Radio Controlled
Soaring Digest
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CONTENTS

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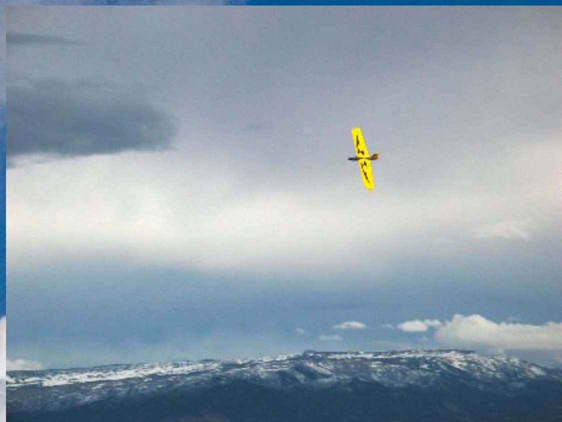

Front cover: A Moth, built by Gregory Luck and piloted by Paul Diaz, over snowy Grand Mesa, from Whitewater Hill near Grand Junction, Colorado. The Moth is a 48" EPP plank from North County Flying Machines, <http://www.northcountyflyingmachines.com>. Photo by Gregory Luck, <http://www.lavawing.com>. Canon PowerShot G3, 1/800 sec., f 4.0, 28.8 mm

Back cover: The prototype Talus EPP constant chord swept wing, designed by Ed Berg, built by Gregory Luck, and piloted by Donnie Colbert, against the sunset at North Desert, Grand Junction, Colorado. Photo by Gregory Luck, <http://www.lavawing.com>. Canon PowerShot G3, 1/1250 sec., f 4.0, 28.8 mm

R/C Soaring Digest

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

In the Air

RC Soaring Digest marks the start of its 24th year with this issue.

There have been a number of format changes during this nearly two and a half decade span, including the size of printed copies, the elimination of advertising, and the more recent move to digital format.

The continuing success of *RCSD* is due to our readers. It is the *RCSD* audience which contributes materials for publication, downloads each issue as soon as it is available, and spreads word of *RCSD* to fellow RC soaring enthusiasts. It is the readers who provide feedback to the editors and writers, making for a better publication. Our sincere thanks for your continued readership and support, and our grateful thanks to those readers who have made monetary contributions through the *RCSD* web site.

This issue includes several articles which have previously appeared elsewhere. Our appreciation to The Orlando Buzzards <http://www.orlandobuzzards.org>, the League of Silent Flight Australia <http://www.lsfaustralia.org.au> and John Skinner, and Harley Michaelis for providing the requisite permissions, high resolution images, and other support services and materials.

RC Soaring Digest relies entirely upon its readership for its content. If you are considering submitting materials for publication in future issues, please download the document Submissions.pdf < http://www.rcsoaringdigest.com/pdfs/Submissions.pdf>. This small (20K) document answers the most commonly presented questions.

Time to build another sailplane!

Raed Elazzawi

In their own words...

Tangerine 2006 Grand Champion Fly-Off

The fly-off for the Tangerine championship was intended as a single man-on-man round for the four pilots who were winners in each of the four events.

Since Gordy Stahl won two events (and even he cannot pilot two planes at once) the CD (Rick Eckel) extended fly-off honors to Kurt Carlson who finished in second place Unlimited on Saturday.

So, the four pilots in the fly-off were: Rick Eckel, winner of 2 Meter, Gordy, Kurt, and the RES winner, Don Cleveland.

The weather was warm and windy, and the wind direction dictated that any downwind flying was in line with the late afternoon sun - and guess where the lift was!

All four contestants are very accomplished competitors but this fly-off really came down to two guys - Gordy and Rick.

Here are their versions of what happened.

Pam Cortner

Raed Elazzawi

Gordy's Story

In the fly off, Rick launched first (by the way he qualified by winning 2m, but you could fly anything you wanted in the Fly Off for Grand Champion flight, so not being a fool, he chose the Sharon, versus a 2m. ;-)

His line broke right at the top of the launch so he got no ping. I got a spectacular launch but proceeded to fly over toward the lift with my landing flap lever about half way down! So we both started with a handicap.

It really was between me and Rick, and he hooked up and skied out for an easy 10-minute max...

Raed Elazzawi

Me, I went deep trying to get into his lift but just couldn't find its center and was way back behind the tree line, so I worked forward and ended up over the pond and a pine tree that had eaten at least one plane today…

I was in a tight spot to say the least…

It was clear that Rick wanted to win this one, and I sure as heck didn't want to just give it to him, so I flew the flight of that field's history likely, literally battling tiny bubbles at tree top danger height for the whole time. I could see everyone watching my plane, I suppose to make sure it was spotted when it tree'd. :-)

When it was time to land, I was totally exhausted and stiff from wiggling every stick on my TX what seemed like a million times, (probably need new gimbles :)…

And as I came in I hit the same turbulence as everyone… But I brought her in low and hot as usual but at the last second got blown off the line for a 50…

And Rick?

He had a 75 for Grand Champ award. He flew a tremendous contest in both 2M and Unlimited.

By the way, the Sharon he borrowed is one of the rare full carbon versions, and I think it weighs even more than the World's Heaviest Carbon Supra! In any case, its about 10 oz. heavier than my standard Sharon and for the last two days it was definitely an advantage.

Rick's Story

After the raffle finished we took up positions at the winches more or less at random. I ended up on the east end of the line.

Since I won 2 Meter but was not limited in what I might fly I chose to continue with the plane I'd been flying in Unlimited; a Sharon Pro that was on loan to me from Bob Brown.

(Bob's a little more trusting than mentally balanced. Who in their right mind would loan someone $2500 worth of fine, molded, state of the art, sailplane full of premium servos to toss into the sky perhaps to come crashing to earth? Thanks Bob!)

Gordy was also flying a Sharon. Kurt was flying his trusty own-design Mantis style ship and Don stayed with the Ava he used in RES.

The wind was blowing pretty hard and Don had already mentally pretty much thrown in the towel due to the Ava's limitations. I only had to worry about Kurt and Gordy.

I knew that Gordy was hot since he and I had been battling all day. Kurt is an excellent pilot as well and I've eaten his dust on many occasions but I decided that Gordy was the one to cover.

With my usual luck I was commanded to launch first. So much for getting a read off of the others' launches and covering Gordy!

The Sharon went up the line steeply and I climbed her aggressively to zoom height.

Kurt Carlson, Gordy Stahl, Rick Eckel. Photo by Raed Elazzawi

Just as I tensioned for the zoom she jumped straight up. The squiggle of winch line beneath the parachute confirmed the line break.

Rats!

I was tired and really didn't want have to come down and relaunch. Besides, some might think I broke the line on purpose to gain the advantage of launching last. The solution was simple - fly it out! Ya, right.

Luckily the chute and a wind shift indicated a nice thermal lifting off on my side of the field. So I went out that way.

I tried not to gain too much altitude immediately so as not to draw my competitors to that side. When I was pretty sure they had all committed to going another way I worked my way to altitude while the thermal worked its way downwind. As I said to my timer, "The only problem I'll have with time is keeping the plane in sight for 10 minutes."

A little after perhaps five minutes, I believe, I heard Kurt and Don landing. About then I caught a glimpse of Gordy's Sharon working slowly across the south (downwind) tree line, east to west, scratching for lift. I felt new lift moving off the field to the west and knew that if Gordy got into it he would probably make his time.

So I went east, out of my good lift, hoping to draw Gordy in that direction. I was too far out and he didn't go for it. So much for an easy win.

Gordy didn't seem to get out into the strength of that lift coming off the field to the west and downwind, but he stayed on the edge well enough to gain altitude and it became obvious he would make his time.

Since I had launched first I was going to have to make the first landing.

One thing I can say about that Sharon, I had been landing it better than I've landed anything in my life, and it gave me a lot of confidence. The landing approach was pretty close to directly out of the late afternoon sun, so judging speed and distance was going to be tougher than it had been all day.

I went into my 2-minute drill and started bringing the Sharon down to landing altitude.

At one minute I was over the field with a little extra altitude for insurance.

At 40 seconds I flipped to landing mode pulled flaps momentarily to get my speed under control and started a long cross wind leg away from the landing zone waiting for the clock to run down.

At 30 seconds I turned down wind and pulled half flaps.

At 20 seconds I was still high so I pulled full flaps and pointed the nose down. In that attitude I turned cross wind and then onto final.

Once on final I released flaps to half flap and got the fuse lined up with the landing line. I was still a ways out with time counting down in the sub 10 second range so I released flaps some to speed up my approach. I felt the wind and it seemed to be holding at my back so I stayed lined up. As I came across the end line I really, really wanted a 100 landing. Gordy had been hitting them like clockwork all weekend.

I crossed the end line still a bit high, pulled full flaps momentarily and put the nose toward the line. The landing was a bit abrupt and the nose skipped away from the line. My timer said, "2 seconds over" and a measurement said a solid 75 landing.

Well, I'd done my best. Not perfect, but at least I hadn't choked. All I could do was stand off to the side to see how Gordy would fare. Another 100 landing from him would take it.

His approach was a bit erratic. He seemed to be having some trouble getting the big Sharon on line. When he finally touched down his first question, even before he measured his landing, was how I had done. I insisted he tell me his landing first. "A 50," was his reply.

And, of course, that meant that I got to take that pretty trophy home!

Closing comments

The 2006 Tangerine Soaring Championships on Saturday included 12 fliers in 2 Meter and 30 in Unlimited. Sunday included 15 contestants in RES and 25 in Unlimited.

Contestants came from several states outside Florida including Delaware, Indiana, Kentucky, Alabama and Tennessee.

Four rounds were flown each day in a seeded man-on-man format. More rounds were desired and the Buzzards will work on ways to execute this format more efficiently.

The challenge of winning (or at least coming close) in your group every round brings an extra edge to the competition.

The final fly-off for the Grand Champion trophy described above certainly enthralled the crowd - almost everyone there was staring into the afternoon sun to see who was going to prevail.

This was our 33rd annual Tangerine and we enjoyed yet another successful contest.

Tom Galloway, Assistant CD

Calculations for scale aircraft
- an Excel spreadsheet -

Len Jones, jonesl@krsrm.com.au
Solid Model Memories, < http://groups.msn.com/SolidModelMemories>

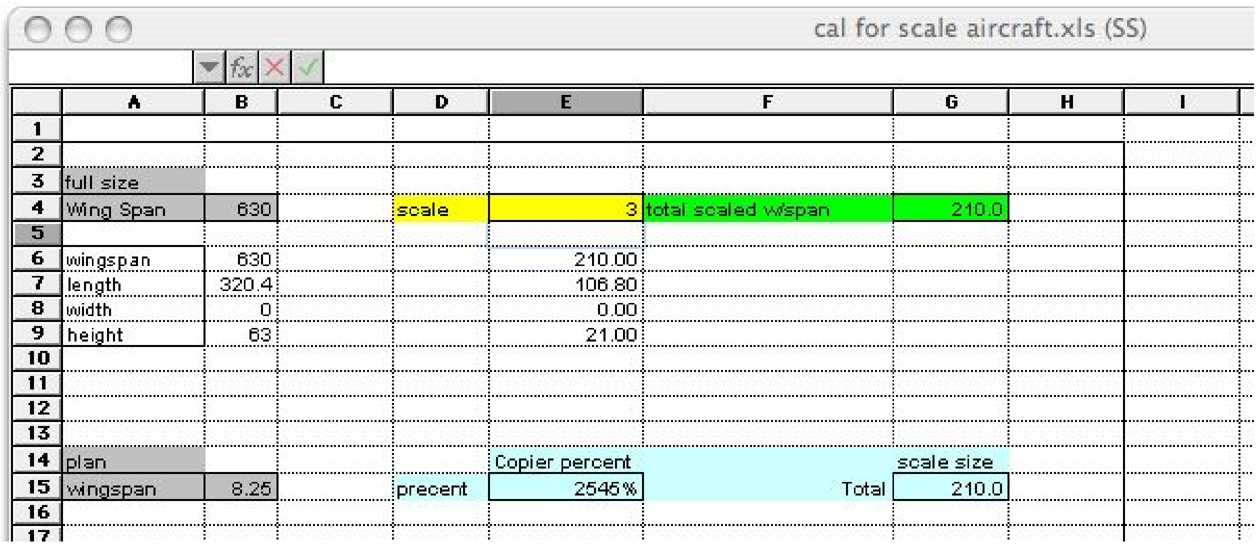
The purpose of the program is for scaling the plan to the scale you require.

Say you have a plan from the net and it is on A4 size paper. You would measure the A4 plan wing span and research the full size aircraft and gather the wing span, fuselage length and width dimensions, and the height.

Enter the plan wing span number in the cell which is labelled "plan wingspan" (15-B) then enter the full size wing span in the cell in the top left hand of the program labelled "full size wingspan" (4-B). Enter the fuselage dimensions and height in the appropriate cells (7-B) and (9-B), respectively.

Go to the yellow "scale" cell (4-E) and enter the scale ratio you require.

At the bottom of the lay out you will see "copier percentage" (15-E). This is the copier setting to enlarge your A4 plan.



	A	B	C	D	E	F	G	H	I
1									
2									
3	full size								
4	Wing Span	630		scale	3	total scaled w/span	210.0		
5									
6	wingspan	630			210.00				
7	length	320.4			106.80				
8	width	0			0.00				
9	height	63			21.00				
10									
11									
12									
13									
14	plan				Copier percent		scale size		
15	wingspan	8.25		precent	2545%	Total	210.0		
16									
17									

Len's XLS spreadsheet with data for a 1:3 scale model of the Schleicher Ka-2b, N582KA, as described in this issue. All aircraft dimensions are in inches. Input variables were the scale (4-E), "Wing Span" (4-B) and length (7-B), and height (9-B). The plan wingspan, taken directly from the plan set included in the walk-around, was inserted into the cell in the lower left (15-B).

The "total scaled w/span" (4-G), "Copier percent" (15-E), and "scale size" (15-G) are automatically generated within the spreadsheet.

<http://www.msnusers.com/SolidModelMemories/Documents/cal for scale aircraft.xls>

Sled Driver Chronicles

Jay Decker, sleddriver@monkeytumble.com


Kelly Johnson

Whether or not to take the Road Less Traveled…

Didn't you just love Phil Pearson's series of articles on the development and construction of the Encore!?! I've been dreaming about having a CNC router like Phil's to create milled wing foam cores with beautifully curved leading and trailing edges, and heck, maybe it could even create mold negatives. If Phil's stuff didn't get your blood pumping, then you might as well turn the page to the next Euro-plastic moldie review, because I'm going to talk about rolling your own composite airplanes again.

Let's quickly review why you should not build your own planes today:

Quickly getting into and staying in the air
I simply don't recall there being the number of available nearly ready to fly planes when I started flying… I think the Hobie Hawk would have qualified. The truth is that today you can buy a number of good airplanes and get in a lot of flying for the cost and time it takes to gather all the stuff to make a composite airplane and build the first flyable plane.

Obtain the finest fit and finish plane The Winch Doctor's spouse calls the Jaro Muller's planes "Lego" planes, because they snap together with the fit and finish of those crafty little Dutch plastic blocks. I can only dream of building planes with the quality of the better Euro-plastic planes before the last batch of epoxy in my modeling career sets.

Saving Money If you really get into composite construction, you will probably have to build at least twenty planes before you will recoup the cost of the tools and materials you need to roll your own scratch composite airplanes. If you in go whole hog, the number is probably something more like 40, or more, by the time you include the cost your building space, utilities, and other overhead costs. However, this might actually be a bargain, if building keeps you out of the bars, the company of attractive twenty year-olds, and divorce court.

You might be thinking that is kind of depressing and wondering, if saving money isn't even a reason to roll your toy airplanes, then why should you should you build your own planes? Let's review why you should build your own planes:

Enjoyment Building is fun and produces a feeling of accomplishment. Remember that guy who built a Gentle Lady and arrived at the field beaming with pride and a sense accomplishment? You might have noticed that his covering technique left something to be desired and his controls did not quite move silky smooth. But, that Gentle Lady flew well enough, and now a few years later, that guy builds competitive planes, DLGs, and some cool slope iron, and he still enjoys building and has that sense of accomplishment derived from building his own planes. That could be you…

Uniqueness Build what ever you want. Don't just have another copy of what a bunch of other guys are flying. Ever find yourself noticing when certain guys arrive on the hill how you want to drop what you are doing to see if they have built anything new? Even though the guy who came flying with you brought a new Euro-plastic plane that cost more than $1,000. And on the trip back home you talk more about the unique plane you saw than your buddies new Euro-plastic plane. You could build a unique plane...

Creative outlet You go to work, you do what you do, and do it for who ever you do it for day after day. Don't know about your job, but mine does not have many outlets for my creativity. Modeling provides a number of creative outlets for guys who dream up cool new airplane designs like Sherman Reed's JART <http://www.jartworld.com>, or produce cool solutions like Doug Boyd's wingeron hardware <http://www.rcgroups.com/forums/showthread.php?t=455707>. Do you ever have ideas for a new plane that streak through your mind? You kind'a get a sense of it down on paper, kind of looks like a 1950's fighter jet with Cadillac fins, and it's really cool. You could build it...

With the benefit of my experience and the detriment of my prejudices, I am going to offer you a couple suggestions for starting down the road of composite construction, if you choose to take it. Here are my suggestions for a progression path:

Step 1: Vacuum Bagging – There are simply too many things to learn to build a soup-to-nuts composite plane from scratch. You can purchase fuselages and foam cores for some great planes, so I suggest that you start with learning to vacuum bag skins (wood veneer or laminate plastics) onto foam cores. Vacuum bagging is a great place to start, because you fly some of your product sooner than later. Truthfully, you really don't need to progress pass this point. You can usually get others to lay-up a fuse and cut foam cores for you. And, in case you didn't know, "Hatching" a wing is one the most satisfying experiences as a builder. For me, hatching a wing is like being four years old again at Christmas as I open the vacuum bag and peel off the Mylar to reveal a shiny new wing.

Step 2: Cutting Foam Cores – Cutting foam is fun, because you quickly create a piece of foam that looks like a wing. It is also freedom. Freedom to try a faster airfoil, freedom to increase the aspect ratio, and freedom to change the wing planform into some sexier.

Step 3: Lost Foam Fuses – Here is where you can achieve independence and totally do your own thing. Most extruded foams sand very easily and can be covered with fiberglass to make a fuselage that looks great, is strong, and is uniquely yours.

Step 4: Molded Fuses – Here is where vision and ego, and the possibility of financial return, start coming together. I'm not going to talk about selling your stuff other than to say that you'd probably be better off return-wise taking a minimum wage job at a local fast food franchise. So, lets talk about vision and ego. To my way of thinking, you build your first fuse mold when your vision of what you want demands that you build a mold to realize it, your ego wants to see others flying your design, or some combination of the two.

Step 5: Fully Molded Construction – Here's the pinnacle. Not many go here, at least yet. The cost is still pretty high either time-wise or cost-wise. I have friends who have built molds for 3-meter sized planes tell me that it takes 500 to 1,000 hours to build the tooling, and they know what they are doing. I've also been told that purchasing milled molds is half of the price of a modest SUV. However, fully molded construction might become more accessible if CNC routers and mills and software continue to become more available and affordable.

Whether or not you decide to take the road less traveled and build your own planes is a personal decision. There is no shame in purchasing planes. In fact, most guys make this choice, including most of the best pilots, which makes sense, if you want to be a good pilot, why not "buy and fly." However, if you are interested in a less traveled road and want to roll your own, the time has never been better. The information available on the 'net, combined with the materials and specialized tools you can now easily find there, have made it easier than ever before... So come on in, the water is fine.

Electric Bird of Time

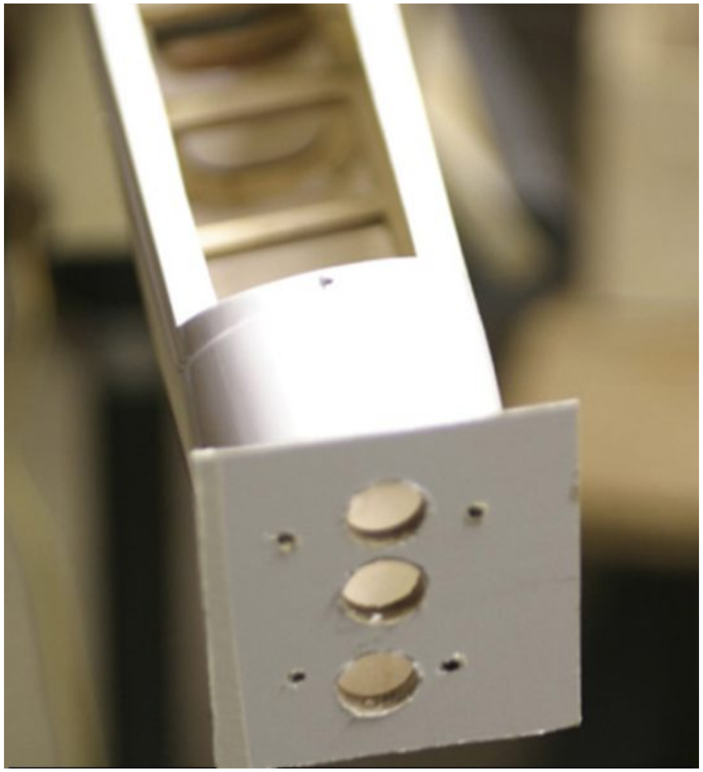
by Robert Samuel, photors@verizon.net

Having recently purchased an ARF Bird of Time and had several successful "bungee" flights, I tried to figure a way to convert it to electric.

The first decision was to use the current ARF or begin again with a kit. The modification of the ARF was hands down the easiest choice. I could find little help from the various RC online forums or the manufacturer. The biggest problem, it seemed, was how to keep the overall weight of the original glider (3.75 pounds) down after adding batteries and a motor.

This project evolved into a summer long event using three BOT ARF kits. The original sailplane carried an 11 ounce plug of some metal in the nose for ballast. Even with this weight, I still required two ounces of lead shot in the nose to obtain balance.

Using a razor saw, I cut the nose section on the line aft of the factory installed nose weight. I was later able to remove the nose weight and gain an extra two inches of length for the fuselage. The nose weight appeared to be solidly glued to the fuselage, but it turned out that it was only held in with

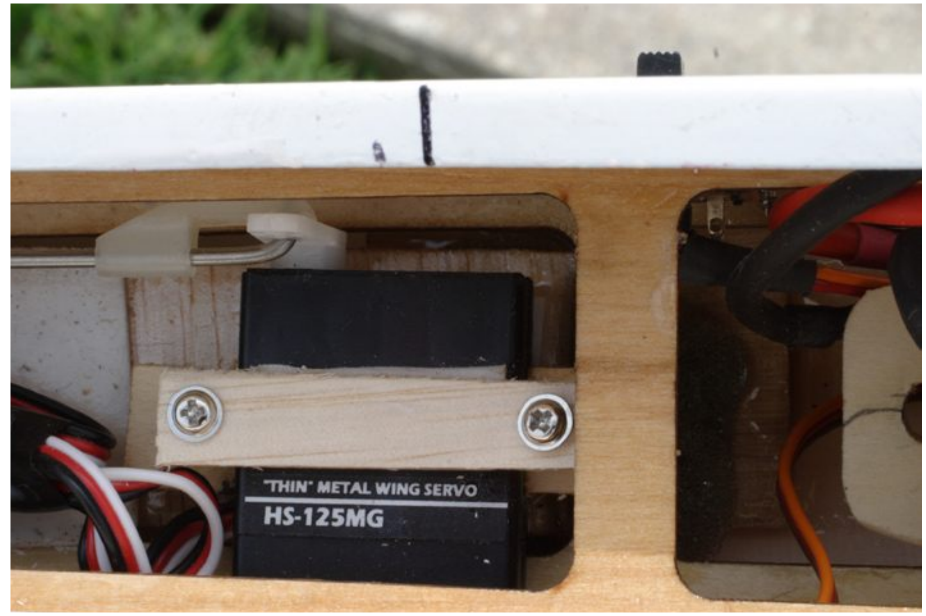


a bead of hot glue around the rear portion. By drilling a 1/4 inch hole in the nose, I was able to insert a 6 inch 3/16" drift punch, and after loosening the seal with several taps, it came free with a solid blow. This made a significant difference in the whole configuration of the airplane. 1) The nose was now extended three more inches, 2) the use of Astro planetary motors (20 and 50) was feasible, and 3) greater leeway was afforded for choice and placement of a battery pack.

To my surprise the total weight came to 16 ounces. With careful consideration of motor and battery pack, I should be able to stay within the 3.75 pound total weight.

My motor selection was an AXI 2820/10 with radial mount . I used the radial mount to extend the nose length, in an attempt to reduce any ballast. I was able to use a much smaller diameter motor, the Astro 20 planetary with the extended nose in the Model 3.

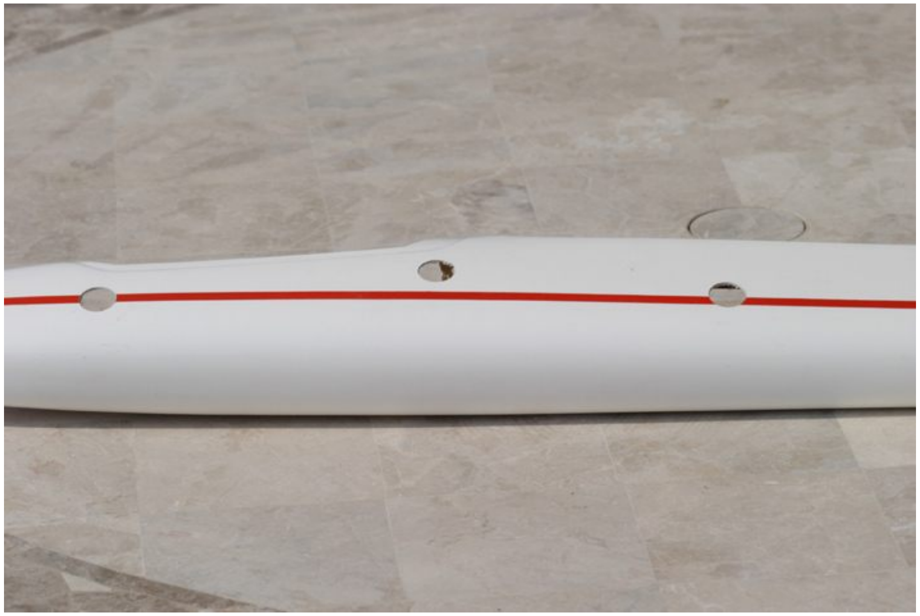
Tracing the outline of the cutoff nose cone produces the firewall of 1/8" plywood. I than traced the outline of the radial mount on the firewall. The tracing gives you an outer dimension, which is about 1/32 inch larger than the internal diameter. Hand sanding quickly produced a fit that would place the firewall just inside the fuselage.



Once this fit was obtained, I contact cemented a piece of white Formica to the mount and clamped the assembly and let it dry overnight. Following the pattern in the mount, I drilled the Formica/plywood sandwich to match. Next I inserted 4-40 blind nuts from the inside and coated them with a light amount of 30 minute epoxy. The next step was to epoxy the mount to the front of the fuselage, using masking tape to secure it overnight. The next morning I measured a length of carbon fiber "rope" to fit the circumference of the inner wall. This was epoxied into place, using a wooden tongue blade to force it into the corner where the fuselage sides and the firewall joined. The Formica is trimmed to fit the outer dimension of the fuselage. Now we have a very strong firewall with a minimum weight.

The receiver and servo were to be placed as far aft as possible, leaving room for the battery pack and controller/BEC. As both servos were mounted with tape, I cut a small strip of 1/16" ply to place over the servos to prevent any movement.

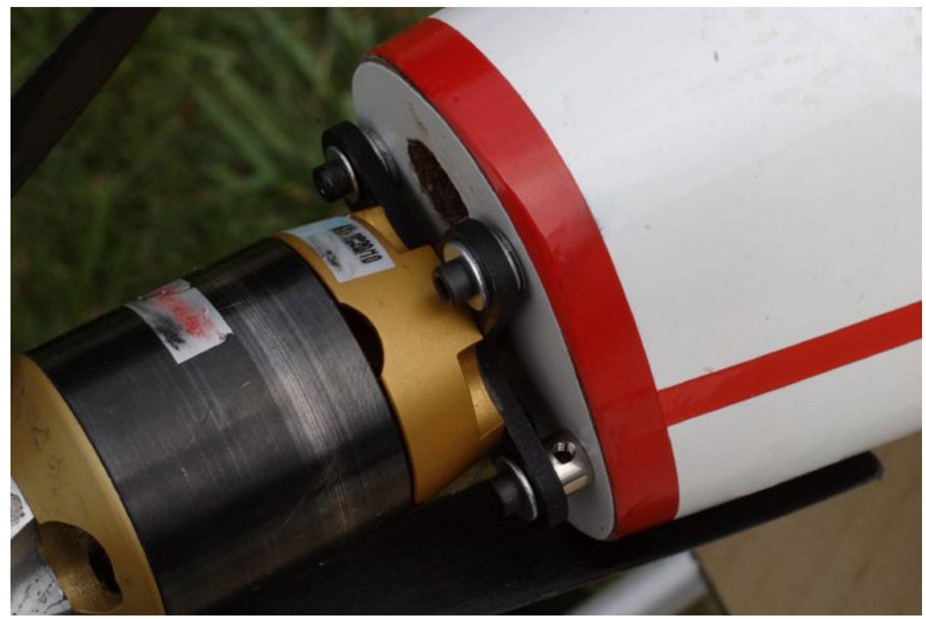
The pushrod and antenna tube were cut off 1/2 inch forward of the rear cabin former. The forward part was easily removed with a needle nosed pliers. The area beneath the wing leaves no room to mount the rudder servo and receiver, so I epoxied a piece of 1/8" plywood to the bottom of the middle horizontal supports. Using 12 minute epoxy, I held this mount in place by drilling two small holes and inserting four inch drywall screws. The screws gave me a hold until curing was complete. Cutting away the areas where the pushrod and antenna tubes were removed left a smooth area to easily fit an 8 cell 1700 mAh NiCad pack, with plenty of length to adjust the final CG. The controller, attached with thin servo tape, mounted



easily beneath the battery compartment with sufficient room for air flow.

The original Bird of Time had no provisions for a power system. With only two inlet holes and no outlet holes, an immediate correction was needed. This was solved by the drilling of two holes, which later evolved to three holes, on each side of the fuselage, forward of the switch, adding sufficient airflow to cool the battery and controller.

The antenna had to be re-routed to exit the fuselage away from the rear mounted stabilizer servo.



The last part of the assembly was to mount the motor with 3/4" 4-40 bolts, place the battery on the tray, then adjust the battery position until it balanced at the original CG. The radial mount conversion for AXI motor uses an 8 mm prop shaft. This initially caused a problem, but I was able to obtain an adapter from Graupner.

The first flight was done in the late afternoon, with practically no wind. Take off was hand launched at full throttle. Climbout was excellent at about 30 degrees. There was no tendency to lose altitude at launch, and it rapidly climbed to a speck in the sky. The motor run was about one minute, when I shut it down and started searching for thermals. It didn't take long to find one, by just following the buzzards. By then the sun was starting to go down, so I restarted the motor to set up for landing. This plane is a floater, so my first approach was short, requiring a restart of the motor and another pass, this time at 600 feet out. This approach was smooth and low and resulted in a perfect landing.

BIRD OF TIME 2

AXI 2820/10 motor with radial conversion
40 amp controller with BEC
Graupner 11x7 folding prop with 8 mm adapter
8x1700 mAh NiCad battery pack.
Finished Flying Weight 48 ounces

BIRD OF TIME 3

Astro 20 planetary
25 Amp controller and BEC
Graupner 14x8 folding prop
10x1700 mAh NiCad battery pack
Finished Flying Weight 56 ounces

BIRD OF TIME 4

Astro 50 planetary
40 amp controller
Graupner 14x8 folding prop
10x1940 mAh NiMH battery pack

The mounting system for holding the model during construction was made from a sailplane holder attached to a video tripod. The model is secured to the stand with Velcro straps. This will not work on a standard photography tripod as its base cannot be extended to prevent tipping over. This combination works very well, as it can be moved into any position for easier construction. This works well as a field stand and is very handy for positioning the fuselage for hands free work in the shop. The tripod will support up to 50 pounds, and is rock steady in winds.

Making Carbon Plate

Harley Michaelis, LSF 023

On occasion, a need for rigid carbon plate may arise. For example, it is very useful as tops and bottoms of the pockets used in installing the Rotary Driver System.

Making plate involves imbedding layers of bi-directional carbon fiber cloth in a matrix of epoxy and letting it cure under pressure between flat and smooth surfaces.

A vacuum bagging setup provides the pressure, and pieces of window glass are flat and smooth. Two pieces a foot or so square are practical sizes to work with. Cloth on the order of 6 oz./sq.yd. and a thinner epoxy, such as that used in bagging, make a good combination.

Cloth that weight results in a finished thickness about .010" per layer. Four layers makes a plate approximately .040" thick, etc. Decide on the dimensions of the plate wanted and cut the layers.

Lightly spray one of the glass surfaces with 3M-77. Cover it with waxed paper. Place the first layer on the paper. Mix epoxy and resin. Use a credit card, etc. to spread and saturate the first layer border to border. Stack and repeat with each individual layer. Lay waxed paper over the work, position the other flat surface and apply tape to keep together.

To keep oozing epoxy off the bagging tube, place the work between pieces of heavier drop cloth, etc. Lay heavy paper toweling, etc. over the work as a breather.

Pull vacuum.

When cured, separate the glass pieces and peel off the waxed paper. Use a wax remover to remove wax residue from the surfaces of the plate so adhesives will stick to it.

Wear suitable protection against carbon dust when cutting the plate. Square up an edge of the plate with a hacksaw and sanding block so it can be placed against a fence of a table saw, etc. and cut into sizes needed.

Plate quickly wears down an ordinary bandsaw blade.

Edges of cut pieces can be trued and pieces thinned down on a disk or belt sander.

Editor's note: This process can be modified slightly to create 'glass/balsa/'glass and plywood/foam/plywood and other laminates.

N582KA

Owned by James and Simine Short, Homer Glen, Illinois

The Schleicher Ka-2B "Rhönschwalbe" was manufactured between 1955 and 1962, and in all 71 were produced. A two place advanced trainer, the Ka-2 was the first two-seater designed by Rudolf Kaiser; the Ka-2B differed only in having an increase in span from 15 to 16 meters. According to public records, S/N 03 was manufactured in 1958.

As a scale model, the Ka-2B would make a marvelous subject for aerotowing in 1/3 scale. Because of the swept forward spar, careful attention must be paid to the strength of the carry-through structure, but otherwise construction would be fairly straight forward.

Span: 16 m, 52.5'	Length: 8.15 m, 26.7'	Height: 1.6 m, 5.25'
Area: 17.5 m^2, 188.4 ft^2	Aspect ratio: 14.63	Airfoil: Gö 533, 16% - 12%, -1°
Weight: 278 kg, 613 lbs	Payload: 202 kg, 445 lbs	Gross weight: 480 kg, 1058 lbs
Wing loading: 27.43 kg/m^2, 5.62 lbs/ft^2		No provision for water ballast

L/D_{max} = 27 at 80 km/h, 50 mph Minimum sink = 0.80 m/sec, 2.62 ft/sec at 65 km/h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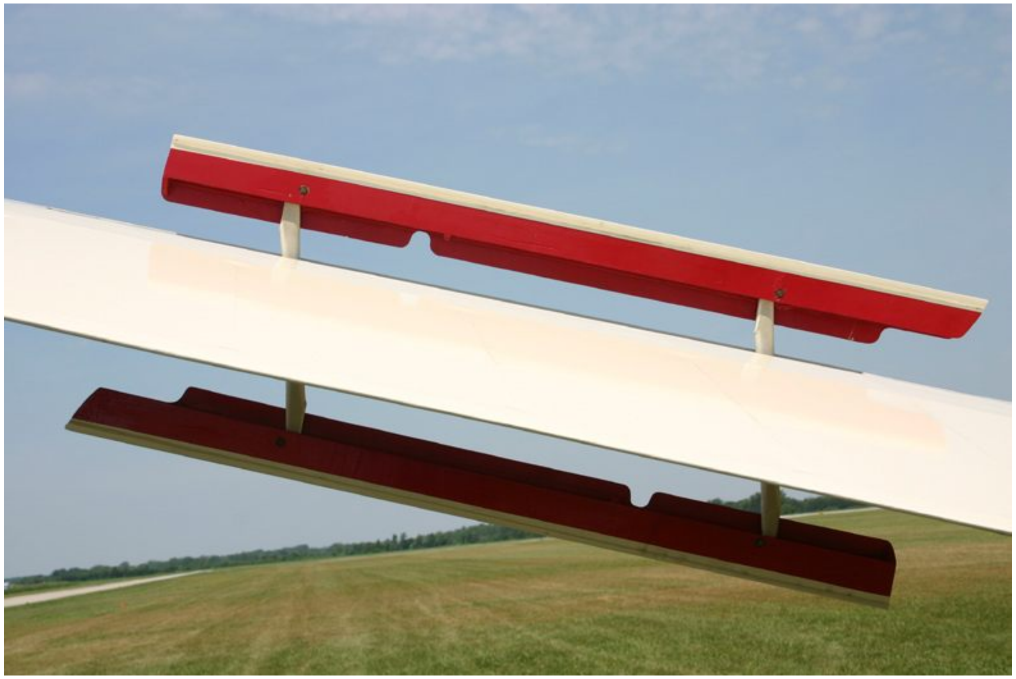


Poppenhausen
a.d. Wasserkuppe


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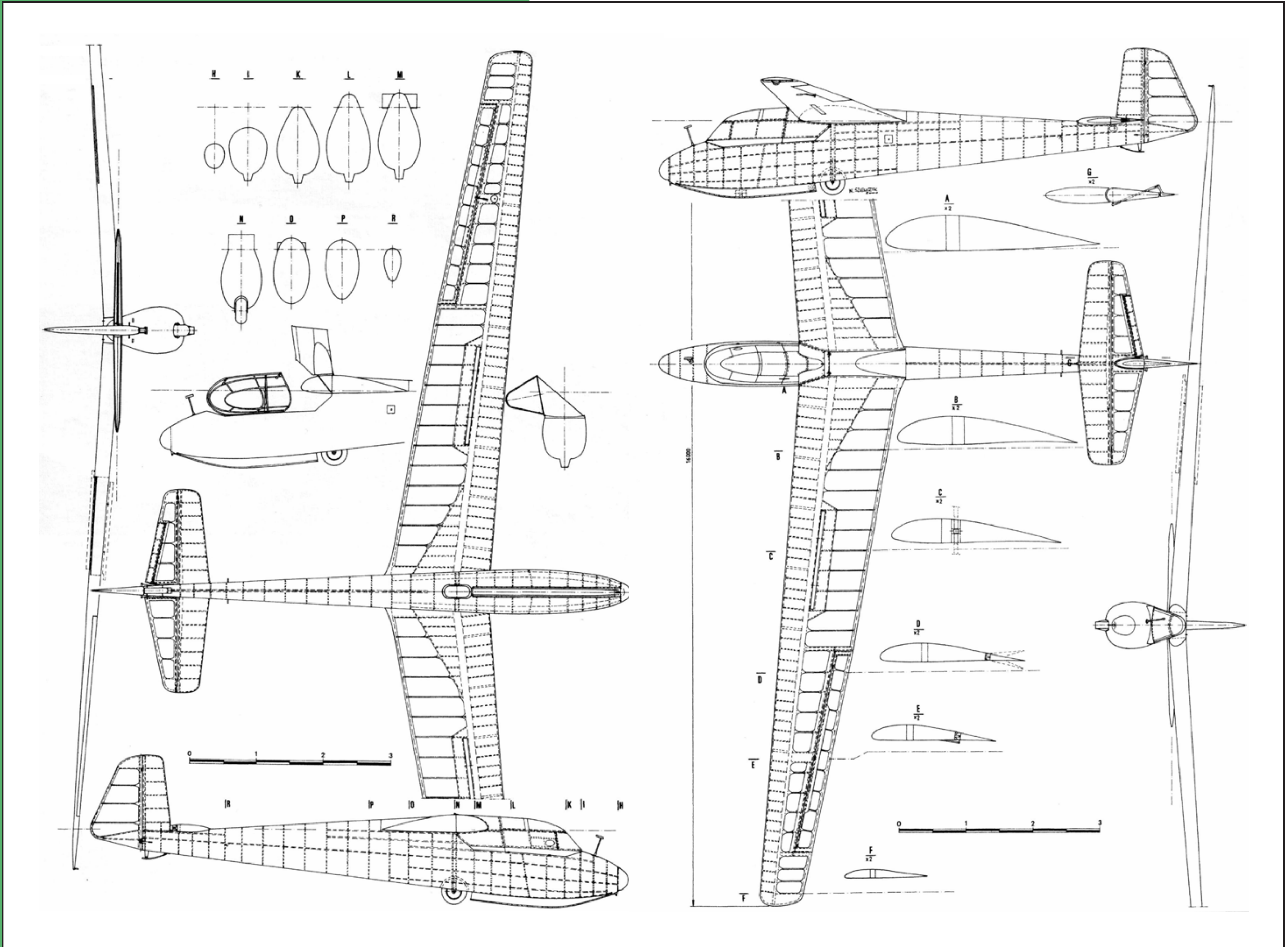
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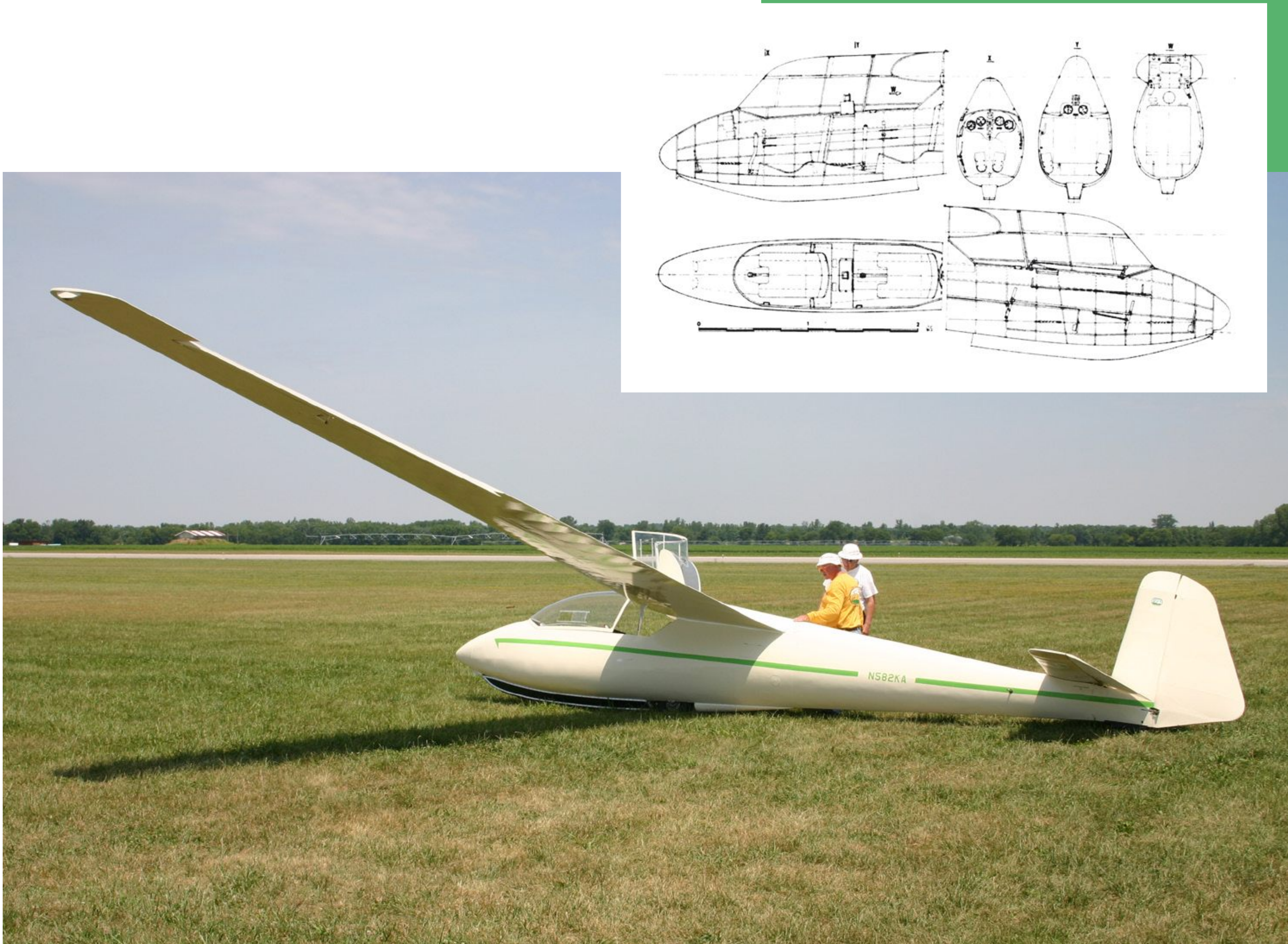
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Chris Erikson flies his prototype Valkyrie at Greyback Mountain. Nikon D70S, 1/2500 sec., f8.0, 70 mm.

A theoretical Analysis of Ellipse 4 Aerodynamics

John Skinner, LSF Australia
<http://www.lsfaustralia.org.au>

This is a theoretical analysis of the aerodynamics of the HQW 2.0-8 profile as it applies to the Jaro Muller Ellipse 4.

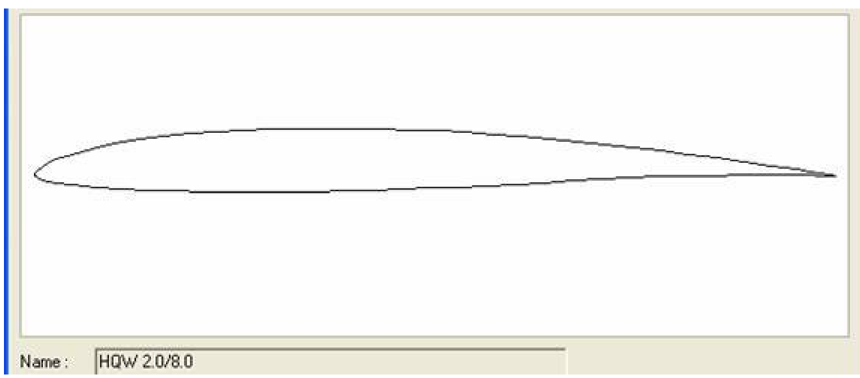
I thought it might be useful to a friend of mine who has one of these gliders and is in the process of optimizing performance. I have utilized a similar approach to get an idea of flap positions that are appropriate for my Nyx and Caracho 3000 and have found that the theory and practice agree pretty closely.

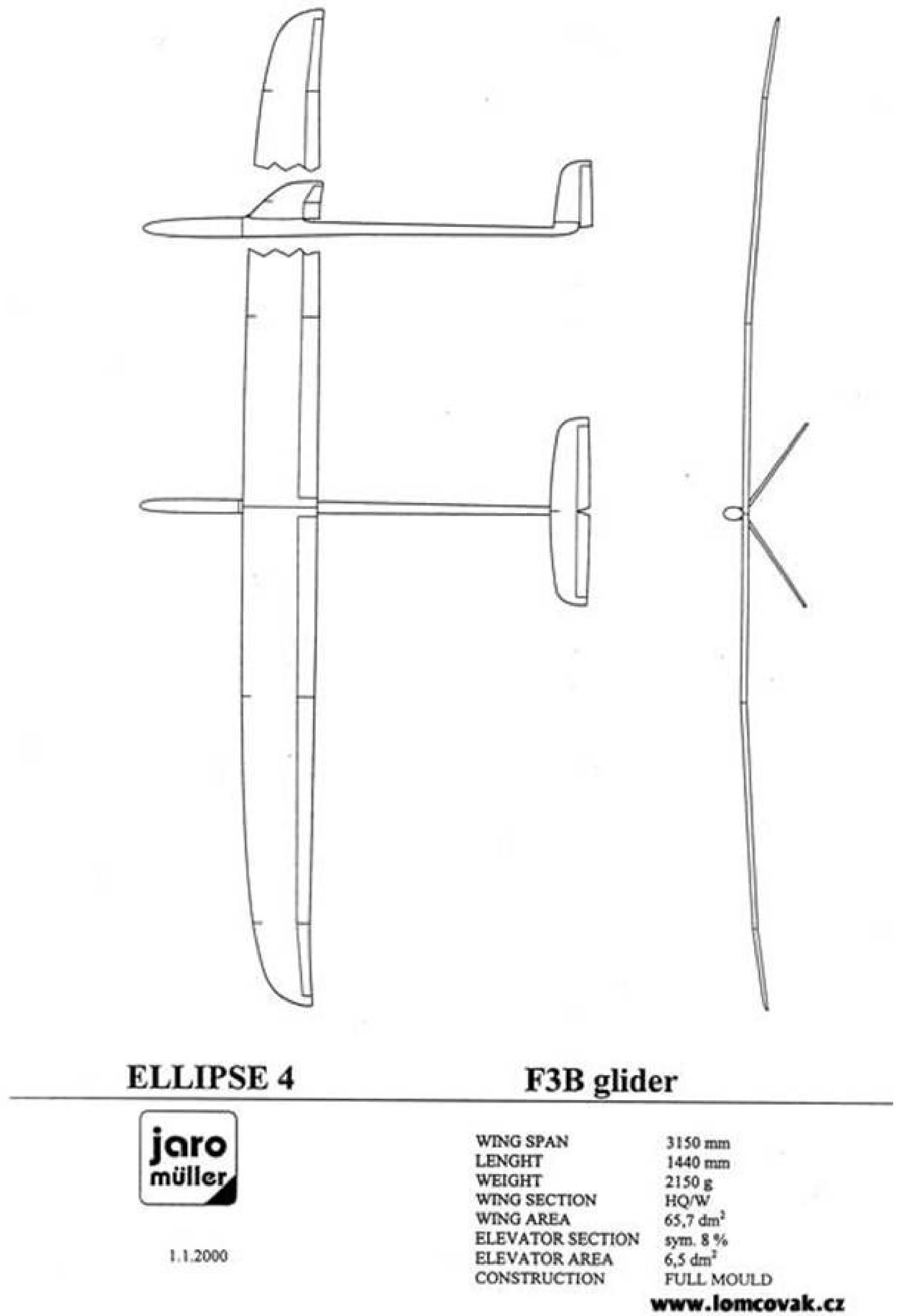
The document started out as a note with a few screen dumps from Profili. I decided though that I should do a bit better and take it to a standard to allow a wider audience. I don't have a degree in aerodynamics, all that I have learned in this subject comes from the experiences of 25 years in aeromodelling, therefore any guidance, comments, criticisms and suggestions on the following would be gratefully appreciated and help my understanding.

The Ellipse 4 is an F3b/F3j model, and the HQW 2.0-8 is designed for variable camber. The analysis revolves around the F3b triple task of speed, distance and duration. The appropriate flap settings for each of these tasks is discussed, and in addition an analysis of turn performance in speed, and launch performance. Note that when I refer to flap I mean raising or lowering the whole trailing edge, flaps and ailerons, to create variable camber on the wing.

The material is not overly complicated, and I try to explain some of the concepts involved along the way. There are plenty of references available on the subject, but I would recommend Martin Simons' book "Model Aircraft Aerodynamics." <http://www.amazon.com/Model-Aircraft-Aerodynamics-Martin-Simons/dp/1854861905>

The aerodynamic calculations utilized Profili 2.19 Pro at <http://www.profili2.com> and Excel spreadsheets. The dimensions for the Ellipse 4 can be found at <http://www.aerodesign.de> and < http://www.jaro-muller.com/ellipse4.html>.





Basic Assumptions: Ellipse 4 wing section is HQW 2.0-8, wing area 65.7 dm². Dry weight is 2150 g. Other estimates include: Root chord 240 mm, MAC 210 mm, flap hinge at 24% on the bottom surface, with capacity to add another 600 g ballast.

What flap setting to use for speed?

In speed, the F3b glider dives for about 3 – 5 seconds to gain speed. During this dive the wing lift is zero, so airfoil CL=0. The glider then completes 4 x 150 m laps with three 180° turns. Assuming 15 m diameter turns with their apex at 150 m, distance traveled is 625 m (of which 71 m or 11% of the total distance is turning). For a 13.5 second run, average speed is 166 km/hr. This speed is a good approximation – as we all know, it is difficult to fly the perfect course, so longer distances will mean longer times!

Assuming a speed of 166 km/hr, Reynolds number at the wing root is 750,000, weight is 2750 g (Ballasted). CL is 0.03.

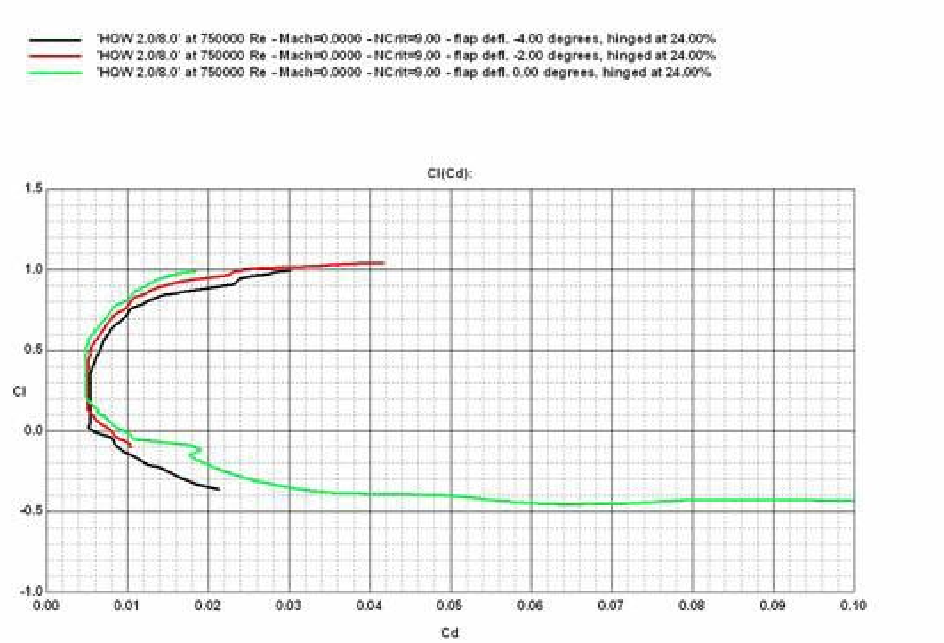
In speed, low drag at CL=0 or slightly above is important for good acceleration in the dive, high straight-line speed and energy retention when flying the legs between bases.

Let's look at some polars drawn by Profili:

Polar 1: HQW 2.0-8, Re 750,000, Flap at -4°, -2°, 0°

• Green curve is the unflapped airfoil. The drag increases for CL values less than 0.3, giving rise to excessive drag in the acceleration dive and flying the speed laps at high speed.

• Red curve (-2° flap) shows that reflexing the flap by this amount lowers the point at which drag increases to CL = 0.2. We have still not reached a low drag state at CL = 0.



Polar 1: HQW 2.0-8, Re 750,000, Flap at -4°, -2°, 0°

• Black curve shows that -4° flap provides low drag at CL = 0, satisfying our criteria for fast level or diving flight. This is a larger deflection than I thought would have been necessary, but -4° flap setting appears to be enough to ensure low drag at CL=0.

What flap setting is needed to help with turns at speed, and what is the importance of snap flap?

To turn, the airfoil needs to be able to produce high CL with low drag.

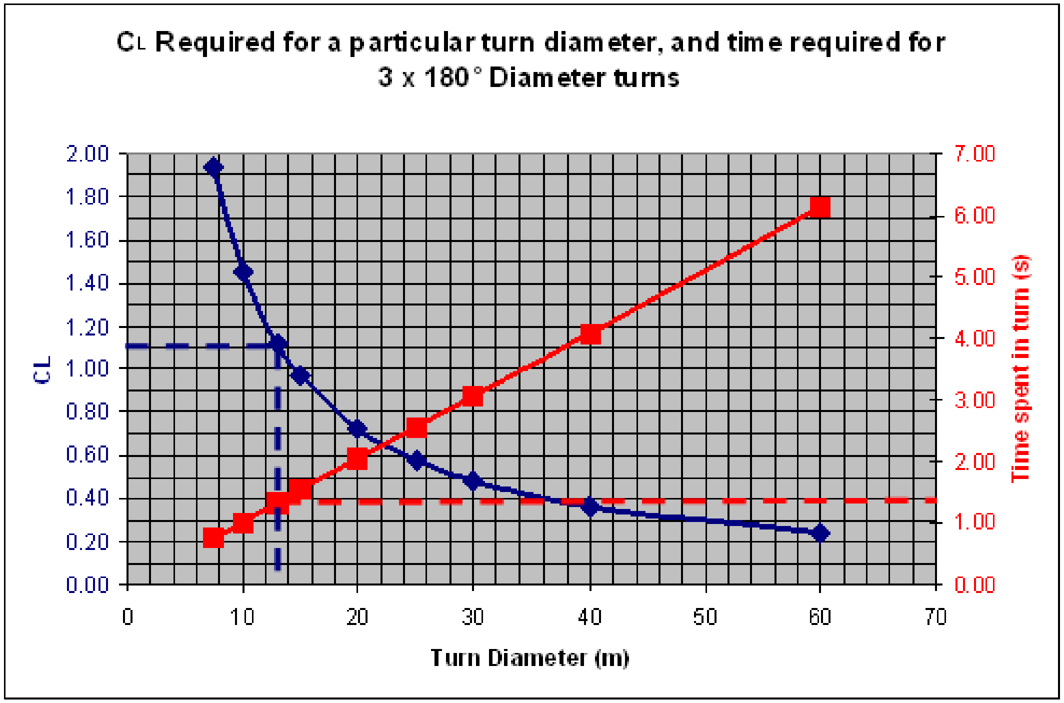
To appreciate the importance of high CL performance, consider the table below:

Turn Diameter (m)	Apparent Model weight (kg)	Wing Lift coefficient (CL)	Time spent in turns (s)
7.5	169.48	1.94	0.77
10	127.11	1.45	1.02
13	97.78	1.12	1.33
15	84.74	0.97	1.53
20	63.56	0.73	2.04
25	50.84	0.58	2.55
30	42.37	0.48	3.07
40	31.78	0.36	4.09

Notes: Assumes that turn is in the horizontal plane, Model speed 166 km/hr, weight 2750 g, wing area 65.7 dm². The apparent weight is related to the model mass, velocity and turn diameter using the centripetal acceleration formula $F = mv^2/r$. The CL required to support this mass can be calculated using the lift formula (see appendix). Time spent in the turn is a result of the distance traveled 3/2 x pi x D and estimated constant 166 km/hr airspeed.

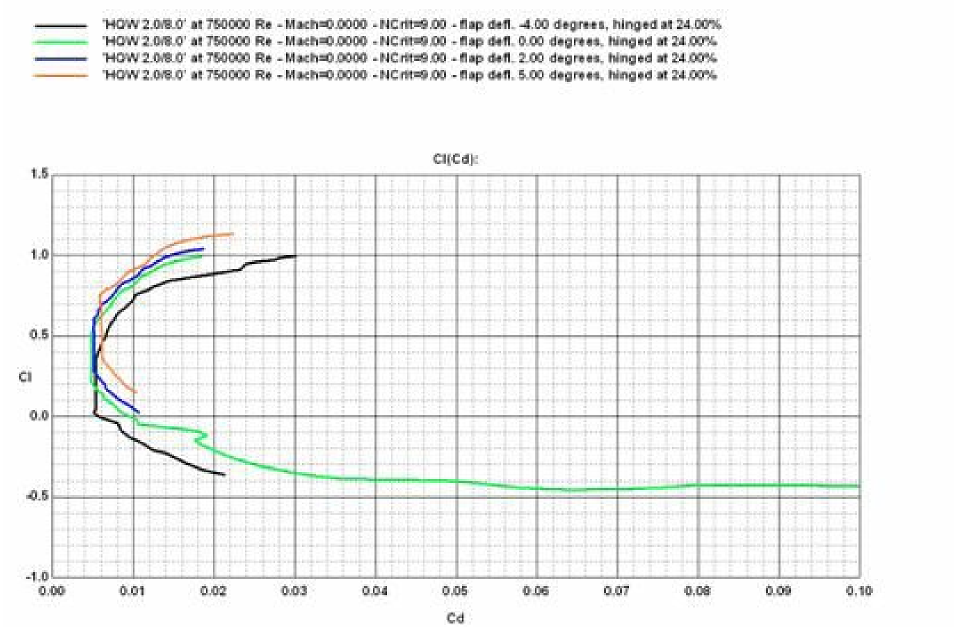
Tight turn diameter is important for fast times, for example, everything else equal, the difference between 15 m and 25 m diameter turns is about 1.3 seconds over the whole course! We need an airfoil that is able to give high CL.

We can plot the turn diameter versus the CL required:



The CL requirement of the airfoil rapidly increases at tighter turn diameters. There is a diminishing return for the time saved in the turn, especially when we put constraints on the maximum CL an airfoil can give. Fast airfoils have problems giving high lift at low drag - even flapped we could not expect much more than around CL = 1.1, indicating a best turn diameter at around 13 m, time for three turns is 1.3 seconds.

We haven't yet taken into account the drag the airfoil gives at these high CL values, and therefore slowing the glider in the turn, then exiting for the next lap at a lower speed. Intuitively, low drag at high CL is important as well.



Polar 2: HQW 2.0-8, Re 750,000, Flap at -4°, 0°, +2° and +5°

Looking now at the Profili polars:

Polar 2: HQW 2.0-8, Re 750,000, Flap at -4°, 0°, +2° and +5°

• +5° flap (orange curve) gives better performance between CL = 0.7 – 1.1 than the +2° Flap case (blue curve). This means less drag in turns at 13 - 20 m turn diameter for +5° flap.

• Between CL = 0.55 – 0.7, +2° flap is better (blue curve has lower drag). This translates to diameters of 20 – 26 m.

• Lowest drag from CL = 0.2 – 0.55 is from the 0° flap setting (green curve is better for diameters between 26 - >>70 m)

• Between CL = 0 – 0.2 black curve is lower drag, -4° is better. Flat level flight at high speed only!

In practice the turn is started by a pull of up elevator to increase CL. More elevator, the tighter the turn and the higher the CL. All of this implies that the movement of flap with the pull of up elevator stick should be geared correctly. I have not considered the tradeoff between turn diameter and speed loss (can anyone help with this?)

The best flap setting for turning is dependant on the CL range that we are requiring from the airfoil.

Summary for speed:

• Highest speed in the acceleration phase the airfoil should have a -4° flap setting to minimize drag at CL=0.

• Lower turn diameter lowers the time spent in the turn, but also exponentially increases the CL requirement.

• Using the correct flap setting for the turn diameter (shaded in yellow in the Table on the following page) will reduce the drag experienced during the turn.

As a result of drag, there is a trade-off between turn diameter and speed loss.

Turn Diameter (m)	Apparent Model weight (kg)	CL	Time spent in 3 turns (s)	Drag coefficient for profile (CD) Flap=0°	Drag coefficient for profile (CD) Flap=+2°	Drag coefficient for profile (CD) Flap=+5°
7.5	178	2.10	0.77	Stall	Stall	Stall
10	134	1.57	1.02	Stall	Stall	Stall
14	96	1.12	1.43	Stall	Stall	.0214
15	89	1.05	1.53	Stall	Stall	.0143
20	67	0.79	2.04	.0093	.0080	.0069
25	54	0.62	2.55	.0061	.0053	.0061
30	45	0.52	3.07	.0049	.0051	.0061
40	34	0.39	4.09	.0048	.0051	.0061

What flap setting to use for Distance?

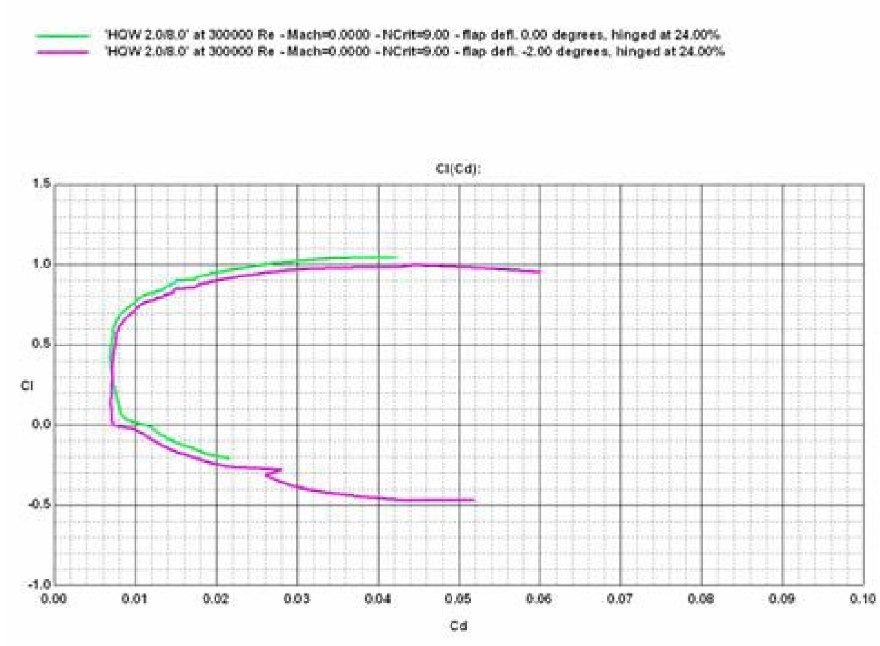
For distance, the model is flown on the same course as in speed, except that the glider must complete as many laps as possible in 4 minutes. In practice, the model is rarely flown at a constant speed within one flight, depending on the air, the number of laps can change radically. Assuming 2600 g weight:

• In good air at 30 lap constant pace, speed is around 75 km/hr and Reynolds number is 300,000, CL is around 0.15. In reality, a 30 lap distance run will have a number of legs where the speed will be much higher, where speed flap settings would be more appropriate.

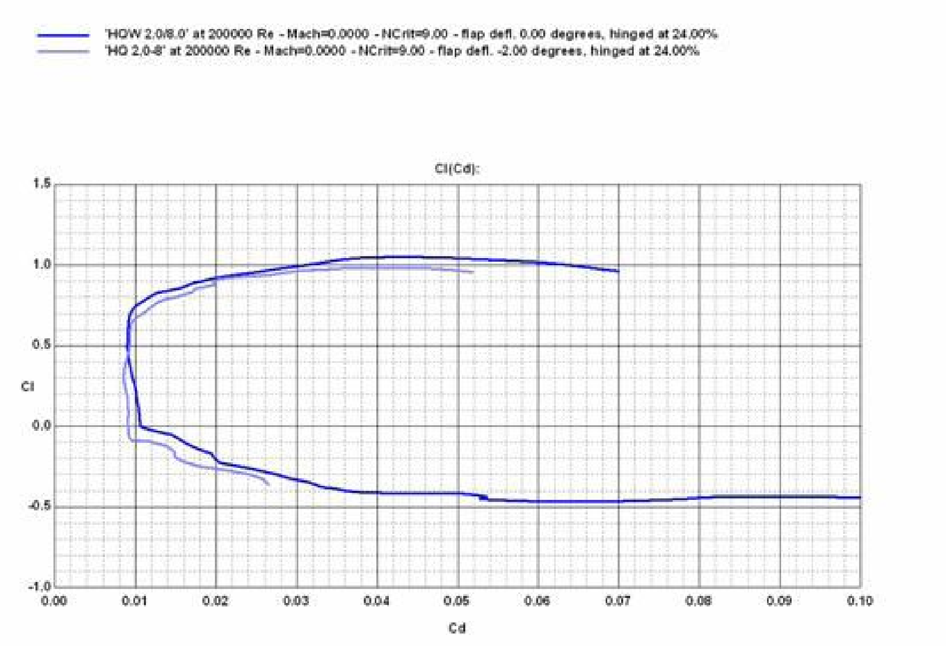
• For 20 laps, speed is around 52 km/hr, Reynolds number 210,000, CL is around 0.31

• In bad air say 13 laps, speed is around 35/ km per hour and Reynolds number around 140,000. CL is 0.67.

For flying the number of legs shown above at constant speed we are seeking the flap setting that gives minimum drag at around the range of CL = 0.15 – 0.67.



Polar 3: HQW 2.0-8, Re 300,000, Flap at -2, +0°



Polar 4: HQW 2.0-8, Re 200,000, Flap at -2, +0°

Looking again at Profili, here are the polars for 30, 20, and 13 lap paces:

Polar 3: HQW 2.0-8, Re 300,000, Flap at -2, +0°

- At 30 lap pace, CL = 0.15, the flap should be reflexed by 2° (pink curve)

At 20 lap pace the airfoil polar looks like this:

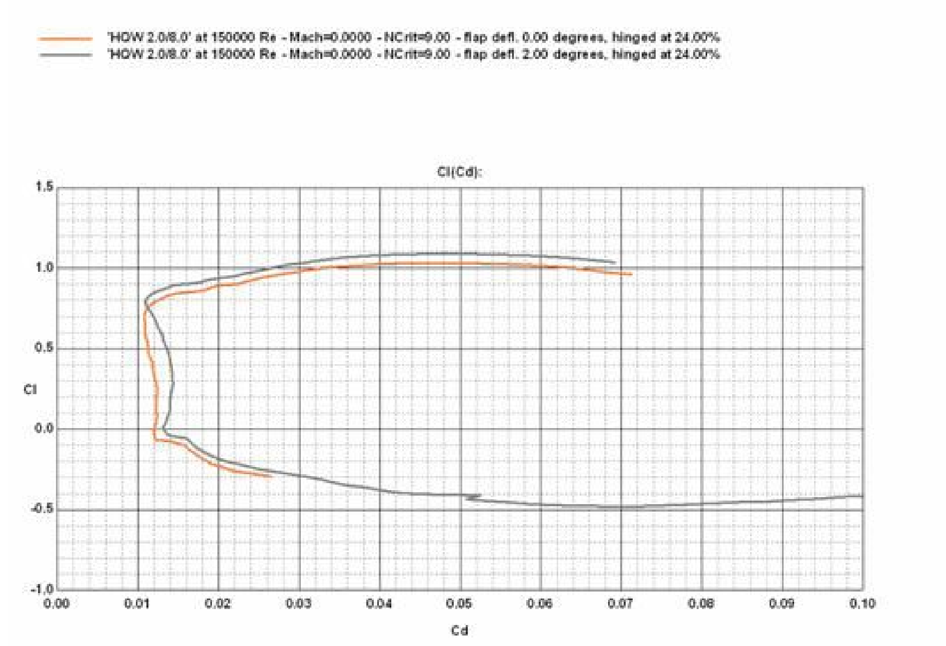
Polar 4: HQW 2.0-8, Re 200,000, Flap at -2, +0°

- At 20 lap pace, CL = 0.31, the -2° reflex is still better (light blue curve)

And now the polar for 13 laps:

Polar 5: HQW 2.0-8, Re 150,000, Flap at 0, +2°

- At 13 lap pace CL = 0.67, the unflapped airfoil provides the best performance (gold curve).



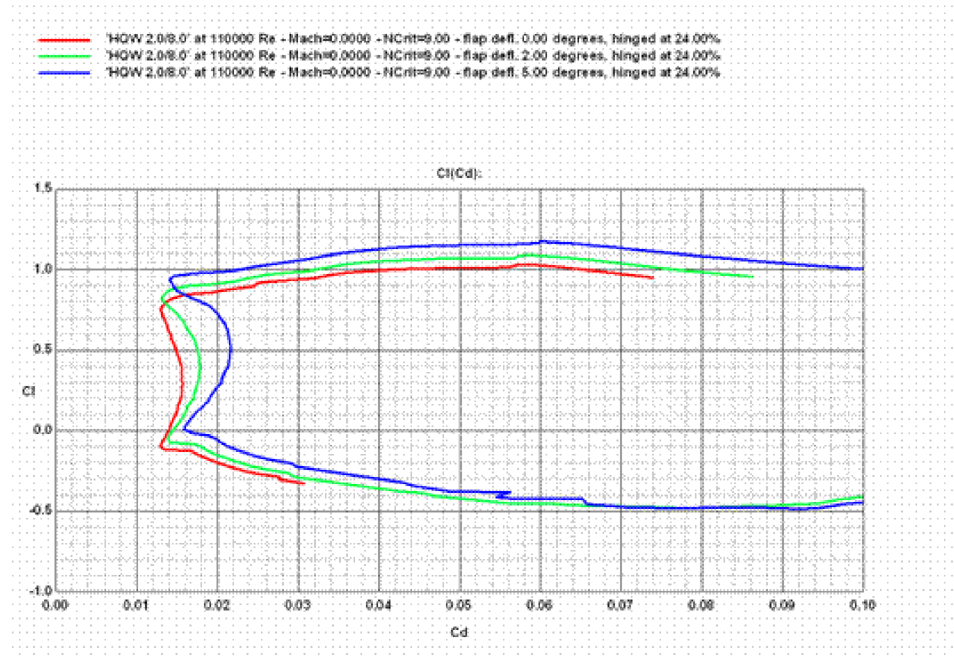
Polar 5: HQW 2.0-8, Re 150,000, Flap at 0, +2°

Summary for Distance:

• At 30 lap pace, and also at 20 lap pace, the -2° flap setting appears to offer the lowest drag. From the consideration of speed performance, more flap will be needed as the speed rises above 75 km/hr. For example, the best flap setting for 166 km/hr flight is -4°

• At 13 lap pace the uncambered section works best.

• From Polar 4, the changeover point between -2° and 0° flap is estimated to be at CL = 0.45, or 42 km/hr, equivalent to 16 laps in 4 minutes.



Polar 6: HQW 2.0-8, Re 110,000, Flap at 0, +2° and +5°

<u>What is the best setting for Thermal?</u>

For still air performance, we need low drag at high CL. The wing loading, and aspect ratio are important as well.

Thermal speeds are generally just above the stall speed, although with modern sections sometimes a little faster. Let's assume a speed of around 27 km/hr, so Reynolds number is around 110,000 at the mean wing chord. Weight is assumed to be 2200 g, so CL required is 0.92.

Applying Profili again:

Polar 6: HQW 2.0-8, Re 110,000, Flap at 0, +2° and +5°

• At 27 km/hr (CL=0.92) +5° flap appears optimum. The performance peak is quite sharp. We are very close to the stall !

• At CL = 0.80, (29 km/hr) Performance is best with +2° flap.

• The unflapped airfoil is the best option when CL values less than 0.75 are required (30 km/hr)

These are all very low speeds, any slower and the model stalls! The polar curve is very sharp at these high CL values, with the "sharpness" increasing as flap is deflected further. The speed difference between optimum flap settings is very close and therefore probably unusable to minimize sink rate as any small variation in speed either slower or faster will quickly increase the drag.

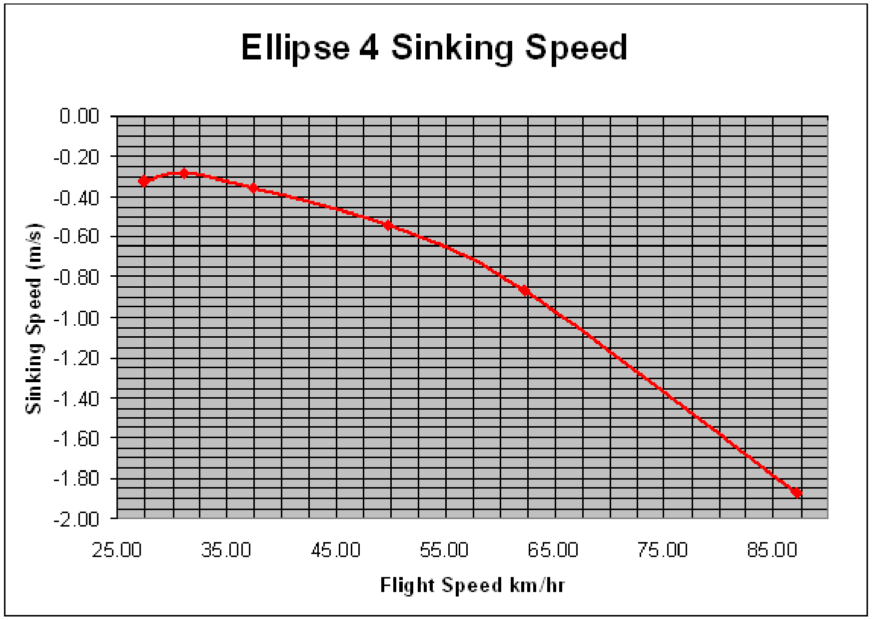
The best may well be to run 0° flap with elevator to flap coupling to maintain low drag during the thermal turn. This is speculation until we look at how the Ellipse 4 airframe interacts with the HQW2.0/8. We need to look at the aircraft polar. See excel spreadsheet - attachment 2. Simply put, flight speed relates to the Reynolds number. With flight speed and wing loading we can calculate the wing lift coefficient, CL. The profile drag coefficient of the airfoil for the required CL can be read off the Profili polar on the curve appropriate for the required Reynolds number. The induced drag coefficient is calculated based on the aspect ratio and CL. The parasitic drag coefficient was estimated to be a constant

0.005. These three drag coefficients are summed to give a total drag. If we divide the CL by the total drag we have the L/D ratio and can now calculate the sink speed.

For the analysis, I have also assumed that the optimum flap setting is used for the different flight speeds:

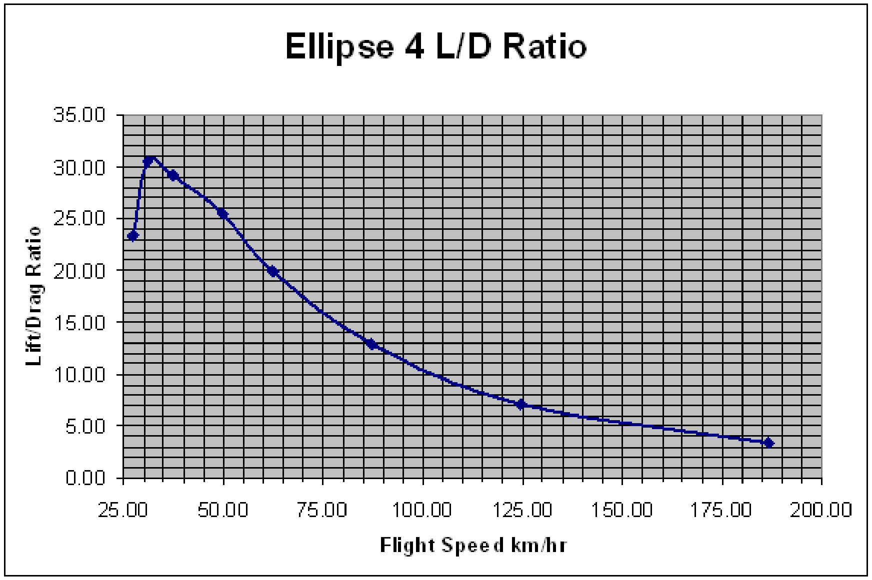
Flap Deflection	+2°	0°	0°	-2°	-2°	-2°	-3°	-4°
Km/hr	27.37	31.11	37.33	49.77	62.21	87.10	124.42	186.64
Reynolds No x103	110.00	125.00	150.00	200.00	250.00	350.00	500.00	750.00
CL	0.92	0.72	0.50	0.28	0.18	0.09	0.04	0.02
CDprofile	0.0209	0.0121	0.0113	0.0088	0.0078	0.0064	0.0058	0.0053
CDi	0.0182	0.0109	0.0053	0.0017	0.0007	0.0002	0.0000	0.0000
CDpara	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
CDtot	0.0396	0.0235	0.0171	0.0110	0.0090	0.0071	0.0063	0.0058
L/D	23.38	30.49	29.17	25.52	19.94	12.91	7.06	3.43
Sink Speed m/s	-0.33	-0.28	-0.36	-0.54	-0.87	-1.87	-4.90	-15.14

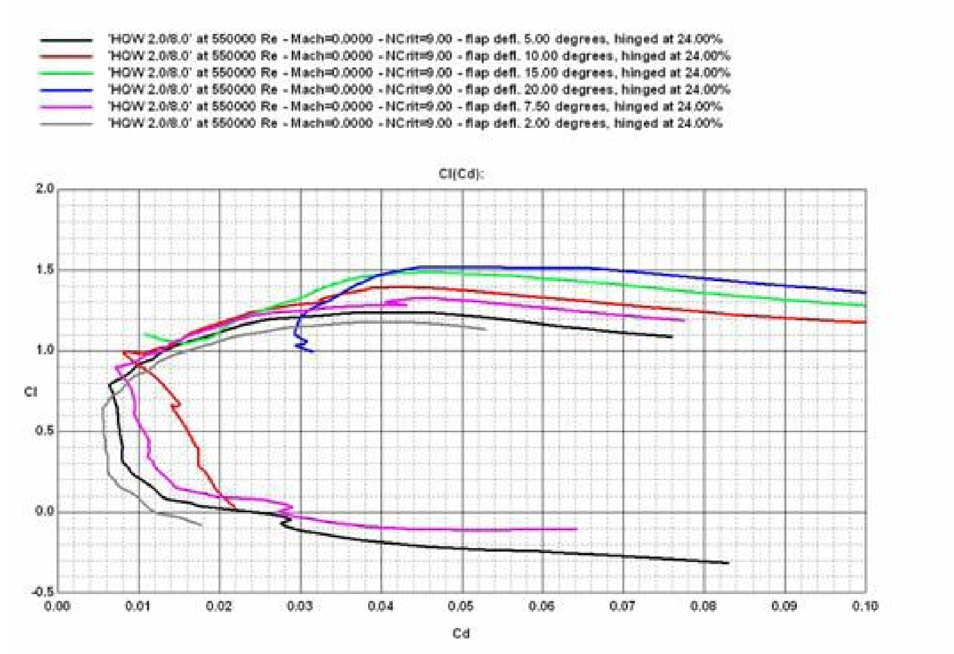
Notes: Model weight is assumed to be 2200 g, $CD_{profile}$ is chosen from the best performing flap deflection at the particular CL and Reynolds number. CDi is the induced drag. Cdpara is the parasitic drag(fuselage etc).



The aircraft sinking speed polar is shown above.

- The flight speed to attain optimum minimum sink is about 31 km/hr with the unflapped airfoil. Minimum sink rate is around 0.28 m/s, indicating that 10 minute still air duration is possible from a 220m launch.





Polar 8: HWQ 2.0-8, Re 120,000, Flap at +2, +5°, +7.5°, +10°, +15° and 20°

The aircraft polar for L/D is also shown above.

Summary for Thermal:

- Best flap setting appears to be 0° for flying at minimum sink.
- The best minimum sink speed is -0.28 m/s at 31 km/hr
- Still air times of 10 minutes are possible from an average 220 m launch.
- There may be some benefit in using elevator to flap coupling to maintain drag efficiency at higher CL values when turning.

<u>What is the best flap setting for launch?</u>

There are essentially two phases to launch – the climb on the line which requires very high CL to produce line tension and store elastic energy before phase two, the conversion of elastic energy into velocity and height (the "ping"). The latter stage requires the same performance parameters as speed, so to set your model up to ping well, have a look at the discussion on speed setup.

Here we will consider the climbing phase only. Assuming we fly in a 200m arc around the turnaround pulley and arrive above the turnaround pulley in 8 seconds, speed is around 135 km/hr (Reynolds number 550,000). The towline tension makes the model appear heavier, so the wings have to produce high CL to generate this tension. The higher the tension the better, providing the line retrieval is not too high.

Using Profili again:

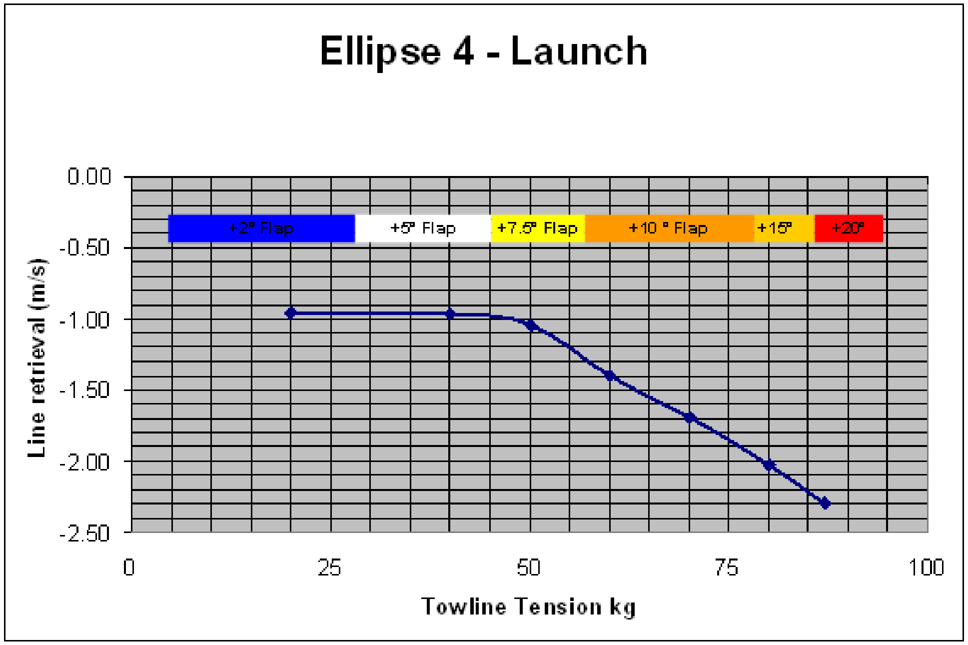
Polar 8: HWQ 2.0-8, Re 120,000, Flap at +2, +5°, +7.5°, +10°, +15° and 20°

- CLmax is around 1.5 for the +20° case, but there is a large drag increase to extract so much lift from the airfoil. There is probably a trade-off between towline tension and drag, ie between CL and CD.

To assess the tradeoff, Excel spreadsheet calculations similar to those used for the thermal analysis can be used to look at the model behavior on the launch - attachment 3. In the calculation, varying the towline tension is the same as increasing the model weight, and the sinking speed is analogous to the rate of winch line retrieval:

Towline tension (kg)	20	40	50	60	70	80	87
Flap Deflection	+2°	+5°	+7.5°	+10°	+10°	+15°	+20°
Flight Speed Km/hr	136.87	136.87	136.87	136.87	136.87	136.87	136.87
Reynolds No x103	550.00	550.00	550.00	550.00	550.00	550.00	550.00
Cl	0.37	0.71	0.88	1.05	1.21	1.38	1.50
Cd	0.01	0.0069	0.0073	0.0148	0.0224	0.0327	0.0424
Cdi	0.0030	0.0107	0.0164	0.0232	0.0313	0.0406	0.0478
Cdp	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Cdtot	0.0094	0.0181	0.0242	0.0385	0.0542	0.0738	0.0907
L/D	39.89	39.22	36.33	27.15	22.40	18.74	16.54
Line Retrieval (m/s)	-0.95	-0.97	-1.05	-1.40	-1.70	-2.03	-2.30

Notes: Model weight is assumed to be 2200 g, CD is chosen from the best performing flap deflection at the particular CL and Reynolds number. CDi is the induced drag. Cdp is the parasitic drag(fuselage etc)



The values for line retrieval can be plotted against the towline tension:

There is a good trade-off between line retrieval and tension below about 50kg tension but above 50kg tension, line retrieval increases.

• There is little point in trying to go for tension above 50 kg or +7.5° flap deflection during the climbing phase.

There may be some benefit to using a heavier flap setting at the very start of the launch as the high drag ensures that the model does not “over-fly” the line, however this aspect has not been included in the analysis.

Summary for Launch:

• Use a maximum of +7.5° flap for launch

• Use speed mode for the ping.

Conclusions

The theoretical analysis has identified the best flap settings for the various F3b flight modes for the Ellipse 4, and gives a guide on how the real glider may behave with different flap applications. The actual numerical prediction of performance eg minimum sink time, best L/D etc. may not be entirely accurate when compared to the real world, however the insight that this analysis provides on flap setting should prove correct.

The intention is that this analysis provides a starting point for setting up the model.

The HQW 2.0-8 is a variable camber airfoil (W in HQW is for Wolbklappe – German for flap). This analysis shows the importance of using the correct camber for each of the flight tasks. The flap deflections serve to broaden the low drag bucket of the polar. This can be shown with a plot of the glider L/D ratio with curves for the best flap setting for each flight speed versus the unflapped state or +2° flap. The coloured bar at the top of the graph shows the recommended flap setting for various speed ranges:

• The best L/D ratios are achieved by flying the model at 42 km/hr or higher using -2° flap. Larger negative flap settings are useful for high speed.

• To turn tight diameter turns in speed, elevator to flap mix (snap flap) depressing the flaps up to +5° may be beneficial.

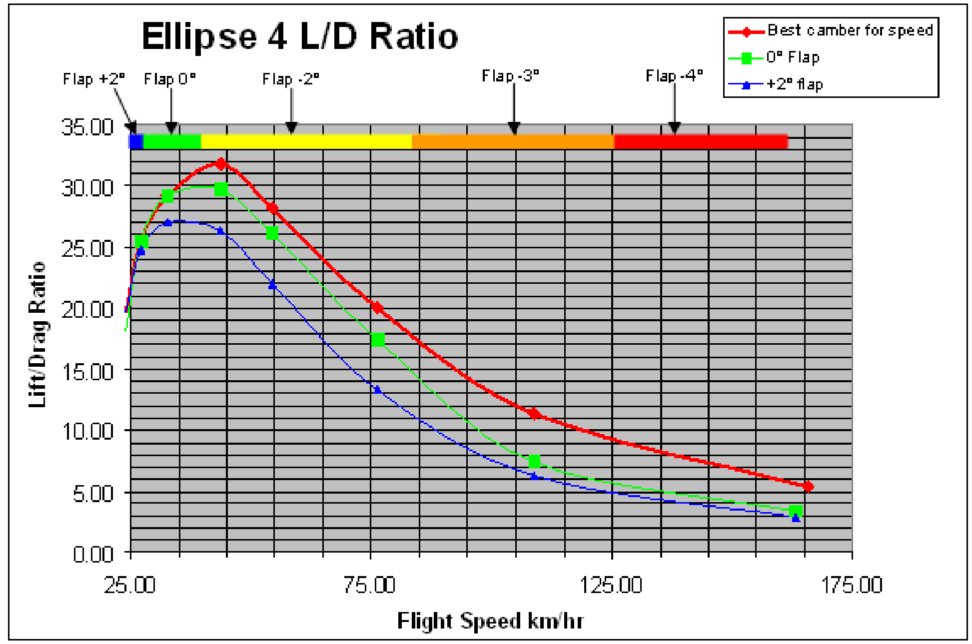
• The minimum sinking speed performance of the model can be summarized in the following plot:

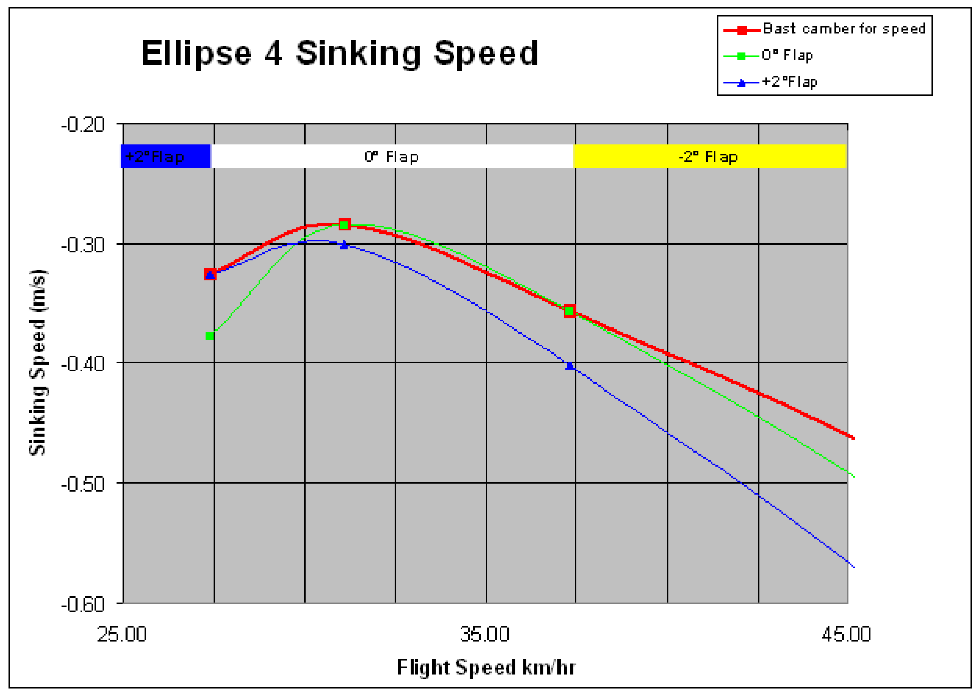
- For thermal, trim the model to fly at around 31 km/hr with 0° flap.

- To move smartly between thermals -2° flap is recommended.

• Positive flap is only recommended for turning in tight lift or as snap flap.

• For launch, +7.5° flap is recommended



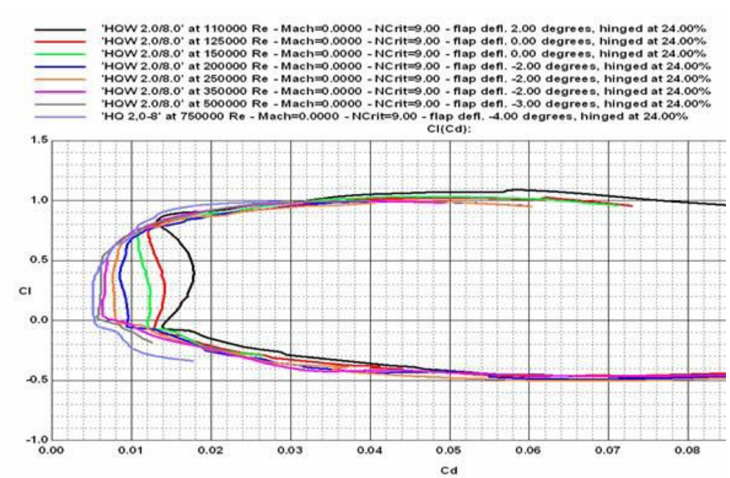


Weight	2.9 kg					
mass (m)	0.32 N					
speed s=	166 km/hr =	46.11 m/s				
area A=	64 dm² =	6.89ft²				
Turn Diameter D (m)	weight (kg) w = mv²/D/2	weight lb Wlb=w/2.2	speed ft/s S=3.2808 x s	apparent loading (lb/ft2) L=Wlb/A	Cl = L / (S/29)²	time in turn (x3) = 3 x pi x D/2/s
7.5	178.73	393.20	151.28	57.08	2.10	0.77
10	134.05	294.90	151.28	42.81	1.57	1.02
15	89.36	196.60	151.28	28.54	1.05	1.53
20	67.02	147.45	151.28	21.40	0.79	2.04
25	53.62	117.96	151.28	17.12	0.63	2.55
30	44.68	98.30	151.28	14.27	0.52	3.07
40	33.51	73.72	151.28	10.70	0.39	4.09

LEFT: Excel spreadsheet to calculate CL, turn diameters and times in turn

RIGHT: Excel spreadsheet to calculate CL, Reynolds number, L/D ratio and sink speed. Example for unballasted, flapped HQW2.0-8

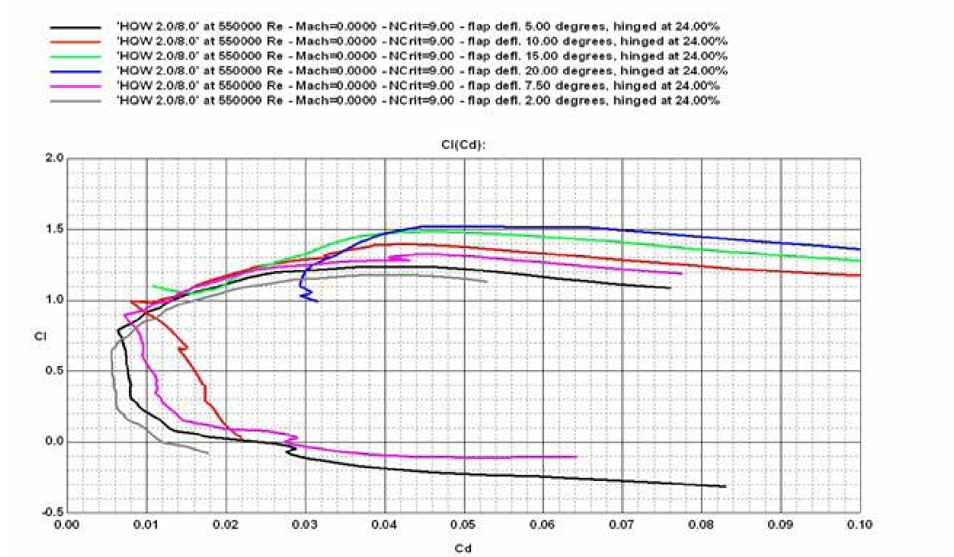
BELOW: Profili polars at the Reynolds numbers listed in the spreadsheet right, used to determine CD.



Ellipse 4								
	metric unit			Imperial unit				
SPAN	3150.00 mm			10.33 ft				
AREA	65.70 dm2			7.07 ft2				
MAC	210.00 mm			0.69 ft				
Aspect Ratio	15.00			15.00				
Mass	2200.00 g			4.84 lb				
Wing Loading	33.49 g/dm2			0.68 lb/ft2				
Flap Deflection	+2°	0°	0°	-2°	-2°	-2°	-3°	-4°
Speed (ft/s)	24.95	28.35	34.02	45.36	56.70	79.38	113.39	170.09
Km/hr	27.37	31.11	37.33	49.77	62.21	87.10	124.42	186.64
Reynolds No	110.00	125.00	150.00	200.00	250.00	350.00	500.00	750.00
Cl	0.92	0.72	0.50	0.28	0.18	0.09	0.04	0.02
Cd profile	0.0209	0.0121	0.0113	0.0088	0.0078	0.0064	0.0058	0.0053
Cdi	0.0182	0.0109	0.0053	0.0017	0.0007	0.0002	0.0000	0.0000
Cd para	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Cdtot	0.0396	0.0235	0.0171	0.0110	0.0090	0.0071	0.0063	0.0058
L/D	23.38	30.49	29.17	25.52	19.94	12.91	7.06	3.43
Sink (ft/s)	-1.07	-0.93	-1.17	-1.78	-2.84	-6.15	-16.07	-49.66
m/s	-0.33	-0.28	-0.36	-0.54	-0.87	-1.87	-4.90	-15.14
220 m time (of 10 min)	0.87	1.00	0.80	0.52	0.33	0.15	0.06	0.02
power factor	22.5	25.8	20.6	13.5	8.4	3.9	1.5	0.5
1/PF	0.04	0.04	0.05	0.07	0.12	0.26	0.67	2.07
sink by PF method	0.33	0.28	0.36	0.54	0.87	1.88	4.90	15.16

RIGHT: Winch line retrieval for various towline tensions. Optimum flap setting used for each value of tension.

BELOW: Profili polars at the Reynolds number and flap deflections listed in the spreadsheet right, used to determine CL.



Ellipse 4 Launch							
	metric unit			Imperial unit			
SPAN	3150.00 mm			10.33 ft			
AREA	65.70 dm2			7.07 ft2			
MAC	210.00 mm			0.69 ft			
Aspect Ratio	15.00			15.00			
Mass	2200.00 g			4.84 lb			
Wing Loading	33.49 g/dm2			0.68 lb/ft2			
Towline tension (kg)	20	40	50	60	70	80	87
"wing loading"	6.91	13.13	16.24	19.35	22.46	25.57	27.75
Flap Deflection	+2°	+5°	+7.5°	+10°	+10°	+15°	+20°
Speed (ft/s)	124.73	124.73	124.73	124.73	124.73	124.73	124.73
Flight Speed Km/hr	136.87	136.87	136.87	136.87	136.87	136.87	136.87
Reynolds No	550.00	550.00	550.00	550.00	550.00	550.00	550.00
Cl	0.37	0.71	0.88	1.05	1.21	1.38	1.50
Cd	0.01	0.0069	0.0073	0.0148	0.0224	0.0327	0.0424
Cdi	0.0030	0.0107	0.0164	0.0232	0.0313	0.0406	0.0478
Cdp	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Cdtot	0.0094	0.0181	0.0242	0.0385	0.0542	0.0738	0.0907
L/D	39.89	39.22	36.33	27.15	22.40	18.74	16.54
Sink (ft/s)	-3.13	-3.18	-3.43	-4.59	-5.57	-6.66	-7.54
m/s	-0.95	-0.97	-1.05	-1.40	-1.70	-2.03	-2.30
Line Retrieval (m/s)	-0.95	-0.97	-1.05	-1.40	-1.70	-2.03	-2.30
power factor	24.4	33.0	34.0	27.8	24.7	22.0	20.3

RC Soaring Digest thanks John Skinner and the League of Silent Flight Australia < http://www.lsfaustralia.org.au> for giving permission to reprint this article in its entirety.

Those wishing to see the article in its original format can visit < http://www.lsfaustralia.org.au/articles/ellipseanalysis/ellipse4.html>.

RC Soaring Digest... Who cares?

The Montreal Area Thermal Soarers do! <http://www.matsclub.org/>

And to prove it, we took up a collection at our recent Annual General Meeting to be able to make a donation to the Kuhlmans at B2Streamlines to show our appreciation... ...and we challenge all RC Soaring clubs to do the same!

Here's how we did it... <http://www.mgertech.com/RCSD.pdf>

We very much enjoyed the Genie and Encore build articles this past year! It's the kind of information that cannot be had anywhere at any price. Keep up the good work! It is very much appreciated by everyone up here !!!!

Mark Gervais, on behalf of all the members of the Montreal Area Thermal Soarers

MONTREAL AREA THERMAL SOARERS

DO YOU ENJOY READING RCSD?

SO DO WE!!!

- **That's why MATS decided to take up a collection for RCSD at our AGM December 10th.**
- **Our donation has been forwarded to B2 STREAMLINES. Has yours?**
- **We're not big, but we challenge all RC SOARING clubs to join us in doing our part to keep the RCSD 'ON THE NEWSTAND' !!!**