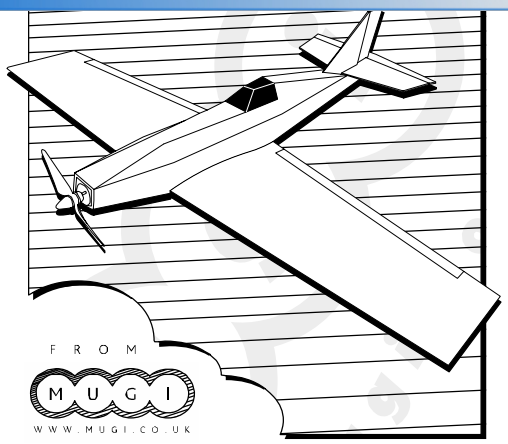


A
DASHING NEW RACING AIRCRAFT
FROM THE DESIGNERS
OF THE
"MUGI EVO"

INTRODUCING THE TEA RACER

Following the popularity of the Mugi Evo delta we decided it was time to create something a little more normal looking. We've been building aircraft prolifically here at Mugi since the turn of the century and in doing so have devised lots of techniques for building in twinwall.

One of the concepts we developed was that of the formerless fuselage; where a monocoque design allows us to build a fuselage free from bulkheads but with a great deal of strength and rigidity. The Tea Racer is the first time we've aired this concept.

"The original sketches for the Tea Racer found influence in classic vehicles of the 1930's - a long bonnet (or hood if you prefer) hinting at an oversize powerplant up front. While the design eventually realigned with normality, the rearward cockpit remains as a nod to those early machines and dreams of speed.

The Tea Racer emerged in 2004, but life is a busy game and there never seemed enough time to draw up plans and instructions. However, in 2006 I changed the course of my life and ventured to flight school in Spain to study for fourteen months for the Airline Transport Pilot's License. While not exactly gifting lots of freetime, moving to school overseas brought fresh energy, enthusiasm and aeronautical motivation. These plans and instructions represent over a year of evenings on-and-off spent drawing diagrams, refining design features and writing up build notes.

I sincerely hope you enjoy building and flying the Tea Racer!"

Morgan Wood

All that's left to do now is cut out the paper templates, glue together where necessary and then, before starting work, brew up an especially large mug of tea.
We recommend Yorkshire Tea - what else!

There are two types of folding technique used in the construction of the Tea Racer. Please familarise yourself with these, perhaps using a piece of scrap twinwall before commencing the build. The score fold is used for the leading edge of the Tea Racer wing and the wing root wrap. The cross-flute fold is used on most of the fuselage components. Visit www.mugi.co.uk and refer to the tutorials section for more info.

Gluing twinwall is best achieved using a contact adhesive such as Evostik Contact (in the UK), DAP Weldwood (USA) and generic Cola de Contacto (España). Spread a thin application on both surfaces, allow to become dry to the touch, and then bring the pieces together. Please test glue several pieces of twinwall to establish how best to get a good bond. More information is available on our website.

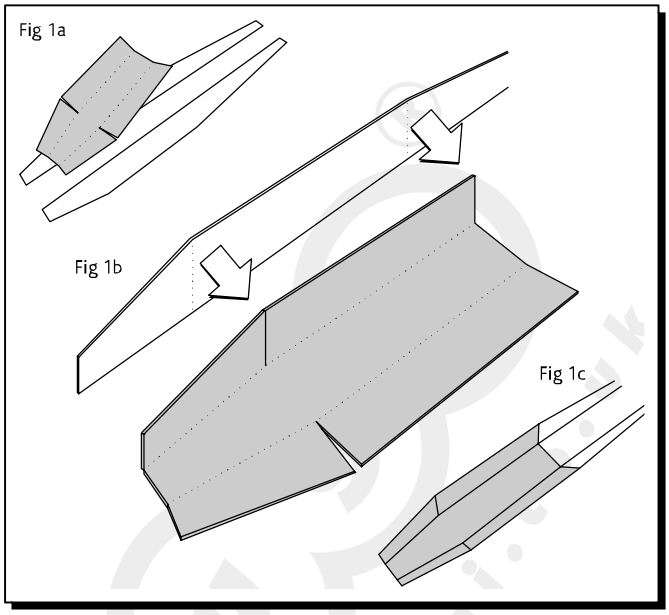
REQUIRED FOR BUILDING

1. 2mm thickness lightweight twinwall polypropylene
2. Contact adhesive - (E.g. Evostik Contact*, DAP Weldwood, Cola de Contacto)
3. A 500mm length of carbon tube 6x4mm diameter* or suitable spar material
4. Micro servos (aileron and elevator - optional rudder) and micro receiver
5. 28mm diameter motor - eg. speed 400 or brushless ~2000rpm/v
4. A sharp knife or scalpel
5. Clear tape such as 3M Scotch tape*
6. Self adhesive hook and loop strip*
6. Coloured polypropylene or vinyl tapes for decoration
7. Control hardware*

*items included in the Tea Racer hardware pack, available from www.mugi.co.uk

REQUIRED FOR FLYING

1. Three channel full range radio equipment
2. Third party insurance suitable for where you fly
3. Good reactions and experience handling a fast, agile aircraft

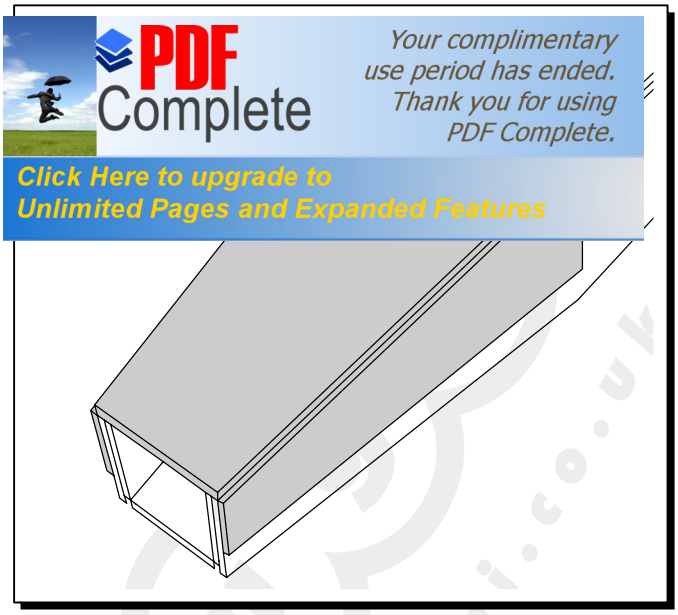


1. GLUE THE FUSE INNER TO THE LONGERONS

Take the fuselage inner piece and the two longerons (Fig 1a). Dry fit the fuse inner and mark a line on the longerons where the rear of the inner will be. This will allow for easier alignment and serve as a guide for applying glue.

Spread the contact adhesive sparingly onto the fuselage longerons and the outside of the fuselage inner piece. After the glue has become tacky to the touch, hold the base of the inner piece firmly onto a flat surface, raise up a side to the vertical and then attach the corresponding longeron (Fig 1b).

Ensure that the longeron rests on the building board for correct positioning.
Press the pieces tightly together for a few seconds and then repeat the process for the opposite side. You now have the first part of the fuselage complete (Fig 1c).

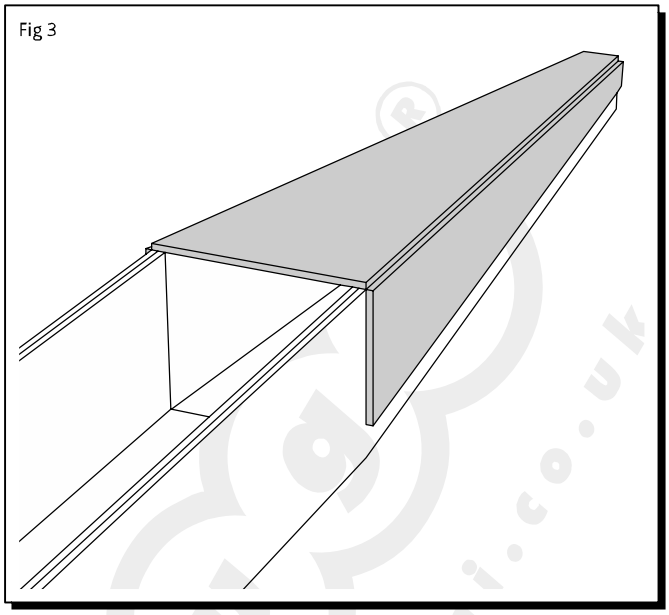


2. FITTING THE NOSE LOWER COWL

Lift the longerons of your fuselage to the vertical and dry fit the nose lower cowl onto the structure. Mark a line around the cowl to serve as a glue line and then spread contact adhesive onto both longerons and the inside of the cowl.

Ensuring that the sides of the fuselage are vertical relative to the building board, make sure the fuse inner is still flat on the board and then fit the cowl. Press all the glue joints firmly.

Fig 3

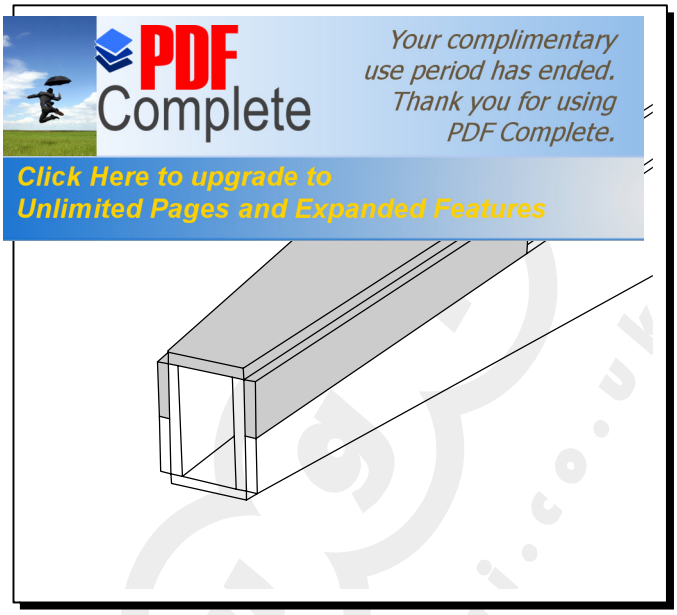


3. FITTING THE TAIL LOWER COWL

The tail lower cowl fits on the outside of the longerons between the rear of the fuse inner and the tail of the aircraft.
Draw a line at least 650mm long on your building board and place the centre of the fuse inner on the line. This is to be used as the reference centreline when you attach the tail lower cowl. You must ensure that the fuselage longerons are an equal distance from the line at all points or the fuselage may develop a twist when you attach the tail lower cowl.

Dry fit the tail lower cowl onto your fuselage and mark a line to use as a gluing guide. Spread contact adhesive onto the longerons and the lower cowl and wait for the glue to become 'tacky' to the touch.

Starting at the frontmost point of the tail lower cowl, place it onto the longerons and then fold down the side pieces to stick to the longerons. Remember to keep the structure straight in relation to the centreline you marked on the board!



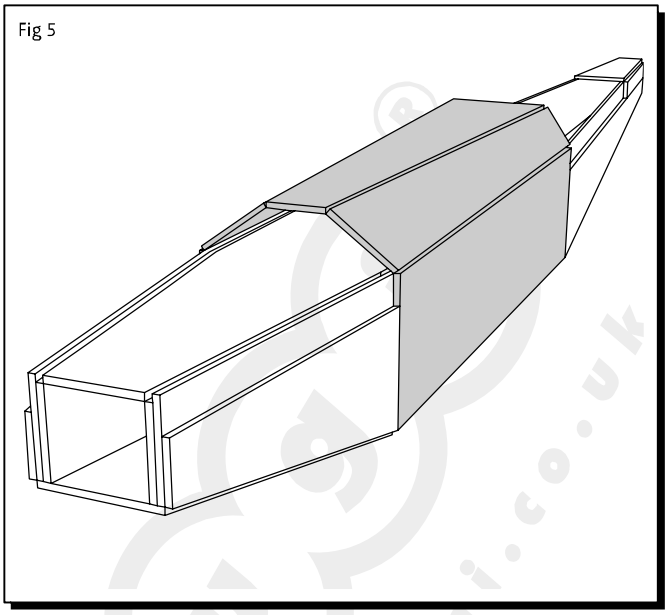
4. FITTING THE STABILISER PLATFORM

The stabiliser platform is similar to the tail lower cowl but forms a flat surface with a relative incidence of zero degrees to which to attach the stabiliser.

Turn over the fuselage, dry fit the piece and mark the extent of the glue area onto the longerons. Apply contact adhesive to both parts and, when the glue is tacky to the touch, attach the stabiliser platform.

While attaching the platform, you must make sure that the sides of the fuselage are vertical and that the underside of the tail lower cowl is flat to the building board. This should ensure that no twists become built into the fuselage.

Fig 5

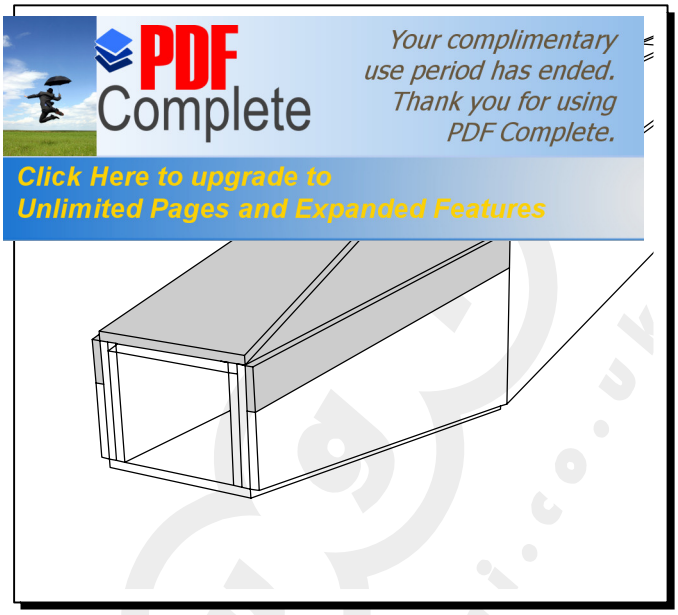


5. FITTING THE MID UPPER COWL

Identify the mid upper cowl and test fit it to the fuselage. It should fit perfectly between the nose lower cowl and the tail lower cowl. The front of the mid upper cowl can be identified by the narrower width of the centre section (20mm width).

Apply glue to the cowl and to the longerons and then, when the glue is tacky to the touch, affix the cowl to the fuselage.

With this component in place you can see that a triple thickness of material has been built up around the wing seat. This makes for a good deal of crash resistance and, usefully, provides a large contact area between fuse and Wing.

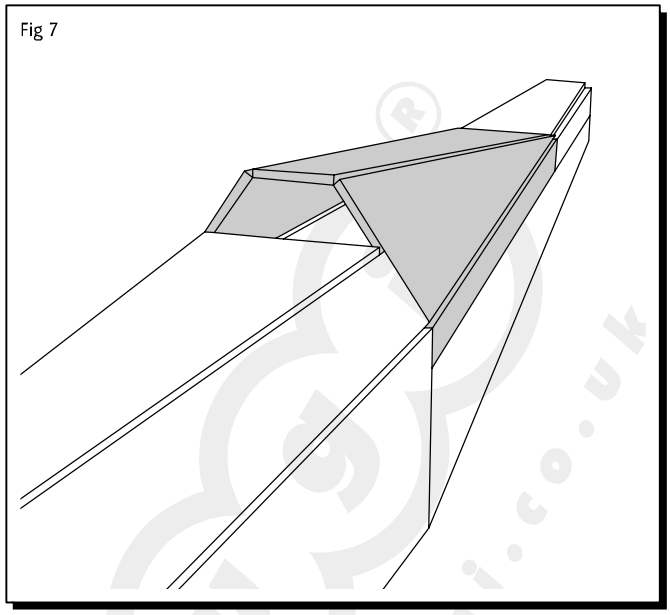


6. FITTING THE NOSE UPPER COWL

The nose upper cowl fits in place as shown in Fig 6. Dry fitting the piece you should be able to see the shape of the Tea Racer fuselage finally becoming recogniseable.

Simply apply glue to both cowl and longerons and then fit the cowl in place. The rear of the cowl should mate closely with the front of the mid upper cowl. However, should you find any gaps or discrepancies at this time then don't worry! All these joins will be tape sealed to achieve a high quality and aerodynamic finish. The upper fuselage cowls only contribute to a minority of the overall structural rigidity so don't worry about effects on the final strength.

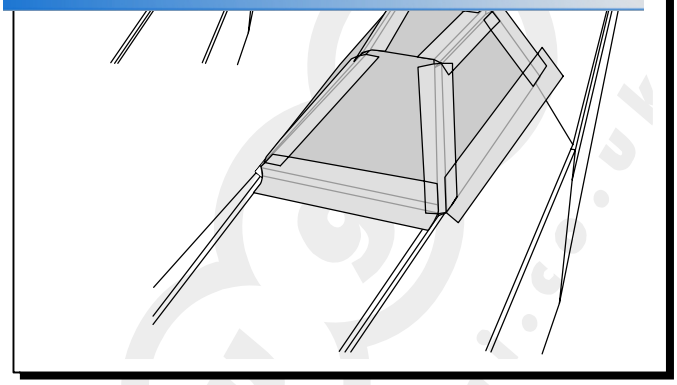
Fig 7



7. FITTING THE TAIL UPPER COWL

Fitting the tail upper cowl is an easy task. By this stage of the build there's only one place it can fit! It should do so and mate seamlessly with the mid upper cowl and the stabiliser platform. Again, don't worry about a perfect gapless finish as the tape sealing later will smooth things over and add lots of strength.

Apply glue to the cowl and to the longerons and then attach the cowl as shown in Fig 7 above. It's a good idea to make sure that the angled sides of the mid upper cowl and the tail upper cowl are at least roughly equal and that everything looks straight, correct and symmetrically aligned. If anything has drifted out of line it should be correctable during taping of the joins later.



8. FITTING THE CANOPY

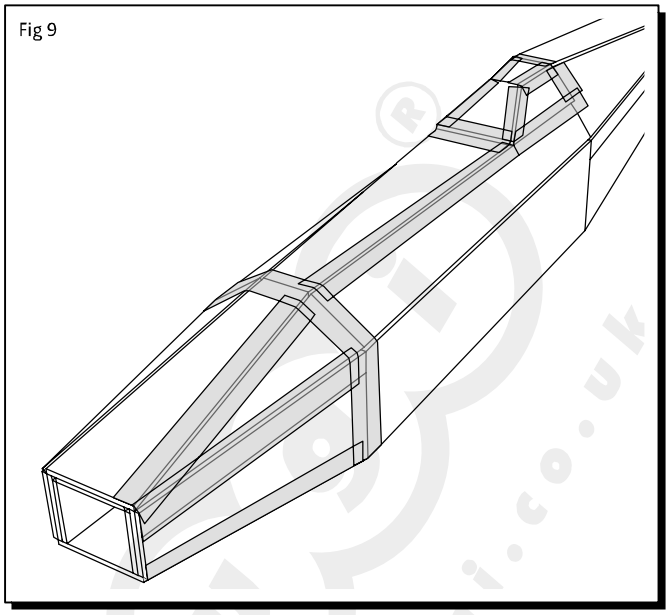
The canopy component is the final piece of the fuselage. The canopy is not glued in place but rather attached with the clear self-adhesive tape included in your kit.

Starting at the rear of the canopy, tape the middle to the tail upper cowl and then fold down the sides and tape them in place. Finally, fold down the windscreen (or windshield if you prefer) part of the canopy and tape it securely in place on all joints.

The canopy should stand a little proud from the rest of the fuselage. This gives a rather more realistic look and defines the lines of a 'sliding canopy'.

You can now sit back and admire your handy-work. The fuselage is almost complete.

Fig 9

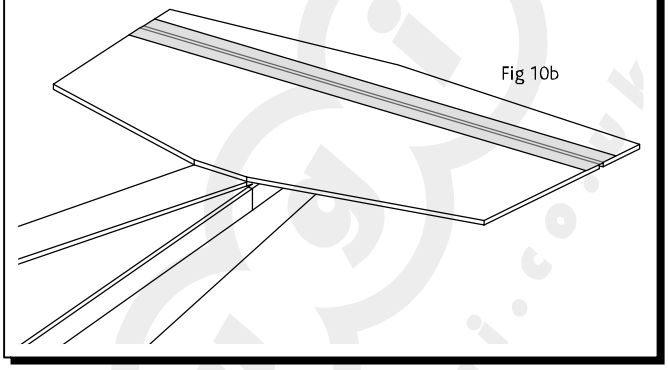


9. TAPING THE FUSELAGE JOINTS

Your fuselage is now structurally complete. All component parts are fitted securely. However, you may be disappointed to find the whole structure feels a little 'pliable'. The fuselage in this raw state, while fairly rigid, is not a wholly solid structure. The folded nature of the joints means that they are somewhat free to move and, although the structure is triangulated for rigidity, applying a torsional force will produce deformation of the fuselage.

Taping over every joint on the fuselage effectively constrains the movement of the joints and so solidifies the structure. The diagram (Fig 9 above) shows how to tape the joints. Don't worry about adding weight with the tape; it's incredibly light and yet adds so much strength to the structure.

Continue in a similar fashion until every join or fold is covered. You will be impressed by how rigid the structure becomes! Take a look inside the fuselage... not a bulkhead or former in sight!

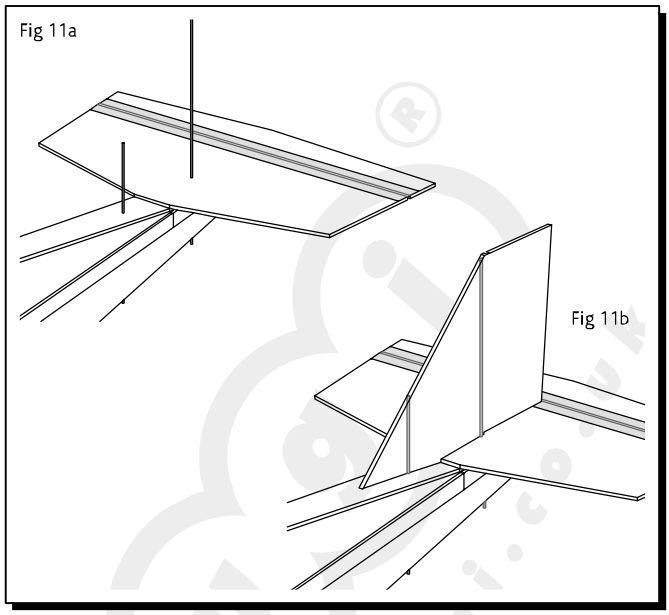


10. STABILISER AND ELEVATOR

A simple and very effective hinge for the elevator on the Tea Racer can be made with the clear self-adhesive tape supplied in the kit. Separate the elevator along the line marked and then place the stabiliser and elevator on a flat surface.

Move the elevator away from the stabiliser forming a gap of around 1mm and then carefully lay a length of tape over the gap to join both surfaces together as shown in Fig 10a above. This will create a hinge and the gap will allow full, unimpeded movement in both directions.

Finally, apply glue to the underside of the stabiliser and the stabiliser platform on the fuselage. When the glue is tacky, carefully set the stabiliser in place (Fig 10b) and apply firm pressure to ensure a good bond. To aid orientation on the fuselage a faint centreline can be drawn on the stabiliser.



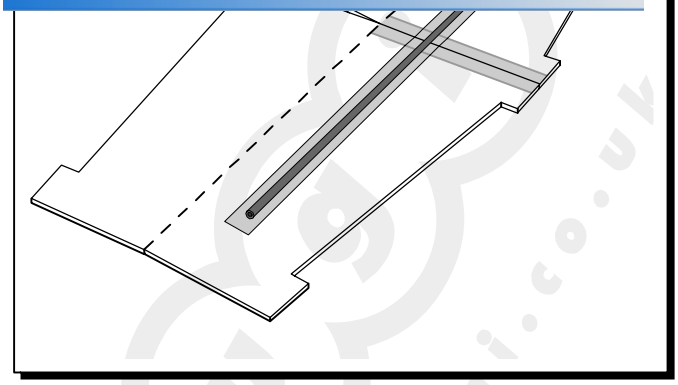
11. FITTING THE TAIL FIN

The tail fin, either with or without rudder is held upright by 2mm carbon rod inserted into the flutes of the fin and through the top and bottom of the fuselage.

Firstly lay the tailfin onto the stabiliser in the correct position, right on the centreline of the fuselage. With a pen, mark two dots on the fuselage corresponding to the open end of the flutes on the fin that correspond with the rod positions shown above in Fig 11a.

Now firmly push the carbon rods through the points marked in the top of the fuselage and, making sure they stay perfectly vertical, continue to push them right out of the bottom of the fuselage. You can now slide the tailfin onto the carbon rods (Fig 11b) and finally tape the join between fin and fuselage/stabiliser to prevent lifting.

If you are using rudder then make sure that the rear carbon rod goes just ahead of the hingeline. Hinge the rudder with a single piece of Scotch tape.



12. JOINING THE WING HALVES

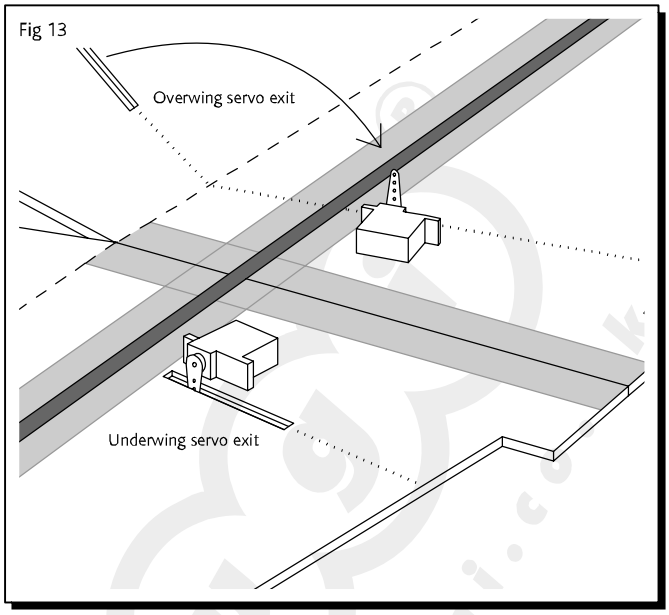
Take the two wing halves and lay them on a table with the wing roots aligned as shown above. Make sure both wings are the correct way up - so that you are looking down into the inside of the leading edge fold - and then tape the central joint with the Scotch tape.

The 6x4mm carbon tube provided in your kit is the Tea Racer's wing spar. This should be placed around one third (70mm) rearward of the leading edge. Hold the spar in place with the Scotch tape. One or two lengths of tape should do the job perfectly.

Now is a good time to think about how you plan to fit your aileron servo(s). There are a couple of different ways to add the aileron linkages, for example:

Two servos with direct pushrods out of the bottom of the wing
Two servos with direct pushrods out of the top of the wing
One servo controlling the ailerons through flexible snakes (available from Mugi)

Fig 13



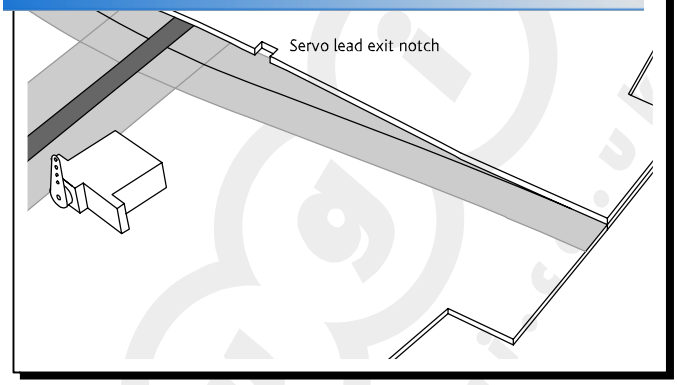
13. AILERON SERVO INSTALLATION

The simplest way to install and connect the ailerons in the Tea Racer wing is to use two micro servos, one for each aileron. These can be connected with a Y-lead cable or by using an electronic Y-lead function featured on many computer radios.

With two servos, the simplest form of connection between the servo horn and the aileron horn is by a 50mm carbon pushrod with threaded adjuster (provided in Tea Racer hardware pack).

With this configuration there is a choice whether to exit the pushrod from the upper or lower surface of the wing. The upper surface exit is perhaps not as tidy as the underwing route but keeps the servo horn well clear of the ground during landing. If you are planning to add an undercarriage then the underwing option is the neatest solution.

An alternative to using two servos would be a single centrally placed servo driving the ailerons through flexible control snakes. The following instructions are for two servos only.



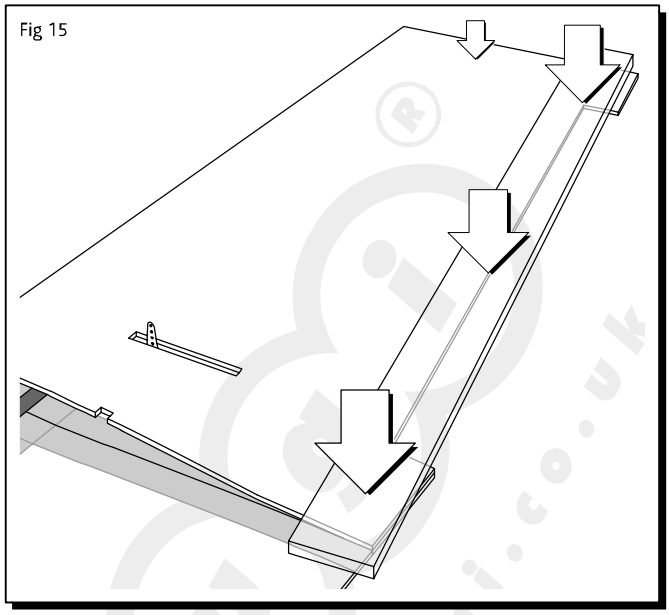
14. AILERON SERVO INSTALLATION - PREPARING THE WING

Plug in your servos to your receiver, attach the output horns and then centralise the controls! It will be difficult to adjust them later.

Draw a line along the bottom surface of your wing at 90 degrees to the aileron hingeline about 15-20mm from the start of the aileron. Now place your servo on the wing with the output horn aligned with this line. If you are using underwing exit slots then cut a small slot to accomodate the servo horn as shown in Fig 14.

Now fix the servo in place with glue, cable tie or self adhesive pads. If you are using overwing exit slots then cut a slot in the corresponding place on the upper surface of the wing. Fold the wing over lightly and apply a little pressure onto the servo horn - it will make a guide mark in the wing upper surface to help you cut the slots.

Cut a small notch at the root of the wing upper surface as shown above. The servo cables will pass through this hole to the receiver.

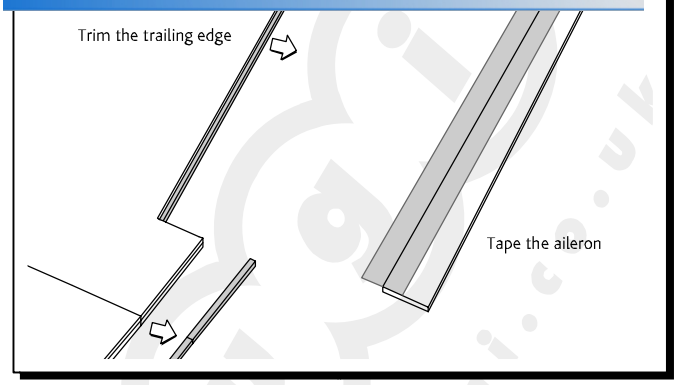


15. WING FOLDING

Take some time to practice folding the top surface of the wing over onto the bottom surface. Notice how the top surface curves to form an aerofoil section. The depth of this aerofoil should be about 15mm just behind the carbon spar. Don't worry if the top and bottom trailing edges don't meet up perfectly - they get trimmed later.

When you're ready to fold your wing for real, smear a thin film of contact adhesive along the trailing edge and wingtip of both top and bottom surface and allow to become dry to the touch. Now fold over the wing and, using a ruler, apply lots of downward pressure to the glue join. This is a very important join and so should be clamped for some time, or held with heavy weights. The wingtip can be pressed together flat to the building board with your hands -automatically adding washout.

When one side of the wing is glued, *making sure both servo leads poke through the exit notch*, glue the other wing half, matching the wing section to the first half.



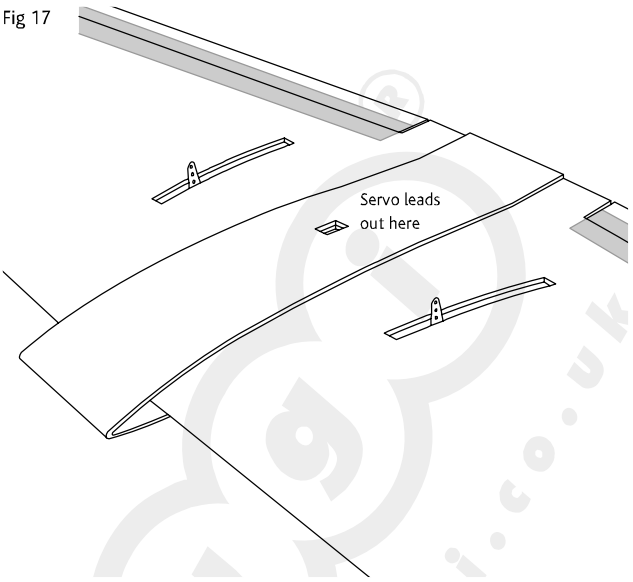
16. WING TRIMMING AND AILERON FITTING

Using a ruler, cut along the trailing edges of the wing. The bottom surface should be removed where it protudes beyond the top surface as shown above.

To hinge the aileron, the Scotch self adhesive tape is used. Simply place the aileron on a flat surface and stick a length of tape along its entire length, half on the aileron and half off. Tape the aileron into place on the wing with the tape on the top surface - be sure to leave a gap of around 1mm or less between aileron and wing to allow full movement in the downward direction.

Now we need to make a wing root cutting template. You will need to cut the fuselage later to match the wing section. To help with this step it's a good idea to make a template. Simply insert the edge of a sheet of paper into the wing root between the wing halves - then trace the outline of the wing section with a pen onto the paper - an instant wing root cutting template.

Fig 17

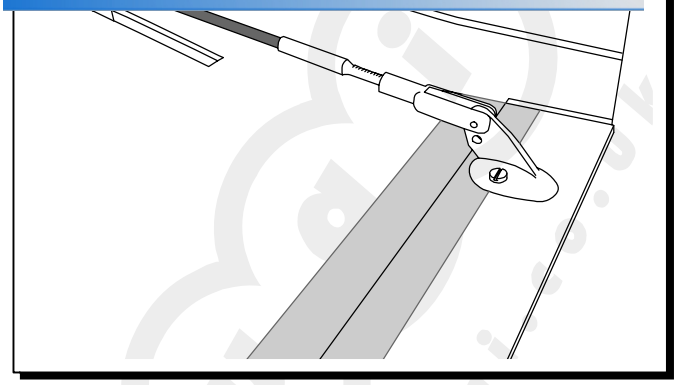


17. WING WRAP AND TONGUE

The central wing wrap adds a great deal of strength to the wing root area where the two halves join together. The extended portion at the front of the wrap also forms a tongue that engages with the fuselage and secures the front of the wing in place for flight.

The wrap is not symmetrical around the fold-line! The top surface is slightly longer than the bottom surface.

You will need to cut a small hole in the wrap to allow the servo leads to pass through. Lay the piece in place around the wing centre and mark the area it covers lightly with a pen. Cover the marked area and the inside of the wing wrap with a thin film of contact adhesive, allow to become tacky and then attach the wrap as above.



18. AILERON SERVO CONNECTION

For a direct pushrod connection from servo to aileron horn, use two white plastic snap clevises and one threaded aluminium adjuster from the Tea Racer hardware pack.

Making sure the servos are still set at neutral, carefully measure and cut a length of 2mm carbon rod to make a connection as shown above. Carbon rod takes some cutting but a clean cut can be achieved by rolling the rod under a knife blade.

Screw the white plastic aileron horn through the aileron surface making sure that it is inline with the output of the servo. The outermost holes can be used for flight but, as shown above, for extra roll rate you can use holes closer to the hinge axis and trim the horns for neatness. As a rough guide, about 40 degrees each direction will give a fast roll rate and high 'flickability'.

Why not try the outer holes first, and then move inboard - before you think about trimming the horn down to size!

Fig 19a

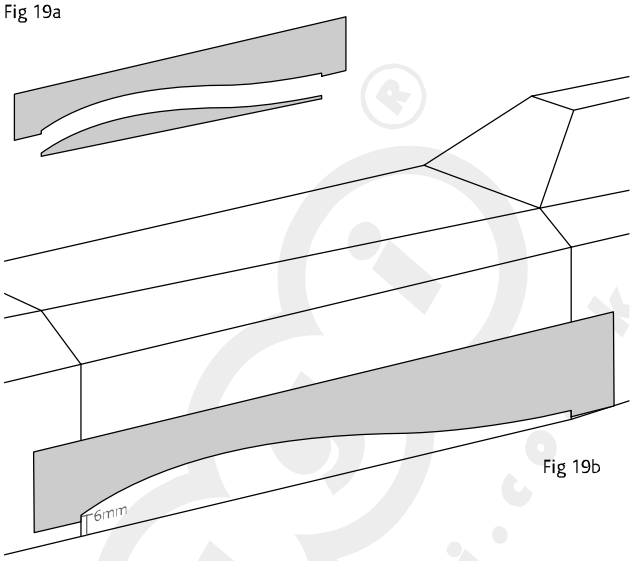


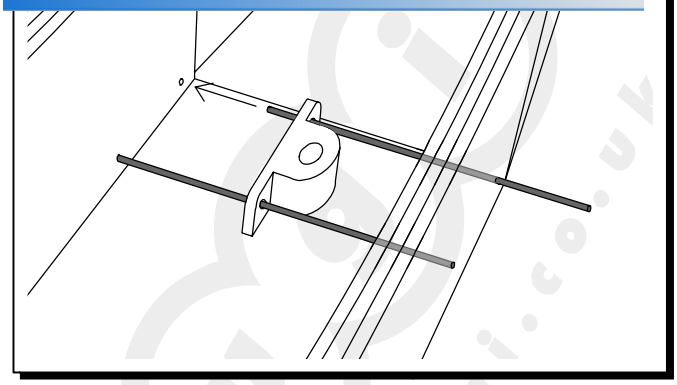
Fig 19b

19. CUTTING THE WING MOUNT

The fuselage bottom must be cut to fit the wing section and to allow the wraparound tongue part of the wing to be located in the fuselage.
Cut the paper wing template made earlier (Fig 19a) and lay the template as shown above on the side of the fuselage. The rear of the template should be positioned to allow the thickness of the trailing edge (4mm) to sit flush with the bottom of the fuselage (Fig 19b).

The front of the template should be positioned so the 'leading edge' sits around 6mm from the bottom of the fuselage. This should allow the tongue to engage correctly with the fuselage and also provide the wing with the correct amount of positive incidence.

Use the template to draw a line and then cut the fuselage along the line. It's easier to cut the fuselage if you slide it over the corner of a building or cutting board much like a blacksmith would use an anvil. When the wing mount is cut, repeat on the other side of the fuselage. Finally check the wing for fit and adjust the mount with a blade if necessary.



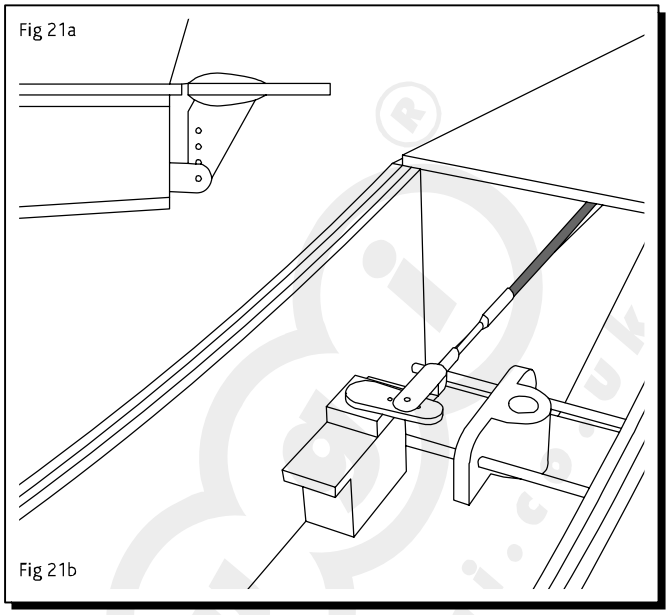
20. MOUNTING THE WING FIXING NUT

The wing fixing nut (supplied in our Tea Racer hardware pack) is the black nylon threaded component that acts as a captive nut for the nylon wing bolt.

Glue the nylon bolt to the inside of the fuse inner as shown above, making sure the hole lies on the fuselage centreline. The glue will not take the load of the wing but simply locates the nut laterally. The rear of the nut should just touch the rearmost edge of the fuse inner for correct positioning.

Now, push two lengths of 2mm carbon rod through the fuselage sides and through the two holes in the wing fixing nut. Don't worry about the carbon sticking out of the fuselage; simply trim it flush. The carbon will be taped over during colouring - or, for white models perhaps a drop of correction fluid over the ends and then clear tape to secure in place.

Push a screwdriver or pencil through the wing in a position corresponding to the wing nut and the wing can now be firmly fixed to the fuselage with the nylon wing bolt.



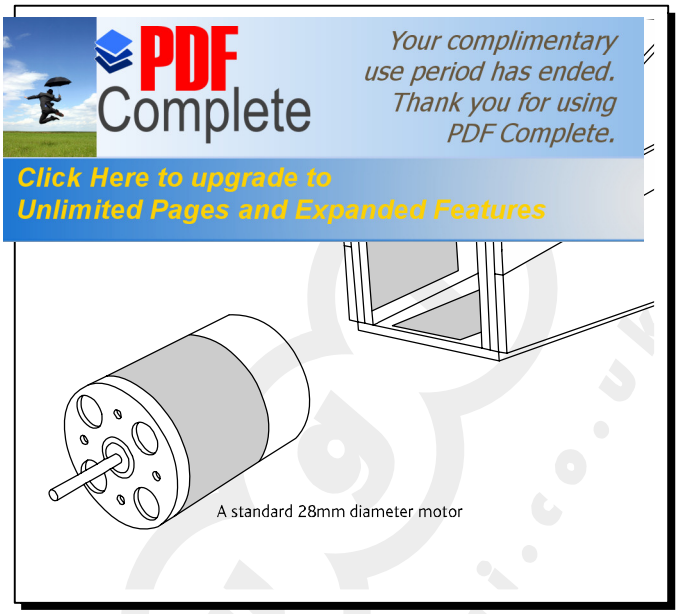
21. ELEVATOR SERVO AND PUSHROD INSTALLATION

Install a control horn on the underside of the Tea Racer elevator as in Fig 21a above. The pushrod can easily exit the open tail of the fuselage and the lack of formers or bulkheads makes a simple run to the elevator servo.

The elevator micro servo should be positioned approximately as shown in Fig 21b above. With a pushrod total length of around 320mm the exact servo location can be moved to obtain neutral elevator. Use a suitable pushrod or snake with fine-adjustable hardware.

The throw of the elevator should be minimal and can be achieved by using an inner hole on the servo horn and the outermost hole on the elevator horn. Movement should be no more than 30 degrees either way but can be adjusted to your tastes later if required.

For optional rudder, mount the servo opposite the elevator servo and run a pushrod directly to the rudder, routing it out the top of the fuselage through a suitable slot.



A standard 28mm diameter motor

22. MOUNTING A 28MM MOTOR

The nose of the Tea Racer is a 28mm square aparture. This is the same diameter as a standard speed 400 and many high performance 'inrunner' brushless motors and means that a very simple and secure mounting method can be employed.

Fig 22 above shows shaded areas on the fuselage and motor. This is self adhesive hook and loop fastener. Although one might never imagine securing a motor using this material, in reality it provides a very strong, rigid and reliable bond while also absorbing vibration.

Place a wrap of self adhesive 'hook' around your motor - the glue will not melt with normal operating heat. Now line the fuselage with the 'loop' material and push the motor firmly into the fuselage until it lies flush with the nose.

The underside of the nose may bulge slightly but this ensures that the motor is well gripped. Additionally, the hook and loop is incredibly strong against shearing forces such as those exerted by the thrust and the torque of the motor.

23. INSTALLING THE RECEIVER, SPEED CONTROLLER AND FLIGHT BATTERY

There is plenty of room inside the Tea Racer fuselage and it can accomodate large batteries with ease. The flight battery (recommended <200g) should be fixed to the top of the wing, on the tongue part as far forward as possible.

The speed controller can be placed in the nose behind the motor and will not move about even if unattached. Plenty of cooling air passes around the motor and through to the tail of the fuselage. However, you may like to cut a small 2cm x 2cm hole at the bottom of the fuselage just behind the wing. This will allow more air to flow and also is very useful for visually locating the wing bolt prior to attaching the wing.

The receiver (micro type recommended) should be mounted in front of the elevator servo and can be attached to either the wing of the fuse inner piece. In this position there should be no problem with regards to the reach of the aileron servo leads.

24. CENTRE OF GRAVITY

The centre of gravity of the Tea Racer should be around one third of the wing chord back from the leading edge. This translates to a range between 70-80mm from the leading edge at the wing root.

25. DECORATING THE TEA RACER

Every racing aircraft needs a distinctive and highly visible colour scheme. Twinwall polypropylene cannot be readily painted but colouring tapes (available from Mugi) are the perfect solution. They provide a high gloss, lightweight finish and can be applied very simply and quickly. Additionally, taping the aircraft adds even more rigidity.

We recommend covering the fuselage in long lengths nose to tail and the wing in spanwise lengths of tape. If you leave the underside of the aircraft white then orientation will be enhanced greatly. The cockpit or canopy part of the Tea Racer should be covered with black or dark coloured tape or use the canopy decals from the Tea Racer decal set.

For hints and tips on covering twinwall aircraft with colouring tapes, refer to the online tutorials at our website: www.mugi.co.uk

26. THE TEA RACER DECAL SET

You can find many useful and fun decorations for your aircraft in the Tea Racer decal set available from our online shop. Why not send us a photo of your finished model - we'd be thrilled to see your imaginative designs. You can email us at morgan@mugi.co.uk