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R/C Radio controlled SOARING DIGEST

THE JOURNAL FOR R/C SOARING ENTHUSIASTS

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CONTENTS

About RCSD

R/C Soaring Digest (RCSD) is a reader-written monthly publication for the R/C sailplane enthusiast and has been published since January, 1984. It is dedicated to sharing technical and educational information. All material contributed must be exclusive and original and not infringe upon the copyrights of others. It is the policy of *RCSD* to provide accurate information. Please let us know of any error that significantly affects the meaning of a story. Because we encourage new ideas, the content of all articles are the opinion of the author and may not necessarily reflect those of *RCSD*. We encourage anyone who wishes to obtain additional information to contact the author.

RCSD Staff & Feature Columnists

The Soaring Site

Dear *RCSD* Readers,

Shortly after the July issue went up on the web site, Judy asked Bunny and me to serve as temporary editors for *RC Soaring Digest*. This is both an honor and a privilege, and we sincerely thank her for asking us to fill in for a while. Her confidence in our abilities is inspiring and we're going to do our very best to meet the challenges which are sure to surface.

Judy has been working with us quite extensively over the past few weeks in an effort to make the transitions as smooth as possible. Despite everyone's best efforts, however, we're sure to hit a few snags. Bunny and I very much appreciate constructive feedback, so don't be hesitant to let us know if you think of ways to improve *RCSD* or point out a glaring error in typography, layout or information.

Alyssa and her newly completed Diva - painted, covered, and ready to fly! Diva has 1000 square inches of wing area and a 123 inch span; overall weight is 56 ounces for a wing loading of 8oz./ft^2. Despite numerous positive comments on her good looks, Diva has proven to be a real handful to control, particularly in pitch, and flight testing continues as this issue is published. All the details are laid out in this month's "On the 'Wing..." column!

RCSD is a "reader written" publication and as such we rely on contributions which spontaneously arrive in our e-mail and conventional mail boxes. If you have a particular interest or project which you believe other *RCSD* readers would like to know about, please contact us. Single photos, contest announcements, suggestions and questions are also welcome. With this in mind, we've set up a temporary e-mail box specifically for *RC Soaring Digest* correspondence. The address is <RCSDigest@themacisp.net>, and all contributions should be sent directly to that address until further notice. We do have quite a bit of free server space for e-mail, so don't be afraid to send large files — up to around 5 MB is OK. If you need to send something larger than 5 MB, please check with us first.

A couple of notes of interest:

• Mark Shryack is looking for an ASW 12 kit, fuselage, plans... well, pretty much anything. He has the 3-views from Bob Banka, but is looking for something to really get him started. You can pass on information directly to Mark at <tmshryack@aol.com>.

• The CVRC Fall Soaring Festival will be held this year on October 2nd and 3rd. 2004 will mark the 31st year of this annual CVRC contest. There's a limit of 325 entries, and while this sounds like a lot, it may already be too late to get a spot. Entry forms are available on the CVRC web site <http://www.cvrcsoaring.com/fall_fest.htm>, and this year entry fees can be forwarded via PayPal.

As you can see from the facing Contents page, this issue of *RC Soaring Digest* has a wide variety of material to present, from two technical treatises to a photo essay, with lots of stuff in between. We needed to add four pages to the usual complement in order to get everything to fit!

The September issue of *RCSD* will be posted to the *RCSD* web site during the latter part of August. If you'd like to receive e-mail notification when the issue is posted, simply join the RCSoaringDigest group on Yahoo!

B2

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TECH TOPICS

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After a hiatus of several months to handle a retirement transition (what day of the week is it, anyway?), I've had a bit more time to get out to the flying field lately. One thing is readily apparent - it takes more than a few sessions to get your timing right. Oh, the basic flying skills are still there (some might question that!) but the little details of approach height, turn coordination, etc. are a bit rusty. Consequently, most of the sessions have been spent relearning the details of launching, landing and trimming a sailplane.

V-TAIL

Although the technology for producing hollow molded wings has made fantastic progress, both in quality and value, there's very little you can do to modify one of these wings if it doesn't fly exactly the way you'd like. The last two planes of this type that I have flown are, in my opinion, low in dihedral angle. In one case, the included dihedral angle was about 2.5 degrees; the current plane has about 3.5 degrees. Experience has told me that I prefer about 5 degrees for an aileron ship and about 10 degrees for an RES.

challenge of setting up the proper turn coordination for this ship motivated some reading and experimenting. An excellent on-line reference for help on this topic comes from DJ Aerotech's web site and the "Ask Joe and Don" column. Joe Hahn and Don Stackhouse have generously shared a great deal of experience on their website. It's one of my favorite bookmarks whenever I'm looking for background on most flying subjects. http://www.djaerotech.com/index.html

The DJ website discussed several questions related to V-tail differential and wing dihedral – all of which fit the types of behavior I had been experiencing.

Picture 1

The equipment I'm using is a sport winch and a new, hollow molded wing (and stab) two meter sailplane. Added to the mix is an Eagle Tree Systems flight data recorder. The latter has been a great tool for looking at launch conditions, trim setup, polar evaluation and the general health of the flight pack. We'll discuss the results of that analysis in another column.

While trying to trim out the new two meter, a number of interesting challenges were encountered and some knowledge gained that I hope is worth sharing. The first topic is V-tail differential; the second is a more in-depth look at turbulator strips.

A symptom of insufficient dihedral angle is low spiral stability – the tendency of the nose to fall into the turn once a stable bank angle has been established. With a low dihedral wing, you generally have to hold a bit of opposite aileron and a titch of up elevator to maintain the proper bank angle and velocity. The upside for this extra effort is very nice roll sensitivity when you're looking for lift; a downside is trying to handle this same roll sensitivity when you're flying at the edge of your visual capability.

Once you have the plane trimmed well, low dihedral is manageable. However, the

In particular, a good V-tail setup should not have any significant pitch response when the V's are used in rudder mode.

When a V-tail is deflected for rudder action, the V-stabs move in opposite directions – i.e. one side goes up while the other goes down. See above photo (Picture 1). In this way, the pitch direction lift components are nearly canceled while the yaw direction forces are reinforced. If the pitch cancellation is incomplete, some up or down response will be observed.

A way to check this out (as per DJ) is to set the plane in a straight and level cruise and then give a full deflection of the rudder stick and hold that deflection momentarily. The initial response should be in the yaw axis only. From a decent launch height, you should be able to execute this maneuver several times for both left and right rudder deflection.

In my case, the plane exhibited a significant pitch up for either yaw direction. What this meant was that the V-tail 'rudder' deflection was not well balanced in pitch .

This pitch response explained one of the trim issues. When entering a thermal turn the usual control input is to roll the plane with ailerons and then pull it through with elevator. For this ship, the low dihedral required a significant amount of aileron differential and rudder coupling to counter adverse yaw. The rudder coupling inadvertently provided an up elevator response – which was fine for initiating the turn.

After the turn was established, opposite aileron was required to hold the turn (due to the low spiral stability from the low dihedral angle). This tended to negate the elevator input and allowed the nose to fall.

Three flights later, all was well. For this ship I actually needed 80% up vs. 100% down to take out the pitch response. Once that was done, the tracking in the turn was much more consistent and the pitch sensitivity, especially while turning, was very manageable.

How to setup V-tail differential? Each radio supplier will probably list different coupling methods on their web sites. I fly a Futaba 9C (H) and found the easiest way was with end point adjustment.

V-tails are normally run on channels 2 and 4 with a V-tail programmable mixer. By limiting the 'up' or 'down' travel on your endpoint menu, you should be able to get whatever differential you need. The total throw for the V tail can then be compensated in the mixing menu once the differential is established (normally V-tails require more rudder throw than elevator).

I'm sure other folks have more sophisticated ways of setting up V-tail differential. Up until this experience, I had not used differential but had assumed that if the throws were mechanically balanced (same amount of up and down deflection) everything was copasetic.

Mechanically yes; aerodynamically no. If you haven't checked your V-tail setup lately, try a few trim flights to see if it's working properly - and check out Joe and Don's website – good advice and good products, too.

TURBULATORS

This topic is more speculative in terms of the final outcome but I think is worth reviewing. With the advent of molded wings and stabilizers, I believe we have the potential for a problem due to the low Reynolds number of our control surfaces and the high quality of the airfoils and surfaces. Sounds a little counter intuitive so let's review the short version of this issue.

Professor Michael Selig, in a series of experiments at the University of Illinois ("Summary of Low-Speed Airfoil Data", Volumes 1-3), has provided a rich source of information for R/C sailplane enthusiasts. Professor Mark Drela of MIT, has provided a terrific complementary tool in the X-Foil program. Both sources have highlighted a problem with certain symmetric airfoils which are often used for horizontal and vertical stabilizers.

Volume 2 of the UIUC research summary defines the topic of 'dead-band' for thin, symmetric airfoils. 'Dead band' is a region of flow in which the change in Cl (and Cd) with angle of attack is nonlinear and may exhibit hysteresis. That is, the specific Cl observed at a given angle of attack depends on whether that angle of attack is being approached from a lower or a higher angle. In particular, Prof Selig's group observed that the NACA 0009 exhibited poor lift linearity at low angles of attack, typically between -4 and +4 degrees (Vol 1).

X-Foil can be run for the NACA 0009 and, for low Reynolds numbers, clearly shows the presence of a large separation bubble around + or – 3 degrees angle of attack for Re of 60,000. The onset of separation occurs around + or – 1 degree and continues to about + or – 3.5 degrees. Separation is due to an unfavorable pressure distribution which does not allow the transition bubble to reattach well over these angles of attack. Consequently, both the lift and drag coefficients are somewhat erratic in this region.

Now consider the results of a polar analysis of a typical 2 meter sailplane – a topic we've discussed in this column at some length. We find that the normal angle of attack for the wing will be in the range of 3 to 6 degrees. That range spans the Maximum L/D to Minimum Sink range of the polar.

The normal decalage for the horizontal stabilizer is around -1 degrees. When the downwash from the wing is considered we find that the most desirable part of the polar curve places the horizontal stabilizer smack in the worst part of the separation regime. This could be a problem.

Figure 1 shows the X-Foil Cl and Cd response vs angle of attack for the NACA 0009 airfoil at Re = 60,000. For this example, the transition criterion in X-Foil was set to encourage laminar flow conditions (Ncrit = 12). The result of the separation bubble in the region below 4 degrees angle of attack is apparent.

Also in Figure 1, the X-Foil result for Cl and Cd at Re = 60,000 is shown for Ncrit =1, which encourages early transition of the flow. As can be seen, the transition problem is essentially eliminated. A closer examination of the pressure distributions for the Ncrit =12 case shows the onset of the transition at around 40% of the chord. This unfavorable pressure distribution is eliminated for Ncrit = 1.

Figure 2 shows a screen capture of X-Foil output for this case. Note that the flow attachment, as seen in the pressure distribution, is much better for the turbulent case (Ncrit=1). Note also that Cl is increased by almost 2x while Cd is reduced significantly.

Although laminar flow is favorable for lower drag, that result is only obtained when the flow

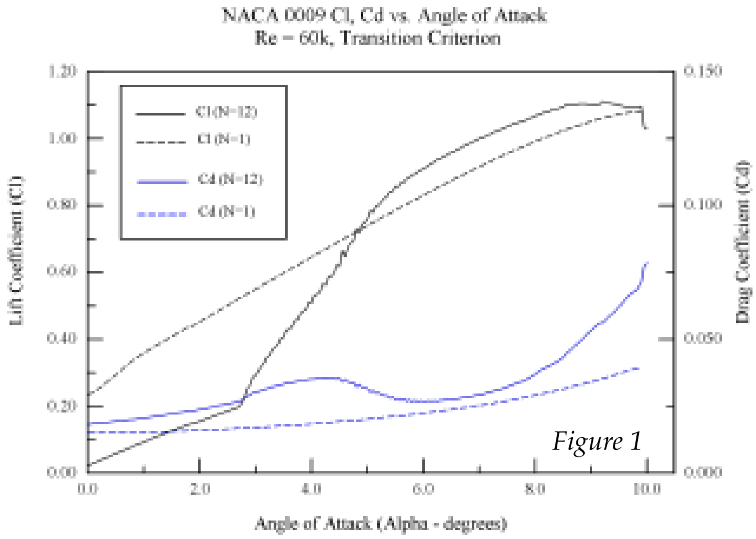


Figure 1

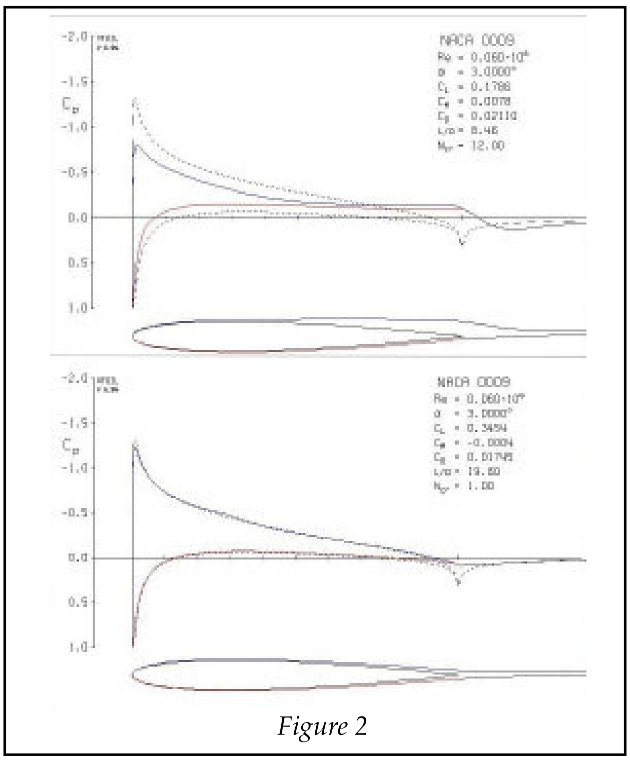


Figure 2

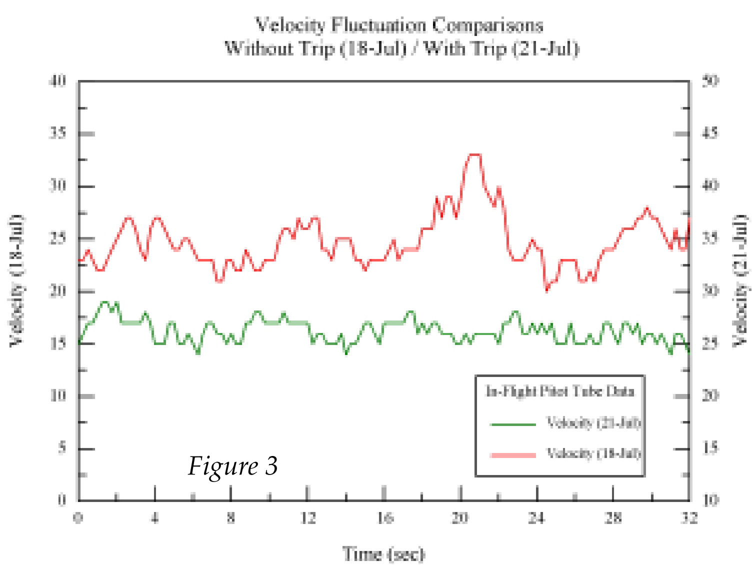


Figure 3

stays attached. For every airfoil, there will be a region of laminar flow near the leading edge. However, at the Reynolds numbers for normal R/C sailplanes (> 50,000), it is difficult to maintain laminar attachment across the entire chord. Thus, management of the transition to turbulent flow and reattachment of the 'bubble' is critical for good airfoil performance. The older symmetric sections often used for stabilizers were not designed to operate efficiently in the low Re regime.

Prof. Selig's solution to this problem was to redesign the stabilizer airfoil to give better control of the low angle of attack transition region. One such airfoil is the S8025 and it appears to be very successful at handling this problem.

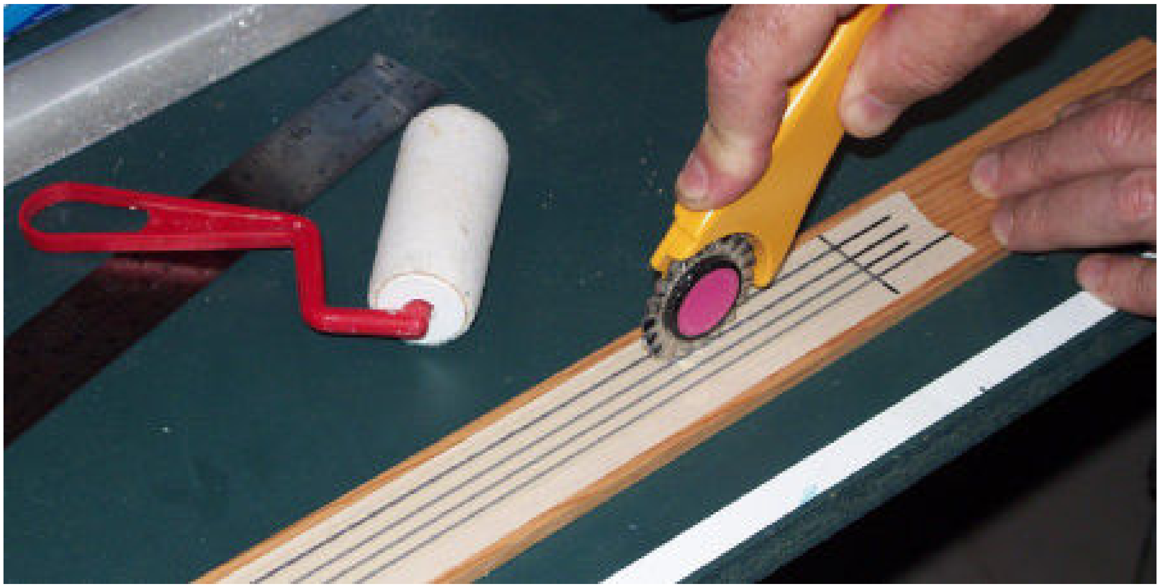
However, what if we suspect the stab has a separation problem and it's a hollow core molded tail surface? How would this affect the flight characteristics? What would one do to solve the problem?

A potential flight response to the 'dead band' problem might be the tendency for the plane to have poor pitch tracking, especially at slower flight speeds. Slower speeds are achieved near minimum sink and higher angles of attack. Under these conditions, the Reynolds number is low and the stabilizer angle of attack is in the region we've highlighted.

At a slow enough speed, the horizontal stab loses efficiency. If no stabilizer control input is made, the nose of the plane will drop, speed will increase and the stab airflow will reattach. Once the stabilizer establishes good airflow, its effectiveness increases and the nose rises again.

Unfortunately, this 'scalloping' type of flight may be difficult to distinguish from a bad CG / decalage combination. It's very important to be sure both of those are correct before assuming there's a problem with the stabilizer – that's why we wrote those articles about the CG and Incidence meters a few months ago!

Probably the most distinguishing characteristic I've found is the tendency for the plane to 'hunt'



Picture 2: Making turbulator strips with an Olfa rotary pinking cutter

in pitch, especially when trying to fly at or near minimum sink. In this case, the plane does not actually stall but requires many small elevator corrections to maintain level flight. Since this is a subtle observation, the cure - if it works - will give a subtle (and probably subjective) result.

How to 'fix' this problem? Since we want to encourage reattachment of the transition bubble, a 'trip', or turbulator strip, seems to be the best answer. Fortunately, Volume 3 of the UIUC study also provides some excellent summaries on trips. I encourage you to study the details of Chapter 6 of Volume 3 of Prof. Selig's work. In this section, a detailed analysis and measurement program was undertaken. For application purposes, I'll give a brief summary here.

Both 2-D (linear) and 3-D (zigzag) trips of various dimensions and locations were evaluated in the UIUC study. The width of the trips did not seem to be critical. The thickness was important and is most efficacious at around 0.005" to 0.015". Position on the wing should depend on the location of the transition bubble but appeared to be highly effective (for the airfoil studied) at anywhere from about 15% to 50% of the chord.

No dramatic difference was seen between 2-D and 3-D trips. However, for all the cases studied, a noticeable reduction in drag was experimentally observed when a trip was used. The effect is more pronounced at low Re and is less noticeable for airfoils that are designed for good transition control. The E374, for instance, benefited significantly from a trip while the SD7037 did not.

For my purposes, a zigzag (3-D) trip of 3/16" nominal width and 0.010" height was used. It was placed at the 25% position on both the upper and lower surface of the horizontal stabilizer. This turbulator can be seen in Picture 1.

Picture 2 shows a very simple way to make this device. A piece of wood is first covered with masking tape. The width of the turbulator strips are marked on the masking tape followed by two layers of clear wing tape. Most wing tapes are about 0.005" thick so two strips will give the desired thickness.

Once this layout has been prepared, a rolling Olfa pinking cutter is run along the marks. Be sure that the flutes of each cut start at the same location. Once all the strips have been cut, they can be lifted off the masking tape and attached to the appropriate location on the wing. After laying down the trips, the tape is rolled down with a small paint roller (seen in the picture).

Off to the field for flying evaluations. Since the original observation was somewhat subjective, I'll allow that the final result may also be subject to interpretation. However, it seemed apparent to me that the pitch problem ('hunting') had been eliminated. Slower, more stable flight was routinely achieved without any apparent loss of efficiency.

As partial verification of this outcome, the flight speed of this plane was measured with the flight data recorder. Typical velocity vs. time samples from flights before and after installing the turbulator are shown in Figure 3. Note that the 'before' trace (18-Jul) shows a characteristic oscillation of the velocity ('hunting'). That effect is almost completely eliminated in the 'after' data (21-Jul).

Admittedly, this result is subject to some interpretation. However, it does appear that near minimum sink, our horizontal stabilizers are flying in an unfavorable operating regime. It is my opinion that the irregularities inherent to built-up stabilizers have probably masked this issue. Spars, longerons, leading edge tape and Monokote seams can all be effective triggers for flow transition.

Although this topic is a somewhat obscure area of study, it may be an important point for deriving the best overall performance from the improved capabilities of molded, high quality R/C sailplanes. As we move to more affordable molded sailplanes, careful selection of the stabilizer airfoil should be considered so as to derive the best benefit from this technology.

on the Wing

B²

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DIVA, PART 5

Diva is complete and has been flown somewhat successfully! This column is devoted to covering and painting the airframe and descriptions of initial test flights. Contrary to plan, however, it will not be the last article in the series, as we still have some adjustments and modifications to accomplish and which need to be related to those wishing to build their own rendition. Read on!

Color scheme

Despite spending substantial time looking over the paint schemes in *Hot Rod* magazine, Alyssa did not find any which she thought appropriate for Diva. Skulls, flames, colorful geometric shapes and 3-D shading were all cast aside in favor of a more simple covering theme which would be easy to apply over the sheeted areas of the wing and vertical stabilizer.

As we had two full rolls already, we had agreed ahead of time to cover the entire bottom of the wing with metallic charcoal, a CG Ultracote Plus color. Ultracote tends to feel a bit thicker than conventional Monokote, and in our experience remains "softer" and a more pliable after shrinking. This makes it ideal for a wing lower surface where the covering must be resilient to puncturing forces from grass, and small sticks and rocks.

At the hobby shop, Alyssa became enthralled with the Monokote pearl colors. She finally settled on pearl red and green with pearl white as the main color. Pearl purple became the trim color after going through and discarding a couple of yellows.

The choice of covering colors pretty much dictated the fuselage be painted white, so we looked for white dope, finally digging our way through two baskets filled with cans and jars of various colors. We finally found several one ounce glass bottles of AeroGloss semigloss Swift white. We collected six with a large amount of diligence, and purchased all of them.

Using several copies of the Diva 3-view published previously, a large number of color designs were drawn out using crayons and colored pencils. Alyssa looked over the more than dozen possibilities and settled on the one most simple — the colored portions would be long and narrow, and all placed over sheeted areas. Red at the leading edge, green behind, with the purple trim used to separate the colors.

Painting

The entire fuselage and wing fillet combination had already had a number of coats of AeroGloss clear applied. Sanding between each coat enabled the clear dope to fill the weave of the fiberglass and provide a smooth surface for the color coats. We didn't bother with any sort of primer. As all of the fiberglass weave was filled, we started brushing on thin coats of white directly over the existing substrate of 'glass and clear dope. Four coats were needed to completely cover the wood color which came through the clear layers. A couple extra coats were applied to the lower front end of the fuselage, as that area tends to get a lot of abrasion.

Covering

We started by covering the bottom of the wing with the Ultracote metallic charcoal. While we were very pleased with the red Ultracote covering applied to our large cross-country Blackbird, this metallic charcoal was much more difficult to work with, especially when it came time to bond the covering to the balsa. Ultracote requires the covering and balsa both be heated, and a cool cloth then applied to press the covering to the balsa while everything cools. This must be done slowly and carefully or the covering will not stick to the balsa. Rather, it tends to grow bubbles across huge areas over a period of days. After several weeks, we still find ourselves reapplying the covering in some areas.

We also had problems with the Monokote pearl colors. The pearl white was applied first, and it went on very easily. This color is not as opaque as we had anticipated, and in certain lighting conditions the interior of the wing can be discerned. This is OK, but not what we had anticipated. As well, the pearl red and pearl green were extremely difficult to apply when used over other covering. These colors were a delight to apply over balsa (the entire structure had been dried out with a heat gun before covering commenced), but the number of small bubbles formed over previously covered areas was no less than astounding. We resorted to using an extremely

fine pin to puncture one side of each bubble, and then carefully manipulating the bubble with the covering iron to expel the trapped air. This worked well, but was extremely time consuming.

Preliminary balancing

As the leading edge of the wing forms a straight line, the mean aerodynamic chord can be determined quite easily. The span without the fuselage is 120 inches and the total wing area is 1000 square inches. The MAC, therefore, has a chord of 8.33 inches, so the MAC quarter chord point is 2.08 inches behind the leading edge. We marked the neutral point and 2.5% and 5% static margin points on the fillet stubs for future reference. It should be noted that these points are roughly 3/16" apart, so balance is critical. We initially set the static margin at 5%, with the CG 0.4 inches ahead of the neutral point. Since we're using the BW 05 02 09 section, we also predicted the CG would eventually be located back at the 2.5% static margin point.

Test flying, Part 1

Hand launching a tailless aircraft of this size (123 inch wing span) is always problematic. The hope is that the aircraft can be thrown with enough force that flight speed can be approximated, yet with force insufficient to create a severe nose up moment which would cause a stall and unrecoverable dive to the ground. But with the static margin at 5% and a small amount of up elevator trim, we felt confident Diva would manage to glide at least somewhat smoothly to the ground. That was not to be.

Rick Helgeson, fellow SASS member and an experienced pilot, volunteered to handle the transmitter for the hand launches. The first two launches ended abruptly with Diva nosing into the ground. Quite a bit of weight was removed from the front end over several more tenuous but more successful glides. Because of its high aspect ratio and accompanying low inertia, Diva is very quick in pitch once the CG is moved back, so from there it became increasingly difficult to determine when increased sensitivity was in reality loss of control.

Flight distance kept increasing with each hand launch, but it became easier to over control as the CG moved rearward, so elevator deflection was switched down to 40% of normal. Despite this adjustment, the last flight of the day was actually more like a semi-controlled crash, with Diva touching the ground with left yaw and the sub-fin splitting open in the area where contact was made.

Rick, feeling he was guilty of breaking a perfectly good airplane, apologized profusely. We countered no apology was necessary from our point of view — we see Rick as a much better pilot than ourselves — we had simply removed too much nose weight at one time, leading to rapid changes in pitch which no pilot could follow and correct, especially

with so little height available. Additionally, the damage was barely more than superficial and easily repaired.

Test flying, Part 2

We needed a relatively low but steep slope to continue flight testing. One of the local schools has two fields, each about the size of a football field, oriented in an L shape with a 16 foot high 40 degree slope separating them. The slope is filled with Scotch Broom, a rather dense woody and firm thornless plant, at this time of the year. We considered this an ideal slope for our purposes. Before the first launch we added some nose weight, hoping to have the same balance point as the last successful flight.

As the wind was coming across the slope at an angle, the first launch was slightly canted into the prevailing air movement. Good thing the Scotch Broom was thick, as the first launch ended with Diva diving into the thick of it. The elevator was not sensitive at all, and in fact was barely sufficient to change the pitch attitude before the aircraft was held firmly by the shrubbery.

A small portion of the weight which had just been added was taken out and another launch attempted. The initial dive was immediately counteracted with up elevator, but not before Diva grazed the top of one Scotch Broom and performed a flat spin into the outstretched limbs of a larger companion plant.

A third attempt, initiated after another small amount of weight was removed from the nose, was successful. Diva traveled 70 paces across the lower field before touching down. Elevator authority was good, but not overly sensitive, so more weight was removed from the nose.

Several more successful test flights were then made, with smaller amounts of weight removed with each success. This process extended the flight distance each time, and the elevator became increasingly sensitive, as expected.

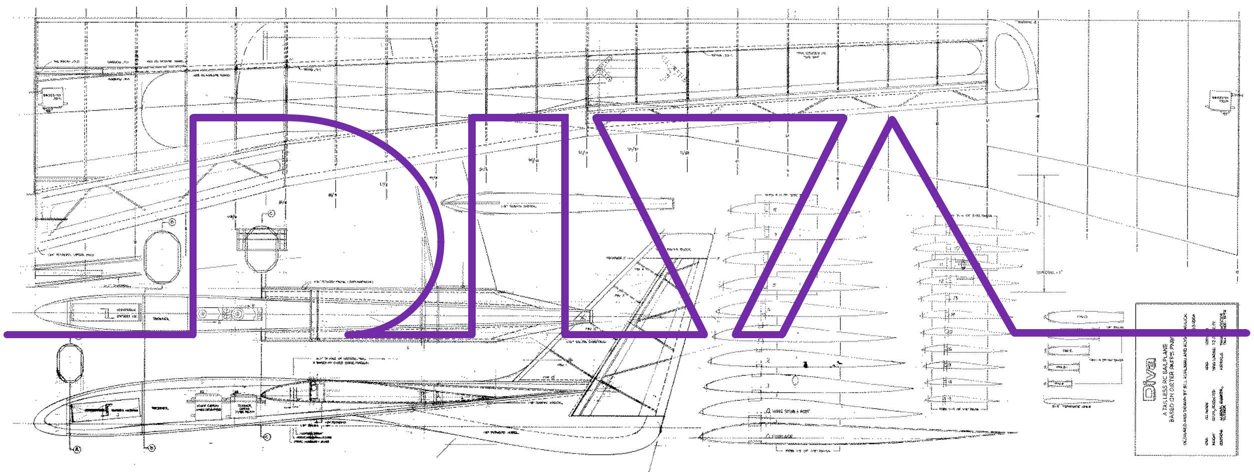
When evidence of pilot induced oscillation was observed, we replaced the weight just removed and performed one last test flight. This flight covered 150 paces, more than double the distance of the first flight.

Once home, we put Diva on our balance stand. The CG was exactly on the point marking the 2.5% static margin!

Test flying, Part 3

While we were fairly comfortable with the CG location and elevator authority, thoughts of a winch

State	Components	Weight	Total
Bare framework	wings with servos and wiring	~600 g	
	fuselage, fin and rudder, with servos, receiver, battery pack and all wiring	~600 g	
	wing rod	84.5 g	~1330 g, ~47 ounces
Completed framework with 'glass, paint, and covering	wings as above	719 g	
	fuselage, fin and rudder as above	671 g	
	wing rod	84.5 g	
	nose weight	108.5 g	1583 g 55.8 ounces 8.0 oz./ft^2
Comparisons	Dieter Paff's PN9f		1692 g 59.7 ounces 8.5 oz./ft^2
	Martin Simons' PN9f		2815 g 99 ounces 14.3 oz./ft^2



launch produced a lot of anxiety. We needed some height to get Diva trimmed out, and the only way to do that was through a winch launch; but just the thought of building line tension and releasing the aircraft to the wilds produced an accelerated heartbeat.

After arriving early at 60 Acres, we immediately set upon putting Diva together. Safety being a concern, we wanted the first winch launch to be with as few people on the field as possible.

We should not have been so anxious regarding winching Diva into the sky, as upon release she climbed out straight and steep with no tendency at all to veer off course. Rather than stressing the airframe, we let Diva slide off the line from a moderate height. The initial 90 degree turn to the left was very smooth, and it was evident the aileron differential and rudder mixing was very close to being right on the mark.

The straight glide to the east started getting steeper, so a small amount of back stick was applied. This leveled the flight path, but as soon as the elevator was neutralized the glide again became more steep. Despite the first signs of panic, we managed another left turn.

This time the bank got steep quickly, but at least the aircraft was not plummeting to the ground on a wing tip, and opposite aileron rapidly rolled her out of the turn and heading away from the field, completing a 480 degree turn. But she was diving again. The elevator was overcontrolled, Diva pitched up, then fell nose down, and recovery was into a 360 degree right turn. The ground was closer now and panic was indeed beginning to take over. Luckily, Diva was flying toward the main field and over the area with tall grass, and we managed to get her level and see a relatively smooth flat landing well out.

Exploring the problems

Once safely on the ground, we immediately began thinking about the reason(s) for the flight behavior. Diva is based on Dieter Paff's PN9f design, a model of a potential full size sailplane. We knew from the original White Sheet article that three of Dieter's models were lost during testing due to elevator blow-down.

As the PN9f used circa 1980 servos with around 42 ounces of torque, we felt a Hitec HS-605BB with 76 ounces of torque would be up to the task, eliminating the elevator blow-down problem. But in testing at home, we found the servo arm could be moved about 1/32 inch each side of neutral through the pushrod before any significant resistance could be felt. Some of this came from the servo itself, but most of the play came from the rubber grommet mounting system.

Moving to the rear of the fuselage, the end the elevator control arm could be moved up and down more than 1/16th inch from neutral with the same seeming lack of resistance. This translates to nearly 1/8th inch at the elevator trailing edge. This additional play came from the elevator pushrod, a segment of #505/506 blue/gold Sullivan Gold-N-Rod. While these assemblies are rated as "semiflexible" rather than "flexible" (red/yellow set), the mounting method of the outer tube has a greater effect on system rigidity than we at first thought.

Although we initially resisted acknowledging our conclusions, we eventually came to realize a lack of rigid elevator control was at the root of the flight control problem. Although the servo and pushrod are inherent contributors to this problem, as outlined above, the flight behavior indicated the airfoil is a major contributor as well, and elevator deflection inside the limits of play is speed dependent.

As we are currently working on modifications to two of the three above noted components, we'll have to end this month's column with "To be continued..." Next month we'll explain in detail what was going on in flight, as well as the effectiveness of our hardware and airframe modifications.

"On the 'Wing..." News

- The recent "On the 'Wing..." poll on the RCSoaringDigest Yahoo! group resulted in an overwhelming 50% of the votes going to a scale project. Our preliminary choice is the Akaflieg Berlin B-11, a beautiful tailless Unlimited Class glider of the early 1960's with high aspect ratio wings swept forward at 18 degrees. This configuration will offer several challenges so far as spar and wing joiner materials and construction methods, along with other items. Although the full size aircraft never flew, we're pretty excited about producing a quarter scale (4.3 meter span) model, suitable for aerotow, and have finally arranged to communicate with a knowledgeable archivist at Akaflieg Berlin.

- Followers of this column will be happy to hear "On the 'Wing... the book," the first volume, is now available in its entirety (52 articles) in PDF format through the B2Streamlines web site <http://www.b2streamlines.com/OTW.html>. The volume can be downloaded as either a single document of 13.7 MB, or as a series of individual PDFs which dramatically vary in size. Volumes 2 and 3 are also available, along with articles from Volume 4 as they appear in *RCSD.*

- While we do have a reservoir of topics for future "On the 'Wing..." columns, we are always appreciative of suggestions from readers. Aerodynamics, structures, model reviews and computer programs are just a few of the areas this column covers.

RCSD readers can always contact us at P.O. Box 975, Olalla WA 98359-0975, or at <bsquared@appleisp.net>.

FAI has received the following Class F (Model Aircraft) record claim :

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Claim number : 9643

Sub-class F3B (Glider)
F3: Radio controlled flight Category
Type of record : N°158: Distance to goal and return
Course/location : St Vincent les Forts (France)
Performance : 7.14 km
Pilot : Frédéric JACQUES, Thierry REGIS (Monaco)
Date: 17.07.2004

Current record : 1.90 km (27.05.2003 - David L. HALL, USA)

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The details shown above are provisional. When all the evidence required has been received and checked, the exact figures will be established and the record ratified (if appropriate).

Basic sizing checks for homebrew RC thermal gliders

by Mark Drela

If you do a lot of homebrews, it really pays to do some simple sizing checks for vertical tail, horizontal tail, and Equivalent Dihedral Angle (EDA). It can save a huge amount of aggravation and possibly unwarranted disappointment with a new design.

Specifically, you should always calculate the following three quantities:

Vh = (hor_tail_area/wing_area) x (hor_tail_arm/mean_wing_chord)
Vv = (ver_tail_area/wing_area) x (ver_tail_arm/span)
B = EDA x (ver_tail_arm/span) / CL_therm

where EDA is in degrees, and CLtherm is the typical CL during slow thermalling.

It's OK to just assume CLtherm=0.7 for big gliders and CLtherm=0.6 for HLGs. For a V-tail, first compute the equivalent hor_tail_area and ver_tail_area, as described in <http://www.charlesriverrc.org/articles/design/markdrela_vtailsizing.htm>

Vh = horizontal tail volume, indicates mainly pitch stability.
Vv = vertical tail volume, indicates mainly yaw damping and rudder power.
B = Blaine Rawdon's parameter, indicates spiral stability...

B > 5 spirally stable
B = 5 spirally neutral
B < 5 spirally unstable

B also approximately indicates the degree of roll power available to a poly glider, provided Vv is reasonable.

For a good-handling poly glider you want to be in these ranges:

Vh = 0.3 - 0.6 (I like 0.4 - 0.45)
Vv = 0.02 - 0.04 (I like at least 0.03)
B = 4.0 - 6.0 (I like 5.0 - 5.5)

For an aileron TD glider you want to have:

Vh = 0.3 - 0.6
Vv = 0.015 - 0.025 (I like at least 0.025)
B = 2.0 - 5.0 (I like at least 3.0)

A DLG wants a huge amount of yaw damping:

Vv = 0.05 - 0.06 is not out of line.

Having said all that, it should be mentioned that moments of inertia influence the choices for the Vh and Vv values. A glider with an unusually small pitch inertia because of a very light tail unit can get away with using a smaller stab (smaller Vh to be more precise). Similarly, a glider with exceptionally light wing tips will have small yaw inertia and can get away with a smaller than usual. And of course gliders with larger than normal inertias will require larger than normal Vj and Vv values.

Comment: The Allegro-Lite seems to have a fairly modest tail sizes.

There are no universal values for Vh and Vv which will work well for all aircraft configurations. This is because the Vh and Vv definitions do not account for all factors which influence tail sizing.

First of all, we should state the standard Vh and Vv definitions:

Vh = (hori_tail_area/wing_area) * (tail_length/wing_chord)
Vv = (vert_tail_area/wing_area) * (tail_length/wing_span)

What do these definitions ignore? First let's look at Vh...

Vh ignores the destabilizing influence of the wing's flowfield on the effective angle seen by the stab. This influence is a complicated function of the tail length, since there's a tip-vortex downwash part which increases slowly with distance, and a bound-vortex part which decreases rapidly with distance. The net effect usually decreases with downstream distance. So longer tails require smaller Vh values for the same stabilizing effect.

Vh also ignores the issue of tail aspect ratio and tail airfoil quality, both of which affect the dCL/da lift curve slope of the tail. Increasing the tail's aspect ratio and switching from a slab airfoil to a good (non-deadband!) airfoil will allow a slightly smaller Vh for the same real stabilizing power. The Allegro-Lite has a high aspect ratio stab with a good airfoil immune to low-Re effects. So it can get by with a smaller than usual Vh.

Finally, Vh also ignores the effect on pitch damping, which depends on tail_length2. But pitch damping is usually adequate for any reasonable tail size, so this is a minor consideration in horizontal tail sizing.

Now let's look at Vv...

Yaw damping is the main issue in vertical tail sizing, especially on a rudder/elevator glider. Since Vv is not a measure of damping power, it is simply not a good indicator of vertical tail size. A much better definition which quantifies yaw damping would be

Vv' = (vert_tail_area/wing_area)*(tail_length2*mass/yaw_inertia)

It's less convenient to use since yaw inertia is not easily computed. But Vv' can be estimated in terms of the “radius of gyration”

rg = √(yaw_inertia/mass)

which has the units of length and is typically some fraction of the wing span. A uniform plank flying wing has

rg = √(1/12)*wing_span = 0.289*wing_span (flying plank)

For normal gliders the rg is somewhat less than this formula indicates since they have more stuff concentrated near the center of mass. For the unballasted Allegro-Lite it is

rg = 0.2*wing_span (Allegro-Lite)

and for a highly-ballasted AL it can be as small as 0.1*wing_span.

Equivalent expressions for the yaw damping parameter Vv' are then

Vv' = (vert_tail_area/wing_area)*(tail_length/rg)2

Vv' = Vv * tail_length * wing_span / rg2

In any case, increasing the tail length clearly allows smaller Vv for the same Vv' (which is what really matters). Reducing yaw inertia or adding central ballast, both of which reduce rg, also allows smaller Vv for the same Vv'.

So to get to the original question, the AL with its long tail and very light tips and tail (low yaw inertia) has in fact a quite large Vv' compared to other gliders. This is apparent in its rather nice yaw damping characteristics, especially when ballasted. The Spirit 2m which was mentioned, has a short tail and broad (heavy) tips, and is very wobbly by comparison.

One other issue which often arises in vertical tail sizing is spiral stability. Increasing the tail size tends to worsen spiral instability on most aircraft.

But on r/c gliders with generous dihedral it has a much lesser effect.

For large EDA values it has in fact little or no effect on spiral stability. According to Blaine Rawdon's approximate criterion, we get spiral stability if

$$\text{EDA} * (\text{tail\_length}/\text{wing\_span}) / \text{CL} > 5.0$$

This favors a longer tail length, but vertical tail area doesn't enter in.

Another obscure fact is that a spirally-stable glider can become spirally unstable above a certain bank angle in a steady turn. It will hold trim in a shallow banked turn, but will become unstable and try to spiral in above a critical bank angle. The larger vertical tail the larger this critical angle is. The AL has a critical bank angle of about 50 degrees.

Randy Martin's 1/3.5 scale DG-1000 with its canopy ajar on final.
From the EMS kit, this model spans 5.3 meters and weighs approximately 22 lbs.

For more pictures from the JR Aerotow 2004,
see Mark Nankivil's photo essay starting on page 20.

GORDY'S TRAVELS

Gordy Stahl
Louisville, Kentucky
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"Your job, should you choose to accept it..."

Anatomy of 'Task Soaring'

Since last season I have been WORKING, not only at my full time job but at honing my task flying skills. For those of you who don't understand 'task soaring,' those of us who have decided that we want to improve our air reading skills and our ability to achieve precision control of our sailplane's actions, we attend Thermal Duration (TD) contests.

When we show up at an event, the Contest Director (CD) is the boss, and he assigns the 'tasks' for the day of soaring, much like showing up to work and the boss telling you what is expected that day.

Do the task well and get rewarded with a trophy and the admiration of fellow soaring enthusiasts, do it sort of well and learn specifically where you need to work in order to improve your soaring skills. Do it poorly and likely if you have the right attitude, have a wonderful day of soaring and learning about soaring.

TD contest formats vary in many ways. Some are set up to provide an opportunity to draw soaring enthusiasts and friends together for an organized day of soaring… this is usually designated as an "Open Winch" contest. With this format, the CD announces the tasks for the day, say rounds beginning with a three minute, five minute, seven minute, and nine minute flight task and a 50' landing circle.

A piece of nylon tape is anchored in the center of the landing zone with graduations drawn on it to indicate landing points, usually starting at 100 points. The tape can be swung around the circumference till some part of it touches the sailplane's nose. That corresponding number indicates the landing points earned. Sometimes the CD will call rounds as the entire groups of pilots have completed the each round. Sometimes the CD will announce that pilots can fly any round at anytime as long as all the rounds are completed by the end of the contest. With this system if you hook a great thermal early you can elect to fly out the nine minutes, or if you get skunked with a down cycle, you can shoot for the three minutes.

The opposite of the Open Winch event is Man On Man (MOM). In this format, groups are randomly assembled for the first task. Usually the task will be ten minutes. Six winches are used and the pilots launch in a consecutive shotgun release. The idea being that those pilots are a mini contest, with all the pilots flying in the same air. Those pilots get to test their strategy, air reading and landing skills against the others in that launch group.

If for instance the air is all down, and the best score is two minutes, then that pilot would get 1,000 points same as if he had flown for the ten minutes. If the next round air is all up and everyone gets their ten minutes, they would still be measured only against the pilots in that launch group.

MOM erases 'luck' from the soaring part of the task… as in one group launches in an up cycle and gets ten minutes and the next in a down cycle, only the first group would have a chances at glory, even though pilots in the first group were far more skilled and practiced.

The standings of each first round flight group are then grouped in the order they finished against pilots who finished in the same order from the other groups. This pits equal pilots against equal pilots (for the most part) against each other all day long. It is easily the fairest variant going. Instead of newer pilots against the most experienced pilots, at the end of the day each pilot can see how his practice and experience stacks up against pilots of similar experience.

Landing tasks can vary based on how many pilots have to move through the event. For instance, if there are 200 pilots at an event, taking time to wait for swinging tapes and the straightening them again can burn up the day.

They also vary depending on the mood of the CD! At large events such as the Fall Festival in Visalia, California, where arguably the best of the best come to have fun and to test their skills, 'gymnastic' landing targets, say in the shape of Pac Man (who's mouth is a zero and body is 6' diameter), or a shuffle board wedge shape with the apex being 100 points!

These landing tasks really test the pilot's ability to control his sailplane's speed, altitude and timing... but mostly allow for immediate recognition by the landing judge, and to clear the landing area quickly.

The most common landing targets are the circle tape (also used in the rest of the world as the official landing task), or the runway tape. This is a piece of tape anchored on both ends with the tape being 100 points and every inch away on either side of that tape a loss of a point. Again measured from the tape to the sailplane's nose, usually done with length of plastic pipe with increments marked along its length.

Task flying is the most fun! Not that just soaring around for a day isn't, but task flying gives soaring a point! The League of Silent Flight (LSF) has an achievement program set up to provide various skill improvement tasks. The LSF Level 1 task sets a task of making a small number of fairly generous measured landings, the LSF levels are all designed to soar a RC sailplane pilot along the skills of RC soaring.

LSF Level 5 is the ultimate achievement including an eight hour continuous flight and a multi-mile flight from one point to another along some roads (the pilot launches, gains good altitude, and then climbs into the back of a pickup and flies his sailplane the distance and back!).

Improved skills means more fun and a lot less opportunities to dig your sailplane out of the ground or out a tree!

There are many variations of task soaring, some involve speed, distance, soaring time and landing skills. Regardless of the variant, task flying turns our sailplanes from soaring machines into 'tools for a task' and turns soaring into a challenge.

It's NOT about 'beating' some other pilots, since that's not possible. The best you can do is to do the task …perfectly. The only person you can beat is yourself… or your last best performance.

Task flying, or flying contests is really about sharing the challenge and the day with friends of like interests. I started this column mentioning that I had been WORKING over the last couple of years at honing my soaring skills. That means practicing, not just going out and floating around for hours on end, but setting a time goal, flying with a talking countdown stopwatch and always having a landing spot to attempt to place the nose of my sailplane.

Remember, its about precision control of your sailplane and finding thermals or flying smoothly to get exactly the amount of time (not one second more or less) of task time... so aimless soaring and landing prepares you for – aimless soaring.

The result of all that task practice? Consecutive wins or placements in the last 20+ events I have flown! Think it was 'fun'? You bet! I didn't 'beat' a single friend, but I did manage to get better results and some pretty awesome trophies from Australia, Washington, Tennessee, Ohio, Indiana, Missouri, Texas, Indiana, Canada... a bunch of fun places!

Give task flying a chance, if you haven't been following my columns in the recent past year and a half or so, go back and check them out. There are a lot of tips and secrets to improving your skills and getting your 'tool' tuned up for the 'job'.

See you on my next trip!

Taking care of foamie wings

Bill Swingle
Janesville, CA

Foamie flying wings have it rough. What other planes get intentionally flown into solid objects? We routinely smack them into other planes, pilots and the ground. It's a tough life indeed. Yet, sadly, most put only a minimum of effort into constructing and maintaining them. Whether your foamie is tailless or convention, here are a few suggestions for treating it right.

Use a ruler to to measure control throws up and down.

Construction

1. Build it FLAT. Build it on the wing beds or at least a flat surface. Don't tension the tape when applying. Use the recommended taping pattern on both sides. Many other patterns are fine too if you're familiar with the concept. Tensioned or wrinkled tape will cause problems later by leading to stress and temperature variances.

2. CG can be deceptive on a flying wing but the common methods of setting apply. The only things to remember are be very precise when doing so and don't be fooled by "sort of OK" results. Meaning watch for deceptive results. I had a wing of my own design that I just didn't like. I thought it was setup as good as possible but 1/2 an ounce on the nose turned it into a great plane. I had the nose weight WRONG by 1/2 an ounce and didn't realize it. It took a friend to see the problem and fix it.

Precision is also important. I had a wing where 1/8th inch difference of CG location made all the difference between average and best plane I've ever owned. Yet, a world class pilot friend of mine built the same plane and thought it was junk. Setup was critical on that one. I got lucky and learned a lesson.

3. Make sure the control throws are equal. Once built use a ruler to measure the control throws up and down. They should be the same. Otherwise you get a pitch input every time you roll. This is simple but most don't worry about it.

4. Equal twist on each half of the wing. Different wing twists between sides really hurts performance. Different planes use different amounts of twist and some have their own personal preferences. Regardless, keep the sides the same.

5. Control throw magnitude is obviously a personal preference. But, with foamies I'll often see throws that are quite excessive. Personally, I like to limit max throw to just less than what will cause the plane to snap. Then, if needed, use expo to soften it near center.

Maintenance

Though durable, a foamie will still require some maintenance. Here are the items to remember:

1. Store the plane flat. Warps in a flying wing can strongly degrade performance. Poor storage can mess up a good plane while proper storage keeps warps to the minimum. Personally, I store my flying wings in their wing beds on a flat surface.

2. Dents and warps happen. Combat can, surprise, be destructive. After a combat session, examine the plane. Fix anything that's broken. Patch holes and tears in the covering. Remove any warps with the judicious application of heat and force. Check the wing twist and keep both sides equal.

3. Look for damaged foam. Noses are a primary location for damage, of course. A crinkled nose can be fixed several times by adding/removing the covering over the area and applying heat.

I store my flying wings in their wing beds on a flat surface.

All nested to prevent warps and damage.

Once your results aren't able to improve the area very much, use stronger methods. Namely foam replacement. The damaged foam can be simply cut away (I like my bandsaw) and the hole refilled with a new portion of foam. Then sand to the needed shape with some course sanding paper.

Foamies flying wings have to be:

1. made properly,

2. cared for properly, and

3. stored properly,

just like ANY OTHER plane.

Abuse them and they'll fly poorly; no surprise.

Abuse them but fix them and they'll last a long time but still eventually fly like dirt and have to be replaced.

The objective is keep them flying well over the course of their life and to make that life a long one.

And it makes transportation easier, too!

JR Aerotow 2004

June 11th thru 13th   Monticello, Illinois

by Mark Nankivil

The beginning of June here in the Midwest means that the JR Aerotow is nearly upon us which for me brings on a level of excitement and anticipation for the drive up to Monticello, Illinois.

Located just a few miles west of Champaign-Urbana in central Illinois, Monticello is surrounded by beautiful farm land and has plenty of shops and eateries to keep the whole family happy while you're out at the local airport enjoying the thermals and great flying conditions.

The event is held on the town's airport which is located on the south side of Monticello. The airport is also home to the Illini Glider Club so the mix of full scale and large scale sailplanes adds even more "flavor" to this event. This year's event was sponsored by JR, Horizon, Eflite, Hobby Zone, Park Zone, Hobby Lobby, Endless Mountain Models and Futaba.. The CD for the Aerotow was the affable Peter Goldsmith ably assisted by his wife Caroline along with many of the Horizon Hobby team. This year saw 52 entrants who brought along 134 sailplanes.

I'll let the photos and captions speak for themselves. Make sure you set aside a weekend in June, 2005 and make the trek to Monticello for a wonderful weekend of flying and friendship! Details on the event will be posted to R/C Soaring Digest as soon as they are available.

Good Health and Good Lift!

Above: The pits - plenty of fine large scale sailplanes to look over.

Page 21: (Top) Dan Troxell brought along this beautiful EMS Mininoa which flies quite well at 18 lbs. (Middle upper) A shot of John Derstine's SZD50 Puchacz. (Middle lower) Peter Goldsmith's Bruckmann Piper Pawnee towplane on final - the JR team, along with Johnny Berlin, were kept busy towing sailplanes throughout the weekend. (Bottom) Rick Briggs 1/3rd scale ASH-26 on final.

Page 22: (Top) Toby Graither's DG-800 leaps off on tow. (Middle) Peter Goldsmith's 1/3 scale Super Cub heads in to pick another tow - a DA-100 pulls it along. (Bottom) What scale aerotowing is all about... Dan Troxell's 1/3rd scale Schweizer.

Page 23: (Top) Tim Lavender's Harbinger flies over on final. (Middle) Here's a close up of the scale finger type spoilers used on this model. (Bottom) One of the many tows heads off on Saturday.

Page 24: (Top) Rusty Rood holding his Ka6. (Middle) Dan Troxell brought this 1/4 scale, 18 pound EMS Minimoa. (Bottom) A close-up of the interior of Rick Briggs' Brequet Choucas, a 6 meter, 27 pound model scratchbuilt by Arnold Hoffman.

T: Don Troxell' Minimoa
Mu: John Derstine's SZD50
Ml: Peter Goldsmith's Piper Pawnee
B: Rick Briggs' ASH-26

T: Toby Graither's DG-800
M: Peter Goldsmith's Super Cub
B: Dan Troxell's Schweizer

T: Tim Lavender's Harbinger
M: Harbinger spoilers
B: Saturday tow.

T: Rusty Rood's Ka6

M: Dan Troxell's Minimoa.

B: Rick Briggs' Brequet Choucas, built by Arnold Hoffman.