38" Span70mm EDF Tornado GR4

So this is the third and final model in a tranche of three offerings and yet again paying homage to the classic British jet fighter of the 1960s and 70s.
Although the Tornado didn't enter service until 1979, its design was embedded in the 1960s.

The Tornado has always been a favourite of mine but it did require four prototypes to get right.
So the model originally started as a twin 50mm EDF version with a wing span of 40".
This first prototype was a little overweight and used a simple plastic electric retract unit.
Although the concept was sound and the principles of the swing-wing geometry was almost mastered, the first prototype unfortunately crashed when the power-hungry model ran out of battery power on a low pass and planted itself into a small tree. The opportunity of redesigning and rebuilding the model didn't take too long as I knew the model was a 'gooden'…So the mark two was made smaller and came out a tad lighter, but still with the twin fan set up. On this particular version, I did experiment with internal weight shifting of the batteries to maintain the correct centre of gravity for both forward and swept wing configuration. Unfortunately, the C of G had to move forward and back by almost 50mm and no matter where the batteries were positioned, you could only achieve one or the other…notwithstanding this, the mechanism was becoming too complicated and too heavy. I was just about to give up the idea of weight shift, when my son suggested putting weight in the wing tips….he's a clever so and so….this was a great idea and although the tip weight still couldn't quite achieve the correct forward and rearwards C of G, it was a cracking idea…I ended up putting around 30g on each tip… For the first test flight, the model got away cleanly and the concept seem to work and allowed me to keep the same elevator movements for both forward and swept wing positions. The second test flight unfortunately revealed a problem.
On hand launching, I didn't quite get the model away cleanly and the wing dropped slightly….trying to correct with ailerons the model was really reluctant to straighten ….because of the heavy wing tips the model began to Dutch roll from side to side, with me over correcting and making things worse. Maybe a gyro would have been the savour, but I really didn't want to go down that route to make this project work.
The final issue that saw the second prototypes demise was in a sharp turn, the aileron response was poor and the elevator ran out of puff….and she slipped into the ground…
Now not wanting to give up I really had to go back to basics.
The Model although now smaller at 38", was still power hungry with the two 50mm EDF set up.
Having recently designed the 37" Harrier and being very impressed with the 4S
Powerfun 70mm fan, I decided to try this option in the next prototype. The unit does give a very good amount of static thrust and as such, launching should be so much easier.
The cost difference will also save you money as the setup is 40% cheaper than the twin fan option.

So prototype number 3 was duly built with a single 70mm 4S unit and the swing wing controlled with a 35kg standard size servo. The reason for the change is the servo can be slowed on the transmitter, so the wing sweep time can be adjusted, making the transition smoother when operated from a two-position switch on the transmitter.
The other main change was to set up the C of G at the forward wing position and then re-adjust both the elevator and aileron trim position and make any adjustments in the throws needed for the swept wing position. Again, the trim position and deflection was programmed into the same two position switch that operate the swing wing. The timing of the trim and deflection change reflected the 3 second sweep time. The result was amazing….the model remained straight and level, turning from a high wing sport model into a ballistic missile …you really have two models for the price of one.

I was really pleased with the way the model was performing now, the launch power was great and with a hefty javelin launch, the model will not drop and always get away cleanly.
In flight I was amazed just how well it performed knowing there was no gyro or clever flight controller installed, just simple radio control…and for this luddite, it suited me.

Now I did say four prototypes didn't I. Unfortunately, pilot error saw the demise of number three…a launch into the evening sun is not to be recommended.
On a positive note, the wings were salvageable and I can confirm that the model has been thoroughly crash tested…lol
As a final note, I would only recommend the Powerfun fan unit, principally because they have excellent static thrust and will accelerate the Tornado to flying speed with very little 'sink' on launch.

One further point I should raise. If you are put off by the complexity of the swing wing and you really want to build the Tornado, there is nothing stopping you from making the model with the wings in a fixed position of your choice. I think a half swing position would be a nice compromise though.
To assist the builder, I have once again made available a VAC set and CNC/wood pack, for those who wish to make the building process a little easier and quicker. There will also be available the swing-wing pivot kit, which will include the 35kg Servo. These parts will ONLY be available through Tony Nijhuis Designs Ltd (TND) and not via Kelsey. The plan itself will only be available in this edition of the magazine with future copies only
being available again through TND Ltd.

The battery used in the prototype was a 4S-4500mah 60c LiPo. The servos were metal geared 6g, 1kg/cm torque for the ailerons and 12g 2.2kg/cm servos for each elevator.
For the ESC, a 60amp 4S speed controller was used. Make sure you set the timing to "High", Set the low voltage cut off to "off" and have a "soft" start which will suit the EDF unit.

Lastly and possibly the most important, a photographic build log is available as a free download to print out from www.tonynijhuisdesigns.co.uk. These photos will be invaluable, and I would suggest downloading these so you can familiarise yourself with the build before you start.

Wings
The wings are a traditional 'built up' construction and are made over the plan.
The sequence detailed below should be followed closely to avoid construction difficulties.

Begin by taking the 6mm x 3mm obechi lower forward spar and pinning this over the plan.
Now fit all of the wing ribs. The top obechi spar can now be glued into position.
Fit the inner leading edge (made from 3mm sheet balsa). Next make up the trailing edge, using 4.5mm sheet balsa that fits between W5 and W9.
Now fit the top wing pivot support PS1 between W1 and W3 Using 1.5mm sheet balsa, begin to sheet the wing panel from the leading edge back.

Remove the wing from the plan and add the 1.5mm balsa shear webbing between the ribs.
Glue into position, the second PS1 to the under wing.
Trim the angled trailing edge as shown on the plan and line the inside edge with a piece of 6.5mm x 9.5mm strip of balsa. This will have to be chamfered flush between PS1 and the trailing edge before sheeting the underside, remove the jig tabs from the underside of each rib and sand smooth. Make up the servo support mounts and fit the servo wiring.
When done, the wing sheeting can be applied in the same sequence as the top sheeting.

Finally add the outer leading edge made from 9.5mm balsa and make up the wing tips from 12.5mm balsa sheet.
Reveal the two holes on PS1. Now make up the opposite wing panel to the same standard.
Now make up each individual aileron to fit the wings as shown on the plan.
These are a simple affair and use 6mm x 25mm standard trailing edge stock. Insert the nylon pivot bearing to the correct depth as shown on the plans. Do not secure with the self-tapping screw yet.
Also install the push/pull M3 horns into PS1. Make sure these are secure and once you are happy the height positioning on both wings is identical, apply some thin cyano to ps1 around the bolt to secure and strengthen the joint.

Rear Fuselage
On the assumption you have bought the CNC pack, number all the parts to avoid any confusion later.
Begin by marking the vertical positions of the formers onto the fuselage sides, FS1 and 2.
Glue the sacrificial former piece F3A and F4A to their respective formers.
Now make up the wing support plate WSP1 from 6mm lite ply.
Add the 1.5mm birch ply wing nut spacers to the underside of WSP1…this plate allows a standard M6 captive nut to sit flush and not create a shoulder on the top side.
Apply some 30min epoxy to the captive nuts and press home using a bench vice. It is very important the nuts both sit flush but also straight and true. I would suggest once they are pressed home, that you screw in a 200mm length of 6mm studding and visually compare the straightness of the captive nut to each other. This process is very important as any deviation will result in an imbalance in wing incidences
When happy, remove any excess glue and leave to dry.
Now glue (using a strong wood glue) the servo mounts on to WSP1. Note that each mount is a sandwich of two SM1.
WSP1 has been designed to accept a standard 35kg size servo which are plentiful and cheaply sourced on the internet. Make sure the servo sits through WSP1 and flush with the top side.

Make up the twin push rods (3mm studding with quick link and ball joint ends) refer to the build photos for clearer detail.
Using an M8 shoulder bolt, washers and the cross brace CB1, put the wing mechanism together as a test rig and as shown on the build photos. Now connect the servo to an RX and set the transmitter up on a two position switch. Make sure the ATV movements are set to only 30% and the servo is slowed to around 3 seconds… this will allow you to slowly gauge the end points.
Now make adjustments to the transmitter ATV so you achieve the full movement of the wing without stalling or overloading the servo.
Now dismantle the test rig (but leave the servo in position) and continue with the fuselage build.
Begin by lining the bottom inside edge of the fuselage between F5 and F7 with 12.5mm triangle stock. Note the saw cuts in the triangle to aid bending of the fuselage sides.
Now glue into position F6 to one fuselage side and fit the other fuselage side. You may wish to use a SLEC building jig for this operation to make sure all is straight and true.
Add the fan mounts FM1 and the former F7.
Add formers F4 and F5 and then add the wing seat doubler WS1…this may need small amounts of adjustment.
Glue into position WSP1
Position the fan unit and mount this to the plates with two retaining screws.
Make up the thrust tube, using the template shown on the plan. This is made from an A3 sheet of 140-micron thick acetate and is normally available from a Stationary supplier or eBay.

Install the ESC and check the fan functions and rotates in the correct direction.

Front Fuselage

Make up the front fuselage sides and line the bottom and top inside edges with 12.5mm triangular balsa. Saw cuts will have to be made (as shown on the plan) to aid bending of the fuselage sides.
You may wish to use a SLEC building jig again for the next process.
Begin assembling the fuselage, adding F2 and F3 first, checking squareness as you proceed. Then add F1.
Glue the front and rear fuselage sections together using the centre openings of Formers F3 and F4 as an alignment guide.
Now fit FS3 remembering to chamfer the edge where it meets FS1.
Now make up the under-sheeting from multiple sheets of 4.5mm balsa and butt glue these together.
Mark out and cut the air intake hole in the under-sheeting in the position shown on the plans.
Remove the sacrificial former F3A and F4A and discard. This will allow the battery to sit cleanly onto the internal bottom sheeting.
The internal edge on the fuselage tailplane slot will need to be strengthened to support the tailplane. So cut four lengths of 6.5mm sq balsa to fit between F6 and F7, and glue these to the top and bottom inside edge of the slot. Use a scrap piece of 4.5mm balsa as an alignment tool for the support strips.
Now sheet the top fuselage between F6 and F7, leaving a gap of 4.5mm for the fin to slot into.
I would suggest at this stage, the bottom front and rear fuselage is razor planed and sanded to former profile as shown on the plan.
Add the forward top sheeting and make up the nose cone using a sandwich of both 12.5mm and 9.5mm balsa.
Shape the nose cone and profile the complete fuselage to a smooth flowing profile.
The air intakes can now be made using pieces AI1 and former F8. Refer to the build photos on my website for a clearer picture of the detail.

When done, the intakes can be glued against F4 and the fuselage sides.
Now sheet, using 3.2mm balsa, the bottom of the intakes, back to F5.
When complete, use a sanding block to blend the intakes to a smooth flowing profile.
Finally add the elevator servo opening reinforcement plates and add the tail fairings pieces TF1.
Note; that two pieces are sandwich together for each side. Blend these into the fuselage smoothly.

Fin & Tailplane

Make up the fin parts as shown on the plan. Glue them together and profile the fin leading and rudder trailing edges. Put the fin aside and only glue into position once the model is nearing completion.
Now make up the tailplane and elevator parts. Round off the tailplane leading edge and chamfer the elevator leading edge ready for the hinges to be fitted.

Finishing off

Reinstall the wings on to the fuselage to retest the swing-wing action. The 3mm quick links that connect onto the wing horn can be a little bit tricky to access so using a flat screwdriver to open the quick link will be a help. You will also find that the bottom air intake hole will also give you access to the quick links.

Check the clearance of both wings against the top fuselage edges (about 0.5mm to 1mm gap should do). When happy all is square and true, secure the nylon pivot bearings in the top of PS1, with a small 2mm x 12mm self-tapping screw, at an angle of 45degs.
The top turtle deck can now be adjusted and trimmed so it sits flush with the top of the fuselage at F4 and F6.
Add two small pieces of scrap spar obechi to the top inside edge of WS1, and fit a retaining pin to the rear of the turtle decking. When happy with the alignment and wings move forward and back without rubbing on the turtle decking, drill and fix, with two M2 screws, the decking

The batteries are accessed through a removable canopy. Make up the canopy floor and detail the inside of the cockpit. Cut out the battery access hole in the top of the fuselage, but leave the insert in. Put some glue on top of the insert and then locate the canopy back on to the fuselage in the correct position. Once the glue has dried, the canopy will then have a locating point. On the prototype, I used two 10mm Dia x 2mm magnets and washers, both recessed in to the balsa surfaces of the canopy floor and the top of the fuselage, to secure the canopy
The fin and tailplane can now be fitted along with the fin doubler FD1. The top outside edge of FD1 should be profiled round to match the turtle deck. Once happy, glue these into position.

Covering and setup
The prototype was covered using light grey Oracover™ from J Perkins/4-Max Models.
The vac formed turtle deck was painted in the corresponding and matching Orapaint™.

A decal set, air intake vents and a pilot are available from www.tonynijhuisdesign.co.uk

Fit all the control surfaces with flat hinges and secure with glue. Fit all the servos and all the control horns. For the control horns, I made these out of 2mm birch ply and slotted these into the control surfaces.
The C of G position should be achieved with just the positioning of a 4S-4500mah LiPos and the wings in the FORWARD position. Do not be tempted to move the C of G back from the stated position…it has been thoroughly tested and where it is shown, is the correct position!
The battery is secured using self-adhesive Velcro.

As I mentioned at the beginning of the article, no gyros or stabilization were used on this model but you will have to set up trim settings for the swept wing position as detailed on the plan. In short, as the wings slowly move back, the elevator will need to deflect up by 5mm, (matching the timing of the wings) to counter act the now forward centre of gravity.
The elevator deflection will also need to increase as a result of the forward C of G. The aileron movements will not have to change fortunately but be prepared to set up a slightly different trim position for the swept position. This was all done via mixing functions within the transmitter.

Flying
The first thing to note with the Tornado is the wing loading is quite high at 33oz/sq' but hand launching the model still remains very easy as long as the javelin technique is used.

As I mentioned in previous articles, what a revelation this technique is. You get a more powerful throw and the projection of the model upwards too, gives you time to get those fingers back onto the controls. However, I suggest for its maiden flight you get a trusted helper to launch the model for you, with the wings forward of course.
I wouldn't suggest flying the model in windy conditions and anything more than 10mph. It really is far more happy with a calm evening than a windy afternoon!
Once the Tornado gets away and is trimmed for level flight at ½ power, get a trusted

helper to take a photo of the trim settings on your Transmitter,
Flying the Tornado with wings forward, the model will not feel jet like but more like a fan powered sport model. I suggest you get use to flying the model in this format before attempting to go into swing wing mode.
Now on the assumption you have followed the guidelines mentioned earlier and the set up as stated on the plan, take the model up to a reasonable height and bring it back into wind at around 2/3 power and then flick the two position switch, on the Transmitter. The model will hopefully stay relatively level but be prepared to input some aileron trim and possibly some elevator trim. If your trusted helper is still available, ask them to take another photo of your changed trim settings.
Once trimmed out, the Tornado will turn into that fast jet you really wanted to see….the model will require more power to fly in swept mode. But what a joy it is. Returning to its forward swing mode, you must slow the model down otherwise the model will be going too fast for forward wing flight. You can land the model in swept mode but the landing speed will be quite high.
If there is trim difference between the two flight modes, use the photos to adjust your transmitter to the swept wing mixed conditions to mimic the trim setting that you adjusted in flight.
It took me about three flights to get the mixed trims correct but I was doing it from memory
Once this is done, the Tornado should transition smoothly, staying straight, level and true.

All the classic jet manoeuvres can be done with this model, but you will need full throttle and speed on some, as the model doesn't have the momentum to carry through manoeuvre such as big loops etc. Just remember to keep the routine smooth and keep what little momentum it has, going.

Landings are very straightforward with the wings forward. Do be careful though and make sure a wing doesn't drop as this can easily damage the swing wing mechanism.
Don't be tempted to adjust the C of G. This model has been thoroughly tested and where it is shown on the plan is exactly where it needs to be!...with the wings forward!
The 4S,12 bladed Powerfun EDF unit does give an amazing punch and flight times are surprisingly good. So expect a good 3-4 minutes depending on throttle use.

I have to say the Tornado has been a challenge to design and get right, but what a lovely model this has turned out to be and has far outweighed my expectations, especially as there are no clever electronics on board. I'm sure some of you will install stabilising gyros etc and I'm sure this will improve the flying performance and the whole experience….. I'm really looking forward to hearing of your clever add-ons.
I think this really will be a popular model as it is such an iconic aircraft. I do Hope you enjoy both building and flying this one…it really is two models for the price of one

Specification:

Tornado GR4	
Wing span	38" (964mm)
Length	42" (1072mm)
Wing loading	33.oz/sq'(10kg/m2)
Target Weight	51oz (1.45kg)

Addition Plans, Vac set, combined CNC / Wood pack, wing pivot kit, pilots and decal sets, are available from :
www.tonynijhuisdesigns.co.uk
email sales@tonynijhuisdesigns.co.uk
Phone 07563 518159 9am to 4pm