HAND LAUNCH GLIDER AIRFOILS (Part one of two parts)

By Curt Stevens

Reproduced with permission from Chris Weinreich, who first published the article as editor of The Bat Sheet, Newsletter of the Strato-Bats of Puget Sound. The article was also in the August-September 2002 Issue of the Florida Modelers Association Newsletter, Frank Braden III, Editor
(Although the article focuses on indoor gliders, there is much here to enlighten builders of all sorts of gliders — ed)

This article was taken from the web site of Model Research Labs, Curt's company. The site is well worth looking at for Curt has a variety of goodies for the free flighter. *http://www.modelresearchlabs.com/index.html*

HLGs are simple flying machines; it's the flying indoor and the digital stopwatch that complicates things. Those factors separate the theorist from the flyers...and the bullshit from the real world.

I have spent 50 years in the real world of the Hand Launch Glider. I have won both indoor and outdoor hand launch at the Real Nationals. I have held both indoor and outdoor records many, many times. I held both indoor and outdoor records for about 10 years after I quit flying hand launch. My two sons won the Nationals and still hold Junior and Senior hand launch records they set in the 1970s. My point in all that is; you never once beat me in any HLG contest. Only those who beat me can prove I'm wrong. Ed Sobot beat me once, Dick Peterson beat me twice, Lee Hines beat me once, and Ken Happersett beat me once. Each time I learned more than they did, and came back better prepared, so can you.

Weight. In the real world of serious Indoor Hand Launch Glider competition weight is where it's at. Weight is the single most important factor determining glider performance. Weight is also the second and third most important factors.

When a glider is over weight *(there is)* nothing that will save it. Indoors there is no magic strong enough to rescue a poorly built glider...stopwatches are not impressed by manure, no matter how deep it's piled.

The ideal weight for a conventional hand launch glider is about 1 oz per 100 sq. in. of wing area. Windy weather outdoor gliders are just barely competitive at 1.5 oz. per 100 sq. in of wing loading. Anything heavier and you might just as well be throwing golf balls at the thermals. Only after you have convinced yourself that weight is by far the most important factor in small model performance, only then can you turn your attention to the minor details.

Drag: Drag is the fourth most important thing to a HLG. Drag is a relatively minor item compared to weight.

Thou shall never add any drag reduction details that increase flying weight, unless of course, you need to increase weight for a good reason. The only good reason I know of is to get the model higher. Indoors you should fly a model that uses all of the available ceiling height. But remember that heavier models have a difficult task in slowing down and making that first turn at the top. Better to be a bit too light rather than a bit too heavy.

In the climb portion of the flight, drag increases roughly on the square of the frontal area of the model. In the glide portion of the flight, drag increases roughly on the cube of the weight. These are two very simplified rules that contain much of our low speed and low Reynolds number knowledge.

Wing. The fifth most important thing to a HLG is the wing. The wing is the only part of a HLG that actually contributes anything to the end result. Everything else is extraneous matter along for the ride. The stabilizer is just that, it stabilizes the wing and keeps it operating at the optimum angle of attack.

The rudder provides directional stability in the climb phase, nothing else. The fuselage's sole purpose is to hold everything together in their correct positions. The correct positions are as follows: High wing, low nose weight, and low stabilizer, and also of course a very low moment of inertia. The important thing to remember is that although the wing is the only functional part of the HLG, it is number five on the list of important factors and it's still just a minor factor compared to flying weight.

In wing design the most important factors are wing platform, wing section, airflow turbulation, and dihedral. Dihedral must include polyhedral break locations and amounts of dihedral, in relation to the lateral areas and vertical locations of such areas of the rudder and of the fuselage.

There is no magic gee haw you can glue on and suddenly become a contest winner. There simply is no magic.

In 50 years I have built well over 1000 gliders, no more than six or eight were identical. I test in the real world. I keep records. I keep that which is of value and discard that which is of no value. The wing section I have currently settled on is a simple flat plate with an expanding logarithmic spiral curve on the top surface to delay the stall. I do not expect the top surface of the wing to produce much useable lift.

In the world of the HLG, about 90% of the lift is produced on the bottom surface of the wing. With a properly undercambered section, that number is perhaps 95%. The main reason for a curve on the top surface of the wing is to control drag at the very high angle of attack that is required to fly slow and rack up glide time. Your wing produces lift by displacing air downward, equal to the weight of the glider. The lighter the model the lower the required airspeed, the lower the airspeed, the lower the drag, and the lower the drag the lower the sink rate and the better the flight times. No kidding, there is no magic here.

Lift. All wings with their associated airfoils produce exactly the same amount of lift. All wings produce lift exactly equal to the weight of the model, it's just that some do it with less drag.

A typical flat bottom airfoil produces only about 3-5% of the lift on the top surface. Another 3-5% is produced by down wash behind the trailing edge, much of this down wash is a result of the curve on the top surface. Undercamber will

increase lift drastically by increasing the down wash drastically, however undercamber increases drag even more drastically at low angles and high speeds. Remember that a properly launched HLG leaves your hand at a speed of over 100 MPH. Really. If yours don't, you are not throwing hard enough

We take exception to Bernoulli's law for hand launch gliders. Bernoulli's law really does not have much to do with wing sections. He was a 17th century scientist who published a book in which he proved that the sum of static and dynamic pressures over a streamline shape always remain constant.

For years our teachers, none of whom ever read the book and didn't understand the physics, have been teaching their unquestioning students that the air over the top of the wing has to travel further that the air over the bottom of the wing. Therefore the air over the top of the wing has a lower static pressure and produces all the lift we need.

My teachers also injected the little know fact that the air molecules that separated at the leading edge had to really speed up in order to rejoin the same air molecules again at the trailing edge. This is all sort of true under certain conditions. The sad news was that I for one believed them, even when I knew that there was something wrong and things did not add up correctly.

The air molecules that separate at the leading edge of the section never ever meet again at the trailing edge. There are at least 20 good reasons for this but one major reason is the span ward flow of those air molecules on the top of the wing. The very best reason for them not meeting again at the trailing edge is simply that there is no good reason why they should.

Wind tunnel data collected within a confined airflow-type tunnel is almost totally useless. Not totally useless, but almost. Hand launch gliders fly at a very low Reynolds number and at an angle of attack that is unbelievable to the old school of aerodynamics. In the climb portion HLGs operate at near a -1 degree angle and in the glide portion we float along in the range of +12 to +18 degrees.

Part Two will appear in the next exciting issue of The Thermalier!!