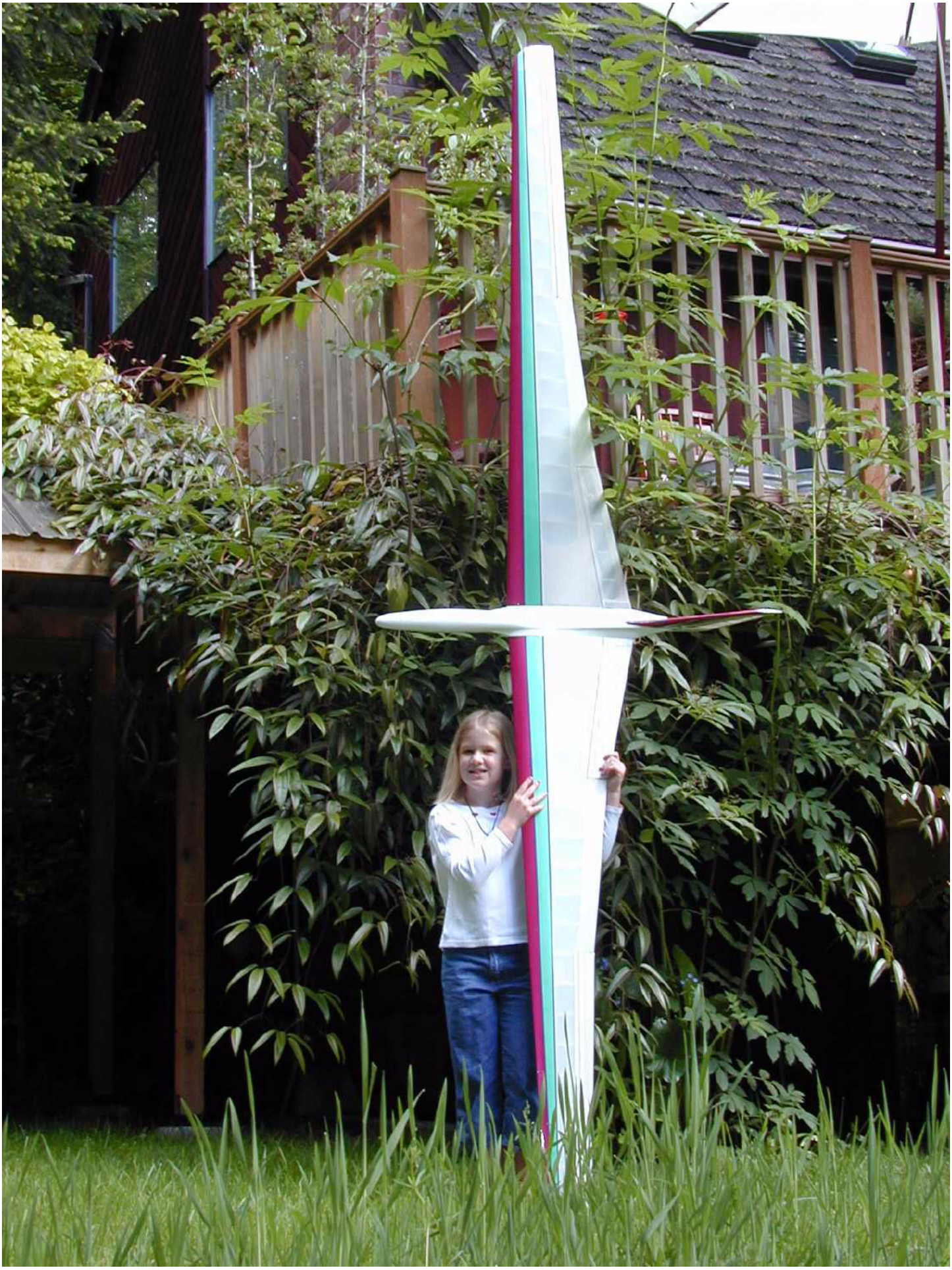


On the ’Wing... # 176

Diva, Part 5

Diva is complete and has been flown 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.

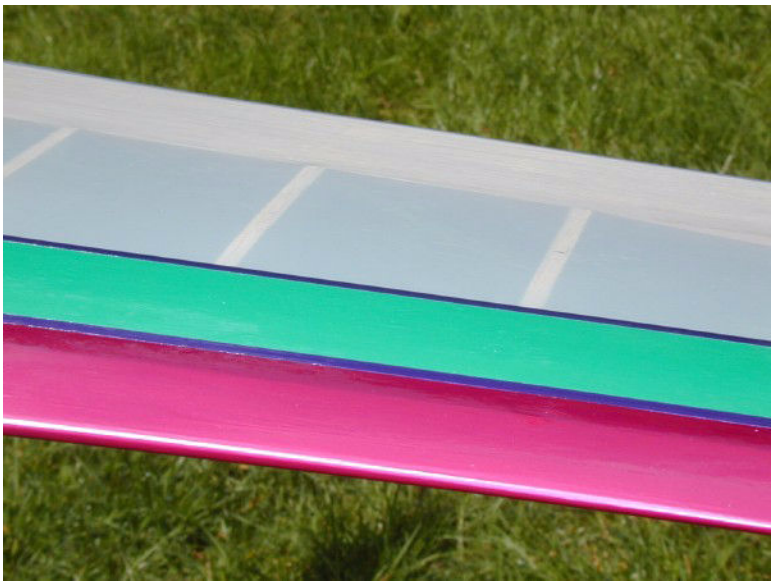
At the hobby shop, Alyssa became enthralled with the Monokote pearl colors. She finally settled on pearl red and green with pearl white as the main color. Pearl purple became the trim color after going through and discarding a couple of yellows.

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 semi-gloss 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.

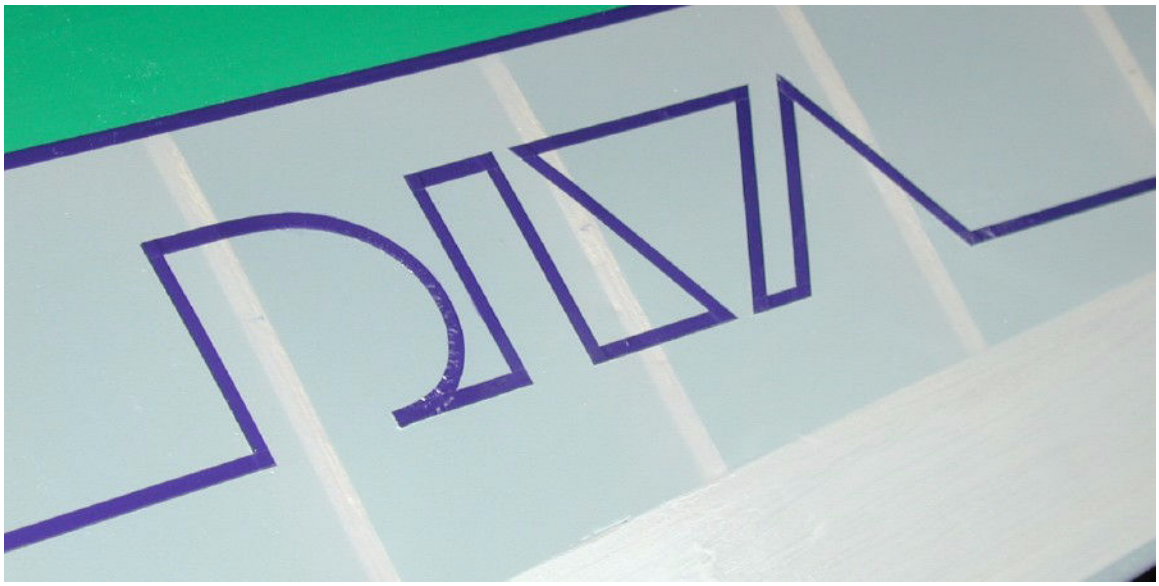
Rick, feeling he was guilty of breaking a perfectly good airplane, apologized profusely. We countered no apology was necessary from our point of view — we see Rick as a much better pilot than ourselves — we had simply removed too much nose weight at one time, leading to rapid changes in pitch which no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

Diva Weight Table

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



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.

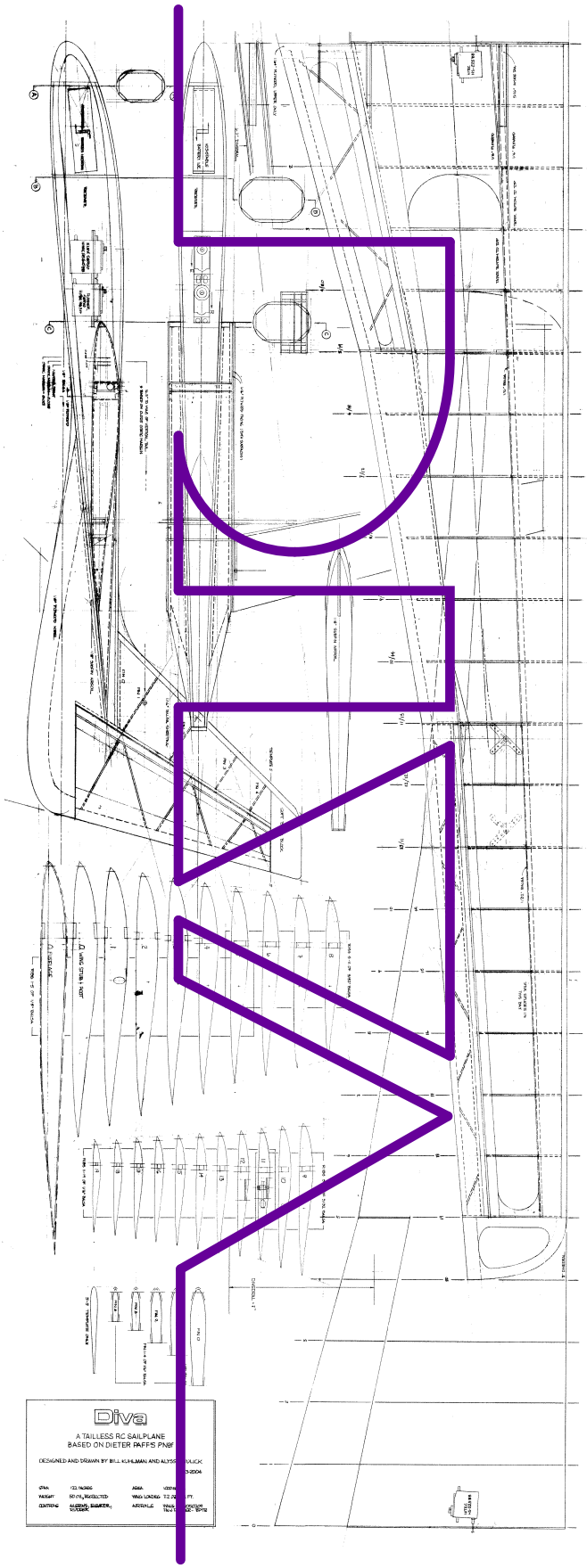
A small portion of the weight which had just been added was taken out and another launch attempted. The initial dive was immediately counteracted with up elevator, but not before Diva grazed the top of one Scotch Broom and performed a flat spin into the outstretched limbs of a larger companion plant.

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.

Once 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 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 one 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. Overcontrolling the elevator, 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 B^2Streamlines 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>.