

TRIMMING FOR AEROBATICS PART 2

Jon Tappin concludes his article on trimming a model to perform smooth aerobatics

Jon built the Vanquish he used as the basis for his two trimming articles



This article is based on the set-up for the Extreme Flight Vanquish 2M, which I reviewed for RC Model World's sister publication, Quiet & Electric Flight International last year.

BALANCE POINT AND THRUSTLINES

The fundamental things to check on a new model are centre of gravity and thrustlines. Without getting these right first any other adjustments made, such as mixing for control interaction or fine-tuning control response, will be wrong and will change when adjustments to these two factors are made. The normal centre of gravity check I do for a symmetrical winged aerobatic model is to climb on a 45 degree line and half roll to inverted; the nose should stay on the 45 line or very slowly drop. The Vanquish held the line, indicating that it was close to the right place. However, my initial impression was that it wasn't quite tracking straight and didn't feel as locked in to the straight lines as I would have

expected, suggesting the C of G could still be a little rearward. For later flights I moved the main battery pack slightly further forward until I was happy.

The next stage is to set the engine thrust line. If the model climbs under power and dives when power is reduced then down thrust is required and vice versa. Make adjustments and fly until you can see no trim change with throttle position. Unless you are a full throttle merchant, without doing this you will have a model that is only in trim at one power setting. To set side thrust establish the model in a true vertical climb and then centralise the sticks. If the model pulls to the left then add right thrust. If it pulls to the right then reduce right thrust. The down thrust setting appeared to be spot on, however it was clear that the Vanquish was going to need some additional side thrust as I needed a small amount of right rudder trim to get the vertical lines straight. Unfortunately with the wind strength on the day it was impossible to get a true indication of how far out it was.

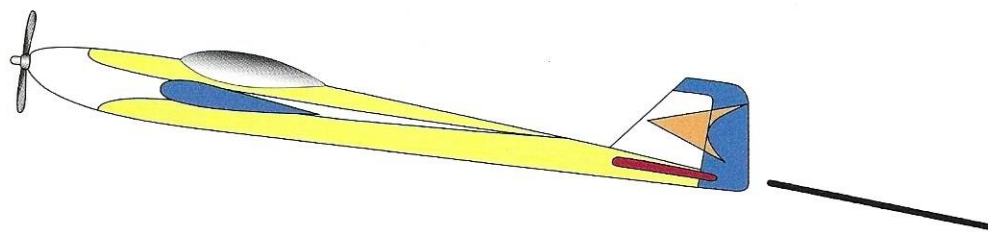
If the model climbs under power and dives when power is reduced then down thrust is required and vice versa



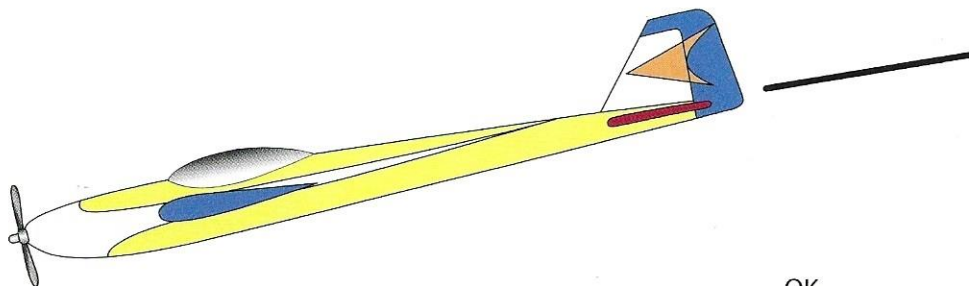
Vanquish looks great on the ground and is super smooth and accurate to fly



Figure 1



IF MODEL CLIMBS UNDER POWER
AND DIVES WHEN POWER IS REDUCED
ADD DOWNTHRUST



Another factor influencing this is the propeller choice. The amount of side thrust required will vary with different sizes. I had a few to try so I wanted to do that to settle on one size before making any changes to the thrust line. To cut a long story short I finally settled on an APC 20" x 13" E, which gave me a maximum current draw of 85 amps and still gave plenty of performance. I tried some lighter props but found that they gave a very non-linear power delivery across the throttle range. The 20" x 13" E still required some adjustment to the throttle curve via the transmitter to end up with a linear response but this is not unusual for electric systems.

CALM DOWN

Eventually, after many frustrating weeks of waiting a day of light winds arrived to give me a chance to fine-tune the trim. The requirement for more side thrust was confirmed and was corrected with a single plain washer behind each of the left-hand motor mounting lugs. The adjustment was so small that the spinner still appeared lined up with the nose ring so I felt there was no need to adjust the mounting position at the bulkhead. With this alteration, and the adjustment to the C of G, the Vanquish was already starting to feel really good. I still had some minor rudder interaction in roll and pitch, which could be removed with a little mixing.

It is possible to cheat a little on side thrust if a small adjustment is required by enabling a transmitter mix, with throttle as the master and rudder as slave. To do this, trim the rudder so that the model flies a straight vertical up-line at full power. Land and set the mixer so that as the throttle stick is

IF MODEL PULLS LEFT
ADD RIGHT SIDE THRUST

OK

IF MODEL PULLS RIGHT
ADD LEFT SIDE THRUST

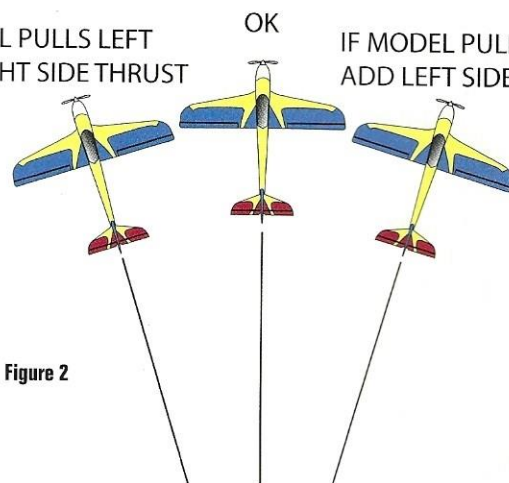
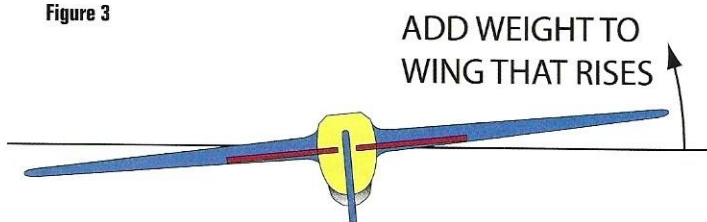


Figure 2

moved from full to idle the rudder trim reduces to zero. This will work pretty well if only a small amount of trim is required but in my experience it will never be as good as actually adjusting the side thrust angle.

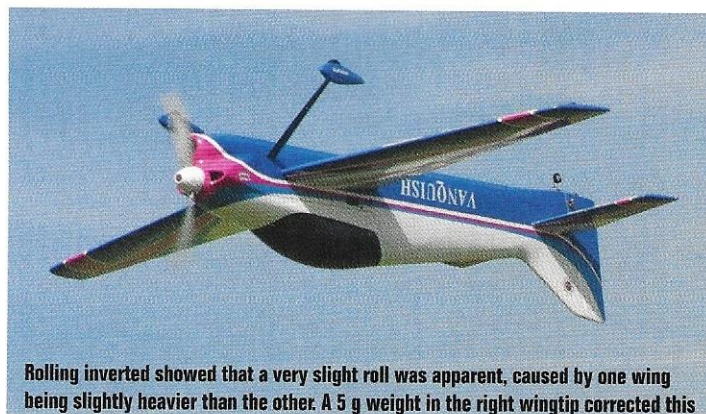
Another issue, which had now showed itself, was that with the model trimmed for upright level flight, rolling inverted showed that a very slight roll was apparent. This was caused by one wing being slightly heavier than the other. The reason being that when upright a small amount of aileron trim will be required to hold the heavy wing up. When inverted the trim acts in the same direction as the weight and the model rolls towards the heavy wing. To correct for this weight needs to be added to the wing that rises when inverted. If in doubt add weight to one wing, fly again and see if it is better or worse. After experimenting with small bits of lead temporarily stuck to the

Figure 3



ADD WEIGHT TO
WING THAT RISES

TRIM UPRIGHT, THEN
ROLL TO INVERTED



Rolling inverted showed that a very slight roll was apparent, caused by one wing being slightly heavier than the other. A 5 g weight in the right wingtip corrected this

If small aileron correction is required in loops set-up a mixer with elevator as master and aileron as the slave. You can then mix small amounts of aileron with elevator input in the required direction



wingtip, 5 g in the right wingtip corrected this issue. This was a very minor difference between the two wings and more than acceptable I would say.

STRAIGHT WING?

As the Vanquish was set-up with an incidence meter I already knew that the wings were very straight. But when trimming any model I use the following procedure to determine any adjustments that may be necessary.

Fly a few consecutive inside loops. You will probably find that you have to make aileron corrections one way to keep the model tracking straight. Make a mental note of which way you are correcting.

Now fly a series of outside loops and do the same. If you find that you are correcting with aileron in the same direction then I'm afraid that you have a warped wing. If you are correcting the opposite way then one wing panel is heavier than the other. The latter is easy to correct as described above but a warped wing can be more problematic. For correcting a warp the very best solution is to saw the wing in half at the root and rejoin it. Or with a two-piece wing the individual incidences will have to be adjusted. With a really severe warp the only real solution



I flew the Vanquish at a recent Wings & Wheels show and it was so windy that many pilots elected not to fly. But Vanquish flew fine in these conditions

is to throw it away and start again. However, if the correction required is small it is practical to correct the problem by setting up a mixer with your elevator as the master and aileron as the slave. You can then mix small amounts of aileron with elevator input in the required direction to correct the fault. Although this will help a great deal with a wing warp, in the end it is a bit of a compromise.

Of course, in reality, what you will probably experience is a combination of weight and warp. Trial and error time again. Try one at a time as described above and eventually you will find the right combination.

With the small wingtip weight and the benefit of setting up with the incidence meter I found no other adjustments were required for the Vanquish as it was now looping inside and out without correction.

CONTROL INTERACTION

I now moved on to look at correcting for control interaction. Starting with ailerons, when rolling the model should roll along its axis with no yawing effect. This is easiest to observe in a vertical climb. If it doesn't roll straight then you must adjust the differential (more up than down movement of each surface). You will need to determine whether to increase or decrease the amount of differential movement.

The way I do this is to establish the model in a true vertical climb – of course by now your model will hold that vertical line with no correction! Now perform a half roll. You will probably find that the model has yawed off line. Use the rudder to correct the yaw back to the vertical. Which way did you move the rudder? If you moved it in the same direction as you rolled then more differential is required i.e. more travel on the up going aileron. If you moved it the opposite way then less is required. So if you roll to the right and correct with right rudder then increase differential; roll to the right and correct with left rudder, less differential. You will probably find that a few adjustments are necessary before you find the correct setting. A computer radio with the necessary software makes this task a simple one. If you don't have the facility you will have to do this by altering your control linkage geometry.

There should be no interaction from the elevator as we have already dealt with correcting deviations during loops. However, if you find that you still have minor problems and can't face doing anymore trimming to the airframe it can usually be

removed using an elevator to aileron mixer as described earlier.

Finally we must deal with the rudder. Most aerobatic models exhibit some secondary effects of roll and pitch with rudder. The Vanquish has very little, as you would expect from a thoroughbred competition airframe, but it is very rare to find none at all. Rolling with rudder is mainly a result of the wing dihedral angle. If the model rolls in the same direction that rudder is applied then there is excessive dihedral. If it rolls in the opposite direction then you do not have enough. Without the benefit of electronic mixers the only way to correct this problem is to reset the dihedral angle. It is likely that this would have to be done more than once to find the correct angle. Not very practical but believe it or not that was how it was done with competition models back in the days of basic radios! With a computer radio all that is required is to set a free mixer, this time with rudder as the master channel and aileron as the slave. Adjust the amount and direction of the mix until there is no roll present when the rudder is used. It is useful to have someone standing beside you when you are flying to make a note of what is happening, as it is very easy to forget by the time you have landed.

Exactly the same process is followed to correct unwanted pitch with rudder although this can be more of a compromise, as the amount of pitch present will vary with the attitude of the model. With a well-designed airframe there should be very little pitch with rudder and it will be easily corrected with a mixer. As mentioned before a bad design can be improved with trimming and electronic mixing but will never be made good. If you have the patience, pitch interaction can often be removed by experimentation with a combination of adjustment of centre of gravity position and wing incidence. But for the small amounts required for the Vanquish the mixing option gives an acceptable result.

After a little experimentation with the Vanquish, I ended up with 2% up elevator mix with both left and right rudder to cure a very slight down pitch with rudder. For roll correction I settled on 4% left aileron with left rudder and 3% right aileron with right rudder as it was rolling very slowly to inverted in knife-edge flight, to both sides. These are very small numbers and more than acceptable for a model of this type, indicating that Extreme Flight have done their homework with the development of this airframe.



After a little experimentation I ended up with 2% up elevator mix with both left and right rudder to cure a very slight down pitch with rudder. For roll correction I settled on 4% left aileron with left rudder and 3% right aileron with right rudder

One final mix I like to use (assuming you haven't run out of available mixers) is an offset throttle to elevator mix. Even the best aerobatic models, after all trimming has been done, have a tendency to gradually pull out of a vertical dive. To correct this, if your radio has the facility to do so, set-up a mix with throttle as master and elevator as slave and offset the mix point to around two clicks above idle. Above this point there is no mix and below it a small percentage of down elevator is programmed (2% for the Vanquish). This will have the effect of holding the vertical line when the throttle is closed. The mix percentage is so small that you should not really notice the mix at any other time.

After carrying out the above steps, you will find a dramatic improvement through all manoeuvres, particularly slow and point rolls, as the model should track much straighter through the roll with no variation in roll rate as the rudder is applied. It may well still deviate from where you intend it to go, but now it will be more likely that you are the problem and not the model!

RCMW

Coming in to land after another demo flight at the windy Wings & Wheels show

