

Combat Flying Wing

# **TORNADO 11**

## **Introduction**

Congratulations! You have purchased an unusual kit you will build unusually getting really unusual experience. Even the material you will use is not usual - it is the Extruded PolyPropylene (EPP).

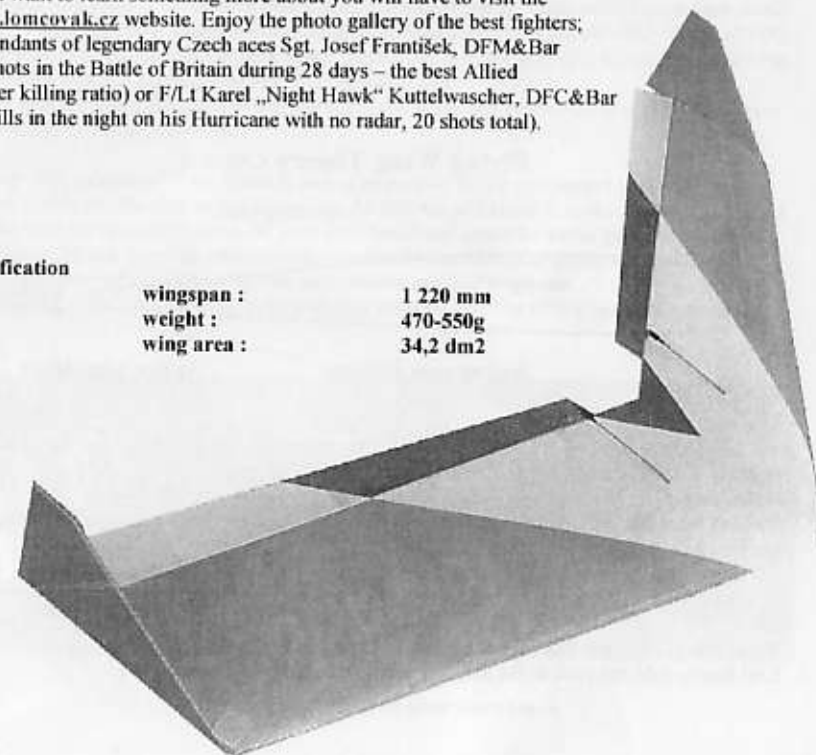
The „full size“ tornado is very dangerous the same as this little Tornado. Flown by a skilled pilot it is a deadly weapon, really killing machine. Fast, manoeuvrable, flying even in almost no wind conditions, almost unbreakable.

In spite of its extra nature Tornado is easy to trim-out and fly, no dirty tricks at all. It can be flown even by a complete newcomer (when low rates are set on controls).

If you want to learn something more about you will have to visit the [www.lomcovak.cz](http://www.lomcovak.cz) website. Enjoy the photo gallery of the best fighters; descendants of legendary Czech aces Sgt. Josef František, DFM&Bar (17 shots in the Battle of Britain during 28 days – the best Allied fighter killing ratio) or F/Lt Karel „Night Hawk“ Kuttelwascher, DFC&Bar (15 kills in the night on his Hurricane with no radar, 20 shots total).

## **Specification**

wingspan :	1 220 mm
weight :	470-550g
wing area :	34,2 dm <sup>2</sup>



## You will need

**Radio:** two channels are the only what you need but there must be an **elevator mixer** „build-in“ your transmitter or a mixing device in your model. Adjustable mixing ratio is invited.

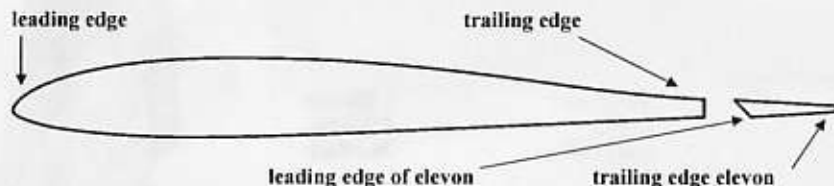
**Servos and receiver:** we recommend standard size ones. Although you might think the cheaper the better (with a plane destined to crash) in fact you will need a receiver with very good selectivity to prevent any interference problem as a typical combat scene can involve even more than ten model at once. Standard size servos are less vulnerable than the micro ones with their tiny gears.

**Batteries:** we recommend a flat pack of four pen cells. Please note: use at least 400 mAh batteries as the servos are almost all the time in action and you will hardly leave the battlefield till the dusk patrol will take off, too.

**Tools you will need:** modellers knife (X-Acto or so), sandpaper No. 60 and 120, pistol type soldering iron, sealing iron, pliers, steel rule, scissors.

**Glue, tape etc.:** 5-30 minutes epoxy, medium cyanoacrylate glue (CA), contact glue spray (3M Super 77, UHU Power etc.), glass tape for reinforcements, colour sticky tape for covering.

## Flying Wing Theory Corner



**Washout:** the wing is twisted so while the trailing edge on the root and on the wing tip are level the trailing edge on the tip is higher than on the root.

**Anhedral:** In the front view the wing tips are lower than the centre of the wing.

**Elevator:** A control surface working in one moment as the elevator and ailerons. The flying wing control surface.

**Up Elevator:** Elevator stick towards you, both two elevons move simultaneously up.

**Down Elevator:** Elevator stick away from you, both two elevons move simultaneously down.

**Right Bank:** Ailerons stick to the right, right aileron moves up and left down.

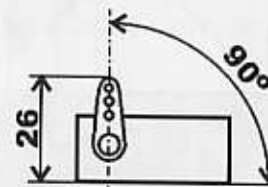
**Left Bank:** Ailerons stick to the left, left aileron moves up and right down.

## Building Sequence

**Please note:** The wing halves have been already cut with the **washout** necessary to get a flyable model. Please keep this washout throughout all the building sequence.

**RC gear preparing:** Wire up the flight part of your RC gear, switch on your transmitter, set trims to neutrals, activate the elevator mixer.

Fit servo arms to servos according to the drawing below. The servo arm is square to the servo case the same as the upper side of the wing. The maximum total height is 26 mm; it is limited by the wing section thickness.



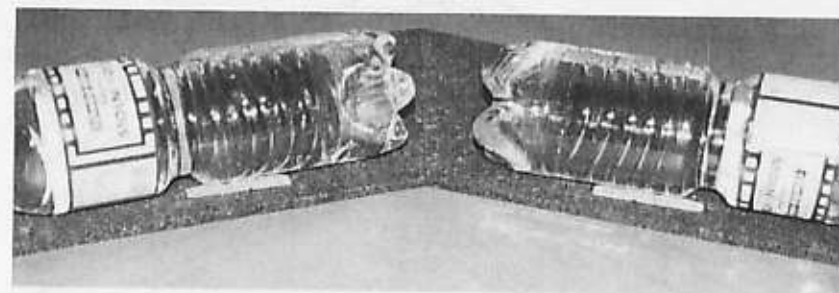
Think twice, cut once and everything check double. Most of the gear is to be permanently glued to the wing so any error may be hard to repair later.

Receiver aerial is to be inserted to a notch cut in the wing; use a reliable connector if you want to keep your receiver removable.

**Setting wing anhedral:** Your Tornado has an **anhedral**. While you cannot see it on Pipers it is often visible on jets with swept back wing. At first we will check it without gluing.

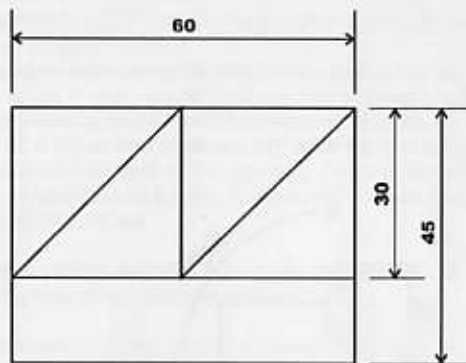
Lay the wing halves upside down on your workbench and press the entire trailing edges to the workbench. Secure the wing with suitable weights (two bottles of drinking water will do the job). The correct anhedral is set up this way without any jigs or gauges.

Now trial the fit of the root sections of both two wing halves. The EPP is quite easy to sand.

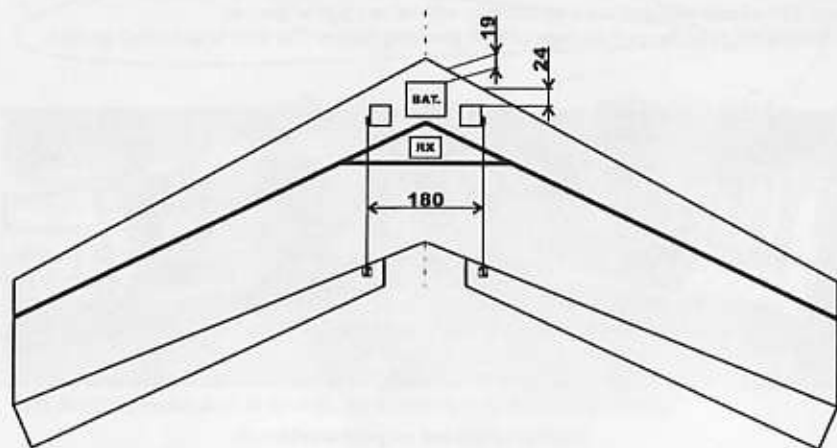


trailing edge fixed on your workbench

Cut the supplied plate according to the drawing below (parts could be cut). You will get four triangular reinforcing plates to be placed under the elevon horns and the wing centre trailing edge reinforcing plate.



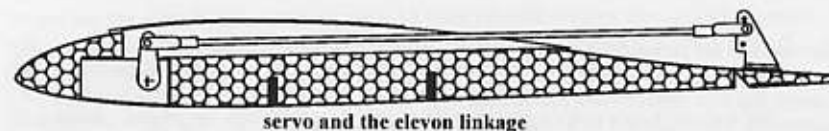
**Cutting the receiver, battery and servo bays.** All the parts of your flight equipment are inserted or glued from the bottom side of the wing. Try to keep the following sketch to get the centre of gravity (CG) to its correct position without any additional ballast.



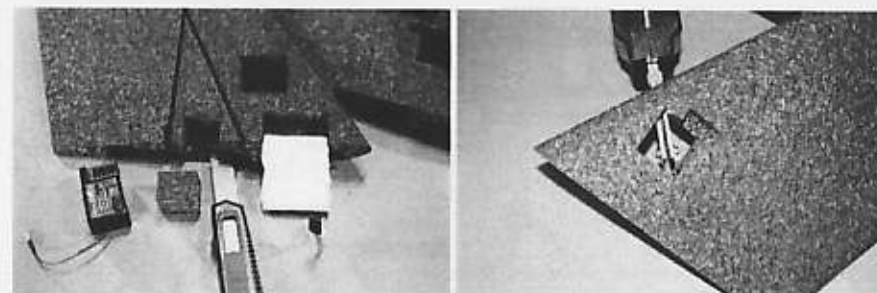
Mark the outline of the RC gear and cut it slightly undersize with a very sharp knife. Cut the receiver bay as deep as necessary to hide it completely.

Batteries are to be sunk right flush with the bottom wing surface or a little deeper, if you have decided to fit a hatch.

Servos: cut off the lugs, the bays are right to the size of your servo case. Keep the cut off material aside, you will need it later. Cut the opening for servo arms.



Use your pistol soldering iron to cut the tunnels for RC gear cables connecting your receiver, batteries and servos.

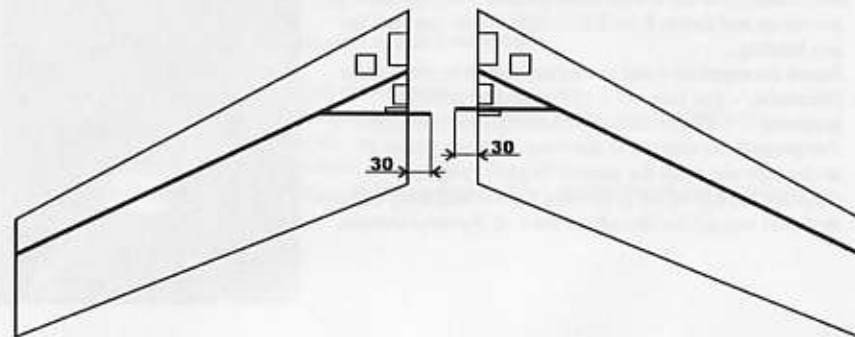


The receiver aerial notch is about 6 mm (1/4") deep. You have to sink it deeper where the spruce spar is crossed. The aerial is directed towards the wing tip.

We do not use a switch as it should be switched off in mid-air collisions...

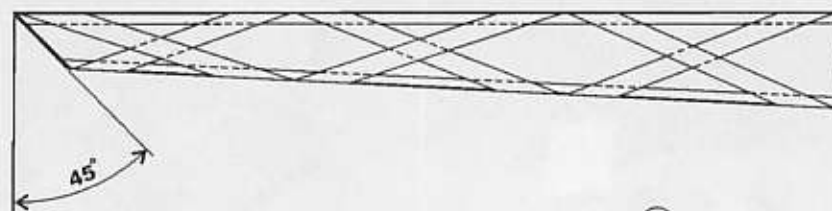
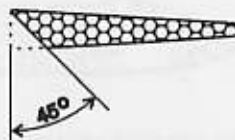
The RC gear is simply switched on by plugging in the battery connector to your receiver.

**Reinforcing spars:** Insert the main spar and cut flush with the root and tip. Please note: the short cross spars must overlap by 30 mm (1-5/16"). Bevel their ends to fit the main spar.



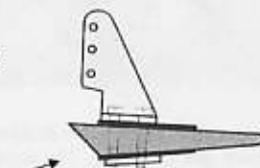
Epoxy the spars to their grooves (or you can use medium CA instead). If you are using a 12 minute epoxy you will use it to fix servos, too. When the epoxy has cured, sand the spars flush with the wing surface. The servos are to be glued flush with the wing bottom surface. If you felt the epoxiing was a savage method you would use a silicone sealant or polyurethane foam instead.

**Elevons:** Cut the elevons to the shape according to the sketch. Use a **very sharp** knife and then sand with a fine sandpaper. Remove the dust carefully and you can start with the glass tape reinforcing. There may not be a twist so you will have to work on a flat surface and take an extra care, too. Stick the tape along the leading and trailing edge. The cross bracing is accomplished by winding the tape around under 45 degrees angle.



Fit the elevon horns over their reinforcing plates; place them so the elevon pushrod will be parallel to the root of wing.

reinforcing plate



**Elevon linkage:** Cut the grooves for elevon pushrods. Make a special eyelet for your pistol soldering iron (hot wire method) or cut it with a sharp knife. Note: the pushrod moves up and down; from left to right. There may not be any binding. Screw the supplied wires to clevises and fit to servo arms (remember – you have set it to the **neutral position** previously). Fit the second clevises to the elevon horns. Temporarily fix elevons to the wing with two pieces of sticky tape and mark the correct length of pushrods. (Elevons have to be set to its neutral positions, too). Cut the pushrods and cut the threads on the end. Remove elevons.



**Joining wing halves:** Apply a thin coat of epoxy to the wing root sections and overlapping parts of spruce spars. Join the halves and lay up side down on a flat working surface. Press the trailing edge to your workbench and fix it as you fixed it previously. Let the epoxy set hard. If you do it just this way the correct anhedral will be set automatically.

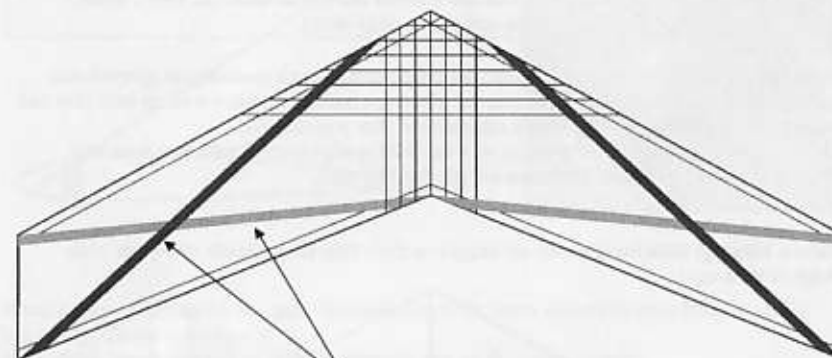
**Preparing the wing for covering:** Use the left aside cut-offs to cover servos from the upper side. Just cut the part according to the thickness of your servo and glue it in place. Glue in place batteries, sand to shape the leading edge and sand the wing halves joint. Glue the trailing edge reinforcing plate on the bottom surface of wing. Then finally remove the dust from your wing with a vacuum cleaner (use a brushed hub). **Fit the elevon linkage.**

**Glass tape covering:** We recommend a 25 mm (1") glass tape. Broader tape you can simply split cutting it between the filaments.

**Beware of building-in any twist – so just stick the tape, no stretching allowed.**

At first reinforce the centre of the wing (width about 80 mm) both up and bottom side. Add a cross strip of tape to the trailing edge.

Cover the elevon pushrod grooves with two 15 x 90mm pieces of a cardboard. Then stick the tape along the wingspan. The ends of strips are to be stacked on the bottom surface.



cross tape reduces the twist

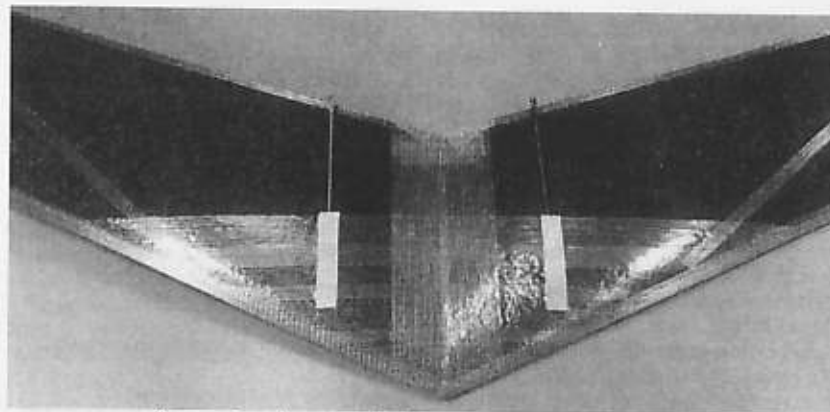
Cover the bottom side of the wing in the same way.

The trailing edge is reinforced with two layers of tape. Strips should overlap by 5 mm.

One layer for the trailing edge is OK.

To reduce twisting of the wing stick on 10-15 wide strips across.

**Finally you should iron on the tape with a sealing iron set on the lowest temperature.**

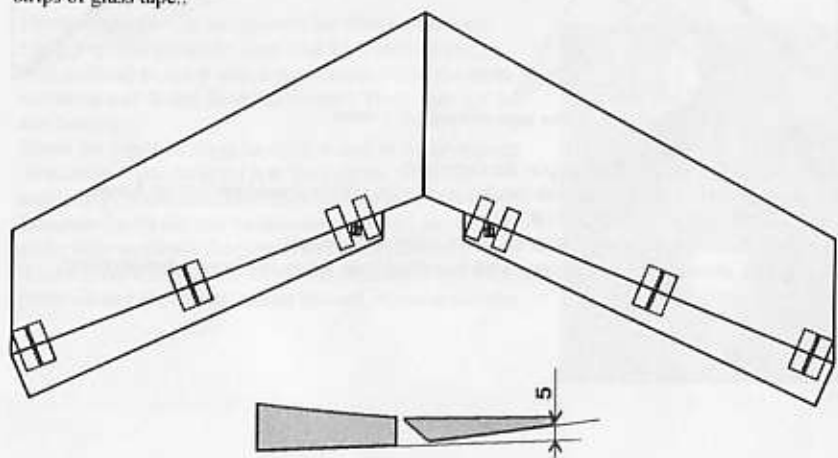


Grooves for elevon pushrods are covered with card strips

**Wing geometry check:** Lay the wing on your workbench. Place a 6 mm jig under the centre of trailing edge. The trailing edge must be than 5 mm over your bench on the wing tip. Trim if necessary by stretching of the cross strips.  
*Wow, you said something about washout and it seems there is no washout. Don't worry – there are elevons that are wider on tips than in the wing centre.*

**Final colour tape covering:** The colour tape covering requires a contact glue sprayed onto the wing surface (it is not necessary over the glass tape reinforcements - it saves both glue and weight). Let the contact glue dry for a moment and than you can start. The tape is to be sticked in strips along with the trailing edge (you should start here, too). Overlap the strips by 2 mm. **Just stick not stretch the tape.**

**Elevon hinging:** Both two elevons are hinged on three tape hinges made of 10 mm wide strips of glass tape.



Prepare 24 strips 30 mm long. Sticking two strips together (5 mm overlap) you will create a half of one hinge.

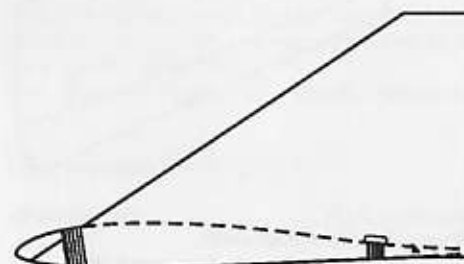
Prepared hinge halves stick alternately on the upper and bottom side of elevons (see the drawing). The hinge close to the elevon horn is very important - stick each half of the hinge from one side of the horn.



Now carefully attach the elevon to the wing. One by one stick the hinges. This step is a little on the tricky side as the tape is mostly managed by one or more Murphy's laws. Try to keep the gap between the wing and elevons as narrow as possible. Finally stick over the gap 10 mm wide strip of a clear tape.

**Fitting the fins, receiver hatch:** Fins are to be sticked with two strips of 10 mm tape. First you have to cut a hole in both two fins according to the drawing and then simply apply the tape.

Make a hatch from the plate supplied. The hatch is fixed by the colour covering tape only.



**Final set-up:** Wire up the RC gear. Neutrals and servo throw directions have been set in the beginning. Check it again.

Now check the elevon mix is working properly and set the servo throws:

Recommended Servo Throws	Low Rate	High Rate
Elevator	+/- 10mm	+/- 15 mm
Ailerons	+/- 15 mm	+/- 25 mm

The throws are measured on the tip trailing edge of elevon.

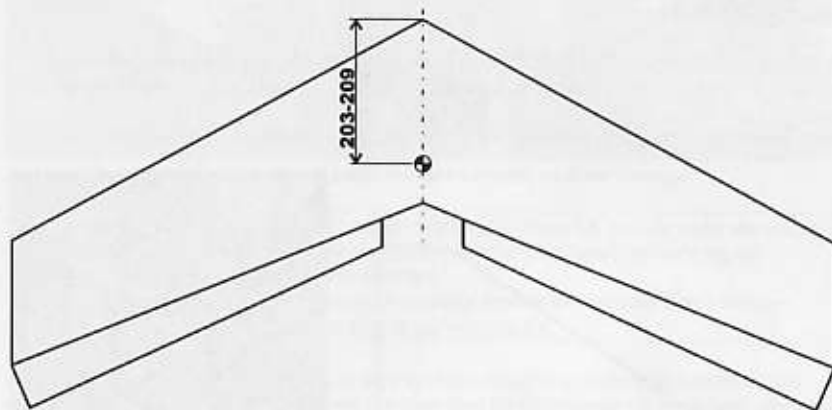
High rates are very good for a skilled war pilot. Low rates are for the rest of us who are learning to fly or who are just relaxing.

We do not recommend to set larger elevator throws as the model is more susceptible to a tip stall ending in a spin.



## Just prior your first battle

**Centre of Gravity.** The centre of gravity (CG) must be within the range 203-209 mm behind the wing nose. *Note: although brave Soviet designers haven't abandoned the stone age idea „ a centimetre less or more – it doesn't matter“ even on Mach 2 fighters, your flying wing is not the case. Flying wing are more sensitive than the normal planes.* A nose heavy model will be easier to fly but you will soon realise it is a sitting duck for enemies. The back CG position is a completely different cup of tea but it should be tricky for a newcomer.



**Flying:** Let's go to your favourite slope!

Once more check the servo directions and throws. Perform a range check.

Hold your Tornado at the centre of the trailing edge, between elevons. Your thumb from under the rest of fingers from above the wing. It may seem quite unusual but you will soon be able to launch your wing even over 10 metres high.

Launch your Tornado. It should fly with no problem from the very first moment. Trim-out and get some height.

Perform the dive test: bring the model to about 30 degrees steep dive and release the elevator into neutral position. If your model tends to loop, move the CG rearwards: move batteries back or add some ballast to the fins. If the dive is even steeper, move the CG forwards. Ideally balanced model will try keep the dive returning slowly to level flight.

**Advanced set-up:** Do not continue unless you have set the CG position as described above.

The flying wing flies like a normal model controlled by ailerons and elevator. It means we bank it with ailerons then turn with some up elevator. Leaving the turn we release the elevator and the wing is returned to the level flight by applying some ailerons in opposite direction. It sounds very simple but there is a factor we have also consider – it is the speed. Any particular speed has its corresponding optimum bank and corresponding elevator throw. In brief the higher speed the tighter turn is possible.

It brings us to the problem of optimum control surface throws.

Large aileron throws are really advantageous. You have to be pretty quick in rolls. And the most important – you have to confirm every kill by a nice victory roll immediately. In brief – you have never too large aileron throws.

It is not so simple with the elevator. You should start with the low rate throw and you can increase it step by step later until your model begins to fall into a spin when quick up elevator is applied.

The elevator down throw is also very important as it is often very advantageous to get off a mid-air collision inverted. You will probably realise it is better to set up different up and down throw to get the best from your Tornado.

Well, you have just set-up your Tornado – it is the time to show your brave heart in your first combat.

## Combat Tactics

How does the combat look? Take three or more pilots, add flying wings, a nice windy slope, shake it... Simply fight to the death. You have to learn some battle cry, too. Sarcastic comments are also quite good. Adrenaline level is pretty high, lots of fun, lots of shots... Beware of a sort of suicide if you forgot anything except the enemy plane. The ground is hard and close to you all the time. Although you would think your flying wing can ignore some basic physical laws it is not the truth completely. Beware of killing yourself or other pilot instead the enemy plane. Just keep your eye on the other models, too.

**Have fun but safety first!**

Short transmitter antennas are preferred whenever modellers are crowded.

There are some basic battle tactics:

„Hare tactics“

He is on the run, all the time runs. It is good only for styrofoam models. Too little contacts, too little shots..

„Stratospheric hare tactics“

You should better purchase a thermal glider.

„Deathmatch tactics“

No one is safe. Nobody knows who will go down in flames – the hunter or the hunted.

**The most preferred and the most attractive for viewers.**

Three model in the air and a brave heart is the only you need to have lots of fun.

„Hyaena (or vulture) tactics“

The models shaken after a mid-air collision are attacked to be killed totally.

Very efficient!

or something even viler...

„Javelin tactics“

Keep your model ready to launch and when an enemy plane is flying around just throw your flying wing against to shot him down.

Not too efficient as usually both two models are shot down.

„I love to ride up stream tactics“ Especially on calmer days models are queued up trying to pursuit the enemy plane. This is the right time for a quick Immelman up stream. Now you are the king!

**How to get your model under control after a mid-air collision:** This is maybe even more important than to hit an enemy plane.

**First:** you have to find out **which model is yours own.**

Then: release the elevator. Try to get your wing parallel with slope with ailerons. Apply ailerons just to stop the rotation. It does not matter if you will end in normal flight or up side down. You have to be very quick especially when you are close to the ground.

Now you should gain some speed (if you have lost it in a collision) and then apply elevator to get your model to the level flight. Fly into the wind away from the slope. If you are finishing up side down you will apply down elevator and vice versa.

It means the „ace“ is able to fly inverted the same as with his head up. You sure will adopt the inverted flight soon – **you have got an unbreakable model!**

**Last but not least:** keep your eye even on the model just crashing to the ground. Sometimes the model is knocked off back into the air. The enemy pilot has no points then!

*Have the highest score and lots of fun in the Battle of Slope*

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**Part list :**

part  
rt/left wing  
rt/left styrofoam elevon  
2X fin  
4X hdwood strip  
2X elevon horn  
4X clevis  
4X screw M2\*16  
2X elevon pushrod  
1X receiver hatch  
1X reinforcing plate (4+1 parts)