Trimming Your Model

Initial Setup and Improving Flight Handling

What is Trimming?

- Adjustments to various aspects of your model for improved flight handling.
- Usually minor adjustments can yield large improvements to the plane.
- Most common adjustments are related to the control system.
- Commonly overlooked adjustments include incidence, center of gravity and benefits to be gained from radio mixing.
- **It's all linked together, trimming is an iterative process.**

Agenda

Several factors may affect flight handling:

- Control system
- Center of gravity
- Radio programming
- Incidences
- Thrust lines
- Other (warped surfaces, type of model, etc)

Control System

- Control throws
  - is the amount of surface deflection correct?
- Hinge gaps
  - Sealing the gaps between moveable and non-moveable parts.
- Remove the slop!
  - Worn clevises and horns reduce centering of servos.
  - Ball links should be snug and not able to pop off.
- Split elevators
  - Take care when building Y-rods
  - Servo setup key with dual elevator servos

Control System - Throws

- Check your model against the manual / instructions.
- Use an angle finder ($10 at crappy tire)
  - Need to know required angles
- Use a ruler
  - Measure at root of surface
- Rudder: deflection is equal on both sides
- Elevator: slightly more down than up
- Aileron: slightly more up than down (differential)

Control System - Hinge Gaps

- Unless you are a perfect builder / hinge installer, the gaps will not be identical.
- Sealing the gap makes the left and right wing or stab panel more closely match each other.
- Sealing rudder will increase authority.
- Use covering material. Clear covering is available. Can also use self adhesive tape of sufficient quality.
- Side benefit: no oil residue gets to the hinges or exposed balsa.

Control System - Removing Slop

- Never use metal horns on metal pushrods without a locking nut. (Radio interference)
- Check holes in horns and servo arms for wear.
- Surfaces should not rattle or feel “notchy”.
- Ensure surface returns to center reliably.
- Use ball links and/or horns with bearings to remove most slop.
- Benefits of digital servos are lost if there is slop in the pushrods and horns!

Control System - Split Elevators

- Mechanical
  - If your model has split elevator halves joined by a Y-pushrod or wire joiner, pay attention to building a straight elevator.
- Electronic mixing
  - If you are using split elevator servos, do not assume they are identical in movement.
  - Use a ruler or angle finder to ensure movements and centering matches

Control Throws - Flight tests

- **Aileron**
  - **Hi-rate: 3 rolls in 4 seconds.**
  - **Lo-rate: 3 rolls in 6 seconds.**
- **Elevator**
  - **Hi-rate: to give smooth square corner.**
  - **Lo-rate: to give a loop of approx. 130' dia.**
- **Rudder**
  - **Hi-rate: approx. 30-35 degrees for stall turns.**
  - **Lo-rate: to maintain knife edge flight.**

Center of Gravity (CG)

- Center of gravity has a huge effect on handling.
- *"Nose heavy planes don't fly well, tail heavy planes don't fly long"* ;-)
- Center of gravity differs from one model to the next.
- Most airplanes need to balance in the range of 25 – 35% of the Mean Aerodynamic Chord (MAC), which is the average center of gravity of the wing.

Center of Gravity

- Most of our models can safely be balanced using 33% of the wing chord at the root (next to fuselage). This assumes a relatively straight leading edge (and a relatively well designed airplane).
- Planes with swept wings and Biplanes require different calculations to determine the CG, than constant chord designs.
- The calculations can be tricky, the theories differ depending on who you ask. There are many calculators available online and ton's of free advice.

Center of Gravity

- Balance low wing planes in an inverted position.
- Best advice is to heed the manufacturer's recommendation as a starting point then work from there to fine tune your model.
- In a nutshell, determining CG of an airframe is a very complex and mathematical process. For the average modeler it is more beneficial to recognize nose heavy or tail heavy conditions and correct them with adjustments within the accepted range.

CG - Nose Heavy

- Said to be “more stable”, but too nose heavy causes other problems.
  - Calm days, plane may run out of elevator when it needs to flare.
  - Plane may not glide well during a dead stick because of elevator trim required to maintain level flight with power on.
  - Landings could be faster than necessary.

CG - Nose Heavy

- Test A: Roll model to 45 degree bank
- Test B: Roll model to inverted
- Flight Observation / Adjustment
  - Nose drops / move CG aft
- Ground Observation / Adjustment
  - Elevator trimmed up / move CG aft

CG – Tail Heavy

- Plane will need power on to stay level.
- Reduced throttle results in nose pitching up.
- On calm day, need down elevator to level plane and throttle on to make elevator effective. Result is the plane must be flown onto the ground at speed.
- Dead stick landing may be impossible!
- So called “3D” planes are thought to need tail heavy CG, but this is not the case. Proper CG placement, coupled with pilot skill and practice is the best recipe for 3D flying.

CG – Tail Heavy

- Test A: Roll model to 45 degree bank
- Test B: Roll model to inverted
- Flight Observation / Adjustment
  - Tail drops / move CG forward
- Ground Observation / Adjustment
  - Elevator trimmed down / move CG forward

Incidence

- Incidence refers to the angle of flying surfaces with respect to centerline of fuselage.
- Most wings are designed to be approximately ½ degree positive.
- Rudder is usually 0 degrees to centerline
- Stabilizer usually neutral or slightly negative.
- Usually difficult to adjust on most models (pattern planes use wing adjusters)
- Similar result can be achieved by using flaperon trim (both ailerons slightly up = lower incidence)

Incidence

- Setup: Elevator must be neutralized
- Test: Power off vertical dive, center controls when vertical
- Observation / Adjustment
  - Model pulls out (nose up) / reduce incidence
  - Model tucks under / increase incidence
  - Model continues straight down / no change
- Easiest to use flaperon trim to make adjustments. Don't use elevator!!
- Adjust aileron clevises equally on both sides to change manually.

Thrust lines

- Relationship of engine mounting angles to centerline of model.
- Left and Right
  - Influences tendency to pull to one side in yaw axis
  - Most noticeable on vertical lines
- Up and Down
  - Causes plane to climb or descend with throttle applied

Thrust lines - Lateral

- Most models have 2 degrees of right thrust (engine points to the right)
- Right thrust counteracts P-Factor of counterclockwise turning propeller.
- Setting is locked into the airframe and set to counteract P-Factor at moderate speed.
- Test by flying model away, pull to vertical, neutralize controls.
  - Model pulls to right, reduce right thrust
  - Model pulls to left, add more right thrust

Thrust lines - Vertical

- Many models have no up/down thrust
- Trainers often have down thrust built in to keep high lift wing from requiring significant down elevator to remain level.
- Test by pulling to vertical climb with power on, neutralize controls (elevator must be neutral)
  - Model pulls to canopy, increase down thrust
  - Model pulls to wheels, increase up thrust

Radio Programming - Mixes

- Sometimes, you just need some help.
- Every model is different, but most have some sort of coupling.
  - Coupling refers to when one input has an undesired effect in another axis
  - Yaw-Roll, Yaw-Pitch, Roll-Yaw, others?
- Use programmable mixes to fight the airframe for you.
- Explore your own radio for available options.
- Experiment.

Radio Programming - Expo

- Exponential (aka: Expo)
- Increase or decreases sensitivity of the control around center.
- Radio brands are different!!
  - Futaba: negative expo = less sensitive
  - JR: positive expo = less sensitive
  - Airtronics: same as JR
  - Hitec: same as Futaba
- Absolutely essential for Fun Fly and 3D planes with huge control throws.
- Use on throttle to reduce sensitivity at low or high stick if you don’t have throttle curves available.

Radio Programming - Memories

- When you are trimming a plane, many corrections are done in the radio once the physical setup of the model is done.
- Learn how to copy model memories so you can make backups and restore them easily if you mess up your model settings.
- You may want more than one configuration (sport flying, float flying, aerobatic, fun fly, etc).
- Once you have trimmed your plane, use the trimmed memory as a basis for alternate configurations.

Using the Trim Sheet

- Trim in calm conditions.
- Make multiple tests before making adjustments.
- If changes are made, go over previous steps and verify or readjust as necessary.
- Process may take 5 – 30 flights to get it right!
- The reward is an airplane which flies as well as it possibly can.

Links

- http://www.rcaerobats.net/trim_chart.htm is an online version of the trim sheet handout.
- http://www.coloradogliders.com/tools.htm#tools is a collection of online calculators.
  http://www.aeroplanemonthly.com has a good glossary of aviation terminology.