# Trimming Wright Stuff Airplanes

**Overview:**

While there is a science to trimming, there is also an art. Many steps and observations in trimming are based on common experience of indoor flying. However, the specific airplane configuration can impact the trimming decisions and results. The bottom line is that we trim for maximum time on the clock. Nothing else matters!

Overall, the plane must be trimmed for stable and consistent climb, cruise, and letdown, in order to maximize the use of the given rubber and propeller. In addition, the plane must go in a circle, as the room size is limited. It is hard to separate the act(s) of trimming from the rubber, propeller, and plane stability. Here we will specifically cover trimming steps, but please refer back to the lesson on stability, and forward to the lesson(s) on rubber and props.

**Vertical Trim:**

In general, the plane is trimmed for a good cruise and letdown, without stalling. The majority of the flight is consumed in these two, slower stages. Therefore, a plane with the trim adjusted for climb (faster, more power) will suffer in the longer later stages. Trimming without active control is a balancing act between the three stages of flight.

Vertical trim is primarily adjusted through wing or tail incidence. Our plane only has wing incidence adjustment (though we have played a bit with tail incidence by gluing in spacers). Most kits are similar. Some allow stabilizer incidence adjustments. We do short flights at lower power to observe the late-flight characteristics, and make adjustments. If the plane is stalling, we reduce incidence (lower the leading edge of the wing), reducing the angle of attack of the wing. If the plane is not stalling, we increase the wing incidence until it just starts to stall, and then reduce it a bit.

Another term is “decalage”, the angular difference between the wing and tail incidence. This affects the low powered portions of flight. We are adjusting the wing incidence, which in turn adjusts the decalage.

How much is a “bit”? Conventional wisdom says reduce it just enough to eliminate stall. Some years, a more optimum trim is attained with a lower wing incidence, leading to faster flight speed without increasing climb. This is particularly true in years with small propellers. This can only be determined through flights with a stopwatch. We have found that reducing the wing incidence about 2mm (in years requiring fast flight) from the “no stall” condition leads to slightly better overall flight times. This is equivalent of about a 1 degree change in decalage. In this situation, the plane will fly a little faster and flatter, which seems to fit the small propeller better. With larger propellers, the reduction in incidence to eliminate stall may only be 1mm, and the plane will fly slightly nose high. This will slow the speed of the propeller which in turn increases duration.

Once vertical trim is set, then motor torque at launch, for a given prop, will determine altitude of the flight. After initial climb, we watch for consistent and long cruise, followed by slow letdown. Failure to cruise, or a fast letdown, may be indicative of trim issues (not enough decalage), or too weak a rubber for the given propeller.

**Stability:**

We learned in a prior lesson about stability. The more stable a plane, the more forgiving it is of disturbances, whether air pockets or girders. However, increasing stability by moving the CG forward also requires more decalage, which means more drag, and could result in a shorter flight.

If we could guarantee no disturbances, we would set up the plane with neutral stability. However, as we have seen we cannot expect a lack of disturbances. Therefore, we want "sufficient" stability. As a starting point, this can be obtained by looking at the decalage after vertical trimming is completed. If it is larger than 3 degrees (typically 6mm wing incidence if the tail is flat, depends on the chord of your wing), then the CG is likely too far forward. If it is less than 1.5 degrees (typically 3mm wing incidence), then the CG is likely too far aft. The only real way to tell is to observe the plane after a disturbance. If a girder strike results in a loss of more than 3-5 feet of altitude, you will likely benefit from more stability (move CG forward or wing back). If it hardly drops at all, you will likely benefit from reducing stability.

This highlights another approach to trimming. On could set up a goal decalage by setting the wing incidence, and then move the clay ballast to trim the plane, instead of moving the wing.

**Circular Flight Path:**

There are a number of factors that contribute to the circular flight path:

- Propeller torque: The propeller torque wants to roll the plane to the left (every action has an equal and opposite reaction). This is the primary reason we want to turn left, because the plane naturally wants to turn left.
- Rudder offset: The rudder offset will turn the plane in part due to the angle the air hits the rudder, but also by presenting the right dihedral plate to the breeze, rolling the plane inward (to the left). Rudder offset is most effective at higher speeds, in the early portion of the flight.
- Stab tilt: The stab lifts, like a wing. A slight stab tilt to the outside lifts the rear of the plane not only upward, but also outward, resulting in a left turn. Stab tilt is most effective at lower speeds, in the cruise and letdown.
- Thrust line: A slight left thrust can be added to help turn at high torque. Thrust line has similar impact as rudder offset, but may not cause as much roll from coupling of the dihedral.
- Left Wing Wash In: This is a slight twist built into the wing, intended to counter the roll to the left. The left wing has slightly more incidence than the right wing
- Left wing length: the left wing is slightly longer than the right, to also help counter the roll to the left. This is accomplished by shifting the wing on the mounting posts in construction.

In general, we start with about 1cm stab tilt, 3 degrees of rudder offset, and 3 degrees of thrustline. In order to counter the rolling of both the propeller torque and the rudder offset coupling to dihedral, we make the left wing slightly longer than the right wing, making the plane want to roll left. This is typically about 1-2cm offset of the wing, making the left wing about 2-4cm longer than the right wing.

If the early portion of the flight is too tight a turn, one must observe the character of the flight. If the left wing is low (rolling in), then increase the wash-in or the left wing length. If just tight but not terribly rolled in, try decreasing the rudder offset. Note: Excessive rudder offset is a real "drag", as it points the right wing tip into the breeze, causing not only roll, but substantial drag. Therefore, if the wash-in is not excessive, start with reducing rudder offset to resolve tight circles. A very exaggerated rudder offset will cause a roll inward as well. If the rudder offset is reduced to very little, consider reducing the propeller thrust line offset.

If the cruise and let-down portion of the flight is tight, decrease stab tilt. You will notice a change (increase or decrease) in circle size about mid-flight, and can separate the issues based on this.

Note that when you change the size of the circle, you essentially change the incidence of the wing presented to the breeze, and so you MUST re-trim the vertical flight after you change circle size! It all works together! In addition, if the circle size seems to vary greatly even after fixing the relative stab tilt and rudder offset, the plane may need more stability. A lack of stability adds un-predictability to all phases of flight!

**A few notes:**

- Trim is speed-dependent. Therefore, changing the propeller and/or rubber may impact the trim, especially the climbing circle. However, cruise and letdown should not be affected strongly. If the rudder offset is changed because of climb, you will need to check the vertical trim as well
- Generally, do NOT change the vertical trim to fix or adjust climb. Only cruise and letdown
- If climb is radically steep or shallow, one can change the vertical thrustline by changing the incidence of both the wing and tail without changing the decalage. This has seen limited results.
- Ideally, the climb phase is stretched out over 3-6 laps. However, with the relatively heavy weight of the SO planes, you may see a stronger climb, even 1-2 laps. In years with small props, this is pronounced. If larger props are utilized, the climb can still be controlled.
- It is critical to add or subtract weight during check-in at the CG. Otherwise, trim changes!
- Initial trim flights should be done with proper (low) torque to simulate late flight characteristics. We have made the mistake of too much rubber motor winds during test flights, limiting the portion of the flight observed for stall.
- Set vertical attitude (stalling, diving, mushing) and circle size (tail tilt, maybe rudder offset) at low torque (low winds)
- AFTER low power is resolved, work on climb. As needed adjust left wing wash and possibly thrustline and rudder offset
- After any changes, go back to low power flight and get that right first!
- On short-coupled planes (such as 2023 Div C), very small adjustments of the CG location, followed by optimization of the trim, can have notable impact on the clock