Trim your model for precision aerobatics

Ground tips for aerial success

by Dan Wolanski

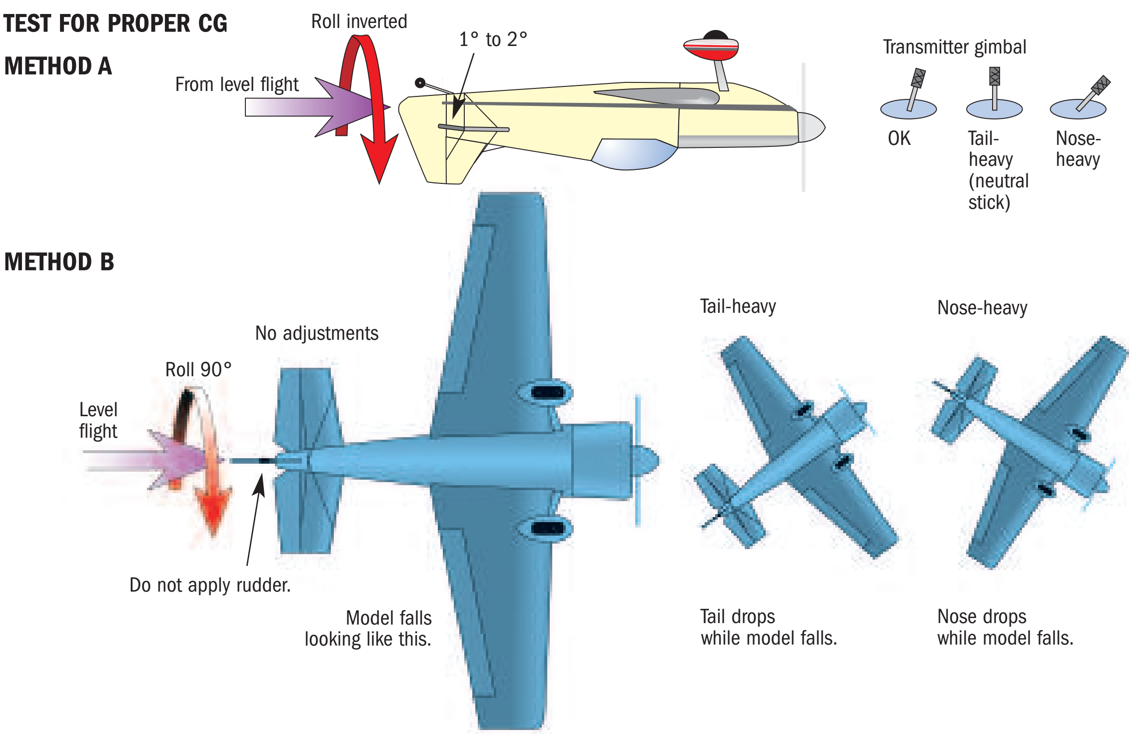
Have you ever tried a hammerhead, Cuban-8, or Humpty Bump, only to have your plane fall out of the maneuver halfway through? You've seen these maneuvers performed by the same plane as you fly, but for some reason, you cannot duplicate them. Well, if you fly one of today's aerobatics designs such as an Extra, a CAP, or a Giles, it must be properly trimmed not only for straight-and-level flight but also for aerobatics.

Flight trimming for aerobatics is very different from just throwing in a few clicks of transmitter trim. It involves a series of setups designed to correct your plane's bad tendencies and to lay the foundation necessary for all aerobatics: pure inputs. By "pure inputs," I mean that when you add rudder, the plane yaws without showing a tendency to pitch or roll. Likewise, when you apply aileron, your plane must roll on an imaginary line without making a heading change. Before you can ever hope to do precision aerobatics, your plane must be able to follow pure inputs at any attitude and speed. This concept may be new to you, but I assure you that every TOC and competitive aerobatics pilot works endlessly to achieve it. If you follow the setup procedures and practice the flight maneuvers described here, you'll be able to successfully set your plane up for pure inputs and practice aerobatics with the same advantages as the top pilots.

GROUND CHECK

Before putting your plane through any set of aerobatics, make sure its static setup is perfect. Eliminating setup flaws now will ensure that your work in the air will be constructive and predictable. If you bypass this step, your plane will not perform consistently enough for you to make sense out of the flight-trimming procedure.

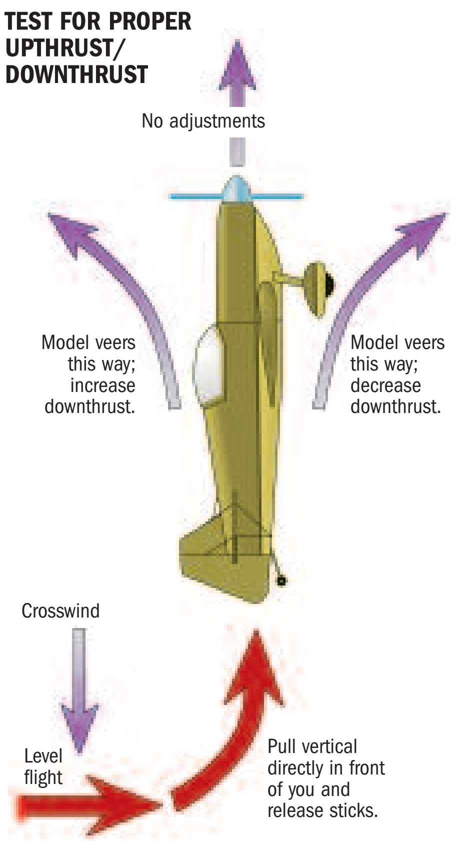
To prevent airflow transfer, make sure all the hinge gaps are sealed with covering. Because control surfaces operate on pressure differential, it is essential that you not lose air pressure between



the trailing edge and the hinged surface. If the gap is left unsealed, it will allow the transfer of pressure and will decrease the effectiveness of your surface. More important, the air transfer will vary with speed and attitude, making it impossible to trim the plane properly when it's airborne. To avoid this problem, disconnect the ailerons from the linkage; extend the ailerons to the maximum upward position and cover the V-shaped crevice. Do the same for the elevators, and seal your rudder gap as well.

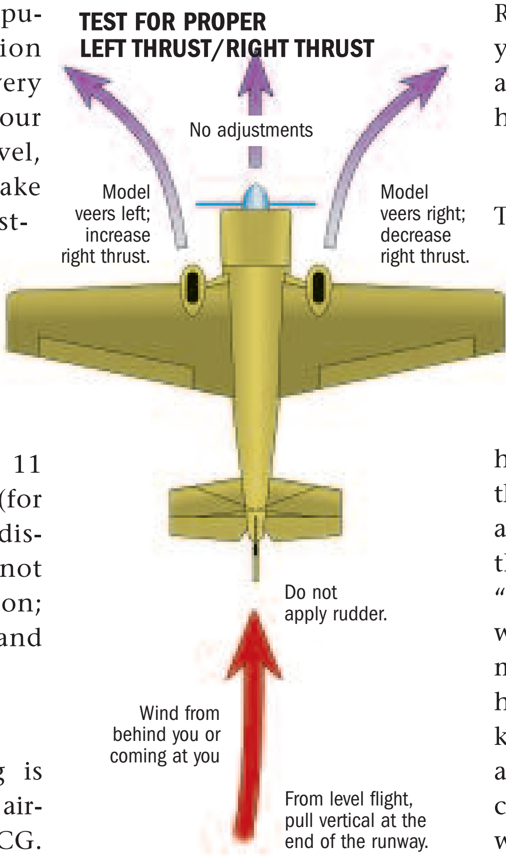
Now buy a good-quality deflection meter and measure the throw of each control surface. Each elevator half must travel the same distance up and down. The same goes for the ailerons; if one aileron has greater travel than the other, you will never achieve a perfect roll.

Check all of the incidences. Be sure they match those called for on the plans. Check and double-check to make sure that your stab and wing are perfectly aligned. (If you have a large plane with a big chord, use the Robart meter and 36-inch conversion.) It's a good idea to check the elevator halves with an incidence meter to be sure that they are centered, too. Simply turn on your radio and check each elevator half by attaching the meter to your horizontal stab. Use the same meter for both sides to show any instrument error. Be sure your plane is propped up securely when you move the meter from one side to the other.



Eliminate control-linkage slop by using superior hardware. If you have any slop in your system, your surfaces will not center properly, and you will always wonder why the plane doesn't respond precisely to control inputs. Do yourself a favor and spend a few extra dollars on some really good hardware.

Set your control throws to the minimum settings given in the plan. Contrary to popular belief, most precision aerobatics are done using very little control throw. If your setup allows too much travel, it will be difficult to make minor flight-heading adjustments, and this will make maneuvers look jumpy and erratic. On my 30-percent Extra 300S, I use 8 degrees up-elevator and 10 degrees down. Ailerons are set at 11 degrees up and 9 down (for differential, which we will discuss later). The rudder is not set for maximum deflection; start at about 20 degrees and work from there.



BASIC FLIGHT TRIMMING

Aerobatics flight trimming is highly dependent on the airplane's thrust line and CG. Before beginning, make sure that the CG and engine thrust are perfectly set. Changing them after you've started trimming for aerobatics will change the airplane's characteristics and flight trim. Consider the CG and engine thrust as your foundation; if you change them, you change everything.

Start with the CG (refer to the chart, "Flight Trimming"). To test for proper CG, roll the plane inverted and gauge how much down-elevator is required for level flight. You should be able to fly inverted while adding only a little down-elevator. Another test is to roll to knife-edge from straight flight and observe how your plane falls. If the nose falls first, the plane is probably nose-heavy; if the tail falls first, it is tail-heavy. Change the CG by moving the battery pack. Resist the temptation to add weight; after all, lighter is better.

Now that the CG is set, you need to work on the thrust line. Fly your plane through a set sequence of vertical uplines to quickly see exactly what is needed. Refer to the chart, and make the appropriate changes before proceeding. After all, if your plane won't track vertically on its own, you will have to wrestle with it constantly. Remember, the goal is to have your plane fly as true as possible at any attitude without your having to make constant inputs.

AEROBATICS FLIGHT TRIMMING

The secret to this can be summed up in three words: rudder, rudder, rudder! In aerobatics, the rudder is the most important control surface. Without it, competitive aerobatics pilots would have a very difficult time making the plane look as though it's always the same distance from the flightline. Notice I said "look." In a perfect world, rudder would be required in only a few maneuvers, such as hammerheads, snaps, spins and knife-edge. I have yet to meet anyone, however, who can successfully complete a sequence without using rudder to correct a bad entry or exit. Crosswinds and gusts can also necessitate the extensive use of rudder.

Let's say you decide to do a hammerhead (stall turn) to turn the plane around. By definition, a hammerhead is a constant-radius pull followed by a vertical upline into a stall. During the stall, the plane must rotate around its CG and head down the path it followed on the way up (within half a wingspan). You pull your plane upward and immediately notice your heading is slightly off; so you input a little rudder to correct it, but your plane is not set up for pure inputs. The rudder input introduces a pitch and roll, and you quickly find the model no longer heading straight up but moving away from you slightly and beginning to roll. So you pull the throttle back and hit the rudder, but the plane flops forward and earns you a big zero! Sound familiar? Now you know the importance of pure inputs and rudder corrections.

ACHIEVING "PURE INPUTS"

Now that you're sold on the importance of pure inputs, let's go over how to achieve them. First, set up your computer radio with two mixes. Make rudder the master and ailerons the slaves. On the second mix, make rudder the master and elevator the slave. Be sure to turn off every other mix that may have come with your radio—especially the aileron-to-rudder mix, which plays no part in aerobatics. Now you'll fly the plane in knife-edge and program out the bad tendencies or coupling using these two mixes. (Coupling is the airplane's tendency to roll or pitch with the application of rudder.)

Fly your plane from left to right, roll right 90 degrees, and apply just enough left rudder to sustain knife-edge flight. Do not apply full rudder. Observe what your plane tends to do. A scale aerobatics design will usually pitch downward (toward the wheels) and roll left. Do this a few times to be sure. Now, land the plane, turn off your engine and begin to program out the coupling. If your plane pitched down during knife-edge, program a few percent up-elevator with the application of left rudder. If your plane also rolled left, program a few percent right aileron with the application of left rudder.

Continue until you can achieve knife-edge flight by using only rudder. Now fly the plane from right to left, and make the same observations and adjustments until the plane will fly knife-edge in either direction using only rudder. You are very close to having pure inputs, but you need to check a few more things.

Fly the plane straight and level at ½ to ¾ throttle, and apply a little rudder to get the plane to slide. Does the plane begin to slide nicely into a beautiful, large, flat turn? If it doesn't, observe what it tends to do (note that a little pitch-down is normal owing to the extensive drag you introduced by turning the fuselage). Now fly the plane from either direction, and pull it straight up in front of you so you see only its side. Apply a little rudder as it flies straight up, and observe it. Finally, fly the plane inverted in the same direction as before and apply the same amount of rudder. If the plane pitched or rolled in the same direction during the flat, vertical and inverted tests, go back into the mix and correct it. If the plane pitched or rolled in a different direction in each test, you may have a misaligned tail group. Keep in mind that few aerobatics designs will ace all of these tests. Sometimes, the best you can achieve is an acceptable average.

Your plane now has pure inputs. Go through some simple maneuvers, maintaining a constant heading by using rudder. You should easily be able to make deliberate heading corrections with rudder without having to add coupling.

To further enhance your flying abilities and your plane's flight characteristics, you may want

FLIGHT TRIMMING

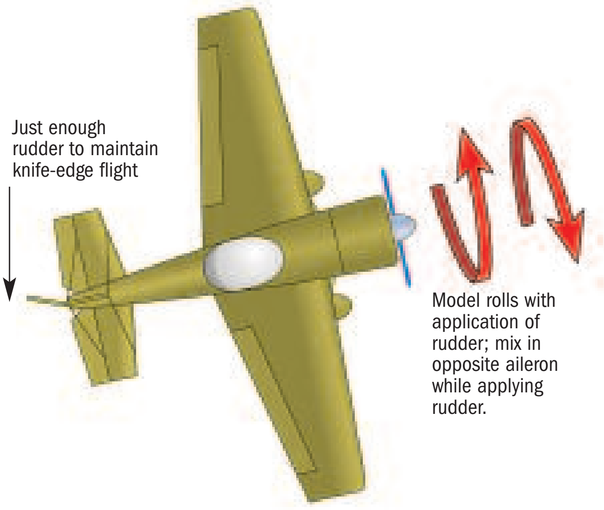
TO TEST FOR	TEST PROCEDURE	OBSERVATIONS	ADJUSTMENTS
PROPER CG —method A	Roll model inverted.	A. Slight down-elevator required for level flight. B. Significant down-elevator required to sustain level flight. C. No down-elevator required to sustain level flight.	A. No adjustments. B. Move battery pack backward. C. Move battery pack forward.
PROPER CG —method B	From level flight, roll model to knife-edge.	A. Model falls without dropping nose or tail. B. Nose drops. C. Tail drops.	A. No adjustments. B. Move battery pack backward. C. Move battery pack forward.
ENGINE THRUST —up/down	Fly model out around 100 yards, pull to a vertical climb directly in front of you, release sticks and observe deviations.	A. Model continues straight up. B. Model pitches toward wheels. C. Model pitches toward canopy.	A. No adjustments. B. Decrease downthrust. C. Increase downthrust.
ENGINE THRUST —left/right	Fly model straight and level into the wind and pull vertical.	A. Model continues straight up. B. Model veers left. C. Model veers right.	A. No adjustments. B. Increase right thrust. C. Decrease right thrust.
KNIFE-EDGE FLIGHT —pitch	Fly model into wind, maintaining knife-edge flight with minimal rudder. Do this from each direction.	A. Model continues on knife-edge without deviation. B. Model pitches toward landing gear. C. Model pitches toward canopy.	A. No adjustments. B. Mix in up-elevator with rudder. C. Mix in down-elevator with rudder.
KNIFE-EDGE FLIGHT —roll	Fly model into wind. Do this from each direction, maintaining knife-edge flight with minimal rudder.	A. Model continues on knife-edge without deviation. B. Model tries to roll.	A. No adjustments. B. Mix in opposite aileron with rudder.
AILERON DIFFERENTIAL	Fly model level heading into the wind or downwind. Pull to a 45-degree climb, and roll with aileron.	A. Model rolls without yaw. B. Model exits yawed in opposite direction of roll. C. Model exits yawed in direction of roll.	A. No adjustments. B. Increase differential. Increase up-throw on aileron. C. Decrease differential. Decrease up-throw on aileron.

to consider programming your computer radio for advanced features such as aileron differential, exponential, snap switches and dual rates.

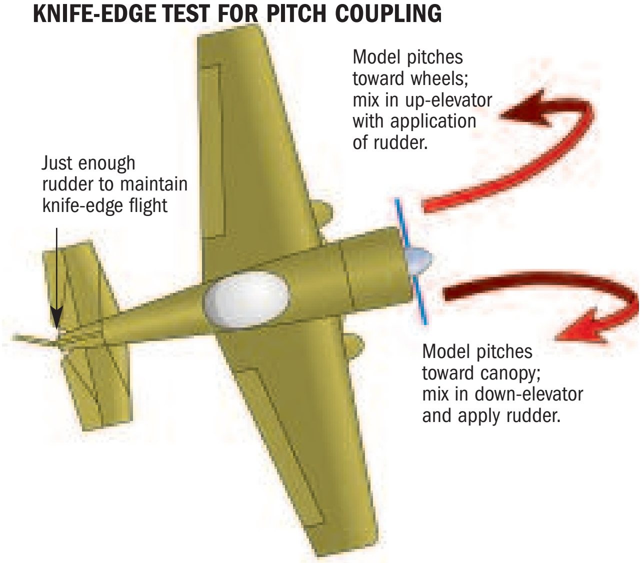
AILERON DIFFERENTIAL

This is probably the most important advanced feature you will want to program into your transmitter. Aileron differential offers a way to get your plane to roll in a more axial fashion; program in more up-aileron than down-aileron. The most commonly accepted theory of why this works says that the downward-deflected aileron creates more drag than the upward-deflected aileron, and that induces a yaw during a roll. To test for this, fly your plane downwind and directly away from you. Pull it to a 45-degree upline and roll it once. If the nose is yawed slightly after the plane has completed the roll, the plane needs aileron differential. To compensate for this differential, a scale aerobatics design such as an Extra will usually require approximately 2 degrees more up-aileron than down-aileron. You may need different amounts of up- and down-aileron for right and left rolls.

KNIFE-EDGE TEST FOR ROLL COUPLING



KNIFE-EDGE TEST FOR PITCH COUPLING



EXPONENTIAL

This is essential if you want your maneuvers and corrections to look graceful. Exponential offers a simple way of making the control surfaces move less around the neutral stick positions. This is one very nice way to hide minor corrections when your knees and fingers are shaking. When setting this up, be careful to ensure that your sticks become less sensitive around neutral and not more sensitive. Futaba and JR use opposite sign conventions (+ and -) to achieve the same results on their transmitters. On my Extra, I have the following exponential percentages dialed in: aileron—40, elevator—24, rudder—70.

SNAP SWITCHES

I've used a snap switch to do snaps during sequences, but I found myself in trouble when trying variations on a snap on downlines and while inverted. If you use a snap switch, be aware that if you plan to enter advanced competitions, you will handicap yourself for certain maneuvers. Many aerobatics routines require positive and negative snaps at nearly every attitude. Programming a snap switch for all of these scenarios is like taking aspirin for a broken leg. You may be able to limp your way through, but you will never be able to run with the competition. Snap switches are great when you are just getting started, but I suggest you do snaps manually when you are comfortable watching your plane fly through one.

DUAL RATES

I don't use dual-rate control throws because I dislike having to flip switches during an aerobatics sequence. Some planes, however, will not enter a spin or a snap unless the throws are considerably increased before the maneuver. Programming in dual rates offers an excellent way to set up your plane for maneuvers that may be difficult to do using low control throws.

Another use for dual rates is 3D aerobatics. With the flip of a switch, dual rates allow you to toggle between huge control throws and precision aerobatics. The drawback is that you must set up your mechanical linkage for huge control throws and then dial back your travel volume for precision flying. When you have your transmitter set to less than 100-percent travel volume, you aren't using your full servo travel. You will have significantly more precise control over a surface if the servo arm completes its full rotation while your surface travels only a few degrees. This is obtained by always placing your linkage as close as it can go to the center of the servo arm and in the outermost hole in the surface control horn. This will also increase your mechanical advantage. I suggest that you use different planes for 3D aerobatics and precision aerobatics.

I hope you find this information useful to prepare for precision aerobatics. Whether you compete or not is up to you. At least, you'll now be able to practice and perform maneuvers with the same foundation as the world's top aerobatics pilots. Now that the secret to obtaining pure inputs is out, there is no reason why everyone at the club shouldn't be able to do a beautiful hammerhead, Cuban-8, or any other aerobatics maneuver.

For more information on competitive scale aerobatics, join the International Miniature Aerobatics Club (IMAC) and receive its quarterly newsletter. To learn how to join, visit IMAC's website: mini-iac.com. If your interest is in pattern (very similar to IMAC but with different restrictions on aircraft size and weight), join the National Society of Radio Controlled Aerobatics and receive its monthly newsletter, "The K-Factor." Check out its website at nsrca.org.