

# Radi- C-ntr-ll-ed Soaring Digest

December 2011

Vol. 28, No. 12



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**Front cover:** - Alex Paul's Duster flies at Lucas Park "main hill." Wilson Lake in the background. This Duster built by Erik Eaton features a split wing and removable tail parts to ease storage and transportation. Magnum RC Models will build any kit they produce to customer specifications. Photo by Dave Garwood. Canon EOS 7D, ISO 200, 1/250 sec., f16, 200mm

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**Back cover:** One of the pilots at the Cumberland Soar-for-Fun had brought along some stuff to sell and had set these five pilot figures on the table. Photo by Pete Carr. "I was amazed at the detail and quality of the accessories each figure had." Sony DSC-P73, ISO 100, 1/650 sec., f5.6

# R/C Soaring Digest

December 2011  
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## In the Air

Personal experiences, refurbishing and improving a couple of classic sailplanes, an inexpensive accessory, technical material, a kit review and event coverage make up this issue.

Dave Garwood is a frequent contributor to *RCSD* as well as other aeromodeling magazines. Dave reviews the Magnum RC Models Magnum, a One Design Racer, this time out in *RCSD*.

It's not often that *RCSD* receives articles devoted to rebuilding or modifying "all balsa" sailplanes, but this month two are featured. Trevor Ignatosky describes his rather intense rebuilding of an Airtronics Legend, and Lance Atkins builds a "thermal freindly" wing for his elderly Bob Martin Bobcat using computer software and a rather unique Craftsman tool.

Speaking of software... Marco Maceri recently started using EDGAR, an airfoil design program which uses evolutionary strategies to design optimized airfoils. Marco describes EDGAR in detail beginning on page 72.

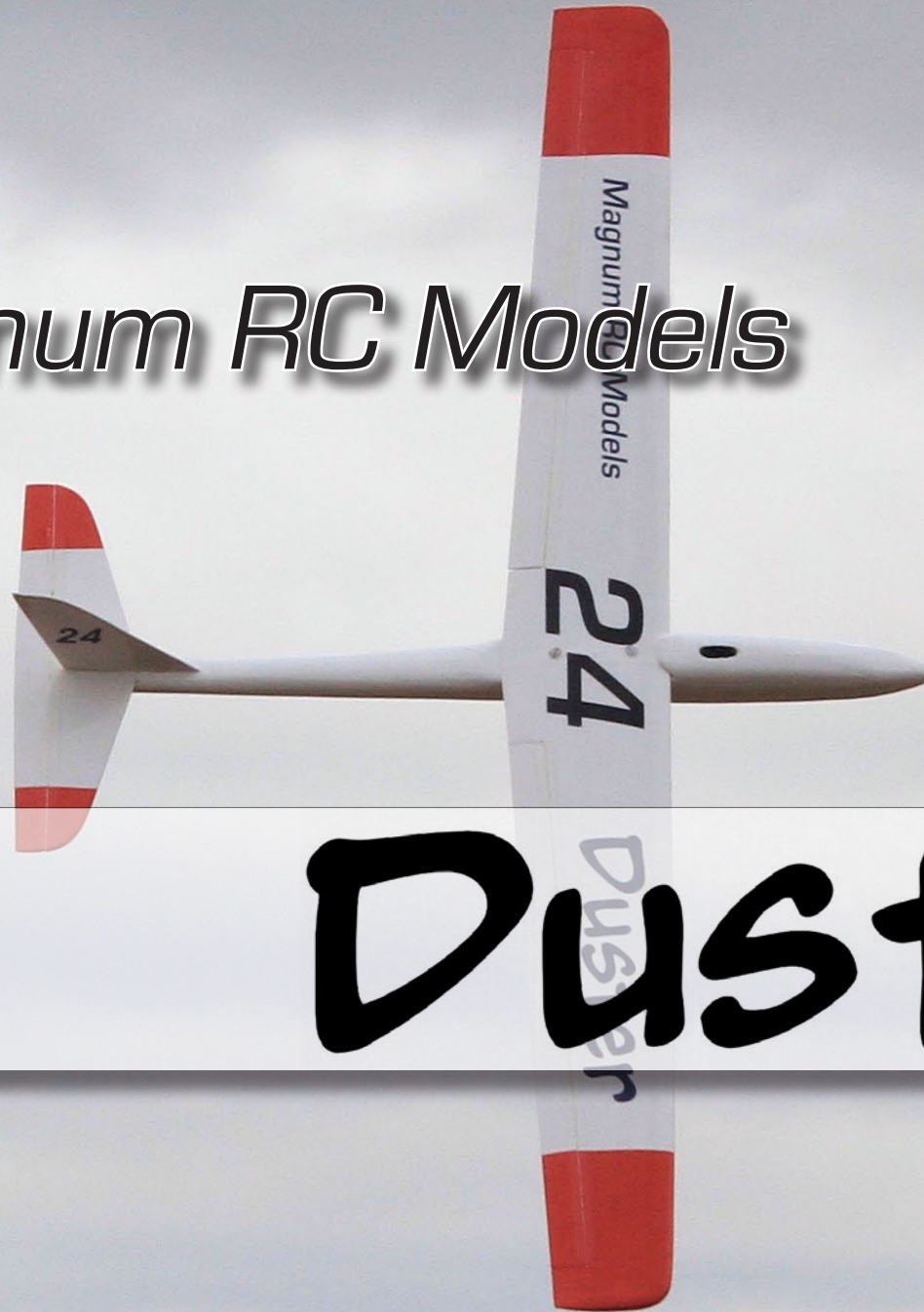
Event coverage starts in Cumberland Maryland, travels to Volksrust in South Africa, and ends in California with the personal experiences of Aric Wilmunder at the Cal Valley cross-country soaring event. Still in California, Bill Keenan reminisces about his early days in RC soaring.

Genaro Solé shows an inexpensive method for protecting exterior control linkages (and the servos that drive them), and Gordy Stahl speaks out on one of his favorite topics - CG location.

We hope you enjoy reading the 98 pages of this issue as much as we enjoyed putting it all together.

Time to build another sailplane!

# Magnum RC Models



# Duster

# *A Tale of Two Dusters*

## kit review and flight report

Dave Garwood, dgarwood518@gmail.com

After the One Design race at the 2010 Midwest Slope Challenge, Rick Stillman offered to let me fly his personal Duster, the one he had just raced with. I was glad he did because I fell immediately into a very comfortable groove with a very cool sailplane.

I bought Rick's plane that day, loved flying it over the next year, and now nominate it as a New York Slope Dogs "Must Have Sailplane."

*"...pure magic. How'd they do it? I don't know, but it's a aeronautical marvel."*

— Terry Dwyer

The Magnum RC Models Duster is a very versatile, highly capable, fun to fly slope sailplane designed to meet the One Design Race (ODR) specification published by the Torrey Pines Gulls in California, and practiced annually at the Midwest Slope Challenge in Kansas.



*Magnum Models Duster kit contents. Note the balsa sheeting applied to the wings at the factory, with leading edge and sub-trailing edge stock glued in place. Also, the carbon fiber stiffening rod and elevator pushrod tube come installed. Suggested radio component layout locations are suggested as well.*

The ODR specification is designed to promote less expensive race sailplanes that are matched in aerodynamic capabilities so as to allow the differences in pilot skill determine the outcome of the race. Over the years the ODR specification has tended to produce pleasant flying sailplanes, but I found the Duster to be a standout.

The Duster is a hybrid design, incorporating a traditional foam-core, balsa-sheeted wing, and more recent development, an EPP foam fuselage containing a carbon fiber stiffening tube. Tail parts are sheet balsa.

This works great in my experience and delivers an air frame that moves and grooves so well that flying it reminds me of the Foreigner song, "Feels Like the First Time." Flying the Duster made me feel like my very first time flying a responsive aerobatic slope plane; it conjured up the happy feelings delivered by the Sig Ninja two decades ago. I love flying this sailplane.

This article is a tale of two Dusters.

First, I purchased Rick's built and ready-to-fly sailplane on the day I first flew it in Kansas. Rick had the job of writing the Duster kit instructions, and he wanted

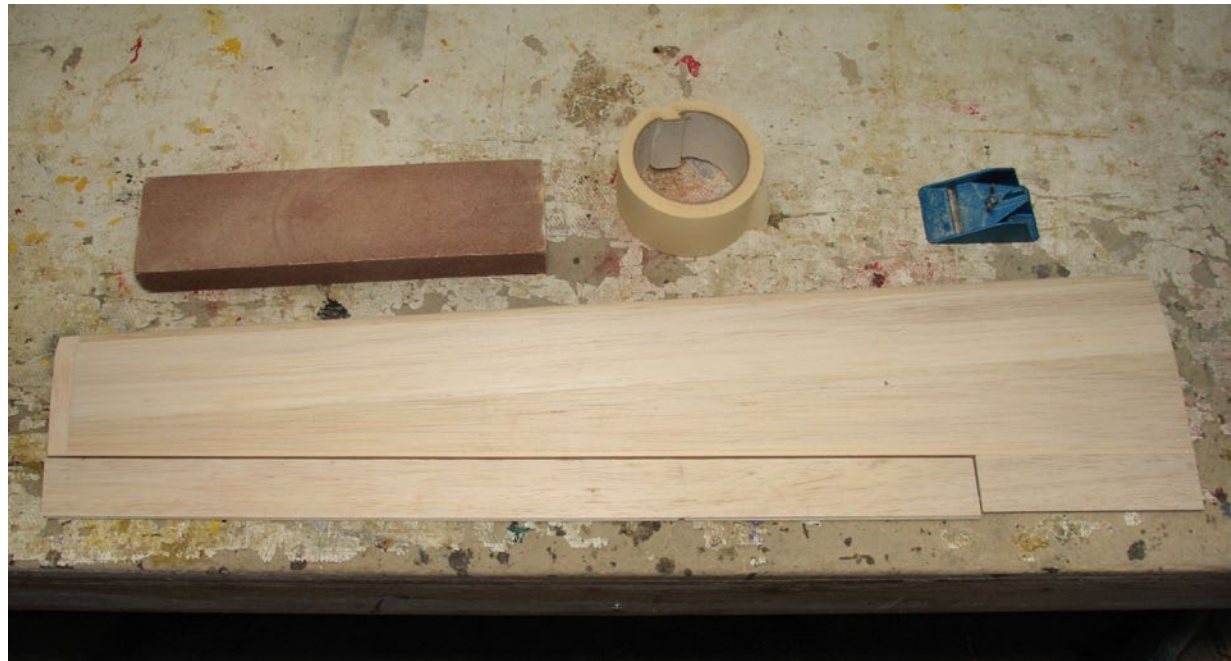
to build a second Duster to refine his building techniques and methods before finalizing the instructions.

Second, I had an opportunity to review the kit, and I built one from the Magnum RC Models kit. When it came time to prepare for the ODR race at the 2011 Midwest Slope Challenge, fellow New York Slope Dog Terry Dwyer needed a fresh race plane and he bought the Duster that Rick built.

## KIT CONTENTS

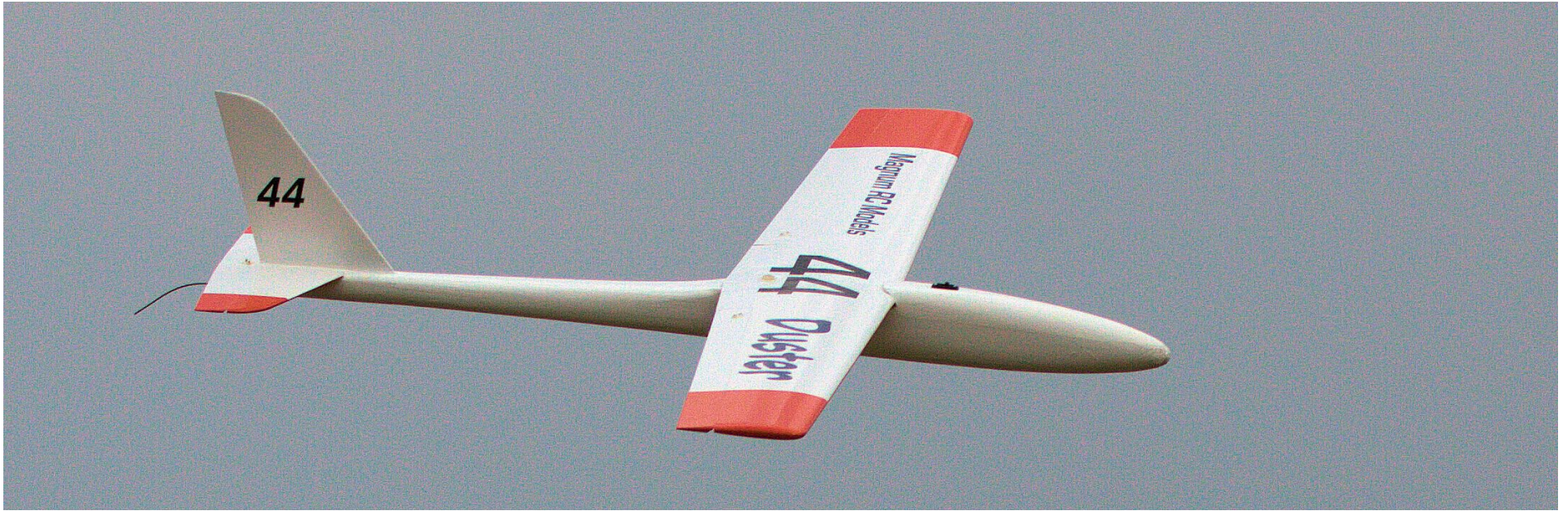
The 60-inch span wing core is cut from Owens Corning pink foam (1.8 pound density) and sheeted at the factory with

*Wing construction with aileron stock glued to sub trailing edge and sanded. Aileron tapered and sanded.*



*Wing servos installed by “potting” them in a mixture of epoxy and micro balloons, with servo protected by two layers of plastic bag. Cables are routed through soda straws. Removing the cable ends allows the wires to fit easily through the soda straws.*









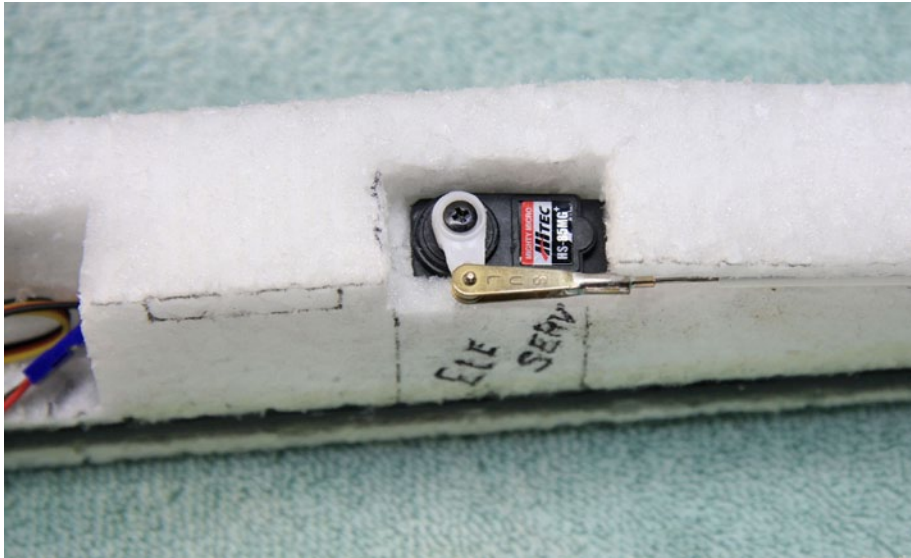
*Opposite page:*

*Upper: Magnum Models Duster ODR over Wilson Lake, Kansas. Photo by Alex Paul*

*Lower left: Alex Paul after a practice flight with his Duster.*

*Lower right: Terry Dwyer from Syracuse, NY with his Magnum Models Duster during the One Design race (ODR) during Midwest Slope Challenge 2011.*

*Above: A pair of Dusters ready for ODR race at Midwest Slope Challenge 2011.*



*The elevator servo location as suggested by the designer. Note that the servo body is offset as the control cable goes down the fuselage centerline.*



*Dave's modification to better align the elevator pushrod clevis with a lower control horn hole. The CF stiffening tube was trimmed with a roto-tool grinding bit and the foam passageway was tapered to allow the pushrod to bend downward.*

1/16 inch balsa. The leading edge and sub-trailing edge stock are glued in place and sanded. Also, the carbon fiber stiffening rod and elevator pushrod tube are installed in the foam fuselage at the factory.

Suggested radio component layout locations are marked on the fuselage to speed construction by reducing the number of decisions required by the builder.

This is a great kit, with lots of work done by the manufacturer to make it a quick-

building sailplane, as well as careful wood selection including weight-matched aileron stock pieces.

A 14-page instruction manual containing 54 photos thoughtfully keyed to the paragraph explaining the procedure pictured is included. The manual is well-written and easy to follow and full of good advice like "We prefer to use metal gear servos because it is easier to replace servo arms than servo gears."

## CONSTRUCTION

Wing construction is mostly done. The builder glues on the tip blocks and completes the final sanding.

The builder mounts the aileron servos using a favorite method - I "potted" mine in a mixture of epoxy and micro balloons, using two layers of bag plastic to separate the servo from the epoxy. When cured and ground flush with the lower wing surface, the "pot" provides a close enough fit that the servos can be secured with tape.

The servo leads are carried through the foam core in a soda straw - removing the end plug temporarily makes this operation go smoothly.

Fuselage construction consists mainly of hollowing out cavities for the on-board radio equipment. Component locations are marked, so this work goes quickly.

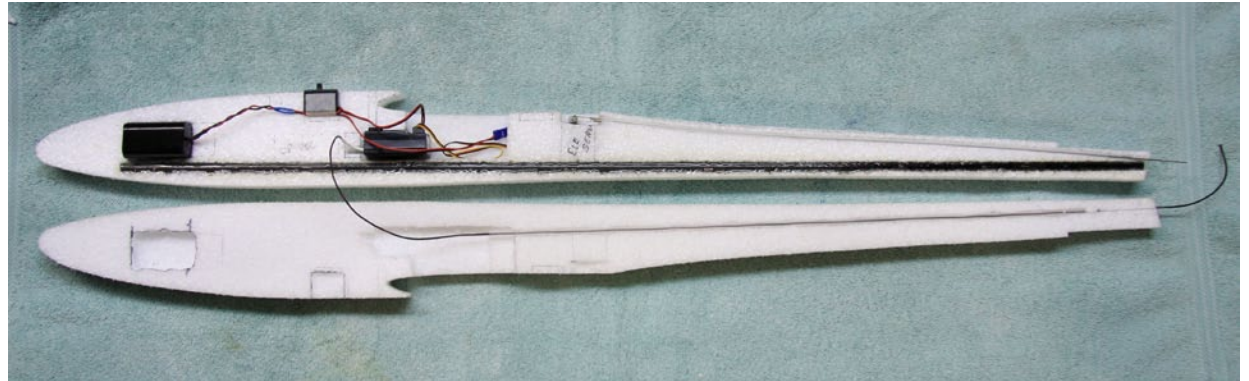
I installed an antenna tube and moved the location of the receiver back a little to make it removable in case it ever needs to be changed. Happily, the elevator servo is accessible in case work is needed on that.

The maker suggests epoxy to join the fuselage halves; I prefer Goop (TM), figuring it's a little more rubbery and flexible when cured, and about the same weight as epoxy.

I also substituted nylon control horns for the plywood horns provided in the kit. I like plywood horns, but I am not enough of a craftsman to handle the plywood horns without chipping off little pieces and weakening them around the holes.

The only item I had any trouble with was the location of the pre-installed elevator control rod tube, as in my estimation it sits higher than it should for two reasons:

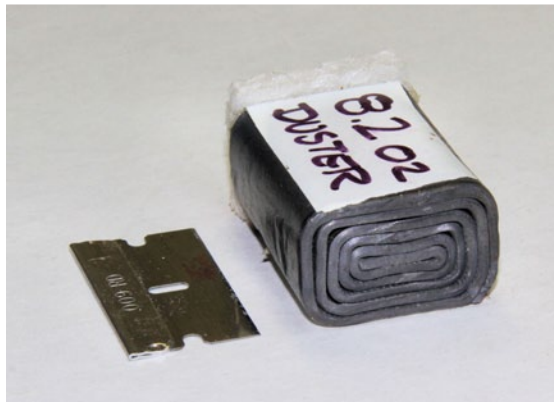
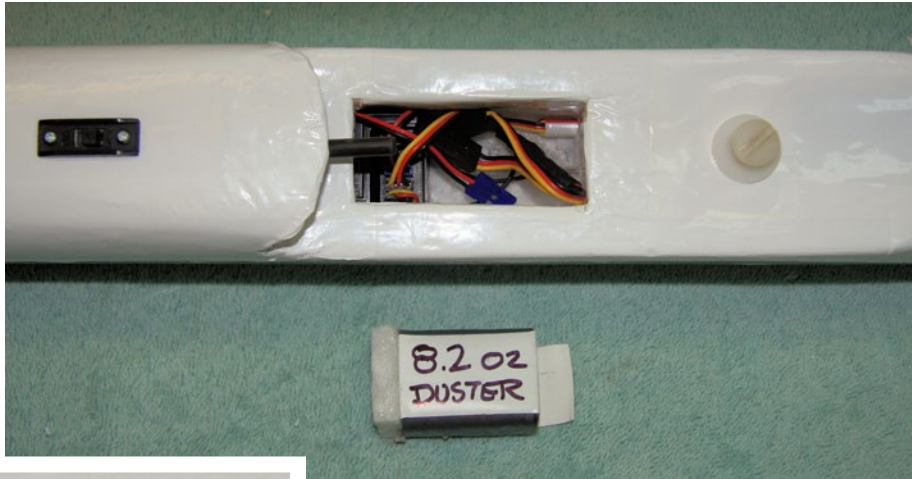
- (1) It interferes with the seating of the tongue on the vertical fin, and without a firm slot-in-groove fit, the fin is not as robustly mounted as I would like. I



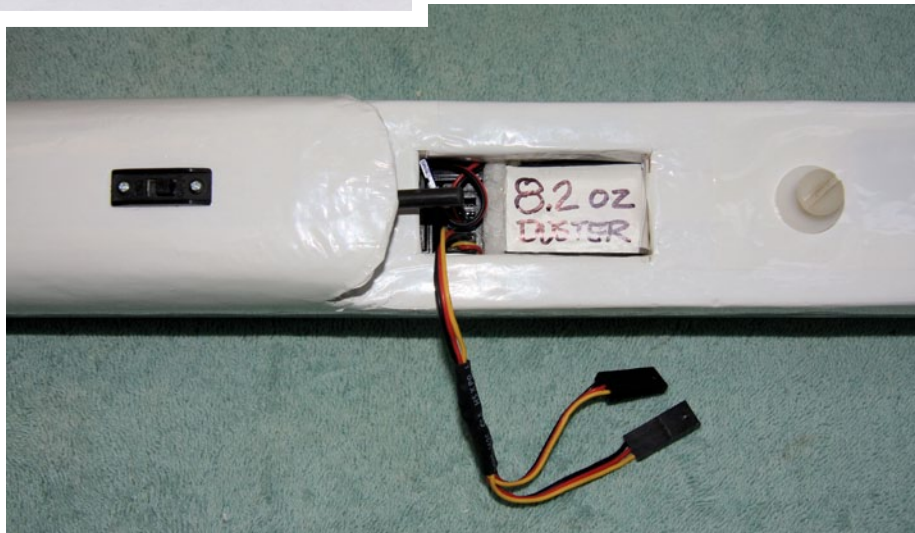
*Layout of the onboard gear before joining the fuselage halves. Note the receiver is installed so that it can be changed out if necessary or desired. Remember you have both sides to work with - in this case Dave installed the antenna tube on the fuselage half opposite the installed stiffening tube and elevator pushrod tube. Making this photo for your records may help in the event you have to repair or replace a hidden component.*



*Fuselage halves glued together and curing. The manufacturer recommends epoxy; the builder favors Goop (TM). Old time 72 mHz radio set needed to have an antenna tube installed to make the receiver removable, which Dave did.*



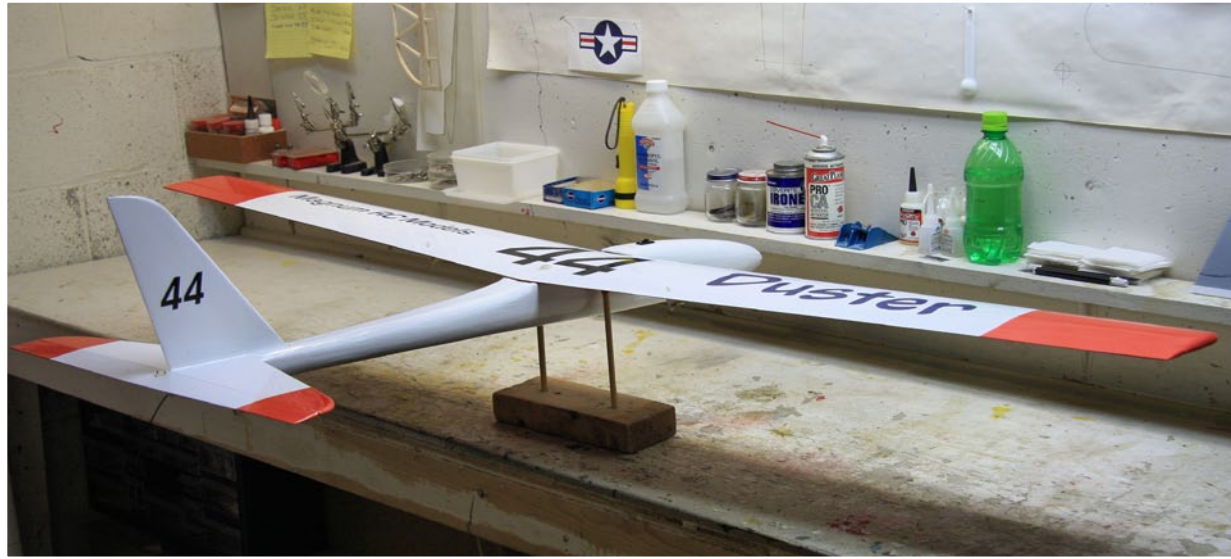
*Removable ballast weight made from roofer's lead sheeting is located at the CG.*



*On-board radio gear in Dave's plane included a Hitec 535 receiver, three Hitec HS-85MG metal gear servos, a Y-cable, a 700 mAh NiCad battery pack and an Airtronics on/off switch.*

*The on-board radio gear weighs 7.0 ounces. It could be lighter using modern 2.4 MHz receiver if the builder flew mostly in very light lift.*





Left: Home made balance stand made from 2x4 lumber, dowels and pencil easer tips. Careful attention to CG, or fore-and-aft balance, is an essential step in having a sweet-flying model.

Below: A pair of Dusters ready for ODR race at Midwest Slope Challenge 2011.





Author Dave Garwood launches Magnum RC Models Duster ODR racer over Wilson Lake, Kansas to practice for ODR race at Midwest Slope Challenge 2011. Photo by Alex Paul

will probably add triangle stock to the base of my fin to attach it more firmly to the horizontal stab - so as to better withstand my occasional inverted landings.

(2) It exits too high to catch a lower hole on the elevator control horn.

In order to get the control linkage alignment I wanted, I had to trim the pre-installed CF stiffening tube to get clearance, and to widen the exit path in the foam to get alignment.

If I had it to do again, I'd remove and replace the elevator control rod tube, burying it deeper.

I might consider mounting the elevator servo in the nose, running the elevator pushrod through the CF stiffening tube. While moving weight from the rear to the nose, it would lighten the airframe, but it would give up accessibility to the elevator servo. [EDITOR'S NOTE: The manufacturer reports that the elevator pushrod tube will be moved down in future releases of the kit.]

"The Duster flies both light lift and strong wind conditions with ease. It may be a One Design Racer but I would say it is a should/must have slope plane for both fun flying in lighter lift, as well as at fast speeds in higher winds. I absolutely love mine."

— Alex Paul

Covering of both Dusters is white and orange Ultracote, with markings custom made by Callie Graphics. A racer has to look like a racer.

I spent 25.5 hours over nine workbench sessions building, covering, and fitting my Duster. It took 1.85 ounces of nose weight to balance at the factory recommended 2.875 inches from the leading edge, and I have left the balance point at that location. My unballasted flying weight is 27.5 ounces. I made a ballast plug from roofer's lead sheet, and my ballasted flying weight is 35.7 ounces, which is where I fly it almost all of the time.

## FLYING

I loved flying this plane from the first moment Rick Stillman handed me his transmitter.

It moves out so easily and carves a groove through turns and maneuvers so wonderfully that it makes me look like a better pilot than I am.

It effortlessly performs small and large loops, axial rolls, outside loops, Cuban-eights and reverse Cuban-eights - all like the plane is on rails. Can't ask for more than that on a sport sailplane.

But wait, there's more.

The Duster is a slope racer, also. The glider as built is well suited for light and medium lift racing.

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*Magnum RC Models Duster ODR racer  
over Wilson Lake, Kansas. Photo by  
Alex Paul.*

There is room in the cavity directly under the wing for ballast. I like flying mine all the time with 8.2 ounces ballast, indicating to me that even a few more ounces could be added for racing in high wind conditions.

In 2011 at Wilson Lake, neither Terry nor I placed in the race. I think it might have been lack of practice by the pilots, and no fault of the Duster's design.

Just watch us next year.



## RESOURCES

Callie Graphics

<[www.callie-graphics.com](http://www.callie-graphics.com)>

Magnum RC Models

<[www.magnumrcmodels.com](http://www.magnumrcmodels.com)>

Torrey Pines Gulls

<[www.torreypinesgulls.org](http://www.torreypinesgulls.org)>

Midwest Slope Challenge

<[www.midwestslopechallenge.com](http://www.midwestslopechallenge.com)>



# 45th annual CUMBERLAND

Pete Carr WW30, wb3bqo@yahoo.com

The annual visit to Old Knobley Hill near Cumberland Maryland was made on November 6th 2011. I have been making the trip since the '70s and it gets better every year.

The weather was exceptionally fine with bright sunshine, seasonable temperatures but very little wind. Aerotow and winch launching were the order of the day.

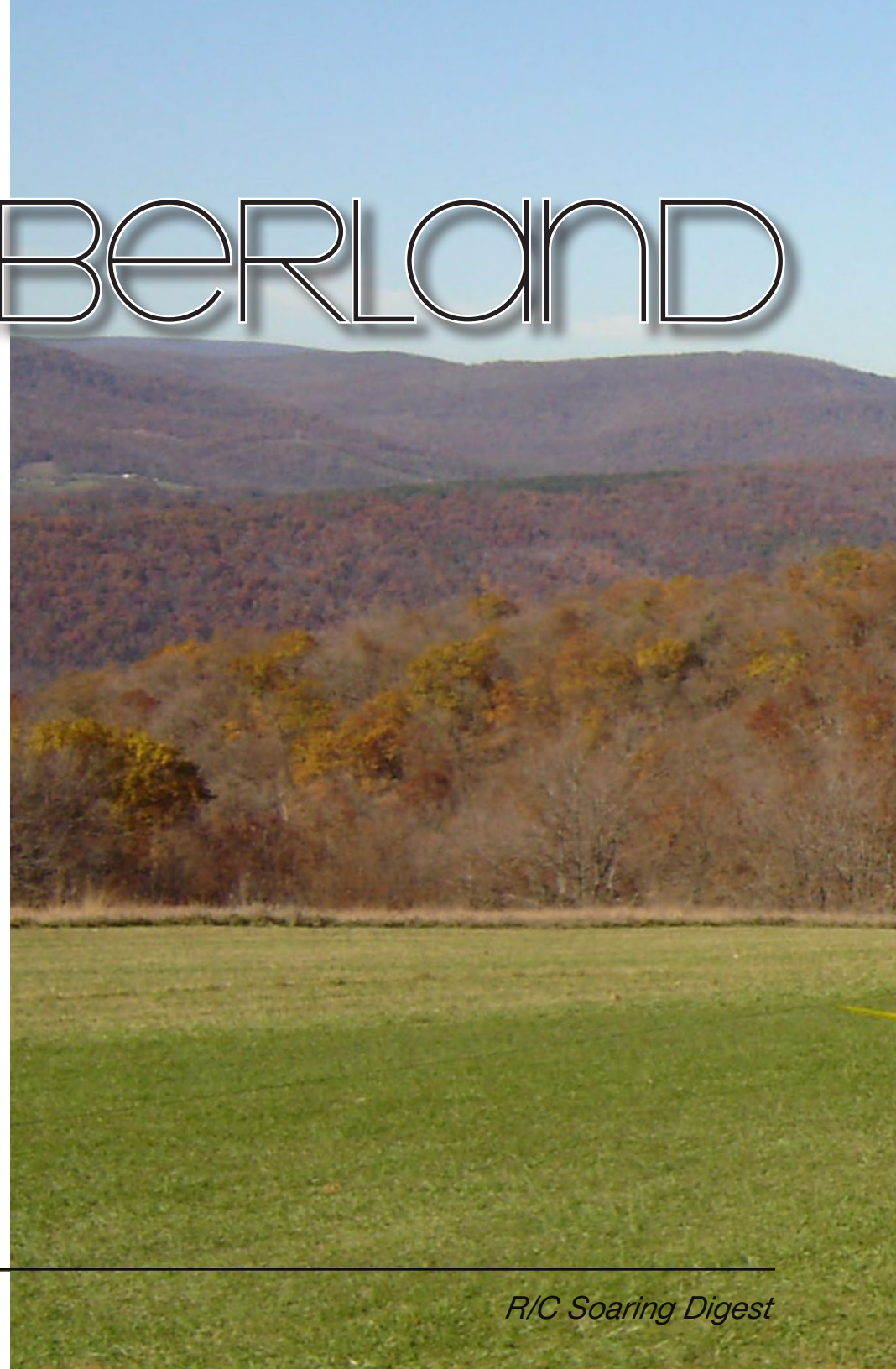
Rich Skellen, my ol' flying buddy and I arrived about 9 AM to watch the beautiful scale sailplanes being assembled. These had been unloaded from some truly awesome trailers that were complete with charging stations and repair facilities.

We went into the building and met Jim Dolly who collected our "landing" fees, a very modest ten bucks for the day. The building has large plexiglass windows, a propane heater and a large table that serves both as a repair and lunch table.

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*A 4.5 meter sailplane is towed aloft from the field. While the trees had lost much of their color, the view from the field was wonderful. This really adds to the enjoyment of watching these 'ships fly.*

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# SOAR-FOR-FUN



Several tow planes arrived in this trailer which was also packed with several large scale sailplanes. My flying buddy Rich Skellen remarked that the inside of that trailer was nicer than the first apartment he had after college, and larger too!



This was one of the smaller enclosed trailers that brought sailplanes and tow planes to the event. The rear door on this trailer supported a tool and repair station that is the nicest I've seen.



Jim Dolly hosted the event. Jim purchased the entire site some years ago and has upgraded the building and the road. It is largely through his efforts that the Soar-for-Fun has continued to grow.

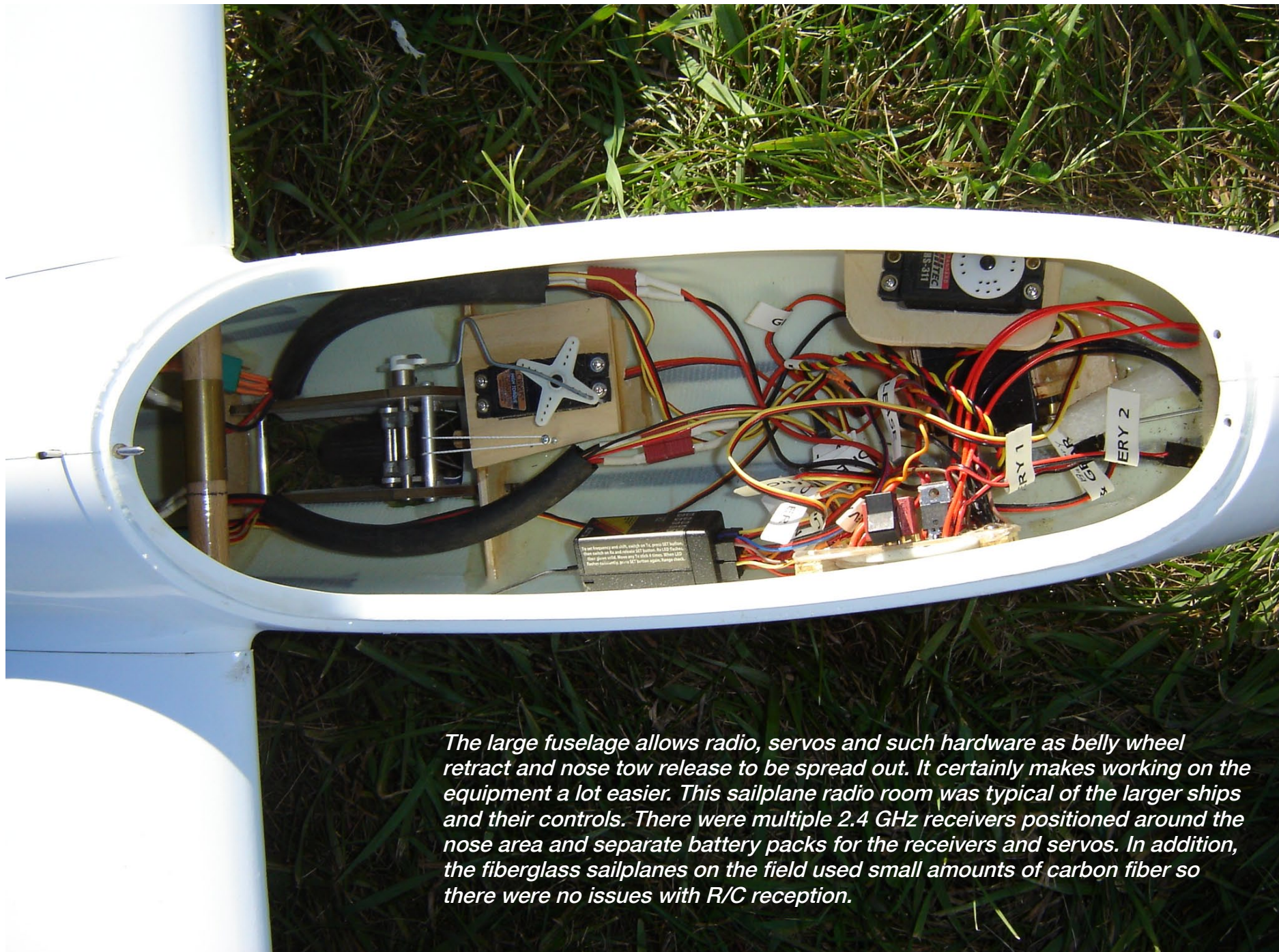


*Above: A Wilga tow plane is nestled into the top deck of the trailer. The 28 inch diameter prop gives you an idea of the size of this monster.*

*Above right: A Piper tow plane is ready for a mission. This ship was an ARF and ran gasoline at 40 to 1 mixture which gave it near vertical performance. It towed the largest sailplanes without a problem.*

*Right: From left to right, Rich Skellen, Carl Luft and Doug Berry watch as a tow is organized. The ground slopes away to the south so tows are easy.*





*The large fuselage allows radio, servos and such hardware as belly wheel retract and nose tow release to be spread out. It certainly makes working on the equipment a lot easier. This sailplane radio room was typical of the larger ships and their controls. There were multiple 2.4 GHz receivers positioned around the nose area and separate battery packs for the receivers and servos. In addition, the fiberglass sailplanes on the field used small amounts of carbon fiber so there were no issues with R/C reception.*



*This Nemere is buttoned up and ready to go. The planking of the fuselage is an example of the excellent workmanship that was put into its creation. While the pilot figure is excellent I was amazed at the craftsmanship of the woodworking around the wing fillets. The veneer that covers this sailplane is a work of art.*



*A Reiber sailplane awaits assembly. There were several of these ships on the field in various sizes. The detail of the canopy is one of the outstanding features of this scale ship.*



*A Fox aerobatic sailplane had many successful tows during the day. While the lift was spotty the Fox stayed aloft with the biggest ships.*

Since the walls are wood it's possible to pull up a chair and fly your sailplane from the comfort of the building in bad weather.

In a change from past years, the frequency board uses cards that are the size of business cards instead of having each pilot post his AMA card. Jim Dolly furnishes the card at sign-in and you post that when you take the frequency card from the board. The people on 2.4 GHz still have to do that, even though there would be no frequency conflict.

The early hours were used by the handlaunch people for some classic flights while the tow planes and scale ships were being put together. For those of us who don't get to see handlaunch very often, it was amazing to see the consistent launch quality. It seems that the old days of 2-servo HLGs are gone as all the planes I saw used ailerons and computer mixing.

I had a chance to sit down with Jim Dolly to talk about the site. Jim has purchased the place and made it available to the sailplane community year-round. For those of us who had tried the LSF 8-hour task and FAILED, this means that the site is available more than just during the fall season. The prospects for an LSF Task Achievement Day or weekend are now much better.

Jim would like to have pilots contact him using his web site  
<<http://www.highpoint-aviation.com>>.

He also mentioned that the money collected during the year is used to upgrade the road into the site as well as improvements to the building.

Jim also purchased a trailer mounted winch and retriever that will be left at the site for those people wanting to winch launch their ships.

The only crash that I witnessed was a mid-air between one of a 120 inch span tow planes and a handlaunch sailplane. Only the nose of the HLG was undamaged while the remainder was completely trashed. The tow plane suffered no damage and proceeded to finish the tow without further incident. The HLG pilot admitted that he shouldn't have overflowed the takeoff area and was good natured about the crash. However, it does point up a problem of coordination with so many aircraft types flying in close proximity.

Since it's a 320 mile round trip, Rich and I packed up and departed about 3:30 in the afternoon. The sun was still strong and warm and the activity on the hill was popping.

Now that the hill is available more often we'll be back to work on our tasks and enjoy a premier soaring spot.



*Myer Gutman is the happy pilot of this Jantar. It weighs 55 pounds and has a 26 foot wing span and thermals with the best of them.*

# VOLKSRUST 2011

## GEMS PSS FEST

Piet Rheeders, [pietlewis@absamail.co.za](mailto:pietlewis@absamail.co.za)





# Greenfields Eastern Model Soarers, South Africa

The summer months have finally arrived in South Africa and normally we get lots of thunder and lightning storms during the nights in November on the Highveld. However, the day temperatures are around the mid-20 deg C/68 F to mid-30 deg C/86 F with plenty blue skies. Ideal flying weather to say the least, and even more so as there are still some strong winds at this time of the year.

It was therefore no surprise to us when we arrived shortly after 10 AM at "Tamatieberg" Volksrust on Saturday the 5th of November to be greeted with the perfect wind conditions on the main North West slope, gusting up to 45km/h in the afternoon.

Izak, Ivan, Paul, Norbert and Mike were already there and unpacking and assembling their slope scale planes. Gert was already flying and testing the slope lift with his JART and had no problems in staying aloft.

At midday all of +/- 17 pilots had arrived and Paul called a pilots' briefing. Shortly



*Static display - The author's Aero Commander is at the upper right. MiG-7 and Mustang racer in the back row along with an SAAF Sabre, SAAF Impalas in the middle row, Norbert Rudolf's F-5 in foreground.*

after a static display and group photo session, the fun began.

The conditions by this time were ideal for the larger and heavier slope scale models. I got my first flight in with my now three year old 1/7th scale Rockwell

Aero Commander. On landing it came in a bit hot and just as I touched down I put the flaps away. The Aero Commander did not need a second invitation and jumped right back into the air, clearing my head by around 3 meters/10 feet and

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*Opposite page: Group photo at the GEMS PSS 2011; the pilots and their scale models.*

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*Above: Norbert launches Mike May's SU-35 on its maiden flight.*

*Opposite page: The Russian Sukhoi SU-35 "Flanker" built and flown by Mike May on its custom made stand and in the air.*



*Above: Jacques Pretorius' SAAF F-86 Sabre*

*Left: Gert Nieuwoudt's Correx Mig-7*



*Glen Pyle's SAAF Impala decked out in the Silver Falcons Aerobatic team 1980 colour scheme*



*Dudley le Roux's Alchemy*

in doing so performing a spectacular but unintentional touch and go. The second approach was spot on and this time I kept the flaps down until the Aero Commander came to a dead stop.

The show stopper for the weekend was the SU-35 Sukhoi "Flanker" of Mike May. Mike scratch-built this model in six weeks and it weighs in at 5Kg /11 lbs.

As Mike and Norbert walked to the edge of the slope just about every one migrated with them to witness the maiden flight.

Norbert managed to get the model launched safely while many action pictures were recorded, including myself, with some stunning launch pictures. The veld-fire at the bottom of the slope made them look even more realistic.

The maiden flight lasted about 30 minutes and Mike reported afterwards that the SU-35 handled easily.

I also managed to get some good in-flight photos and I am sure that this will inspire modellers with similar projects in mind to get started. Mike indicated that he will post the build on RC Groups

and the project will also be included in a future issue of *RCSD*.

Paul's Cessna "Dragonfly" — last year's winner — also put up some good flights and I joined him on one of the flights with some formation flying.

Both the Aero Commander and the Dragonfly have a similar speed range and flying close to each other was a great experience and an awesome sight.

By the end of the day I had three long flights behind me, and most of the slope scale planes there, except for the very light ones, were flown as well.





*Relaxed Sunday morning flying in light slope lift on the south slope.*



*Sacred Ibises and Ivan's Tsotsi high above the slope in a huge thermal on Sunday morning.*



Gift Packs for the five best models as voted for by all the pilots present were sponsored by AMT and handed out by Paul on Saturday evening.

Early Sunday morning the wind came from a southerly direction — this normally happens when a cold front passes by — and it was clear that we were going to fly off the south slope.

Evan tried one flight with his E-Tsotsi before breakfast and before we departed to the mountain, but flew more backwards than forwards.

Evan and I were the first to arrive on top of the south slope. The wind, although still coming from the south, was now much lighter and this made for relaxed flying with the odd thermal/sink cycles to make flying somewhat interesting.

Izak once again demonstrated how to fly around the huge 200 meter high communication tower without hitting or flying into any of the four steel suspension ropes.

While on the south slope a group of us took a short walk to the Rob Street Memorial. Rob died in the hotel just below the south slope on a flying weekend in the year 2000.

Just before 11.00am the slope lift became weak but some huge thermals came through. A flock of Sacred Ibises that soared high — around 200-300 meters — above us were joined by Ivan's



*Paul Carnall getting his Dragonfly ready to fly.*



*Above: Paul Carnall's Corsair, the smallest scale RC model at the PSS Fest, launched by Evan Shaw.*

*Left: Izak Theron's Corsair*



*Norbert Rudolph's F-5 in flight*



*Static display: Cessna "Dragonfly," SU-35, and A10 in foreground*

Tosti and I managed to get some long distance photos of this.

As usual this sparked the argument of who was the highest and several passes were made to prove the point. After this Ivan had to spiral his two meter Tsotsi down in order not to lose it in the strong lift.

As the slope wind swapped around from the South to Northerly around midday most of the pilots decided to depart to their various destinations, between three and five hours travelling.

Some of us went back to the North slope to make the last few flights of the 2011 Fest before we also departed for home.

Judging by the turn out this year, I am sure that we will see many more new projects and RC PSS pilots next year. "Well done" to Paul and the GEMS club for a great event.



*Izak Theron's "around the communication tower" flight.*



# New from

## HOBBY CLUB



P.O.Box 6004, San Clemente, Ca. 92674 - U.S.A.  
 (949) 425-1362 (877) 235-0702 Fax

<http://www.hobbyclub.com>

e-mail : hobbyclub@earthlink.net

### Super TopSky 2 Competition D-HLG

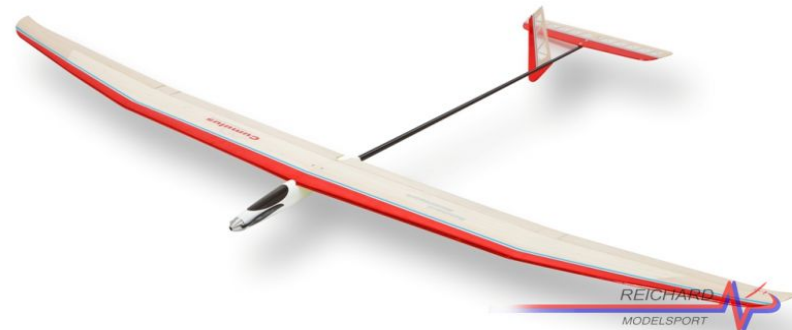


ARF WITH FOLLOWING CONTROLS: AILERONS, MOLDED RUDDER & ELEVATOR

Wingspan	58.6 in. (1490 mm)
Length	46.4 in. (1180 mm)
Airfoil	AG 45/46/47ct (Dr.Drela)
All up-weight	9.1 – 9.8 oz (260-280 grs)
Wing area	22.84 dm <sup>2</sup> (354 sq. in.)
<b>Introductory price</b>	<b>\$315.00</b>

### Cumulus 2.5m ALES-LMR-F 5 J

ARF Competition e-Glider



Price \$379.95

<b>Wing airfoil</b>	<b>Special F5J</b>
<b>Length</b>	<b>1270mm (50.0")</b>
<b>Airplane empty weight</b>	<b>450g (15.79oz)</b>
<b>Wingspan</b>	<b>2500mm (98.4")</b>
<b>Wing area</b>	<b>40.6 dm<sup>2</sup> (629.3 sq.in.)</b>
<b>Functions</b>	<b>Ailerons, Flaps,Elev.,Rud.,Mtr.</b>



# Gordy's Travels

## "My sailplane stalls!"

Gordy Stahl, gordysoar@aol.com

"A nose heavy sailplane is destined to fall because IT will stall - A properly balanced sailplane will fall because its PILOT let it stall."

Remember, one dot more lead in the nose than is needed to make your model fall forward, it will want to fall forward and nose down. Which means your model will need some up elevator trim setting. Then when the model's airspeed increases the nose will shoot up... and stall. If the airspeed drops, its nose will fall. Airspeed changes, not changes in lift and sink conditions.

A properly balanced task sailplane is not set to some "feel" or some protective/defensive stability... It's set so that the model only changes its attitude due to the effects of lift and sink on its tail (the tail directs the nose), not due to airspeed changes.

That means if the model flies into cold sinking air, the tail will be pushed down

causing the nose to angle up. If the pilot doesn't recognize why the nose went up, that is he isn't in control, it will stall. The PILOT.

A properly balanced task sailplane is directed by lift, sink and its pilot. A nose heavy model will do what it wants or what airspeed changes empower it to do.

Models balanced with a dot more lead in them in order to "tame" them for new pilots hurt their pilots. They handicap their pilots from learning to read lift and sink, they keep their pilots busy trying to correct for airspeed changes, and they keep sailplane pilots from learning to read and understand what their models want to tell them. Improperly balanced task sailplanes fly fast and right through most indications of lift and sink, the tail constantly battling for control of the nose against gravity and too busy to communicate indications of lift and sink.

"Airspeed empowers tail feathers and the

tail directs the nose." A simple firm and flat hand toss will tell you if your model has been flying with too much lead in its nose. A firm flat hand toss will cause the nose to shoot upwards to a stall because it's been flying with up trim. That's a crooked sailplane. A properly balanced sailplane will simply rise when tossed firmly and flat.

There's a caveat: Fixed stabs make it all very complicated and it's why we use full flying stabs. Full flying stabs give us the ability to adjust stab incidence to changes in nose weight and air conditions.

In any case....

Which would you prefer, nose up or sailplane up?

Dive test, inverted test... These are all designed to keep the average modeler distracted from learning to read air.

Questions? Contact me!



# SPRAYER COVERS = Linkage COVERS (CHEAP AND EASY)

Genaro Solé, genarosole@gmail.com

Landing your glider on grass, mud or dust can ruin your servos, but linkage covers are there to protect servos and prolong their life. Most linkage covers are cheap, but sometimes it's difficult to find one that suits your needs. You can make them yourself with fiber, but that requires time and patience.

Here I present a cheap and easy solution: sprayer covers, made from the upper section of most cleaning sprayers. They weigh just 0,07 oz (2 grams), are tough enough, and perfect to protect servos on landings. They even work great to prevent the wing tips from touching the ground on hard surface fields.

1. First, find a cleaning spray cap that suits your needs. You can choose from a big selection of sizes, shapes and colors. I prefer those rounded corners in order to reduce drag.
2. Next step is to pull the plastic upper cover away from the pump system.
3. With a Dremel cutting disc, cut the cover to your desired size and remove the internal plastic channels that can compromise the servo arm and linkage movement.
4. Finally, fix the cover with cyanoacrylate, or use your preferred fixation method. I use these linkage covers on my Multiplex Easy Glider and my Fun One without problems.

The good news is that the sprayer can still operate without the protective cap, so don't worry about complaints from the wife/mom!







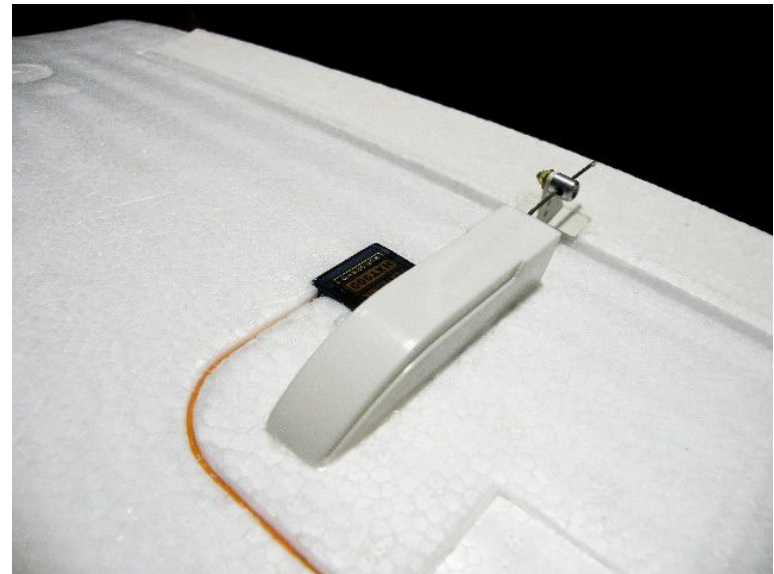
1. Typical trigger sprayer



2. Top removed



3. Top trimmed



4. Linkage protector fixed in place

# REBUILDING A LEGEND



Trevor Ignatosky, [powerbud@optonline.net](mailto:powerbud@optonline.net)

Looking at an old-time radio control sailplane is like looking at a vintage sports car. It's a whole new world to explore and question. "Did it actually come with a hand crank for the engine? Really? Look at the skinny tires. What is it like to drive? Where's the computer screen?"

And like a vintage sports car, an old-time sailplane can show us where the limits of design were being pushed to back in its day. We, in perfect hindsight, may say "How quaint," and still appreciate it for the thought that went into its design and the craftsmanship displayed in executing it.

This article is about the rebuilding of an old competition sailplane. The sailplane is only two decades old, a youngster in the world of old-timers. However, in terms of airframe wear and tear, it's like a DC-3 that made it through another war, limped home, kept on flying and, over the decades, slowly packed on weight from repairs.

This article skims along hitting the high points encountered and giving a rundown of thoughts and decisions made as work progressed while rebuilding the model. It's an if-I-can-muddle-through-this-so-can-you sort of article.

Even more so, it's an unabashed call to get those old-timers repaired, rebuilt or, if you're truly dedicated, restored. And then get them out on the field.

Be foretold. I like to build, but I'm not a "Builder." I don't have tool cabinets with lots of tools. I have a small toolbox and a few tools. I don't have much room for building. Most work gets done on a kitchen table or building board.

The point is, well, I get discouraged looking at articles where everyone has all the "right" tools and a workshop to store them in. So for the rest of us, here you go; everything's been done with the "wrong" tools and in a workshop you should be right at home with.

### **What is a Legend?**

An Airtronics Legend was designed to be a relatively heavy 2.9 meter sailplane at 70 – 75 ounces, of what Airtronics called "flying weight" back in 1990. It is a fast flying plane: a lead sled (in the traditional sense of the phrase) as opposed to a gasbag like the Bird Of Time. Due to its weight, it has a good deal of potential energy stored up at any altitude and, with its clean lines, is capable of translating that energy into a lot of distance in search of a thermal or just coming back home when flying into the wind.

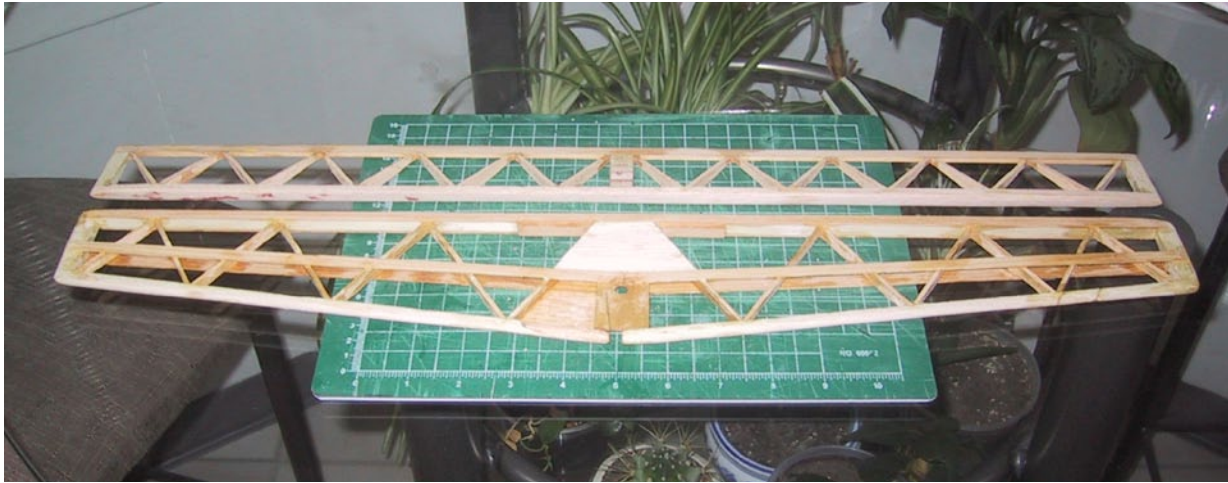
November 1, 2010. That's when I took possession of an Airtronics Legend: at that time a twenty year old model that had been through a couple of owners and a lot of wear and tear. The Legend was my first full house sailplane coming from DLG and electric. When I first saw it I was thinking of it as an expendable trainer and stepping stone on my way to something better. I liked the look of it right away: particularly the T-tail and winglets. To me, the T-tail was very modern looking and the winglets were retro looking. If you're looking at a modern full scale performance sailplane or a model of one, you're likely looking at a T-tail. Somehow the T-tail hasn't made the transition to sport and competition model sailplanes from full scale sailplanes as well as it could have; although, currently, T-tails are branching out and making an appearance in dynamic soaring.

Some people have suggested taking away the Legend's T-tail and replacing it with standard tail feathers to save weight. In my opinion, the T-tail is what makes the Legend. Take it away and what would be left is a modified old sailplane with winglets. From a historical point of view, it's a lead sled. Why try to make it something different?

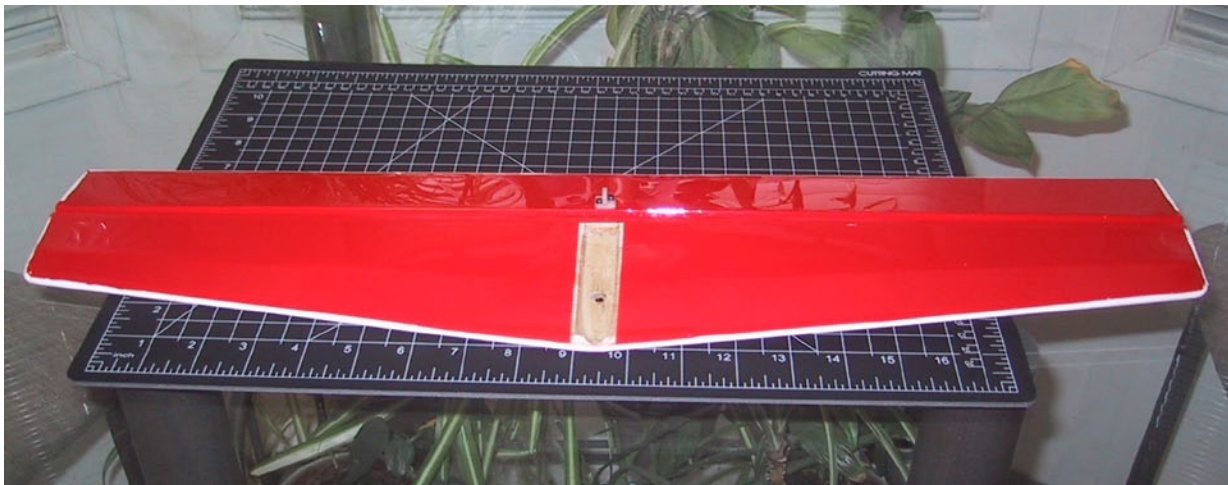
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*Illustration 1: The original Legend, as I received it, poses with a 1 meter ArtHobby Bobolink for scale. They share something in common: a need for speed.*

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*Illustration 2: The old covering and some bad wood has been removed. The remains of the leading edge still need to be removed before starting the process of rebuilding the horizontal stabilizer.*



*Illustration 3: As it is today, with a pre-shrunk Monokote hinge, so it doesn't develop the same restricted movement problem again. The center has a thin epoxy bead at its edges molded to fit the vertical fin, so the horizontal stabilizer is always aligned correctly and much less tippy.*

## Getting Started

I got into rebuilding the Legend by accident. I found the elevator had restricted down movement due to a too tight Monokote hinge when I was starting to set it up with a new receiver. There was no help for it, but that I'd have to remove and replace the elevator hinge, which meant stripping the covering off the elevator and horizontal stabilizer. I could have, in keeping with the state of the other control surfaces, cut through the hinge, slapped some packing tape on it and gone flying. Could've, would've, should've: it was one of those turning points in my life. In this case, peeling the covering off was my first step down a long, bumpy and balsa chip strewn path.

On opening the horizontal stabilizer and elevator, I found both suffered from glue joints that had broken loose. The horizontal stabilizer also had a broken spar and a leading edge that had been sanded down to the point that it was wavy: sort of hill and dale as one's eye traveled past the glue joints on its ribs. The elevator... well, you get the picture. The top Monokote had been changed eight years previously and since then had been faithfully holding everything together, nice and tight; until I came along.

I found some white crystals inside the horizontal stabilizer that turned out, after investigation, to be residue from using CA and baking soda to fill in gaps and

build up areas. Twenty years after being used on this model, this was a new technique to me. Anyway, baking soda was right there in my kitchen workshop, so I started to use it and ended up using it extensively while rebuilding this model. It has since earned a permanent place in my bag of tricks.

How many ways can good wood go bad? Some was dried out, some was broken, some was warped and some had a greenish tinge. After replacing the bad wood and straightening the elevator and horizontal stabilizer assemblies I felt much better about the Legend. I wasn't thinking about doing much more work on it at this point.

## Rebuilding

Since I had taken a flattened balsa shim out from under the horizontal stabilizer, I also removed the epoxy that had been added to the wing saddle, returning the decalage to its stock value. At this point I was officially rebuilding and even doing a little restoration, without any real understanding of just how big a project I had started.

Next, I started cleaning out the old epoxy, old wood and old baggage from inside the fuselage. It had a few old layers of de-laminated and loose epoxy in it that were along for the ride and made for a time consuming and boring task to remove. I could have stopped there, put everything back together and called it a day, but no-o-o-o.



*Illustration 4: The epoxy shims simply popped off the wing saddle. Sometimes, I just get lucky, but all that the ease of removing the shims did was entice me into continuing to clean up and rebuild the fuselage.*



*Illustration 5: The original fuselage had layers of epoxy repairs built up over the decades. If they could be seen edgewise it would be like looking at the stratified layers of the Grand Canyon. Removing them was like peeling an onion... from the inside out.*



*Illustration 6: Much cleaner and lighter. Narrow strips of heavy fiberglass, to be able to follow compound curves, are CA'd to the fuselage, both inside and out, to hold the broken sections together. These repairs have held up to numerous high impact landings.*

By the time all the old dead epoxy was cleaned out, the fuselage was in three separate pieces with gaps where epoxy patches were removed. The patches were made up of epoxy that either was soft enough to bend back on itself or brittle, which broke under finger pressure. Neither had remained properly bonded to the fuselage.

I decided to use CA and heavy five ounce fiberglass cut into long thin strips, inside and outside of the fuselage, to hold the sections together. CA and baking soda was used to fill in the gaps between the fiberglass strips where the fuselage should have been.

Once the repairs were done, a very thin layer of Bondo was used to fill in, edgewise, between the fiberglass strips and smooth everything out before painting.

The bottom center of the center wing was found to have had a lot of repair work, which was beginning to come loose. After looking at the number of old repairs visible in that one small area and feeling along the length of the center wing section's sheeting and finding soft spots, I could see the writing on the wall.

Oh, I could drag it out and take off a little bad wood at a time, but there was only one outcome: the wing was going to be



*Illustration 7: Under pressure the vertical fin reveals its little secret: it's cracked from top to bottom. This is the result of the vertical fin bending and vibrating sideways on hard landings.*

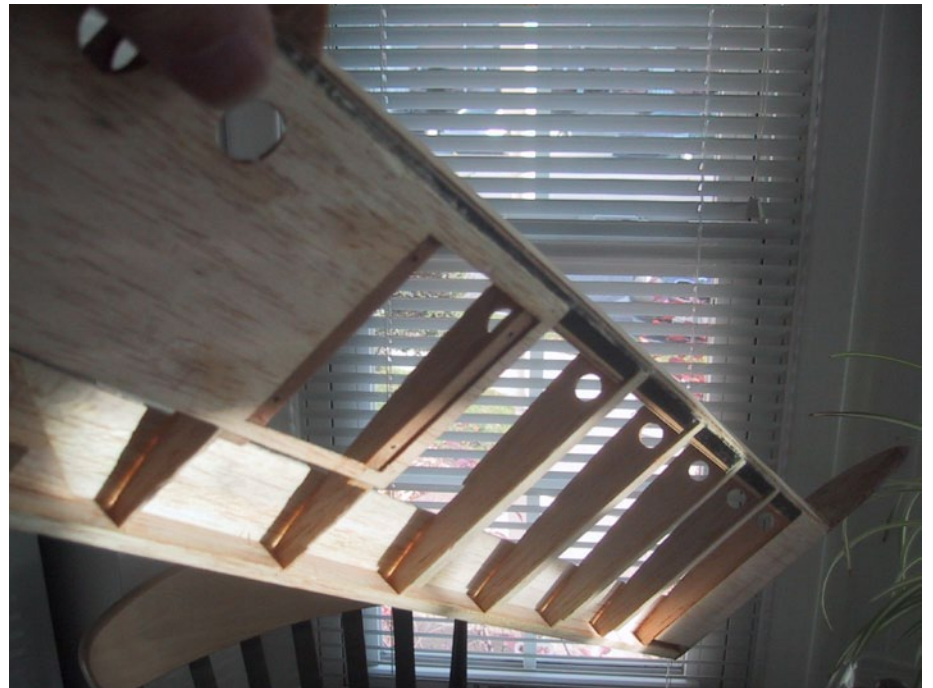


*Clockwise from above:*

*Illustration 8: The fibreglassed over old repairs are coming loose and need to be removed.*

*Illustration 9: The morning sun reveals that the sheeting wasn't completely glued to the rear of what's left of the ribs. It was the same on the other side, too; very consistent. This led to a crack in the sheeting from one end of the center wing to the other. Once again, good old Monokote was holding everything together.*

*Illustration 10: There is a new leading edge and all new front ribs in the center wing section. Additional ribs and doubled up sheeting are used in the very center where the old wood started to collapse under the model's own weight while balancing it.*





*Above left: Illustration 11: The old wood has been sanded down so much, presumably during repairs and recovering, that it had to be built up and sanded flush with the new sheeting in places like these rib caps and around the servo wells.*

*Above right: Illustration 12: Attaching the flaps. Pushrod stock is used as a spacer to form the hinges. The Monkote was pre-shrunk before being applied. Later on, the entire wing was stripped down, yet again, and recovered, top and bottom in red.*



*Left: Illustration 13: The wingtips get stripped down, for the second time, to reduce their weight.*



stripped down and all the bad wood, epoxy and fiberglass removed.

The wingtips were rebuilt and then rebuilt a second time to reduce their weight using a lighter balsa sheeting. Also, more attention was paid when recovering them the second time to reduce the gap in the aileron hinges.

The wingtips' spars were also carbon capped at the cost of adding 0.2 ounces to each wingtip. It wasn't required and it added a little more weight, but I felt better doing it after repairing the original wood used in the wingtip spars.

The original rudder and rudder assembly were removed, rebuilt with lighter wood and recovered. The long metal screws in the carbon rod were replaced with shorter nylon ones.

In accordance with the rules of the build, once I'd gotten the old beat-up fuselage rebuilt and started flying with it, I was able to find and purchase a pristine fuselage with plans and an updated manual.

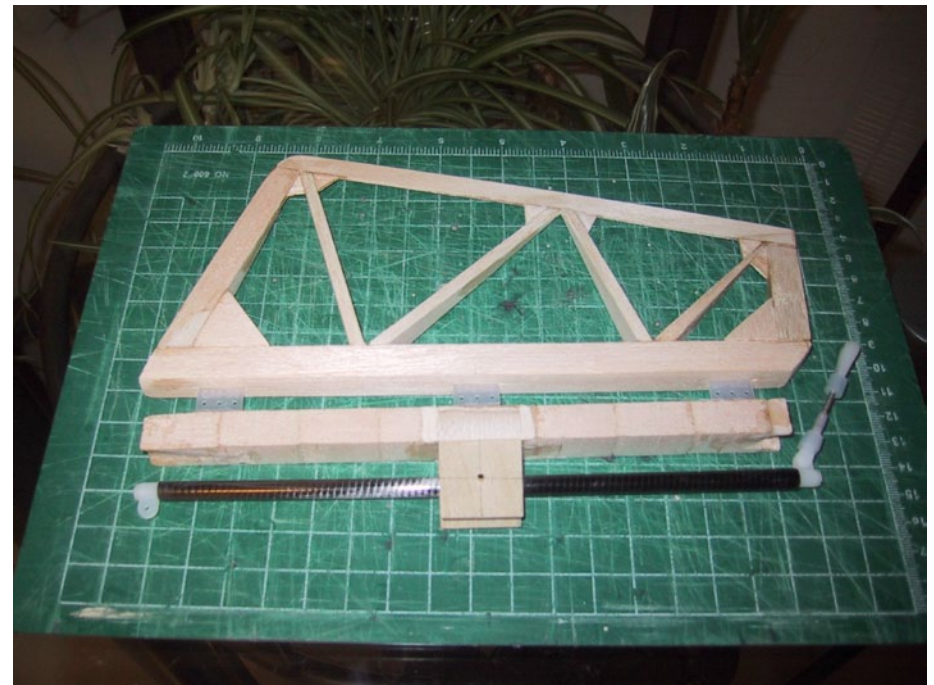
The materials used in the new fuselage and its construction looked just like the old fuselage's, so I felt I was staying true to the original.

Instead of the old fuselage's plastic pushrods for the elevator and rudder, I used a carbon rod and a pull-pull system in the new fuselage, per the plans. This improved the flying experience,

*Illustration 14:  
Ready for re-sheeting. A wingtip has been cleaned up and its spar carbon capped on top and bottom.*

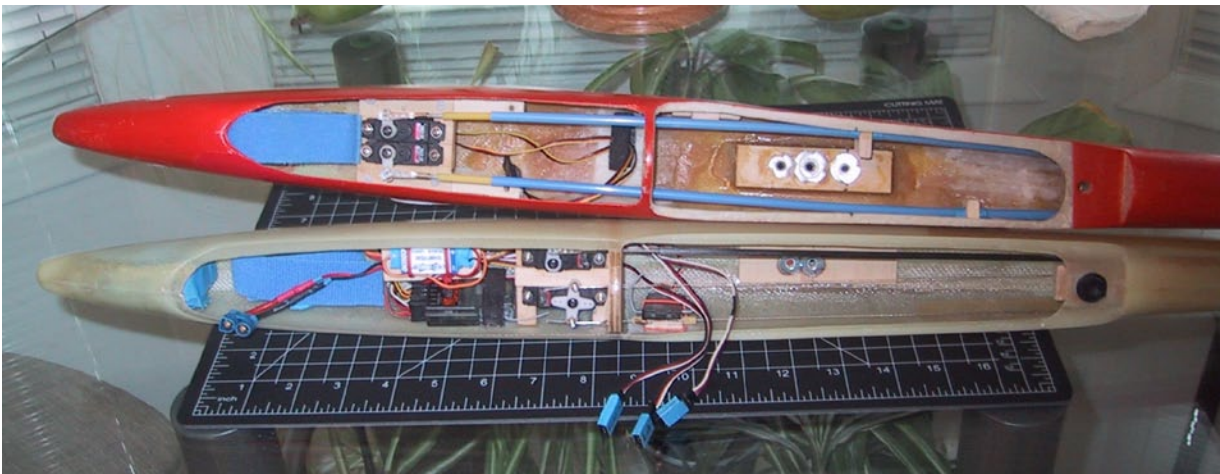


*Illustration 15:  
Rudder assembly hinges being checked for alignment.*





*Illustration 16: The rudder assembly built for the new fuselage is even heavier than the first rebuilt one by 15 percent. I did mention that I'm not a builder.*



*Illustration 17: Old fuselage on top and new one on bottom. They are lined up by their rear wing mounting holes. The old bulkhead was moved back so it was away from a major repair (the white area visible in the bottom center of the old fuselage).*

particularly for landings and turning in a thermal.

Old-time woodies are good ships for rebuilding. You can expect to find broken wood, not crushed foam inside them. You can rebuild them lighter, stronger, faster or keep them stock, however you want. You can make them look decades younger, too. Old Monokote covering, from way back when, can be replaced with new Monokote. And they still sell the matching paint.

If you restore a sailplane completely, you get a reward. You can fly a plane that flies just the same as the day it left the nest; that is, if it was originally built to its plans. It may have very different flight characteristics than you are accustomed to, which is what makes flying an old-timer interesting and sometimes hair-raising.

## History

While working on the Legend, I could see the original workmanship and subsequent repairs and changes made by different hands over the years. I got a feel for each person's skill, favorite techniques, attention to detail and how much they cared about what they were doing. It was no longer just an old model: it had history.

I learned about an old technique that still has value today: the use of CA and baking soda to fill gaps, strengthen and build up areas.

I learned that rebuilding an old bird involves detective work, demolition, construction, and is quite different from building a new model.

Take your time and rebuilding can be a rewarding experience in itself. If that isn't enough, take it to the next level and restore a model to its original design. When you're done there's the thrilling experience of flying it.

### **Flying the Legend**

I spent a good deal of time flying the Legend and not feeling comfortable with it. Frank Strommer, one of our club's best TD pilots, demonstrated that the Legend can fly very well with the master's hand on the stick. He test flew it and gave some suggestions for setting it up. I think they were mainly to do with ailerons (reduce the differential) and rudder (reduce the throws when mixed with the ailerons). By the time I got home I wasn't too clear on what else he said to do. I put in his changes as best I could and I also put in exactly the control surface movement called for in the plans and the manual for aileron/rudder coupling, flap/elevator compensation, aileron crow mixing, reflex and camber. I had a little too much for all of them. Throws were primarily reduced by moving the pushrods in on the servo control arms and out on the control horns. Using a mechanical change, like this, in addition to a small transmitter programming change, rather than only using a



*Illustration 18: Rudi Oudshoorn chucks and pedals the Legend.  
Photo by Sandie*

transmitter programming change, gives better servo resolution for the amount of control surface movement. Translation: The controls are much smoother and, incidentally, have more torque and less slop at the control surface.

While flying the Legend as a novice in an unlimited contest, in what other contestants called weak lift, it amazed me by hanging in there and making its times on a couple of occasions. I keep thinking "You can't beat physics; it's heavy." Still, it did launch straight, thermal and glide well, covering a lot of territory in light winds. In the hands of a better pilot, no doubt it could have placed better. Maybe one day I'll be able to fly it well enough to give a better accounting of itself in a contest.

In the meantime, the Legend is fulfilling its original goal from when I first got it, which is to be a trainer. As a trainer, it keeps me on my toes. As an old-time sailplane, it's level of performance still leaves room for me to grow into.

The new fuselage was used after implementing Frank's suggestions. With Frank's changes and the new and lighter fuselage, tip stalls are a little less severe. One wing will drop, but not snap down, and if I bring the nose down I can recover without losing too much altitude or even altering direction much. In that regard, windy days help. It's those low wind, almost calm, days that tempt me to slow down and fly closer to stall speed, when

dragging in a landing, that are the most dangerous to fly in.

## Weight

The center wing is where the majority of weight gain over a stock build occurred from building it stronger. Lightening it would make for a weaker wing. I don't want to do that when I can use its strength to launch a little harder and gain more altitude. As we know, launch altitude makes a big difference when hunting for thermals.

It's surprising how far a lead sled, like the Legend, can travel into a little wind off a hand toss and act like a much lighter plane. I just can't forget it's a heavy plane and, when I'm flying slow, and if it's still in the air, it's most likely flying right on the feathery edge of its flight envelope.

Keeping the CG a tiny bit forward from Airtronics's recommendation (0.25 ounces more nose weight) helped reduce tip stalls to start with and recover with less altitude loss when they were encountered. That made the Legend a lot more pleasant to fly and more likely to return home in one piece. I don't feel I'm missing anything, since even with the forward CG it still indicates lift well.

## Now what?

Should I keep it the way it is? I think so. It flies like a stock Legend, because it basically is a stock Legend. Once it was a competition sailplane. Now it's an old-time sailplane. I don't expect an old-time

sailplane to outperform a new one, but it has a certain charm of its own. And it's a sailplane. How bad can that be?

## Final Thoughts

Never bothering to look ahead far enough to see the next pitfall is what helped me to keep going to the end of this project; if there ever is an end. I had the blinders on for everything. There was more work, more time and more money devoted to this project than I might have volunteered for if I knew about it up front. If I had taken my initial outlay plus all the money I spent on parts and materials, I could have bought another used and more modern sailplane needing far less work. But ... I would have missed out on an adventure in building and the satisfaction of flying an old-time sailplane that can still be somewhat competitive and isn't, from any perspective, just another sailplane.

We need diversity to keep our interest in this sport up and having the old-time RC sailplanes around helps give us that. Also, the old-timers are a good part of our history and to see them flying and talk to the folks who built, rebuild, restore, maintain or fly them is an education. I appreciate the opportunity to connect with the builders, the pilots and these planes and I hope, having read this, you will be interested enough to connect with them, too.



#### References:

“Rebuilding a Legend” thread: <<http://www.rcgroups.com/forums/showthread.php?t=1430660#post18082958>>

“Building a Modern Legend” thread: <<http://www.rcgroups.com/forums/showthread.php?t=1454593#post19237095>>



# Modifying the Bob Martin **Bobcat** for better thermal flying

Lance Atkins, anis29005@mypacks.net

It said so right on the box “Perfect Contest Ship or Aileron Trainer.” The Bob Martin Bobcat “T-tail Aileron Thermal Sailplane” caught my eye as I browsed the shelves of Mid-Cal Hobbies in Clovis, California on that spring day in 1987.

I was in my second semester at California State University, Fresno, and looking for something to build that would provide a flying challenge. The Gentle Lady that got me hooked on sailplane flying three years earlier was both no longer a challenge to fly and a bit tattered as it had been gifted to me by my R/C instructor after he was finished using it as an 0.49 powered motor glider.

I decided I needed an airplane that would let me develop some aileron flying skills. What I didn't know at the time was that 24 years later I would be using some new design and fabrication skills I was learning to try and better that same airplane's thermal flying capability.

You're probably wondering why someone would bother trying to modify a perfectly good antique airplane design in this age of thermal duration composite beauties, so a little background is probably in order.

The *RCSD* background on the Bobcat is exceedingly short. *RCSD* carried the new product announcement of the Bobcat in

the November 1985 issue, but it wasn't until the May 1987 issue that a letter submitted to *RCSD* shed some light on the characteristics of the airplane noting that it had a habit of falling out of tight turns and that rudder control seemed like a necessity. Unfortunately, a planned review never materialized, leaving the plane to only show up two more times as footnotes in the *RCSD* pages.

My personal history is obviously a bit longer as this airplane and I have been together awhile.

In a perverse way, it did meet my needs for an aileron trainer by having nasty adverse-yaw, partly inherent and partly

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*Bob Martin Bobcat with improved AG34-35 airfoil wing replacing original wing*



the result of control linkage construction mistakes I made. This punished me every time I forgot to pay attention to my left rudder thumb (Mode 2).

While that helped my training, I never found it particularly fun to fly during my thermal “bush flying days.” I should probably call those days “tree flying days” as more than a few of my model airplanes got snagged by the oak trees of the California Central Valley and Sierra Nevada foothills.

As a result of the plane’s uninspiring performance, it got stuffed in a closet around 1990 to collect dust for years while I moved on to flying a Spirit and some other airplanes.

It wasn’t until 2001 that I dug out the Bobcat for slope flying with the Peninsula Silent Flyers (PSF) in Southern California.

At this time, I discovered my control linkage errors that contributed to the adverse yaw problems and corrected them while refitting the plane with more modern equipment and individual servos for the ailerons. Thank goodness for computer radios... Bye, bye adverse yaw.

The refitted Bobcat flew well enough on the slope, but as a woody, it couldn’t handle the rigors of slope flying at the highly regulated, postage stamp sized yet scenic PSF field.



*Above: Vintage 1999 photo of Bobcat as originally constructed in 1987.*



*Right: 2002 photo of refitted Bobcat at Peninsula Silent Fliers slope soaring site.*



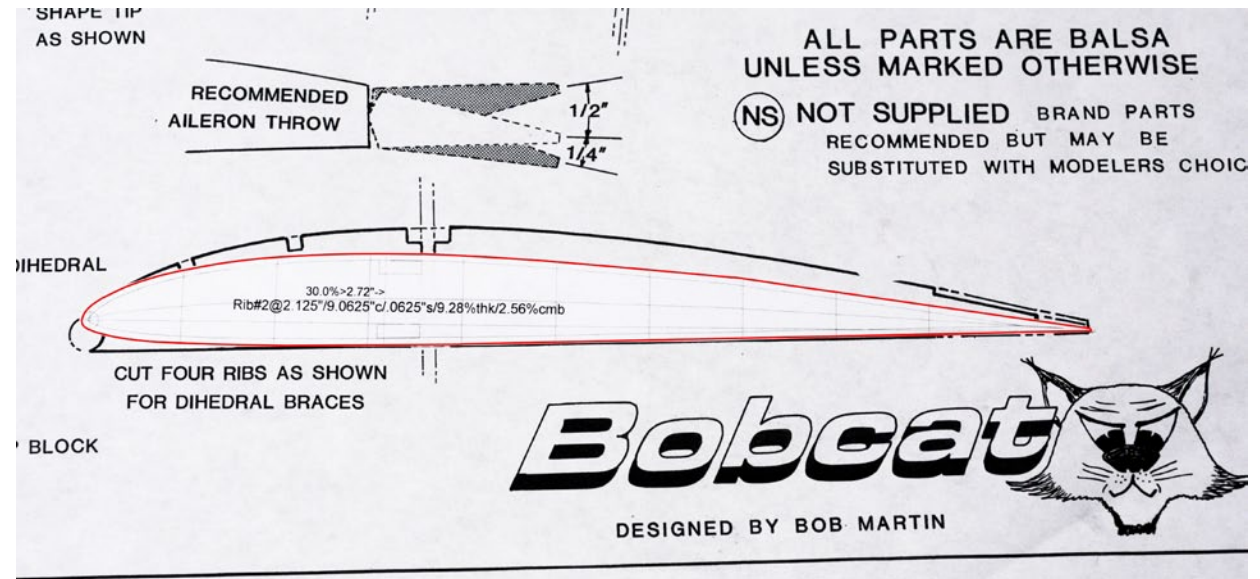
I eventually had to revoke its flight certification status when a difficult-to-repair polyhedral brace cracked during a somewhat less than perfect landing.

Back into the closet it went again until I pulled it out in 2009 to repair it and fly with the Sacramento Valley Soaring Society (SVSS). After two summers of occasional thermal flying at the SVSS field, I finally got irritated with the two to three minute flights and lack of ability to find or work thermals. Either it needed modification or it was headed to the deepest recesses of the closet where it might never see daylight again.

As luck would have it, I had been working on a couple of other design and fabrication technique projects which I realized could be used in an effort to improve my long time flying companion. So with a good deal of nostalgic compassion, I began the thermal improvements to the wing of my 24 year old Bobcat.

### **Bobcat Thermal Wing Design Parameters:**

Given my level of irritation with the Bobcat performance at the time, I wasn't willing to spend a bunch of time agonizing over optimizing the design. Almost anything seemed likely to be an improvement, so the improved thermal wing design was based on simple "that looks about right" engineering.



*AG34 airfoil compared to original Bobcat airfoil*

### **Design goals were:**

- Improve thermal performance to a level similar to the Spirit
- Retain original look
- Retain ability to use original wing
- Use simple techniques for the software and equipment I was using for the first time.

### **Airfoil:**

I chose Mark Drela's AG34-38 airfoil series mostly because I've been impressed with his aircraft designs and because this Bubble Dancer airfoil is optimized for built-up construction. In

addition, this airfoil is flat for much of the bottom which allowed it to fit within the flat-bottom wing saddle of the existing fuselage with virtually no changes required except for a small support block under the semi-symmetrical leading edge and a little sandpaper adjustment to the fuselage where it goes over the top of the wing.

I simplified the design work by using only the AG34 with a transition to the AG35 from the polyhedral joint to the tip. This combined with a little 1/32" washout was used to help control tip stalling.

### Planform:

I retained the original planform to maintain the rakish good looks of Bob Martin's original. However, I did lengthen the ailerons by one rib bay because I couldn't easily find trailing edge material of the original width; I maintained the same aileron area by extending the length of the slightly narrower ailerons. I also made the tip blocks slightly longer allowing for a full two meter span and a more gradual transition from the tip rib to the wing tip.

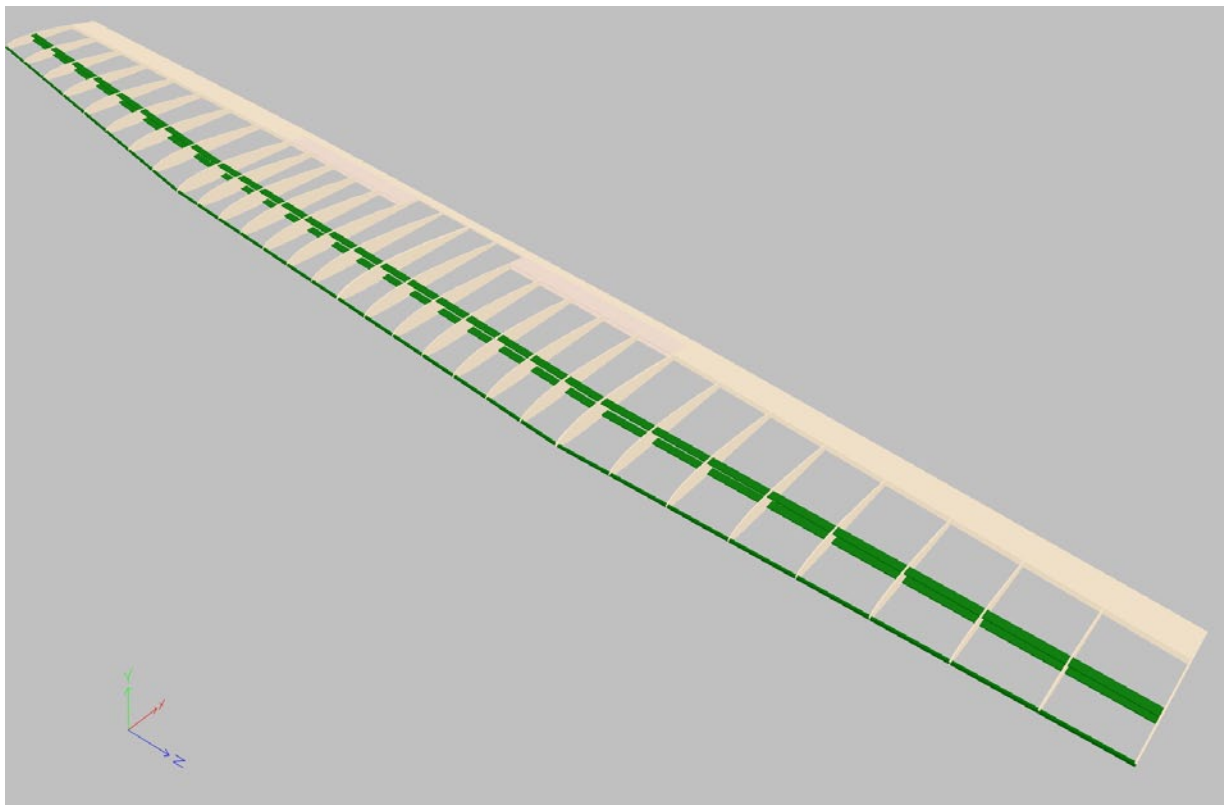
### Polyhedral:

The original Bobcat wing design has a flat center section with just under two degrees of polyhedral for each of the outboard panels. My own flying experience agreed with the 1987 *RCSD* letter that the plane did not circle well for thermals and needed more dihedral.

After some time staring at the 3D wire model generated by CompuFoil, I decided four degrees at each polyhedral joint looked good and didn't change the overall looks of the airplane much.

### Construction:

Basic built-up construction from the original plans was used because part fabrication for built-up construction was one of the new techniques I was working to develop.



*Wing 3D-view from within CompuFoil software*

I did make some modifications to ensure this thinner wing had adequate strength and better airfoil fidelity.

The leading edge was D-tube sheeted with 1/16" balsa from a 5/32" carbon tube leading edge to the combination 1/8" basswood spar with 0.032" carbon spar caps. The center panel used 1/8" vertical grain shear webs between the spars with 1/16" balsa for the tip panels. This spar is over-kill for this airplane, but

I couldn't find more appropriate 0.014" carbon at my local hobby shop when I was buying materials.

### Servos:

Hitech HS-65HB servos were chosen for the ailerons because of their light weight and small size while delivering torque similar to the Cirrus CS-26BB servos I had used with good results in 2001 when refitting the original wing.

## **Rotating Airfoil Coordinates Mathematically:**

In addition to my design reasons for picking the AG34-35 airfoil for the Bobcat improvement project, it helped that I had been working on these airfoils for another project by making changes that allow them to work correctly within the CompuFoil wing design software.

I've found a few other airfoil coordinate sets that might need the same type of correction so here is the mathematical process needed to modify airfoil coordinate sets in case it is helpful for others. It certainly helped me create the wing ribs I wanted for the Bobcat modifications.

The AG34-38 series of airfoil coordinates is plotted in a slightly non-standard manner with the flat bottom run along the X-axis instead of having the X-axis located at the airfoil chord.

Basically, the coordinates are rotated upwards around the trailing edge point. This non-standard coordinate DAT file for the AG34-38 series shows up in most locations on the web including the University of Illinois at Urbana-Champaign (UIUC) airfoil database.

The Charles River Radio Controllers had files purported to be CompuFoil versions of the airfoil coordinates, but I found they were poorly adjusted versions that still didn't completely meet the format requirements of CompuFoil.

To work correctly, CompuFoil requires a one unit long airfoil with the chord running from the nose of the airfoil to the trailing edge. The "X-Y" coordinates start at point 1,0 on the trailing edge and proceed over the top surface to point 0,0 at the nose of the airfoil before continuing along the bottom surface back to point 1,0.

I'd like to say that after digging through my old mathematics books I knew exactly what to do, but it was a co-worker of mine who noted that rotating the airfoil coordinates would be much easier if they were in polar coordinate format.

My brain matter "light bulb" finally came on with that comment and the transformation of the coordinates became a simple matter of subtracting angles after a relatively simple trigonometry conversion from Rectangular "X-Y" coordinates to the Polar "R-Theta" coordinate system.

The process is shown on the two following pages (60 and 61) using a simplified nine coordinate point version of the AG34 airfoil.

MS Excel was used to automate this process on the 181 coordinate points for each of the original AG34-38 airfoils.

With corrected airfoil coordinates for the AG34 and AG35 airfoils available, I was able to easily draft the improved Bobcat thermal wing ribs in CompuFoil

and export these to TurboCAD Designer for further clean-up and drawing of the polyhedral braces and shear webs.

During the Compufoil drafting, I even located holes for the aileron servo wiring to pass through the appropriate ribs. The part drawings included wing ribs, shear webs and polyhedral braces.

In preparation for the machine cutting I was planning to do, some additional guides were included in the drawing. Red boxes defined balsa/ply sheet panels 12"x3" in size, and a green circle three times the 1/16" CNC cutter diameter was used to confirm adequate space between the parts for the cutting bit.

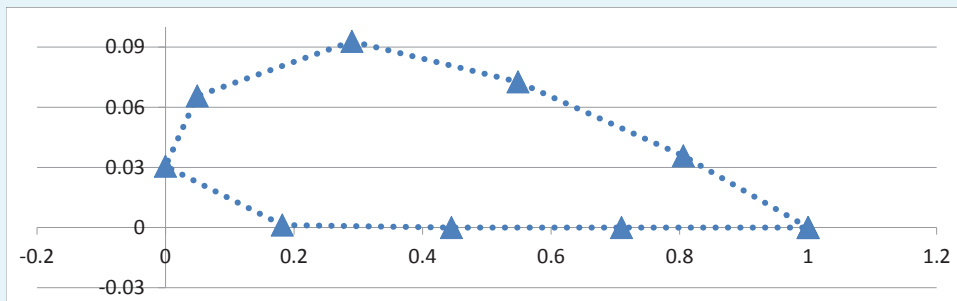
Unfortunately, the shear webs didn't have enough cutter clearance on standard 3" wide balsa sheet stock so they were cut with an X-Acto using paper printed templates.

### **Machine Cutting Parts at Home:**

Once I had the new Bobcat thermal wing parts drawn and materials purchased, it was time to make the parts.

I have my sharp-eyed wife to thank for making cutting of wing ribs easy by providing me with a useful machine for scratch building projects.

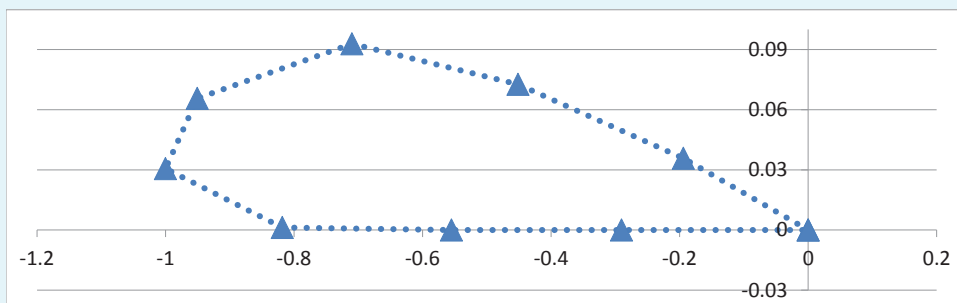
I was attending a conference that had just adjourned for a break when my cell phone rang. It was my wife on the other end telling me, "I'm at an estate sale and they have something that looks like a big



STEP 1

Step 1 – Identify the rotation center point

Here are the original (nine point simplified) coordinates showing the upward rotation of the airfoil coordinates. The trailing edge point is the needed rotation center. The amount of rotation will be found in a later step, but for reference, the rotation needed to correct this airfoil is -1.75 degrees.



STEP 2

Step 2 – Shift the rectangular axis origin to the rotation point

The 0,0 origin for the axis is moved to the rotation point by subtracting the X and Y values of the trailing edge rotation point from the X and Y values of all the coordinate points. You will have a new set of “X-Y” coordinate points with the trailing edge point being 0,0.

Step 3 – Convert the Rectangular “X-Y” coordinates to Polar “R-Theta” coordinates & find rotation angle

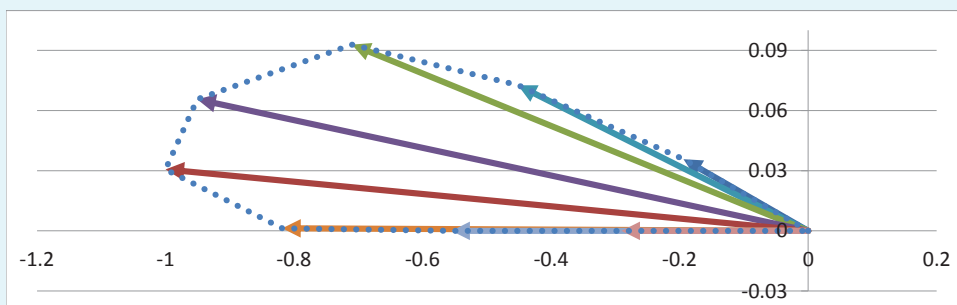
Changing the Rectangular X-Y coordinates to the R-Theta (radius and angle) coordinates uses some simple Trigonometry. The radius (R) is found using the Pythagorean theorem where:

$$R = \sqrt{X^2 + Y^2}$$

The angle Theta (Theta) is found using the inverse Tangent function of trigonometry which is simply:

$$\text{Theta} = \tan^{-1} \cdot (Y/X)$$

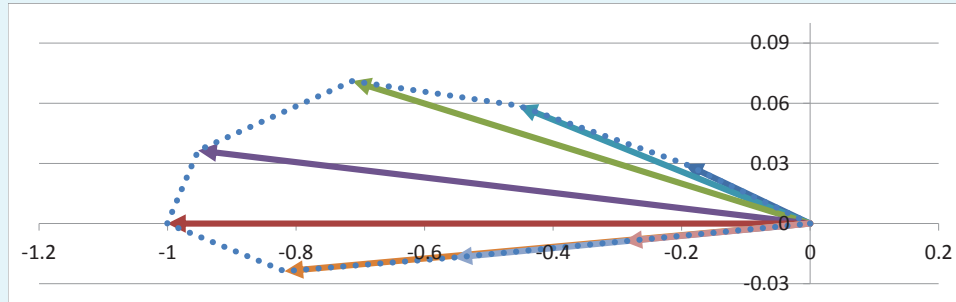
In this case, we get small negative angles that show the amount of upward rotation from the negative X-axis for each of the radius lines. You can find the needed rotation correction angle by finding the longest radius line. This longest radius will be the nose of the airfoil. In this case, you find the Red radius line is the longest and has an angle of -1.75 degrees from the negative X-axis.



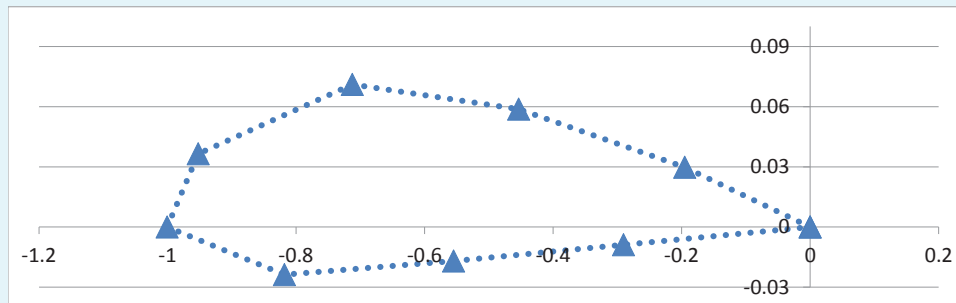
STEP 3

Step 4 – Rotate the “R-Theta” coordinates by the needed rotation angle and create unity length airfoil

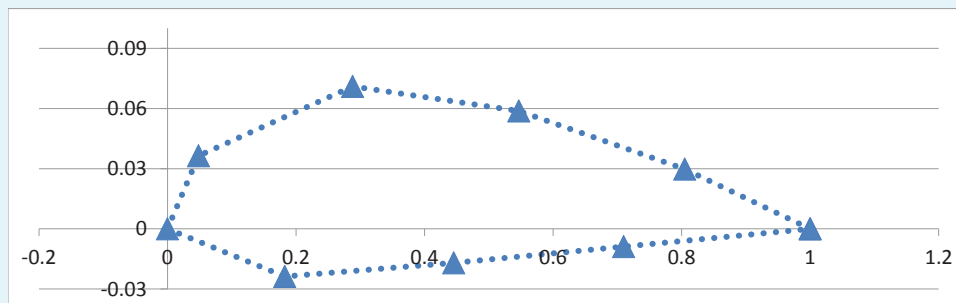
This step takes advantage of the simple mathematical transformation we made previously to turn what could have



STEP 4



STEP 5



STEP 6

been a very complicated calculation into simple subtraction. Simply subtract the angle found in the previous step from the angles of all the coordinate points. This will give you a new set of “Theta-Prime” (Theta’) angles to match with your original “R” values. For the Red radius line, the calculation will be  $(-1.75) - (-1.75)$ . Subtracting a negative is the same as adding so the result is 0 degrees. Our cord line now lies along the X-axis. However, you will notice the length of this line is longer than 1 so the airfoil is slightly larger than a unity airfoil. To correct this, divide all of the “R” values by the length of the longest radius to give a new set of “R-Prime” (R’) radius lengths. You should now have a new set of “R-Prime” and “Theta-Prime” coordinates with the longest “R-Prime” value being 1.

#### Step 5 – Convert back to Rectangular coordinates from the Polar coordinates

The conversion back to Rectangular coordinates uses the Trigonometry Sine and Cosine functions to find the X and Y values for the end point of each radius line. Because we are in the second and third quadrants of the Polar coordinate system and using angles to the negative X-axis, multiplying by negative 1 is needed to get the correct sign for the X and Y values.

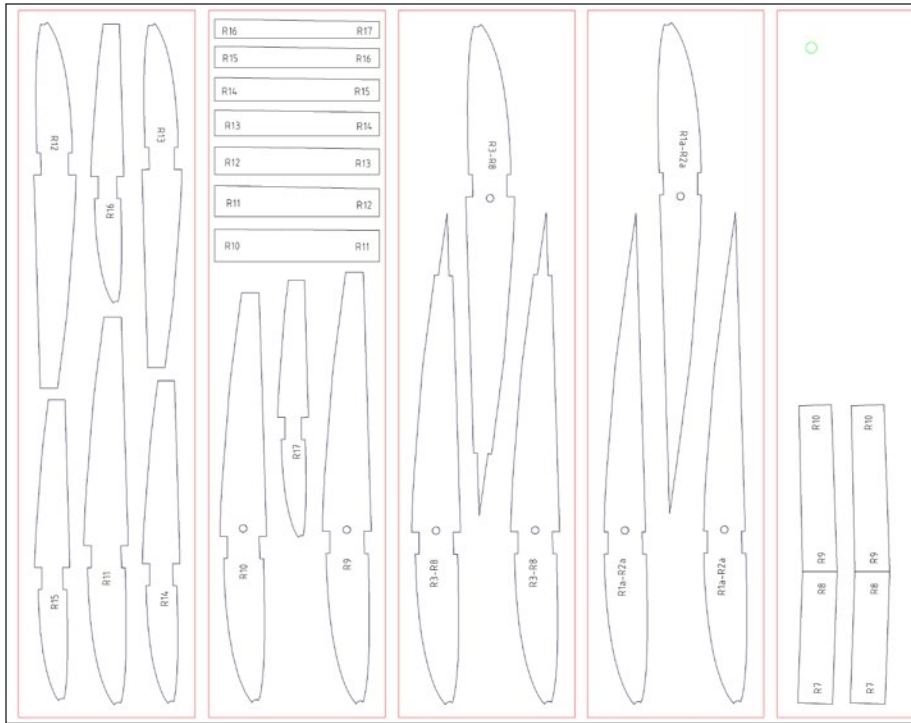
The X value is found using:  $-1 \cdot R' \cdot \cos(\text{Theta}')$

The Y value is found using:  $-1 \cdot R' \cdot \sin(\text{Theta}')$

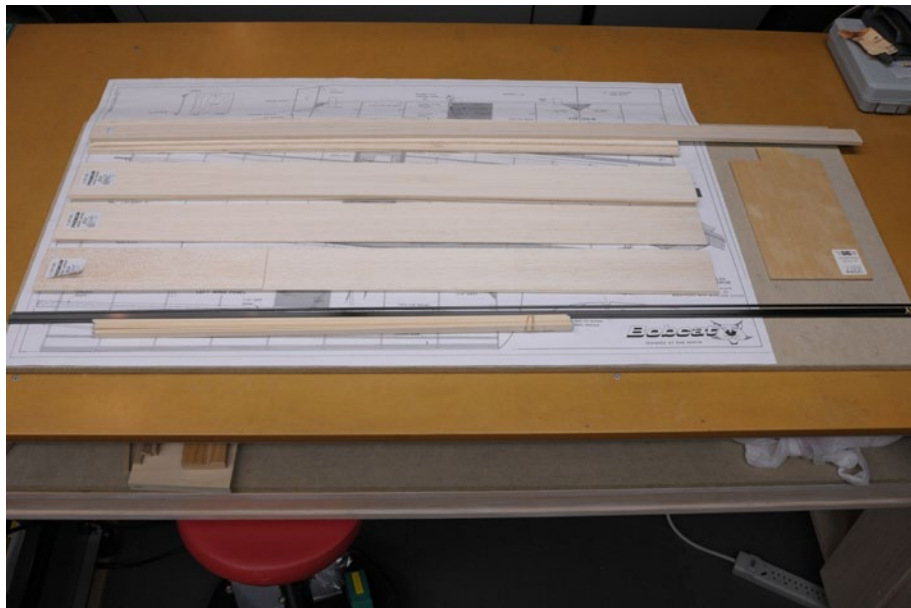
Doing this for all points will yield a new “X-Y” coordinate set.

#### Step 6 – Shift X-coordinates back to standard format

The final step is to simply add 1 to each of the new X-values thus shifting the airfoil coordinates back to the standard format for airfoil coordinates. You now have an airfoil mathematically identical to the original but rotated to the correct format and resized to a unity length that can be properly scaled to any new size.



*Bobcat improved thermal wing part drawings laid out in panels for machine cutting*



Raw materials ready to start making parts

inkjet printer for wood. Would that be helpful for your airplanes?”

My brain muddled reply from the abrupt change away from the conference topic was, “Huh? Maybe... What does it do?”

“I’m not sure. But it connects to a computer and takes wood instead of paper, and there’s a cutting bit where the printing head would be.

“How much does it cost?” I ask as I try to remember how much money I have in the modeling budget.

“They want several hundred dollars for it, but I think it’s valuable. The estate sale coordinator has it hidden off to the side. I think he’s trying to avoid selling it so he can get it.”

“Expensive for something I don’t know works” I think to myself. “Does it have all the parts?” I ask.

“I think so. I can check on that... so do you want it?”

As I notice someone from the conference that I need to talk with walk by, I realize there’s no way I’m ever going to make a sensible decision from this side of the phone.

“Honey, you’re going to have to decide whether it’s worth buying. I’m not there, and I can’t see it. It sounds like it might be useful, but I’m not sure of that. I have to go so the final choice is yours.”

After further investigation, she decided it was worth buying, much to my benefit and to the relief of the estate sale coordinator's wife who was happy it wasn't going to be added to her garage which was already packed with tools her husband was buying from estate sales they coordinated.

The machine turned out to be an early version of the Craftsman "CompuCarve" also called the "CarveWright" by the company that still makes them.

It's a simple 3-axis computer-numerical-control (CNC) milling machine designed to do decorative carving for wood working projects.

I've not done extensive research on CNC machines so I can't say it's the best for modeling use, but the CarveWright does have some benefits for home use.

The first is its relatively small size which allows it to be stored when not in use, and the second is fairly simple operation software.

Although the newest version C units have been improved over the earlier version A unit that I have, this is still a fairly light duty device, and it does require tinkering, maintenance and creative problem solving to make it produce the desired results.

Although there is a learning curve to use the machine, the user groups on the web provide a great deal of information to help answer those early questions. They also demonstrate the versatility of the device with a wide variety of projects that range from basic relief carving to 3D sculpture and musical instruments.

2D cutting of wood parts for scratch built airplanes is a fairly simple task for the CarveWright once the Drawing Xchange Format (DXF) file import feature is added to the machine's basic software package.

Most CAD programs can export files into the standard DXF format, meaning virtually anything you can draft can be cut on the machine provided it is wood or wood-like material. The



*Wing rib cutting completed on Craftsman CompuCarve called the CarveWright by the company that makes them.*

machine doesn't have the correct tool speeds and feeds to cut metals of any type.

Accuracy seems to be within +/- 0.005" which is more than close enough for modeling wood work purposes.

One quirk that I discovered using the DXF import feature is the CAD drawing must have all splines or other connected elements of the drawing "Exploded" into individual line elements before importing into the CarveWright software. The CarveWright software then has a feature that reconnects these line segments into continuous tool cut paths. Without doing this, my TurboCAD DXF files had one missing line from each connected set of lines. Not sure why, but it's an example of the kinds of minor issues you find using this machine.

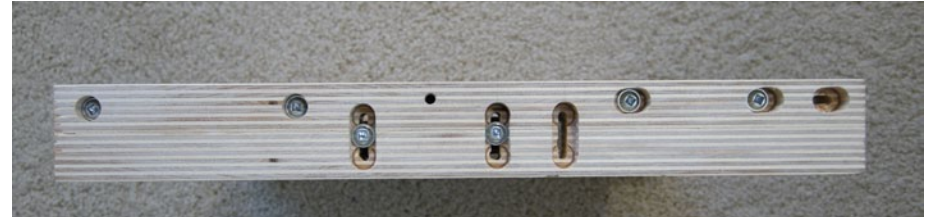
The CarveWright's small size is due largely to the fact that it moves the wood rather than the cutting head for the X-axis direction of cut. This eliminates the need for a large fixed cutting bed that takes up space, but it does mean creative use of sleds is required to hold thin or unusual material as it is fed through the machine.

CarveWright published an entire "Tips & Tricks" article on their website in April 2008 that covers some of the techniques for creating and using sleds. Using this information and several evenings of pondering how best to hold varying thicknesses of balsa sheet, I created a small cutting sled to cut the parts for the Bobcat.

The re-useable cutting sled I created is shown in the photos. Three-quarter inch birch plywood laminated to 1½" thick was used to create two rails connected by a permanently attached headstock and an adjustable tailstock.

Standard 3" or 4" width balsa stock can be accommodated by the adjustable tailstock along with slight variations in width for those standard sizes.

A height adjustable cutting bed allows varying thicknesses of balsa or plywood to be aligned with the top surface of the sled.



*Cutting sled rail attaches to headstock on the left and has adjustable tailstock slots on the right to handle standard 3" and 4" wide balsa sheet stock. A cutting bed can be adjusted up & down to accommodate different material thickness.*



*Cutting sled top view shows headstock in the foreground and adjustable tailstock in the background while the cutting bed is shown in the lowest position. The aluminum tension tab on the right rail keeps material tight between the rails.*





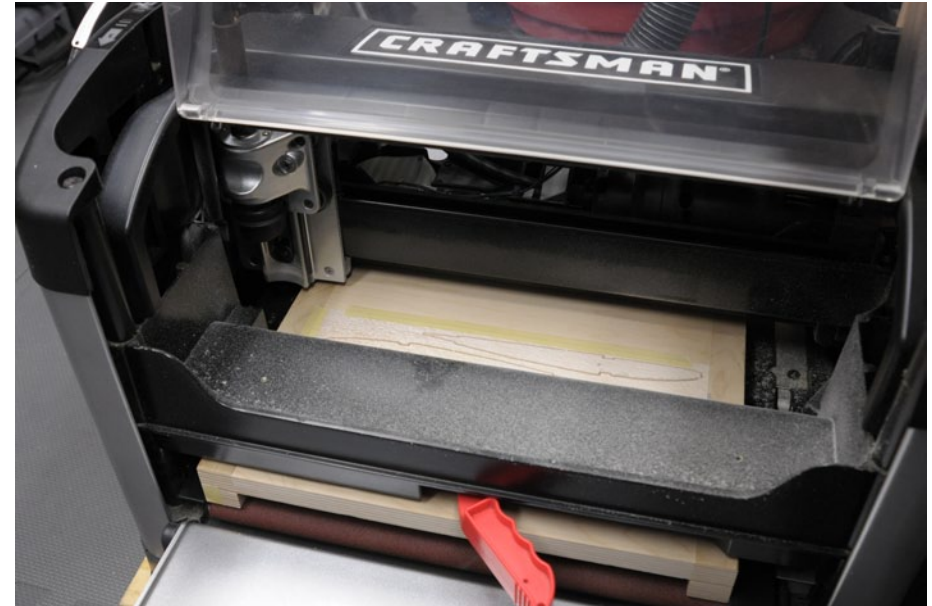
*Close-up of tension tab*

Some ½” rigid polystyrene craft foam is used under the balsa as a sacrificial cutting surface when cutting through the balsa so the cutting bed doesn’t get damaged.

I created an aluminum tension tab that is adjusted by a set screw to hold the material tight between the rails. I had hoped this and the adjustable tail stock would be enough friction to hold the material down during cutting, but it turns out simple masking tape around the edges does most of the important work of keeping the material in the sled during cutting.

For the Bobcat project, I cut the wing ribs in pairs by stacking two sheets of balsa tacked together at the corners with a small drop of medium CA. This reduced cutting time and ensured ribs for each side were exactly identical. I did a couple sheets of the center section ribs to have enough of these identical ribs.

It’s important to have a minimum of four anchor tabs to hold each part in place in case one of them breaks. The CarveWright software sets the number of tabs automatically with a setting in the cut path dialog box.



*Shop-built cutting sled in use to cut parts for the new Bobcat wing*

It’s also important to note that inside corners can’t be cut square because of the radius of the cutter. This is an area where laser cutters with their much smaller cut diameter do a better job, but the CarveWright has hollowing and shaping capabilities that can’t be done by laser cutters.

It was an easy task for me to square the inside corners of my parts after they were cut so this isn’t a significant issue. It’s certainly much, much easier than cutting all those parts by hand, and the ability to modify or recut small batches of parts without having to wait for an outside



*CarveWright at work cutting wing ribs for the improved Bobcat thermal wing*



*Bobcat wing ribs in stacked pairs of sheets after cutting in the CarveWright*

laser cutter vendor makes it a great tool for development projects like the Bobcat.

### **“Hatchless” Wing Servo Mounts:**

Once the CarveWright cut all the parts for my improved Bobcat wing, construction began using typical built-up fabrication techniques and carbon reinforcement with nothing special except perhaps for the “hatchless” servo mounts that I made.

In an effort to 1) reduce overall weight, 2) reduce weight at the wing tips and 3) lower drag, I tried to minimize the amount of material, protrusions and gaps

associated with mounting the HS-65HB servos I had selected in part because of their light weight. The photos probably do a better job of showing the servo mount than I can describe in words, but I’ll comment on a few of the details.

The mounts were fabricated from a single soft pine block. The block was slotted for the servo ears using a small table saw with a slitting blade. A couple passes over the blade made a slot wide enough for a snug fit on the servo ears. The slots could also be cut with a razor saw and small chisel, but using a small table saw to cut the dado is much easier.

The block was then ripped to width and cut roughly to length. Cutting the dado first on a larger block is much safer than trying to do it later on the individual blocks.

The front mounting blocks were then rabbeted on both ends to fit between the spars. This is a little tricky as the spars taper together so the rabbets must also be slightly angled to match.

The rear mounting blocks also had a large rabbet on the bottom to tie into the servo box spar.



*Wing rib sheets separated into individual sheets*

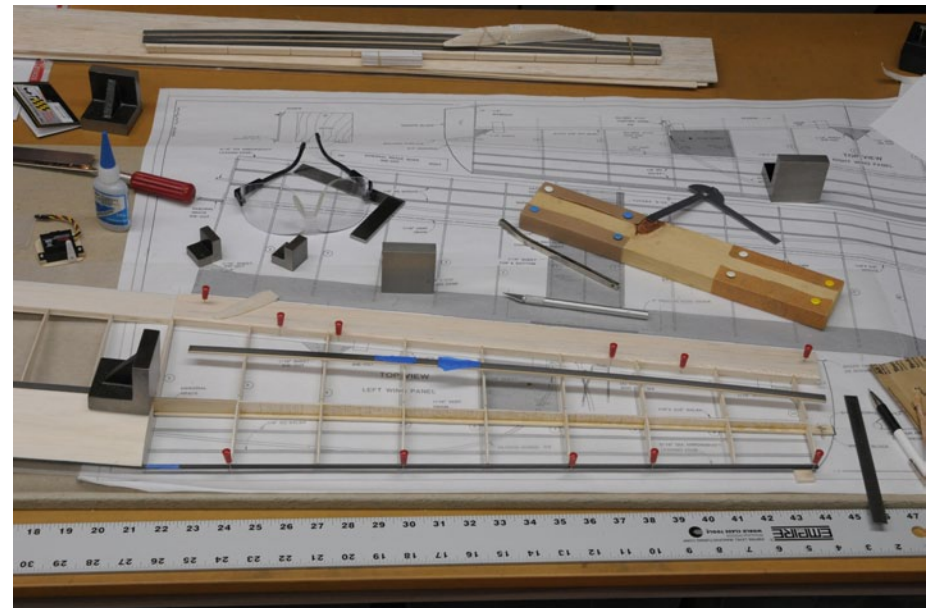


*Bobcat parts finished and ready for construction to start*

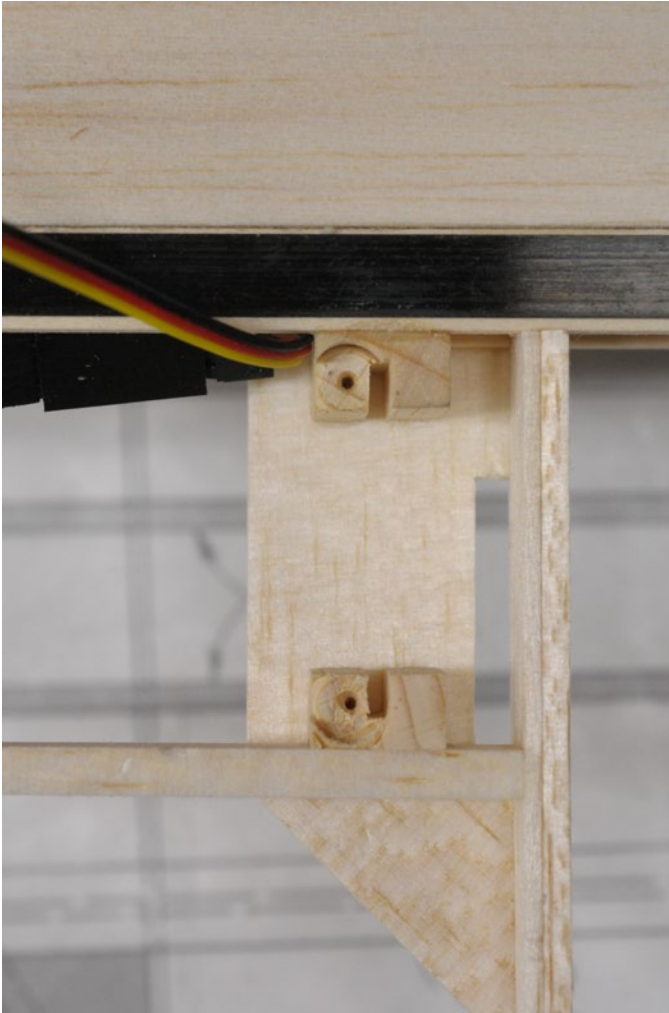
It's not obvious from the pictures, but the rear servo box spar does not reach the sheeting on the top surface of the wing. The top surface sheeting only attaches to the angled tops of the mounting blocks so the edges of the sheeting not attached to the spar or rib are floating.

After careful mockup, the depth of the screw mount recess was marked. The recess was cut with a brad point drill bit in a drill press. A drill press vice was used to hold the small parts while drilling. One nice thing about the brad point bit is it creates a flat bottom and most of the pilot hole needed for the mounting screw.

Some small aluminum washers combined with the servo mount screws that came with the HS-65HB servos completed the servo mounting.



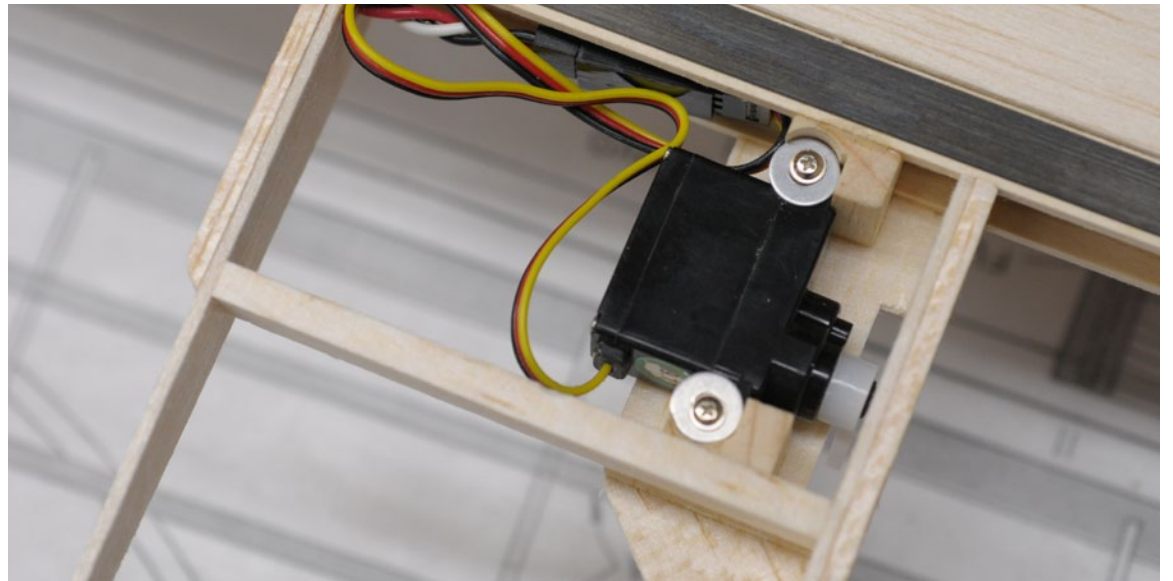
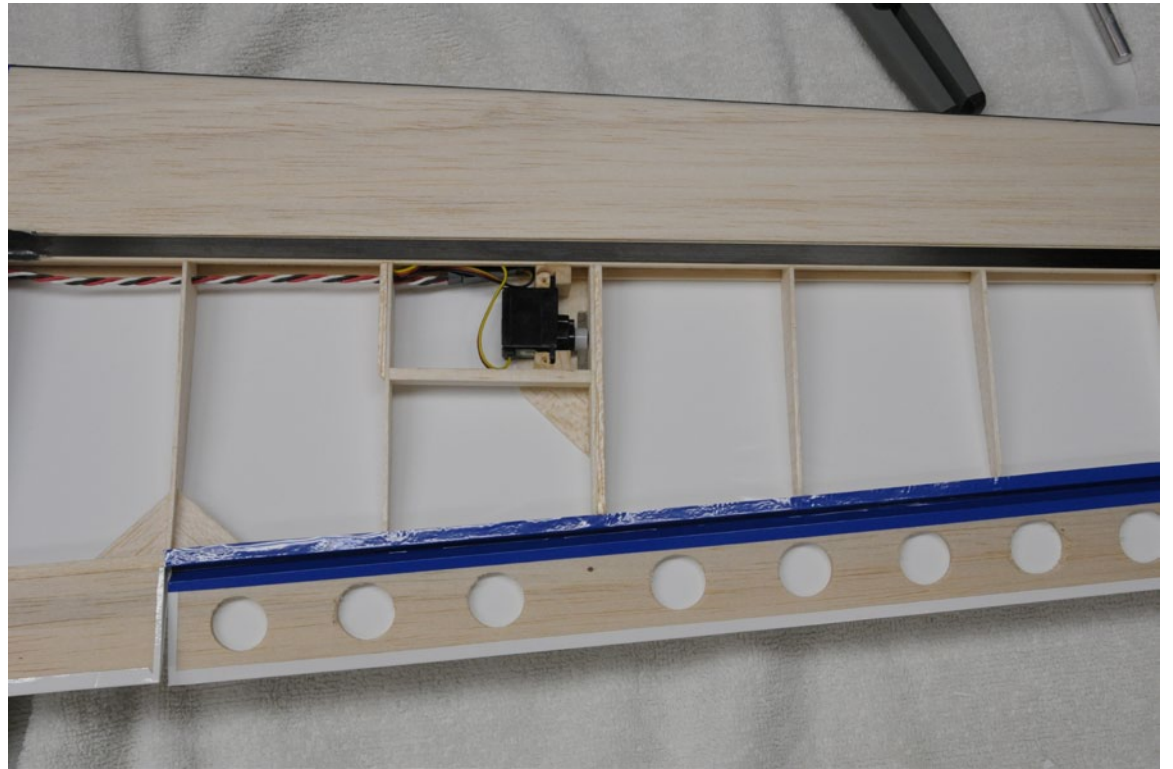
*New Bobcat wing construction underway*



*Above: Empty “Hatchless” servo mount blocks*

*Above right: Servo installed in mount during covering process. Note that the mounting screws aren’t yet installed. That mistake will cause grief later.*

*Right: Servo screwed in place within “Hatchless” mounting blocks*



Additional 1/8" square brace material was added to the servo output shaft side rib. This both strengthens the servo mount and provides stiffness and adhesion surface area for the covering material.

A small section was also added to the lower surface of the servo bottom side rib for the same reason. Monokote can warp thin material when the covering is cut, so the extra stiffness helps avoid this and wrinkles when the lower covering is cut to access the servo for maintenance.

The photos show a lovely example of this access. That photo followed a long string of expletives after which I realized I can't keep track of my building process and watch a Formula 1 race at the same time. I had forgotten to install the servo mount screws before dazedly covering over the area while watching the race.

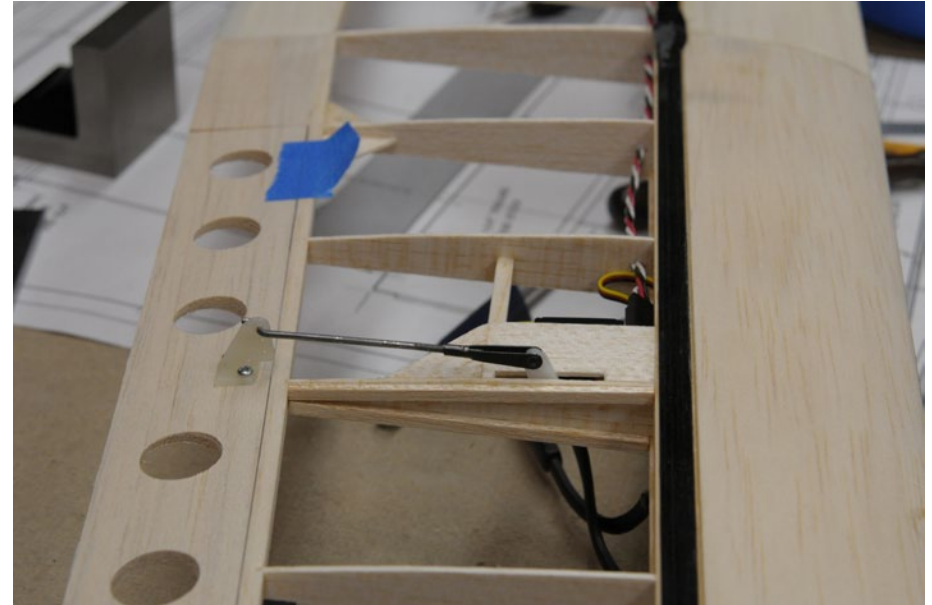
The good news is the incident proved my service access concept works fine. I just wasn't planning on needing to patch my newly covered wing before I even got the covering finished.

### **Test Flying the Bobcat:**

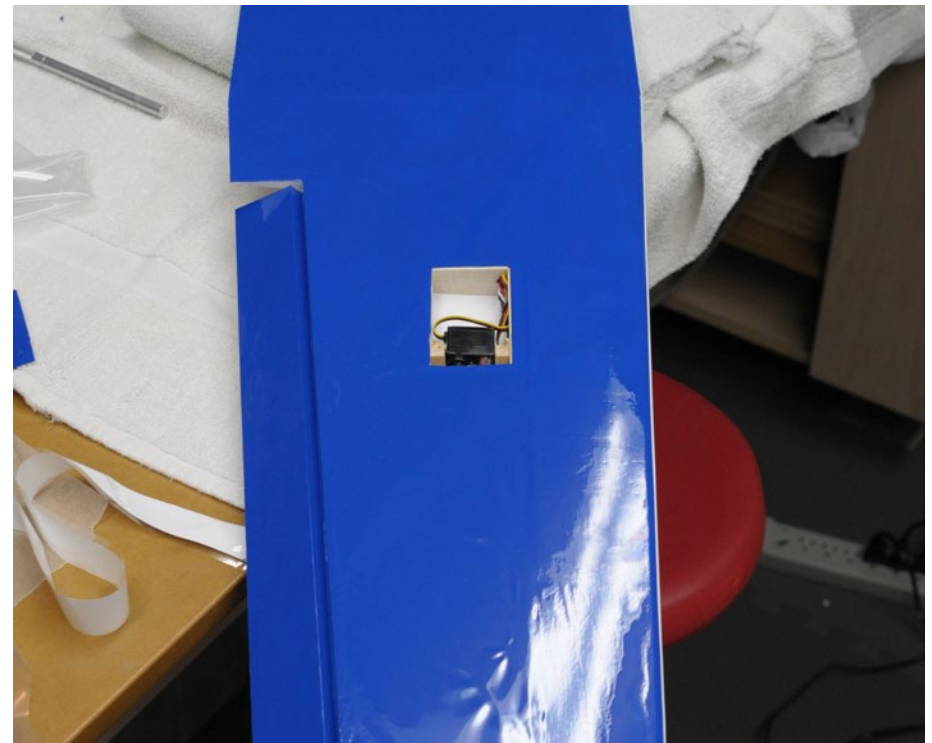
After completing the covering and decorations, I was able compare the original Bobcat wing with the improved thermal wing.

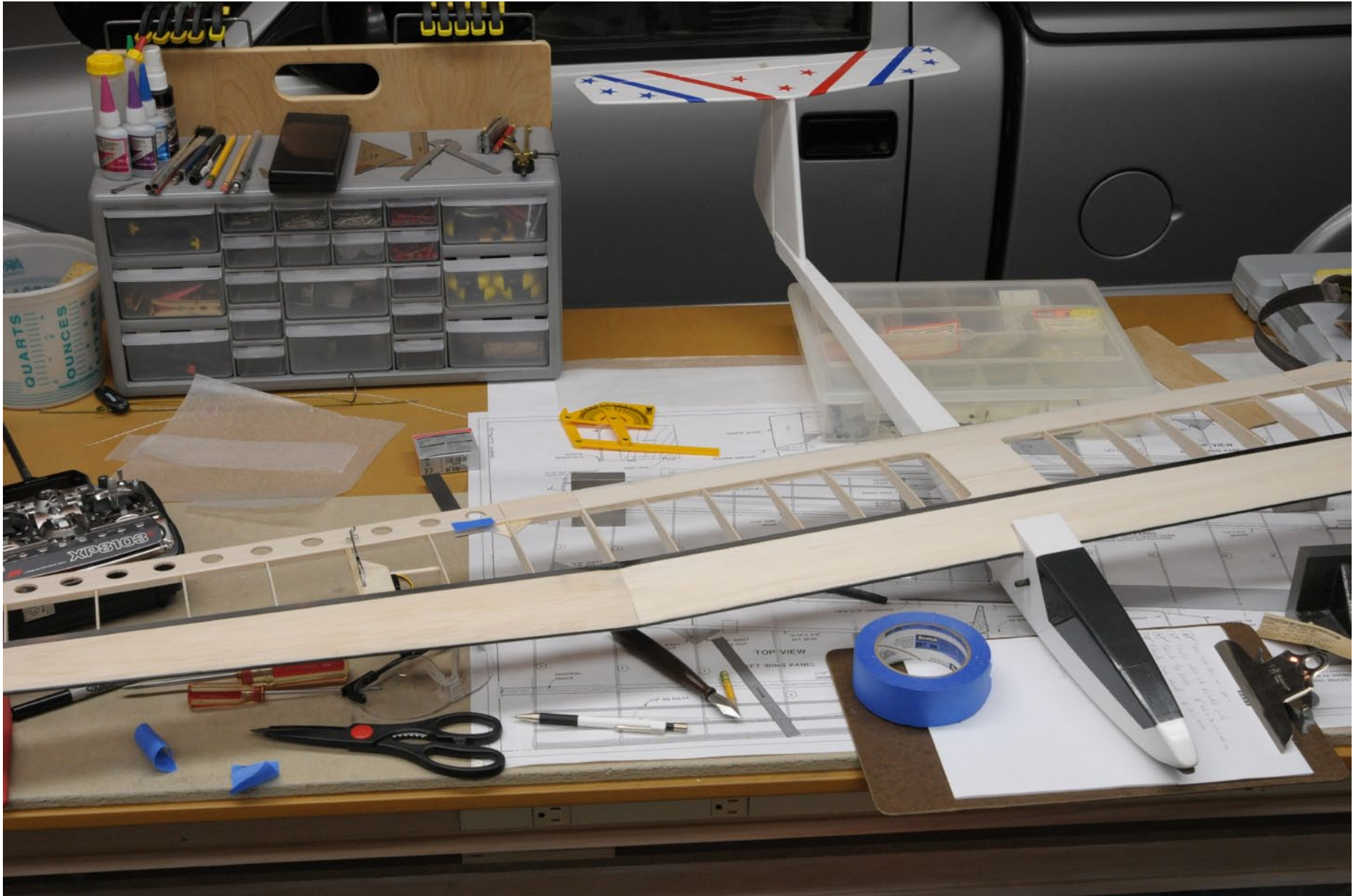
The new one was much sleeker, 3.7 ounces lighter and noticeably stiffer. In my impatience to see how the new wing would behave, I resorted to my rubber-

*Top view of servo installation and linkage including rib bracing part of the mount.*



*"Hatchless" servo bay open for service. Necessary because the mounting screws weren't installed before the covering was applied... oops! At least the concept works well.*





*Improved thermal wing construction nears completion*



*New AG34 airfoil Bobcat wing construction complete and ready for covering*

free-flight-model childhood practice of swinging the wing in a circle from a wing tip to see how the wing would fly. I was somewhat surprised to find the new Bobcat thermal wing had a noticeably nicer carving action as the angle of incidence was changed.

The original wing had a distinct pitch-up, stall and high drag mush behavior beyond a very minimal positive angle of incidence. This is hardly a scientific way to evaluate wings or airfoils, but it always gives me some satisfaction that what I've just built has a chance of flying. The proof though is in the actual flying so I headed out to my local school field for some hand-toss trimming.

I started the hand-toss testing by fitting the original wing and doing a few of my usual hand-tosses. The plane behaved normally so I switched to the new wing.

My first hand-toss with the new thermal wing left me gaping in astonishment. The plane covered nearly twice the distance and almost out-flew the size of the field.

Subsequent hand-tosses confirmed the significantly lower drag and improved glide slope. It consistently covered 1.5 to 2 times more distance than the original wing.

On another day out at the SVSS field, my first winch tow also confirmed this with a flight time of slightly over five minutes which was better than all but a few of my previous flights with the Bobcat. The low drag of the AG34 airfoil on the new Bobcat thermal wing was a marked improvement over the original flat-bottom turbulated airfoil.

Additional flying, however, showed a great deal of control sensitivity that made it difficult to fly thermals. I resorted to



*Original turbulated Bobcat airfoil wing on the left compared with new AG34 airfoil wing with increased polyhedral on the right.*



using Curtis Suter's SailplaneCalc spreadsheet (*RCSD* Apr 2008) to look at the stability margin and tail size coefficients.

I should have done this at the start of the project, but I'd forgotten about his convenient spreadsheet until I bumped into it on the web while I was doing the flight testing work.

The calculations indicated moving the CG forward would be appropriate. Doing this improved the handling, but didn't cure all of the Bobcat's original handling problems.

#### **Design Changes for the Future:**

In looking at Curtis' SailplaneCalc spreadsheet further, some of the reasons for the Bobcat's inherent handling issues become apparent.

Most of the tail size coefficients are at the lowest end of the recommended range. This is especially true of the vertical stabilizer volume for yaw damping and rudder power.

The short tail-moment and small area of the vertical stabilizer limit the control authority and so contribute to the adverse yaw problems of the airplane. This combined with minimal dihedral makes this airplane side-slip easily.

This can be quite a problem on the winch as rudder alone is not enough to correct the launch direction. A little aileron is also needed. This characteristic has been

improved but not eliminated with the increased polyhedral of the new thermal wing.

While my "looks about right" engineering decision of four degrees at each polyhedral break is close, the spreadsheet indicates five degrees or better would be more appropriate for the spiral stability coefficient.

My thermal flying indicates this would be a slight improvement as it still has a very slight inclination to fall in tighter on the tightest turns, but the issue is not significant enough to make building a new wing worthwhile.

For the future, I'm interested in building a new fuselage in the hopes I can find a good way to add yaw stability and control without significantly changing the looks of the plane or creating new structural problems in the T-tail and connecting fuselage boom.

Marc Pujol's November 2011 *RCSD* article seems to have some helpful information on that topic. However, I think I may get a lot of value out of simply reducing the weight to bring the wing loading down from the current 7 oz/ft<sup>2</sup> to something closer to 6 oz/ft<sup>2</sup>.

My early building skills and repairs to the T-tail over the years have resulted in a somewhat heavy fuselage.

#### **Final Thoughts:**

Despite the remaining handling issues with the Bobcat, the new wing mostly meets my original design goals.

Although my 24 year old Bobcat with improved wing attached doesn't fly quite as well as the Spirit I used as a design benchmark, it still looks original and is now capable of providing enjoyable thermal flights. And during the design and building process, I learned some interesting new airfoil, machine cutting and servo mounting techniques I can take to my next project.

In the end, this project reminded me even old airplanes and designs like the Bob Martin Bobcat can provide learning and fun which is one of the attractions of this hobby/sport we enjoy.

My best wishes to your own projects during this building season.

#### **Resources:**

CompuFoil <[www.compufoil.com](http://www.compufoil.com)>

TurboCAD Designer  
<[www.TurboCAD.com](http://www.TurboCAD.com)>

CarveWright <[www.carvewright.com](http://www.carvewright.com)>

Curtis Suter, "Sailplane Calc";  
*RCSD* Apr 2008

Marc Pujol, "Let's talk yaw stability";  
*RCSD* Nov 2011

# Design an optimized airfoil for your R/C glider



Marco Maceri, marco.maceri@gmail.com

In the light of my profession, I was asked several times by a few friends, who are very much into scale R/C gliders, to design some sort of revolutionary airfoil for their models.

To their greatest disappointment I always refused. Indeed, designing a wing section is a lengthy job, or at least it was, until... I found the right tool: EDGAR. So, before talking about this new software downloadable at <http://www.evolutiondesigns.eu> I'll try giving an insight into the reason why I was so reticent.

The first thing to do in wing section design, no matter if it's about a real aircraft or a scale model, is to

understand what one wants the wing to do.

Talking about scale R/C gliders, I was often told by my friends that they usually do not climb as easily as a model in the F3B category. That's not hard to believe, as the fuselage (and therefore the drag) of the latter is reduced to its minimum. As a matter of fact, they say, it is always advisable to climb to the closest slope gracefully exposed to a sustained wind and to launch from there. Therefore, a recurring question was whether it wouldn't be possible to design a wing with a combination of a number of wing sections able to minimize the sink rate.

This is indeed a good starting point. However, in any engineering problem

an optimal design has to cope with a number of different and often conflicting requirements. Wing profiles are no exception. Therefore, designing only for climb would produce a wing which does not perform well in cross-country flight. This is certainly true for the real competition gliders and perhaps it applies to the scale models (5+ meters wing span; can you call it a model!?!?) as well.

OK, let's say then that the objectives of such a design are the minimization of the sink rate and yet a very good performance in inter-thermal flight.

But there's still a long way to go to achieve a good result.

The second thing to do is to try calculating the lift distributions of our wing under the selected conditions. The lift coefficient at the location where the new airfoils are going to be designed will be our design lift coefficients. The respective Reynolds numbers are straightforward to be calculated knowing weight and wing area of the model.

Calculating the lift distribution of a wing is already a bit more difficult to achieve, not being an aerodynamicist. But again, because of my profession, I would have access to the right tools. With some specific background in aerodynamics it would also be relatively easy writing a small program, based on the lifting line theory or on a vortex-lattice approach. Yet I refrained from pleasing my friends.

The real reason for that was that the aerodynamic characteristics of a wing section depend in a very non-linear fashion on its shape parameters, i.e.; small changes of the profile's contour produce unpredictable results! This fact excludes any trial and error approach to the problem.

Therefore, if I ever accepted this task, I would have had a few possibilities. The easiest one would be using an inverse design method as the one implemented in Xfoil and by redesigning the pressure distribution to try improving a given wing section (any one that my friends wanted to improve). But this procedure

would allow controlling only one design objective.

A more powerful and a bit more complex procedure would be using, again, Xfoil or the Eppler code in order to perform a sensitivity analysis of the coefficients on the shape parameters of, again, a given airfoil. In either case, I would have been supposed to start from a selected profile and try to improve it.

With either procedure the attempt to design something better than, say an HQ profile, would have taken quite an effort and yet, "something better" is far from being an optimal design. As good as I could be at this my final result would be very much depending on the selection of the starting solution. Besides, selecting the starting solution is another lengthy task on its own.

Not to mention the fact that in a glider wing worth this name and also that of a "scale model," there should always be more than one airfoil. In conclusion, designing "ad hoc" airfoils for scale gliders would mean to invest quite a long time of work with no guarantee that one would end up with a really optimal design.

This panorama changed radically very recently.

As I anticipated at the beginning of this article, a new tool is now available: EDGAR.

You can tell how disappointed I was when a few days ago my friends came up with this web site:

<<http://www.evolutiondesigns.eu>>.

After glimpsing at the home page I all of a sudden realized that I had no excuses anymore to slip away.

EDGAR, the program downloadable at the web site, offers the opportunity virtually to everybody to design loads of optimized airfoils in very little time and, listen to this, the software is downloadable for free after registering. I was struck by that bit of an exotic but very intriguing name: "Evolution Designs."

After a short reading around I was very pleasantly surprised! These guys made some of the state of the art optimization techniques — those based on the evolutionary approach used at the large aircraft manufacturers — available to a very large community, ranging from aeromodellers to small aircraft and glider manufacturers.

So, what I did next was download, install and play around with the program. Ah, I should mention that EDGAR runs on Windows XP, Vista and 7 only. Unfortunately, no Mac or Linux version exists. Also, be aware of the fact that in your system international settings the dot "." and not the comma "," must be selected as a decimal separator, otherwise the software won't work.

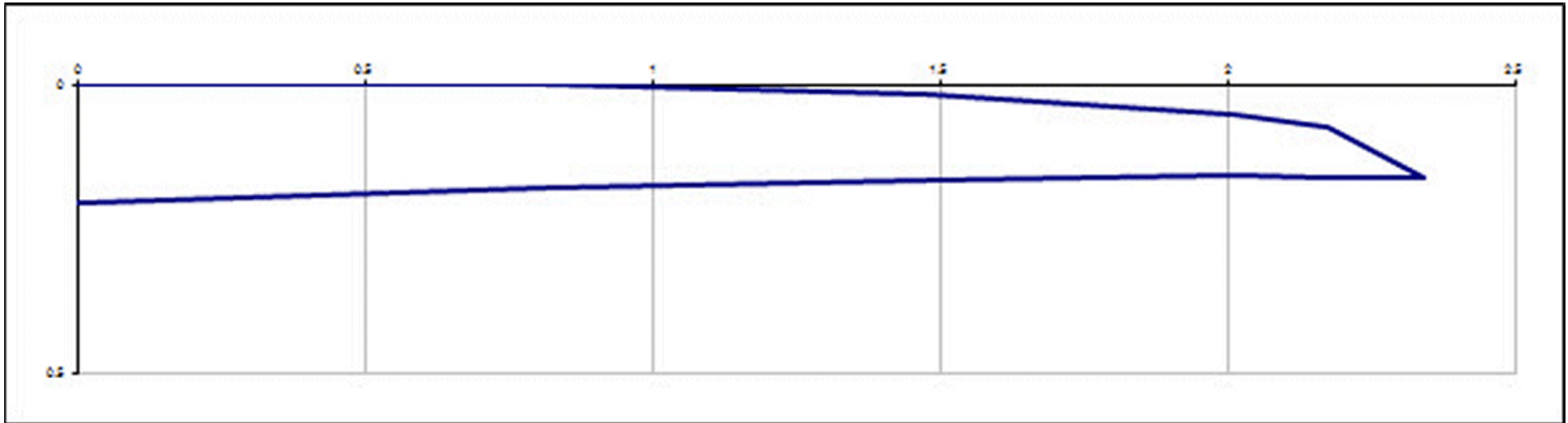


Figure 1

The package comes with a useful help system in .html format. In there I found a tutorial that was designed exactly on the problem I've been describing so far. The first runs were really encouraging, so much encouraging that my friends encouraged me to publish this article in *RC Soaring Digest*, sharing with this community how to design optimized airfoils for an R/C glider by means of EDGAR and the evolutionary strategy.

So, keep on reading and you'll shortly see how easy it is.

Even with such a nice and powerful tool at hand the lift distribution must be known to set-off, but that's all that it takes to get started. In order to do that we have to know the planform of our

wing. I took for this digression the wing of a 4.7 m, 6 kg replica of the Ventus 2C. It's not that hard to figure out the planform geometry of that glider from internet sources. (See Figure 1).

The wing area is  $0.76 \text{ m}^2$  and the aspect ratio 29.5. Then I used the lifting line theory to calculate the lift distributions at the two conditions announced above: the inter-thermal (130 km/h, 1g, as my friends like flying fast) and the climb in a turn (60 km/h, 1.5g).

As expected, the  $C_l$  distributions are pretty constant as the planform shape resembles the elliptic one. I assumed a wing with zero camber distribution. This detail is important for casting the designed airfoils at the proper angle

in the wing once they're designed, but this matter goes out of the scope of this article.

For the inter-thermal the local  $C_l$  throughout the span are 0.12 (See Figure 2) and for the climb condition 0.79 (See Figure 3). At those speeds the Reynolds Numbers are around 460,000 and 215,000 respectively, considering a 0.2 meter chord in the first third of the wing span.

OK, now we have almost all that is needed to launch EDGAR. The last bit of information that is still missing is about the relative thickness of the section. Following the suggestion of my friends I assumed 13%.

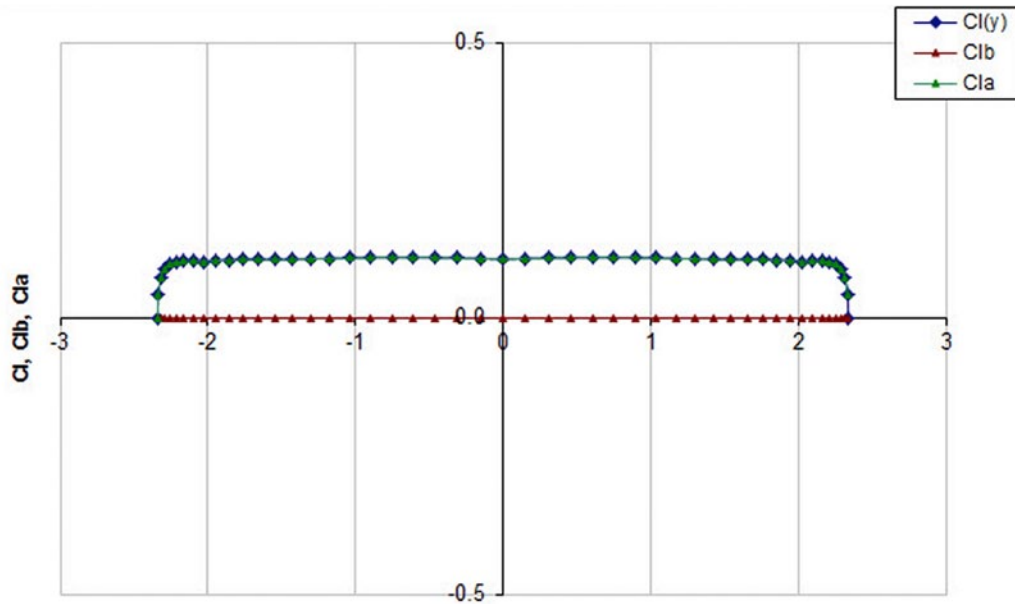


Figure 2

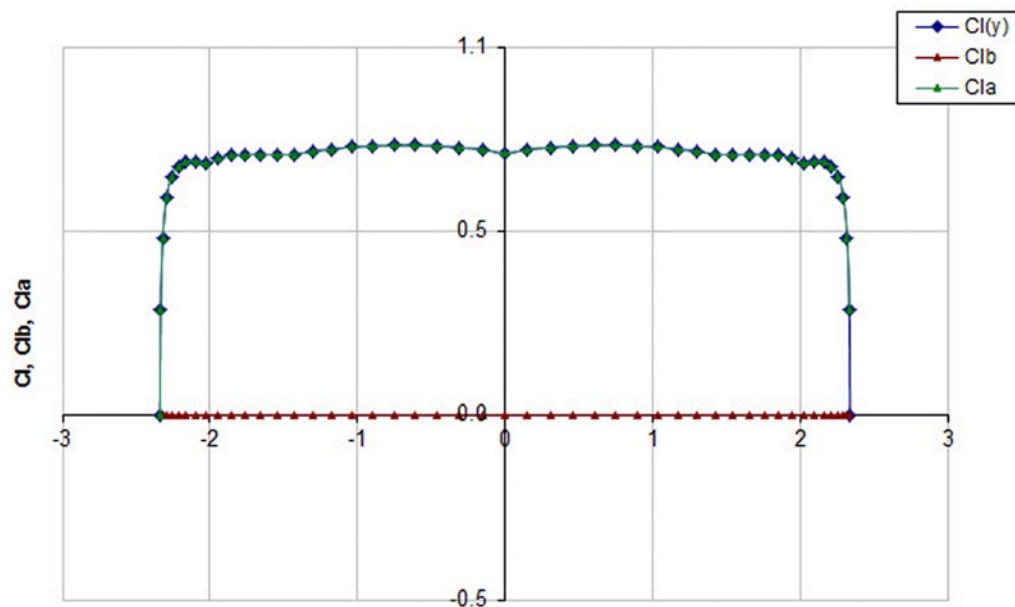


Figure 3

Once EDGAR is launched, the GUI appears. There are not the usual endless windows menus but only a few buttons.

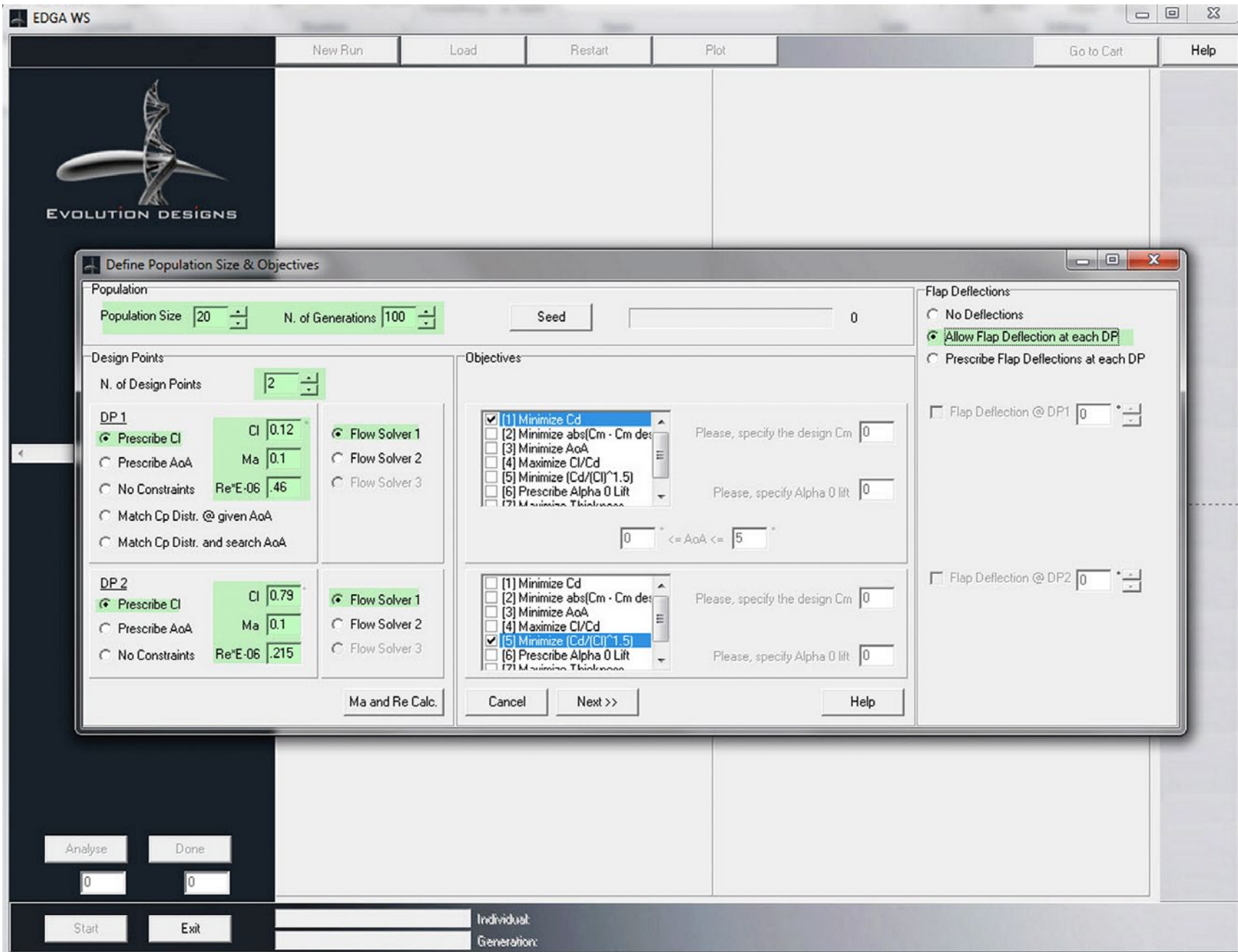
First thing to do is to click on the “New run” button. This will bring up a series of forms where the proper input must be specified. You will see for yourself that everything was designed to be functional, pretty intuitive and not prone to inconsistent input.

The first form allows defining the population size and the number of generations along with the optimization objectives and the respective flight conditions.

As for the population size and the number of generations I picked 26 and 200 respectively. I kind of know what you’re wondering now. As I anticipated above, EDGAR uses an evolutionary algorithm; that is to say, it lets the airfoils literally evolve and select the best ones (where “best” is those which best fulfill the design objectives) on the basis of algorithms which mimic the natural selection mechanism of biology... Uhhmm, this brings a thought. You might not want to use EDGAR if you’re a “creationist” model builder.

Anyhow, by knowing this the input request shouldn’t sound so strange anymore.

In the “Design Points” panel of this form one has to enter the number of



design points. According to the previous discussion I selected two.

The panel changes accordingly, giving now the opportunity to specify two flight conditions and a series of objectives for each of those.

As we know our design lift coefficient, we leave the default “Prescribe  $C_l$ ” as it is. In the edit fields in each of the two sub-panels, one has to specify the flight conditions: Mach and Reynolds numbers plus, as we selected to prescribe the lift coefficient, the respective  $C_l$  value.

So, let’s specify the inter-thermal conditions in the first sub-panel:  $C_l = 0.12$ ,  $M = 0.1$ ,  $Re = 0.46$  (the Reynolds Number is understood in millions).

Let’s do the same for the climb condition in the second (bottom) sub-panel:  $C_l = 0.79$ ,  $M = 0.1$ ,  $Re = 0.215$ .

Let the program use the first flow solver (a panel method).

Now that the flight conditions are correctly specified the objective selection lists turn active and are ready to receive the objective selection input. Therefore, we shall select to minimize the  $C_d$  at the first design point (i.e. maximize the efficiency) and minimize the climb index ( $C_d^2/C_l^3$ ) at the second one.

One last thing: EDGAR can look for the optimal flap deflection by selecting the radio button “Allow Flap Deflection at each DP,” where DP presumably

stands for “Design Point.” (See Figure 4) However, we won’t use this possibility for this exercise.

By clicking on the “next” button we arrive at the form where the geometric input have to be specified. (See Figure 5)

This form presents the ranges of variation of each geometric parameter. By varying those the software modifies the shape of the airfoils.

The tuning of the ranges could be cumbersome for a novice, but fortunately the developers provided some pre-tuned values for each topology of the profile. Therefore, I pressed the “Sailplanes” button and the minimum and maximum values changed accordingly.

One thing is not clear from the help. “Gamma” is the exit angle of the mean line at the trailing edge, whereas “beta” is the angle that the upper and lower contours form at the trailing edge.

In order to generate only 13% thick airfoils, the only thing I had to do was to make the minimum and maximum values of the relative thickness equal to 13.0%, so that to have a zero range of variation for this parameter.

I also noticed that the relative thickness of the trailing edge can be specified. My friend told me that for a 200 mm chord a trailing edge thickness of 1 mm can be easily built. My input reflected this suggestion.

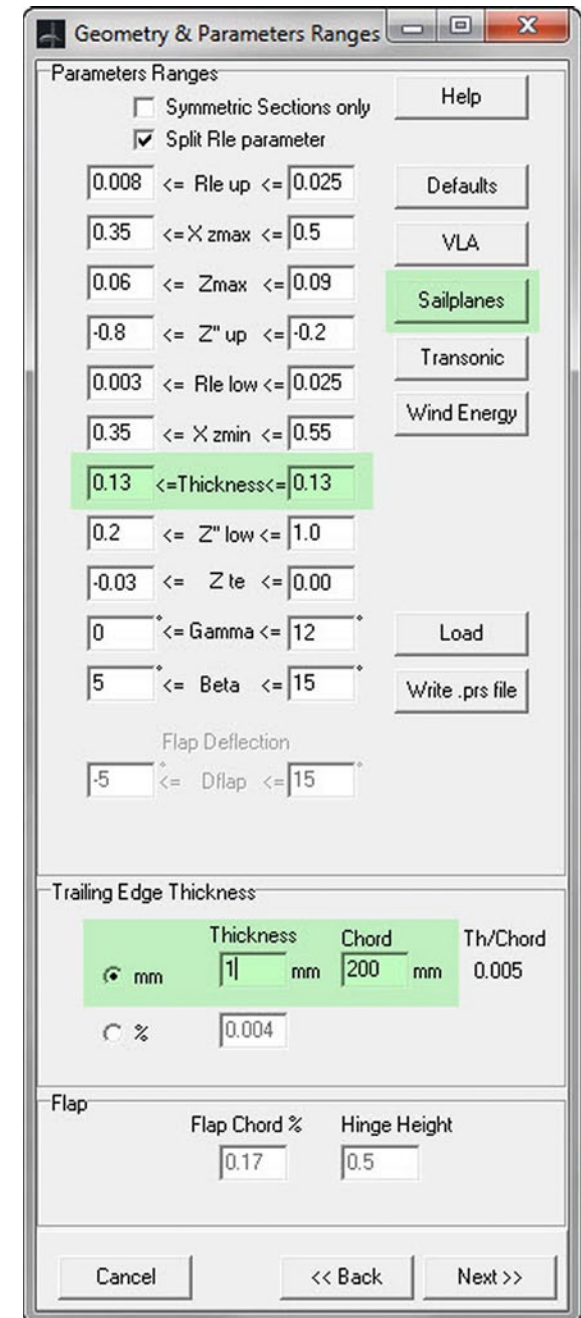


Figure 5

Well, all of the relevant input has now been specified. Pressing again the “Next” button will bring the end of the input phase.

A couple of forms more will be encountered, but for this exercise the default input values are just fine. Finally the control goes back to the GUI and the “Start” button at the bottom left corner turns active and EDGAR is ready to start the evolution.

Just press the button and... Go do something you enjoy.

... One and half a hours later...

A population of 26 individual airfoils evolved over 200 generations. This means that EDGAR generated, analyzed and ranked 5200 individual sections in less than one hour for a total of 10400 evaluations (5200 times two design points). Pretty amazing, especially because among those 5200 airfoils there are optimal solutions!!!

Oh, I perhaps forgot to mention that you have to activate the displays.

Click the “Plot” button. A form pops up. Check the checkbox on the top of the form and a cloud of colored dots will populate the displays. Each dot represents an individual (or an airfoil if you do not want to stick to the analogy to biology). Immediately below the checkbox you can select which one of the parameters to visualize on the

display. This is what you need the most to identify the optimal airfoil in the cloud of solutions.

So I selected to display the objectives values against the number of generations in the first two displays, and again the same values against each other in the third one.

By “drag and drop” with the left mouse button on one of the displays, you can zoom-in a particular region of the cloud. A click on the right button zooms back. Figure 6 is what appeared.

The first panel (to the right of the displayed profile) shows a cloud of dots with, I’m afraid, no pattern. Ummm... puzzling.

Let’s see what’s up on the other two. The second panel shows that EDGAR has been really doing what it was asked to do. The climb index values decreased as the evolution proceeded through the generations. Very encouraging!

But the most interesting aspect appears on the third display. You can see from the figure how the dots after a few generations start clustering along a curved boundary, the so called Pareto’s front.

The emerging of such a boundary is the smoking gun revealing what was announced at the very beginning of this discussion: in all engineering problems an optimal solution is a compromise

between a number of conflicting requirements and wing sections are no exception.

So, by glimpsing at the front, one immediately grasps that by selecting the airfoil with the least values of objective 1 (least Cd) the performance in climb would be compromised and vice-versa.

This information is very valuable and it’s there on the display with no effort spent by the user. Try to imagine what would be like having to approximate the Pareto’s Front by designing thousands of airfoils with any of the classic methods. It would be a job lasting years.

Thanks to EDGAR and Evolution Designs, that information is available after about one and half a hours with a modern intel Pentium CPU during which you can watch your favorite football team on TV. It is now (after the football match is over) up to the designer to properly select an airfoil on the boundary. He shall decide how much of a feature to sacrifice in favor of the other one by analyzing a few individuals laying on an interesting region of that boundary.

Easy, isn’t it?

Besides, all the tools for analysis are built in. When you click on a dot the GUI prompts for performing the analysis, either a point analysis or a sweep in alpha, Reynolds number and Mach number.



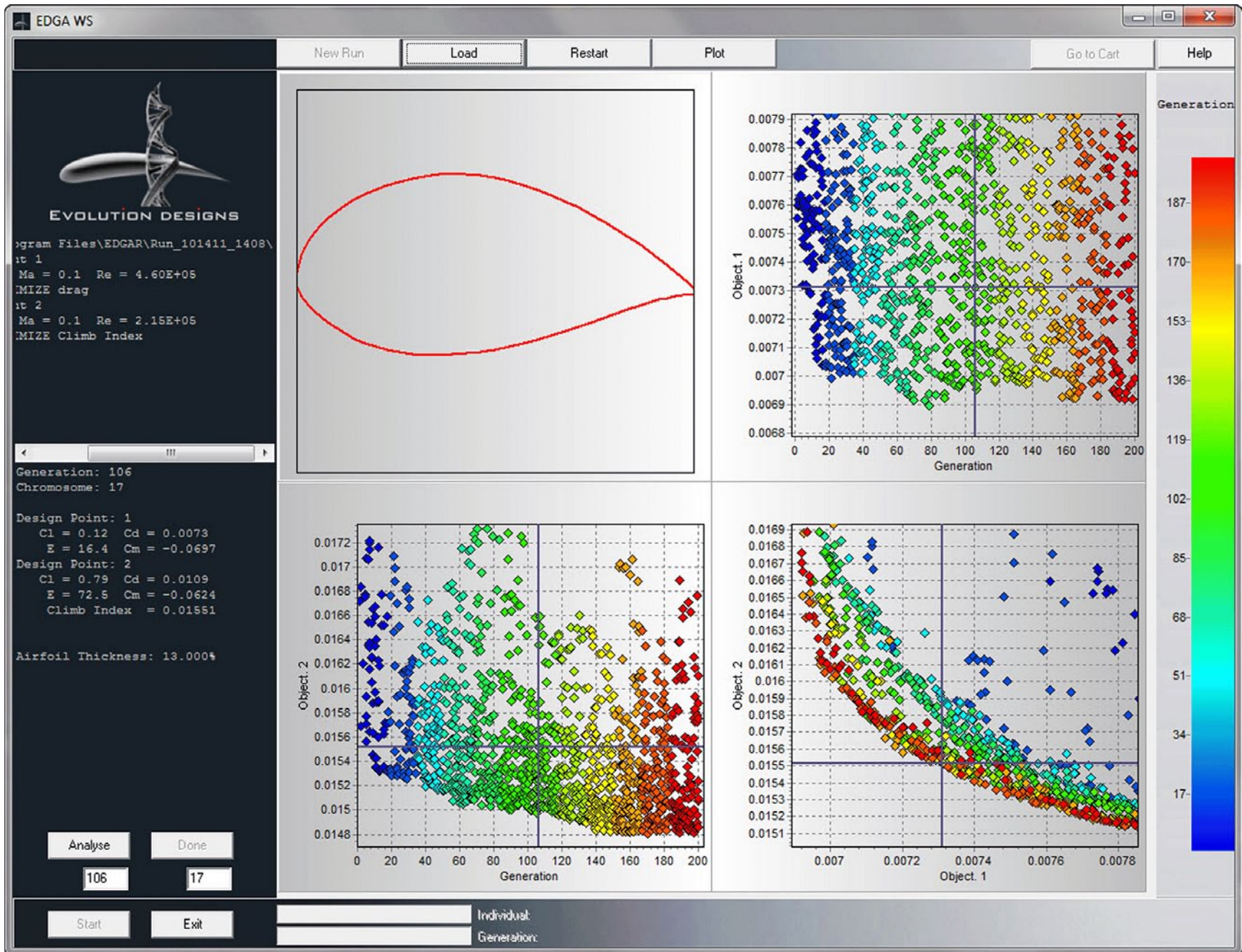


Figure 6

Oh, if you're now playing with EDGAR, you might have been scared by the strange airfoil contours popping up on the screen all the time. The Genetic Algorithm (GA) can indeed generate odd shapes during its search. However, those airfoils are likely to have bad aerodynamic features and therefore the natural selection model implemented in EDGAR will mercilessly and very quickly dump them...

Uhhmm is natural selection as merciless? I'm afraid so, but here we're about to slip into a philosophical discussion.

Back to the odd contours... Besides the naturally strange ones, it is explained in the manual that pseudo-contours are actually displayed.

This made me immediately think that the results of the optimization might be encrypted. Unfortunately, I was right.

The software provides the ability to design wing sections out of nothing but an educated guess of the design lift coefficient.

Moreover, after the evolution is concluded the software provides all the tools for analyzing the evolution itself and each of the solutions generated during that. So, at the end of the day, one can use EDGAR at will for free.

If one at last convinces himself that one or more of the produced solutions fulfill

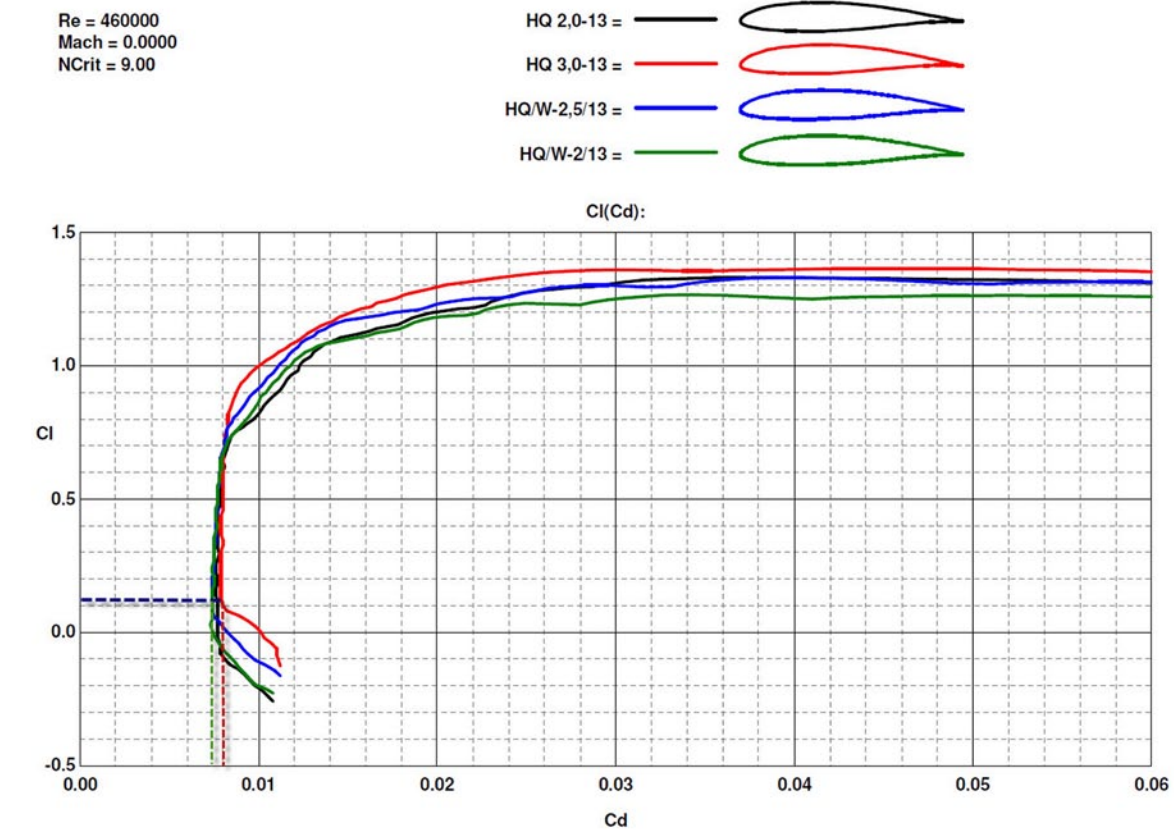


Figure 7

the design requirement, he can send a quotation request to Evolution Designs directly from the GUI. I personally find this marketing strategy as neat as the tool. After all, the program can be tested for free and, only after one judges that an optimal airfoil was generated, he or she can decide to buy the coordinates for a

reasonable fee. (I was not authorized by Evolution Designs to disclose it.)

If you want to request a quotation for one or more solutions, simply load the .des file from the GUI (it contains all the details of that particular solution), select the airfoil by clicking on the relative dot on either of the three displays, and add it

Re = 215000  
Mach = 0.0000  
NCrit = 9.00

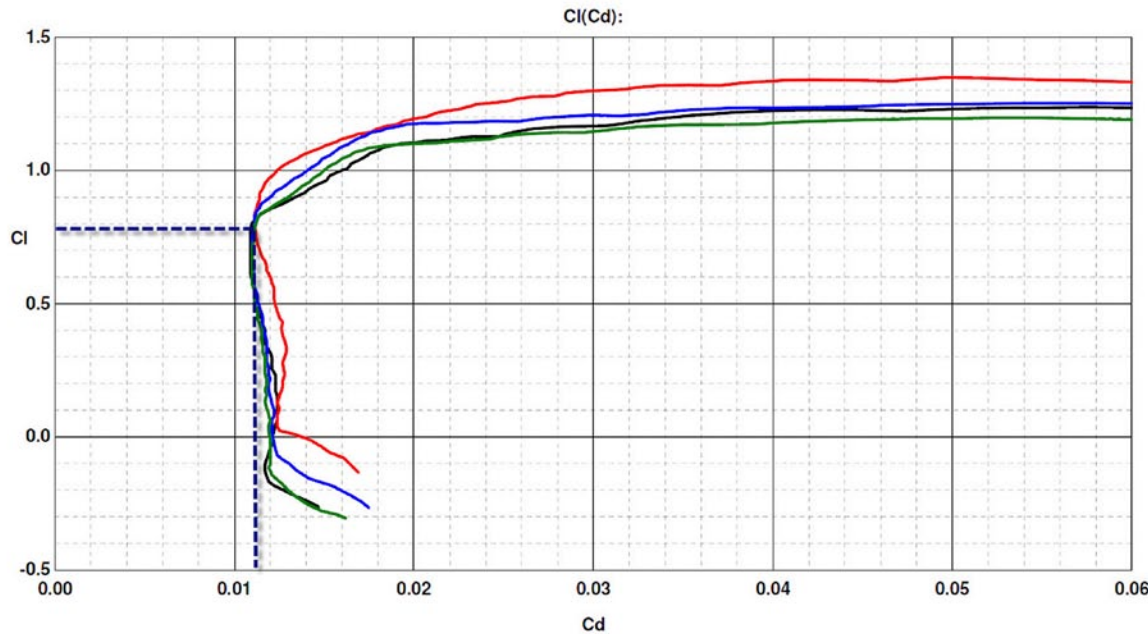
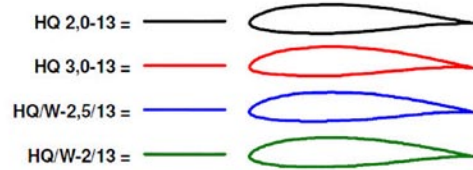


Figure 8

means of the excellent software Profili 2.28b Pro:

- HQ 2,0-13,
- HQ 3,0-13,
- HQ/W-2/13, and
- HQ/W-2.5/13.

Figures 7 and 8 show the calculated polars at the same design Reynolds numbers.

Concerning profiles HQ 3,0-13 and HQ/W-2/13: they have 73 and 80 drag counts respectively at  $Cl = 0.12$  (first design lift coefficient) and the same 116 drag counts at  $Cl = 0.79$  (the second design lift coefficient).

In a turn, these values mean a very good 60.5 power factor (recall power factor is the inverse of the climb index) for both the champions.

The best one then seems to be the HQ/W-2/13 as it's able to achieve a 60.5 power factor but with 7 drag counts less in the inter-thermal regime.

Uhhmm... sounds like a hard to be beaten opponent!!!

By reading the incidences from the lift curves (See Figure 9) and then consulting the power factor plot (See Figure 10) we confirm the calculated value of 60.5.

Well, now I know what I have to look for on the front: I need to find either an airfoil that at the same inter-thermal drag coefficient (73 d.c.) is able to provide

to the cart. The GUI will then prompt for sending the request of quotation.

At this point you might be rightfully wondering if any airfoil worth being purchased lives in those clouds of dots.

In order to know this, we've to compare against a champion. I actually chose four for this exercise. We do the straight

comparison by drawing on the pool of solutions obtained by this one single run. As genetic algorithms are in some respect a stochastic process, it is usually a good practice to repeat the optimization a few times (two to three).

I analyzed four 13% thick HQ profiles with different camber distributions by

a power factor higher than 60.5 (i.e. a climb index lower than 0.01652) or a profile which while delivering the same power factor produces less than 73 drag counts.

As I said before, this choice depends now on which side the designer wishes to push the design — a better penetration or a better climb or a good compromise among those.

By inspecting the front, it looks like several candidates are there! That's great news as the HQ profiles are really good airfoils!

The cross on the displays and the relative aerodynamic value displayed on the left panel indicate that in that region airfoils exist (cross points the individual 17, generated at the 106th generation) able to deliver a 64.5 power factor (climb index = 0.0155) while producing the same 73 d.c. of HQ/W-2/13!!!

My friends were so enthusiastic when they saw the results that they started talking about the possibility of building an 18 meter span replica of a Duo Discus... I had to draw their attention again on the fact that that's not a model but the real glider!

So, I shall conclude this article with my personal impressions about the EDGAR software. The fact that I decided to publish this already speaks to the fact

Re = 215000  
Mach = 0.0000  
NCrit = 9.00

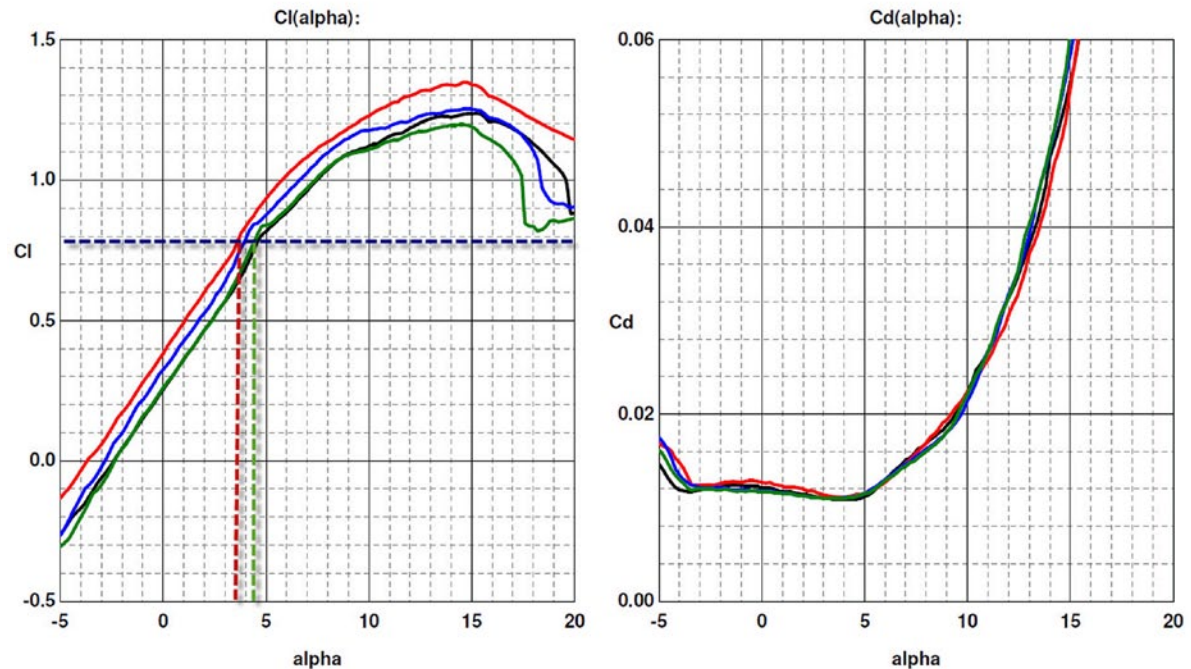
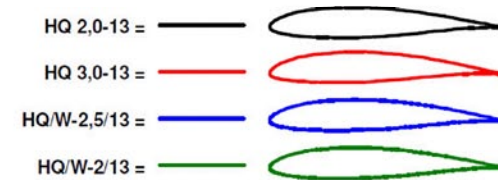


Figure 9

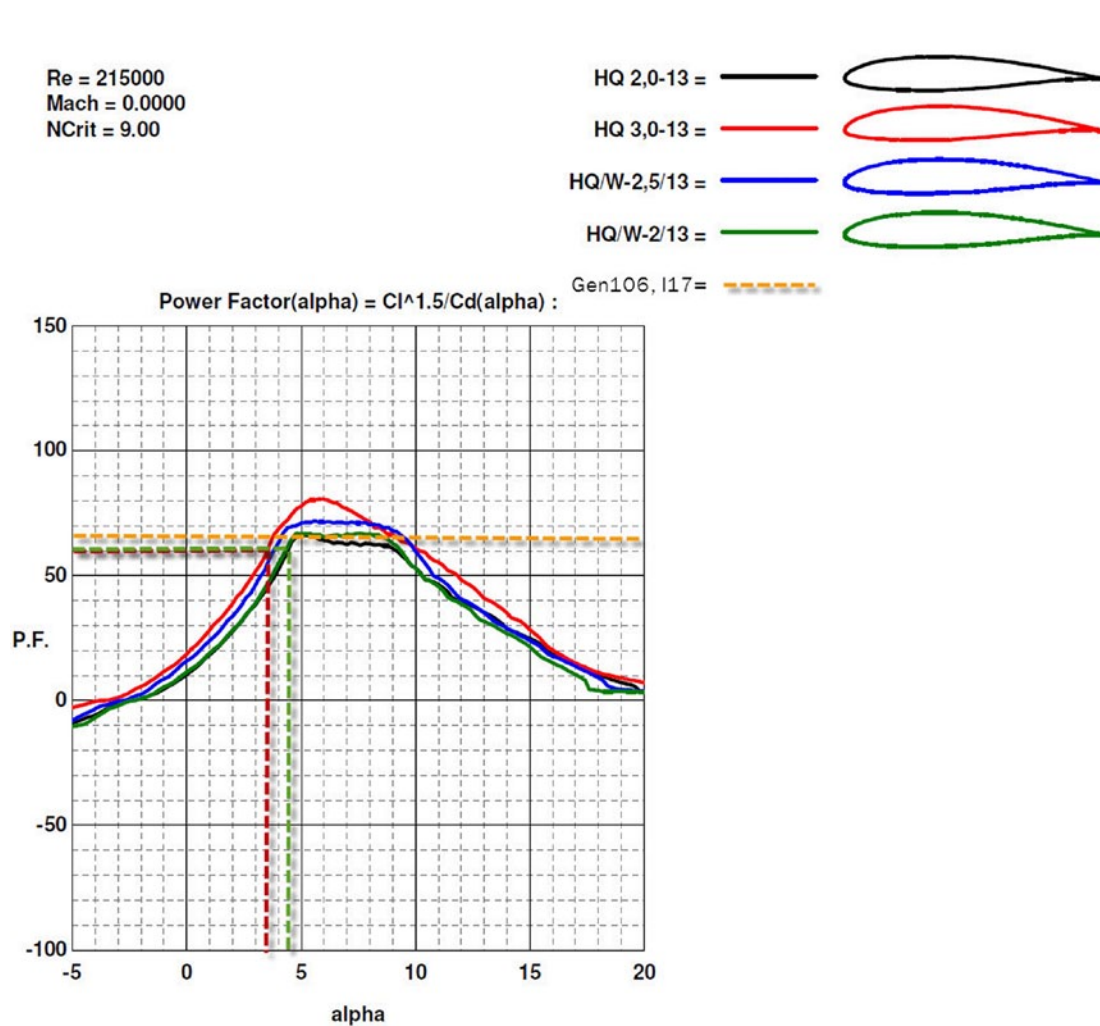


Figure 10

that I'm quite enthusiastic about Evolution Designs and EDGAR.

After a little practicing, everyone should find it easy to use.

The key features of EDGAR are:

1) it does the job from scratch, without having to look for a good profile to start with;

2) EDGAR was designed to perform multi-objective optimizations and it delivers very clearly the trade-offs among the different requirements;

3) to my knowledge the Genetic Algorithms are an extremely powerful optimization tool, able to discover the absolute extreme in the search space. As a matter of fact they're widely used in the commercial aircraft design community;

4) last but not least, no one asks for a penny for using the program. I guess that EDGAR was developed for the VLA and sailplanes builders community, but it can be used with satisfaction also at the two extremes of those, the general aviation and the aircraft model builders...

5) According to the Evolution Designs Team, a lift distribution calculator should be implemented in the next release of the software some time next year.

At the end of this digression only one thing is not yet clear to me. Do you guys really call a 5+ meter span R/C glider a model?!?

# "Call me Ishmael"

## MY EXPERIENCES AT THE CAL VALLEY CROSS-COUNTRY SOARING EVENT

Aric Wilmunder, aric\_wilmunder@hotmail.com

It isn't often that a writer has an opportunity to repeat those immortal words, and even rarer to have an experience that in many ways seemed to parallel those of a young sailor on his first whale hunt in the 1800's. So sit right down and a tale I'll tell of men, Mother Nature, and man's struggles against her forces.

My journey started in the eighth grade when my English teacher had us select three different books covering conflict. One book had to be in the style of "Man vs. Man" showing clashes between individuals. The next was "Man vs. Himself," showing internal struggles, and the third was "Man vs. Nature" where the book must demonstrate how man could combat the forces of the natural world.

The protagonist might win or lose, but he would demonstrate the breadth of the human spirit against overwhelming odds.

For my report, my teacher suggested that I read *Moby Dick*. I grew up mostly without television, but still had visions of Gregory Peck roped to the side of the great white whale as it submerged, and this seemed pretty exciting. What I hadn't realized was that most of the book is spent in anticipation of the encounter and is instead about life out on the ocean. The whale doesn't even show up until page 494.

Now jump ahead 35 years while I was between rounds of a SVSS club contest and Dudley Dufort casually asks whether I was interested in flying cross-country. A few months earlier, I had seen teams

leaving the field in the backs of pickups, and this seemed way outside my flying ability. But it also harkened back to the John Wayne movie *Hatari*, where hunters drove across the African veldt in jeeps capturing wild animals for zoos, or that scene capturing dinosaurs from the second *Jurassic Park* movie, but instead of tracking them on the ground, the dinosaurs would be flying in the air like Pterodactyls.

I let Dudley know that I would think about it, but I might have been secretly hoping that I had some conflict on my calendar. Flying my own planes makes me nervous enough. Flying someone else's that is 50% larger, twice as heavy, and many times more expensive without even factoring in the driving aspect

would certainly push me well outside my comfort zone. Still, this would be far better than sitting comatose in front of a TV watching ball games over the weekend.

Less than two weeks later I found myself driving south in a car full of planes, repair equipment, camping gear, and plenty of bottled water. I was heading towards a desert valley where the two key points of interest are the Caliente Mountains and the Alkali lakebed. I spoke enough Spanish to know that Caliente translated as “Hot,” so along with the fresh Chapstick, I also packed #50 sunblock.

I met my team, including Dudley, Scott Woodward, and Sheldon Smith on Highway 5 just south of Tracy, and we caravanned down to Cal Valley. After we turned west, the biggest sign of civilization was the Avenal State Prison, so things were looking a bit bleak. We stopped in a small diner for lunch, and the walls were covered with James Dean photos. I hadn't seen the monument outside, but we had turned at the intersection where Dean and his mechanic were hit by another car as they were on their way to a race in Salinas and Dean was killed. That was almost exactly 55 years to the day when we were there and as we waited for our chili and sandwiches, a local reporter came by our table and asked our thoughts about the crash. Scott retold the details as he

remembered them and I had worked for George Lucas, who survived being thrown from a car crash as a youth back in Modesto, so I made that comparison, but later I thought about this place stuck in time where the most relevant event was one person's tragic death. This seemed to parallel cities like Deadwood South Dakota, where Wild Bill Hickok was shot in the back while playing cards. Time seems to stand still in these places, while the rest world moves forward.

As we pulled into the Cal Valley Lodge I found there were even more similarities with Deadwood. Instead of a Gold Rush, here there had been a land rush back when they thought that the California Aqueduct would be built there. Desert land was sub-divided and an airport was built in anticipation of a new Palm Springs. The water never came, but a hotel was built that now sits mostly empty except for a few workers who stay there while building a nearby solar power



*John launching*

plant and a couple of bicyclists looking for a challenging course. Finally there are the ten teams of semi-fanatical sailplane pilots who show up for three days each year in order to test their flying skills.

Desert has a way of separating out the less hearty. One afternoon two ATV riders pulled up to the hotel. I thought they were wearing camo, but it turned out they were simply covered with layers of different colored dirt. In the mornings you could hear the few coyote calls, but the wildlife seemed to be mostly limited to snakes, carrion birds, and a few tarantulas that liked to hide in crevices. Still, the longer you are out here, the more you see signs of civilization. An old fence line that disappears into the edge of the alkali lakebed. A small ranch with a few rows of corn. Stakes that were set out to mark property borders, where construction was never started. Some items are remarkably preserved. Glass soda and beer bottles shine brightly, while small farmhouses have collapsed in on themselves and will soon disintegrate into piles of rotted timbers.

While unpacking our gear, it was reassuring to see the teams that had already arrived with their planes set up in the open patio while they ran through their pre-flight checks. This was a reunion for many and an opportunity to catch up on the events since the previous contests. Rich Beardsley had

been in Reno when the Galloping Ghost went down, and many were curious about his thoughts on what led up to the tragedy. After a while there was little else that could be said on the subject, so the conversation meandered off in new directions often touching on the oddly changing colors and lack of clarity of the hotel pool. Despite the 100-degree temperatures, nobody was quite crazy enough to test the waters

that had already claimed one life, a large kangaroo rat that had been fished out earlier.

Friday morning started with a sliver of a moon and a gorgeous sunrise. Ron McElliott and the cooking crew put breakfast together while the pilots checked their trims and range-tested their planes with the same attention that a whaler might put into sharpening his



*Landing out after TPH*



harpoon or checking his lines before a hunt. The motel's assorted cats would wander between the planes often rubbing against the outstretched wings, and were grateful when a hand would reach out and give them a rub.

At the morning's pilots' meeting, the final teams signed in and the daily course was presented. The first event would be a fairly straight run down the valley about 15 miles and a return to the launch point. This would give each team plenty of time to familiarize themselves with their surroundings as well as opportunities to re-launch and re-enter the course if their planes were to lose lift and drop out. There were two winches set up behind the restaurant where we had our morning and evening meals. The restaurant was closed to passersby, but the owner lets us use the facilities during contests. As the day warmed, lift became more common, and one by one the team planes began to pick up altitude and moved onto the course.

When to enter the course is always a difficult decision since you might rise up on a thermal that is downwind from the start point, forcing you to race back upwind trading your altitude for speed and entering the course lower than you would like. While we were in the staging area, Dudley gave me an opportunity to fly our team plane, and familiarize myself both with the controls as well as

with the 'Vario', the radio system used to tell the pilots whether they are flying in lift or sink. At low altitudes, you could often see when the plane would hit a bump and the vario would respond with a higher pitched tone. When at altitude, the visual signs are impossible to pick out, so you have to rely on listening to the tones in order to track your plane's altitude. Dudley's system would also notify you when you crossed through each 100-meter height, and at about 700 meters up we quickly moved ourselves into Dudley's truck and drove onto the course.

Each vehicle reminded me of the long boats used by the whalers in Moby Dick. No two were alike and some teams preferred flying from the back seat of

convertibles, while others, like Dudley, built a wooden frame in the back bed and attached seats scavenged from a motor home. As the truck turned corners, you would rotate the seats in an effort to balance the plane's visibility against the location of the Sun, all the time taking into account the truck's speed and the winds blowing through. Losing your hat was always a risk, and I eventually fashioned a clip to keep mine from taking flight.

I quickly learned that one of the greatest challenges can be trying to work a thermal while traveling down a road. Even if you have a good sense for where the center of the thermal is, not only is the thermal moving with the wind, your orientation may be changing as the



*XC 'ships in front of the hotel rooms*



*Above: Team Windward*

*Below: Team Warlock 2*



vehicle is moving, so you are constantly having to re-adjust your flight patterns as all of the dynamic forces continually change the equation. Another challenge is the necessity to develop a tremendous level of tunnel vision to keep your focus on the plane and the air around it, and to try to mostly ignore the environment that you are driving through.

I never had a complete view of the course until after the end of the second day of flying when we were returning to the starting point and I was finally able to look around as we drove back up the valley. After landing on the Moon, Buzz Aldrin described it as “Magnificent Desolation.” When arriving in Cal Valley I could see the desolation, but I would not have described it as magnificent. The longer you are here, the less desolate this valley feels. Maybe your senses become attuned to the bird chirps and the yipping’s of coyotes or the low whistle of a car driving on the far side of the valley. You begin to acclimate to being around fewer people, so much so that returning to ‘civilization’ can come as a bit of a shock.

One of the pilots described the relation between Thermal Duration and Cross-Country as being like the differences between fishing in a river and fishing in the ocean. The challenges are greater, and your reliance on others in your team is crucial. You can fly TD alone, but it takes a crew to fly XC. I was incredibly fortunate to fly with my team, and on the second day they put aside the contest for a few hours and instead took me out to make an attempt at a 25-kilometer solo flight. This was unexpected on my part and the first indication was when Dudley told Scott to skip one of the course turns and “head straight for 17 miles.” That was when I figured out his plan, but it didn’t seem like the time to argue with the team captain.

As you are flying, it is like the hunt on the ocean. You have to stay focused on your plane, while also paying attention to the lift conditions as you fly. If your altitude is sufficient, you may decide to pass through a thermal and keep traveling. If you are losing lift, you may decide to ‘fill up’ by stopping in the next

thermal and gaining as much altitude as possible for the next stretch. I found that the concentration was so demanding, that I was often traveling with my mouth open since it took extra effort to think about keeping it closed.

One of the highlights for me was the final run towards the finish line. On the first day, we were passed by Rich Beardsley and his crew, but then later we passed him by. We found a nice thermal and were recharging when Rich appeared on the road behind us. We debated about leaving the thermal and heading out so Rich wouldn't know where we had found rising air, and as a result we were another mile or two down the road recharging again when Rich and his team went blasting by. After we gained enough altitude to make it to the finish line, we began what the whalers would call a "Nantucket Sleigh ride," where we aimed the plane towards the finish and traded as much altitude for speed to allow ourselves to cross the finish line with little room to spare. During this final run, we were approaching speeds that might have gotten us pulled over elsewhere, and with the wind streaming by, and our eyes watering, we crossed the finish line with just a few hundred meters altitude remaining.

That night we were treated to a magnificent lightning storm. During the day, we could see the storm coming up

the valley, and as we gathered to discuss the day's events, the storm moved our direction. As we ate popcorn and peanuts we were treated to a display of lightning flashes that eventually moved overhead and we scrambled to move our planes and equipment under shelter. This again reminded me of *Moby Dick* where the harpoon Ahab holds glows green from St. Elmo's fire. Fortunately, in our case it only foreshadowed the next few

days of clear skies and a light cooling off. I could run through the event scores, but what I learned was that to many, the rankings were less important than the experience itself. The chance to spend time with like-minded individuals working together to challenge nature was paramount. How you placed was truly secondary.



*Team Dust Devils launching*

# SOARING

## Burning the days

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It began long before I was 12 or so, but those memories are fading fast. I had a paper route and always wanted to get involved in R/C. I had my eye on a Cirrus 3-channel radio system, mostly because it was the cheapest thing I could find. In those days, it took me four months to save everything I could earn to make the \$100.00 necessary for that system. I worked every day for that purpose. Then the day came and I had it in my hands. What to do, all of my investment went into the radio.

I built various weird contraptions such as a block of wood with a sail and wheels to run down the street guided by servos and wind.

One day I was visiting a friend at his house and noticed in the basement a large box with a sailplane in it. My friend said it belonged to his dad and he had owned it for several years and done nothing with it. Coincidentally, it too was a Cirrus by Graupner. I schemed for a while and confronted his father about the possibility of putting said ship together — for him, of course. I had dreamed about such possibilities for months, years even.

I don't know how I convinced him, but it worked. I spent months putting together this balsa wing and glass fuselage 3-meter sailplane with many dreams about how to fly it as I built.

Back in those days Ambroid was the only real balsa glue to use, cyno was decades into the future. The dining room table was my workbench. We had a basement with a Ping-Pong table, but this prize deserved a much better venue. Eventually I had it finished and rigged as a rudder/elevator 2-channel control airplane.

I had been eyeing the local high school. It had a press box at the top of the bleachers on the football field. There was a ladder that led to the roof from where the photographers would shoot the Friday night games. I had a friend climb up there to make the maiden launch.



It was about 30 or 40 feet above the practice field, a fairly large open area behind the bleachers. I never did think about hand launching it first, I don't think so anyhow.

I knew the basic control setup, up and down elevator and left and right rudder. I had never before flown anything RC, but here I was, nervous thumbs and all.

Ready. Go!

He threw it off the top and it immediately banked hard to one side — all the way to knife edge. I had full opposite rudder in, but to no avail. The Cirrus made a perfect 180° descending arc right back at the bleachers.



*A Cirrus as depicted by Graupner.*

There was a chain link fence at the back of the bleachers and it hit the top of the fence right at the root of the wing. The wings were vertical, it being knife edge flight and all. Well, that one wing stopped at the fence and the rest of the plane kept going. You know, it's that kinetic energy thing. A whopping 3-4 second maiden flight and my first crash all together.

I repaired it and discovered that one wing was much heavier than the other,

It didn't do that. At least the wings were balanced this time. I don't remember how, but we had to retrieve it from the top of the tree at the back of the back yard. It was at about the same height as the dormer window. It had flown perfectly straight across the back yard and I don't think I even moved the controls. That was success as far as we were concerned.

That is the last memory I have of that Cirrus and the Cirrus radio as well. I don't remember if I gave it back assembled

That uninstructed flight also lasted about 3-4 seconds. The red Chipmunk was toast, as they say.

Shortly after. I wandered back into that same hobby shop and there it was. Hanging from the ceiling was a complete Graupner Cirrus, minus a radio. It was \$75.00 and I snapped it up.

It was an ugly bathroom green so I painted the fuselage black. The wings were opaque yellow so it seemed a good choice.

## ***Self-discovery is a great teacher, the mother of invention.***

hence the knife edge flight. After repairs I remember getting the same friend to launch it again. This time we had him throw it from the dormer window in his third story attic. I probably leaned out of the window and assembled the wings to fuselage there on the roof. Then I ran down to the back yard and yelled for him to throw.

His back yard was big, mind you, but I didn't really know then what glide ratio was and thought "It will just fall about a 45 degree line and I'll flare it and land in the back yard."

to my friend's dad or what happened to it. I can only hope that someone gained some happy soaring days with fewer repairs.

Many years later I finished a job in Oklahoma and traveled to live in the San Francisco Bay area. I actually had a bit of money in my pocket so I wandered into a hobby shop in Dublin in the East Bay and bought a Futaba 7 channel AM system. It was king in those days of the mid '80s.

I also picked up a foam Chipmunk and a .15 sized engine. I dry flew that plane and visualized flight in my head once more.

I hand launched this one and it flew straight and true.

Then I happened upon a fellow that rented full size planes from the place I worked. We stumbled into the conversation about RC soaring. He was an avid participant and offered to take me out and show me the ropes. I jumped at the chance.

He took me to a local business park in Pleasanton that had been groomed for development, but nothing had been built at this site yet. The green flowing grass was knee to hip deep in places, perfect

for impact resistance. You could dive your plane inverted and uncontrolled into the tall grass and it was like hitting powder snow. The only downfall was you had to bound through it to retrieve your plane. It was great fun, like playing in the snow with airplanes.

He had a high start and showed me how to use it and taught me the basics of RC soaring. He had a Sagitta or an Antares and flew it very well. I think I had a couple of good sessions at the business park with him and spent some time there on my own as well. I wish I remembered his name. Like WC Fields said, “A woman drove me to drink and I never thanked her for it.”

Then I met another guy I worked with, Bruce, who had an Olympic 650 in a box and was interested. I took him out to the park and we flew my Cirrus one day. He was hooked, too. He had the Oly built very quickly, about a week if I remember right.

We didn't even know that thermals existed, only that from the top of the high start we could get a loop or two in before it was time to land. We had a great time. We would sometimes actually lose the planes in the tall grass and bound about searching for them.

I don't remember which of us discovered or knew about it, but one day we ended up southeast of Livermore, where we worked at the airport.



*Looking west down the canyon from our slope.*

There is a winding drive that goes up the side of a ridge line and down into a reservoir called Del Valle. At the peak of the drive is a long sweeping curve that opens to the west in a beautiful bowl looking down the canyon. You could drive up, park on the side of the road, get out of the car and yell your frequency. If no one responded, throw and fly. All day — or until the battery ran empty. We had

discovered slope soaring — on our own, so to speak.

We flew every day after work. It became addicting. I don't remember anything like the chargers we have today, so we either flew a battery empty or brought two of them with us.

Bruce lived north about 25 minutes from the Livermore airport in Danville. Their



*Bruce and his penny-laden Olympic.*

house was surrounded by hills and what was once farm land. It too was under development, perfect development. That means the roads are paved but nothing is built yet. Behind his house we discovered a hill that had a canyon to the west of it with Mt. Diablo at our backs. A long canyon. The hill was probably 500 feet up from the valley floor with a

nice rolling grassy top and an easy back side. It stretched north into a sharp ridge about a 1/2-1 mile away. It became our own, personal slope. We would drive up into the development and park at a turn around, walk about 100 feet, cross a cattle fence and sail.

We spent a lot of time there honing our skills and just relaxing. We learned not to

get onto the back side of the hill. A few times it happened and the other would run across the hilltop to keep the plane in sight, yelling commands back to the pilot. LEFT! UP! UP! DOWN! RIGHT! UP! Crap! Then the walk of shame. And repair time.

I cannot recall how many times the spars and ribs were doubled on that Cirrus and Olympic, but they never quit flying. We knew my plane was a lot heavier than the Oly and it flew better when the wind was up.

One day Bruce loaded his plane up with pennies and it flew better. We had discovered ballast and its importance. Self-discovery is a great teacher, the mother of invention.

Those early days for me still drive what I do today.

The fond memories on the hill for long afternoons, driving a plane around for hours. Squinting into the setting sun and flying when only silhouettes were visible.

Some days in Oregon I'll make a tow hour drive to the slope, remembering when I would toss a plane after work every day.

Maybe I took for granted our own personal slope. There are houses there now; property rights and owners that know not what took place in their back yard for a few good years.





*Left: Our slope looking north. On a good wind day we would cross the valley and fly in front of the ridge north of our slope, just to the left of my head. It was almost a half mile away and a challenge.*



*Right: Another good day at the slope. Or maybe the same day. Same work clothes, same airplane, same slope. Every day.*

