

# ABOUT TRIMMING YOUR MODEL

Reproduced with the kind permission of Brian Green from an article written by Peter Goldsmith ("The Great Waldo") for Brian's "RCM News" magazine.

Traditionally, the first thing you do with your latest aerobatic model is to trim it, so I feel it would be suitable to start off with a trimming article. For those of you with sports models, listen up --- a well trimmed sport model can fly lower inverted than a badly trimmed one, so don't assume that trimming is just for us pattern-heads. Even your latest slope gliding hot-dogger can be improved by good trim. Most modellers trim their models by just moving the transmitter trim levers until it flies straight, hands-off so to speak, but a well trimmed model should be correct in every axis... vertical, horizontal, track and yaw. A little patience and some common sense will give you these results.

Remember this: a good model is and always should be very easy to fly. Those that are hard to fly are not good ones. I've seen a well trimmed Ugly Stick beat a poorly set-up current pattern aircraft. So if you're wrestling with your latest model, and your loops are moving the judges out of their chairs (and people in the pits run for cover), your knife-edge flight is uncontrollable and your rolls are a little gooey, then trimming could be just what you need to make your flying more controlled.

The first thing and the most important thing is control set-up. How wonderful the modern computer radio is with all those mixes, ATV's end points and so on. But the computer quite often complicates the simplest of tasks: so many times I see servo throws as low as 40% of the stick value! This makes the model twitchy and difficult to fly. All throws should be as close to 100% as possible. This, with around 30% exponential added will give you a linear feel. This applies to yaw, pitch, and roll. What I mean by a linear feel is half stick movement will give you half reaction, 20% stick movement will give you 20% reaction. For example, let's say that full aileron deflection gives one roll of 360 degrees in one second (which I recommend), then half stick movement would give you one roll in two seconds. Another important consideration on controls is to balance the feel in pitch and roll: don't have a quick roll rate and a soft elevator. Balance them by adjusting the control surface throws.

I'm sure a lot of people are still using non-computer radios, and all this may seem irrelevant, but don't despair, there is still hope! A well set up standard radio with dual rates is still competitive, and more can be done during the construction of the aircraft. As an example, to improve the feel around centre, thicken your trailing edge---this is like an aerodynamic exponential. One warning about exponential, don't use too much, as in rough turbulent air you will have trouble controlling your aircraft. You shouldn't need any more than around 40 % except for rudder. A little more on rudder sometimes helps the mode one flier if they bump the rudder while pulling elevator (you could also tighten the rudder-centering spring in the gymbal - G.S.). So there you are, your controls are now set up. You have balanced your pitch with your roll, your model feels good and solid around centre, and flies more or less hands-off. Now we are ready to start trimming, and you thought I was finished!

The simplest way is to break the trimming up into its' individual elements:

1. Wing balance.
2. Dihedral.
3. Right thrust
4. Downthrust.
5. Differential.
6. Knife-edge tracking.
7. Power-off tracking.

Please note the order in which each axis is trimmed. Most trimming confusion is caused by trimming in the wrong order. For instance, how do you get your differential right if your right thrust is not correct? and so on. Start with a CofG around 34% of the average mean chord. You may feel you need to move it around a little from this position, but it's a great starting point. *The CofG position will have the least effect on the trimming of your aircraft.*

**1. Wing balance.** First on the list is wing balance. Before flying I recommend static balancing as this will save some time and move us closer to the optimum. This means the model should balance laterally when supported on the fuselage centre line (pick the model up by the fin & prop). Add weight to the lighter wingtip until it does so. Also make sure the elevators are correctly aligned, and giving the same deflection. If your model carries any aileron trim, then fix it. A twisted wing is the hardest thing to compensate for. The reason I moved to plug-in wings was to make them easier to align. Most trimming articles say 'pull up vertical and watch which wing drops'. May I suggest you dive the model vertical with power off and pull an abrupt corner. Position the aircraft so you can clearly see your wings, and of course pull out into the wind. If you have a wing weight problem, it will clearly show up (the heavy wing will be the low one). The reason for no power on a vertical downline should be obvious!

But if you pull up with power on, engine thrust may confuse the issue. With a vertically down idle-power pull out, only wing imbalance will show up. If you feel you have a weight problem, then sneak up on it. Add plasticine or nails to the light wingtip a little at a time until you can consistently pull out with your wings level. Another good reason for checking your wing weight this way is that from vertical to horizontal flight, your wings are always level no matter which way you are pointing. If you pull up from horizontal to vertical, your wings might not have been perfectly level: this will give a veer off and quite often confuses the issue. This process should take 5 to 10 flights; keep re-checking until you are perfectly happy.

**2. Dihedral.** This one's easy to find but harder to fix. Fly straight and *level*, and apply left or right rudder. Your model will probably pitch down when you do this, but don't worry, we'll fix that later. Now pay attention to the model in roll. If you have applied left rudder and your aircraft rolls left, then you have too much dihedral. If you applied left rudder and your model rolls right, then you guessed it, you don't have enough dihedral. As I said before, easy to find but harder to fix.

Some people put the model in knife edge to check this, but it's more accurate and easier to do it in level flight. If you have a one-piece wing, then saw through the top skin on the centre joint. If your model has too much dihedral then open it up with a small wedge and reglaze. If your wing has not enough dihedral then saw a taper in the joint and close the gap (assuming you have a balsa-skinned foam wing).

Move the wing 2mm. at a time, no more. That's one mm. at each wingtip. Don't be afraid to cut your wing! I would quite often have some quick-set epoxy and some glass cloth in my tool box when trimming a new model to save going back home to fix it. You can probably see another reason for plug-in wings. Yes, you simply bend the tube making sure it can't rotate in flight. Most aerobatic mid wing aircraft that have double-tapered wings have what is called a 'flat across the top' configuration. This means that at zero incidence (leading and trailing edges the same height off the board for a symmetrical section) your wing is flat across the top when upside down on your workbench. Your dihedral should be close assuming you have gone for the 'flat across the top' way.

**3. Right thrust.** The big boogey man of trimming. It's not that hard providing you use a little common sense. There are two things that are very important when checking right thrust. One is to make absolutely sure that you are pulling up into the wind. Two, and most important, *make sure your wings are level*. If your wings are 2 degrees out, your vertical lines will be 2 degrees out. It is best to pull up in such a position you can clearly see that your wings are level. Now pull a medium radius corner, making sure you don't bump any controls as you pull to vertical. If you have trouble bumping controls, then tighten the springs on the rudder stick for mode one, or aileron stick if you are a mode two flyer. You can back it off later when you are trimmed.

What we want to see is a clean 4 to 5 second vertical; you don't need to go to the moon nor to 20,000 feet -- just as high as the tallest maneuver. What I want you to do is to do many pull-ups and retrim with the rudder remembering to *keep the wings level*. Now the rule of thumb here is to halve the rudder trim and use that measurement to add to the right thrust. What I mean is, if after 50 *absolutely level* pull-ups you have 2 degrees of right rudder trim, then you add 1 degree of right thrust and centre your rudder trim. Keep doing this until you are happy.

Another little tip, it is better to have a little less than too much. Too much right thrust will cause barreling in rolls, and no amount of differential will fix it. Another tip, if you change propeller size your thrust may change, so try to

stick with the one prop. If you are not sure what prop to use, ask an experienced flyer for the most suitable prop size and then buy two, so that if you break one you can keep trimming.

**4. Down thrust.** Not as hard as right thrust, but still important. If your model is carrying any elevator trim then it would be a good time to fix this first as otherwise it may confuse the issue (adjust the elevator trim so the model goes truly straight down while in a power-off dive). Hopefully by now you are an expert at flying level and pulling vertical. You are going to need to be because I want you to pull vertical. When you pull vertical you only want to see the fuselage side as this will show up pitch trimming more precisely. If there is any wind at all, pull up as near to a 90 degree crosswind as you can get. The wind can be in your face or on the back of your head whichever you prefer, but calm conditions are always the best for trimming.

If the model pulls back towards the canopy, then increase the down thrust. If it pushes towards the undercarriage, then reduce the downthrust or even add upthrust. Once again, don't be afraid to cut the stab. out or pack the wing. It is far more important to have a well-trimmed model than just a pretty one. Hanno's models aren't what you would call pretty but they sure are trimmed well. CofG position is not the way to get rid of elevator trim, it actually has very little effect on it. So do it properly by re-aligning the incidences. Most modern aerobatic aircraft have 0 degrees stab. and wing incidence, and 0.5 to 1.5 degrees of downthrust.

**5. Differential.** Up until now we haven't used a fancy radio to solve our trimming problems and the case still exists, although the computer radio can save you some time. How to spot the differential problems? There are many ways to do this, so I'll keep it to the simplest way.

But before you even attempt to check the differential make absolutely sure that you have equal throws up and down, (and the same throws for each wing!), and always measure in degrees because it's more accurate than distance. Most of my models have 12 degrees up and 11 degrees down for each aileron. Pull to a 45 degree upline, into the wind of course, and roll to the right. Now watch very carefully which way the aircraft wanders. If you're rolling right and it wanders a few degrees to the right, the aircraft is positive barrelling and you need to increase the upgoing aileron travel on both sides. If you roll right and the model goes left then your model is adverse rolling or negative barrelling.

What you do here is increase the downgoing aileron travel on both sides. If you're using a computer radio, use two channels for ailerons so you can precisely move your ailerons to the desired throws. For those doing this with the older style radios, then it's a matter of changing the horn angles or redrilling the servo output wheels to achieve the results. Moving the pushrod attachment point on the servo wheel towards the rear will reduce the down travel (where the servo horns are on the top of the wing).

A tip: when initially installing your horns make sure all clevis attachments are over the hinge line, especially if you don't have a flashy radio to fix the geometry.

**6. Knife edge tracking.** Now this is definitely a job for that new flashy radio, but it can still be solved without a computer. Now when I talk of the old style radio I still mean proportional digital radio that is only pre-computer or PC! For those who may have trouble flying knife edge, it may be a good idea to get an experienced flyer to do it while you take notes. Put your aircraft into knife edge flight making sure you are exactly 90 degrees from level. Once again if you're out a few degrees then other controls will have an effect. What we want to achieve is rudder only input for knife edge flight.

If your aircraft moves in knife edge flight towards the canopy, then try lowering both ailerons two turns for a starter. If it moves towards the undercarriage, then raise both ailerons the same amount. If your aircraft pitches up one way and down the other way, you have a wing and stab. misalignment. Your vertical fin must be exactly 90 degrees to both wing and stab. and the wing and stab. must be in exactly the same alignment. This is something that should be checked and rechecked before the model is ever flown. It can take all day just to align wings, stab. and fin.

The only way to fix this without a computer radio is to realign everything, or simply fly out the problem. For those of you with a computer radio, the task is far simpler. Select a programmable mix function and use rudder as the master and elevator as slave, then simply add elevator in small increments until knife edge flight is achieved with rudder only. Most aircraft can be corrected with less than 5% mixing, so start with 2%, and then add to that as required. If you find your model is still rolling off in knife edge, then your dihedral may still be out slightly. To fix it, select another programmable mix and use rudder as master and aileron as the slave channel. Once again, small increments at a time. If you have set your dihedral as I have suggested you should need little to no mixing.

**7. Power off tracking.** This is the most overlooked trim aspect in aerobatics. Actually when I mention it most people don't even know what I'm talking about. When you pull the power off in level flight you will find your model will drop its' nose slightly and roll to the left. Yes, most models will roll to the left, and quite substantially in a lot of cases. This means that when your model is on a vertical down line your aircraft is rolling off and when you pull to level you could be as much as 10 degrees out. I have found that to fly level at all speeds in a propeller-driven aircraft, it has to be out of alignment by 1/4 of a degree. All my latest Lotus designs have a 1/4 degree right twist built into the wings. This is the only way I could achieve the same roll trim at all power settings. Others have now tried this and found it works.

The other problem is vertical down tracking. When in a dive, your model should track vertically down, and not pull out as many aircraft do. A good clean vertical looks much better than one with an arc in it. Also, if your model pitches up in a dive, it could pull back into the box and reduce the time you have between centre manoeuvres. The solution is really only for the computer radio, although the stab. height is the problem. If it pitches up in a dive, the stab. is too high and if it pitches down then the stab. is too low. Now after cutting your wing for dihedral and realigning the stab. for the thrust, you don't want to make any more mess, although you do become quite good at touch-ups. I think we will use the computer this time. For a roll off at low power, select another programmable mix and use throttle as master and ailerons as the slave. 1 to 3% mix is all that you need. Some radios have 'stick offset', if so then have the mix comes in at low throttle. For vertical down tracking, use another programmable mix having throttle as master and elevator as slave. Now you know what all those programmable mixes can be used for.

**And now for a little philosophy.** The better your aircraft is trimmed, the more consistent you will fly and the quicker you will progress. Not putting up with bad habits allows you to adapt to new designs quicker and also makes you a better pilot. So many times I see people change from one model to another trying to find the perfect model, and yet, often the problem is they never trimmed it properly. At seminars that I conduct, others have flown my model and commented on how my model flies better than theirs, thinking that I'm some super-builder. Nothing could be further from the truth, my building is what I call functional. The secret is that my model is trimmed better.

A great pattern flyer once said to me that victory comes from **enthusiasm, persistence, and ability** in that order. So don't give up, most of us have lots of enthusiasm, plenty of persistence, and lots of ability. We just need to harness it.

**Waldo.**