# *Trimming the Profile*

By Jeremy Chinn

Designing and selling kits, I have had the opportunity to observe many people go from a box of wood to a flyable airplane. Happily, I've been lucky enough to see a lot of people that are very happy with the final result.

I've also seen a lot of people finish their bird only to be frustrated in the first few flights. Some persevere, trim/tune the plane and have a great time with it, some sell them immediately, and some continue on frustrated and are never totally satisfied.

In reality, the odds are against a builder on his first flight. There are a huge amount of variables involved such as incidences, control surface set-ups, radius's sanded on control surface edges, etc that help to push and airplane this way or that. The list goes on and on, and in the end, 10 kits built by 10 different people will yield 10 different results. Laser cutting and the new building techniques help eliminate many variables, but in the end, its up to the builder to set up the plane right.

So how on earth do you get a plane to perform the way you want it to, or the way your buddy's did? The process starts with the building of the airframe, continues with equipment selection, and ends with final trimming of the airframe.

Starting with the end in mind, building a straight airframe is of the utmost importance. Without a straight and true airframe, all the set-up and trimming in the world will just be a compromise at best. You'll never get the performance you want without a straight airframe.

Most wings are now built with alignment tabs under the ribs to help build a straight wing, but take the time to make sure your bench is flat to start with. Any warp in the bench will show up in your wings and tail surfaces. The same idea goes for building profile fuselages. Built up fuses built on a flat surface will generally be flat, and those built on a warped surface will be warped…..

Take your time with covering- Especially on the wing and control surfaces. When helping people maiden their birds, I constantly find elevators that are warped, ailerons that are warped, etc. Warped elevators will cause snaps in hard maneuvers, as well as causing the airplane to roll and need trim. The same goes for warped ailerons.

Taking warps out of control surfaces can be done fairly easily. I often put them on a flat bench and look to see if any corner is 'up' off the bench. If I find that a corner is, I'll weight the corners flat and use my heat gun to straighten the surface. Some wings can be done in a similar fashion, but may need to be held by a helper as you twist the wing and heat with the heat gun.

Finally, the most important factor in building an airframe straight is getting the incidences right and the surfaces aligned. Most if not all .40 size profiles are built with the wing, tail and motor at 0 degrees incidence. My Yak 55 and Paul Swanson's Mojo series all have features built into them that cause the wing and horizontal stab to sit at 0 degrees automatically. However, it is still possible to get the motor crooked, or to get a wing or horizontal in crooked in reference to the wing.

To get these things straight, a few cheap tools are invaluable. The first is a Robart Incidence meter. My own meter is now over 20 yrs old and has set countless airframes to the correct incidences. It has a feature built in as well that helps me get the motor to 0 degrees incidence (no up or down thrust). A builder's square is cheap and extremely helpful in getting the wing and horizontal in straight – IE perpendicular to the fuse vertically (from the nose or tail) and from above. When working with the square, use the hingeline of the horizontal or wing spar (if it's a straight spar) to ensure squareness from above. Use the upper surface of the horizontal or wing (with a constant thickness wing) and the fuse to ensure squareness from the nose or tail. The TLAR (That Looks About Right) method is not good enough here- get the tools and

use them.

I could continue writing about building a square airframe for days, but these concepts are the basics for getting it right. Different airframes may necessitate different techniques.

Next up in the batting order is equipment selection. This is a real opportunity to turn a sow's ear into a silk purse, or just another sow's ear. Most kits come with suggestions about what gear to run for best performance. The most common reaction I see from builder's is to go 'bigger' with gear. Bigger servos, bigger motors, all add more weight and bring the wing loading of the airplane up. Higher wingloadings generally result in poor flying airplanes.

If a kit suggests a certain size motor, its best to stick with it. Putting a bigger motor on an airframe will usually result in the airplane hovering at a lower throttle setting, however the higher wingloading that results from the bigger motor, bigger fuel tank, heavier prop, etc will most definitely compromise the flight characteristics. The bigger prop used on a larger motor also will cause trimming issues if the plane was not designed for it. Landing gear clearance becomes a problem, and roll issues in Knife Edge and while in a harrier may begin to appear because of the bigger prop disk. Almost all .40 size profiles need some right thrust, and those with proportionally bigger props need more right thrust.

3D airplanes need powerful servos, but with servos being mounted in the tail- away from the center of mass, straying from the designer's suggestions can be costly. Most airframes are designed with a specific size gear in mind, and going to the next larger size usually adds useless weight, and causes balance problems.

Once you've mounted all your servos, take a moment to zero all the trims, sub trims and mixes in your transmitter on the selected model. Next mount the arms to the servos, and move the arms to perpendicular with the hingeline of the surface they will affect (sub-trim them to this final position if necessary). Finally, use the clevise or ball link to set the final setting of the surface. Set all surfaces to zero deflection. Take extra time with your ailerons as they are harder to zero, and can have a significant effect on trim. For a tube fuse model, you can zero the ailerons using the tube as a reference, and for others, tape a straight ¼" stick to the tip of the wing. Center it perfectly on the leading and trailing edge of the wing and secure it. Then center your aileron on the stick with the clevis.

After all the servos have been installed, set them all up to the suggested throw specifications, and if you prefer to run exponential, then set it up now. Check all your surfaces to ensure equal movement in either direction.

To get to the correct CG, don't ever add weight if at all possible. The 3d'able CG of most airplanes is further back than the indicated CG on the plans. How much further back is a matter of personal debate, but the designer can usually tell you where to start. Also keep in mind that this is only a starting point. You will most likely have to adjust the CG as your final trimming progresses.

While you are setting the CG, don't forget the vertical and lateral CG's. The plane should balance tip to tip (lateral), and should balance top to bottom. The lateral and vertical CG's of most airplanes is on a line through the crankshaft of the motor, through the wing and the horizontal centerlines.

Now that you have an airplane that is 'zeroed out' and very straight, its time to put it in the air and see what she'll do. My first flight is usually pretty brief. I get her in the air, check to see if any of the trim buttons need bumping and get her down. Things like loose landing gear, loose motor bolts and other pesky problems will often show up on this first flight. Get all that tight, make sure the keepers are staying on your clevises and get her back in the air.

If you truly built a straight airframe, you should not have needed any substantial aileron, rudder or elevator trim. If you do need any substantial aileron trim, figure out where the warp is, correct it and then start this process.

For me, trimming is a multi step process. Each builds upon the next to get to the final setting. After first verifying that the airplane is tracking straight and true, and does not appear to have any obvious issues such as up or downthrust in the motor we need to get the CG set.

To set the CG, I start with simple level flight. With a .40 size profile, I fly at half throttle and trim the airplane to fly level while upright. Next, I roll the airplane inverted and try the same test. If the airplane dives towards the ground, then the airplane is noseheavy, if the airplane climbs while inverted, its tail heavy. Move the battery fore and aft to get the CG right. Stick some masking tape on the wing at the root and mark each CG change. Only move the CG ¼" at a time for a .40 size, 1/8" for a small electric or foamy.

As you get nearer to a 'neutral' CG, the airplane should fly with little or no backpressure upright or inverted during these tests. You can further test and refine the CG by putting the airplane in a ¾ throttle setting Knife Edge. If the airplane pulls to the canopy on KE, then it is still noseheavy. A pull to the belly indicates it is tailheavy. Its worth mentioning that if you did not get the ailerons set at zero degrees up/down, then these tests will not work.

Next up on the menu for setup is right thrust. I start with 2 degrees for a 2 stroke on a .40 size profile. To test if this is right, first set the rudder trim to 0 degrees rudder trim. Next get the airplane in the air and point the nose straight up in a vertical up-line with the top to you. The plane should go straight up and not wander to the right or left. If the plane wanders to the left, it needs more right thrust. After dialing in the thrust, pull the plane in close in a low hover. If you are constantly feeding in right rudder corrections, you may still need more right thrust. The opposite is true if you are feeding in left rudder corrections.

At this point, you should now have a plane that flies straight and true and handles well. Push it through its paces and see what it will do. Further testing may show more things to 'trim out'. A few common problems I've seen and their solutions are:

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Problem - Wobble/Rock in upright harrier (inverse of fixes mentioned below work for inverted harrier)
Cause- Ailerons reflexed down slightly, CG too far forward or aft, Vertical CG too high, lateral CG to far to one side.
Solution- Zero out Ailerons, resolve CG issues. Move Vertical CG lower (heavier wheels, move battery, etc)

*Problem- Pitch coupling in Knife Edge (pull to belly or Canopy)
Cause- Ailerons reflexed down or up slightly, CG to far forward or aft
Solution – Zero out Ailerons, resolve CG issues.

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Problem- Roll coupling in Knife Edge
Cause- design flaw, vertical CG wrong
Solution- mix out with computer radio, re-set vertical CG.

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Problem- Snap out during tight pitch based maneuvers (walls, waterfalls, etc)
Cause- Ailerons not deflecting evenly, elevator halves uneven, lateral CG wrong, Vertical CG wrong, Wing warped
Solution- Center and zero out Ailerons, Even up elevator halves/stiffen elevator half joiner, move battery to opposite wing, de-warp wing

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Problem- Inability to reliably set CG for most speeds
Cause- Servos not centering right, up/down thrustline on engine incorrect

Solution- Replace servos, Adjust vertical thrustline of engine to zero

I hope all of this helps. While it may seem like a lot of work, it can make flying a lot more fun and is definitely worth the effort.