The Dead Stick Flyer

Newsletter of Swan Harbor RC

Volume 33, Number 3, March 2022

www.swanharborrc.com

Tech Talk – Trimming Your Plane

As a continuation of our monthly Tech Talk discussions, this month Steve led a discussion from two articles, presented below, on how to Trim Your Plane. This process is not simply the routine trimming you would do right after taking off and then adjusting the up or down trims on the elevator or left or right trims on the ailerons. It would involve a sequence of flight patterns and maneuvers designed to determine the true flight performance based on the actual construction and flight characteristics of your plane. Once you set your mind to following this trimming method it is highly recommended to do it in the exact sequence and flight patterns noted. However, for the more experienced pilot, if you notice that your plane is doing something identified in one of the trimming tests, you could try to improve your plane's flight performance by performing that individual test.

1st Article:

FLIGHT TRIMMING

This article was reprinted and provided in part by the Great Planes Model Manufacturing Company, courtesy of Scale R/C Modeler magazine, Pat Potega, Editor, August 1983 issue of the magazine.

A model is not a static object. Unlike a car, which can only hunt left or right on the road (technically, a car does yaw in corners, and pitches when the brakes are applied), a plane moves through that fluid we call air in all directions simultaneously. The plane may look like it's going forward, but it could also be yawing slightly, slipping a little and simultaneously climbing or diving a bit! The controls interact. Yaw can be a rudder problem, a lateral balance problem or an aileron rigging problem. We must make many flights, with minor changes between each, to isolate and finally correct the problem.

The chart accompanying this article is intended to serve as a handy field reference when trimming your model. Laminate it in plastic and keep it in your flight box. You just might have

a need to consult it at the next contest! The chart is somewhat self-explanatory, but we will briefly run through the salient points.

First, we are assuming that the model has been C.G. balanced according to the manufacturer's directions. There's nothing sacred about that spot, frankly, it only reflects the balance point where a prototype model handled the way the guy who designed it thought it should. If your model's wing has a degree more or less of incidence, then the whole balance formula is incorrect for you. But it's a good ballpark place to start.

The second assumption is that the model has been balanced laterally. Wrap a strong string or monofilament around the prop shaft behind the spinner, then tie the other end to the tail wheel or to a screw driven into the bottom of the aft fuse. Make the string into a bridle harness and suspend the entire model inverted (yes, with the wing on!). If the right wing always drops, sink some screws or lead into the left wing tip. You may be surprised to find out how much lead is needed.

At this point the model is statically trimmed. It's only a starting point, so don't be surprised if you wind up changing it all. One other critical feature is that the ailerons must have their hinge gap sealed. If shoving some Scotch tape or Monokote into the hinge gap to prevent the air from slipping from the top of the wing to the bottom, and vice-versa, bothers you, then don't do it.

To achieve the maximum lateral trim on the model, the hinge gap on the ailerons should be sealed. The easiest way to do this is to disconnect the aileron linkages and fold the ailerons as far over the top of the wing as possible (assuming they are top or center hinged). Apply a strip of clear tape along the joint line. When the aileron is returned to neutral, the tape will be invisible, and the gap will be effectively sealed. Depending on how big the ailerons are, and how large a gaping gap you normally leave when you install hinges, you could experience a 20 percent increase in aileron control response just by this simple measure.

Your first flights should be to ascertain control centering and control feel. Does the elevator always come back to neutral after a 180° turn or Split-S? Do the ailerons tend to hunt a little after a rolling maneuver? Put the plane through its paces. Control centering is either a mechanical thing (binding servos, stiff linkages, etc.), an electronic thing (bad servo resolution or dead band in the radio system), or C.G. (aft Center of Gravity will make the plane wander a bit). The last possibility will be obvious, but don't continue the testing until you have isolated the problem and corrected it.

Let's get down to the task of trimming the model. Use the tachometer every time you start the engine, to insure consistent results. These trim flights must be done in calm weather. Any wind will only make the model weathervane. Each "maneuver" on the list assumes that you will enter it dead straight-and-level. The wings must be perfectly flat, or else the maneuver will not be correct and you'll get a wrong interpretation. That's where your observer comes

in. Instruct him to be especially watchful of the wings as you enter the maneuvers. Do all maneuvers at full throttle. The only deviation from this is if the plane will routinely be flown through maneuvers at a different power setting.

Let's commence with the "engine thrust angle" on the chart. Note that the observations you make can also be caused by the C.G., so be prepared to change both to see which gives the desired result. Set up a straight-and-level pass. The model should be almost hands-off. Without touching any other control on the transmitter, suddenly chop the throttle. Did the nose drop? When you add power again, did the nose pitch up a bit? If so, you need some down thrust, or nose weight. When the thrust is correct, the model should continue along the same flight path for at least a dozen plane lengths before gravity starts to naturally bring it down.

Do each maneuver several times, to make sure that you are getting a proper diagnosis. Often, a gust, an accidental nudge on the controls, or just a poor maneuver entry can mislead you. The thrust adjustments are a real pain to make. On most models, it means taking the engine out, adding shims, then reassembling the whole thing. Don't take shortcuts.

Don't try to proceed with the other adjustments until you have the thrust line and/or C.G. correct. They are the basis upon which all other trim settings are made.

Also, while you have landed, take the time to crank the clevises until the transmitter trims are at neutral. Don't leave the airplane so that the transmitter has some odd-ball combination of trim settings. One bump of the transmitter and you have lost everything. The trim must be repeatable, and the only sure way to do this is to always start with the transmitter control trims at the middle.

The next maneuver is somewhat trickier than it looks. To verify C.G., we roll the model up to a 45° bank, then take our hands off the controls. The model should go a reasonable distance with the fuse at an even keel. If the nose pitches down, remove some nose weight, and the opposite if the nose pitches up. The trick is to use only the ailerons to get the model up at a 45degree bank. We almost automatically start feeding in elevator, but that's a no-no. Do the bank in both directions, just to make sure that you are getting an accurate reading of the longitudinal balance.

We now want to test the correct alignment of both sides of the elevator (even if they aren't split, like a Pattern ship's, they can still be warped or twisted).Yaw and lateral balance will also come into play here, so be patient and eliminate the variables, one-by-one. The maneuver is a simple loop, but it must be entered with the wings perfectly level. Position the maneuver so that your assistant can observe it end-on. Always loop into the wind. Do several loops and see if the same symptom persists? Note if the model loses heading on the front or back side of the loop. If you lose it on the way up, it's probably an aileron problem, while a loss in heading on the way back down is most likely a rudder situation.

Note that the Yaw test is the same looping sequences. Here, however, we are altering rudder and ailerons, instead of the elevator halves. We must repeat that many airplanes just

will not achieve adequate lateral trim without sealing the hinge gaps shut. The larger you make the loops (to a point), the more discernable the errors will be.

The Lateral Balance test has us pulling those loops very tightly. Pull straight up into a vertical and watch which wing drops. A true vertical is hard to do, so make sure that your assistant is observing from another vantage point. Note that the engine torque will affect the vertical fall off, as will rudder errors. Even though we balance the wing statically before leaving for the field, we are now trimming it dynamically.

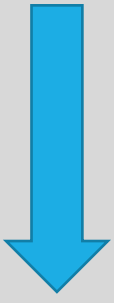
The Aileron Coupling (or rigging) is also tested by doing Hammerheads Stalls. This time, however, we want to observe the side view of the model. Does the plane want to tuck under a bit? If so, then try trimming the ailerons down a small bit, so that they will act as flaps. If the model tends to want to go over into a loop, then rig both ailerons up a few turns on the clevises. Note that drooping the ailerons will tend to cancel any washout you have in the wing. On some models, the lack of washout can lead to some nasty characteristics at low speeds.

Again, we reiterate that all of these controls are interactive. When you change the wing incidence, it will influence the way the elevator trim is at a given C.G. Re-trimming the wing will also change the rigging on the ailerons, in effect, and they may have to be readjusted accordingly.

The whole process isn't hard. As a matter of fact, it's rather fun — but very time consuming. It's amazing what you will learn about why a plane flies the way it does, and you'll be a better pilot for it. One thing we almost guarantee, is that your planes will be more reliable and predictable when they are properly trimmed out. They will fly more efficiently and be less prone to doing radical and surprising things. Your contest scores should improve, too.

We wish to acknowledge the Orlando, Florida, club newsletter, from which the basics of the chart presented here were gleaned.

Reference the Flight Trimming chart below.



TRIM FEATURE	MANEUVERS	OBSERVATIONS	CORRECTIONS
CONTROL CENTERING	Fly general circles and random maneuvers.	Try for hands off straight and level flight.	Readjust linkages so that Tx trims are centered.
CONTROL THROWS	Random maneuvers	A. Too sensitive, jerky controls. B. Not sufficient control.	If A, change linkages to reduce throws. If B, increase throws.
ENGINE THRUST ANGLE[1]	From straight flight, chop throttle quickly.	A. Aircraft continues level path for short distance. B. Plane pitches nose up. C. Plane pitches nose down.	If A, trim is okay. If B, decrease downthrust. If C, increase downthrust.
CENTER OF GRAVITY LONGITUDINAL BALANCE	From level flight roll to 45-degree bank and neutralize controls.	A. Continues in bank for moderate distance. B. Nose pitches up. C. Nose drops.	If A, trim is good. If B, add nose weight. If C, remove nose weight.
SPLIT ELEVTORS (Also Yaw and CG)	Into wind, pull open loops, using only elevator. Repeat tests doing outside loops to inverted entry.	A. Wings are level throughout. B. Be planes tends toward outside when right side up, and to the inside when inverted C. Plane goes in on regular loops and out on inverted. D. Plane goes out on both types of loops. E. Plane goes in on both types of loops.	If A, trim is fine. if B, add weight to right wing or add right rudder If C, add weight to Left wing, or add left rudder If D, raise right half of elevator (or lower left) If E, raise left half of elevator (or lower right)
YAW[2]	Into wind, do open loops, using only elevator. Repeat tests doing outside loops from inverted entry.	A. Wings are level throughout. B. Yaws to right in both inside and outside loops. C. Yaws to left in both inside and outside loops. D. Yaws right on inside and left on outside loops. E. Yaws left in insides, and right on outside loops.	If A, trim is correct. If B, add left rudder trim. If C, add right rudder trim. If D, add left aileron trim. If E, add right aileron trim.
LATERAL BALANCE	Into wind, do tight inside loops.	A. Wings are level and plane falls to either side randomly. B. Falls off to left in loops. Worsens as loops tighten. C. Falls off to right in loops. Worsens as loops tighten.	If A, trim is correct. If B, add weight to right wing tip. If C, add weight to left wing tip.
AILERON RIGGING	With wings level, pull to vertical climb and neutralize controls.	A. Climb continues along same path. B. Nose tends to go to inside loop. C. Nose tends to go to outside loop.	If A, trim is correct. If B, raise both ailerons very slightly. If C, lower both ailerons very slightly.

1. Engine thrust angle and C.G. interact. Check both.
2. Yaw and lateral balance produce similar symptoms. Note that fin may be crooked. Right and left references are from the plane's vantage point.

2nd Article:

"Trimming Your Plane" by Peter Goldsmith

You can trim the grass, trim the turkey, or even trim the tree, but in the RC world, "trimming" is mostly thought of as something you do with a new plane on its first flight to get it to fly straight and level, with hands off. "It may have needed a few clicks of up elevator and/or a few clicks of right or left aileron and it was good to go" is a phrase you may have heard or something pretty close to that.

But is there more that you can do to get your plane to fly better? This article will describe a systematic process that will make your aerobatic RC model fly better and allow you to fly better. This article will describe the trimming process developed by Team Horizon manager and TOC competitor Peter Goldsmith and what follows is a description of his "system."

Several years ago, a friend of mine, Mike Hurley, was writing the Scale Aerobatics column in the AMA magazine and he interviewed Peter and published his techniques. That's when I was first exposed to this great trimming process. I'll be borrowing very heavily from Mike's article. If you Google "Peter Goldsmith trimming article" you'll find it but it's pretty long and I'm going to try to give you the short version.

About The Trimming Process

The first thing that Peter says is that you won't ever find a perfectly trimmed plane and so that's not the goal. It's pretty much impossible to do. The goal is to reduce the pilot workload so that you can concentrate on putting the plane where you want it to go and not spend energy fighting against what the plane is trying to do.

Another important note is that you must follow the recommended steps in the order shown. Each time you change something on the plane it can affect it in ways you aren't expecting. For example, balancing the plane or determining the correct center of gravity (or CG) is the first step. If you get halfway through the balancing process and change the CG you have to start over at the beginning because the new CG has thrown off the other adjustments you've made.

This trimming process is intended for aerobatic planes (scale aerobatic planes like an Extra, Yak, etc.) and pattern planes. It may apply for other types of planes too.

To fully take advantage of this trimming process you'll need a radio that has the ability to "mix" channels. An example of a mix is when you input rudder, the rudder moves as commanded but the elevator adjusts ever so slightly as well. Most radios these days have at least basic mixing capabilities.

You have to commit to the process. By that I mean it takes a lot of flights to get through it. It can take several flights on the plane just working on the first step: adjusting CG. You won't get it done in one day or even a week. Work on parts over time and go at your own speed. I've spent weeks trimming out a plane, dedicating a flight each time I come out the field to trimming and working down the list.

<u>Servos and Linkages</u>

Of course, the better the servos you use, the better your plane can perform. By better I mean…

- ***How fast is the servo (a faster servo is better)***
- ***How well does the servo center (does the servo center exactly at the same place every time you neutralize the transmitter's stick?)***
- ***How much torque does it putout (more torque the better)?***
- ***What kind of servo resolution do you have (the finer the better and this can be influenced by linkage setup)?***

You don't necessarily need to buy the best, most expensive servos you can find. There are many fine servos available now and it really boils down to what you want for yourself and the trimming process will benefit you regardless of the servos you use. You want tight, slop free linkages and strong pushrods that don't flex.

No matter what servos you use or what linkages you have, setting them up mechanically so that you're realizing the full potential of your servos is easy and important. For example, don't use a longer servo arm than necessary and then restrict the servo throw in order to achieve the surface deflection you want (this also reduces servo resolution). Instead, connect your pushrod as close as you can to servo center while maxing out the servo travel for more leverage and tighter servo resolution while getting the surface travel you need.

How much surface travel should you have? That can be a personal preference but I find for normal aerobatics (not 3D) I do not need any more than 10-15 degrees of elevator, maybe 20-25 degrees of aileron and 30-35 degrees of rudder to start out and then adjust as I get used to the plane.

The Process and The Order:

1) <u>Nose to Rudder Balance</u>: Adjusting for proper Center of Gravity (CG) on the wing:
   a. Is the plane nose heavy, tail heavy, or just right?

2) <u>Lateral Balance</u>: Is one wing heavier than the other?

3) <u>Engine thrust</u>: right/left

4) <u>Engine thrust</u>: up/down

5) <u>Aileron Differential</u>: how much "up deflection" vs. "down deflection" in your ailerons

6) <u>Throttle to Aileron mix</u>: When you move the throttle, the aileron trim adjusts

7) <u>Throttle to Rudder mix</u>: when you move the throttle, the rudder trim adjusts

8) <u>Rudder to Aileron mix</u>: when you move the rudder stick the aileron trim adjusts

9) <u>Rudder to Elevator mix</u>: when you move the rudder stick, the elevator trim adjusts

10) <u>Down line mix</u>: making adjustments so that when the nose is pointed straight down the plane continues to maintain that straight line down and doesn't pull out on its own.

Let's get started: remember, follow the steps in the order from 1 to 10

Trimming Step	*Maneuver*	*What To Look For*	*What To Do*
1. Center of Gravity (CG)	*Pull to 45 degree up-line, release elevator, observe flight path*	*A. Nose rises* *B. Nose gently falls* *C. Nose falls quickly*	*A. CG too far aft, add nose weight* *B. CG is just about right* *C. CG too far forward, add tail weight*
Notes: • *Start with the "recommended" CG for your model* • *CG is largely a matter of preference- once you get to "about right" you can adjust to your comfort level* • *For precision aerobatics, a little nose heavy is better than a little tail heavy* • *If your model is very sensitive in pitch with minimal control throw, you are probably tail heavy*			

Trimming Step	*Maneuver*	*What To Look For*	*What To Do*
2. Dynamic Balance ("Heavy Wing")	*Starting high, push to a vertical down line and throttle back, after about 3-4 seconds pull sharply to upright- observe if one wing drops- do this several times*	*A. Left wing consistently drops* *B. Right wing consistently drops* *C. Wings remain level*	*A. Add some weight to the right wingtip* *B. Add some weight to the left wingtip* *C. Nothing- you're good*
Notes: *When you pull, pull hard enough for a tight quarter loop to upright but not so hard that the plane will snap* *Be careful not to input any aileron when pulling back on the elevator*			

Trimming Step	Maneuver	What To Look For	What To Do
3. Engine Thrust- Right/Left	*Fly overhead directly into any wind, pull to a vertical up-line, and observe model as it climbs without giving any corrections*	*A. Plane veers to right* *B. Plane veers to left* *C. Plane continues on a straight line*	*A. Add left thrust* *B. Add right thrust* *C. Nothing- you're good*

Notes:

- *Works best when you have a wind coming straight at you (crosswind) and you can fly straight away, pull up and see the top of the plane*
- *Typically, any aerobatic plane will start out with some right thrust- a 2-3 degrees and sometimes "adding left thrust" is actually done by removing some of the right thrust*
- *Keep adjusting until you can get long extended up-lines with the plane continuing to climb without veering one way or the other*

Trimming Step	Maneuver	What To Look For	What To Do
4. Engine Thrust- Up/Down	*Fly straight and level across the field at high throttle making sure that the plane is trimmed for level flight- quickly chop the throttle and observe flight path*	*A. Plane pitches up* *B. Plane pitches down* *C. Plane remains level and slowly begins to lose altitude due to reduced speed*	*A. Add up thrust, re-trim for level flight, retest* *B. Add down thrust, re-trim for level flight, retest* *C. Nothing- you're good*

Notes:

- *When you have too much down thrust and trim for level flight you are carrying unnecessary up elevator trim to maintain altitude when flying with power. This condition shows itself when you cut the power. Once you add up thrust to correct you'll end up needing to take out some or all of the up elevator trim- you'll see that when you retest*

Trimming Step	Maneuver	What To Look For	What To Do
5. Aileron Differential *Ailerons have more throw in one direction versus the other* *example: ailerons have 20 degrees of up deflection but only 15 degrees of down*	*Fly overhead directly into the wind or downwind, pull to a 45 degree up line, give full left aileron and perform one roll*	*A. The plane "walks to the left"* *B. The plane "walks to the right"* *C. The plane remains on the same line*	*A. Reduce down aileron throw* *B. Reduce up aileron throw* *C. Nothing- you're good*

Notes:

- *Differential is required when the drag of the "up-going" aileron is different that he drag of the "down going" aileron*
- *The example above was with left aileron- do it both ways and fix for both right and left aileron*

Trimming Step	*Maneuver*	*What To Look For*	*What To Do*
6. Throttle to Aileron Mix	*Climb to high altitude, fly overhead go to idle and push to a down line. Hands off the sticks and watch for any rolling before pulling out*	*Look to see if the plane rolls at all on the down line*	*Set up a mix in your radio so that the aileron trim changes at the low throttle settings*

Notes:

- *Most planes require a little bit of right trim at high throttle due to the rotation of the propeller – it wants to ever so slightly roll to the left (the opposite direction of the rotation of the propeller)*
- *The trim you put in for high throttle isn't needed at reduced throttle settings so you set up your radio so that the trim goes away as you reduce the throttle*

Trimming Step	*Maneuver*	*What To Look For*	*What To Do*
7. Throttle to Rudder Mix	*Climb to altitude, fly overhead, into the wind and push to a vertical down line for a few seconds- observe the plane*	*A. Plane veers to the right* *B. Plane veers to the left* *C. Plane continues to flight straight down*	*A. Mix in a little bit of left rudder that doesn't activate until near idle* *B. Same but right rudder* *C. Nothing- You're good*

Notes:

- *Assuming you bothered to trim for yaw (rudder) – most don't, your plane is likely trimmed for high throttle settings. At reduced throttle settings, the plane is likely to yaw differently*
- *This is a good mix to have active at only lower throttle settings (no mix at high throttle- it kicks in when you get below, say, half throttle)*

Trimming Step	*Maneuver*	*What To Look For*	*What To Do*
8. Rudder to Aileron Mix	*Fly wings level across the field in front of you then apply and hold right rudder*	*A. Plane slowly rolls to the right* *B. Plane slowly rolls to the left* *C. Plane does not roll*	*A. Mix in some left aileron with right rudder, retest* *B. Mix in some right aileron with right rudder, re-test* *C. Nothing- you're good*

Notes:

- *Description above is for right rudder – you'll need to trim left rudder too. It works the same.*
- *Most people actually do this test on knife edge- but it's easier and just as effective to do it from level upright. You can do it both ways- knife edge or upright- to be thorough*
- *You usually need in the neighborhood of 3%-8% mix to eliminate rolling with rudder*
- *The safest way to make adjustments is to land, secure the plane, make the mix adjustment on the ground, take off and retest- repeat until satisfied*

Trimming Step	*Maneuver*	*What To Look For*	*What To Do*
9. Rudder to Elevator Mix	*Fly wings level across the field in front of you then apply and hold right rudder*	*A. Plane pitches down* *B. Plane pitches up* *C. Plane does not pitch*	*A. Mix in some up elevator with right rudder, retest* *B. Mix in some down elevator with rudder, retest* *C. Nothing- you 're good*

Notes:

- *Description above is for right rudder – you'll need to trim for left rudder too. It works the same.*
- *Most people actually do this test on knife edge- but it's easier and just as effective to do it from level upright*
- *You can do it both ways- knife edge or upright- to be thorough*
- *You usually need in the neighborhood of 3%-8% mix to eliminate pitching with rudder*
- *The safest way to make adjustments is to land, secure the plane, make the mix adjustment on the ground, take off and retest- repeat until satisfied*

Trimming Step	*Maneuver*	*What To Look For*	*What To Do*
10. Down Line Mix	*Climb to altitude, fly overhead with the wind to the side, push to vertical down-line, center controls and observe path as the aircraft dives*	*A. Plane pitches towards canopy* *B. Plane pitches towards belly* *C. Plane stays perfectly on track of vertical down-line*	*A. Mix in a little bit of down elevator (1-2%) at idle* *B. Mix in a little bit of up elevator (1-2%) at idle* *C. Nothing- you're good*

Notes:

- *In almost every case, the plane will pitch toward the canopy (begins to level out)*
- *Let the aircraft continue on the down-line for several seconds*
- *Mix should not kick in until idle- anything above idle should not include the mix*