Flapper glider trimming for Science Olympiad Glider Event 2026-27 season
NFFS Youth Development Program
By: Brian Turnbull

I have been building and flying outdoor and indoor handlaunch gliders for about 60 years and built my first flapper catapult launch indoor glider in 1992 after reading the article about the "Slow Poker" Stan Buddenbohm design (google it if your parents allow). Here are the tricks/methods that I have learned from studying many, many designs; building many gliders and coaching many students in about six seasons of glider over the last 15 years; and reading the material from pretty much all of the great glider fliers.

This is a longer document than I usually write for middle school, but if you are trying a flapper glider, you are making a serious effort in the event and you need all the details below. You can take this document with you to trimming practice and read it and do it step by step. Also, I am hoping that any coaches you might have are reading this before you start trim flights.

Yes, this is lots of info! I think that all of it is necessary to get a good result. The good thing that you will find though is that doing of these steps is much quicker than reading about doing them!

<u>Basic trimming steps:</u>

Watch the NFFS Glider Overview video before reading this. The two launch angles mentioned below (inclination and bank) are demonstrated in this video.

1. Verify that all parts are perfectly aligned and adjusted and launcher is correct (recommendations below are for a launch that curves to the right and a glide circle that also is to the right).
    a. Straight fuselage; or if slightly (1 mm) curve, the curve is up at the tail
    b. No wing, fin or stabilizer warps or twists
    c. Wing mounted straight on the fuselage
    d. Wing and stabilizer both mounted on the top of the fuselage and the fuselage top is a straight-line surface.
    e. Flap deflection is even at is about 3/16" to ¼" drooped down at trailing edge
    f. If the stabilizer is tilted (one tip higher than the other), verify that it is tilted with the right tip higher than the left. Tilt should not be more than 1/8" or maybe 3/16".
    g. Bend the trailing edge (TE) of the vertical fin 1/32" for right turn. This will be easy if the fin TE has been sanded thin (to about .020-.015").
    h. Set the wing pylon incidence angle so that the front edge of the wood portion of the wing and the rear edge of measure equal distance from a good reference

point like the fuselage bottom edge (effectively 0 degrees incidence; see the pictures). As the curved down flap effectively gives the wing some incidence even during the high-speed portion of the launch, zero degrees wing incidence (on the wood portion of the wing) is often correct for flappers (not true for basic gliders).

i. Set Center of Gravity (balance point fore and aft; or CG) per the plan by attaching the correct amount of putty ballast to the nose.

2. Remember that a heavy glider always flies poorly. It takes more launch speed, is very sensitive to launch angles, transitions poorly and glides fast and with lower flight times. Heavy for a 12" glider wing span with 3" chord is anything over 4.5-5 grams. Heavy for 14.5" span glider (around the maximum to fit in the 2026-27 box) with an average chord of 3.5" (like Freedom Flight) is anything over 6.0 grams. If you do the math, you'll see that heavy is anything over 0.16 grams/square inch wing "loading". If you built a heavy glider fix it by sanding weight off by airfoil shaping the wing slightly, thinning the stabilizer and fin and removing some wood from the fuselage area between the stabilizer and the wing trailing edge. You don't need to remove weight from the front of the fuselage unless it is extremely heavy. Or, better yet, build a new glider and use better wood! A heavy glider is an exercise in frustration to fly!
3. Build the glider with the wing mounted on a pylon or wing mount stick (see pictures). If the kit is not designed this way, modify the kit to add the pylon. Pylon length should be full length of the wood section of the wing plus an additional 4mm. The extra 4mm allows 2mm of pylon to be visible from under the front edge and back edge of the wing to make it easier to mount the wing straight. It is easy to add the pylon and helps enormously in the trimming. Pylon wood thickness should be the same as the fuselage if the fuselage is balsa and should be no thinner than 3/32" and can be 1/8" thick and can be lightweight wood, like 5-6 lb cu ft. If the fuselage is thin carbon rod or tube, attach a 1/8-1/4" tall stick of the pylon wood the length of the pylon base to the fuselage. The stick of wood should be the same thickness as the pylon so that the pylon bottom has a flat surface to rest on (see pictures). Creating a round groove in this stick's bottom so that it glues well to the carbon is a good idea. The pylon, which is attached to the wing, will rest on the surface of this stick and be attached with masking tape allowing the wing incidence (actually the pylon incidence) to be easily adjusted with shims between the pylon bottom and the fuselage top edge. This shimming capability lets you adjust the wing incidence which is critical as very slight differences in wing incidence of 1/32" or less can have a big effect in all phases of glider flight. The pylon height we use is 3/8". Which along with the 3/16" height fuselage stick used in most kits and designs with wood fuselages gives a reasonable surface area for attaching the masking tape.
4. Begin testing by hand gliding. This is harder than it sounds. All of the students I've coached have needed numerous attempts to learn to release the glider as if it is a very

light dart and to release at a slight downward angle (aimed at a point on the floor about 25-30 ft away) and releasing very gently with a downward follow-through of the hand. The downward follow through is very important. If you release the glider "flat" it will nose up and stall. Try this hand gliding a few times and move to the next step before you get frustrated. As long as the glider does not dive sharply nose down, you will be ok to launch with the rubber band. If it does nose down sharply in repeated test glides, add a 1/32" thick and ¼" long shim under the front edge of the pylon between the pylon and the fuselage. Instead of using shims, you can make and preinstall a tapered shim per the pictures. This can be preinstalled so that the pylon is at zero degrees incidence and is easy to slide in and out to change incidence. You will need to mostly remove the tape on the front of the pylon (but not the back tape) to slide the "wedge shim" or install a rectangular shim. Then test glide again to get a flat, gently descending or slightly nose up glide.

5. First launches with the rubber band should be at shallow inclination angle of about 20 degrees (see the video; a 20 degree inclination angle in a 24 ft tall gym would mean aiming at a point on the ceiling that is about 60 ft away, as measured along the floor) and about 45 degrees of bank angle and stretching the rubber about 4" if using around a 5" loop of 1/16" wide rubber strip. This means the 5" loop is stretched to 9". This should produce a smooth banking shallow climb to about 8-10 ft and a smooth right turn into the glide circle.
6. You can measure inclination angle of launch by aiming at a particular point on the ceiling (a girder or light) and measuring on the floor how far horizontally along the floor you are from that girder. I teach my students to learn the length of their pace (we use a long tape measure, have them pace 5-10 steps and calculate). This allows them to document in their log the exact inclination angles and allows them to duplicate best inclination angles at any competition even if the ceiling height is different than their practice location (ex. If best launch inclination angle is 45 degrees, determined by testing, at your 25 ft ceiling height gym this means pacing 25 ft on the floor from a particular aim point on the ceiling and you are competing in a 20 ft tall gym, the student paces 20 ft from the ceiling aim point and has the same launch inclination angle; a good practical intro to trigonometry!)
7. If the glider noses up sharply in this first low-power high bank low inclination launch and does not bank/turn to the right, try the next launch with a 60-80 degree bank angle. This much bank is rarely needed unless there is something misaligned on the glider or a glue joint is loose on the glider allowing the wing or stabilizer to shift during launch. Check all the glue joints to verify that nothing is loose, including checking any carbon attached to the fuselage. If the glider noses do

8. If the glider hooks sharply to the right, try #4 again with half the bank angle. Very rarely we have a glider that needs zero bank and every now and then a glider needs a few degrees of bank in the opposite direction (bank to the left to get a smooth curve to the right)!
9. You can't evaluate the transition or the glide till you get the bank angle correct and get the glider starting to fly per #4 above.
10. Once you have a launch path that is like #4 above, stretch another 1" and at the same time, increase inclination angle from 20 degrees to about 30 degrees. Yes, you are changing two variables, but this time it is a good idea.
11. With each subsequent flight, add another 1" of rubber stretch and try different inclination angles and bank angles as you try to get close to the ceiling of the room. Usually, as you stretch more, you will need to increase inclination angle and also decrease bank angle. My students have found that flapper gliders typically will fly best with inclination angles between 45 and 80 degrees and bank angles from zero to 30 degrees, with a few needing reverse bank of 10 degrees and a few needing as much as 80 degrees of bank.
12. Best glider turn circle diameter for typical SO competition rooms is 25-30 ft (you can go larger if in a very big facility like a fieldhouse; bigger circle gives more flight time). If the glider turn is too large (>35 ft dia circle) or too small (<20 ft circle), verify that the fuselage is straight and the flap deflection is even. If the fuselage is curved right or left (or the fin is mounted angled right or left or the wing is mounted inaccurately angled slightly right or left), the bend in the fin for right turn might need to be more or less. Stabilizer tilt for turn has less effect on flappers than on basic flat sheet wing gliders, but if the stabilizer tilt is extreme (more than ¼" one tip higher than the other) this can be corrected by removing the wing and sanding a slight angle in the bottom of the pylon (carefully and accurately!) so that the wing tips are slightly angled higher or lower relative to the stabilizer to fix the excessive stab tilt. This corrects stabilizer tilt relative to the wing. This is often only a 1-2 degree angle you are sanding!

Fine Tuning for maximum duration:

13. Once your glider is flying 15-20 seconds and the glide circle is correct, you can evaluate the transition and glide "attitude" and begin to test variations in CG, wing incidence and flap deflection to get more flight time.
14. For transition, if you have built accurately and setup accurately, you will be able to find a perfect inclination angle and bank angle at a particular rubber stretch (and therefore climb height) that gives perfect "dutch roll" transition from climb to glide with no loss in altituce. Sometimes the transition looks like a gradual slight roll to the left combined with a gradual yaw to the right (look up the terms in the glossary and watch the

overview video as I demonstrate what a dutch roll transition looks like). Sometimes the transition is a very quick left roll with right yaw that some people say looks like the glider "flops" or "snaps" into the glide.

15. First thing to test fine tuning is CG. For the flap deflection measurement and incidence you have started with, there will be a perfect CG for maximum duration. The modeling clay or putty ballast on the glider nose is hopefully around .25-.3 grams (the approx. weight of the stab and the fin). For the initial test, remove 20-30 mg clay and do several launches at the previously determined best angles and stretch and observe the glide and transition. If both are still good and the glider is not stalling (nose porpoising up and down repeatedly) gently throughout the flight, remove another 20-30 mg. Continue to do this till stalling throughout the glide is obvious and then put back 30-50 mg ballast on the nose (a little more than last removed to give a safety margin). Remember that if you get the launch angles slightly wrong and get a stall on transition, this transition stall might continue throughout the remainder of the flight or maybe the first half of the descent. This is not a stall due to CG. It is a stall from bad launch angles or rubber stretch!
16. Once perfect CG is determined for the current flap deflection and incidence, the next thing to fine tune is flap deflection. Increase flap deflection 1/8" (3mm) and see if the transition is still ok and see if the glide is slower and flight time longer. Sometimes increased flap deflection means you need a little more nose ballast. Evaluate based on flight time. Do repeated tests to be sure.
17. The last thing to fine tune is wing incidence. This is more challenging and time consuming as the tape at the front of the pylon has to be mostly removed each time the shim is changed. Also, be sure that when removing incidence you do a "safety check" flight or two as in #5 above. We have occasionally found that changing incidence as little as 1/100th of an inch can help flight time between 0.5-1.5 seconds. An indicator that wing incidence is excessive is a significantly upward curving climb path that requires a low launch inclination angle of 45 degrees or less. The teams that I coach often skip this incidence fine tuning if the current incidence is in a normal range (zero to one degree on the pylon) and the climb flight path is not too much upward curving and the current CG is in a normal range (around 45-55% of wing center chord).