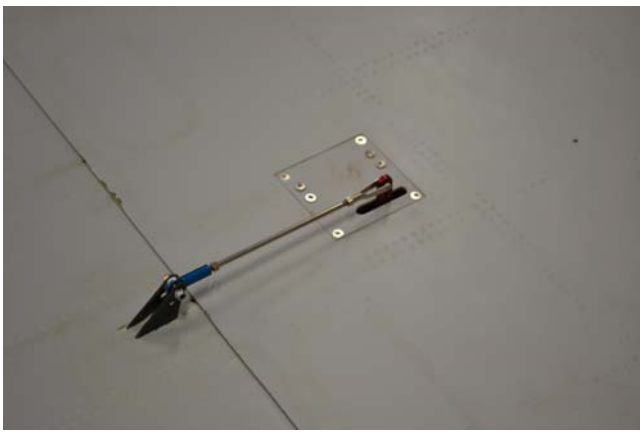




Remove the servo cover for the elevon and with the mounting hardware supplied fit your servo. Given the size of this control surface it is important that a premium quality, high torque servo is used.

A slot has been cut into the elevon for the control horn, fit the horn using hysol.

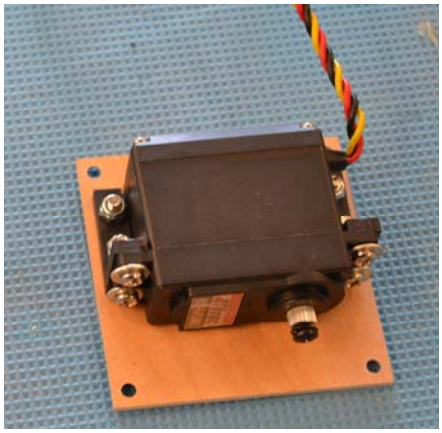
(Note - the photo shows two horns fitted but only one is required and supplied).



Fit the control rod between the servo and the elevon and ensure adequate movement of the surface.

It is very important to ensure that there is no free play in the linkage system as this may induce flutter and the loss of control. Ensure all lock nuts are secured.

As with the elevon, remove the servo cover from the slat openings and fit your choice of servo using the mounting hardware supplied.



Locate the two slat pushrods one short and one a bit longer. Fit the pushrod to the servo arm and put through the opening in the front of the wing. Pull the slat forward and fit the clevis over the horn, then slide the servo into wing.

Given the space in the wing only a short servo arm can be used to ensure there is no binding on the upper wing surface.

Do this for both servos, it will take some trial and error to get the rod lengths correct for both servos to ensure even travel and no binding.

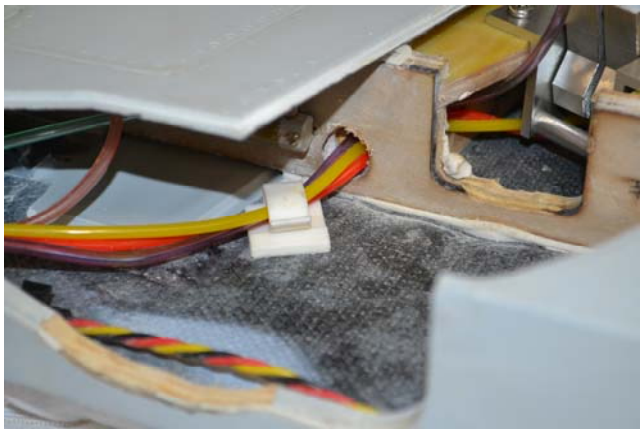
It is recommended that a power box or matchbox is used to drive the four servos to fine tune the travel, it is important that there is no binding when the slat is retracted as this will increase the load on the system and may cause a servo to malfunction or drain the batteries prematurely, either is undesirable.

Remove the main undercarriage and check that all bolts are secure and apply loctite if necessary. Remove the axle and grind a small flat on the shaft where the grub screw secures the shaft as an added measure of security.

Attach the brake airline and secure to the main oleo with clips or cable ties (not supplied) and refit the undercarriage.

A grub screw may also be fitted (grub screw, drill and tap required) in the retract trunion to assist in anti-rotation of the main undercarriage.

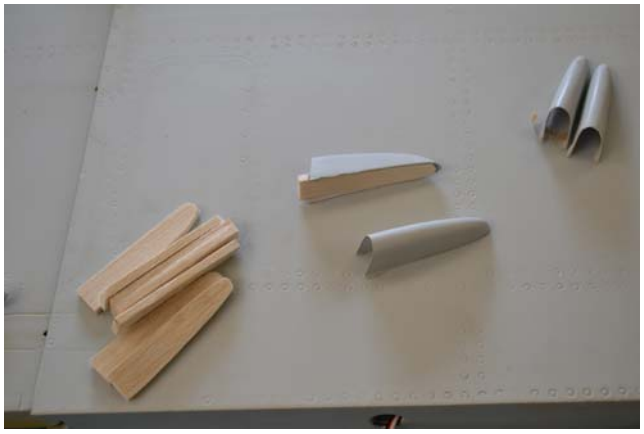
These items are not supplied but are a good idea for added protection against the main oleo rotating during take-off and landing.



Connect the airlines to the retracts and air brakes. It is a good idea to use a different colour line for each function, these aids in setting up the different functions.

There are many different methods of routing the air line and wiring the picture is just a suggested option. Which ever method you adopt ensure that all wiring and airlines are secured so as not to foul the operation of the undercarriage.

Locate the scale hinge covers and trim any excess from the mouldings. To ensure good adhesion to the wings it is recommended to make balsa bases for each of the covers. Once you are happy with the covers fit to the wings with medium CA in the locations etched in the lower wing surfaces.



Attach the missile rails to the wings using the bolts supplied. Trial fit the missiles and once satisfied remove as they may be damaged if left attached to the wings. Fit just before flight.

Now repeat for the other wing.

Fuselage

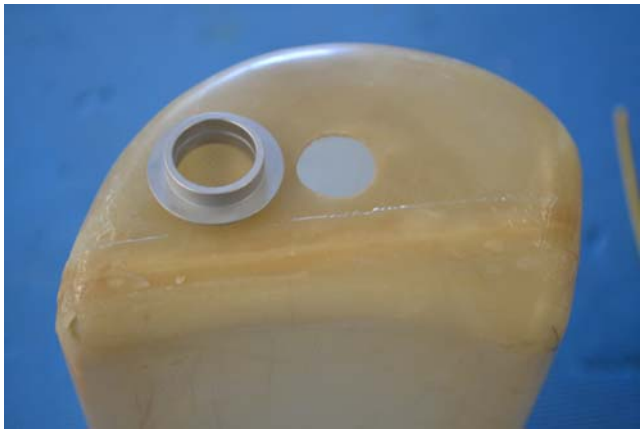
Mounting Trays

There are two equipment mounting trays included within the kit and may be used depending on your chosen system. In the case of this model these were used as templates for new trays as the cut-outs did not match our intended set up. A further mounting tray was fabricated to be located above the intake ducts to accommodate the turbine pump and ECU, pictures of mounting trays are detailed in further assembly sections below.

Fuel Tanks

Firstly locate the fuel tanks and the fuel tank components. The fuel system contains three tanks holding approximately 3.9 litres. If required an additional tank may be fitted to increase capacity for larger turbines.

The hole in the tank will need to be enlarged with a dremel or similar tool to fit the fuel tank bung fitting. Once enlarged glue the fitting using hysol and leave to dry.

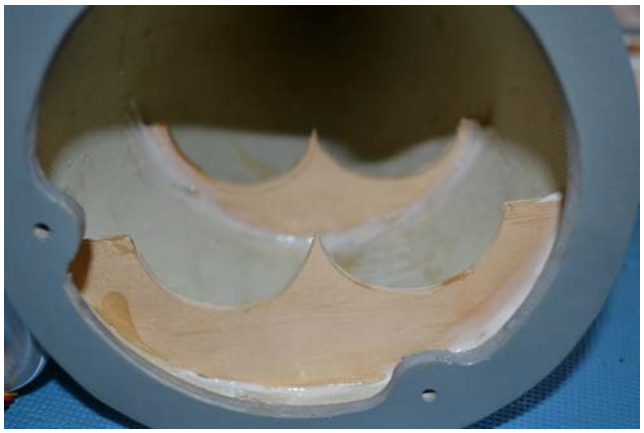


Once dry make up the fuel and vent lines to ensure adequate movement of the clunk so it does not bind in the tank and the vent line goes to the top of the tank.

Once satisfied, wash the tank with fuel to ensure all debris is removed. When dry assemble the tank ensuring all lines are lock wired to prevent air entering the system and ensuring security. It is a good idea to pressure test the tanks outside of the model by filling with fuel prior to installation.

Air System

There are four air tanks supplied, two large and two small. There are a number of ways to set up the air system and the following is only one recommendation. In the test model we used the two large tanks for the undercarriage and the two smaller bottles for the air brakes, brakes and gear doors.



In the test model the two smaller bottles were fitted to the nose cone while the two larger bottles were fitted to the rear of the fuselage.

There is also room below the turbine rails and front nose section if preferred.

Mounting system for the bottles was fabricated as shown in the pictures.

Connect all air lines to the gear doors and run the lines for the retracts, brakes and air brakes from the wing connection points to forward fuselage.

Wiring

Run the servo extension cables from their respective positions to the forward fuselage mounting tray. There are three different access points from the wings to the fuselage for servo connections. Ensure all wiring is secured to the fuselage to prevent fouling and chaffing. Pay particular attention to the servo extensions running from the rear fuselage forward as these should be protected from heat by either a protective sheath or metal tape.

Nose Wheel Steering

The supplied forward mounting tray contains a servo mounting position for nose wheel steering. If you choose to use this system steering cables will need to be routed backwards, around 180 degrees and then forward to the nose leg.

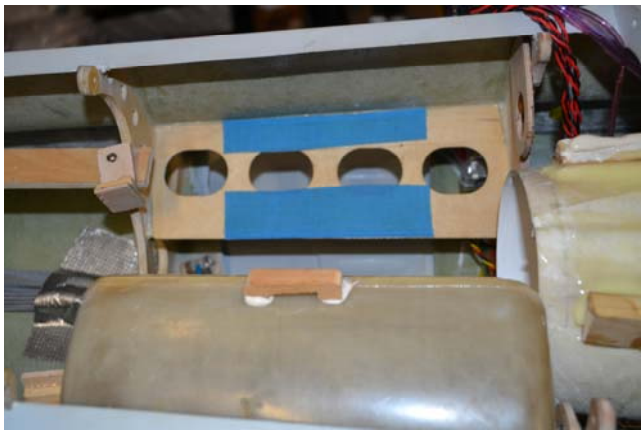
In this build it was decided to use a new mounting tray and make a new servo mount so that the steering cables are a direct pull onto the nose leg.

If using this method it is important to ensure that the servo position does not contact the nose leg when retracted.

Fuel Tank Installation

Determine the position for the tank vent line and fit your desire vent system. Using high strength Velcro attached the forward fuel tank against the inlet ducts.

There is ample room in front of the main tank to fit your desired UAT, make a mount as appropriate and fit the UAT.



Next install the two saddle tanks in the engine bay using high strength Velcro. It may be required to trim the former to get the tank lines and bung assembly to clear the former. In this build a separate bracket was made to locate the front of the tanks against the former. Once fitted plumb the tanks in your desired method either in series or parallel then to the main forward tank.

Note: it will be necessary to remove the turbine and forward inlet duct, if fitted, prior to fitting the two saddle tanks.

As we were using a larger turbine we added an extra dubro tank located between the two saddle tanks and above the inlet duct, this gave another 700mls of fuel.

Turbine Mounting

The kit is supplied with a standard bell mouth and dual wall thrust tube. A carbon bypass is available as a separate purchase.

The kit is also supplied with an inlet tube that attaches between the inlet duct and the front of the turbine. Cut this tube to length depending on your turbine positioning.

Once the thrust tube is mounted attach the tail cone and tighten.

Mount your turbine as per manufacturer's instructions on the turbine rails. It is very important to ensure that the thrust line of the turbine runs down the centre of the thrust tube to avoid hot spots and an offset thrust line.

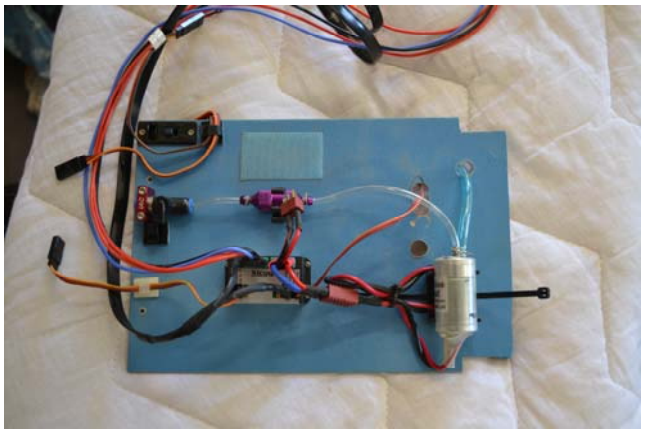
The supplied thrust tube should be good for turbines up to 16 Kg thrust but may deform if larger engines are used.

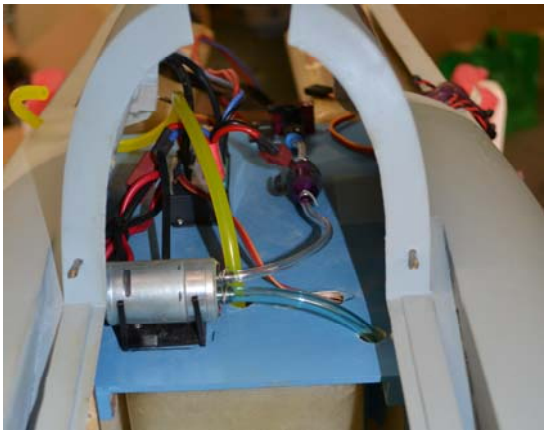
In this build an 18 Kg thrust turbine was used so a larger thrust tube was purchased separately. For this set up the bypass was not used. (larger thrust tube shown)

Turbine Controls

To accommodate the turbine controls for this build we fabricated a tray to mount above the inlet ducts.

This allowed the electronics to be better spaced, as there is limited space available.





Air System Valves

The front mounting tray was used to house the air valves. There are mechanical valves supplied with the kit which are adequate to undertake the air system requirements. In this build we chose to use electronic valves which you will need 3 x 2 way valves and a brake valve.

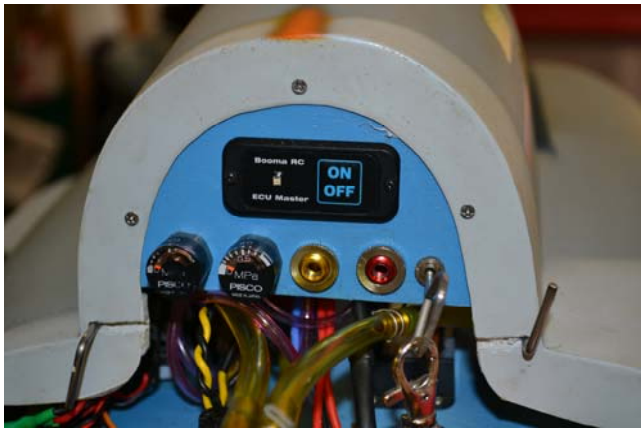
All air lines were routed under the mounting tray in plastic then up through the mounting tray to the air valves. This way the airlines are contained and out of the way. Ensure you leave enough slack in the air lines to remove this tray if required.

Main System Mounting Tray

A new front system tray was fabricated using the supplied tray as a template. Arrange your chosen system in the desired position and connect the power and servo lines.

Don't install the batteries at this stage as their position can be used to balance the model without using lead.

Control Panel



A control panel was made to fit in the forward opening of the turbine compartment.

All aircraft services are accessed on this tray or the lower deck below making it easy prepare for flight.

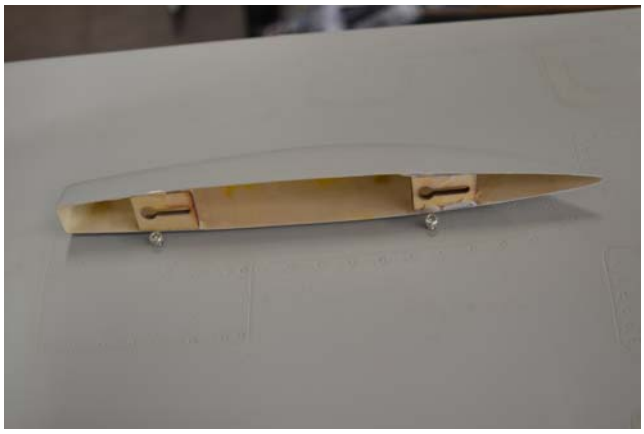
Final Assembly

Attach the fin to the fuselage using the prepositioned internal bolt.

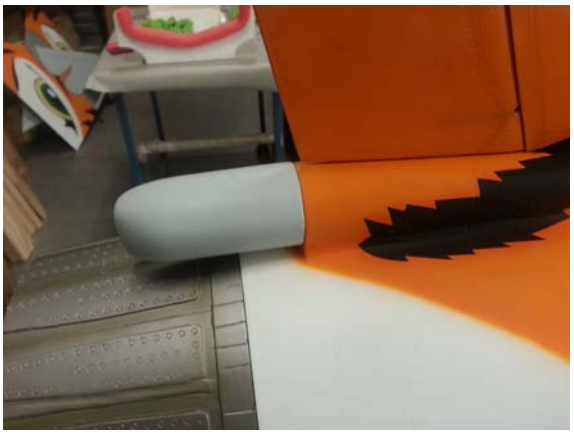
Position the front strakes on the fuselage side and cut a slot for them to insert.

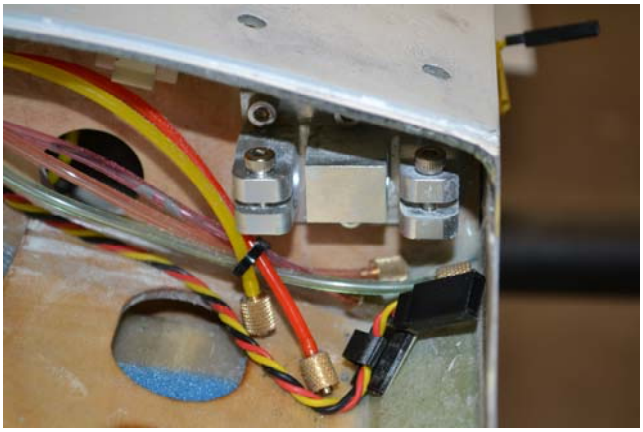
Using hysol attach these to the sides of the intakes and allow to dry.

Attach the refuelling probe, flare dispenses, centre fuselage tank mount and rear fuselage fairing to their respective positions.



Its best to screw on this piece to the tail of the Mirage prior to fitting the thrust tube as it needs to be screwed from the inside.



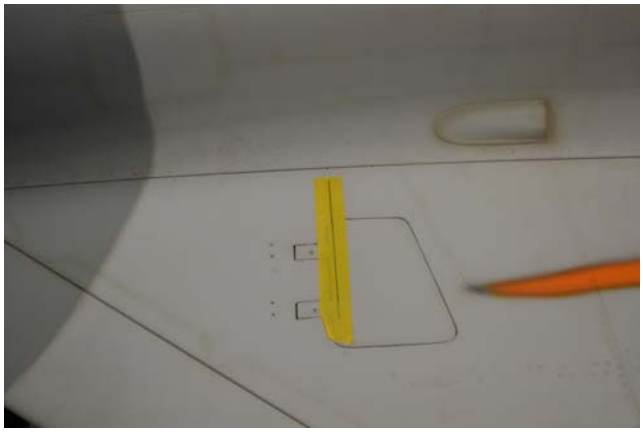


Insert bolts into the wing attachment points

Trial fit the cockpit and if necessary trim the canopy lugs to ensure an easy fit.

Balance and Battery Position

It is important to get the balance of your model correct. The initial balance point is 400mm from the point where the wing meets the fuselage. Ensure the wheels are retracted and the UAT is full. Move your chosen batteries around the fuselage to get a good balance.



The position indicated above is good for first flights and may be adjusted, slightly, to conform to your respective flying style.

Once balance is achieved, secure the batteries in the fuselage to maintain balance. For this build the batteries are located in the nose cone, this is a result of using a larger turbine and heavier thrust tube, no lead was required to achieve balance.

System Test and Control Throws

Once you are satisfied with the balance test all systems for correct operation, this includes direction of all control surfaces, retracts, brakes and speed brakes, turbine ground run and range check.

The following control throws were used for this model:

Ailerons	20 mm up and down with 40% expo
Elevator	45mm up and down with 30% expo
Rudder	As much as possible with 10% expo
LE Slats	15 to 20 mm
Nose wheel	If possible have two settings, one for taxi with large movement and one for take off with limited movement.
C of G	400 - 430 mm measured from where the wing meets the fuselage

You have now completed construction, enjoy flying your FeiBao Mirage 2000.