R/C
Radio controlled
Soaring Digest
THE JOURNAL FOR R/C SOARING ENTHUSIASTS

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ABOUT *RCSD*

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

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The Soaring Site

Scale Request

We received the following request for information, this month:

"I am interested in building an up-and-go (retractable motor) electric powered scale sailplane, probably 3 to 4 meters. I would prefer a kit, but would build from plans if necessary. I've seen some German a.r.f.'s at Elmira, but the smaller ones, about 3 meters, seem to be rather heavy for scale-like flight characteristics, and are costly.

"Maybe someone out there has info. on a source for a kit or plans. I would appreciate any help with this inquiry, and will reimburse any postage required.

"Awaiting my next project in Pennsylvania."

(signed) Edmund E. Elsner
30 Crestland Terrace
Doylestown, PA 18901
(215) 345-9037

For any of you that have thoughts or suggestions regarding Edmund's request, either contact him direct or e-mail to us at <RCSDigest@aol.com>.

Happy Flying!
Judy Slates

SLOPE SCENE

Greg Smith and his 2-1/2 year old daughter, Sydney, watch Dad's SH-50 make a close pass at Big Bay Park, Whitefish Bay, Wisconsin. Syd is a regular at the slope and loves to watch the planes.

Photo by Tracy Brown.

Tony Elliott with his ASH-25. Note the nice landing area. No rocks! No trees!

Jer's Workbench

Jerry Slates
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Los Banos 9th Annual Scale Fly-In

Several years ago, Los Banos was a place where I spent a great many hours slope flying while standing on the cliff edges which surround the Los Banos Reservoir. When we moved away, I knew just how much I missed being able to slope fly. Having returned to California 10 years later, I was looking forward to doing some serious slope flying, again.

Shortly after moving back, I noted that the South Bay Soaring Society, based out of Sunnyvale, California, was hosting its 9th Annual Scale Fly-In which would be held at Los Banos Reservoir, about 1-1/2 hours drive south of San Francisco Bay just off State Highway 5 and 152. Lynsel Miller was the contest director.

If you like scale sailplanes and slope flying, then Los Banos is likely the place for you. If you've never tried any slope flying and you haven't the heart (It can be extremely intimating, believe me!) to throw a scale model off a cliff, you can still give Los Banos a try, as there are winches and aero-towing planes available.

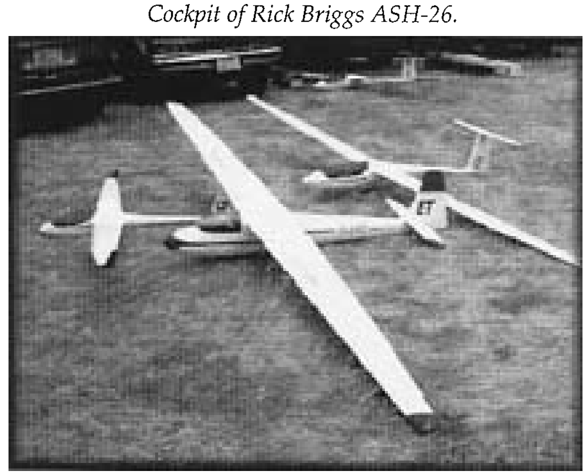
This yearly event attracted 46 registered flyers, most of which brought several models apiece. That equates to somewhere around several hundred scale gliders in the pit area! Yup, there were quite a few models to see from Vintage types to Modern Day types. Sizes included 1/6th and 1/5th scale, as well as the usual 1/4th and 1/3rd scale.

There was one model that caught my eye: Tony Elliott's 1/3, scratch built "ETA", 10.3 meter wing span. It was really big and truly beautiful. Unfortunately, the pictures did not come out, so I can't share it with you. (Sorry, Tony. I'll try to catch you another time and give the camera a go, again!)

For those of you that have any interest in Los Banos, and you have as yet to make the trek, I encourage you to give it a try, at least just once. It is, indeed, one of the best places I know of to slope fly. And, if you look carefully at the photos (the ones that did come out reasonable well), the slopes are free of obstacles such as trees and rocks. The same is true of the landing areas, which makes for a perfect location for a fly-in.

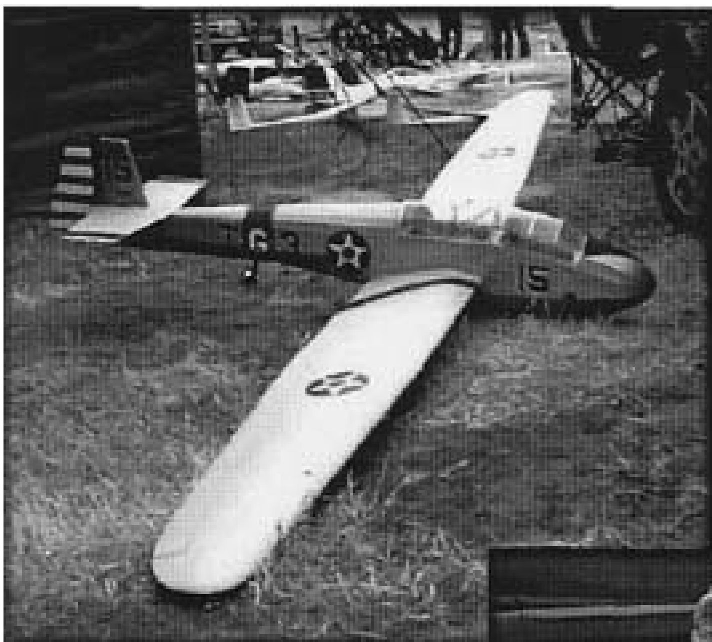
While walking around, focused on all the beautiful models, and chatting with old friends, I overheard many positive comments about the event.

Cockpit of Rick Briggs ASH-26.



K-6 belonging to Chris Pratt.

Stan Sadorf flies a Salto. Note the clean slopes.



Lynsel Miller, CD, and his beautiful TG-3.

Those who flew were having a good time. Some folks that didn't fly were overheard to say, "I could get hooked on this!"

If you haven't already done so, mark your calendar now for next year's 10th Annual Los Banos Scale Fly-In event!

See ya there! ■

SCHEDULE OF SPECIAL EVENTS

June 7-9, 2002
Montague Cross Country Challenge - 5th Annual — Montague, CA
Dean Gradwell, (541) 899-8215
dean@xcsoaring.com

June 21-23, 2002
Mid-South Soaring Championships — Atlanta, GA
www.atlantasoaring.org
Tim Foster, (770) 446-5938

June 22-23, 2002
Spring Fling — Davis, CA
Jim Thompson, (530) 662-7268

July 27-Aug. 3, 2002
LSF Soaring NATS — Muncie, IN

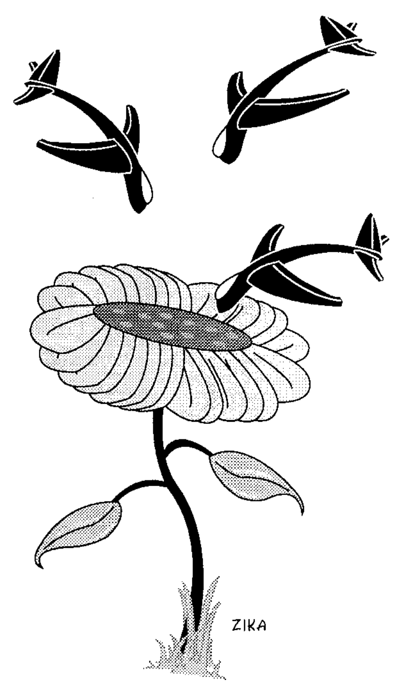
Aug. 31-Sept. 2, 2002
SOAR UTAH — Salt Lake City, UT
www.silentflyer.org

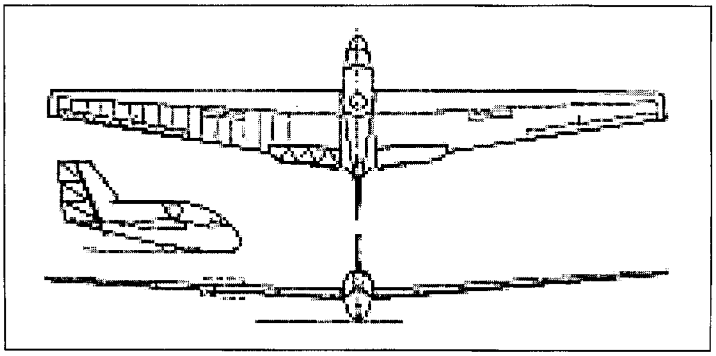
September 13-15, 2002
Last Fling of Summer — Broken Arrow, OK
Dave Register, (918) 335-2918
regdave@aol.com

September 14-15, 2002
Pacific Northwest HL Glider Contest — Redmond, WA
Adam (Red) Weston, (206) 766-9804
red@tgworks.com
http://www.reddata.com/sass

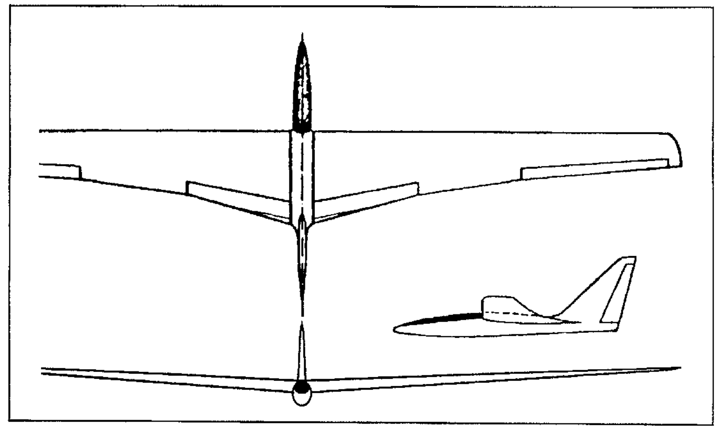
February 1-2, 2003
Southwest Classic — Phoenix, AZ

Please send in your scheduled 2002 events as they become available!





Jim Marske's Pioneer II-D. An example of a full size plank with taper and an enlarged wing root chord which allows the elevator to be placed more rearward. Note also the swept back vertical fin and rudder which gives a slightly longer arm. Span is 13 meters.



Dieter Paff's PN9f. This is an RC model based on a preliminary design for a full size sailplane. The wing span is just over three meters.

on the Wing

B²

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Plank vs. Swept

We are often asked to comment on the relationships between planform and performance potential. Our response nearly always focuses on the task (thermal duration, casual slope flying, dynamic soaring, etc.) and the design and building abilities of the person making the inquiry. Because of the positive and negative aspects of plank and swept wing aerodynamics, structure, and construction methodologies, that response can become quite involved.

We've made a list of the advantages and disadvantages of the plank and swept wing configurations and created a Table which outlines the major points involved. This month's column is devoted to expanding on the listed items.

The plank planform impresses would-be designers with its simplicity. Because there is no sweep, the wing can be built using standard construction methods. A spar which is strong in bending supports the wing. Torsional loads, which are quite small, can be carried by the spar, but are better handled with a D-tube structure at the leading edge or through a thin skin which covers the entire wing. The plank wing, if properly designed, requires no twist.

The swept wing, on the other hand, impresses would-be designers with its grace in the air. The internal structure of the swept wing must take into account both a longer effective span and substantial torsional loads. The supporting spar must be strong enough to minimize wing bending under load. (Bending a swept wing in the spanwise direction changes the incidence angle of the wing tip.) Because of weight considerations, the torsional loads are better handled with an engineered skin, usually fiberglass or carbon fiber with the grain running at 45 degrees to the spar rather than a torsionally rigid spar.

The swept wing structure is also complicated by use of winglets. While winglets can improve performance by contouring the air flow near the wing tips, numerous studies have shown the performance improvement falls off dramatically as flight parameters move away from the design point. While there may be some advantages to using winglets rather than a single vertical fin on a thermal duration machine, the spar must accommodate the winglet junction and the various aerodynamic loads the winglet creates as the aircraft moves through various flight regimes.

Planks with taper and small amounts of forward sweep (as typified by a straight leading edge from tip to tip) may be harmed by winglets. Use of winglets or Cessna-type downturned wing tips prevents the outer portion of the wing from stalling with the rest of the wing, and their generated lift is far enough forward to generate a nose up moment. This is quite dangerous and makes recovery from a stall more difficult. If properly set up, a plank of this type should be very nearly stall proof, even with full up elevator. This is because pitch authority decreases as the turbulent flow off the wing blankets the elevator.

From an aerodynamic standpoint, the plank once again offers simplicity. Airfoil design is not complicated, but poses some challenges due to the positive pitching moment required for stability in pitch. The positive pitching moment is almost entirely controlled by the trailing edge angle, mandating some sort of reflex in the mean camber line. While early reflexed sections had relatively large positive pitching moments, the trend toward values closer to zero is now several decades old. Reducing the reflex lowers drag and increases the maximum coefficient of lift. Because the wing is not swept, the air flow tends to remain parallel to the aircraft centerline.

Swept wings obtain their stability through aerodynamic wing twist. Depending on the airfoil(s) used, some amount of geometric twist may be required. As can be easily imagined, twisting the wing is a necessary evil — it's needed for pitch stability, but increases drag during most flight regimes.

Aerodynamic twist is related directly to some design coefficient of lift. As an example, if the wing twist is set up to provide the stability and coefficient of lift required for thermal flight, high

	Plank	Swept
+	• no twist • basic structure • aileron differential possible • airflow remains parallel to centerline • conventional control system • flaps possible, but see below	• airfoil design has few constraints • substantial elevator arm • winglets improve tip flow • fuselage behind wing leading edge • flaps possible, but see below • can take advantage of "induced thrust"
neutral	• low inertia in pitch	• higher inertia in pitch
–	• airfoil design limited by C_m • increased drag due to reflex • elevator arm relatively short • elevator deflection works against C_L • flap effects are limited • fuselage forward of wing leading edge • winglets may harm stall characteristics	• required twist increases drag • complicated structure • aileron differential affects pitch • cross-span airflow • winglets work best at one speed • non-conventional control system • flaps difficult to size and position

speed flight will suffer. Large amounts of down elevator will be required to overcome the effects of the built in washout. This cannot in any way be considered to be aerodynamically "clean." Drag thus tends to be minimal around some single predetermined design point.

Airfoil design for swept wings is challenging as well. While the pitching moment constraint is removed, an airfoil for use on a swept wing must be able to handle some amount of cross-span flow. Airfoils designed using two dimensional flow often fail to meet expectations once sweep is applied. The three-dimensional flow induced by sweep is very much different than the two-dimensional flow which is assumed by the designer and the computer software used.

Swept wings may also be able to take advantage of "induced thrust." Briefly stated, sweep tends to increase the effective angle of attack of outer portions of the wing. To maintain a constant effective angle of attack across the span, some amount of washout is needed. The lift vector can actually be rotated forward in relation to the flight path by this washout and produce some amount of thrust.

But flight is more than simply going forward in a straight line. We want to make sure we can control the aircraft in all three axes — pitch, roll, and yaw — so that we can take off, travel from one area of lift to another, core any thermals we run into, and land safely.

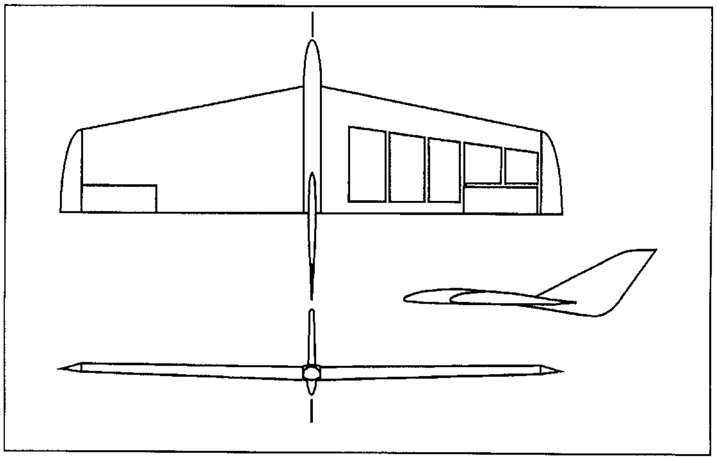
In a conventional tailed aircraft, pitch is handled by the elevator which is mounted on a long arm (the fuselage) well behind the CG. A similar arm is easily applied to a swept wing design by making sure the sweep is sufficient to place the elevator some distance behind the CG. The plank planform is somewhat more limited when it comes to achieving an adequate elevator arm.

There are two generalized means of obtaining the required arm within the plank planform: If the planform is of relatively low aspect ratio, obtaining the arm is not too difficult. The elevators may be placed outboard where they can influence the effective angle of attack of the outer portion of the wing. With the elevators deflected upward, the wing has some amount of effective washout, inhibiting tip stall. Dave Jones' Blackbird 2M serves as an example of this design methodology. As the planform tends to higher aspect ratios, this simple trailing edge placement becomes less effective. The usual way of handling this difficulty is to enlarge the local chord near the wing root so the elevator can be moved inboard and thus further aft.

It should be noted that elevator deflection on a plank planform always works against the desired coefficient of lift. That is, as the elevator is deflected upward to force the wing to a greater angle of attack, it produces a downforce which to some extent counteracts the generated lift. Similarly, it acts as a flap and produces an increase in lift as it is deflected downward to force the wing to a lower angle of attack.

Aileron function is a bit more problematic for swept wing aircraft than for planks, but there are also some tantalizing possibilities. Adverse yaw is the major problem involved in use of ailerons. In conventional aircraft, adverse yaw is compensated for by aileron differential — the aileron moves further upward than downward — and judicious use of rudder. This is not possible on the swept wing because of the aft location of the aileron on the wing. The upward moving aileron, with greater deflection, will always tend to pitch the aircraft upward. There are some rather complicated ways of overcoming this tendency, but these involve either some sort of auxiliary control surface actuated through a mixing function or a special twist and lift distributions.

For a plank with a high aspect ratio tapered planform and a central elevator acting through a large local chord, like the PN9f or Pioneer II, the outboard ailerons are so close to the CG that any differential has no effect on pitch at all. Some method of inhibiting adverse yaw, such as Frise-type control surfaces, may be necessary on a plank with a lower aspect ratio.



Dave Jones' Blackbird 2M. The Blackbird 2M is a low aspect ratio plank which uses elevons only. The outboard elevons put effective washout in the wing tips during thermalling. Flaps hinged at 40% chord have been used successfully on this model.

A single central vertical fin and rudder can be used quite effectively on a plank planform. Proper contouring of the wing-fuselage junction will normally provide a protrusion behind the wing on which this flying surface can be mounted. If there is no fuselage at all, a lightweight boom can be used. It's important to get a sufficient arm for the fin and rudder to work through. Sweeping the surface rearward can be used to move the aerodynamic center of the flight surface further aft, but it should be noted that a swept hinge line will affect the aircraft in pitch. Some amount of downward lift will be generated each time the rudder is deflected. A swept back vertical fin alone can be used very effectively on designs which do not require a rudder. The statements above hold true for swept wings as well.

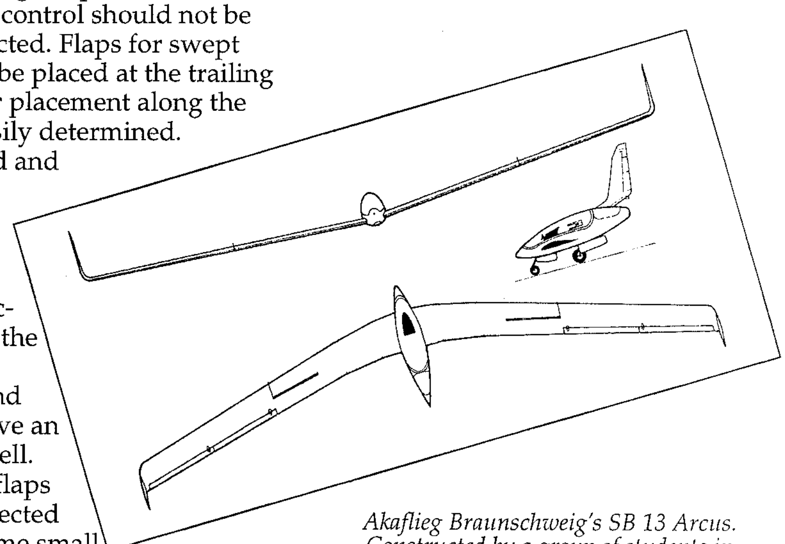
Flaps are always an interesting proposition on tailless aircraft. Conventional tailed aircraft can readily handle all sorts of flap deflection. That's because the elevator is mounted on a generous arm, and as long as it's out of the wing wake, it has a lot of control over the aircraft pitch angle and hence the wing angle of attack. Tailless aircraft, whether swept wing or plank, have a shorter elevator arm. This limits the amount of control over pitch that the elevator has, but control problems usually do not arise because of the inherent low moment of inertia. As flaps are deflected, however, large moments can be generated which cannot be acceptably controlled. It's important to formulate the flap size, shape and placement such that deflection does not produce adverse pitching moments.

For a plank, flaps of about five percent of the total wing area can usually be mounted such that their hinge is at 40% of the local chord. Such a placement minimizes any pitching tendency as the flaps are deflected. Deflection angles of 45 degrees are sufficient. It should be noted that flaps of this type are not to be used to improve thermal performance, as the increased lift is far outweighed by the tremendous amounts of drag produced. Such flaps can, however, be used to increase the height achieved on a winch launch and to effectively control the glide path during landing approaches.

Flaps on swept wings can be used as a means of glide path control and to improve both thermal and high speed performance. Again, placement is an issue, as pitch control should not be adversely affected. Flaps for swept wings should be placed at the trailing edge, but their placement along the span is not easily determined. Too far inward and the wing will tend to pitch upward. Too far outboard and flap deflection will force the nose down. Overall size and local chord have an influence as well. Ideally, inner flaps should be deflected downward some small amount while thermalling. The outboard elevons should also be deflected downward to compensate, thus increasing the generated lift across the entire span. If the root section has a negative (nose down) pitching moment, deflecting the flaps upward by a very few degrees will remove the camber at the rear of the wing, reducing the local coefficient of lift and increasing the flight speed.

Inertia in pitch is the one characteristic which we have difficulties evaluating. Our thoughts at this time are that inertia in pitch is one of those "eye of the beholder" items. Pilots used to flying conventional tailed aircraft, which have a large amount of inertia in pitch, are initially uncomfortable with the relative lack of inertia demonstrated by well designed planks and some swept wing planforms. For full size aircraft, like Jim Marske's Pioneer II and Monarch, lack of inertia in pitch gives a more comfortable ride in turbulence. The aircraft reacts quickly to differences in angle of attack and tends to fly through turbulence by aligning itself with the movement of the local air mass. Tailed aircraft in similar situations tend to bounce up and down. Swept wings tend to react in a way which is somewhere between the two.

Some of those who contemplate flying a plank are quite concerned about the lack of overall length and are worried that they will not be able to see the changes in pitch which allow them to monitor the performance of their tailed aircraft. After a few flights with a plank, however, they don't miss that piece of feedback at all. It becomes



Akaflieg Braunschweig's SB 13 Arcus. Constructed by a group of students in Germany, the Arcus follows the Standard Class rules — 15 meter span, no flaps. Air brakes are used for glide path control. Note there are two elevon surfaces per side. The spars meet at the fuselage center perpendicular to the centerline, then curve back roughly following the wing sweep and continuing up the winglet. The spars are monolithic structures of carbon fiber. This airplane was a real handful to fly until wing fences were installed.

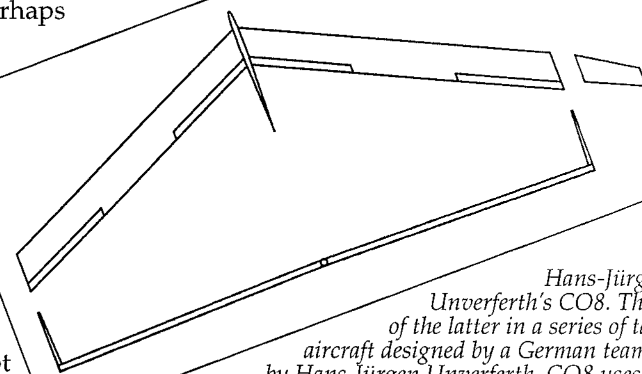
"normal" to let the aircraft seek its own attitude and to control its speed using elevator stick position rather than reacting to perceived fuselage alignment. The same flying method becomes second nature when steering a swept wing around the sky.

From all of the above, it appears a plank would be the choice of the designer looking for an airframe which can be relatively easily formulated and constructed without resorting to composites. Plank performance can be exceptional, particularly within thermal duration tasks, and control systems are essentially similar to those of conventional tailed aircraft.

A swept wing, while it does pose several unique problems so far as design and construction, certainly has the potential for greater performance in all flight regimes. Although control systems for swept wings can be quite complicated, with numerous control surface mixes being the norm, it is possible to tailor the lift distribution across the entire span, greatly increasing efficiency while maneuvering. Additionally, the effective dihedral of swept wings varies in direct proportion to the coefficient of lift, making them very stable in thermals.

In the end, it would seem that the designer who is performance driven may be more willing to expend large amounts of design time for the potential significant performance improvements available from a swept wing. The question as to whether that time and effort is worthwhile, however, is never known until the aircraft is flown.

While we most likely haven't solved any problems, or defined the specific direction a designer should take in producing an airframe, we hope this treatise has provided some useful information and perhaps initiated some new lines of thought within the minds of readers.



Hans-Jürgen Unverferth's CO8. This is one of the latter in a series of tailless aircraft designed by a German team headed by Hans-Jürgen Unverferth. CO8 uses elevons and flaps on a relatively high aspect ratio wing having a span of 2.6 meters.

Future "On the 'Wing..." columns will cover two topics related specifically to swept wings — wing twist distribution schemes and "induced thrust." Perhaps an exploration of these topics will entice a few fence sitters to more intensely investigate the rather unique potential of swept wing planforms. In the meantime, if you have ideas you'd like to see discussed in a future "On the 'Wing..." column, please contact us at P.O. Box 975, Olalla WA 98359-0975, or through the internet at <bsquared@appleisp.net>.

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Nurflugel e-mail list. Swept back wings vs. Marske wings, 13 May through 19 May 1999. Contributions by Al Bowers, Anton Lawrence, Gregg MacPherson, Andrè Luiz Martins, Mat Redsell, and others. <http://www.nurflugel.com>

Paff, Dieter. PN9 and PN9f. *The White Sheet*, Sean Walbank, editor. February/March 1982. ■

GORDY'S TRAVELS

Gordy Stahl
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A 'Case' of Sailplanes & Snowboards The Sportube

I travel; you pretty much get that part. What most don't understand is the challenge of transporting my sailplanes on airlines and rental cars. For some of my travels I transported my planes in a large coroplast box, created for that purpose. It held a couple of planes, TX, tape, charger, stuff in general. It worked great!

Sure I had to talk my way past some ticket clerks who wanted to charge me oversize penalties, and trudging through baggage with my luggage, laptop and the box was no fun, but I did it. The one thing that was the biggest challenge was figuring out what to do with that huge box once I got to my rental car. (The box was nearly as big as some of the rental cars!)

Finally, I switched to using just a strong cardboard box packed with bubble wrap; that way I could cut the tape, flatten the box and store it in the car till it was time to pack up to go home. It wasn't the best choice, made clear to me the second time my wings got broken in halves.

Then one day, surfing the web, I found Sportube. Literally a plastic tube within a tube, a handle and some wheels, made for transporting two Snowboards. It seemed big enough to fulfill my sailplane travel needs. Keep in mind that I only travel with open class size plane (120") and with airline inspections as they are, I needed something I could open… if need be… and lock.

The Sportube double snowboard tube fit all of my travel needs. It fit at least two planes (got to have back-up on the road) and support stuff, it was easy to get through airports, both through the check-in process and from the baggage belts. Its wheels and handles let me haul it in one hand and my duffel in the other (laptop on my shoulder). never even blink at it when I walk up, assuming its 'ski's'. I did tape a photo of one of my sailplanes on it, just in case, as everything inside must look like a bomb in the x-ray track. And once at the rental car, I can pull out my planes, slide the tubes together and store it in the trunk till its time to head back home.

Here's how it works. It consists of two high impact, high density, polyethylene shells. An inner shell with a perforated ridge which makes up one half of the locking mechanism and an outer shell with a perforated groove to match the inner's ridge.

The outer shell slips over the inner, it has two handles and a shoulder strap. Its recessed slot, perforated to allow a special padlock to fit through it and the inner's ridge, makes up the locking/sizing mechanism.

The 'bottom' end has solid rubber wheels recessed into each corner that allow the case to track straight behind you, even at a dead run, as in late for a plane.

Packing planes inside involves padding the bottom as I have found airline baggage handlers tend to throw or drop packages that need special handling. After a trip to Europe, Texas, and Oklahoma, the Sportube had its wheel corners crushed in. No small feat as I tried to dent the case with a hammer when I first received it, and couldn't! Yet a trip on American and Northwest 'riding' in a baggage compartment managed. Fortunately, a heat gun lets the dents pop out again, but most importantly, nothing happened to my TX or sailplanes.
key is to pack it full. When I came from Germany I had a 60" composite sloper, a 3 meter slope plane, a 2 meter TD ship, my Stylus, a charger and a bunch of hardware I scored at the Dortmund Model Show. I had all of it in a padded sailplane bag, with some careful use of bubble wrap material.

For larger planes, with the Sportube fully extended, the center gets somewhat soft, so some guys have made an

Double Snowboard Sportube

- High-density polyethylene shell safely protects up to TWO Snowboards with bindings AND boots.
- Fits most board/binding configurations.
- Wheels make those awkward boards easy to transport - just wheel them along like a suitcase.
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- $149.95, plus $20.00 shipping.
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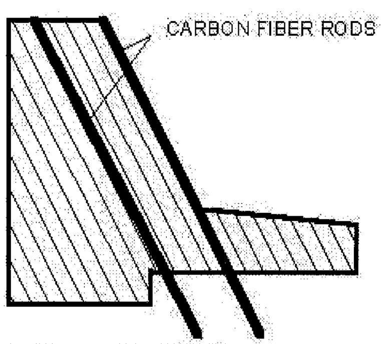
aluminum reinforcing shell which is riveted to the inner shell at its center.

Honestly, I had misgivings about the fact that I would have to 'end load' my stuff, especially after the convenience of working with a standard box case. But after traveling with it, I have to say it's great. It is sooo nice to be able to 'shrink' it down to its 44" 'half' size. (That half size is also nice when stored at home!)

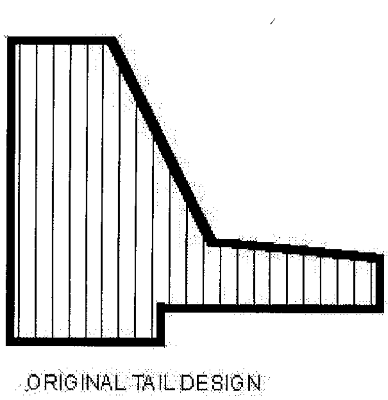
Since I got it, others have tried it and have found that they like it just as much as I do. For the money, for how well it does its job, I have to say, it's the best RC sailplane transport case I have ever seen or used.

If you have specific questions, contact me via e-mail at GordySoar@aol.com. Or you can wait till I show up at your flying site... It's just a matter of time!

Hope you enjoyed this trip! I did. ■

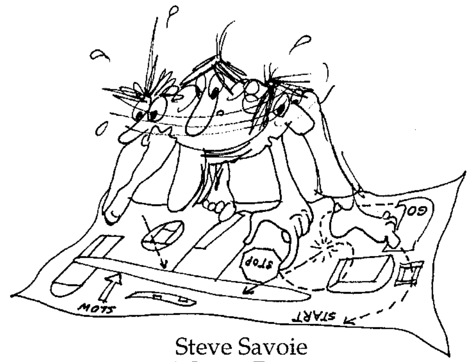


MODIFIED TAIL DESIGN



ORIGINAL TAIL DESIGN

"SHORT CUTS"



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mainerinvt@yahoo.com

MUSTANG MODIFICATIONS

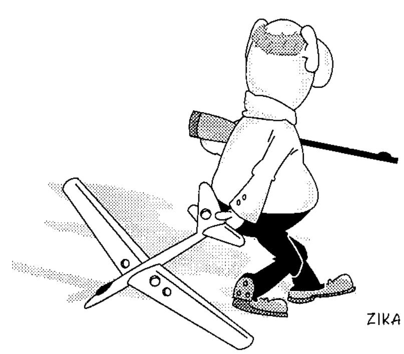
I've had my DAW Mustang for four years and it's now time for a little modification work. Don't get me wrong, this is a great plane and I'm astonished that it has lasted this long. The modifications I'm speaking of are to improve the plane's survivability as well as improve its light air capabilities. Both are related to the New England climate which is much colder than California and experiences lighter winds, especially at inland slopes.

My first modification is to the tail, mainly the vertical fin. I have had no problem with the tail until this February when in 38-degree weather I got my tail sheared off by a ME-109 (another great DAW plane). I have seen vertical fins torn out of the EPP foam but never sheared. I looked like someone took a skill saw and just ripped through the cloroplast. The plastic was very badly torn and the plane was down for the count. I can only assume that the cold weather was the reason for the tear, the ME 109 was unscathed with only a mark of gray paint on the leading edge of the wing. I was lucky enough to have some cloroplast lying around so that I could make the repairs and modifications without any delay. I also had .100" solid carbon fiber rod that fit nicely between the outer skins of the cloroplast.

In my club we don't have any DAW warbirds configured with the rudder, because it's just something else to break the way I look at it, so I decided to rebuild it w/o the rudder as it was originally configured. Well, for my repair I decided to reinforce the leading edge of the fin with the carbon rod as well, inserting another length of carbon rod about 1.5" back from the leading edge, both penetrating the fuselage all the way through. At the leading edge, I cut the cloroplast in such a way as to have the side skins surround the rod on both sides. I used GOOP to bond both into the cloroplast and EPP. I did have to change the orientation of the internal splines of the cloroplast to be parallel with the leading edge. This does preclude using the skin as a live hinge for the rudder, but I'm not using one anyway. Since making this modification I taken some very heavy hits on the tail and have had no problems at all.

The next modification is actually in the works and that is to stretch the wing. I know of two DAW warbirds with stretched wings and they fly just as sweet as the original but do have a little more hang time when the wind drops from thermal activity in front of the slope. While the originals are just scratching the slope to stay flying the stretch versions are flying strong enough to score hits. The modification requires just two inches of extra foam per tip. No other changes are needed. These extra two inches go a long way and don't really hurt the heavy wind performance of the plane. The looks are not bad at all and, when flown with other DAW warbirds, one can not see the difference. In fact, only the owners of these planes know of the stretched wings, until now that is...

The entire line of DAW warbirds are very refined and I don't want to infer that they are not absolutely great right out of the box; they are great designs. I don't think that the cloroplast was intended for near freezing temperatures and for the stretch wing; we just don't have the consistent slope winds found in most other areas of the country. So, keep up the good work Dave! When is the next release? ■



TECH TOPICS

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Airfoil Analysis With X-Foil

Over the past 20 years, a great deal of progress has been made in understanding low speed flight. Much of the theoretical work was pioneered by the development of the original Eppler-Somers code, and the subsequent update by Eppler. Experimental work was advanced through efforts such as Paul McReady's AeroVironment programs leading to the Gossamer Condor and Gossamer Albatross.

The NACA legacy of high Reynolds (Rn) number theory and experiments was passed on to NASA and approached the low Rn regime from the necessity to understand long duration powered flight in the upper reaches of planetary atmospheres. Although a strong motivation for that work was a concept for Martian exploration, the most recent embodiment has been achieved in the pioneering work of the Pathfinder and Helios programs.

Recently, the low Rn region of interest to modelers has been explored experimentally by the work of Prof. Michael Selig at the University of Illinois, Urbana-Champaign (UIUC), which built on the earlier work by Selig and Donovan at Princeton. Additional computational work has been done by Prof. Mark Drela, Massachusetts Institute of Technology (MIT), which was released as the ISES code. But apart from the earlier (inviscid) camber line theory developed by NACA, tools for airfoil analysis have been not been readily accessible or user-friendly enough for routine application by modelers.

With the recent release of the X-Foil code by Prof. Drela, both accessibility and accuracy may have been solved for the rest of us. This month, let's look at this very powerful tool for a test case of interest for DLG to see how well it holds up.

The X-Foil code is currently in release 6.94 and can be found on the website listed in the references.

Tom Clarkson has helped to deploy the code in various forms which have been optimized for different platforms (P3 and P4 Pentiums, Unix platforms, etc.). All of this information is available on the website. There is also a downloadable users guide prepared by Prof. Drela which describes the rudiments of the code and most of its operations. It helps significantly to have a modest background in aerodynamics and viscous flow concepts, but the code can be run without detailed understanding of the theory.

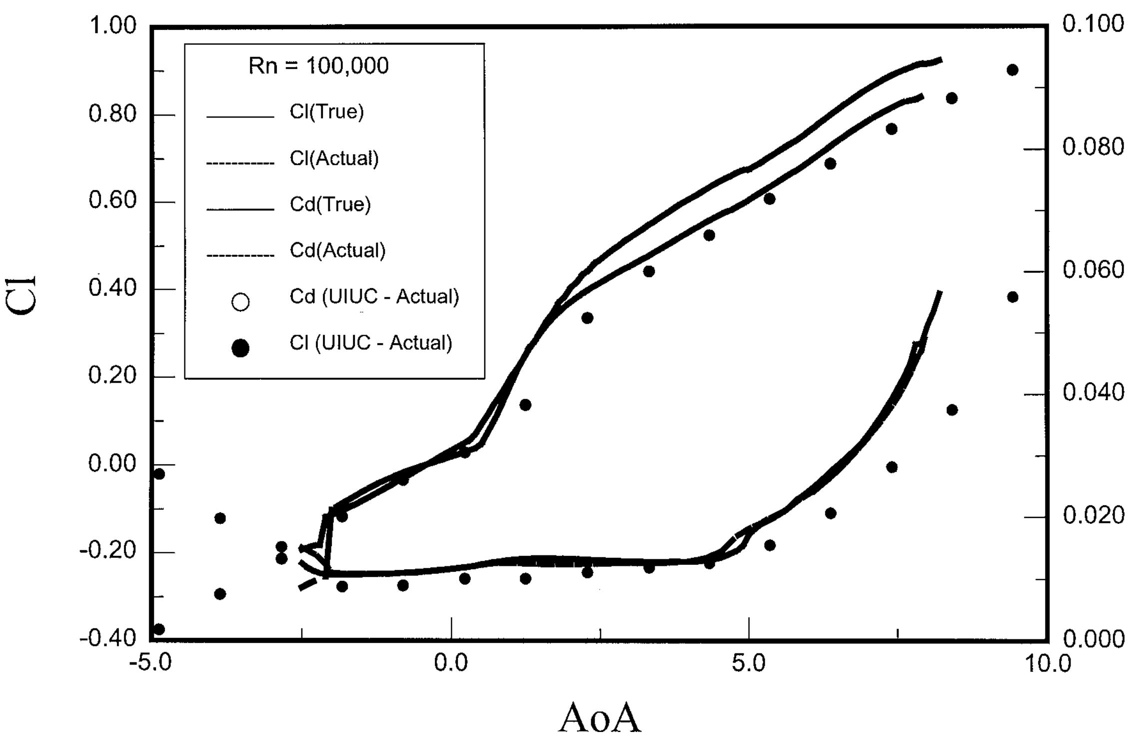
What sets this program apart from earlier work is its ability to run both an analysis of an existing airfoil and the ability to work the reverse problem. That is, set the desired flow conditions and specifications for flight and allow the program to develop the airfoil to match. All of this is available in a platform that will run on a PC.

The analysis reported here deals exclusively with the results for a specific airfoil for which data from the UIUC wind tunnel is also available. This allows us to look at some of the sensitivities in the simulation as well as draw some conclusions about both the experimental and theoretical results.

The section we'll analyze is the S6063. In earlier columns this was identified as a section of potential interest to Discus Launch Glider (DLG) planforms. Prof. Drela has developed a more optimized set of airfoils from the X-Foil code and those are likely to be preferred for DLG designs. In a subsequent analysis, we'll try and look at some of those differences.

For now, we'll run the S6063 at Rn=100,000 for comparison. The results of that evaluation are shown in Figure 1. Please note that there are TWO S6063 results presented. Those are for the true S6063 airfoil and for the model actually run in the

Figure 1: UIUC Date / X-Foil Results (Ncrit=9)



wind tunnel experiments. Fortunately, the actual airfoil used in the tests was digitized and presented in Volume 3 of the series of publications Herk Stokely provided on the UIUC tests.

A comparison of the true and actual S6063 outlines is given in Figure 2. This is done to an exaggerated Y axis scale to emphasize the differences in the surface contours. Two things should be expected from this comparison:

1) The reduced camber of the actual airfoil should produce a lower Cl(0) and subsequent lower result for the overall lift curve, and

2) The small amount of reflex at the trailing edge of the actual airfoil should appreciably reduce the observed moment coefficient.

Clearly, the X-Foil results are in very good agreement with the lift coefficient for the actual airfoil. For this part of the analysis, the results are exceptionally good. We'll discuss the moment coefficient in a few minutes but for now, note that the agreement for the drag coefficient, while representative, is not as good as for the lift term.

To understand this a bit better, a more detailed analysis of the boundary conditions for the flow over the wing needs to be undertaken. Incorporated within the X-Foil code is a full viscous calculation which should do an excellent job of representing the flow conditions at low Rn. However, both experience in flight and the UIUC wind tunnel data tell us that separation effects can significantly alter flight and test results.

By separation we usually mean a point at which the well-ordered, initially laminar flow over the forward part of the airfoil makes a transition to turbulent flow as the airflow progresses along the surface. If this occurs in a region of unfavorable pressure, the separation event may not re-attach, or may require an extended path before re-attachment is achieved. This region is known as the separation bubble. For best results, the extent of the bubble needs to be minimized. That's part of the trick to designing low Rn airfoils.

Boundary layer separation is very dependent on the flow conditions associated with the airstream. If the air is very calm, laminar flow may be extended. If the air is very turbulent, the transition may occur early in the flow across the surface. The latter condition is normally more stable as the pressure gradient favorable to re-attachment normally occurs before the high point in the airfoil surface is reached. However, extending laminar flow generally will help in drag reduction. So it's a trade-off in drag minimization vs. the robustness of the turbulent re-attachment.

X-Foil allows a parametric variation of the airstream turbulence by use of a critical power factor in an exponential representation of the frequency spectrum which is most likely to trigger separation. For the normal case (used in Figure 1), this value is Ncrit = 9. By varying this power term from ~ 4 (turbulent) to ~ 14 (low turbulence), we can get an idea of how the airfoil may perform over a range of atmospheric conditions.

In Figures 3 thru 5 we've looked at Cl, Cd and Cm for the actual S6063 vs the calculated values for the three values of Ncrit of 4, 9 and 14. Now we begin to see some interesting correspondence with the UIUC data.

For the lift coefficient, there is not a lot of sensitivity to the Ncrit value. There is some response to the lift offset which may be due to partial separation from the lower surface of the airfoil at low angles of attack. This will be very sensitive to the exact contour of the airfoil, surface roughness and turbulence in the airflow. I would not consider the exact prediction of this offset to be a critical test of the method. X-Foil correctly represents the lift coefficient for this airfoil and the subtleties of construction may be sufficient to explain the minor differences.

What is fairly obvious is that the width of the drag bucket is in much better agreement for Ncrit = 4 than for the higher (less turbulent) conditions. This perhaps represents one of the most difficult aspects of low Rn wind tunnel experiments - lowering the turbulence in the tunnel to mimic normal environmental conditions. At high Rn

Figure 2: Comparison of True and Actual S6063

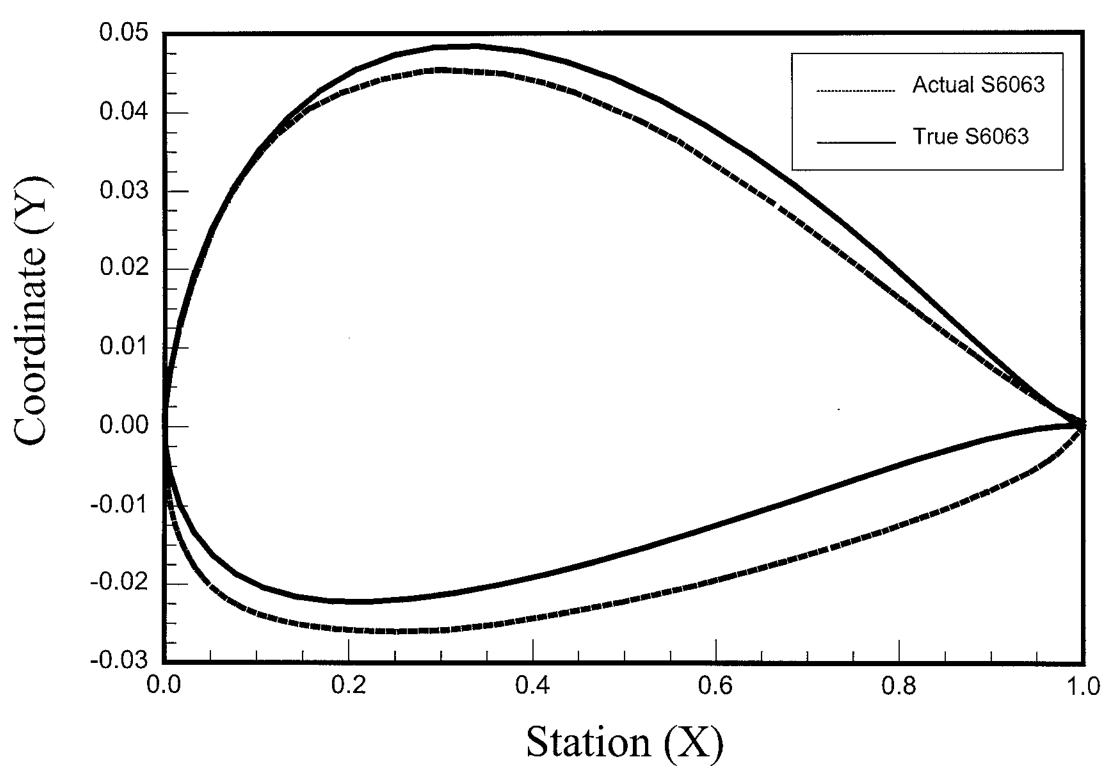


Figure 3: Cl vs Alpha for Ncrit = 4, 9, 14

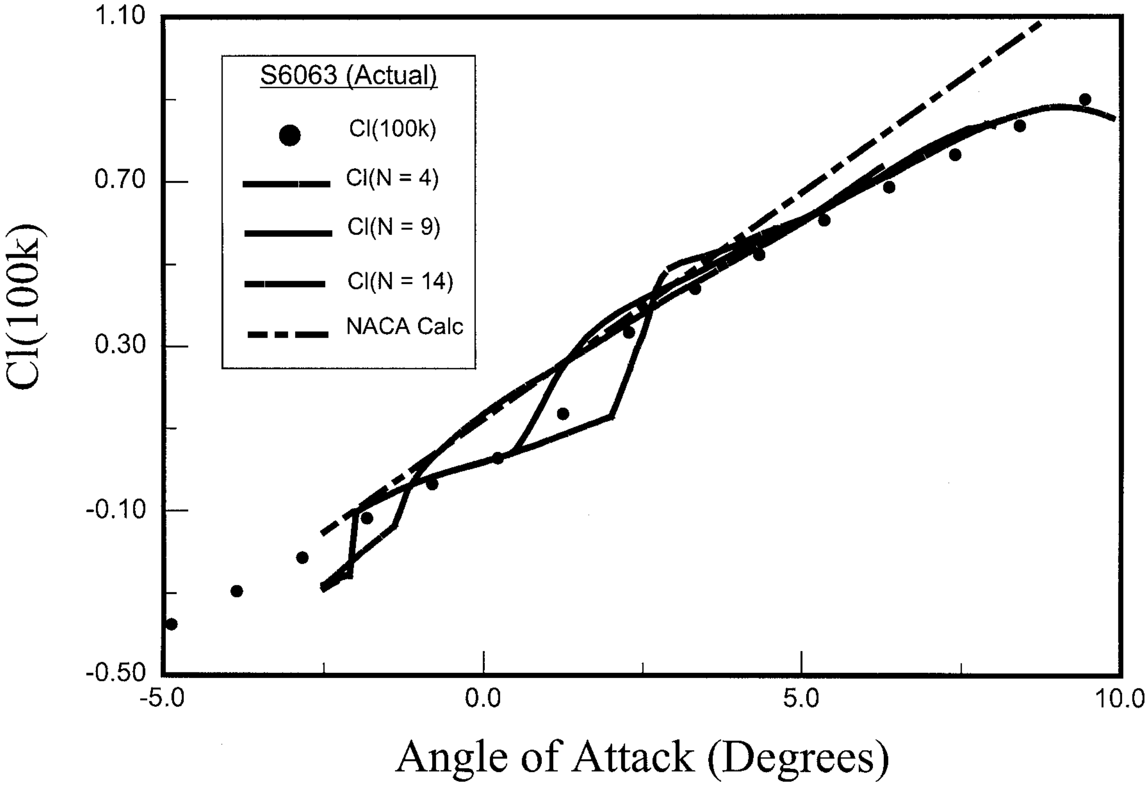
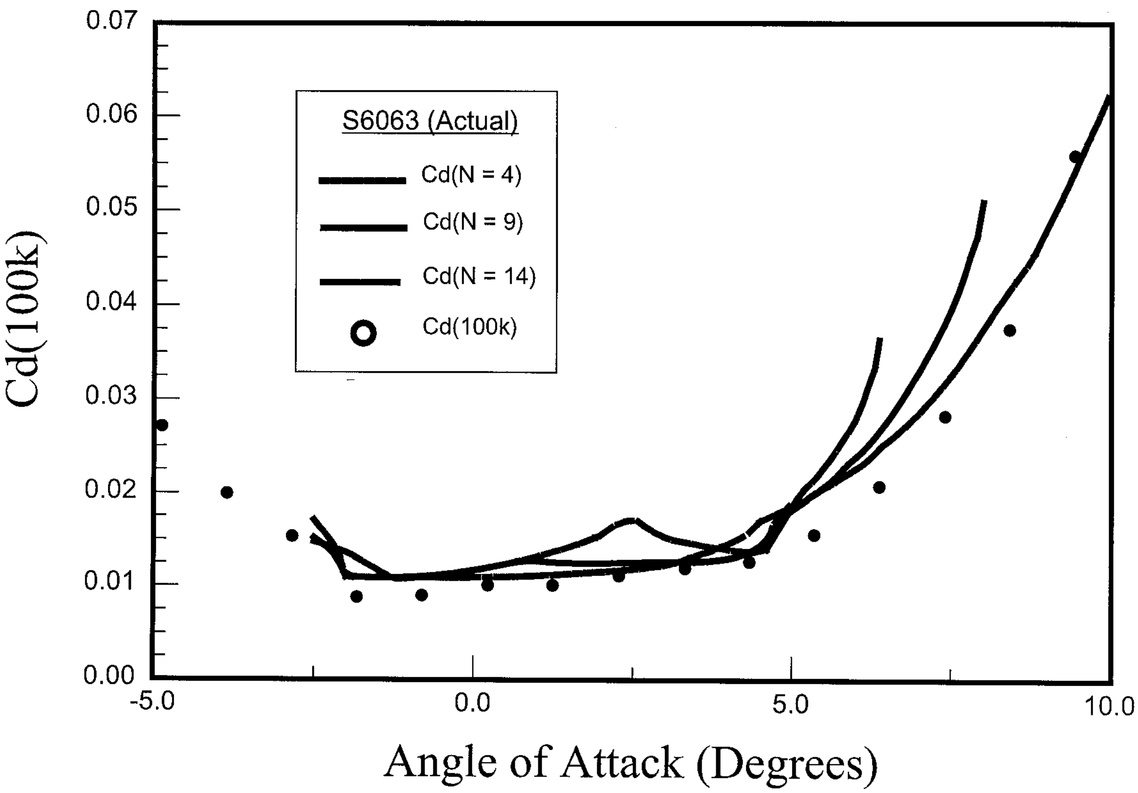


Figure 4: Cd vs Alpha for Ncrit = 4, 9, 14



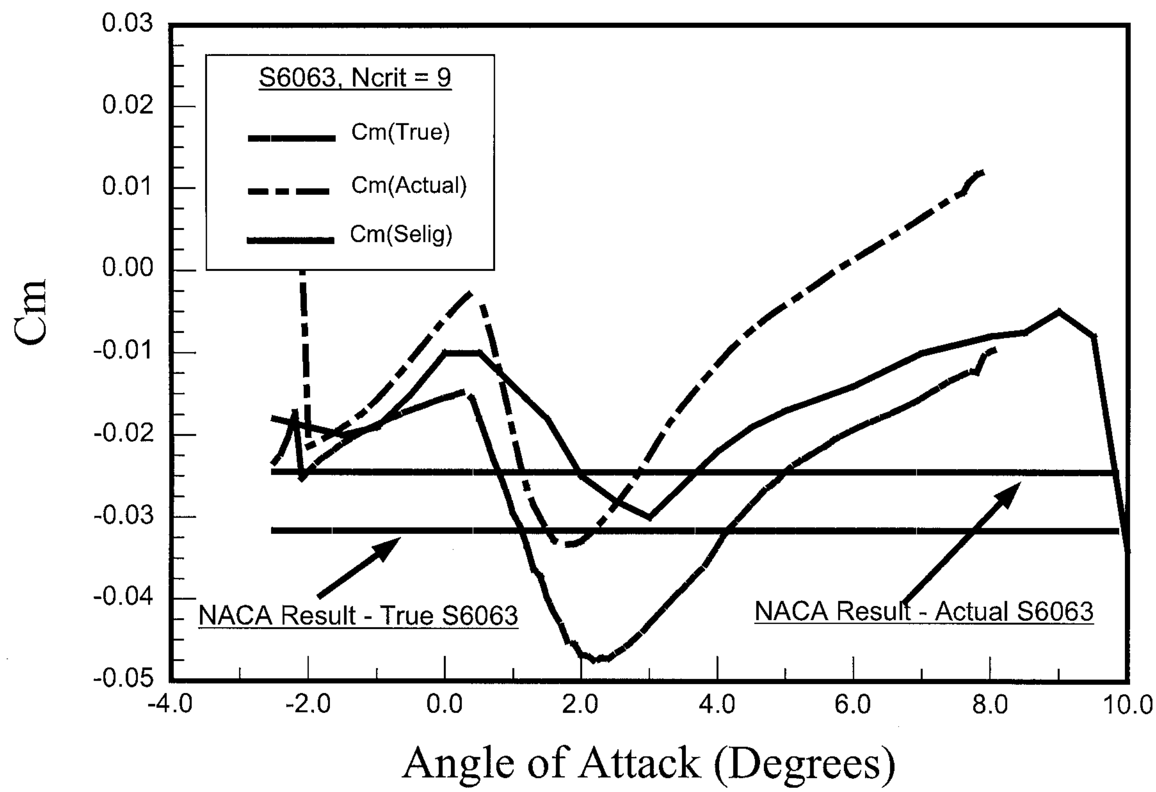
this is not a significant effect since transition will almost certainly occur in a favorable pressure gradient for Rn >500,000. But for Rn <150,000, this becomes the most critical issue for the experiments.

Values of Ncrit in the 4-8 range are suggested by Prof. Drela as representative of wind tunnels. This result may not necessarily reflect the quality of the wind tunnel airflow but is also affected by the smoothness of the airfoil surface used in the test. But for whatever the reasons, X-Foil does an extremely credible job of predicting the drag profile for the actual S6063 by using lower Ncrit values.

With that knowledge in hand, and recognizing that on relatively calm flying days, the airflow we actually use is probably more representative of the normal Ncrit ~ 9, we can choose to use this comparison (at Ncrit=4) to validate both the code and the experimental data. We should then probably use the calculated values at Ncrit =9 as more representative of the actual performance to be expected. Now I've been a working physicist for over 30 years and that's only the second time in my career that I'll venture that the simulation may be more representative than the experimental data. But I really do think the agreement is that good.

Finally, let's look at the moment coefficient calculations. The UIUC

Figure 5: Cm vs Alpha, S6063 at Rn = 100,000



results are not tabulated in the reports so I've interpolated them from the graphs and then compared with the calculated numbers. I've also included (for Ncrit=9) the calculations for the true S6063. As can be seen, the calculations and data are in very good agreement. And, as expected, the actual airfoil has an appreciable lower Cm than the true airfoil. The reflex at the trailing edge has a much more pronounced effect on Cm than either of the other coefficients.

Finally, in both the Cl and Cm plots, I've also added the calculations for thin section theory from my airfoil analysis and plotting code. The Cl result is obtained by calculating Cl(0) and then using the ideal lift slope of 0.11/degree. Cm comes from the Fourier series expansion discussed in Abbott an VonDoenhoff. As can be seen, the lift curve is in modest agreement but the Cm values are significantly different. Camber line theory assumes Cm is essentially constant around the quarter chord location. Separation effects are the most likely culprit for the deviation seen in the X-Foil results.

I would encourage those of you who have an interest in analyzing airfoils to download and evaluate X-Foil. There is a Yahoo chat group that supports this interest. Beware that Yahoo now releases your e-mail information so be prepared to be spammed unless you reset your Yahoo preferences. The Yahoo default is to release your information automatically - which really stinks because I found out about this too late - and I'm a bit too old for all those Viagra offers to do me much good!

Next time we'll try and look at a few more airfoils and compare them with calculations for airfoils developed specifically for DLG applications.

References:

A Computer Program for the Design and Analysis of Low-Speed Airfoils, Richard Eppler, Dan Somers, NASA Technical Memorandum 80210, 1980

Airfoil Design and Data, Richard Eppler, Springer-Verlag, 1990, ISBN 3-540-52505-X

Theory of Wing Sections, Ira Abbott, Albert Von Doenhoff, Dover, 1959 ISBN 486-60586-8

Soartech Publications (Herk Stokely) of the UIUC Reports: Airfoils at Low Speeds, Soartech 8 Summary of Low-Speed Airfoil Data, Volumes 1-3

Web-Sites:

X-Foil: http://raphael.mit.edu/xfoil/

Yahoo Group: http://groups.yahoo.com/group/xfoil/

UIUC: http://amber.aae.uiuc.edu/~m-selig/

Helios: http://www.dfrc.nasa.gov/Projects/Erast/helios.html

PathFinder: http://www.dfrc.nasa.gov/Projects/Erast/pathfinder.html

AeroVironment: http://www.aerovironment.com/

■

Gulp

"The Sloper's Resource"

By Greg Smith of slopeflyer.com
greg@slopeflyer.com
http://www.slopeflyer.com

I've been getting ready for the main 2002 flying season. I say main because we fly year round here in Wisconsin, just a little more frequently in the warmer months. Anyway, I managed to build several planes over the winter and thought I'd share my thoughts and flying experiences about a couple of them with you.

Wizard Compact 2

I had been noticing the emergence of this plane among the F3F elite of the world and after seeing the size was 2.5 meters, or about 100 inches, I thought it would be just the plane I had been looking for. It also helped that a world-class pilot like Espen Torp gave it glowing recommendations for just the kind of flying I would be asking it to do!

What I wanted was a plane that is small enough to fly at our local hills, and more importantly to be able to land at them in big wind, while still being large enough to rip on the big hills. The plane also needed to be tough as our landing style can reek havoc on lightly constructed planes. I found the plane and it is called the Wizard Compact 2.

The Wizard is molded by Milan Janek in Slovakia and arrives ready to install the radio gear. It is available from Espen Torp at ET Air. Espen is in Norway and is the worldwide distributor of the Wizard so getting one is not as easy as going to the local Hobby-R-Us but it is a fairly painless process for us helpless souls who really want one.

The Wizard uses a SD-2030 airfoil which I had not flown until I got this plane. It has a great speed range and in the 3 months I have owned my Wizard I have had it out about 15 times in a wide range of conditions from just dragging around the sky to ballistic 40 plus winds with 44 ounces of ballast on board while running an F3F course. Oh, did I mention it was my first F3F? My confidence in the plane and its ability to do what I tell it to with no surprises gave me a pretty strong advantage in the conditions and I was able to win the event. I also have flown it at some fairly inhospitable slopes as far as the landing zone is concerned and had to use unconventional landing patterns. I can attest to the predictability and durability of the plane. It can fly in a wind as light as 10 mph at our local slopes and is a very capable thermaller. There is a nice adjustable hook on the bottom for winch or strong bungee. I can stick over 2.5 pounds of ballast in it if needed and it can really rock in the big wind. In fact, at the recent Cape Blanco Slope Fest a beefed up version tied for top speed at 186 MPH! I always look forward to the next time I can fly it.

The slope closest to my house is only about 70 feet high and the open face is about 200 feet wide with tons of trees and million dollar houses on either side. I had never flown a plane as big as the Wizard there but the lure was too great because, once you are in the air, this is a super spot. I was not disappointed. Landing is done by sweeping low over Lake Michigan and climbing, down-wind or cross-wind, up the face of the slope to bleed off speed. The Wizard is so predictable that it was almost anticlimactic landing at a spot that can still give me trouble even after I have done it several hundred times!

Finally, to paraphrase Ferris Bueller from the timeless classic "Ferris Bueller's Day Off", I love flying it... It's so choice, I highly recommend picking one up, if you have the means.

Gulp

My need for a plane like the Gulp first became evident last year during the October South Dakota Slopin' Safari and Rob Hurd DS University trip. I had no EPP plane to learn DS with so I used my SH-50 instead and while the SH was capable, as were a Prodij and an Extreme, I really wanted a plane that could take a hit because I was being cautious with the glass planes and want to expand my DS skills without sacrificing one of those ships.

The Gulp was borne out of Steve Drake's need for a fast but durable DS plane for the likes of Parker Mountain. Steve wanted a plane that he could explore the limits of DS fun and aerobatics; he achieved his goal and more. This plane is great on the front side as well!

The Gulp is a flying wing design so there is no tail boom to break. It is made from high-density EPP and is very bash resistant. The wing is stiff with the upper and lower carbon spars and it uses elevons so only 2 servos are needed. In addition, it is a well thought out and tested design that flies great! I had been looking at a couple of other similar planes but when I saw the Gulp I thought, "That is what I am looking for." It is larger than some of the popular designs and has a really nice fuselage. You can mount all the radio gear inside and it is very slippery.

Building the Gulp is straight forward, much like any other EPP plane out there. The finished product is definitely more than the sum of its parts.

Flying the Gulp is what sloping is all about. The ability to fly in a variety of conditions and have fun doing it makes the Gulp a "must have" in my quiver!

During 4 days in Kansas DSing at the Wilson Lake Dam, the Gulp met rock or hillside several times at high–speed and the most damage it sustained was tearing the hinge loose on one of the elevons. The pristine covering job didn't last long but the battle scars and the fact that it keeps coming back for more make it a plane with a lot of character.

In addition to producing a great slope ship, Steve has been very responsive to e-mails and questions plus he is constantly improving an already great plane. For instance, he recently made the spar installation much easier. If you are looking for this type of plane you can't go wrong with a Gulp.

Next month I should have some anecdotes from the first of the year 2002 South Dakota Slopin' Safari and Rob Hurd DS University taking place the first weekend in May and I still have a lot of work to do to get ready for the Midwest Slope Challenge so maybe there will be a story in there somewhere, as well!

Resources

Et Air – Espen Torp's online home for the Wizard Compact 2
http://www.torp.as/etair/index.htm

Steve Drake – maker of the Gulp
stevedrake@aol.com

■

SVSS

Spring Fling

June 22nd & 23rd 2002

2 DAYS OF THERMAL DURATION~~AT LEAST 3 CHANCES FOR A WIN!

Location:	SVSS flying site in Davis..............See www.SVSS.org for map & more info.
Schedule:	Pilot check in Friday afternoon. Check in Saturday-Sunday 7:00 A.M. Pilots meeting both days at 8:00 A.M.
Tasks:	Saturday: 5 Rounds-4, 6, 8, 10 & 12 minutes in any order. Sunday: 4 Rounds-3, 5, 7 & 9 minutes in any order. All times will be normalized to 1000. Landings will be a painted Bulls-eye, 10 ft. dia. 50, 75 & 100 points.
Awards:	1 award will be given for 1st place in each category (Open, RES & Grey Cup) on Saturday & Sunday. Overall (Saturday & Sunday combined) awards will be given 1st-5th place for Open, 1st-3rd for RES & 1st-3rd for Grey Cup (60 & over).
Food:	Available all day Sat. & Sun. provided by Sacramento Police Officers Association
Raffle:	Tickets will be sold at the contest and the raffle will be held on Sunday.
CD:	Jim Thompson 530 662-7268
Motels:	Motel 6 530 753-3777 $39.99 1 Bed & $45.99 2 Beds Howard Johnson 530 792-0800 $79.00 1 Bed & $89.00 2 Beds Holiday Inn Express 530 758-2600 $99.00

Camping is permitted at the flying site. There are no hook ups & fires are not allowed.

ALL ENTRIES SHOULD BE IN BY JUNE 15TH~~Confirmation by e-mail

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Please make your check payable to "SVSS" and mail entry to:

Cheryl Thompson 530 662-7268
23464 County Road 102 gsdsvr@earthlink.net
Woodland, Ca 95776

Name:______________________________Phone:______________

Address:____________________City:____________State:____Zip:________

E-Mail____________________Club:__________AGE (60 & over):________

Classes: Open_____Channel 1st______2nd______3rd______ Limited to 5 Planes per channel

RES______Channel 1st______2nd______3rd______

Entry Fee: Both days $30.00 for one class, $40.00 for two. ________
One day $20.00 for one class, $25.00 for two. ________

Which days will you be there? Sat._____Sun._____Both______

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Reference Material

Summary of Low-Speed Airfoil Data - Volume 3 is really two volumes in one book. Michael Selig and his students couldn't complete the book on series 3 before series 4 was well along, so decided to combine the two series in a single volume of 444 pages. This issue contains much that is new and interesting. The wind tunnel has been improved significantly and pitching moment measurement was added to its capability. 37 airfoils were tested. Many had multiple tests with flaps or turbulation of various configurations. All now have the tested pitching moment data included. Vol 3 is available for $35. Shipping in the USA add $6 for the postage and packaging costs. The international postal surcharge is $8 for surface mail to anywhere, air mail to Europe $20, Asia/Africa $25, and the Pacific Rim $27. Volumes 1 (1995) and 2 (1996) are also available, as are computer disks containing the tabulated data from each test series. For more information contact: SoarTech, Herk Stokely, 1504 N. Horseshoe Circle, Virginia Beach, VA 23451 U.S.A., phone (757) 428-8064, e-mail <herkstok@aol.com>.

BBS/Internet

Internet soaring mailing listserve linking hundreds of soaring pilots worldwide. Send msg. containing the word "subscribe" to soaring-request@airage.com. The "digestified" version that combines all msgs. each day into one msg. is recommended for dial-up users on the Internet, AOL, CIS, etc. Subscribe using soaring-digest-request@airage.com. Post msgs. to soaring@airage.com. For more info., contact Michael Lachowski at mikel@airage.com.

T.W.I.T.T.

(The Wing Is The Thing)

T.W.I.T.T. is a non-profit organization whose membership seeks to promote the research and development of flying wings and other tailless aircraft by providing a forum for the exchange of ideas and experiences on an international basis. T.W.I.T.T. is affiliated with The Hunsaker Foundation which is dedicated to furthering education and research in a variety of disciplines. Full information package including one back issue of newsletter is $2.50 US ($3.00 foreign). Subscription rates are $20.00 (US) or $30.00 (Foreign) per year for 12 issues.

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The LSF program consists of five "Achievement Levels". These levels contain specific soaring tasks to be completed prior to advancement to the next level.

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P.O. Box 3028
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http://www.silentflight.org

Sailplane Homebuilders Association (SHA)

A Division of the Soaring Society of America

The purpose of the Sailplane Homebuilders Association is to stimulate interest in full-size sailplane design and construction by homebuilders. To establish classes, standards, categories, where applicable. To desiminate information relating to construction techniques, materials, theory and related topics. To give recognition for noteworthy designs and accomplishments.

SHA publishes the bi-monthly ***Sailplane Builder*** newsletter. Membership cost: $15 U.S. Student (3rd Class Mail), $21 U.S. Regular Membership (3rd Class Mail), $30 U.S. Regular Membership (1st Class Mail), $29 for All Other Countries (Surface Mail).

Sailplane Homebuilders Association
Dan Armstrong, Sec./Treas.
21100 Angel Street
Tehachapi, CA 93561 U.S.A.

The Vintage Sailplane Association

Soaring from the past into the future! The VSA is dedicated to the preservation and flying of vintage and classic sailplanes. Members include modelers, historians, collectors, soaring veterans, and enthusiasts from around the world. Vintage sailplane meets are held each year. The VSA publishes the quarterly BUNGEE CORD newsletter. Sample issues are $2.00. Membership is $15 per year. For more information, write to the:

Vintage Sailplane Association
1709 Baron Court
Daytona, FL 32124 USA

International Scale Soaring Association

There is a growing interest in scale soaring in the U.S. We are dedicated to all aspects of scale soaring. Scale soaring festivals and competitions all year. Source for information on plans, kits, accessories and other people interested in scale. For more information:

web site: www.soaringissa.org

Books by Martin Simons: "World's Vintage Sailplanes, 1908-45", "Slingsby Sailplanes", "German Air Attaché", "Sailplanes by Schweizer". Send inquiries to: Raul Blacksten, P.O. Box 307, Maywood, CA 90270, <raulb@earthlink.net>. To view summary of book info.: http://home.earthlink.net/~raulb

The Eastern Soaring League (ESL) is a confederation of Soaring Clubs, spread across the Mid-Atlantic and New England areas, committed to high-quality R/C Soaring competition.

AMA Sanctioned soaring competitions provide the basis for ESL contests. Further guidelines are continuously developed and applied in a drive to achieve the highest quality competitions possible.

Typical ESL competition weekends feature 7, or more, rounds per day with separate contests on Saturday and Sunday. Year-end champions are crowned in a two-class pilot skill structure providing competition opportunities for a large spectrum of pilots. Additionally, the ESL offers a Rookie Of The Year program for introduction of new flyers to the joys of R/C Soaring competition.

Continuing with the 20+ year tradition of extremely enjoyable flying, the 1999 season will include 14 weekend competitions in HLG, 2-M, F3J, F3B, and Unlimited soaring events. Come on out and try the ESL, make some new friends and enjoy camaraderie that can only be found amongst R/C Soaring enthusiasts!

ESL Web Site: http://www.e-s-l.org

ESL President (99-00): Tom Kiesling (814) 255-7418 or kiesling@ctc.com

2002 Mid-South Soaring Championships

Atlanta, Georgia

June 21,22,23

http://midsouth.atlantasoaring.com/

The North Atlanta Soaring Association (NASA), in conjunction with the Louisville Area Soaring Society and the North Alabama Silent Flyers want to welcome you to the 11th Annual Mid-South Soaring Championship (MSSC), June 21st -23rd. This year it will be held at the Bouckaert Sod Farm located 20 miles Northwest of Atlanta in Rome, GA. The Bouckaert site consists of over 6,000 acres of hybrid Bermuda sod. We wish to express special thanks to the Bouckaert family for allowing us access to this beautiful site on the banks of the Etowa River.

This is the first time NASA has hosted the MSSC. We plan to continue and expand the fellowship of fliers attending this annual event. In the past there have been as many as 125 entrants from as many as 25 states. We encourage contestants to bring their families and extend their visit take in some of the many Atlanta metropolitan attractions and events. Links to the Atlanta and Rome Chamber of Commerce sites are included in this web site.

While competitive spirit draws many of the contestants, we cannot forget that the MSSC would not be possible without the support of the many sponsors. These sponsors are listed on our web site along with the prizes they are contributing for the raffle. Check this page often as we are continually signing up new sponsors. Also, visit them via their links on the Sponsor's Page, buy some of their products if you so choose, and be sure to thank them for their great support. Be sure to mention that you saw their ad with this MSSC web site. Because of their kindness and donations, many great prizes have been given away over the years.

This year's contest will consist of hand launch and RES (Friday) and two separate thermal duration events (Saturday & Sunday). The best overall score (counting all four events) as well as the 1st prize in all events will be awarded handcrafted intarsia plaques crafted by two NASA's master wood workers. Details of the events including the possible range of tasks and other awards can also be found in the site. A special drawing will be held immediately following the end of the hand launch event Friday. After the RES event we will hold a soirée and fun fly. The big raffle will be held at end of day Saturday.

We encourage you to register now to take advantage of the Early Registration Discount. We have introduced on-line registration and Pal Pals option this year.

On behalf of all of the supporting clubs and sponsors, welcome to the 2002 Mid-South Soaring Championships Atlanta style.

AJ Wilson,
President
North Atlanta Soaring Association

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