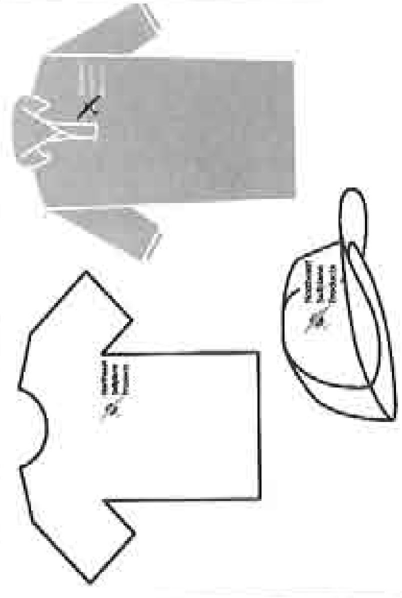

R/C Soaring Digest

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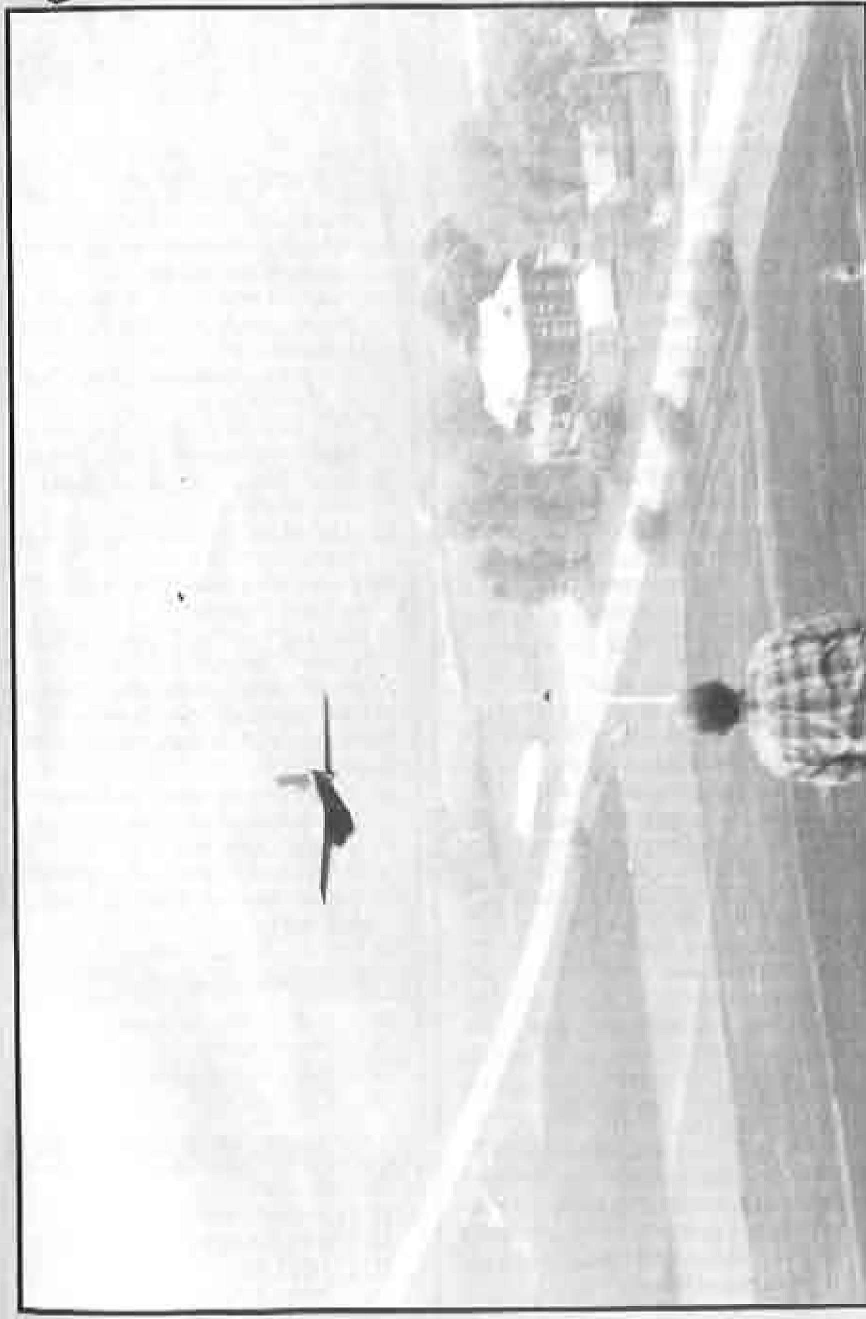

R/C Soaring Digest

A publication for the R/C sailplane enthusiast!

Advertiser Index

Table of Contents

Other Sections

Special Interest Groups

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. He can be reached at: 210 East Chateau Circle, Payson, AZ 85541, (602) 474-5015.

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The Soaring Site

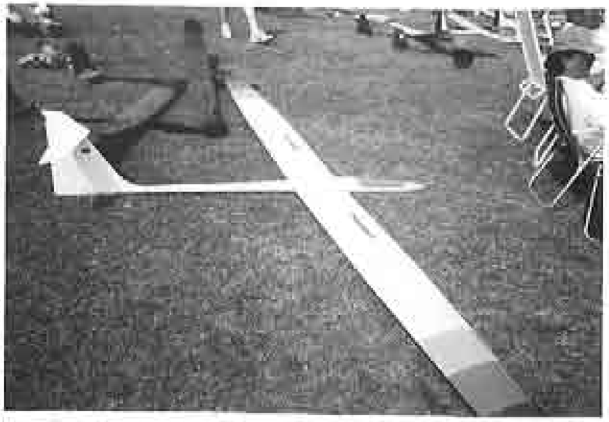
About the Cover

The cover photo was sent in by Gordy Stahl of Milwaukee, Wisconsin. He says, "Here's another Wisconsin "Super Slope" photo. I know it looks more like the English countryside, but it's actually Plattville, Wisconsin (The Mining Hill). Pictured is Mirko Bodul with his ME 163 from VS Sailplanes. It's a huge fuselaged model. Mirko is Wisconsin's premier slope flier and he's been the inspiration (or winch!) to get most of us to the slope."

Southwest Winter Soaring - Arizona

Chuck Wehofer, editor of the newsletter for the Central Arizona Soaring League (C.A.S.L.), dropped us a note to say that they are gearing up for their big contest on February 6th and 7th. He says, "I have sent out flyers to all the past participants and to all the newsletter editors in the southwest. After just a week from publication, we have 9 entries and 7 of those are from out of state. It looks like this year we'll be getting a good sized group from the Colorado area and, of course, the guys from the Southern California area. One of our club members went to the Visalia contest and distributed about 100 flyers and made an announcement and got a very favorable response from the flyers from last year's Southwest Winter Soaring Contest (SWSC). I guess we can expect about 100 or more flyers. Our contest date is February 6th & 7th and the C.D. is Iain Glithero, (602) 813-1905. Also, could you ask all newsletter editors in the country to send their addresses to you. I am trying to get as many clubs on our mailing list (as possible) for an exchange program." The contest date has been added to the schedule and, for those of you interested in the exchange program that Chuck suggests, please send in your addresses.

...and from England



Mike Harvey of Hants, England sent in the photo. "Here is a photo from the British BARCS Radio Glide contest. Very large open model by Dave Charles."

What's different about this issue?

First, there are two "Ridge Writers", Wil Byers and Mike Bamberg, who will change off every other month. We welcome Mike to the pages of *RCSD* as a columnist with this issue.

Second, there is a new group forming called the North American Scale Soaring Association (NASSA) and we expect to be sharing information with you on a bi-monthly basis. The first press release and rally announcement are included in this issue.

Third, because of material that many of you have sent in recently, and new ads, of course, this issue contains more pages than usual. Will we continue with the increased size? We don't know. We hope you enjoy this issue and the extra pages.

Seasons Greetings!
Jerry & Judy

Epoxy & Cotton Flox for High Stress Areas

...by W.D. Williams, Pendleton, Oregon

I've noticed many times people recommending a mixture of epoxy and micro-balls as a filler, even in high stress areas such as installing wing rod receiver tubes in wings. While the micro-epoxy works, it seems to me that a better material for high stress areas would be a mix of epoxy and cotton flox. At least, so I was taught by Burt Rutan when building a Vari-Easy.

Cotton flox is a cotton fiber milled into very short lengths (on the order of a hundredth of an inch in length). It is inexpensive and available from homebuilt aircraft supply houses such as Wicks or Spruce Speciality. When it is set up with epoxy, it has more strength in tension, compression, sheer and greater resistence to shock than the familiar epoxy micro-balls mix. The cured material is somewhat like maple, but without any grain direction.

For structural purposes of the epoxy and cotton flox, mix using the same technique as a micro-ball mix. I haven't measured it, but it is probably somewhat heavier, which may not be of any significance for uses of limited volume such as bedding a wing receiver tube into a spruce-ply spar. Because it is heavier and more resistant to abrasion, it is not so suitable for ordinary purposes as the micro-ball mix as a filler surfacer.

On plywood bodies the flox epoxy mix can be used to make high strength corners either alone or combined with glass or other fabrics. Trowel a small amount of flox into the corner, work it into a smooth radius. When fabric is applied, the radius makes it much easier to produce a lamination without voids. With more epoxy and less flox, it is a good material to use for structural wood joints that are very crude. Mixed to the proper consistency, it resists running out of the joint and the joint itself is as strong or stronger than the materials it joins. Check it out. ■

1591 Calle de Cinco
La Jolla, CA 92037
October 31, 1992

R/C Soaring Digest
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Wylie, TX 75098-2108

Editorial Comment:

On June 6th, 1992, the Torrey Pines Gliderport in San Diego, California was designated a U.S. National Soaring Landmark by the National Soaring Museum, Soaring Society of America. More recently, the San Diego City Historical Site Board designated the Gliderport to be a historic site. Motorless flight has been accomplished at this location for over 60 years and many aviators who went on to break national and world records in silent flight developed their skills along these cliffs. Currently, sailplanes, radio-controlled gliders, hang gliders and paragliders share this unique airspace.

The University of California Regents, owners of almost half of the Gliderport property, have appealed the decision of the City Historical Site Board on the grounds that although the site is historic, the City of San Diego does not have jurisdiction to label any University property as such. Evidently, the University of California at San Diego feels incumbered by the historic designation, for that would preserve the use of this site as a gliderport. In view of this appeal, the future of the gliderport will be decided by the San Diego City Council at an upcoming meeting.

We need your help. If you want to see this famous gliderport preserved please write or call:

Councilmember Abbe Wolfsheimer
202 C Street
San Diego, CA 92101
(619) 236-6611

Mayor Maureen O'Connor
202 C Street
San Diego, CA 92101
(619) 236-6330

County Supervisor Susan Golding
1600 Pacific Highway
San Diego, CA 92101
(800) 852-7334

California Governor Pete Wilson
State Capitol Building
Sacramento, CA 95814
(916) 445-2841

Thank you with your concern and action. We will keep you posted on this issue.

Sincerely Yours, (signed) Gary B. Fogel, Torrey Pines Scale Soaring Society member

Some Thoughts on Introducing Young Minds to Science

...by Alan Schwerin, 439 Washington St., Lake Charles, LA 70605, (318) 474-0667

Photos by Tom Fox

It had been a busy day. And the chalkboard showed it. Diagrams and notes on lift, drag, camber and airfoils abounded. We had then progressed to exploring questions on spars, aspect-ratios and dihedrals. As I turned to clean the board a soft voice behind me asked the question that would dictate much that would occur in that lab over the next seven weeks: "What is a fuselage?"

Now, it's not that this was a dumb question, or a question that couldn't be dealt with easily enough. No. What struck me about this question was its emergence from a context that would need to be seriously reconsidered. As with any discussion, I had made a number of assumptions - some overt, most covert - about the knowledge my students already had of airplanes and aviation in general. Elaine's question would force me to review these assumptions.

Layne Keele and Janet Yang preparing to put the right wing together. Both students are accomplished pianists, which convinced me that they ought to work on the more demanding part of the plane. (Janet is studying the plans here - an act many students did not always emulate.)

For instance, could I expect the students to understand the discussion on undercambered airfoils if some of the more basic concepts - like 'fuselage' - remained a mystery? If not, I clearly had to determine what, if any, understanding the class had of airplanes and the principles of flight before attempting to introduce some of the more 'advanced' concepts. Most important, Elaine's question served as a forceful reminder that I should take little, if anything for granted in our forthcoming excursions into aviation science.

Elaine was one of a group of twenty-six seventh and eighth grade academically gifted students that had been selected to attend an intensive science and technology program over the summer. Hosted by McNeese State University in Lake Charles, Louisiana, the Prefreshmen Enrichment Program, or PREP as it is called, is funded by the US Department of Energy and financially supported by a local petro-chemical corporation. Besides their journey into aviation science and technology in my design lab, the class attended lectures on algebra, computer assisted (CAD) labs, technical writing workshops and a very popular personal motivation course. As it turned out, the aeronautical design lab developed into a, if not *the* cornerstone of the entire program, for many of the students.

The plan was to learn a little about airplanes and the principles of flight. With my obsession with sailplanes, the focus would be on silent flight. Two instructors, that had some experience with model-building, assisted me in the lab. If necessary, we could also call on some senior MSU engineering students to help. As it happened, some extra assistance was called for towards the end of the program, when a few hands became idle! Our budget made it possible to purchase four 2m *Spirit* kits, four basic Airtronics *Vanguard* radio systems, a hi-start, plenty of covering, glues and general hardware. With a few tools and eight hollow doors from the hardware store down the road, we were set. But how should we arrange the group, to ensure

Team work in operation. Part of the rationale for the PREP program was to foster group participation in problem solving - and when seven minds focus on some common construction challenge, the problem can be, and usually is solved.

In the beginning, even the most basic of tasks needs to be carefully explained - such as how to align the fuselage pieces over the plans to ensure that the sides later attach securely.

Greg Norsworthy being told where to find his thermal by an enthusiastic band of helpers. Greg and I were asked to fly a demonstration round for the competitors at our reunion contest.

The local television station sent a crew out to cover the reunion contest. Greg Norsworthy is explaining to the TV reporter how to operate the transmitter. We had excellent coverage of the contest by the local media. Perhaps CD's could work harder at promoting their contests, both locally - even nationally?

at least a semblance of order? With twenty-six young live-wires on our hands that could prove a challenge.

In the end it did not; we split the group into four teams, only had two teams in the lab at any one time, and subdivided each team into three units. Some students worked on the wings of the team's plane, others on the fuselage, and the rest on the tail feathers. This division of labor within the team kept everyone occupied - for the most part that is - and seemed to promote friendly rivalry among the teams to produce quality parts first. The teams were assigned their own tables, and planes left on the tables as the glues dried overnight. This display not only made it possible for a team to watch their creation slowly take shape before their eyes - a thrilling experience, and a source of pride for any builder - but also showed *the others* how well, or poorly, a team was progressing. This gentle "competition" between the groups seemed to foster team spirit, and in my view, helped sustain the students attention and interest in their planes. Seven weeks can be a long time to wait for a completed plane to emerge from the lab! As we know, eager young minds can become impatient, and possibly disruptive, unless measures are taken to extend their attention and interest spans. Admittedly, we did have our problems - one student in particular proved a nuisance at times - but overall, the group stuck to their guns, and waited patiently for the plane to be completed.

The 2m *Spirit* kit proved to be an excellent choice. The forty-page manual, that is profusely illustrated, is written

Every flight was preceded with a brief explanation of the control surfaces, and the operations required on the transmitter to deflect these surfaces. As close to twenty-five percent of the participants at the contest had never seen a radio-controlled airplane, let alone flown one themselves; these pre-flight checks and explanations were vital!

clearly, and with one or two minor exceptions, is very readable for beginners - even for those unfamiliar with the most basic terminology used to describe planes and their parts. Routine safety precautions were taken during construction. For instance, regular wood-glue was used most of the time, especially at the beginning of the program. Easy to clean, strong, and most important, reversible, this glue made it possible for students to painlessly acquaint themselves with some of the basic construction techniques and materials. Where C.A. and epoxies were essential, the instructors initially applied the glues. When we were convinced that the novices could cope without too much mess, we permitted them to use these glues.

Having heard that the plywood joiners in the two-winged version of the 2m *Spirit* were suspect, we opted for a one-piece wing with the forgiving elastic bands. Single wings are possibly a little lighter than the others, less complex, and not that difficult to transport and store. Besides, they build quicker than wings with joiners, and with an eager group such as the one we had, this was an important consideration. With its built-up structure, and triple taper, the 2m *Spirit* wing builds fairly quickly, and is not particularly complex. Nevertheless, we did find that ribs can be misaligned, placed in the wrong sequence, and incorrectly attached to the balsa leading edge sticks. The students made insufficient allowance for the 1/16 sheeting that is attached to the leading edge of the center-sections. This was a small mistake and easy to rectify with the razor saw and C.A.

"Look Ma, no hands!" To forcefully demonstrate to a skeptical novice competitor that the 2m Spirit *is inherently stable, I have taken my hands off the sticks as the plane flies up the hi-start. This proves the most difficult lesson for novices to learn - the less you manipulate the transmitter, the better the flight. Note the trainer cord connecting the transmitters.*

To help speed things along, the instructors were shown how to apply Monocote to the bare structure, and rather than wait on the students to complete this task, we covered the planes and installed the radio equipment.

The flying sessions had to wait awhile because I took off for the LSF nationals. We had made allowances for this pause in the program, relying on another professor's expertise to help the class work on a different project - building robots in my absence. As you might guess, I was keen to return to the design lab and begin flying with the students.

The trainer cord proved invaluable for this phase of the program. With sufficient planning, it was possible each day to take a group of fourteen students to the field - of which there are many in

Lake Charles - and provide everyone with the opportunity to experience at least three action-packed flights under close supervision. The grass at the McNeese farm was a little high, and produced shrieks from the girls whenever it was their turn to retrieve the hi-start! Nevertheless, it became clear that week that the flying sessions marked the pinnacle of the course, at least as far as the students were concerned. The students had been excited to see their planes take shape on the tables in the lab, but this excitement fell far short of the abundant enthusiasm shown at the field. These were the moments the team had waited so patiently for - the culmination of weeks of discussion and careful construction. As many of the students pointed out in their evaluations, the time spent flying their planes was the most enjoyable component of the entire PREP program.

So much for the administration of the program, the construction of the planes, and a little on the flying. What about the science? To be frank, we were hard-pressed to fit in discussions on the theory of flight. As I pointed out earlier, we started with theory and aviation concepts, and whenever the opportunity arose later - while we pieced the plane together, or when we flew - we would draw on theory to help explain what we were doing. But elaborate theoretical lectures were not given to the students. Was this a shortcoming of the program? Perhaps. It depends on one's views on how science ought to be taught.

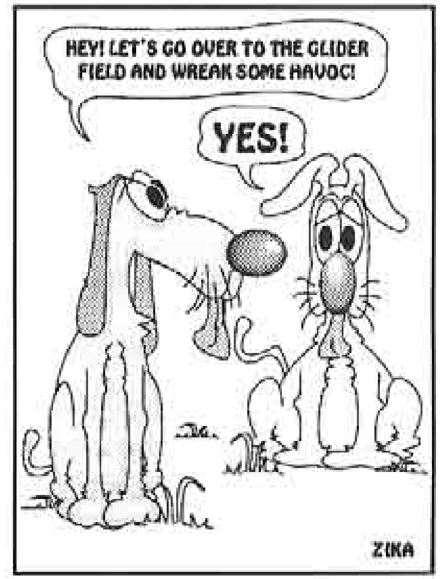
If the view is that practice should imitate theory, then the failure to immerse our students in Newton's laws and Bernoulli's views on pressure from the outset, and other theories, must count against the program. On the other hand, if one thinks that theory and practice coexist in some symbiotic relationship - as I do - then there is surely little place for extensive theorizing about sailplanes and flight. Do some theory - build - discuss - continue building, and so on. That is to say, relate the construction techniques and the design of the parts of the plane to their theoretical underpinnings while the work is in progress. This is what we did for both philosophical and practical reasons. Furthermore, there was another crucial factor in favor of our approach to the course. As I pointed out before, our young students could prove restless and ultimately become bored with what we were doing unless we kept their enthusiasm up. So we fed them *small* doses of theory as they glued their planes together and later while they flew them. In hindsight, we could possibly increase the theoretical component *somewhat* next year with our new group of PREP students. But the time constraints on the program, and the concern that we not put the class to sleep with theory, will make it difficult to decide how far and how deep to dig into aviation theory. Time will tell.

Now the big question: was the program a success? In my view there can only be one answer to this question: *YES*. There can be little doubt that this immersion in aviation science and technology through model sailplanes has left an indelible positive impression on the students' minds. For they learned something that many of us know full well already - namely, that science can be exciting and both intellectually and emotionally fulfilling. Furthermore, and most important, the students realized that aviation science, and for that matter any science is not the exclusive preserve of an elite coterie well versed in some elaborate and abstract set of theories. For the sciences can be made accessible to the non-initiate who possesses the barest grasp of the fields' concepts and theories - as our sailplane design lab amply illustrated. Recent National Assessment of Educational Progress (NAEP) examinations show that only nine percent of seventeen year-olds have attained a level where they understand and can use relatively sophisticated concepts in science. Perhaps more courses similar to ours could ultimately help improve this dismal statistic.

Postscript

The design lab closed shop at the end of July. But the university administration, let alone the students were not prepared to leave it at that. So we organized a competition as part of their reunion this past weekend (October 12). In August Frank Weston - of *Magic* and *Terminator* fame - announced his very generous offer of a kit of his to CDs that put together hi-start contests of at least thirty competitors. I knew that this was a challenge we would have little trouble meeting. And who wouldn't be enchanted with a *Magic* kit?

As it turned out, thirty-seven competitors registered, from our class of twenty-six! Many of the students simply *had* to introduce their friends to the excitement and challenge of soaring. When the pizzas, sodas and adrenaline had settled down, the following winners emerged from the fly-off: Derek Haywook, Lyne Keele, Adrian Foster and Mark Richard. Hard on their heels in fifth place, was Jon Norman - a *seven year-old novice*, whose presence and performance at the contest speaks volumes about the future of soaring! ■



Winch Line
...by Gordon Jones

Gordon Jones, 214 Sunflower Drive, Garland, Texas 75041; (214) 840-8116 After 5:00 P.M. CST

Composite Wings Part 5

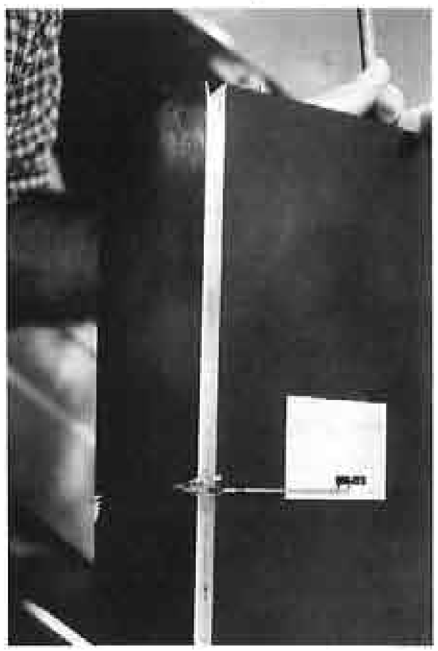
Finishing a fiberglassed wing is really no different than finishing any other wing, except the folks who use the heat shrink coverings will have to switch methods. There are a couple of theories about how the steps should progress, as each individual builder has techniques and processes that he is comfortable with and will pretty much follow. The best method that I have found is to first sand down the little bump at the trailing edge to get a feel for how things are going to go. I use 220 grit paper on a small sanding block that I can easily manipulate (2 x 12 inches and 3/4" thick). This is light enough to not be cumbersome and at the same time stiff enough to do the job. While sanding all this fiberglass it is wise to wear long pants and a paper mask so as not to inhale the fiberglass dust.

The leading edge is the time consuming part of this operation. When you cut the flashing off the edges it is a wise idea to try to cut it close enough to save some sanding time while not cutting into the leading edge itself. This is sometimes a pain, but if done carefully it will save time. Once the flashing is off I start at the tip and round off the tip leading edge and end to get into the groove. I have been cutting the tips ala the Synergy (i.e., at a 45 degree angle and slightly rounded off). This is easier to work with and it is ascetically pleasing as well.

Once the tip is complete, move around to the actual leading edge and continue along the leading edge being careful and taking your time. I have found that taking one's time and changing paper on the sanding block often will actually speed the process along. Dependent on where the mylar stopped on the leading edge, there will be a small hump that must be sanded down to match the contour of the wing as well. One option that many folks will try is to get some heavier grit paper to speed the process along; DON'T! You will find that this will provide large gouges in the surface and additional time will be required to fill these in later on. Plus, if you get too carried away on the leading edge you could get into the foam, where you don't want to be.

While sanding the leading edge you will notice the edges of the layers of fiberglass, once these are pretty well down switching to 320 grit feathers these edges quite nicely. I generally finish the initial sanding with 320 and then switch to 400 grit at the end. I figure I may as well get it as smooth as possible from the start so that the filling process prior to painting is less work.

Once the leading edge has been returned to the airfoil shape, it is time to attack the root rib. Dependent on the



type of carry through arrangement you put in different techniques will apply here. For the root rib/subrib version find a friend with a radial arm saw or a table saw. Depending on the working surface of the saw measure the dihedral angle and mount a prop that will provide the proper angle while cutting. Then simply run the root rib through the radial arm or table saw to get the proper angle on the root rib. Be sure to try to cut as little wood off the rib as possible leaving the meat of the rib. I first saw this method on Julian Tamez's bagging video and was surprised that it was so easy. This can be accomplished with a hacksaw and a sanding block but the radial arm saw it the perfect tool here.

Painting the wing is the next step on the agenda. I do it prior to cutting out the ailerons and flaps because I use the Kevlar hinge method, and this is best accomplished after the painting has been done. First wet sand the wing with 220 grit paper to get is smooth and get a uniform surface. Fill any voids or surface defects with Model Magic, or epoxy and microballoons. The key is to fill everything so that the primer and paint will not get to the foam! This can lead to bad things and we don't want to make hollow core wings just yet. The primer and paint is entirely up to the builder; use whatever you are comfortable with to get a good looking paint job. Do go to the trouble of wet sanding between coats as it is easier to wet sand and it adds to the looks of the paint.

When the painting is complete it is time to cut out the aileron and flap servo cavities. I have found the the best method for this is to use a Dremel tool with the router attachment and a router bit. First measure and locate where the servos will be installed. Mark the outline of the servo locations and servo cavity areas with a felt tip pen. Use an X-acto knife or razor blade to cut out the skin on top of the servo area. Then using a T pin measure the depth of the wing at the thinnest point of the servo cavity area. Set the Dremel tool to a slightly shallower cutting depth than the actual depth that was just measured. Carefully route out the foam in the servo cavities. This is another of those steps that should be approached with caution as you don't want to cut through the top skin. With a little practice you will find this is the easiest and neatest way to get perfect looking servo cavities every time. Plus this provides a flat servo cavity floor to work with due to the router attachment.

Since we have servo cavities it is a good idea to have a place for the servo wires to run through. For this step I use an aluminum arrow shaft as a drill. I set the wing upside down on the foam bed and then set up a V jig to hold the arrow shaft level. With the wing level and the jig level I mark a line from the root to the forward edge of the servo cavities. I then drill a hole at the root location with a normal drill bit the size of the arrow shaft bit. Set up the jig and the line to be drilled. Carefully start the drilling being careful to watch the alignment of the drilling with regards to the line to the servo cavities and the depth of the drilling so that the arrow shaft does not try to go through the top of the wing skin. This is not very difficult, but do take your time.

Along the way I have advised you to be careful during various procedures. In most instances this was due to something that you may not have seen before or a step that could result in ruining the work that you had previously accomplished. Cutting the ailerons and flaps for the Kevlar hinges takes a light touch and again with a little practice will be another easy trick for great hinges. However, this step will require extreme care so that you don't cut off the ailerons and flaps. One good thing about this is that if you do accidently cut off a flap or aileron you are not in any great trouble. You can always cut off the other control surface to match and use the tape method of hinging.

Measure the aileron and flap lines on the wing; I try to use some masking tape so I have a line that won't disappear. Be sure that the hinge lines on both the wing panels are the same length and distance from the trailing edge. Using a new X-acto knife blade carefully scribe a line along the hinge line on the upper side of the hinge. Remember that you are working on the top of the wing for the ailerons and the bottom of the wing for the flaps. What you are trying to accomplish is to just break the outer layer of fiberglass and resin. It may take more than one pass at the line, but by all means take your time and try not to go too far. You will be able to feel the difference in the Kevlar once you reach that point.

Next flip the wing panel over and repeat the process on the bottom of the control surface. Remember that you are working on the bottom of the wing for the ailerons and the top of the wing for the flaps. Once you have made the initial scribe on the bottom of the control surface line, continue until you have broken through the fiberglass. There is no Kevlar on this side so once you break the fiberglass you will be cutting foam. Next I use a long X-acto blade to cut through the foam at 90 degrees down to the top or bottom of the foam. When you get down near the end of the cutting again be careful so you don't cut through the Kevlar and ruin the hinge. During this process try to keep the cuts at 90 degrees. I think that you will find that once you have cut one hinge in this manner things will go a lot easier and quicker.

To cut the angle in the ailerons, apply masking tape, then mark a line along the bottom of the aileron about 1/4 inch back from the original cut line. Cut along this line trying to just break the fiberglass surface. Once this has been accomplished set up a piece of foam for an angle jig and cut along the line angling back to the hinge line for the undercut of the ailerons. This again takes a little practice but is not difficult. Use a sharp blade to perform your cutting so the facing is smooth. The facing can be smoothed with a sanding block when you get done. To finish the facings I use a little epoxy applied with a finger tip or scrap piece of balsa. You can even go whole hog and paint the facings if you want for that super finish.

With the exception of installing control horns and servos that completes the wing. Installing the remaining goodies is nothing new and I will not get into that as there are more than enough methods to fill several pages. New ideas are coming up all the time with the normal resourcefulness of the modeling community. Take advantage of some of these ideas and try new things.

Next, we will look at the end results of the weight and strength of the wings that I built and I will pass on observations about the materials. ■

Curt Nehring
San Dimas, California

Understanding Sailplanes

...By Martin Simons

13 Loch Street, Stepney,
South Australia 5069

(When Martin began writing his first series of articles for *RCSD*, the column was called "Understanding Thermal Soaring Sailplanes". His current column, "Flying in Wind And Weather", has been changed to simply "Understanding Sailplanes", which should not be confused with the original series. This issue of *RCSD* and the next will contain some answers to questions; the subject of flying in wind and weather will be continued after that under the new column name. Ed.)

Some replies to questions

In the November issue of *RCSD*, Daniel Hatfield asks several questions which I think I can answer, though to give all the details would require me to write (*another*) book.

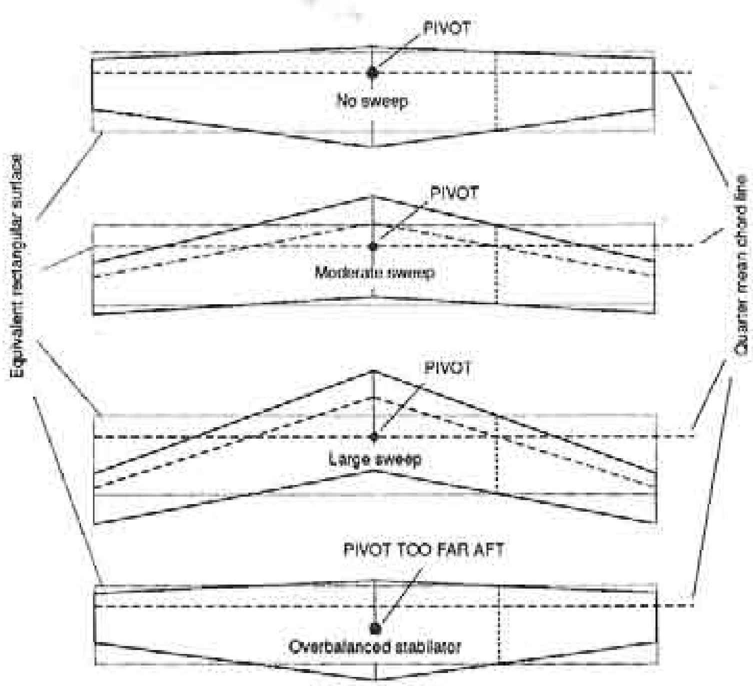
(1) What are the advantages and disadvantages of an all moving stabilator versus a fixed stabilizer with elevator?

Virtually all full-scale sailplanes, as Daniel remarks, have fixed stabilizers now although there were vogues for the all moving type sixty and again thirty years ago.

Probably the main reason most modelers prefer the all moving stabilator is because it is easier to build and at the same time any errors in setting up the rigging angles of wing relative to the tail, are easily corrected by simply adjusting the length of the stabilator push rod.

The fixed stabilizer type of unit can be made stiffer without excess weight, and rigidly mounted. The elevator can be very light and easily mass balanced. These features reduce the danger of flutter. The same applies to models.

Figure 1. Pivot points for stabilators. For smallest or zero loads on servo, the pivot should be at the quarter mean chord point



The all moving stabilator tends to be more flexible, even sloppy, and hence more likely to flutter. This applies to models as well as full sized aircraft, especially since the wire rods used to mount the stabilator are often much too thin and elastic. (I never use a rod less than 1/8th inch diameter for the pivot, on this type of model.)

The control forces felt by the pilot on the elevator stick of a full sized sailplane are light but positive, which is essential. The RC pilot on the ground does not know directly what the servo is feeling but a well designed elevator is at least not likely to overload the servo.

If the pivot for the stabilator is positioned carefully at the 25% mean chord point of the surface, control forces needed are very small. In models this saves the servo from having to work too hard. In full scale flying stabilators are always provided with some mechanical gadgets such as counterbalance tabs or springs in the control circuits, to provide feel.

A badly positioned pivot for the stabilator can easily lead to control overbalancing. That is, if too much surface area is ahead of the pivot, it tends to be driven by the airflow right over to one extreme, either up or down, like an automobile door in a wind (Figure 1). The servo resists, of course, but this is not a desirable situation.

From the drag point of view there is very little to choose between them, providing the units are well designed. The drag of a stabilizer/elevator, if the hinge line is well sealed and faired, is quite small at all normal operating angles. The same is true of the stabilator, but sealing the gap, or gaps, at the root end is not very easy.

The all moving surface, if it does not flutter, may do slightly better at high speeds, for reasons mentioned below, but there is really very little in it.

On the whole, the fixed stabilizer/elevator is probably best, but it takes a little more trouble in design and building, and most of us are lazy.

(2) Is there any advantage in using a non-symmetrical airfoil for a stabilizer? And what about the (full sized) ASW 24?

There is no advantage whatever in using an upward lifting tail. (Free flight model fliers give themselves a built in disadvantage. I have never understood why.) There may be a tiny gain, though negligible in practice, in using an airfoil with a very slight negative camber, i.e., 'lifting' downwards.

In all normal flight conditions, providing the sailplane is rigged with its center of gravity in the right place, the load on the tail is downwards. This is a very small or even vanishing load at low speeds and a symmetrical tail is easily capable of carrying it with minimal drag.

At high speeds, although modelers find great difficulty understanding this, the down load on the tail increases. The faster the model is flying, the more down force is felt by the tail. This is despite the fact that, with a normally stable sailplane, to go fast the elevator has to be trimmed slightly down. Since the force has to be met, the stabilizer produces some 'lift' in the downwards direction. A symmetrical surface is still perfectly able to do this but the drag penalty, caused by the tail tip vortices which appear, is not negligible.

A very small amount of negative camber on the stabilizer will in theory save a little profile drag at high speeds, but it is not really enough for it to be detected in practice.

One point that will occur to readers, is that the stabilizer/elevator, with elevator down, is in effect an airfoil cambered the wrong way for high speed flying. The all moving symmetrical surface at least is not wrongly cambered for the condition. But all these effects are negligible. The tail vortex drag cannot be removed.

Concerning the ASW 24, I too, know this aircraft quite well and have a 1:3.5 scale model of it. (Now rebuilt. See *RCSD* August. p 54.)

The elevator of the (full scale) ASW 24 has a slight cusp on the underside of the trailing edge (Figure 2). The stabilizer itself is fully symmetrical. The elevator cusp is there, I believe, for two reasons. First, it is much easier to glue the top and bottom skins of the very thin elevator if they are squeezed together for a short distance rather than meeting on a knife edge. There is probably also a slight improvement in control force gradient. A slight pressure on the control rods and bearings, etc., caused by the elevator cusp, helps to remove any slight sloppiness. (Of course, in flight the load on the stick is normally trimmed to zero for the selected airspeed.) The very small variation from the truly symmetrical form, is otherwise negligible. The ASW 24 tail is not designed to give any lift in normal flight.

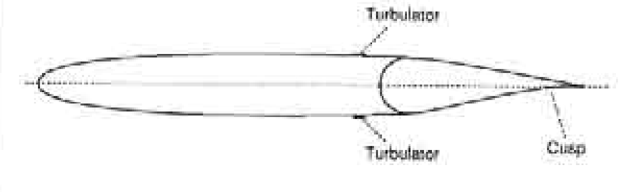
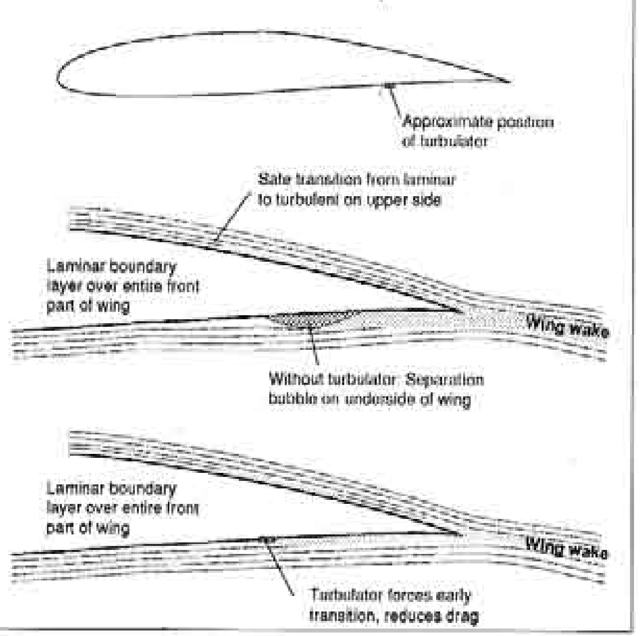


Figure 2. ASW 24 stabilizer and elevator section

Figure 3. ASW 24 wing turbulator (Schematic only. Does not show correct section)



Yes, there are zig zag turbulators on the ASW 24 stabilizer and fin, and all the way along the underside of the wing too, which Daniel did not mention. Most other modern full scale sailplane use turbulators, nearly always under the wing well back towards the trailing edge. The zig zag tapes are usual now, but a few years ago some aircraft used pneumatic turbulators, tiny rows of holes on the underside of the wing, with air fed through them to upset the boundary layer. These were a thorough nuisance to maintain in good condition.

The objective of modern full scale sailplane design is to preserve laminar flow over as much as possible of the entire aircraft. This reduces drag enormously and is responsible for great improvements in performance. All modern plastic sailplanes use laminar flow wing and tail sections, without exception.

Why turbulators? As the air flows over the wing, eventually the boundary layer flow will change to the thicker and more draggy turbulent flow. The profile is designed to delay this transition as long as possible, but it cannot be prevented altogether. If the transition is simple, as it usually is nowadays on the upper side of the wings, the extra drag caused by the turbulent boundary layer, is not too serious. But often on the under side, about the 70% chord location, there is a laminar separation bubble (**Figure 3**). The laminar flow actually leaves the skin of the wing for a small distance, before breaking up into turbulent flow and re attaching. This causes some excess drag. The turbulators are placed just ahead of the point where the bubble would otherwise form, to force transition slightly ahead of time, and so save a fraction of drag.

(3) How thin should stabilizers be?

On the whole I think Daniel's instincts are right, they should be as thin as possible consistent with structural stiffness and strength. Flat slabs of balsa have been used for decades on all kinds of models, with no very serious disadvantages. By using a properly shaped airfoil section we save a little drag and may get a smoother control response, but thin sections are generally better at low Re numbers. So for tail surfaces, which are small, thin is beautiful.

However, 10% is still not very thick and if the Selig 8020 does succeed in retaining a good percentage of laminar flow, it may have less drag than some thinner sections. There are reasons sometimes for preferring a thickish profile, or at least one with a fairly well rounded leading edge. The very thin profile tends to have a narrow range of usable angles of attack. Such sections tend to stall early. For these reasons, 7% is probably as thin as we should go.

(4) If we are going to expect some lift out of our stabilizers, should we be concerned about the planform?

If my advice above is accepted, we are not going to expect lift from our stabilizers, except for balance and control. To reduce the vortex drag of the stabilizer, yes, a fractional saving can be made by increasing the aspect ratio, but this entails some structural problems and flutter is always lurking round the corner to grab us. Further small improvements can be had by attending to the other details of planform, taper, slight crescent sweep, even winglets.

But there is an over-riding consideration. If the vortex drag of a stabilizer is reduced, however it is done, the lift curve slope will be made steeper. That means that the surface will become more sensitive. Small changes of angle of attack will have larger effects. This may be a desirable thing, since stabilizer effectiveness is one of the factors in designing for stability, but experience also suggests that most sailplane accidents are caused by the pilot 'pumping' the elevator control too much, too quickly. The more 'twitchy' the stabilizer is, the more difficult the model becomes to handle. So, proceed with care!

(5) Dead spots mentioned by Michael Selig for the NACA 0009 section. What to look for.

Some profiles at our low Re numbers, especially thick ones, do show 'dead spots' in the lift curve, or even reversals, around the zero angle of attack. This was shown up quite dramatically some years ago in an AIAA research paper which Daniel will have to find at UC Davis for himself, since I don't have the exact reference just now. The author was, I think, Professor Muller of Notre Dame U., the section tested was, from memory, a 16% thick, symmetrical NACA 6 digit type, thicker than we would normally use on a model but useful for illustrative pur-

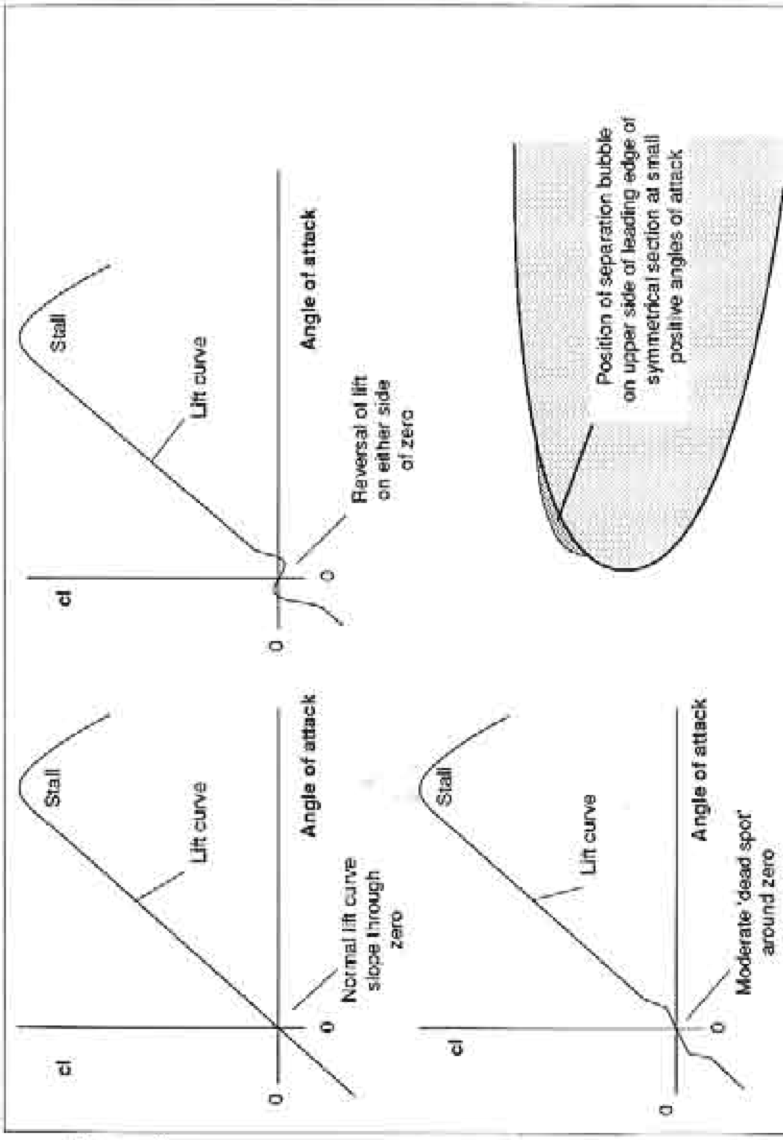


Figure 4. The 'dead spot' around zero angle of attack on some symmetrical airfoil sections

poses (Figure 4).

When a wing section is tested in the wind tunnel, we normally expect the lift curve to be more or less straight until the flow begins to separate and stall. At the aerodynamic zero angle of attack with a symmetrical profile, we find zero lift, as the angle increases we expect the lift also to increase in proportion.

With some profiles at low Re and at very small positive aerodynamic angles of attack, a separation bubble forms just behind the leading edge on the **upper** side. This is enough, apparently, to modify the effective shape of the profile. The main air flow has to pass round the bubble, giving the section a kind of reversed camber at this critical point. The result is, instead of immediately giving lift at the positive angle, it actually lifts in the wrong direction. If the angle of attack is increased a little more, the bubble usually slips aft, the flow becomes more normal, and the section gives positive lift as would be expected.

The result is that such a profile, if set to fly at zero angle of attack (like a fin on a sailplane), will actually give reversed forces for small deflections - a highly undesirable state of affairs.

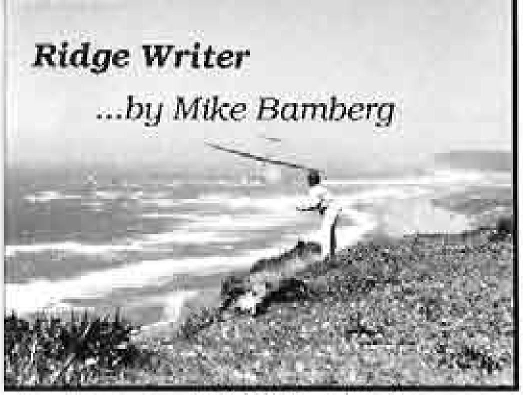
The NACA 0009, as the Princeton group found, is not so bad, since the lift curve around the zero angle of attack is still positive. But it does show these features in an embryonic form. Around zero, the lift curve does not slope as steeply as it should. Quite large increases of the angle of attack are required, before the section behaves normally.

How serious is this? For fins, it is quite important, and the answer seems to be to keep the sections thin and use modern, laminar flow airfoils.

As mentioned above, we do not normally operate stabilizers at aerodynamic zero. They are almost always required to carry some small lift loads. Hence, they are probably going to be out of the dead spot most of their time. All the same, we do not want any control surface to behave like this, so it is wise to avoid any profile which shows a nasty kink in the lift curve around zero. ■

Ridge Writer

...by Mike Bamberg



– 1059 NW Darnielle St.,
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Hello, my name is Michael Bamberg. Wil Byers and I will be taking turns writing the slope soaring column so Wil can have time to build a few models for next season. It seems kind of strange, but now he wants to fly models and not just talk about them.

For just a moment I'll talk about me so you can have something to pick at when you write. You will write won't you? I have been a modeler for almost 30 years. I began flying free-flight handlaunch and towline gliders. I tried control-line but got tired of rebuilding them. I began flying R/C gliders when the only (read that the cheapest) radio I could get was a single channel escapement system. I put that in a Jetco Thermic 50 and learned to fly R/C. When the rubber ran down on the escapement I hoped I was on the ground. Just for grins sometime try flying your poly wing glider on rudder only. It can be done but it is challenging. I had a break from R/C for a few years of college but I still flew FF slope soarers. I bought my first proportional radio in 1976 and have flown regularly since that time. (Well the planes have, I can't move my arms fast enough.)

Perceived Speed

I decided to address this topic after seeing various claims by modelers about how fast their slope models were. There seems to be a need to have the fastest plane around and everyone wants 'bragging rights'. I don't claim to be the last authority on visual perception or the interaction of size and perceived speed but I have had a bit of education in the matter. My major in college was physiological psychology, particularly visual perception, memory and learning.

In particular I will limit this article to cues we use for detecting speed as well as pointing out the failings of those cues in the special circumstances we encounter with soaring.

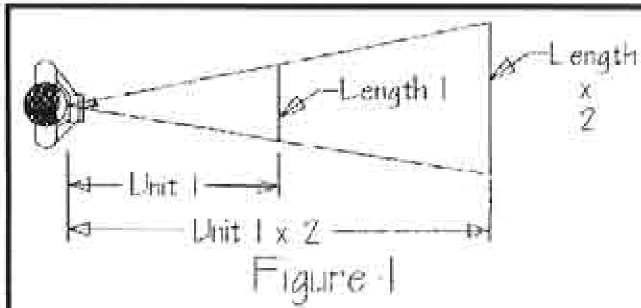
In spite of the great abilities of the human visual system, we are often surprised by the limitations. Most of us have seen optical illusions in school books and other material and we know that the eyes and visual cortex of the brain are prone to fallibility. We have developed many visual cross references in our everyday activity to make up for the failings of the system.

The following descriptions of visual cues will probably be somewhat different than you will find in the college text. (It's been several years since I was in college and I don't remember the normally used terms.) In general, we used the following cues for speed (remember speed is Distance times Time):

1. Relative speed - Time to move a distance relative to a known moving or stationary object.
2. Subtended angle and ocular convergence - Time for moving object to traverse a visual angle combined with distance to the moving object.
3. Rate at which object increases or diminishes in apparent size.
4. The last cue is best described as maneuverability. An object that changes direction rapidly is perceived to be moving quickly.

Now for some examples:

If you have ever seen a Boeing 747 on approach to landing you would swear that it should be falling out of the sky when in fact it is doing well over 150 MPH. If the 747 is followed by a small private plane you will see the 747 easily pull away from the little plane. The cues fail because the only measurement you have of the object in the air is the object itself. There are no stationary objects in the sky. Even when slope soaring the other objects in the field of vision are often too far away to use for judging speed. You can only observe the time it takes for the object to traverse its own length. I prepared a table to compare the time it takes for various length fuselages to traverse 4 of their own lengths at various airspeeds. See Table 1.



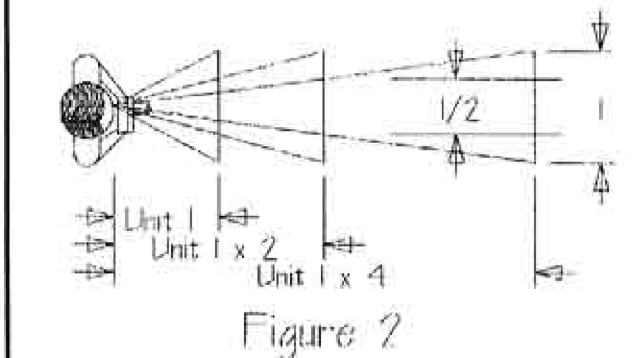


Table 1

Time for plane to traverse 4 fuselage lengths

Speed	Fuselage Length (Inches)			
	25	35	45	55
At 25 MPH	.23	.32	.41	.50
At 35 MPH	.16	.23	.29	.36
At 45 MPH	.13	.18	.23	.28
At 55 MPH	.10	.14	.19	.23

Formula — (Length * 4)/(Speed * 5280 * 12 / 3600)

As you can see a 55 inch fuselage has to go more that twice as fast as a 25 inch fuselage to appear to move as fast, WHEN COMPARED TO ITS OWN LENGTH ALONE. But we do have other cues.

The 747 is easy to see from a great distance. The little plane is much more difficult. If you were close to the 747, watching it land, its speed would be much more apparent. This is related to the second cue listed. If you have ridden in a go-cart you know how fast you seem to be going, but in a straight line speed run with a normal car it's easy to see the go-cart rarely travels more that 35 or 40 MPH. When you're in one, close to the ground, it seems to move by much faster. Conversely, if you climb into an 18 wheeler and cruise at 65 (I know that's not legal in most states.) it will seem you are going slower than the same speed in your family car. So, if you're closer to a moving object, it seems to move faster because it crosses the visual field faster. This relates to our model in this way: bigger models can be flown farther away and smaller models are often flown closer just so we can see them. See Figure 1.

As you can see, a model flown twice as far away takes twice as long to cross a given visual angle at the same speed. If it is twice as fast it will seem to fly the same speed, IF WE ONLY USE THE TIME TO CROSS A GIVEN VISUAL ANGLE.

We also have the cue of convergence to assist in determining distance to the object to factor in with the visual angle. This is also called depth perception.

Depth perception is a less then perfect sense for most people. How many times have you said, "I'm no where near that tree!" Crash!? We all have experienced the failing of depth perception. The human eye is not a good rangefinder for stationary objects and is even worse for moving ones. In addition, both eyes must be working well together for convergence to be very accurate. If you have a dominant eye which does most of your visual work, as most of us do, then the only cue for range is retinal image size, cue number 3.

The retinal size of an object in our vision changes quite rapidly when the object is close and somewhat slower as it moves away. See Figure 2.

If we call the closest viewed distance, unit one for distance. Then we must move the object two units to get the object to appear half its original size. To get yet another halving of the image, we must move the object to a range of four units. The image size changes as the inverse of the square of the distance change. When we are standing on the ground, let's say next to a tree, and someone asks us to move twice as far from the tree, we can be fairly accurate because we have the ground as a reference. Once we move to the slope, the ground is lost as a reference and the only range cues we have are convergence and retinal size. If you have ever lost a plane out and down a slope you know that the plane is often found either well below or much closer than your original estimate of the distance the plane was out from the ridge. Part of this is due to the fact that we cannot retain accurate retinal images. Our knowledge and memories of the object distort the memories of the last visual image and we cannot accurately compare the images. This is also true when we are flying, we cannot move the plane twice as far away because we cannot retain the last image to compare to the next one. It is possible with some handheld sighting device to mark and compare image sizes but I haven't heard of anyone really trying that for this purpose.

Lastly, we come to rapid changes in direction. We tend to lead with our eye when we are looking at a moving object. This is the same thing a cameraman must do to keep an object in the viewfinder while taking a picture of a moving object. Fortunately, our eyes have a much greater field of view and we don't lose sight of the object but we still tend to overshoot the turn by a little. As the object reverses direction it moves to the edge of our peripheral vision as we begin to reverse our eye scan. This intrusion into our peripheral vision cues us that the object is moving quickly. This is closely related to the visual angle cues but is accentuated by the eye scan overshoot.

Now, let's put this all together. Why is it hard to accurately judge the speed of a model sailplane, especially on the slope? It really boils down to a lack of "normal" visual cues and the size and maneuverability of the sailplane. A smaller plane is flown closer, is more maneuverable, and covers its own length fairly rapidly. A larger plane can be flown farther away, doesn't turn as rapidly, and covers its own length more slowly when flying at the same speed as the smaller plane. The only accurate way to measure the speed of various models is to use a timing trap and fly in the same conditions and the same flight track, which is not easy since you have to judge distance...... I think that's enough.

Just remember slopers keep it up the longest! ■

B.A.T. Winch Product Report

...by Rob Glover
Huntsville, Alabama
First Serial Rights

This is a review of some of the many products brought to us by Basic Aircraft Technology (B.A.T.), which is a co-op headed up by Bob Harman. Bob's business card states that he also offers sailplanes, fuselages, foam wings, electronic mixers, and drums. His "catalog" consists of a rather primitive looking bunch of xeroxed paper, chock full of neat stuff that none of us could ever do without. It is obvious that Bob spends his time on product rather than marketing.

The winch unit tested consists of the machined aluminum drum, brake, side plates, and outboard bearing portion of the winch. Related items supplied by BAT were welded winch base, aluminum control panel, turn around pulley, and line. The other items needed to finish the winch were obtained locally. Bob can supply anything from a built up winch, or the parts you need to finish your winch. All of his drums are "upward compatible", so that you can start out with a minimal set-up and progress to something fancier as your needs change. The components all fit the ubiquitous Ford long shaft starter motor. For those of you who have been gradually collecting the parts to build a winch, as I had, this approach works really well. Winches are available anodized in your choice of decorator colors, for those of you who don't care for polished aluminum.

My first impression of the winch unit was, "This thing is built like a brick outhouse, only pretty!" The design is intelligent, and craftsmanship superb. It is built out of machined aluminum stock, and polished up like new money.

The drum is of the 3 piece bolt together with integral V-belt brake variety. The drum OD is 2.75". It has side plates for

B.A.T. winch unit is $185.00 + S&H. All other winch accessories are extra. 1" metal base, 3/4" ply base, 1/8" control panel, 2 - 4 winding motors, foot switches w/or w/o base, electrical components available. (String #24 braided nylon.)

mounting the motor, brake arm, and outboard ball bearing motor shaft support. It comes with a well placed, sturdy handle for carrying. The included hardware is of a very high quality. Fit and finish of the parts are excellent. Holes for mounting the unit to a base plate and starter motor are drilled and threaded. The current price of this unit is $185.00.

The winch unit bolts to a base made of welded steel square tubing. The base has a frame to set your battery in, and comes with rubber feet. With the battery holding the whole thing down there is no need to stake the winch down. I was skeptical about this, and Bob thoughtfully drilled some holes in the frame to stake it down with. I have not needed to use them yet, and I really put a strain on the winch.

The control panel Bob sent is quite pretty. The engine turns an aluminum plate, which mounts to the base. I drilled the plate to fit my electrical controls, and mounted them to it. The whole unit looks as pretty as a speckled pup. It's obvious that Bob takes pride in his products.

The turn around pulley is the type that stands up off the ground a few feet. The "stake" that holds it up is 3 pieces of cold

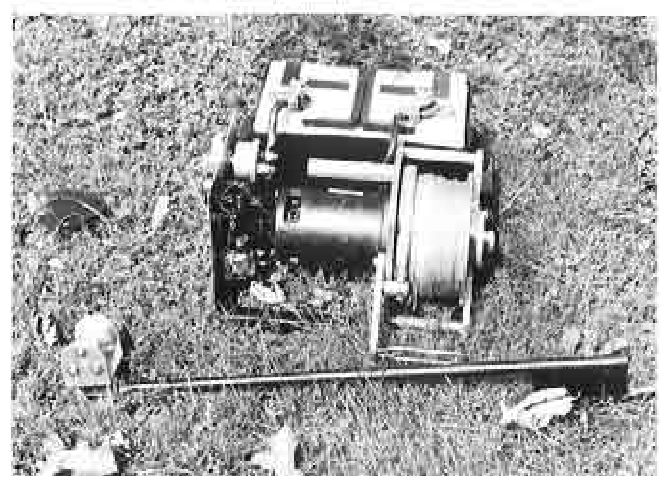
rolled steel. The pointy part is 3/4" diameter bar, which is welded to a piece of 3/4" plate, in turn welded to another piece of 3/4" bar that sticks up in the air. The stake is a fine piece of iron mongery. The pulley itself drops on to the machined top end of the bar. It is self aligning, and held on securely with a "safety pin". Bob has prototype pulleys in three different diameters, the one tested is 15/32" in diameter. This will probably be the production size, and has worked well for me. The machined aluminum pulley is installed on the stake after the stake has been pounded into the ground in order to save its ball bearings from damage. It spins quite freely, and has no projections for the line to snag on.

Bob also has several innovative products for the electrical portion of a winch, such as arc-suppression circuitry for the solenoids and foot switch, indicator lights to tell you when a solenoid has welded itself shut, battery level indicators, and redundant control circuits. If you have ever seen a glider after it was pulled through a turn around pulley you will want to investigate these further.

After a month or so of use by myself and fellow club members the winch has proven to be as sturdy and well thought out as it looks. I really enjoy the brake, which can be totally ignored after initial adjustment. (Try spraying some silicone lubricant on the brake belt if it grabs.) I spooled it up with some of the 230 lb test braided line that Bob sells, and the results make it necessary to give warning to visiting fliers. The thing will jerk you off the foot switch if you aren't ready! This is kind of fun to watch, so I don't warn everybody. The thing will toss a Synergy '91 with the gusto that it deserves, which is no trifling feat. With a 200 amp/hr marine battery it will launch planes of all sizes all day long.

The whole system is sturdy enough for heavy club or contest use. It works with a minimum of maintenance or operator intervention. The turn around might need some additional guying out in very soft or sandy soils, but works fine here in North Alabama. The winch is pretty enough that when I brought it in the house to photograph it, and got caught by wife Valeta, I got comments about taking pictures of a wench on the bedroom floor instead of demands that the carpet be cleaned.

Bob Harman has proven to be very easy to work with throughout. While working with some of the prototypes involved in this report he was very responsive to suggestions and quick to supply modifications, some of which were admittedly overkill. I wish all the people that I do business with were as committed and diligent.



For more information contact Bob Harman at Basic Aircraft Technology, 10424 Golden Willow Dr., Sandy, Utah 84070; (801) 571-6406. ■

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New EH Airfoils

In the November 1990 issue of *R/C Soaring Digest* we described three airfoils designed by John Yost - the EH 1.0/9.0, 1.5/9.0, and 2.0/10.0. The EH 2.0/12.0 and 3.0/12.0 described this month are new additions to this series.

The first number within the EH designation denotes the percent camber, the second the percent thickness. All of the EH airfoils have very low pitching moments, essentially zero, and are ideal for swept flying wings with quarter chord sweep angles of about 20 degrees. None of the EH sections should be used on planks, as that planform requires airfoils with a substantially positive pitching moment.

These new EH sections, with their 12% thickness, can be used as root sections where a greater spar depth is needed. Some designers may consider using a thicker, higher cambered airfoil at the root and a less cambered thinner airfoil at the tip in an effort to improve efficiency. The EH 3.0/12.0 can be used where higher lift coefficients are needed. Use Table 1 as a general guide when choosing an appropriate airfoil.

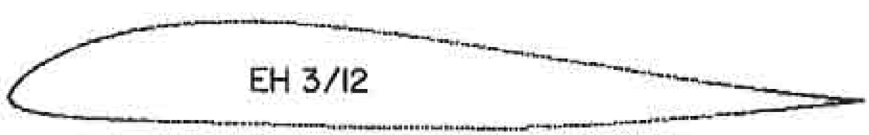
Since the camber line of reflexed sections is of an "S" shape, there is a very sharp curve on the lower surface of the section near the trailing edge. Even at higher angles of attack, there is the possibility of separated flow over this area. The solution is to turbulate the airflow upstream of the separation point. The lower surface turbulator should be placed at about 65% chord. It is particularly important to place a turbulator in front of any control surface which deflects upwards. As with normally cambered airfoils, the performance of reflexed airfoils can be improved when operating at relatively low Reynolds numbers by installing a turbulator at about 15% on the upper surface.

We would appreciate hearing of your experiences with these new sections. ■

Table 1

Section	Use	C_{mo}	$\alpha_{L=0}$
EH 1.0/9.0	F3B	0.00088	- 0.37
EH 1.5/9.0	F3E and thermal duration	0.00073	- 0.55
EH 2.0/10.0	thermal duration	0.00165	- 0.74
EH 2.0/12.0	thermal duration and scale	0.00165*	- 0.74*
EH 3.0/12.0	thermal duration and scale	0.00165*	- 1.10*

* Approximate values from published polars.



EH 2.0/12.0

X	Y	X	Y
100.000	0.000	0.099	- 0.390
99.901	0.060	0.394	- 0.767
99.606	0.024	0.886	- 1.144
99.114	0.061	1.571	- 1.516
98.429	0.121	2.447	- 1.869
97.553	0.207	3.511	- 2.192
96.489	0.319	4.759	- 2.481
95.241	0.456	6.185	- 2.736
93.815	0.617	7.784	- 2.959
92.216	0.801	9.549	- 3.153
90.451	1.009	11.474	- 3.323
88.526	1.244	13.552	- 3.470
86.448	1.503	15.773	- 3.599
84.227	1.788	18.129	- 3.711
81.871	2.096	20.611	- 3.809
79.389	2.427	23.209	- 3.894
76.791	2.779	25.912	- 3.967
74.088	3.150	28.711	- 4.028
71.289	3.537	31.594	- 4.075
68.406	3.937	34.549	- 4.109
65.451	4.346	37.566	- 4.127
62.435	4.762	40.631	- 4.128
59.369	5.178	43.733	- 4.109
56.267	5.589	46.861	- 4.069
53.140	5.990	50.000	- 4.006
50.000	6.373	53.140	- 3.919
46.861	6.731	56.267	- 3.806
43.733	7.058	59.369	- 3.669
40.631	7.346	62.435	- 3.508
37.566	7.587	65.451	- 3.324
34.549	7.774	68.406	- 3.119
31.594	7.901	71.289	- 2.897
28.711	7.962	74.088	- 2.661
25.912	7.952	76.791	- 2.416
23.209	7.869	79.389	- 2.164
20.611	7.709	81.871	- 1.912
18.129	7.473	84.227	- 1.663
15.773	7.162	86.448	- 1.423
13.552	6.780	88.526	- 1.194
11.474	6.332	90.451	- 0.980
9.549	5.824	92.216	- 0.785
7.784	5.266	93.815	- 0.609
6.185	4.666	95.241	- 0.453
4.759	4.035	96.489	- 0.318
3.511	3.385	97.553	- 0.206
2.447	2.728	98.429	- 0.121
1.571	2.082	99.114	- 0.061
0.886	1.470	99.606	- 0.024
0.394	0.915	99.901	- 0.006
0.099	0.427	100.000	0.000
0.000	0.000		

EH 3.0/12.0

X	Y	X	Y
100.000	0.000	0.099	- 0.381
99.901	0.060	0.394	- 0.731
99.606	0.024	0.886	- 1.063
99.114	0.061	1.571	- 1.374
98.429	0.121	2.447	- 1.654
97.553	0.207	3.511	- 1.894
96.489	0.319	4.759	- 2.093
95.241	0.457	6.185	- 2.253
93.815	0.619	7.784	- 2.382
92.216	0.805	9.549	- 2.485
90.451	1.017	11.474	- 2.570
88.526	1.256	13.552	- 2.643
86.448	1.524	15.773	- 2.708
84.227	1.819	18.129	- 2.771
81.871	2.143	20.611	- 2.834
79.389	2.493	23.209	- 2.901
76.791	2.870	25.912	- 2.971
74.088	3.272	28.711	- 3.044
71.289	3.697	31.594	- 3.119
68.406	4.141	34.549	- 3.193
65.451	4.602	37.566	- 3.262
62.435	5.075	40.631	- 3.324
59.369	5.555	43.733	- 3.372
56.267	6.035	46.861	- 3.404
53.140	6.507	50.000	- 3.415
50.000	6.964	53.140	- 3.401
46.861	7.397	56.267	- 3.361
43.733	7.795	59.369	- 3.292
40.631	8.150	62.435	- 3.194
37.566	8.452	65.451	- 3.068
34.549	8.691	68.406	- 2.915
31.594	8.858	71.289	- 2.738
28.711	8.946	74.088	- 2.540
25.912	8.949	76.791	- 2.325
23.209	8.863	79.389	- 2.099
20.611	8.684	81.871	- 1.866
18.129	8.413	84.227	- 1.633
15.773	8.053	86.448	- 1.403
13.552	7.608	88.526	- 1.181
11.474	7.084	90.451	- 0.973
9.549	6.492	92.216	- 0.781
7.784	5.843	93.815	- 0.607
6.185	5.149	95.241	- 0.452
4.759	4.424	96.489	- 0.318
3.511	3.683	97.553	- 0.206
2.447	2.942	98.429	- 0.121
1.571	2.223	99.114	- 0.061
0.886	1.551	99.606	- 0.024
0.394	0.952	99.901	- 0.006
0.099	0.437	100.000	0.000
0.000	0.000		

Building Your Own Hands-Off Foam Cutter

...by Cameron Ninham
Bloemfontein, South Africa

After obtaining Frank Weston's plans to scratch build a Magic sailplane I realised that I had to perfect my foam cutting technique.

Recently there have been several articles on how to cut your own foam cores, as well as how to build foam cutting bows and foam cutting "machines". For this reason I will not go into these matters any further, and I am certain that most people have developed their own unique methods for building such devices and cutting foam cores. What I would like to do is share my method of building and USING a hands-off foam cutting machine. Please note that this method will only work with the double/split template method.

Firstly, let's consider the bow. After building the bow there are several ways of rigging the bow to the foam-cutter. One way of doing this is by suspending the bow from the ceiling or other object by an elastic rope or spring. This is done so that the bow will lie resting only with its own weight on the templates and be able to travel the full distance along the template without lifting away from the template surface. Another way of rigging the bow is by placing the foam core on a flat surface/platform with no legs or obstructions to the side or front of the platform (E.g., like a tongue extruding out from a wall). Then, let the bow hang upside down suspended with the cutting wire resting on the template. In both cases gravity will ensure that the cutting wire does not lift away from the template and the pressure on the template is correct - proportional to the weight of the bow.

Secondly, let's consider the propulsion method. Here again are various ways of implementing a propulsion method. One way of achieving propulsion is mechanically by an electric motor or similar device. The other is by natural forces, i.e. gravity. Again, both these methods can vary from one implementation to another. I am just trying to give some ideas. The first method can be accomplished by letting the whole setup lie on a flat and horizontal surface. (See figure 1.) Connect a cable or thin piece of string to the END of the moment arm (lever) and hook it up to an electrical motor with a small drum (winch). This should be done in such a way that when the motor is switched on it will pull the moment arm in a direction towards itself. The other method, and the one I use and prefer, is by letting nature do the work for you. It's cheaper as well! This is accomplished by routing the wire that pulls the cutting wire towards the edge of the table around one pulley and then down a second to the moment arm. The moment arm will be hinged in such a way that it will swing vertically from the edge of the table (or any other position) downwards towards the floor. If the moment arm is built of a light weight material extra weight can be added at the end of it. Be sure not to make the lever too heavy as the wire must cut through the foam at its own pace, it must **not be forced** through the foam.

Let's look at Figure 1. Place the foam core on the work surface. Let the cutting wire lie on the templates at the starting position on both sides. (I prefer to cut my cores starting with the top half of the profile and cutting from the trailing edge to the leading edge, then turning the core around and cut the bottom cut starting from the leading edge through towards the trailing edge. This gives extremely sharp and thin trailing edge cores.) Attach one cable to the cutting wire at the root template, let it run around the pulley at the hinge line, then around pulley # 2 and fix it on the moment arm at point

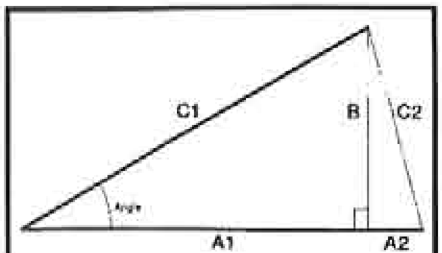


Figure 2

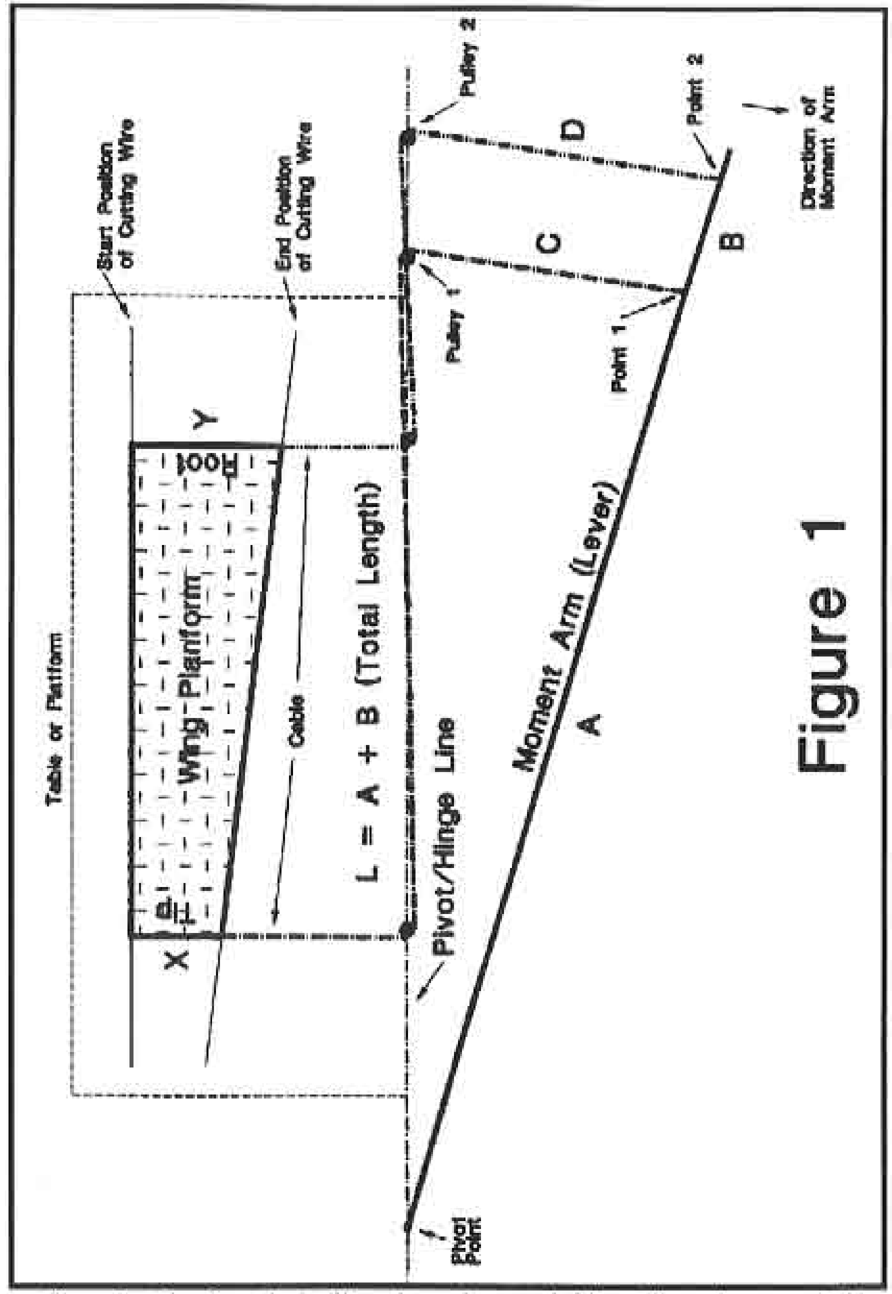


Figure 1

2. Take the other cable and tie it onto the cutting wire right next to the tip template. Run the cable around its pulley at the hinge line, around pulley # 1 and tie it on the moment arm at point 1. If you pull the moment arm through an arc (either by the gravitational or electrical method) till the cutting wire reaches the end mark at the root it should be at the end mark at the tip as well! You can cut perfectly tapered cores this way. If the panel is not tapered, run both cables around pulley 2 and fix them both at point 2.

Now the great question arise: What distance must point 1 and 2, and pulley 1 and 2 be from the pivot point? Remember that the distance from the pivot point along the hinge line to pulley 1 must exactly equal the distance from the pivot point along the moment arm to point 1. The same is true for pulley 2 and point 2.

$$A = \frac{X(A+B)}{Y}$$

$$= \frac{X * L}{Y}$$

$$B = \frac{A(Y-X)}{X}$$

The equations can now be used to calculate the distances as follows. The root and tip lengths are known. Let's assume that the core is 50", at the root (Y) 10" and at the tip (X) 7". One of two methods can be followed:

1. Use a Total Length of L for the moment arm.

If we want the total length (L = A + B) to be 40", we can calculate the length of A by using equation 1.

$A = (X * L) / Y$
$= 7 * 40 / 10$
$= 28$

Thus, if L = 40", then A = 28" and B = 40" - 28" = 12"

2. Use A (take any value) and calculate B.

If we want to assume a value for A, we can calculate B by using equation 2. Let's use A = 28".

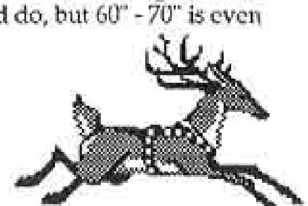
$B = (A * (Y - X)) / X$
$= (28 * (10 - 7)) / 7$
$= (28 * 3) / 7$
$= 12$

Thus, if A = 28", then B = 12" and L = 28" + 12" = 40"

There is a mechanical way to determine the distances as well. I will try to describe it as simple as possible.

Once more, we know that the root and tip are 10" and 7" respectively. Let the cutting wire lie at the starting position on both templates. If we were to tie one of the cables to the cutting wire at the root template and run it around its respective pulley at the hinge line, around pulley 2 and tie it to the moment arm at point 2. Pulley 2 and point 2 must be equal distances from the pivot point but can be any length. When the cable is fixed to the moment arm, the moment arm lays along the hinge line. Pull the moment arm away from the hinge line so that the distance D = Y (Root = 10"); it must pull the cutting wire to the end mark on the root template. Now take some measuring device/object that is equal to the length of the X (Tip = 7"). While keeping the moment arm still (Distance D) move a ruler or object **parallel to line D** so that the distance between the hinge line and moment arm (C) equal that of the Tip (X). Where this happens is where pulley 1 and point 1 must lie on the hinge line and moment arm respectively.

To ensure the effectiveness of the system it is advisable to use a long moment arm. 40" would do, but 60" - 70" is even better. ■



Press Release

North American Scale Soaring Association

Scale R/C soaring has grown quite rapidly over the last few years. Now a group of scale proponents want to promote scale R/C soaring on a National level. So, scale advocates have started a new association dedicated to the R/C scale soaring movement. This new association will include the interests of Power Slope Scale, Vintage, Modern, Slope Scale, and Thermal Scale; with special emphasis being placed on bringing all scale specialties together. The fathers of this new association are scale enthusiasts such as Pete Bechtel, Gene Cope, Gary McVay, Erik Eiche, Gary Brokaw, Frank Smith, Roy Lightle, Randy Holzapple, Greg Neveau, Wil Byers and Mike Mellor. All of these modelers and R/C scale soaring buffs want you to share in their affiliation and comradery.

Theirs and hopefully your new association will have the title, North American Scale Soaring Association (NASSA). These Northwest founders want to attract members from throughout the United States, Canada, and Mexico. Judy and Jerry Slates have most graciously agreed to provide a dedicated bi-monthly column to disseminate news to members of the association. Therefore members will be able to keep abreast of all the happenings within NASSA via *R/CSD*. By utilizing *R/CS.D.* as the news provider the dues members will have to pay can be kept low. The dues will allow NASSA to sanction events for scale across the country. It will also allow the association to host a special annual Scale Rally sanctioned by NASSA and the AMA. Members will also play a crucial role in developing policies and a direction for the scale soaring movement. While, the Scale Rally will provide the focal point for that and any other development. As well, all members will provide momentum that will propel scale now, and into the 21st Century.

To kick this association off and get individuals interested in scale, the association has a couple of things planned for its new members in 1993. The first is supported by a tremendous R/C soaring scale enthusiast and a representative of **J.R. Radios Corporation**, Mr. Tom Kikuchi. Tom has been involved in R/C and scale soaring for a number of years now and has offered to provide a J.R. Radio X-347 as a raffle prize to members who join the association by May 15, 1993. The winner will be drawn at random and the association will pay for shipping the radio to the lucky and exuberant R/C scale soaring member.

Tom wasn't sure one radio was enough to motivate R/C enthusiasts in North American in the direction of scale. So, Tom added to the incentive by offering 3 more X-347 radios. These radios are to be given away at NASSA's first informal, but AMA sanctioned scale rally. This event is scheduled for July 10 & 11, 1993 in Richland, Washington, the former site of the International Scale Fun Flys. The event's format will be set around flying scale models of all types from either a thermal field (using winch or aerotow) or from one of the many good slope sites available in the Tri-City area.

As a special point of interest, the 1993 Scale Rally will feature a thermal flying task established by Mr. Martin Simons' club from Australia. By the way, Martin Simons has heartily endorsed the idea of a scale soaring association here in the North America and sees it as a chance for the scale soaring to become a truly international movement. (Some of you may have read or purchased Mr. Simons book "Vintage Sailplanes" published by Kookaburra Technical Publications PTY LTD, P.O. Box 648, Dandenong 3175, Melbourne, Victoria, Australia.) Anyway, the task is a simple one: to stay aloft for a total of 40 minutes with a multiple of launches allowed if necessary. It also requires that the model be landed on a runway, but not spot landed, just landed on the runway. Models will be judged for accuracy of detail, however, the judging will be done from outside a circle of 25 feet in diameter. Also, the models will be divided into three classes. Two classes will be separated by date only. The date being the first year an all fiberglass sailplane was introduced. That date was November 1957 and all gliders patterned after designs built from then on will be considered Modern. While Vintage will be models copying gliders designed and built prior to November 1957. A special class will exist for Power Scale type models and some of them may even be aerotowed; who knows. Rest assured, however, it will be a really laid back event and all who attend should enjoy themselves. If the wind is blowing the event becomes a slope soaring rally. If it doesn't it will be a thermal field rally.

Now, if you are suppressing that desire for scale and finally want to become part of a new and growing movement write to NASSA. You will without a doubt be discovering some of the best performing sailplanes that R/C soaring has to offer. NASSA's address is 3540 Eastlake Dr., W. Richland, WA 99352. For information please include a S.A.S.E. To join the association the cost is $10.00 per year, which will be used to sponsor the annual scale event. It must be noted that the NASSA intends to host its annual scale rally at different sites each year so that scale modelers from all parts of North America will eventually have a chance to attend. Come on, join in the **FUN of SCALE!** ■

1993 North American Scale Soaring Association Rally
July 10 & 11, 1993
Pre Registration Form
Please PreRegister by June 1

NAME: ____________________
ADDRESS: ____________________
CITY: ____________________
STATE: ______________ ZIP: __________
AMA # ______________ PHONE: __________
Radio Frequencies: ______ ______ ______ ______
Model Design ______________ ______________
______________ ______________

ENTRY FEE: ______________ $20.00
ADDITIONAL MODELS: _____ QUANTITY _____ x $2.00 ea. _____

LATE REGISTRATIONS ARE CHARGED $5.00 SORRY!!

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Cavanaugh's Inn	**Silver Cloud Inn**
1101 N. Columbia Center Blvd.	**7901 W. Quinalt Ave.**
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1-800-THE INNS	**1-800-551-7207 #7**

Both Hotels are * Clean, Close to Slopes, Columbia Center Mall, Many Shops, Golf, Water Park, Columbia River, Meals, Vista Airport & Nearby Day Care is Available**

NASSA
North American Scale Soaring Association
3540 Eastlake Dr., W. Richland, Wash. 99352
1-509-627-5224

Schedule of Special Events

Date	Event	Location	Contact
Dec. 12	Calif. Slope Racers TPG 60"	North Duane Gibbs South	Hal Krammer (510) 449-0441 (714) 731-3461
Jan. 1	Mini-Hand Tow Contest	Irvine, CA	Scott Smith (714) 651-8488 Eve
Jan. 1-9	International Model Engr. & Modelling Exhibition	London, England	Argus 0442 66551
Jan. 9	Calif. Slope Racers TPG 60"	North Duane Gibbs South	Hal Krammer (510) 449-0441 (714) 731-3461
Feb. 6-7	Southwest Winter Soaring Contest	Gilbert, AZ (602) 831-1905 or 839-1733	Iain Glithero
May 28-31	Mid Columbia Cup Slope Races	Richland, WA	Joe Conrad (206) 630-2670
June 26-27	NASF/MASS Mid-South Soaring Champs	Huntsville, AL	Ron Swinehart (205) 883-7831
July 10-11	North American Scale Soaring Assoc. Rally	Richland, WA	Wil Byers (509) 627-5224
July 16-27	AMA NATS	Lubbock, TX	
Sept. 18-19	TNT Texas National Tournament	Dallas, TX	Henry Bostick (214) 279-8337

3rd Mini-Hand Tow Contest Announcement

...by Scott Smith

The 3rd Irvine Model Aviation Mini-Hand Tow contest will be held on January 1, 1993, at the Irvine Civic Center Community Park Site at Irvine City Hall in Irvine, CA. Rules will be the same as the 2nd contest; however, the tow lines will be modified slightly. They will be the same length; however, the stretch on the rubber will be limited to 2.5 times the relaxed length by a limit line. This is because contestants discovered how to zoom launch by over-stretching the rubber; hence, several launch lines broke. In addition, an optional 1.5 overstretch limit will be provided for very light sailplanes that otherwise tend to launch ahead of the runner and hence drop off the line too early.

This is on New Years Day; bring your new 2-meter or smaller ship, and get home early enough to watch the football games! The field will open at 8:00 for practice (tow lines will be provided), pilots meeting at 10:00, and the first round will start at 10:30. The contest should be over by about 12:30. There is **no entry fee**. See the February and July issues of *RCSD* for rules and contest discussion and/or call Scott Smith at 714/651-8488 evenings for directions, etc.

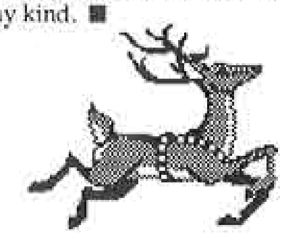
Ten contestants participated in the 2nd Hand-tow contest on October 18, 1992, in Irvine, CA. 8 60" gliders participated as did 2 2-meter ships.

Contestants were surprised to find the field completely graded and half-covered with sawdust. This was due to the festival held there two weeks before. Conditions were light for the first group of the first round, but improved to excellent thereafter. Many contestants stayed after the contest to enjoy the numerous thermals and light wind conditions.

Many contestants practiced before the contest. Spectators enjoyed watching Dr. Norm's launch bottle drag along the field when the tow ring failed to disconnect from his glider. He corrected the problem and had a very successful contest.

The only casualty was Kim Reynold's Skyhawk which was towed to stall and couldn't clear the ground on the dive. It was a clean break and was repaired in five minutes.

Pat Conway impressed everyone with his incredibly high zoom launches, and Robin Riggs turned in an impressive score considering that this was only his third contest of any kind. ■



Pre Registration Form
1993 MID COLUMBIA CUP
SLOPE RACES
MAY 28,29,30,31, 1993

NAME: ______________________
ADDRESS: ______________________
CITY: ______________________
STATE: ____________ ZIP: ____________
AMA # ____________ PHONE: ____________
CHANNEL CHOICE: 1st____________ 2nd ____________

ENTRY FEE: $55 U.S.; INCLUDES AWARDS, & $1000 FIRST PLACE PURSE. MAKE CHECKS PAYABLE TO TRI CITY SOARERS.
NO LATE REGISTRATIONS ACCEPTED!!!

PRE REGISTRATION DEADLINE MAY 1

MODEL SPECIFICATIONS

MODEL NAME: ______________________
WING AREA: ________ **SQ. IN. ELEVATOR AREA** _____ **SQ. IN.**
MAXIMUM BALLASTED WEIGHT ____________ **LBS. OR KGS.**
INCLUDE A 3 VIEW & MEASUREMENTS OF MODEL IF POSSIBLE

AMA SAFETY CODE APPLIES
UNLIMITED CLASS
TASK - PYLON SPEED - MAN ON MAN

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C.D. Joe Conrad 1-206-630-2670

Self-Scoring Form Instructions

...by Scott Smith

A contest director is indeed fortunate if he has a field-portable computer along with software to tally the contest scores while the contest is running. However, such a situation is not always available, and having one person manually make the calculations can be time-consuming and error-prone. It occurred to me that, given the right form and instructions, contestants themselves could calculate their own scores.

A sample scoring form is shown for a hand-launch contest. The format includes provision for man-to-man scoring. Anyone who fills out their own income tax forms will recognize the format.

The key to the design is to be careful to make the scoring algorithm as simple computationally as possible while maintaining the features needed to support the scoring objectives. For example, a scoring system that computes man-on-man will be more complicated than a system that doesn't.

Instead of declaring 1000 points as the maximum score for a round, 600 is used because that is the number of seconds in 10 minutes. 10 minutes is the time for a round in hand-launch rules. Therefore, one point equals one second.

Up to three raw times are entered for round 1, one for round 2, and five or six for round 3. The blanks for this purpose are found at the left side of the form.

The numbered blanks are where calculated results are entered; instructions for calculating the blank precede the blank itself, and the number identification for the blank follows it.

Filling out the form requires no data other than the raw times except for the round leader scores. This one piece of information must be coordinated by the contest director.

Here's how a round would be scored. Remember that this is for a hand-launch contest.

In round 1, everyone is directed to convert the minutes and seconds for their best three flights into seconds (blanks 1A, 1B, and 1C), and then sum to get the total number of seconds (blank 1D). At this point, the contest director asks for the best round 1 score in each group. The contest director calculates the difference the best score and a perfect score, in this case, 600. This difference becomes the "round leader seconds from 600" value for blank 1E for everyone in that group. When 1E is added to 1D, then all scores are normalized to their groups' best performance, thereby achieving the man-on-man scoring objective. Therefore, if someone achieves a perfect 10 minute flight in round 1, then the round leader offset is zero.

The other two rounds are scored similarly. Round 2 is slightly more complicated than rounds 1 or 3 because of two additional requirements: First, a flight over 5 minutes must be converted to its "equivalent" flight under 5 minutes; this is the purpose of blanks 2B and 2C. Second, since the flight objective is 5 minutes instead of 10, the score needs to be doubled in order to carry the same weight as rounds 1 and 3; this is the purpose of blank 2D.

Finally, some "human factors" for the contest director to keep in mind. First, most flyers are intrigued by the scoring themselves and take to it with relish; however, some won't, usually because they are uncomfortable with some of the arithmetic. Hence, encourage the "bean counters" among the flyers to assist those who hate bean counting. Second, make it very clear who belongs in what group and what the "round leader from 600" score is for each group. I find that it is best to list the contestants, their group assignment, and the 3 round leader offsets scores on a large poster board (or "white" board if you have one). The printing should be neat and professional, and the board should be posted so that everyone can easily see it.

In summary, properly designed scoring forms relieve must of the labor of scoring from the contest director when a computer is not available. A side benefit is that some contestants understand the scoring for the first time when they calculate it themselves! ■

Self Scoring Form
California Hand-Launch Rules

Name ____________
Contest Number ____

Round 1 *Best 3 Flights / no limit on launches*

1. ___min ____ sec. *Calc total seconds:* _______ (1A)
2. ___min ____ sec. *Calc total seconds:* _______ (1B)
3. ___min ____ sec. *Calc total seconds:* _______ (1C)

Add (1A), (1B), *and* (1C): _______ (1D)

Round Leader seconds from 600: _______ (1E)

Add (1D) *and* (1E) *for round 1 score:* _________ (1F)

Round 2 *5 minute flight / no limit on launches*

min sec. *Calc total seconds:* (2A)

If (2A) *is greater than 300, then subtract 300 from* (2A): _________ (2B)

then subtract (2B) *from 300:* _________ (2C)

If (2C) *is filled in, then multiply* (2C) *by 2, else multiply* (2A) *by 2, and fill in the result:* _________ (2D)

Round Leader score from 600: ___________ (2E)

Add (2D) *and* (2E) *for round 2 score:* _______________ (2F)

Round 3 *Five 2-minute flights / 6 launches max*

If any score in (3A) *through* (3F) *is greater than 120, then set it to 120 seconds.*

1. ___min ____ sec. *Calc total seconds:* _______ (3A)
2. ___min ____ sec. *Calc total seconds:* _______ (3B)
3. ___min ____ sec. *Calc total seconds:* _______ (3C)
4. ___min ____ sec. *Calc total seconds:* _______ (3D)
5. ___min ____ sec. *Calc total seconds:* _______ (3E)
6. ___min ____ sec. *Calc total seconds:* _______ (3F)

Add the 5 best scores from (3A) *through* (3F): ______ (3G)

Round Leader score from 600: ___________ (3H)

Add (3G) *and* (3H) *for round 3 score:* __________ (3J)

Total contest score, add (1F), (2F), ***and*** (3J): ____________________

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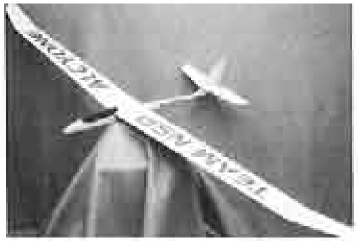

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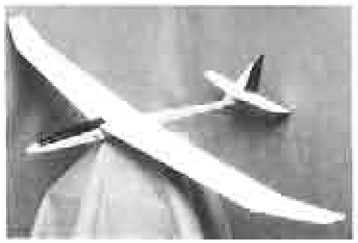
- Builds easily, includes top quality hardware and instructions.

GET A FIBERGLASS FUSELAGE FOR $50 MORE!



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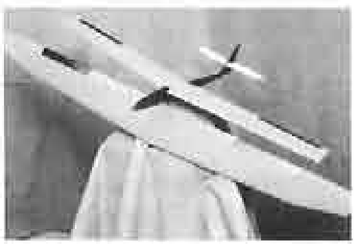

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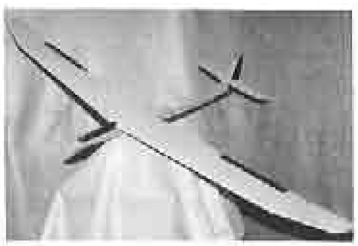

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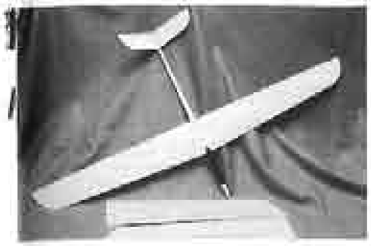

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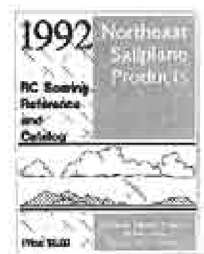

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Reference Material

Madison Area Radio Control Society (M.A.R.C.S.) *National Sailplane Symposium Proceedings*, 2 day conference, on the subject and direction of soaring. 1983 for $9.00, 1984 for $9.00, 1985 for $11.00, 1986 for $10.00, 1987 for $10.00, 1988 for $11.00, 1989 for $12.00. Delivery in U.S.A.is $3.00 per copy. Outside U.S.A. is $6.00 per copy. Set of 8 sent UPS in U.S.A. for $75.00. Walt Seaborg, 1517 Forest Glen Road, Oregon, WI. 53575

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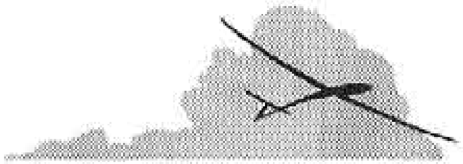

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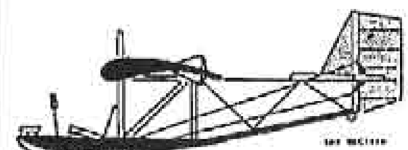

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Design Considerations for an Aerobatic Sailplane

...by Jef Raskin
Eight Gypsy Hill Road
Pacifica, California 94044
(415) 359-8588; FAX (415) 359-9767
October 1990 [revised August 1991]

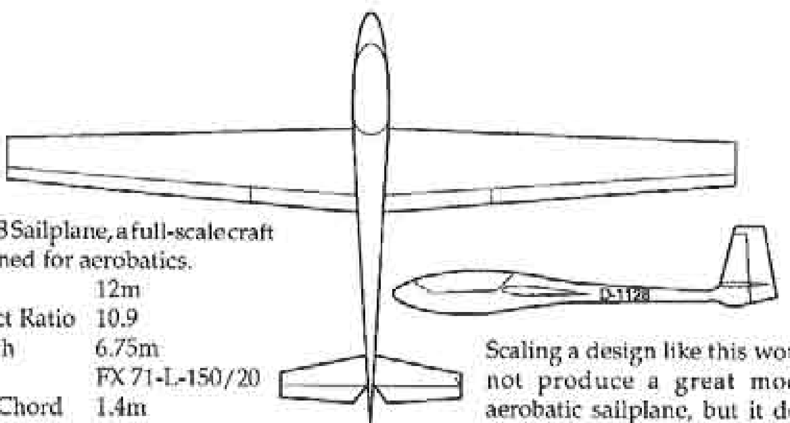
The Unsung Sport Of Sailplane Aerobatics

Aerobatics is not yet taken too seriously by the R/C glider fraternity in the U.S. It is a challenging and enjoyable sport with no upper limit to the quality of flying one can achieve. I am sad to report that even the prestigious LSF still awards its highest skill levels without the pilot being able to control the craft in inverted flight, much less be able to fly a figure M or do an outside snap roll. Full scale sailplane practice is far ahead of modelers, with organizations and formal aerobatic competition at the international level. At present, the only AMA-sanctioned aerobatic sailplane competitions are the ones I have organized. Few articles have addressed the design of sailplanes for aerobatics or published glider designs or airfoils suitable for this kind of work.

To be fully aerobatic a model aircraft should have, among other attributes, (i) three independent axes of control and (ii) the same control responses for upright and inverted flight [1]. Many self-proclaimed "fully aerobatic" kits currently on the market have asymmetrical wing airfoils so that they will not do outside maneuvers with the same ease as inside ones. Most aerobatic sailplanes with ailerons have no rudder, so that true hammerheads and snap rolls are impossible and four-point rolls a crude approximation at best. I can imagine the laughter that would ring out at a flying field if someone tried to pass off a model power plane with a non-symmetrical airfoil as "fully aerobatic" [2]. Our need for good L/D may incline us to couple flaps or flaperons to the elevator, or to use separate camber-changing controls, but there is also a need for relatively simple three-channel aerobats. This article shares my practical experience in designing, building, and competing in sailplane aerobatics as well as exposing the holes in my understanding, in the hope that others will help fill them in.

Small is Practical

A good starting point for a design is size. While increasing size is advantageous from the point of view of aerodynamic efficiency, agility decreases. Some sites



Mü-28 Sailplane, a full-scale craft designed for aerobatics.

Span	12m
Aspect Ratio	10.9
Length	6.75m
Foil	FX 71-L-150/20
Root Chord	1.4m
Tip Chord	0.7m

No dihedral on top of wing.

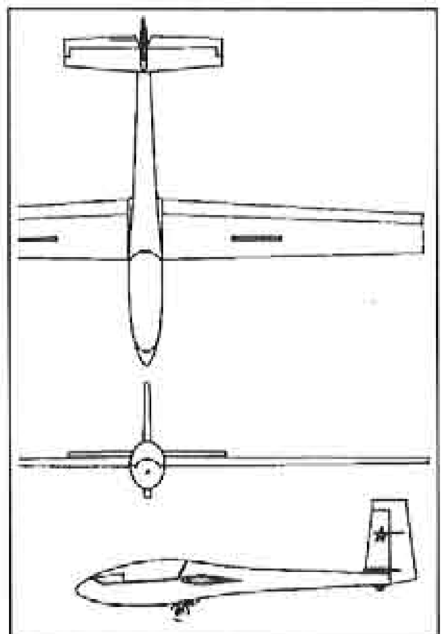
Scaling a design like this would not produce a great model aerobatic sailplane, but it does bring up the idea of scale sailplane aerobatic competitions!

have small bands of lift, making it awkward to fly a large plane: at one slope near my house, a 40" span craft could cavort through a triple roll easily, but my 80" span plane was well out of the lift (if not quite out of sight) before the maneuver was completed. An aileron roll (rolling on a downward vertical path) is ever the more comfortable if you can roll quickly enough to have time to pull out before the plane becomes an auger. But smallness can be taken to the point where fitting equipment is difficult. Planes from 38" to 54" span seem to do best in both sport and contest aerobatic flying. Even the smallest can handle 30+ mph "breezes" without difficulty.

Choosing a Configuration

The next design decision for me is overall configuration. I have not been successful at designing flying wings that can do snap rolls and hammerheads. Their slow rolls tend to wander in yaw and thus lack precision. Deltas do wonderful rolls and graceful loops but the yaw maneuvers are hard to accomplish since their high degree of sweep tends to couple yaw into roll. My deltas can do very nice rolls with rudder alone. The canard is popular for home-built aircraft because the wing will not stall; without stalling a wing you cannot do spins and snaps; hence they are not fully aerobatic though loops and rolls are no problem. V-tails are sometimes ineffective in spin recovery, and you lose some elevator authority when rudder is applied and vice versa. In addition a V-tail "induces a torsional moment in the fuselage larger than that caused by any ordinary vertical surface" [3]. Both V- and T-tails are not vertically symmetrical. Biplanes are out since the penalty of extra induced drag is undesirable in a sailplane, the ones I tried felt draggy. Perhaps something else can be made to work, but the conclusion that I have come to is that a standard layout seems best. This makes me a bit sad since I like unusual configurations, but aerobatics and not gawkworthiness is our goal here.

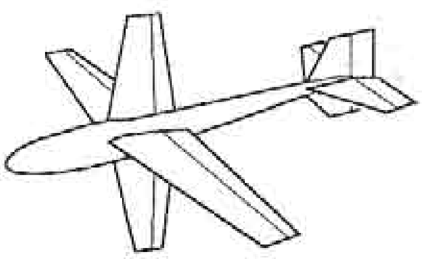
Another possibility is to design a plane with two wings, set at right angles to one another. In normal fight, the secondary



Celstar GA-1 Aerobatic Glider
Span: 11.05 m
Aspect ratio: 11.7
Section: FX 71-L-150/25 (symmetrical for 25% flap)
Length: 6.5 m
Construction: GRP composite
Mass: 265 - 375 kg
Stall: 80 km/h
Max speed: 324 km/h
Rated for +10 g and - 10 g
Best glide angle: 28:1
Price (US $, FOB) $50,000 (1991)
Notes: 2 slip indicators
Full span ailerons giving exceptional roll rate

This is a more recent design than the Mü-28. All dihedral has been eliminated, the ailerons are actually flaperons and are full span. They also are wider. Performance is increasing.

wings would point straight up and down, and in knife-edge flight they would support the aircraft. A variant on this idea is that the wings make an X when viewed from the front. This way the two lower wings could act as landing gear with small wheels at their tips, useful when flying from paved runways. At most slope sites, however, either of these wing configurations would be a disaster upon landing. Someday I hope to build one for the fun of it, perhaps catching it at the cliff's edge instead of landing it. You would have to introduce some visual asymmetry so that you could tell in what attitude the plane is flying - this is hard enough with our present models and would be impossible in an aircraft that looked the same right side up, upside down, and in knife-edge flight! The rules for pattern planes prohibit knife-edge wings, and I think we should follow their lead in this regard.



An ideal aerobatic sailplane?

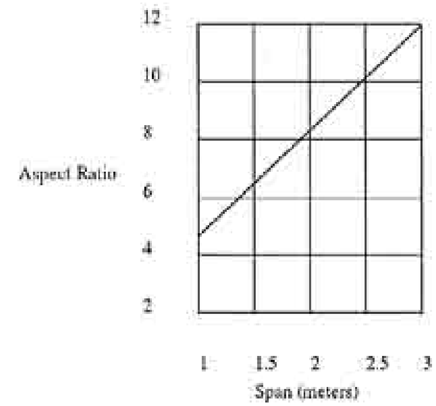
Wing Planform

For our design exercise, the wing planform is easily determined: to uncouple roll from yaw, the lifting action of the wing should be exactly at right angles to the centerline of the aircraft. Since symmetrical airfoils act as though all their lift is generated at the quarter-chord line, that line should be straight and perpendicular to the centerline. Almost all full-size aerobatic power planes and gliders adhere to this planform. Thus if the rearward sweep of the wing's leading edge at the tip is one unit, the forward sweep of the trailing edge should be three units. A rectangular wing has this property; tapered wings such as that of the Laser-type aerobatic planes, the world champion Extra 230's (and the P-51 Mustang) do too.

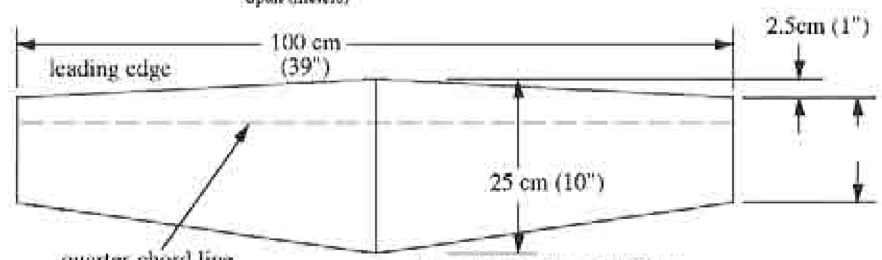
The amount of taper is a major factor in determining how easily the tips will stall. The less taper, the gentler a wing's stalling characteristics and the more difficult it is to get the plane to snap. In an aerobatic plane we do not want washout, since when inverted it becomes washin. In short, there is no utility in any amount or direction of wing twist. As Simons points out [4] a wing planform with straight leading and trailing edges and a taper ratio of about 0.5 is quite efficient, suffering only a few percent more induced drag than the ideal elliptical planform. A tip chord to root chord ratio of 0.5 is typical of aerobatic planes, higher ratios snap too readily. One "aerobatic" kit I bought had a highly tapered (0.5) wing and as a consequence the plane often did an impromptu snap roll, for example at the bottom of a loop. A number of others of like design have had the same problem. Due to Reynolds number effects, our wings should probably have less taper than full scale examples, but I have no exact data on which to base the taper ratio. The wingtip should be simply squared off. This is easy to build and, surprisingly, efficient aerodynamically [5]. In particular, it is more efficient than rounding the tips. Tips bent up or down (as on the Savage series) if they help at all, will not work when inverted: symmetry is to be desired. Changing the tip thickness ratio can also be used to control the way a wing stalls. Thicker tip ratios show less tip stalling.

On full-size aircraft, higher aspect ratio wings are more efficient. However at the low Reynolds numbers at which our models fly, this is not necessarily true. Dowdy's one-meter "Stylus" sailplane [6] is an example of an appropriately low aspect ratio (about 4.5) design. Simons

gives a discussion of the benefits of low aspect ratios at some length [7]. For a one meter plane, the optimal aspect ratio based on Simons' discussion would seem to be between 4 and 5 (whereas it is about 6 for a two-meter plane). Low aspect ratios also contribute to the desired high roll rate. The following chart shows the optimal aspect ratios for different spans (constant area) for a particular airfoil and aircraft design. [22]



safely ignore questions of efficiency. The Princeton tests [20] show the NACA 00— airfoils (e.g. NACA 0009, 0012), are not particularly good. More convenient for experimental purposes are foils such as those used by Walter Extra in his aerobatic planes. Carson [17] says that they are the same as those developed in France on Aerospatiale's computers for the Mudry CAP 21. According to Hollmann [9] they consist of an ellipse faired to a point by two straight lines tangent to the ellipse and meeting at an extension of its major axis (a design technique used for years by control line stunt pilots, but with thicker airfoils). For a given chord, such a foil is completely determined by two parameters, the point of maximum thickness and the thickness ratio. I designate them by four digits, for example a WE2512 has its point of maximum thickness 25% of the distance from the leading to the trailing edge, and the thickness-to-chord ratio is 12%. We can ask, what is the best place for maximum thickness



An aerobatic wing planform.

Having chosen an aspect ratio of 5, and choosing a taper ratio of .6, we have fully determined the planform. By pure luck, the measurements are convenient to lay out in both the metric and the English system (The few percent differences are unimportant.).

The Airfoil

The airfoil for this wing is another difficult consideration since there is little data on symmetrical foils at our Reynolds numbers: few people use them in sailplanes, and power plane designers can and what is the optimal thickness ratio for this series of foils? Extra's foils have a blunt trailing edge, which reportedly increase aileron effectiveness and do not increase drag on full-size aircraft. However, at our Reynolds numbers, as reported by Triebes [19], a sharp trailing edge is best.

My best aerobatic slope soarer so far had a thickness ratio of 10% and those that have been significantly thinner have not performed as well (especially in pitch-intensive maneuvers). But this is weak evidence at best since other factors may have been at work. Most popular R/C airfoils have their maximum thickness at from 25% to 40% of chord. The WE3009 seems like a good place to start. A foil where both surfaces are the curve of the upper surface of the SD7003 [20] might have unusually low drag.

The WE series makes it easy, by using a straight edge on the finished wing, to see if the ailerons are trimmed when you are setting up a model. "WE" stands for "Wedged Ellipse" or, if you like, "Walter Extra."

Control Surfaces

Many aerobatic sailplane designs suffer from undersize control surfaces, copied from powered pattern designs. To maintain control at low speeds, the aileron chord should be from 25 to 30% of wing chord. I can see no reason to not make them full span. Making them larger than 30% of chord does not buy much control and increases servo load unnecessarily. [10] Larger surfaces work at lower deflections and therefore generate less drag than smaller ones, useful for keeping momentum through a maneuver. As Simons [1, pg. 133] points out, deflections over 15 degrees cause flow separation and at that point the drag curves show a sharp rise.

All-flying surfaces have become popular but are probably not a good idea in aerobatic craft. I built my first all-moving wing slope aerobatic plane in 1981. It combined elevator and aileron control in the wings via a mixer with a very light, non-moving V-tail (no rudder). It worked for racing, but at low speeds aileron control tended to vanish. In addition, a cambered surface (e.g. a wing with a deflected aileron) can develop more roll force than an uncambered one. For this reason aerobatic planes should probably use (i) conventional ailerons, (ii) a fixed stabilizer with moving elevator, and (iii) a conventional fin and rudder. It has been argued that for a given angular deflection an all-flying stab generates more force than an elevator, but while this is true it is irrelevant since it is the total force, not force per degree that counts. Another nail in the coffin of all-flying surfaces for aerobatics: the all-flying stab (or wing) will stall at a lower coefficient of lift than the hinged arrangement.

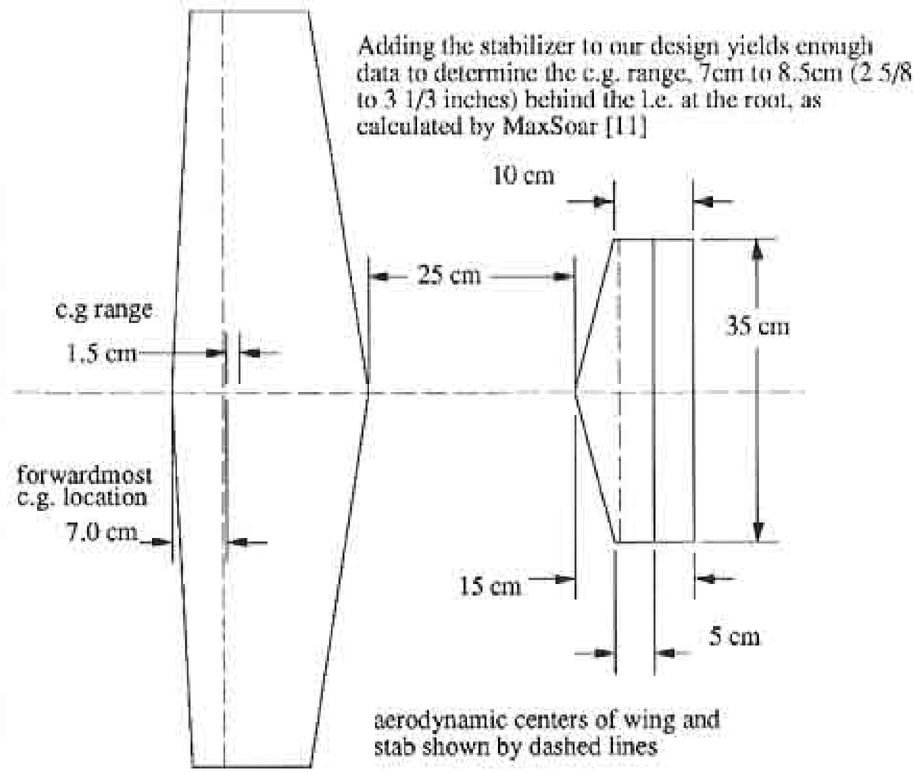
Empennage Position and Configuration

Engineering is the art of compromise. The wing-to-stabilizer distance is one of those compromises. Making the tail longer improves the precision of rolls, but slows down snaps and pitch-based maneuvers. Here again I do not know how to compute an "ideal," but observe that most aerobatic monoplanes have the aerodynamic centers of the two horizontal surfaces about 2 to 3 times the wing root chord apart.

Stabilizer shape is probably not critical; you do make its aspect ratio less than that of the wing so that the wing stalls before the stabilizer: my planes usually use a stab aspect ratio of 3. Oversize stabs also slow the roll rate. For mechanical and esthetic reasons, I choose to make the stab with a swept leading edge and a straight trailing edge; a rectangle is as good or better aerodynamically. A rule-of-thumb stabilizer area for aerobatics is 20% of the wing area. Stability calculations run on Hohensee's MaxSoar program [11], show that a smaller stab will be stable, but the extra oomph of an oversized surface can be handy. The elevator chord will be about 30% of the stabilizer chord at the root in keeping with our earlier discussion of control surface chord. For our plane we get a stabilizer span of 35 cm (14"), a root chord of 15 cm (6"), and a tip chord of 10 cm (4"). The elevator portion of this will be a rectangle 5 cm (2") in chord. The aerodynamic center is about 5.7 cm (2.25") behind the leading edge. Most full-size aerobatic planes use flat control surfaces and at the small size of our planes, a few slabs of balsa or a simple built-up frame with rounded leading and feathered trailing edges suffice. Experience tells us that 4 mm (3/16") balsa is sufficiently strong. Clearly, this is all rule-of-thumbism, so another area where some data would be appreciated is in the matter of appropriate sizes of stabilizers and elevators for aerobatics, answers are in hand for pure soaring.

Using our rule of thumb and putting the aerodynamic centers of the wing and stab 2.5 chords, or 50 cm (20") apart we find that the l.e. of the stab should be 25 cm (10") behind the t.e. of the wing.

The size of the vertical fin is another difficult-to-compute number. As is evidenced by the almost arbitrary fin/rudder shapes that have appeared on aircraft in the past, one might correctly guess that the fin/rudder appearance is almost pure aesthetics: de Havilland "signed" his aircraft from WWI to the jet age with a distinctive tail. Clearly, the most effective position is as far back as possible and with equal areas above and below the centerline, but for mechanical simplicity I have adopted the arrangement shown. The advantages of direct, slop-free linkages and strong surfaces are not to be denied. In models flown with this arrangement, I have not been able to detect any roll with rudder application, the main difficulty to be expected from the asymmetry. The fin/rudder design is also affected by the depth of the fuselage, but I know of no method for accurately taking this into account. The height must be kept low if roll rate and axialness is to be preserved.



The Fuselage

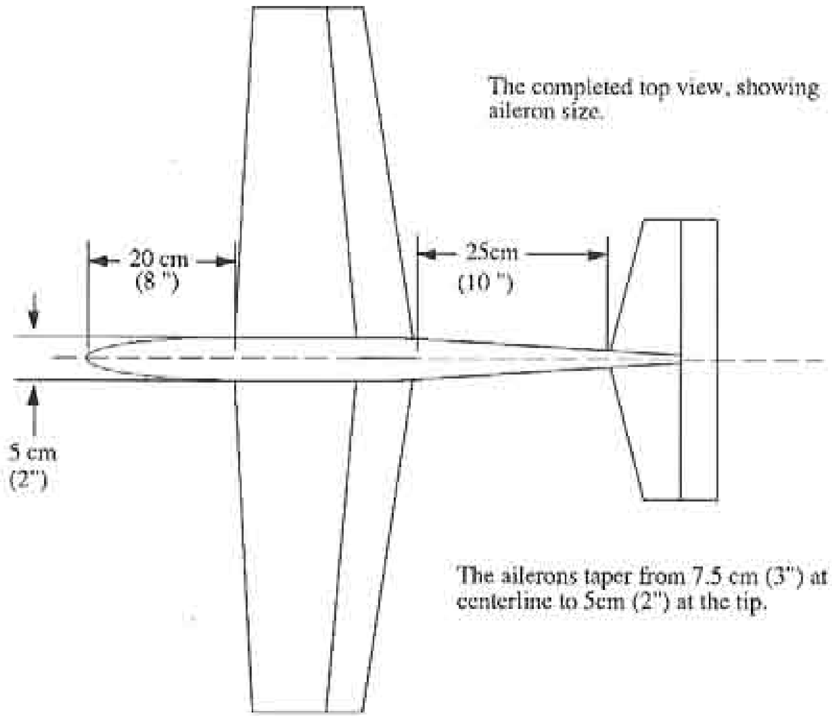
In an aerobatic plane, the fuselage does more than protect the radio gear and attach the empennage to the wing; in knife-edge flight it also supplies the lift. Putting aside the idea of knife-edge wings as discussed above, it is nonetheless the case that aerobatic fuselages tend to be deep. In knife edge flight the fuselage is a very low aspect ratio wing, with the rudder playing the role of the elevator. The thickness of the fuselage is usually determined by the size of the radio gear - usually less than two inches - but if it is considered as a wing whose chord is the length of the fuselage (which will be about 75 cm (30")), then even a 10% thickness ratio dictates a fuselage thickness of 7.5 cm (3"). The aspect ratio will be, at most, about 0.3. There is very little data on the optimum thickness ratios for such airfoils.

Timings over measured courses show these 1 meter planes typically fly at from 10 to 20 meters per second (20 to 40 mph). With chords of from .1 to .25 meters (4 to 10 inches) we find the Reynolds number, Re, to go from 70,000 to 350,000. (Multiply the speed in meters per second times the chord in meters times 70,000 to get a close-enough-for-all-practical-purposes Re. [12]) The fuselage's Re ranges up to over 1,000,000.

We now have almost enough data to design the fuselage and fin/rudder. Treat the fuselage as a flying wing, and keep in mind that the side view shares the same center of gravity location with the top view. As with the wing, sharp lateral edges improve the lift [15]. On the other hand, rounded tops and bottoms of fuselages reduce drag in yawed or non-coordinated flight; and one must decide to sacrifice a little drag or a lot of lift. Furthermore "the area of a small aspect ratio wing aft of its maximum effective width does not produce lift" [13] which suggests that the top and bottom of the fuselage should be parallel or divergent. This does not necessarily make for a handsome aircraft. The rudder hinge line should be perpendicular to the centerline, although the penalty for small tilts (under 20 degrees) is negligible. A sub-fin and sub-rudder, if you don't mind replacing them after each hard landing, is another possibility. You cannot raise or lower the stabilizer with respect to the wing without changing the relative upright and inverted performance because of the downwash of the wing.

The nose length is another empirical, that's-what's-worked-before, factor. Another good rule of thumb (I guess we are rule-of-thumbing our nose here.) is one wing root chord from the a.c. On our example we get a nose length (tip of nose to wing l.e.) of about 20 cm (8"). The more concentrated the masses of an aircraft, the faster it will rotate about its axes. An early example of this thinking was Fieseler's F2 Tiger of 1932, the second [21] designed-for-aerobatics plane with symmetrical airfoils. "It was so sensitive in all three axes, with the masses of pilot, motor and fuel tanks concentrated in one area, that [Fieseler, the world champion aerobatic pilot at the time] took ... six weeks before he had the mastery of the machine." So if the nose requires a bit of ballast, don't make it longer instead or you will find that pitch and yaw response will suffer. [14]

The top view of the fuselage starts with an ellipse with a minor diameter of 5 cm (2") and a major diameter of 40 cm (16") faired into parallel sides to make wing attachment easier, tapered to a small opening at the rear for the pushrods. I suppose a WE3008 could be used as a fuselage top view, but I do not know if the extra work would give better results. Again, this is a topic ripe for investigation.



The completed top view, showing aileron size.

The ailerons taper from 7.5 cm (3") at the centerline to 5cm (2") at the tip.

Flying

With small throws on the surfaces, (10° each side of center on ailerons and elevator, 30° on rudder) these planes are surprisingly tame, and not at all squirrely as some people would have you believe of small gliders. With 30° throws (45° on rudder) planes designed along the lines outlined here become incredibly agile. We have found no Aresti or other aerobatic maneuvers excepting those that require torque or extended vertical or knife edge performance that cannot be done by a radio-controlled sailplane in the proper hands.

Groups

At present there is no organization of which I am aware which either specializes in model sailplane aerobatics or even has a substantial dedication to the issue. The much lamented magazine Slope Soaring News [16] used to cover this topic. Perhaps the time has come to start a special interest group for aerobatic sailplanes, perhaps to be called the Legion of Aerobatic and Formation Flying Sailplanes. The acronym is LAFFS, since nothing in flying is quite as much fun (and as interesting to watch) as aerobatics.

Competition

This is conducted as with any aerobatic contest except that no k-factors are assigned and a delay to regain altitude (via slope lift or using a winch) is permitted between maneuvers. See the 1992 AMA Rules and Regulations.

The 1993 precision aerobatic sailplane sequence is shown in the November, 1992 issue of *RCSD* on page 49.

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20. Selig, Donovan, and Fraser, Airfoils at Low Speeds, Soartech 8, 1989
21. The first was the Albatroswerke G. m. b. H. L-79 "Kobold" (Lynn Williams, Personal communication, March, 1990)

22. This chart shows the point at which aspect ratio increases become ineffective at improving maximum L/D. That is, there is little point in building a 2-meter span glider with an aspect ratio much over 8, or a 3-meter ship with an aspect ratio much over 12 in terms of L/D. It is a rather approximate chart, based on computer experiments with varying airplane parameters in MaxSoar [11], but is backed up by considerable practical experience. The weights of the planes were estimated from Schlosser & Schlosser [18]. At the lower spans, increasing aspect ratio eventually decreased L/D, for example an A.R. of 8 was worse than one of 6 at one meter span. For larger spans, increasing A.R. continued to increase performance, however once you are above the line these increases were very small. At 3 meters span going from an aspect ratio of 10 to 12 improved the L/D by about 3%, going from 12 to 14 less than 1/2%. On the other hand, going somewhat below the line did not carry much of a penalty. Dropping the aspect ratio by 25% lowered the maximum L/D less than 5%. Maximum L/D isn't the only important parameter, but it is indicative of overall efficiency.

Please note that this chart was based on one wing section, one plane design and used a particular wing loading formula. It is presented to show that for smaller models, high aspect ratios are often not beneficial, not to predict performance or be used to design particular models, for which individual analysis is required. This work may have some implications for certain classes of free-flight models as well.

Acknowledgements: I would like to thank Martin Hollmann for reading this manuscript and suggesting that I calculate the aspect ratio chart, and Professor John Donovan, whose careful reading led to many useful suggestions and improvements. The San Francisco Vultures get the credit for helping run the aerobatic contests that inspired this work. ■

Jef Raskin, a contest director and life member of the AMA, is best known for having created the Macintosh project when he worked for Apple. His flying interests run like this: R/C slope aerobatics, R/C sailplanes, R/C electrics, free flight catapult gliders, and anything else that flies. He enjoys building and flying his own designs, and has a soft spot in his heart (or head) for computational aerodynamics. Jef has been running sailplane aerobatic contests since the 1970's. ■

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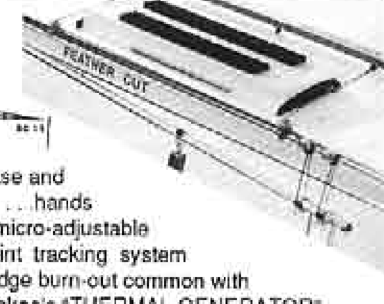

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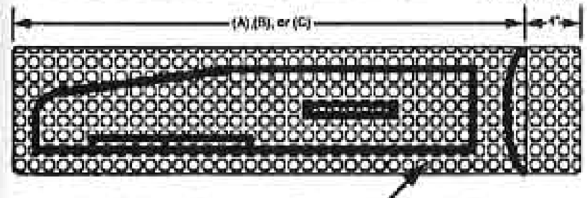

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NEW PRODUCTS

The information in this column has been derived from manufacturers press releases or other material submitted by a manufacturer about their product. The appearance of any product in this column does not constitute an endorsement of the product by the *R/C Soaring Digest*.

The Dove

...from NorthEast Sailplane Products

NSP, in conjunction with Culpepper Models, is pleased to announce an exciting new kit called the Dove. This two meter sailplane springs from a revolutionary concept for sport flying and competition. A progression of the 2M Chuperosa, the Dove's thermal performance exceeds our expectations. Going along a completely different design concept for a two meter, the Dove has a planform similar to an open class sailplane. Though it is a small sailplane, with its efficient planform, low wing loading and excellent choice of airfoil, the Dove flies very much like a cross between an open class sailplane and a hand launched glider.

The sailplane has many uses. It can be hand launched, hi-started or winched, and is fun in light winds on a slope. The Dove sports ailerons, elevator, rudder and flaps. In simple configuration you can fly it with as few as two servos; or use up to six servos for multi-function flying. If spot landings are important to you, the multi-function Dove is unbeatable.

The Dove uses a foam wing with balsa sheeting and a carbon fiber composite spar. Fuselage is fiberglass with canopy. The tail is built-up construction to minimize weight. Comes with a complete hardware package, as all Culpepper models do.

With the sleek fuselage, full flying stabilators, high aspect ratio wing with tuned-up tips, the Dove looks very much like a high performance, miniature open class sailplane. Its flying characteristics include a flat glide, low sink rate and agility. The Dove is capable of the smallest turning radius giving it the ability to core light, small thermals. The low drag planform, with its attendant high L/D, can get it back from the farthest downwind thermal. "This is a surprising ship. I love it!" ...Sal...

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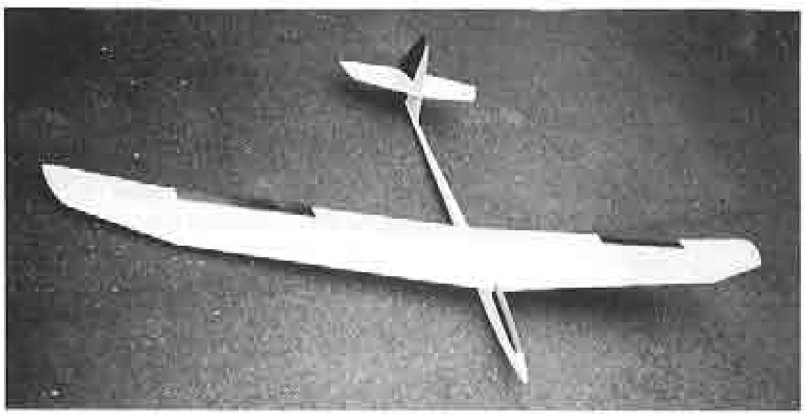
Wing Area	515 Sq. In.
Weight	23 Oz.
Wing Loading	7 Oz./ Sq. Ft.
Airfoil	SD 7037
Skill Level	INT/INT



Sailplane Computer Radio Comparison Chart & Servo Conversion Chart

...from Dynamic Modelling

Have you ever wondered how the computer radios that are available compare? Did you ever have a need to know what types of sailplane mixing functions are available? Do you need to know how they stack up against each other? will one brand's receiver work with another?

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The chart, created by *RC Modeler's* Soaring Editor Don Edberg, compares the Ace *micropro*, Airtronics *Infinity 600* and *Vision*, the CSL *Vision Upgrade*, the Futaba *9VAP* and *Super Seven*, and JR's *X-347*. It consists of four full-size pages packed with data and printed on a single 11 X 17 inch sheet, and comes with a short written commentary with suggestions on how to evaluate the radios.

To get your copy of the **Sailplane Computer Radio Comparison Chart** and the accompanying commentary letter, just send $2.00 or seven first class stamps. We'll send the chart to you by first class mail. (Canadians send U.S. $2.50 or nine U.S. first class stamps.)

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A high quality partial kit retails for $48.00 (US). This price includes shipping and handling in the continental United States. The rest of the kit is simply stick and sheet balsa, lite-ply, spruce stick and some sheet plywood. Three small nyrods, a piece of carbon reinforcement, a couple nylon bolts, two pieces of music wire, some brass tubing, and a few brass clevis and couplers is all you need to complete the kit. To start with, the computer drawn (CAD) building plans are simply "the best". You can literally build the airplane off the main drawing sheet without instructions. Two more drawing sheets are provided for clarity. The first sheet is a 3-view drawing including SD7037 airfoil templates in case you want to "cut your own" wing cores. The second sheet is a full size template drawing. This sheet provides accurate templates for each wood part necessary to build your Thermal Grabber. The use of the template sheet keeps you from ruining the main drawing sheet. The SD7037 white foam wing cores are of the highest quality 1 lb. virgin white foam cut with computer generated (CNC) laser templates using the now famous "FeatherCut"™ hot-wire foam wing machine™. You are assured to receive a true airfoil. The Obechi sheeting is flawless and is already pre-cut oversize for you. You may sheet the wing with the transfer tape that is provided or use epoxy. The transfer tape is a no-mess and very quick way to sheet the Thermal Grabber wing. You do not need to use a vacuum bag if you use transfer tape to apply the Obechi sheeting. The transfer tape method allows you to go right back to work on your Thermal Grabber without having to wait for epoxy to set up. The final straw in making the Thermal Grabber a good value is the 20 page detailed building instructions. The building instructions not only explain what to do, they also explain how-to do it. If you follow the building instructions you will not work yourself into any corners and will build a very nice flying sailplane in a reasonable amount of time. The box your Thermal Grabber is shipped in is intended to be used as a transport box to and from the field for the fuselage and stabilizer. With an all up flying weight between 21-26 oz (depending on building experience, technique and wood selection) the Thermal Grabber has a wing loading of 6.2 oz (6.2 at 26 oz. flying weight) with an aspect ratio of 11:1 on a 35.5" long fuselage.

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For $48.00 (US), including shipping and handling in the continental US, the Thermal Grabber is a good value. You may find, like I have, that your Thermal Grabber will become the sailplane you carry in your car at all times because of its versatility. As my wife says, "Most husbands take a briefcase to work...my husband takes his plane to work." Enough said.

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Basic Aircraft Technology (B.A.T.) offers high quality, heavy duty, fully machined winch drums and components. This allows you to taylor your winch to your growing needs. Components can be purchased to complete your winch or upgrade it to a heavy duty, long lasting, state of the art winch. The selection of our best "V" belt pulley drum is the way to go to prevent backlash or tangles of the line and to move into more advanced configurations without having to change drums.

Both our sport drum and more efficient "V" belt pulley drum fit the Ford long shaft starter motors with 5 3/4" long shafts. These motors were used on the Fords up through the 1964, 289 cubic inch engine. Ford tractors and even diesel engines used these motors. The cost of a special 4 winding motor over the 2 winding motor is about twice. Prices vary from one source to another. New parts are still available to convert to 4 windings, motor and repair. For special applications, starter motors can be machined out to put bearings in place of the bushings. But, the extra performance is hard to justify the extra cost. Your money is better spent in buying a B.A.T. Heavy Duty winch unit with the bearing support on the outer end of the shaft where the load is greatest.

Reliability of the electrical control components should be considered since a run-away winch is a nightmare that generally destroys the plane. Unlike the operation of a car starter, sailplane winch flying requires numerous on-off cycles of the foot pedal to control the speed of the winch motor or risk tearing the wings off the plane. It is not the on cycle that is the problem. It is the arcing at the beginning of the off cycle that welds or burns the foot pedal switch or more likely the starter solenoid contacts. If either sticks, it is good-by airplane. To reduce the likelihood of this happening, B.A.T. recommends using 2 solenoids in a series circuit since both is far less likely to stick at the same time. Further, B.A.T. builds inboard test circuits or monitoring circuits to indicate a stuck solenoid prior to launch. Quality solenoids are used and then an additional arc reducing circuit is added to B.A.T. winches that are sold completely assembled. If the foot switch sticks closed both solenoids will again remain energized and again run-away. The possibility of this happening is far less than sticking a solenoid contact, because current flow is much smaller in the foot switch circuit. However, the results are the same. To reduce the probability of the foot switch sticking, again B.A.T. offers a protective circuit. This circuit also allows other automatic protection circuits such as automatic shut down for a stalled motor, run-away, over heating motors, or even a low battery condition. The latter bells and whistles are only offered on special request and on completed B.A.T. winches.

The single motor mounting plate is adequate for light thru medium winch flying. A carrying handle can be attached to this plate using the pre-drilled taped hole. Add the second motor mounting plate with outer bearing support; it's standard in our heavy duty winch units. This provides support on both sides of the winch drum and also attaching points to the winch base. A carrying handle is included. Either the single or the double mounting plate winch unit has the "V" belt brake/anti-backlash system option that matches our best "V" belt pulley drum. The amount of braking/anti-backlash is adjustable to meet your flying needs on B.A.T. systems.

The B.A.T. winch base is offered in 3/4 exterior plywood pre-drilled to fit our winch unit and with 2 stake down holes. It is large enough to hold a large RV deep cycle battery and a control panel. It comes finished or unfinished at half the price. Rubber anti-skid bumper legs are also a recommended option as are hold down stakes.

Our better base is fabricated from square tubing, welded and painted ready for mounting the control panel, winch unit, and with a battery holder. This base comes standard with 4 rubber anti-skid bumper legs and holes for hold down stakes. From our experience, this base with a battery on it launches the heavier sailplanes without movement but the holes are there for those in doubt.

Each additional item described above adds cost to the winch, but all are worth the money. We don't sell gimmicks - just quality and satisfaction. Taylor your winch to your needs and budget. B.A.T. makes it possible to advance into the state of the art winches.

For detailed information on Basic Aircraft Technology winch drums, precision winch units, winch bases, control panels, controls and indicators, control packages, braided nylon winch line, anodized finish, and other sailplane products, OR for help in determining what set-up fits your needs, contact Bob Harman, 10424 Golden Willow Dr., Sandy, Utah 84070; (801) 571-6406. ■

B.A.T. winch unit - $185

B.A.T. companion piece to the winch - B.A.T.'s turn-a-round

E-Z Vac

...by Mike Stump
Cadillac, Michigan

The E-Z Vac vacuum bagging kit from Aerospace Composite Products is an ideal system to make the first step into vacuum bag technology. With this kit and a couple of basic accessories you can be on your way to building the current state of the art sailplanes that are dominating the competition environment. This product review will highlight the E-Z Vac kit and also hopefully remove some of the mystery about this procedure.

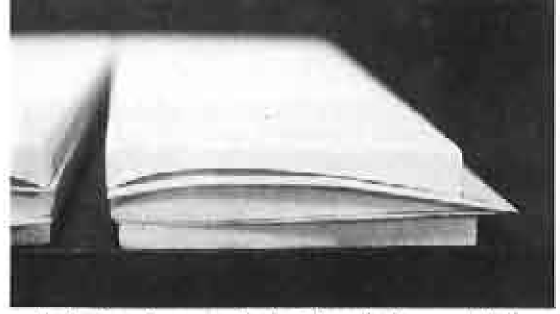
After having read about vacuum bagging for a couple of years and having a chance to help bag the wings for my 2 meter and standard DUCKS in Troy Lawicki's shop, I made the decision that this is a process I had to add to my personal building arsenal. Besides the 40 mile drive to Troy's was a bit much just for access to a building tool. After seeing the E-Z Vac kit at the TOLEDO MODEL SHOW, I decided this was the perfect way to get what I needed to start bagging on my own. I had read several articles on salvaging refrigerator compressors and building components around them, but right there, for $75.00 was everything I needed to get started.

The E-Z Vac kit consists of: a continuous duty electric pump that is pre-set to pull approximately 7" HG, 9' of 18" wide bagging material, two 18" X 72" sheets of breather felt, the E-Z Valve, and 25' of bag sealing tape. By the time you read this the sealing tape will probably have been replaced by a nylon channel & rod sealing system which should be a must for anyone. This system is almost too easy to use, leakproof, and is reusable. From what I understand the price on this sealing system, which is 22" wide, will be $3.50 ea.

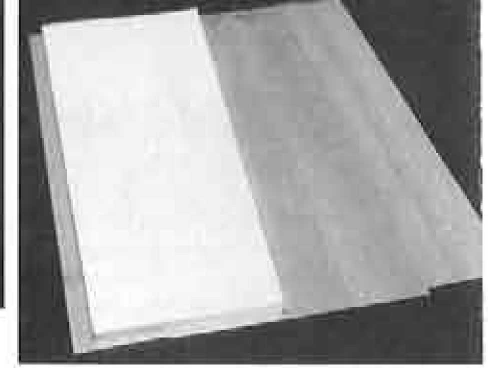
The additional items needed to ready yourselves for bagging are: a thin laminating epoxy (I chose E-Z Lam, also from ACP.) and spreaders. (I purchased a pack of 3 auto resin spreaders from Wal-Mart for $1.65.) I also purchased a t-fitting and additional 1/8" ID tubing to allow me to run two bags at once. For the second bag I also purchased an additional E-Z Valve. The E-Z Valve is placed through a small hole near the seal in the bag and allows for the vacuum to be drawn through this valve. This eliminates the need to build a seal around the tube, a much easier way to set up your system. You may also want carbon fiber tow for spar reinforcement and 2-4 oz. fiberglass cloth for trailing edges and servo bays if these items are not supplied with what you are building or you are scratch building.

The first step in vacuum bagging is to prepare your cores and sheeting. All spar systems, if any, should be in place and the cores clean. I have eliminated the step of gluing the edges of my sheeting together. Make sure your sheeting edges are straight, lay them tightly together and tape (on the outside only) together with masking tape. This works for butt splices as well as along the grain. It helps to use sheeting well matched in thickness although the differences can be sanded out later. Using your core beds as a guide (if you are using full-size beds), cut the sheeting to the general shape of your wing panel with the sheeting 1/8 - 1/4" too long chord-wise. You do not want a lot of overhang as the bag under a vacuum can crush the wood where it is not supported. IT IS IMPORTANT AT THIS STEP THAT THE SHEETING DIMENSIONS ARE TO FINISHED SIZE AND NOT TO CORE SIZE. BE ESPECIALLY CAREFUL IF YOU ARE NOT USING FULL SIZE CORE BEDS. Sizing to the core itself may not leave enough sheeting for the rear portion of the airfoil.

Prepare any other materials that may go between the sheeting and the core, or that may be used as a trailing edge reinforcement. I have been using 2-4 oz. glass cloth top and bottom on the TE which,



End view of core and beds. These beds are not full size and T.E. will extend past bed during bagging. Care must be taken to make sure T.E. is straight as vacuum is drawn.



Bottom core bed used to measure sheeting. Cut to appropriate size making sure to leave just enough for complete T.E.

EZ-Vac system with small wing panel. This bag had been heat sealed on the end. I now use an easier method, the "Quick Lock Bag Seal" from A.C.P.

after sanding, yields a very sharp, stiff, and durable finished TE. ACP has a variety of glass cloths plus some very interesting carbon mats that should be great for trailing edge reinforcement. If you are going to reinforce the spar area with CF tow, now is the time to prepare the tow for installation. Item UP-06 in the ACP catalog is 12" wide unidirectional CF cloth that can be purchased by the foot. I cut this into 1.25 - 1.5" strips and place over the spar area extending out past the aileron cut-out. A 3 ft. section will do 2 pairs of wings. Have all of your components ready to go before you wet the sheeting with epoxy.

Clear an area to lay your sheeting on while you apply the epoxy. A glass table top is ideal for this. At this time I am using an old table with a formica top. Lay your sheeting out core side up. If you are going to be laying any glass or CF reinforcement on this sheeting now is the time to mark these areas with a felt pen so you can accurately place the material. TE reinforcement is almost a must and if you are using servos in the wing you will want to reinforce the top sheet in the area of your servo bay. I use a 4" X 4" piece of 4 oz. glass cloth for this. CF mat or cloth will also work well for this purpose. The glass cloth strip for TE reinforcement should be from 1.5 - 3" wide. I use a single layer for hand launch wings and place a layer on both the top and bottom sheet for everything else.

With all components ready you can now mix your epoxy and wet the sheeting. Follow the instructions supplied with the brand resins you are using for the proper proportions. The E-Z Lam epoxy system uses a 2 to 1 mix by volume. It is a good idea once you have a feel for how much epoxy you need for a given job to mix the whole quantity at one time. Until that time, mix approximately an ounce at a time as you're learning the ropes. I have found the average foam hand launch wing and stab set to require about 1.5 -

1.75 oz. My 2 meter DUCK (740 sq." wing and stabs) needed about 3.75 oz. of resin. You will be surprised at how far these laminating epoxies will go as they are much thinner than what you are used to working with in general purpose epoxy.

Once the resin is mixed pour beads on the surface of all sheeting. Use the plastic spreaders to spread the epoxy into a very thin layer over the entire sheet. Work the resin out to all edges but be careful not to let any drip onto the sides as it will stick to the bag. Once the entire sheet is covered use the spreader to work any excess up and transfer it to another sheet or back to your mixing container. If the sheeting looks wet there is too much resin on it. Now is the time to lay any TE or servo bay reinforcement cloth on the sheeting. After it is in place use a brush to lightly wet it out with resin; don't over saturate it.

If you are using CF tow to reinforce the spar area start with the bottom first. Lay the core in the top bed with the bottom side facing up. Lay the tow over the desired area and wet it out with the resin. This will work much easier if you can get it tacked in place at the root then work out toward the tip. This will keep the tow from bunching up.

Now lay the bottom sheeting in the bottom cradle lining up the Leading Edges. Carefully place the core onto the sheeting making sure that everything lies in proper position. Now apply tow to top of core if it is being used and place the top sheet in its proper place. At this point, tape the top and bottom sheets together with some small pieces of masking tape to hold everything in place.

At this point your bag(s) and pump should be ready. You want to set this up on as flat an area as possible. Set the bottom cradle on your bench and lay the bag on the cradle. If you are using breather felt around the entire wing then lay some into the far end. Insert the sheeted core and carefully align on the bottom cradle. Once again the Leading Edge is the best reference point for alignment. Lay your breather felt around the wing if you are using it in this manner and also in the area from the wing to the valve. Place the top cradle over the wing and make sure there are no wrinkles in the bag material. Place some weight (I use 4-5 bricks) on the top cradle to keep everything in line until the vacuum has been applied. Now seal the open end, attach the hose to the valve, and plug in the pump.

Using the E-Z Vac pump you will hear the sound of the motor change as the full 7" of vacuum is applied. As this happens you can also see the bag draw up tightly to the wing. Listen closely around all seals for any leaks and repair them now if you find any. Once you have a good vacuum on the wing the weight can be removed if you want. Leave the vacuum on the wing for the whole cure time for the resin you are using.

The components of the E-Z Vac kit make many of the above tasks much easier than what even this same kit offered 6 months ago. With the new nylon rod sealing system it is extremely easy and fast to have a leak proof, removable seal. The E-Z Valve makes the use of this type of sealing system possible. I have bagged 4 sets of wings and stabs and the valve has performed flawlessly. The E-Z Vac pump is very quiet and is designed for continuous duty operation. If you are sheeting balsa over white foam this is the perfect system.

My bags use the new nylon seal on the open access end with the other end permanently sealed using a heat sealing tool. I also discovered in my attic a wedding present my wife and I had never used, a DAISY SEAL-A-MEAL. this item can also be used to seal the bags supplied with the E-Z Vac.

I hope this has encouraged those of you who were afraid as I was of jumping into this new technology to take the step forward. This system will give you stronger, straighter, and more durable flying surfaces faster than you ever thought possible. A system like the E-Z Vac will open doors into high performance construction for the average builder/flyer. ■

Hook a Better Tow!

...by John Lightfoot
Editor of the Southern Soaring Club newsletter, *Southeaster*
Rondebosch East, South Africa

Everyone checks the Centre of Gravity position on his model before flying it for the first time — at least I hope they do! Models not subjected to this check are liable to have a very short and undistinguished career, unless someone was dead lucky! Most people even check that the CG is still where it should be from time to time — repairs have been known to alter its position to the point where the model becomes unflyable.

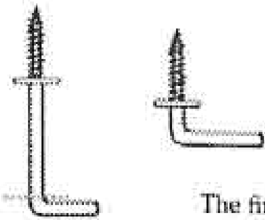
But how many of you check the Tow Hook Position? In many cases, particularly in "trainers", the towhook position is fixed and there's nothing that can be done about it — it's epoxied to the main fuselage former and that's that! In other cases it's put in where the plan suggests and there it stays. But some kits have an adjustable hook and many early gliders had two or even three hooks! — why?

Next time out on your flying field, have a look at the different ways in which different models climb on the line. Some seem to tear up the sky almost vertically and finish at a lovely height, promising a good long flight. Others seem to travel more towards the turnabout than upwards, dropping the line at little over half the height of the former example, fighting for every metre of height.

Well, that's exactly what they are doing — fighting for height — being pulled inexorably downward by the very line which is supposed to be launching them skywards!

The difference lies in the towhook position!

The ideal situation is where the model will climb straight up with no elevator applied at all (i.e. "aerodynamically clean") except for a quick pull a second after launching, as soon as the model has flying speed, to get it standing on its tail. Any model which has to be flown up the line with the elevator stick held back is flying inefficiently and so wasting height!



The first requirement is an adjustable hook, and it would be hard to find a cheaper or simpler version than can be made with a minimum of effort from a cuphook (the straight variety), obtainable from almost any hardware store. There are several sizes available, but the two I find most useful are 2,5 mm diameter / 30 mm long for most models and a slightly heavier one for bigger models, 3,0 mm diameter / 35 mm long.

First cut off the angle as shown by the dotted line, and then make a new bend about 6 mm below the flange. That's the hook, but it needs a suitable mounting in the model — all that it takes is a piece of 6 mm ply (or similar) glued into the bottom of the fuselage, preferably all the way from one side to the other so that the load is spread to the longerons and so to the fuselage sides.

Drill several holes along the centre line, about 6 mm apart and screw the hook into the one closest to the position shown on your plan or about 10 mm ahead of the CG position. Tow your model up and see what elevator is needed to make it climb steeply. Move the hook back 6 mm at a time until the model becomes unstable on the line. Placing the hook one position forward from the unstable position will give the optimum climbing ability.

However — as with all finely-tuned instruments, it becomes more sensitive to control input! Recently, I found my Sagitta going every direction except straight up — I was wondering who had stood on it or kicked the trim lever on the transmitter . . . trim? . . . what was the lever doing down there? I had last flown a different model which required more "up" trim and I hadn't reset it! My model was trimmed so closely for the climb that just half the movement of the trim lever had put it into the unstable flying region. With the trim back where it belonged, launches were as stable and straight as ever.

Whatever model you build, never install an immovable towhook! The chances of your hitting exactly the right position are very slim indeed. Throw away the "one position" type and install a piece of wood and a modified cuphook.

The towhook is not just a necessary appendage on which to hang the 'chute before launching — it is as sensitive to adjustment as any flying surface and needs to be trimmed to find the position which gives best performance.

A word of warning however — as related above, a finely-tuned towhook will turn and bite you if you treat it casually! The slightly forward position may not give quite the height but it is much more stable. Choose the sensitivity to suit your ability.

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Bristol Virginia Soaring Meet

...by Ashley Davis
Travelers Rest, South Carolina

Summertime in the BLUERIDGE mountains might be one of the prettiest things you'll ever see. The 3 hour drive from Greenville S.C. to Bristol was a real pleasure. Then, to spend the weekend in the rolling hills of Virginia/Tennessee with such hospitable company was an added bonus.

The town of Bristol lies on the border between Tennessee and Virginia and, just northwest of town nestled between high rolling hills, the BRISTOL R.C. club maintains a 1000' mowed flying field complete with shelter - real nice.

My intent is not so much to document the contest, but to draw attention to this wonderful site and give recognition to the organizers - the BERNARDS LEONARD (Senior and Junior, that is). They staged a well run and very pleasant contest, drawing people from S.C., N.C., Tennessee and Virginia. Try not to miss their next meet if possible. They are great hosts and real scrappy competitors.

Conditions were ideal all weekend. This is not to say the sky was clear and thermals boomed but plenty of challenging conditions kept places moving around. The cold front that promised to move through Friday stalled and didn't move in until after the final round Sunday, but provided a broad range of conditions to cope with. Light rain and drizzle Saturday kept everyone under the tents until noon when the decision to proceed was unanimously accepted. This must be what the British endure all the time. Lift was available even in the drizzle,

but a good sink rate and smooth flying made for the best times. Many max flight times were turned. Three flights for 15 minutes with no single flight over 7 minutes was the task for both rounds on Saturday.

Sunday dawned dry but with heavy overcast and lift no more abundant than the previous day. Unpredictable ground winds made landings very difficult at times. Tasks were standard 8 minute duration with L4 landing task.

Floater type gliders dominated the light conditions but the aileron equiped machines handled the landing conditions better. Planes that could hangout/hangup/hangin stood the best chance of finding enough lift to max with more than a few flights being saved while setting up for early landings - the main runway was the best source of lift under the overcast sky. Winds remained moderate all weekend so penetration was never an issue but the ability to search far and fast was. With the newest gliders burning up the workbenches coming from 'out-West', it remains to be seen if they are as effective in the East Coast conditions, or is there still a generation of light, fast (read clean) machines yet to be developed? Let's see what happens. ■

LIFT OFF!

...with Ed Slegers
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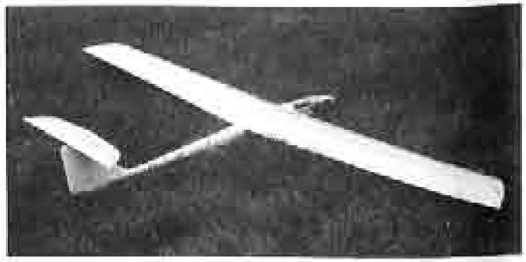

Arcus

At the KRC meet (November, 1992 *RCSD*), the plane represented the most was the Arcus by Robbe. I think I saw about four, all of which flew very well. In fact, they flew so well that Robbe, who had a display at the KRC meet, sold all they brought with them, plus some, in a very short period of time.

A couple of years ago I had one that I had purchased from Carl's Hobby Center in Randolph, NJ (201-366-4300), but I sold it to Stan of NorthEast Sailplanes. Ever since then I've been sorry that I did. (John Goldman, the owner of Carl's Center, is an avid soaring enthusiast. If you are ever in the north Jersey area, stop in to see his fine selection of products for the electric and sailplane enthusiast. It is his Arcus that is pictured in this article.)

The Arcus is a two meter high performance electric sailplane. It is not a thermal plane like the Falcon 550E, although it will thermal in strong lift. Nor is it an F3E type plane like the Surprise. The Arcus is just a good, strong, and fun electric sailplane.

The kit is very complete, and for the money (about $140.00), an exceptional buy. The fuselage is of a molded plastic which is extremely strong. The wings are pre-sheeted with balsa. The stab and rudder are balsa and pre-sheeted so that there is very little work to finishing them. The leading edge of the wing is also pre-shaped and there's a bag full of all the necessary hardware. The step-by-step instruction book (in English) and the two sheets of plans to aid in construction are excellent.

I won't go into a step-by-step construction article because the instruction booklet and plans cover that very well. But I will go over a few things that I changed from the instructions that came in the kit. The instructions show one servo to operate both ailerons. I wanted to try spoilerons and also be able to adjust for differential, so I used a servo in each wing panel. Just be careful and don't cut into the spar to mount the servos if you decide to use two servos. To mount the servos, I ordered Servo Mounting Kit #8156 from Robbe. They worked very well and seemed to be made for the Arcus.

The stab and rudder need very little work, but to keep the weight down, I cut some holes in them. The fuselage needs very little work. The hardest part is to cut the nose off. Remember, this was originally a glider to be converted into electric. The easiest and most accurate way to do this is to order Firewall #7775 from Robbe. Just keep cutting the nose off, a little at a time, until the firewall fits snugly in place, and then epoxy it permanently to the fuselage. The only part of construction that is difficult and takes a lot of time is the installation of the pushrods. If you don't get them exactly right they will bind.

The instructions explain the construction for both the 7-cell and 10-cell versions. I would suggest following the 10-cell instructions even though you may want to fly on 7-cell. This way you can fly on 7 cells and, at a later date, progress to 10. My first Arcus, and the one pictured are powered by a Keller 35/5 on 7 cells and the performance is excellent. My latest one, that is not quite done, will be powered by a HP 320/4 10-cell motor which make this one very hot plane. (In an experiment to see what it was like to order planes from Europe, I ordered an Arcus from Gliders of Nottingham in England (*RCSD*, August, 1992), which arrived quickly and in good shape.)

The Arcus may not be the lightest or the fastest, but it makes a fine entry level high performance electric sailplane.

Good Flying! ■