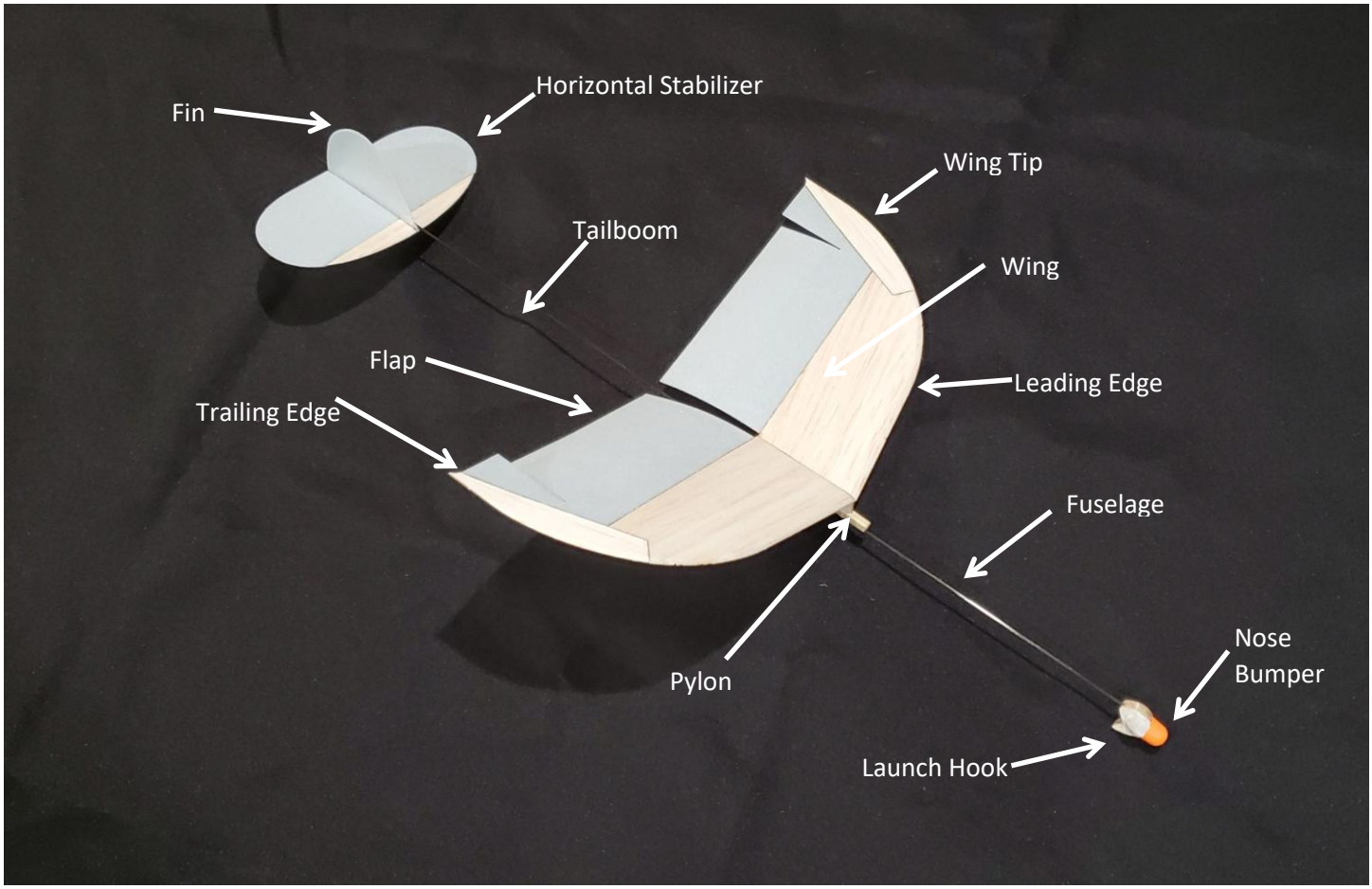
Elastic Launched GLider Glossary

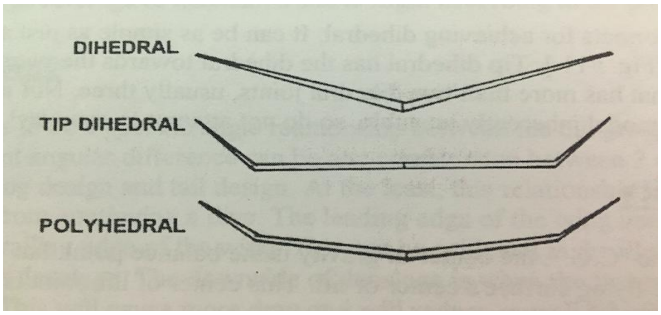
These are terms utilized in construction, initial flying, trimming, and optimizing the flight characteristics of a Science Olympiad Elastic Launched Glider. It helps to understand these terms when asking for assistance. In addition to defining the term, we explain some of the impact each item has on the flight of the plane.

Glider Structure



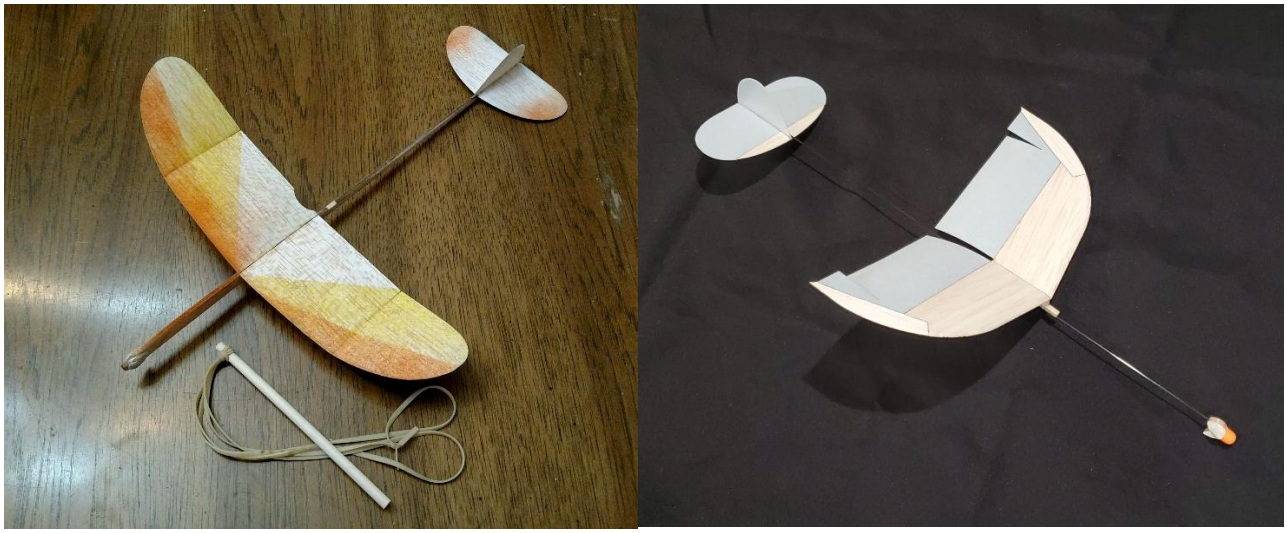
1. **Wing.** The primary lifting surface of the Glider. The wing may have an airfoil or may be flat. The wing creates lift as the plane moves forward.
2. **Wing pylon (aka wing mount)** On many gliders the wing is glued to a small spacer, or pylon, to lower the CG relative to the wing, and to make positioning the wing on the fuselage simpler.
3. **Horizontal stabilizer.** The smaller flying surface, typically in the rear of the plane, which provides pitch stability to the plane.
4. **Tail Moment.** The distance between the center of gravity of the plane and the center of lift on the horizontal stabilizer, multiplied by the area of the horizontal stabilizer. A larger stabilizer or a longer tail boom create a larger tail moment.
5. **Conventional Wing.** In this configuration, the primary lifting surface (wing) is forward, and the horizontal stabilizer is aft. The plane in the diagram above has this type of wing.
6. **Leading edge (LE).** The horizontal edge of the flight surface that defines the front of the flight surface (wing or stabilizer).

7. **Trailing edge (TE).** The horizontal edge of the flight surface that defines the back of the flight surface (wing or stabilizer).
8. **Span.** The horizontal length of the wing, tip to tip. Generally span is the length of the wing projected onto a flat surface, not the length following the shape of the wing.
9. **Chord.** The horizontal length of the wing from leading edge to the trailing edge, measured in a straight line.
10. **Dihedral.** The flying surface, usually the wing, has an angle upward from the root to the tips.



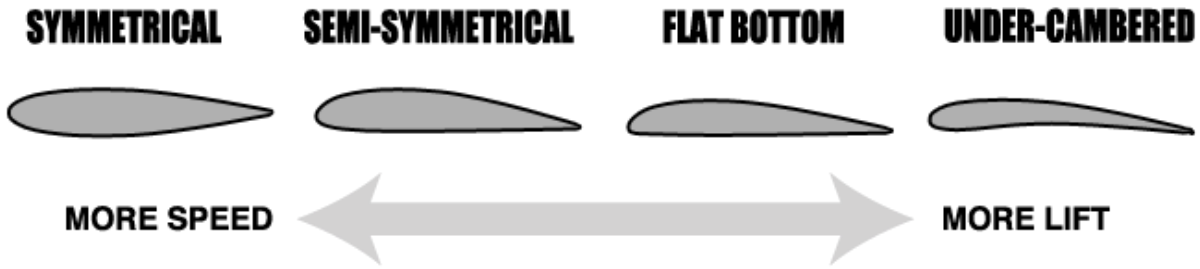
This provides roll stability, and converts yaw imposed by rudder offset into roll to help in turning. (Roll and Yaw defined in the flight characteristics section below). The dihedral is optimally an elliptical shape as viewed from the front of the plane, but this is difficult to construct with preformed carbon and wood. An elliptical shape may be approximated using central dihedral (simple dihedral, where the wing is in two pieces, each side angled up uniformly), Tip dihedral (some portion usually a few inches, of the outer end of each wing is angled upward), Polyhedral (a combination of several breaks in the wing shape to more closely simulate an ellipse), or tip plates (an extreme case of tip dihedral)

11. **Tip Plates (aka winglets).** An entirely flat wing may be fitted with tip plates, especially in a case where wing span is limited by rule. These tip plates are essentially vertical tip dihedral, and help to control tip vortices in addition to providing the effect of dihedral.
12. **Flaps.** Some glider designs incorporate flaps which flex to a flatter shape during the high speed climb, and curved downward (increased camber) during slow speed flight. Flaps may help increase duration, but a flapper plane may be harder to trim.



Example Gliders from J&H. Left is a non-flapper solid wing model with poly-dihedral. Right is a flapper model with simple dihedral.

13. **Fin.** One or more vertical surfaces near the rear of the plane that provides yaw stability and yaw directional control. (yaw is defined in the flight characteristics section) The fin is usually centered on the tail boom, above or below. An alternative is dual tips on the horizontal stabilizer. As tips, they may be installed with dihedral instead of vertically.
14. **Airfoil.** The shape of the cross section of the wing, usually sanded in to the balsa wing or may be developed through shaping of a foam or balsa flap section.

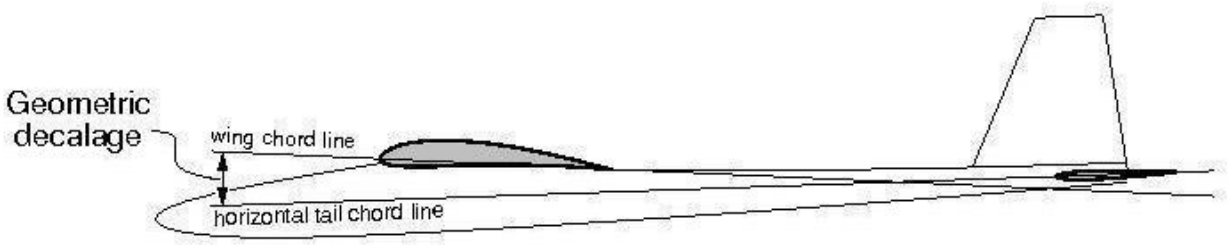


The airfoil may be flat, convex on top and concave on bottom (under cambered), Convex on top and flat on bottom (flat bottom airfoil), Convex on top and bottom (symmetric or semi-symmetric airfoil). Most indoor gliders are sanded with a flat bottom airfoil, with perhaps some upturn on the bottom near the leading edge. Flaps may be incorporated to provide an undercambered glide shape. The airfoil converts forward motion through the air into lift, and the amount of camber and design of the airfoil determines the lift vs drag profiles at different speeds.

15. **Camber.** The amount of curvature of the airfoil. The camber is usually expressed as a percent height vs chord length.
16. **Fuselage.** The fuselage of the model, which provides structure to support the flight surfaces. The fuselage is typically a single piece including the tailboom on ELG. The construction is typically semi-hard balsa, balsa reinforced with carbon fiber, or a carbon fiber tube.
17. **Tail boom.** The portion of the fuselage behind the wing. The tail boom function is to support and position the tail surfaces (fin and stabilizer) relative to the wing. It should be stiff enough to not flop around under normal flight loads.
18. **Ballast.** Weight, usually clay, used to balance the plane. Ideally this also brings the plane up to minimum weight. In the case of a heavy plane that is out of balance, it is more important to set the CG properly than to be at minimum weight, so ballast may be utilized even if the overall weight is high.
19. **Nose Bumper.** The rules require the nose of the plane to NOT fit within a lip balm cap, to prevent spearing people or objects. A soft bumper, such as a foam ear plug, can perform this task as well as soften harsh landings, helping to preserve the plane.
20. **Duco/Cellulose Glue.** This “model cement” is solvent based, Duco is one available brand. The advantage is that it is easily dissolved with acetone, allowing repositioning of parts. The bond to carbon fiber structures may be limited. This glue takes longer to set up than CA glues.
21. **CA Cyanoacrylate Glue.** This is “super glue”, and can be used for assembling model airplane parts. It is available in various densities. Only Thin or Medium should be used on SO planes. It is important to apply carefully to prevent excessive weight buildup. The CA cures fast, but is heavier and harder to dissolve than Cellulose glues.

<u>Trim Parameters</u>

1. **Wing Incidence**. The angle of the wing relative to the motor stick, with positive being the leading edge higher than the trailing edge. Add positive incidence to address a dive.
2. **Stabilizer Incidence**. The angle of the horizontal stabilizer relative to the fuselage or tail boom, with positive being the leading edge higher than the trailing edge. Add negative incidence to address a dive.



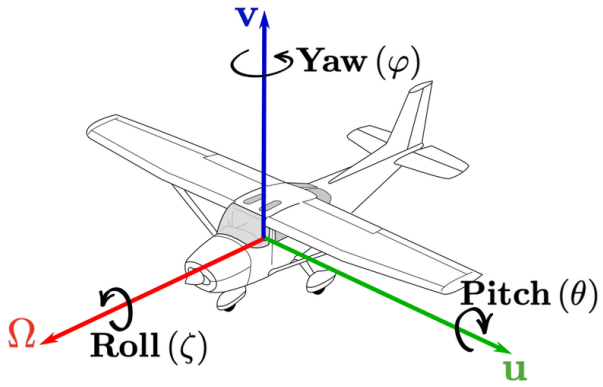
3. **Decalage**. The difference between the wing incidence and stabilizer incidence. Increasing decalage will address a dive, decreasing will address a stall.
4. **Center of Gravity (CG)**. This is the fore/aft balance point of the plane in flying condition. The CG affects stability. Moving forward relative to the wing increases stability, but requires more decalage, reducing efficiency. Moving back reduces stability, but may increase efficiency. An unstable plane will dive sharply upon disturbance such as hitting a rafter. On planes with sliding wing saddles, moving the wing forward moves the CG back relative to the wing, and vice versa. For most SO planes the CG is measured relative to the rear of the wing, or as a percentage of the root chord of the wing.
5. **Tail boom offset.** The vertical stabilizer is offset to the right at an angle to help induce a right turn. This can be just the vertical fin or the entire tail boom.
6. **Stabilizer tilt.** The horizontal stabilizer is tilted relative to the wing, with the right tip higher than the left tip. With a lifting stabilizer (if it has an airfoil), the lift is now directed slightly to the right, pushing the tail to the right or the nose to the left. Tail tilt is most effective at slower speeds after the transition from climb to glide.
7. **Wing wash-in**. **(aka wing warp or twist).** The leading edge of the wing is higher than that of the opposite wing, relative to the trailing edge. The wing essentially has a twist, creating more lift on the the side with the higher angle of attack.

Launcher Parameters

The launcher consists of a stick and a loop of rubber to shoot the glider into the air. The stick may be just big enough to fit the modeler's hand, or may be up to 1m long with markings to determine the pull-back distance, elevation angle, and roll angle.

1. **Rubber Width.** This is the cut width of the rubber loop. The wider the motor the more force it applies for a given pull back distance. Ideally the rubber is selected such that the plane is pulled the full stretch of the students arms, or nearly full length (1m) of the measured launcher, in order to limit the acceleration rate when the plane is released.
2. **Rubber Thickness.** The stock thickness of the rubber, generally around 1mm (0.040"). This thickness varies due to the manufacturing processes, and is not controllable by the user. Thickness typically can vary 5-6% within a batch of rubber, and can vary more than 10% batch to batch.
3. **Rubber Linear Density.** This is a characterization of the rubber "width" in g/in (typical mixed units), which accounts for variations in thickness and density. The power of the rubber corresponds well to the linear density. This is a preferred method of characterizing a piece of rubber. The actual density (g/in^3) does not vary much, so the linear density is generally proportional to the cross-sectional area of the rubber.
4. **Rubber Loop Length.** The length of the rubber loop before stretching. Once it is used some, it will be longer. For consistency we usually record the loop length of the stock rubber before use.

Flight Characteristics



1. **Roll.** The plane rotates about its fuselage. Typically, the glider is launched with some degree of roll (right roll for a right-handed launch), adjusted to obtain a good transition at the peak of the flight.
2. **Pitch.** The plane rotates about the left-to-right horizontal axis of the plane, with the nose going either up or down relative to the center of the plane.
3. **Yaw.** The plane rotates about a vertical axis, with the nose moving to the right or left relative to the center of the plane.
4. **Elevation.** The plane is launched upward at an angle, called the elevation angle, to convert the potential energy in the launcher rubber into altitude. The angle may vary form 30 to 90 degrees depending on the trim of the glider, and is an important measurement for flight consistency.
5. **Lift.** An upward force on the airplane generated by the flying surfaces.
6. **Thrust**. A forward force on the airplane generated by the launcher rubber loop
7. **Drag.** A rearward force on the airplane caused by friction and aerodynamic forces on the plane. Drag increases with speed. Drag is caused by the frontal area and by aerodynamic forces on the lifting surfaces. Generally lift-producing surfaces will also produce drag.
8. **Angle of attack**. The angle of the wing flying surface relative to the direction of travel. Increasing the angle of attack will increase the lift (and drag) of the plane until stall occurs.
9. **Stall.** The wing of the plane reaches a high enough angle of attack that it fails to generate lift, and the nose of the plane drops. The plane recovers (typically) and then repeats the cycle. A stall may be induced by too much decalage or in some cases a CG too far to the rear.
10. **Dive.** The nose of the plane pitches downward continuously while the plane picks up speed. A dive may be induced by insufficient decalage, a forward CG, flaps that are too soft, or damaged parts. An unstable plane may dive and not recover after a disturbance.
11. **Stability.** The ability of the plane to recover from a disturbance such as hitting a girder or rough air. An unstable plane will lose a lot or all of the altitude after a disturbance, whereas a very stable plane may only lose a few inches of altitude. An overly stable plane may not be as efficient as a neutrally stable plane. Stability is affected by the CG location relative to the lifting surfaces.