Trimming

model aircraft

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We wouldn't drive a car that drifted across the centre of the road. We wouldn't ride a bike at speed that had a warped wheel. We shouldn't fly our models that are not trimmed correctly.

For the newcomer

What does trimming mean? It means adjusting various settings on a model until it flies straight and level (SL) under cruise throttle or level gliding flight. For some, but not all, models it means you can take your fingers off the sticks and the model will fly SL.

What can we adjust?

- Centre of gravity
- The neutral positions of the control surfaces
- The throws on the control surfaces
- How much small stick movements move the control surfaces (sensitivity)
- Lateral balance
- The thrust line of the motor or engine
- The angle of attack of the wings and tailplane (incidence)
- The dihedral

What do we check?

- The flying surfaces for warp or misalignment
- The control surfaces to make sure they are solidly and freely hinged

Some of those are part of the design of a model. If you buy a ready to fly (RTF) model you should not find warps and the thrust line, angle of attack and dihedral should be correct. If you build a model or, even more, if you design and build, then all of the above are relevant. Even an RTF will need checking after you have crashed and repaired it.

Checking the soundness and freedom of the control surfaces should be part of your pre-flight checks.

Assuming that you have a new RTF model how do you set about trimming? A good start is to RTFM, a computing term meaning 'Read The Friendly Manual.' At least I think that's what the F stands for.

Basic trimming

Centre of Gravity (CG)
The manual will tell you where the model should balance, in other words where the centre of gravity should be. Often it will give a range. For the maiden flight it is best to set it to the most forward position. You can balance the model on your finger tips or preferably use a stand. Many foam models have the CG stamped into the wing underside. Another tip is to stick on the reinforcing rings used when filing sheets of paper where the CG should be. You can buy transparent ones to avoid spoiling your model. You can feel the holes with your fingertips. Move the batteries and radio equipment around till the CG is correct. If that does not work, add self adhesive steel weights, or even lead, to the extreme nose or tail to balance. You will need a lot less in the tail than the nose.

Neutral positions
The ailerons, elevator and rudder should be **exactly** in line with the flying surfaces, not ‘near enough’. Full size aircraft have small trim tabs. On our models the whole control surface must be moved for trimming so exactitude is crucial. The best way to adjust the position is to disconnect the servo linkage from the control horn and the turn the clevis until all is correct. Don’t forget to return the locking ring to the clevis. You can also adjust the position using the servo offset or bias if your transmitter (Tx) allows it. That will mean having the ailerons on separate channels. Yes, you can use the trim buttons on your Tx but it is far better to start correct.

Throw
This also called ‘weight’ or ‘rate’. If you have RTFM you will have found data about how far the control surfaces should move. There will usually be a maximum and minimum. It is normally given in millimetres but sometimes, less helpfully, in degrees. Set the throws to the minimum value for first flights. If your Tx allows you can add the higher value as well. You use a two-way switch as a rate switch and set the minimum as the ‘low rate’ and the maximum as ‘high rate’. If you set the throws higher than given in the manual the model might be beyond your ability to control.

Sensitivity
Most Txs allow you to vary the effect of stick movement. Movements close to the neutral point move the control surface less than the same movement farther away from the centre. This is called ‘expo’, and makes it easier to give gentler control when the model is close to stable. You would normally set expo to around 30 for low rate and to zero for high rate.

Lateral balance
This will probably only apply if you are using an engine set at an angle. Upright or inverted engines usually balance. Hold the model at the front of the propellor spinner or the nose and at the centre of the extreme tail. The model should not noticeably tip over. A small amount won’t matter but you might need to add a small weight to one wing tip to balance. Even an electric model is worth checking.

The maiden flight (ulp!)
We all feel a bit nervous at this point, but it’s only money (and pride). You could of course ask someone else to do the maiden flight but really it is best to do it yourself unless you are very nervous or the model is a big step up. Get the model into the air and find the throttle setting that gives level flight. Ideally have someone standing with you to observe and to move the trim buttons if you feel you can’t.

What to look for

Does the model turn with neutral sticks?
- It does but the wings stay level - adjust with rudder trim.
- The model banks - adjust with aileron trim.

Once correct land and adjust the servo linkages.

Does the model fly nose down when the stick is neutral?
Try up elevator trim.
Even if this fixes it you might need to move the CG back a little and try again.

Does the model fly nose up or porpoise?

Porpoising is when a model's nose goes up then down then up and so on, like a dolphin. It is usually the result of the CG being too far back. The big danger is that the model is close to a stall and might become difficult to control. Or perhaps the model flies steadily but looks nose up. Note that some models always fly nose up. Land and move the CG forward.

Does the model respond sluggishly?
Try the model at full throttle. It might be acceptably reponsive then. It could be that it is sluggish by design, perhaps as a trainer model. More likely the CG is too far forward or the throws are too small. Land and adjust the throws and try again. If that doesn't help move the CG back a little. Don't do both at once.

And now the advanced stuff – aerobatic aircraft

If you do all of the above you should now have a stable model that responds well to your control. If you are moving to a truly aerobatic model there are further things to think about. The model needs to be more neutral than for sport flying to reduce the corrections you need to make. The higher speeds make the control surfaces bite better too.

Thrust line
Most models will be designed with some right and down thrust.
Fly SL at half throttle.
Increase throttle to full

- Model climbs – increase down thrust
- Model dives – reduce down thrust
- Model turns left – increase right thrust
- Model turns right – decrease right thrust

Centre of gravity
Fly SL at full throttle
Start a 45 degree climb
Roll inverted and see if the model holds 45 degrees

- Down elevator needed – move CG back
- Model climbs – move CG forward

Incidence
From a good height, zero the throttle and dive in a straight line
Model's nose goes up – reduce wing incidence or increase tailplane incidence
Model's nose goes down – increase wing incidence or reduce tailplane incidence

Lateral balance
Fly directly towards you or away from you.
Pull a tight loop and a tight bunt.

- One wing drops on exit – add weight to high wing

Half roll to inverted at half throttle.

- One wing drops on exit – add weight to high wing

Aileron differential
This where the aileron moves up more than down. It can be twice as much.
Fly towards yourself.
Go into a vertical climb.

Half roll.

- Model turns in same direction as roll – increase differential
- Model turns in opposite direction as roll – decrease differential

D**ihedral**
This is the least likely to be needed as an aerobatic model is unlikely to have dihedral. Roll to knife edge with top rudder to fly level.

- Model rolls to inverted – increase dihedral
- Model rolls to upright – decrease dihedral

Gliders

These are different in two main ways.

First, having no motor they always glide downhill. Only if the air they glide through is moving upwards do they climb or maintain height.

Secondly they can fly in different modes at different times. When circling in a thermal they fly slowly close to a stall. When travelling across country they fly faster and in this mode they achieve their best glide angles. This is the distance they move forward in still air for a certain distance down. It can be as high as 40:1.

To achieve these modes a glider's wing aerofoil can often be varied. The under camber can be increased using a small amount of down flap and aileron for slow thermalling flight or moved slightly up for fast flight. This makes trimming more difficult, so the best approach is to trim for normal gliding flight using the basic trimming above. You will find that the recommended CG position is further back than on a powered aircraft. This can be at half chord or even further back. To get the very best out of your model use Brian Agnew's method below.

Some text is omitted from Brian's article and and my comments are in square brackets []

Centre of gravity (CG)
Charge your sailplane and get to bed early because we're getting up early enough to be out at the field 1/2 hour before dawn. If we're going to test our sailplane, we need the deadest air Mother Nature can provide. By the time you set up your winch and plane, there should be just enough light to launch. It is imperative to get consistent launches, but if you can't zoom consistently, don't, just let the line fall. [For electric gliders use your vario to start gliding at an identical height each time.]

Time every flight. Each flight should be as hands off as possible and in straight lines to the limits of your vision. Go straight out and straight back 'til touchdown. [On a smaller field turn at the same points on each circuit.] Record your times.

After each flight, change your elevator trim to max[imise] your time.

Once the optimum elevator setting (longest flight) is found, remove 1/8th oz [3 g exactly but use 5 g weights.] of nose weight and start over, again. [If there is none in the nose use 1 g weights on the tail.] Every flight should be flown as close to minimum sink as possible. This is closer to a stall than you probably realize. It usually takes 3 - 4 flights to find the best elevator trim after removing weight. If the air is dead and you are launching

consistently, your flights are going to get longer and longer as you remove weight from the nose and you are going to think, "There is no end to this process," until all of a sudden, your timer peak will start to suffer.

What happens is simply that as the performance of your sailplane increases, your sailplane's stability decreases. This is the trade-off. You don't get something for nothing as they say. You will notice that as you remove weight from the nose, the performance (dead air times) increases, but at the same time you are having to put in more control input to keep the sailplane flying straight and at minimum sink. Eventually, the airplane requires so much input that the drag from the constantly moving control surfaces brings your Thermal Wonder 1500 down to Earth sooner. Put weight back into the nose until you reach your maximum dead air flight time and call it good. You will never have to wonder about your C.G., again, only your elevator trim.

The rich are not useful for much. However one thing they have done is to answer Plato's question, 'How should men live?' The day should begin at 10 am. Before that the streets aren't aired. The bit of Brian's excellent article involving getting up during the night is not for me. However the message I get from it is that we should keep moving the CG back until the instability means that we increase drag by constant corrections. Having started out flying A2/F1a freeflight gliders with the CG at mid-chord I always think the CGs specified for gliders are too far forward.

Some argue that to fly with a rearward CG you should reduce the decalage or longitudinal dihedral. In other words adjust the angles of attack of wing and tailplane perhaps to make them equal. An excellent account of doing this for a Radian glider is in: https://youtu.be/E5dQVqPivXY

Sources

For aerobatics: thanks to Great Britain R/C Aerobatic Association

For gliders: Thanks to a1997 Radio Control Soaring Digest article by Brian Agnew https://www.rcsoaringdigest.com/Trimming.html

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