AEROBATICS!

Jef Raskin's Introduction to Aresti-Style Aerobatics for Slopers

Slope Soaring News

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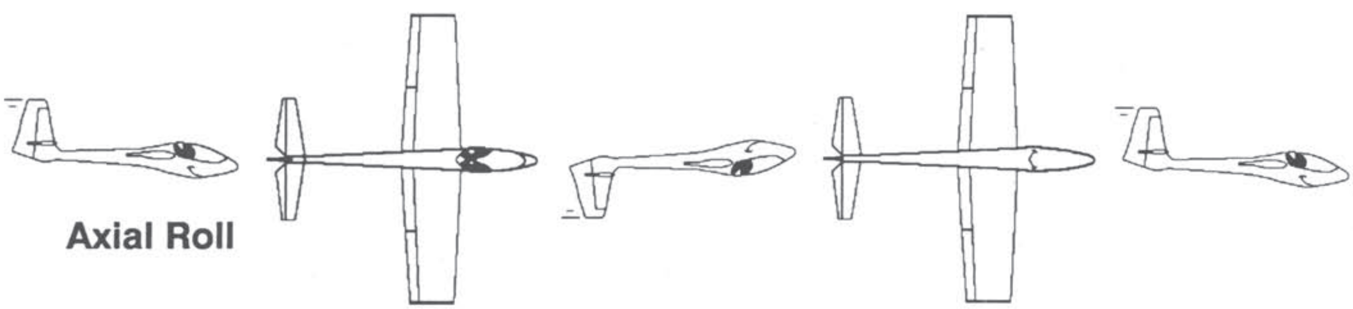
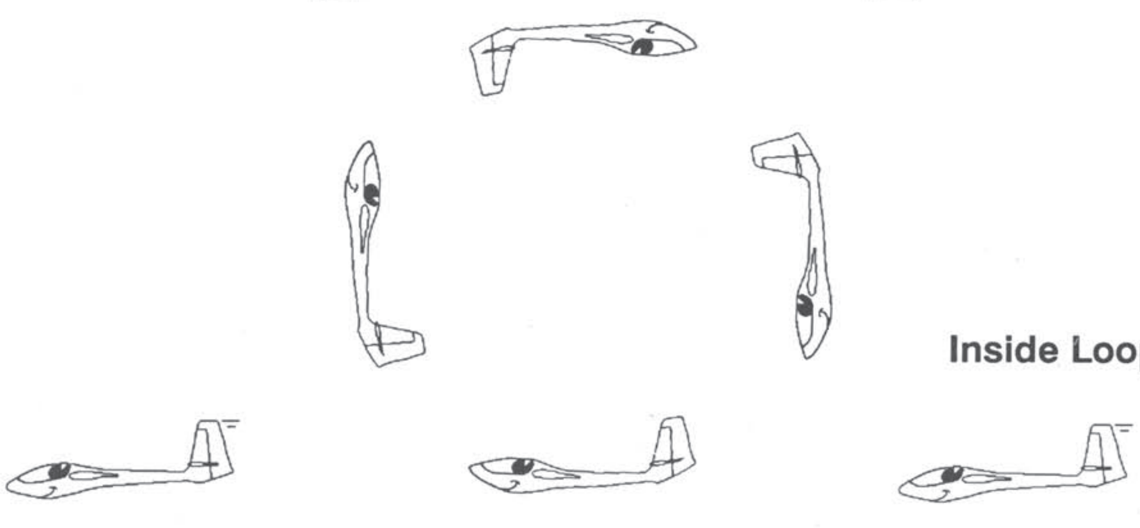


Axial Roll



Inside Loop

Miss Go-Fast Construction Continues: How To Plot Airfoils Three Different Ways! • Aerodynamic Answers: Dave Fraser, John Donovan and Michael Selig Discuss Reynolds Numbers, Separation Bubbles and Sharp T.E.s • Join California Slope Racers! • Need A Ride To Richland? Call Charlie!

Wingin' It

I FEEL THE NEED...

Slope racing! Until you've witnessed a pack of those eight-foot fiberglass "lead sleds" dropping in toward the starting line from altitude, you can't imagine how fast or how well a radio-controlled sailplane can perform. They are (please pardon the California-ism) totally awesome! Absolute state-of-the-art slope ships. As good as it gets!

The organization of slope racing events, on the other hand, is not (yet) up to par with the pilots or their equipment. Slope racing happens. That's sort of like the bumper stickers we've all seen that say "Sh-t Happens!" It's survived over the years due to the inspiration of a few energetic individuals who have been willing to act as contest directors, sometimes on their own, sometimes with the support of a club. But although it's survived, slope racing never quite developed into the full-blown sport it deserves to become.

CALIFORNIA SLOPE RACERS
Charter Members

Mark Allen	Jerry Arana
Rich Beardsley	Stephen Bircher
Jay Brehm	Del Brengman
Jerry Bridgeman	Brian Chan
Bob DeMattei	John Dunn
John Dvorak	Don Edberg
Ray Kuntz	Gordon Jennings
Ted Kowalke	William Highfield
Earl Levin	Tony Martin
Charlie Morey	Rudy Mullen
Oliver Northrup	George Paige
John Pappas	Daryl Perkins
Pete Russell	Jim Snead
Rick Spicer	Jack Sutherlin
Richard Tiltman	Mark Triebes
Ron Vann	Joe Wurtz

That may be changing. The newly-formed AMA club – California Slope Racers – has run the Hans Weiss Memorial Slope Race at Hughes Hill, and they're currently hard at work setting things up for the traditional International Slope Race at Davenport.

(Ray Kuntz, who promotes events at Hughes Hill, and Daryl Perkins, who's won most of them, are sharing ISR contest director duties. Ray can be reached at 213/645-4269, and Daryl is at 818/358-8707, if you need information on the event.)

I just received a letter from *RCM* soaring columnist Don Edberg asking for donations (kits, supplies... and, I guess, newsletter subscriptions) to be awarded to participants at the ISR. That's good news for two reasons: 1. It lets the industry get involved, and their support can only help the slope racing effort to grow. 2. Don writes for the largest modeling publication in the U.S., and his involvement indicates that the event will probably get good coverage in the magazine. Also listed among the Charter Members is Mark Triebes, slope soaring columnist for *Model Aviation* magazine. Good press is important to any effort! Now we need to get John Lupperger (*Model Airplane News*) and Bill Forrey (*Model Builder*) involved, too.

Speaking of involvement, what about you? Are you interested in slope racing? How about your club? Does your favorite local hill seem like a good spot to hold an event? Would you like to learn more about slope racing?

If any of the above apply, make a point of attending the International Slope Race. Don't be intimidated; people who race sailplanes are among the friendliest I've met. Just show up, look around and ask questions. They'll help.

I've been involved in a number of discussions where the same dream has been expressed: Wouldn't it be great if there were a slope racing series? With only three or four sites and the personnel to run monthly events, we could start a full-on summer series with awards for each event, and of course, championship points earned during the series to determine an overall season winner.

I'd like to see races at our established sites – Hughes Hill and Davenport – and new sites like Torrey Pines, Lompoc or perhaps your hill. Any ideas? Volunteers? Please feel free to use the *SSN* letters column – Air Mail – to share your thoughts with other slopers. Or contact California Slope Racers directly at P.O. Box 171, Lompoc, CA 93438. (That's Rudy Mullen.)

See you at Davenport? I hope so!

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EDITORIAL CONTRIBUTIONS are welcomed. Unfortunately, we can't pay for them. Editorial material is selected based on its perceived value to the slope-soaring community, and the publisher assumes no responsibility for accuracy of content.

CLUB CONTRIBUTIONS are welcomed. Please keep us notified of your club's events and/or fun flying activities. Material printed will be selected at the discretion of the editor.

ALL CONTRIBUTIONS should be addressed to SSN, c/o Charlie Morey, 2601 E. 19th St., #29, Signal Hill, CA 90804. All contributions requested for return must be accompanied by return postage. The editorial deadline is the 15th of the month preceding the cover date. All material is subject to editing and revision as necessary to meet SSN requirements. We can accept Ascii text files over the phone or work with your IBM-compatible 3-1/2" or 5-1/4" disk. Please call first for details at 213/494-3712. Don't get depressed if you get our answering machine. Just leave your name, phone number and the purpose of your call, and we'll get back to you.

ADVERTISING inquiries should be addressed to SSN, c/o Charlie Morey, 2601 E. 19th St., #29, Signal Hill, CA 90804, 213/494-3712.

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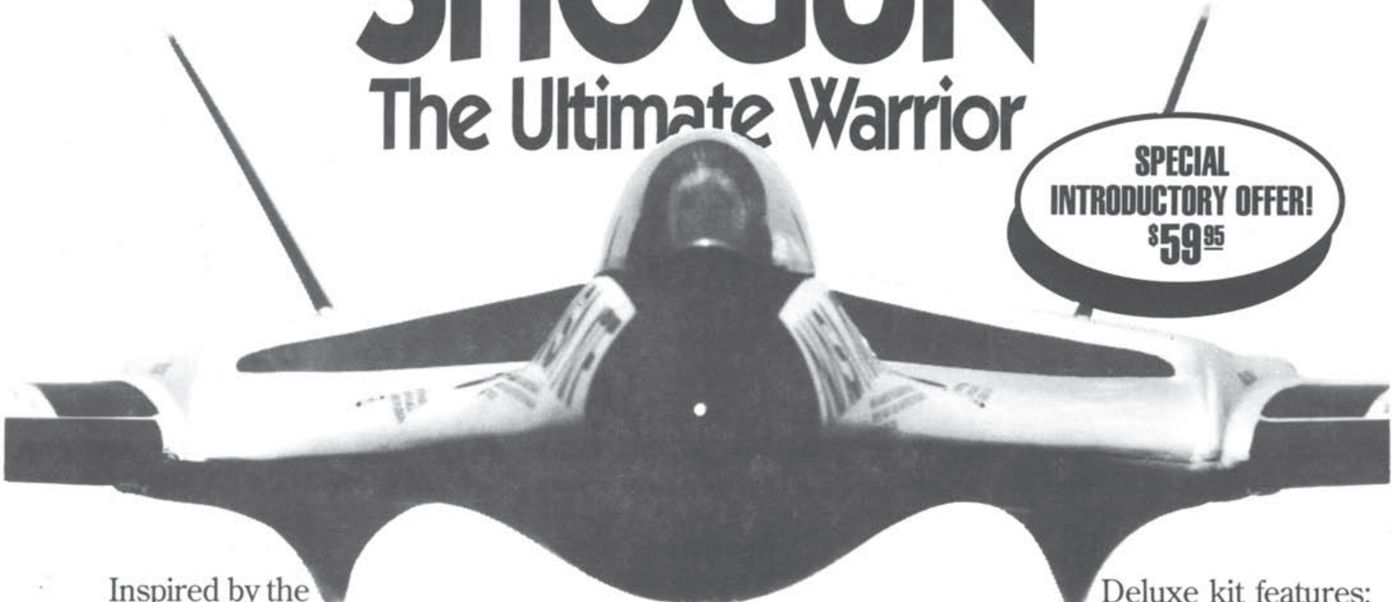
SHOGUN

The Ultimate Warrior

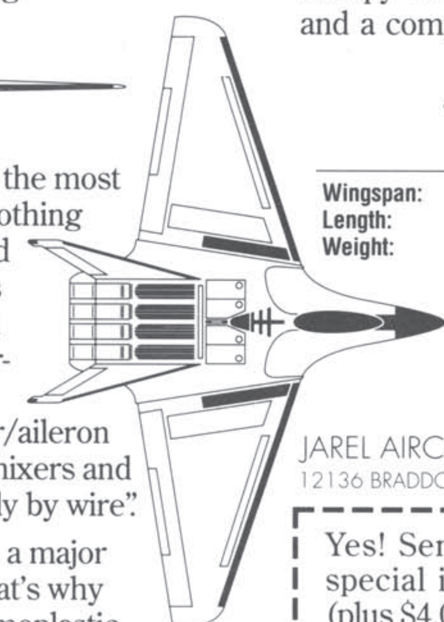


SPECIAL INTRODUCTORY OFFER! $59.95

Inspired by the YF-22 Advanced Tactical Fighter, Shogun transforms the force of the slope into the power of absolute control! Loops and rolls are crisp and precise. Inverted flight is just a "walk in the park" and with ATF technology like Shogun's thrust vectoring elevator, becoming "Top Gun" at any slope becomes a sure thing!

Although patterned after the most advanced aircraft in the world, nothing could be easier than building and flying a Shogun. Shogun accepts full size radio gear with ease and because Shogun's stall characteristics are mild mannered, you won't have to be! Simple elevator/aileron control eliminates the need for mixers and gives new meaning to the term "fly by wire".

Armor has always played a major role in strategic survivability. That's why JADE's new CrashGuard™ thermoplastic alloy is used to create Shogun's nearly indestructible fuselage. Like an impenetrable energy shield, CrashGuard™ provides the kind of security that quickly turns weekend pilots into rulers of the sky!



Deluxe kit features: CrashGuard™ thermoplastic alloy fuselage with molded vertical stab supports, pushrod exits, and inlet detailing • Precision machined wood parts • Foam wing cores • Balsa wing sheeting • Preshaped thrust vectoring elevator • Highly detailed plastic cockpit and pilot • Molded clear canopy • Photo/illustrated instruction booklet and a complete hardware package!

Shogun Specifications

Wingspan:	**40"**	**Wing Area:**	**310 sq. in.**
Length:	**25.5"**	**Loading:**	**9.7 oz./sq. ft.**
Weight:	**21-24 oz.**	**Radio:**	**2 ch reqd.**

JADE

JAREL AIRCRAFT DESIGN AND ENGINEERING
12136 BRADDOCK DR., CULVER CITY, CA 90230 (213) 390-1348

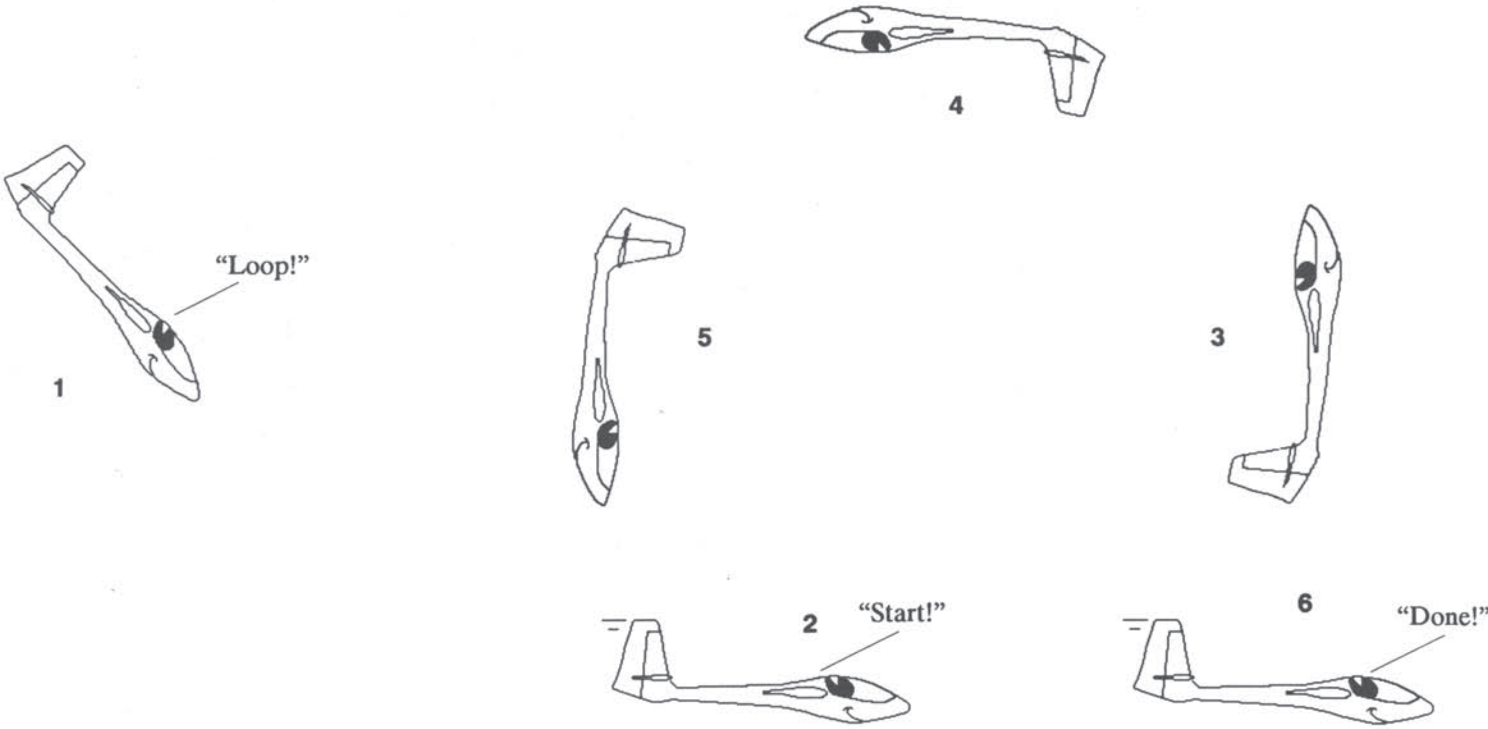
Yes! Send me ___ Shogun kit(s)@ the special introductory price of $59.95ea. (plus $4.00 shipping and handling per kit)

Name

Address

City State Zip

Send check or money order only. Sorry, no COD or credit card orders accepted. Allow four to six weeks delivery. Offer expires 6/1/90



Loop it!
After generating enough speed in a dive (1), pull gently back on the stick to level out. Call "start!" (2) and, with elevator inputs, steer around a perfect vertical circle (3, 4, 5), using aileron and rudder if necessary to correct any errors of tilt or heading. When the loop is finished (6), you should be on the same heading and altitude as when you started the loop (no bobble up or down, please). Then call, "done!"

QUICK, ARESTI THAT AIRPLANE!

A Primer on Precision Glider Aerobatics

By Jef Raskin

Having flown in a number of glider aerobatics contests, and been a C.D. for some of them, I have learned that many fliers are a bit in the dark about some of the aerobatic maneuvers and what makes them good or bad. The AMA's rule books and most articles speak to power flying aerobatics, and while a lot of what they say applies to glider aerobatics, there are some differences.

Some maneuvers, such as torque rolls or lomcevaks are impossible in gliders since they depend on gyroscopic or torque forces from a rotating propeller. On the other hand we can do right and left snap rolls equally well whereas a power pilot finds one easier than the other.

FLYING PRECISION AEROBATICS

Non-precision aerobatics are easy. Just dive almost any glider and then pull back on the stick. Voila! a loop. Take most aileron-equipped slope soarers and give them full aileron at speed. Egad! a roll. That's sport aerobatics. It's fun, and they're the first aerobatics we all do once we've mastered keeping the beast in the air for a while.

But with human beings, novelty wears off quickly, and we try to get our planes to do more—inverted flight, Immelmans—the maneuvers we read about in stories of aerial combat and see illustrated in rule books.

For a few of us, the desire to do the maneuvers cleanly, our loops precisely round and ending at the same altitude with which we started, our rolls straight and stopping exactly in level flight, sets in. This is the beginning of precision aerobatics; what in the power model world is called "pattern" flying and in the full-scale world "competition aerobatics."

Later, we struggle to fly our aircraft inverted with the same ease with which we've mastered upright flight, and learn to coordinate ailerons, elevators, and rudder so that the simple maneuvers come out cleanly and the more complex become possible.

To perfect our knowledge and test ourselves, we may even begin to fly in aerobatic contests. Here, we must know the proper names and methods of execution of many maneuvers, and how to present them so that spectators and judges can best appreciate them. Here are some things I've learned that might be helpful.

STARTING STRAIGHT

The first rule is that *all maneuvers begin from straight and level flight!* You may be inverted when you start, but you still should be flying straight and level. In a glider, you must often dive to get enough energy to fly a maneuver, however that dive is *not* part of the maneuver.

The second rule is that all maneuvers *end* in straight and level (possibly inverted) flight. If you do not call the beginning and ending, the judge cannot tell what part of your gyrations to score.

In non-precision contests the rules are more relaxed, but they leave room for questions as to just what was the intended maneuver.

LOOP IT!

Say you are going to fly a loop in precision aerobatic competition... You gain some altitude and call out "Loop!" You dive to pick up speed, level out and when the plane is straight and level, you call out "starting now!" The maneuver is only judged between when you call out something like "now" or "start" (ask what is preferred) and when you call out "done."

After calling "now," you gently pull back on the stick using elevator inputs to steer around a perfect vertical circle, using aileron and rudder if necessary to correct any errors of tilt or heading. When the loop is finished you should be on the same heading and altitude as when you started as you flatten out into level flight (no little bobble up or down please) and call out "done!"

MORE ABOUT LOOPS

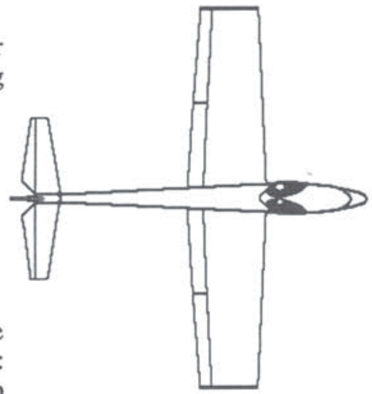
An outside loop is one where you push the stick forward instead of pulling it toward you to go around. Hence there are *four* basic loops: inside loop (upwards) from upright flight; outside loop (downwards) from upright flight; outside loop (upwards) from inverted flight; inside loop (downwards) from inverted flight. You should be able to do all four.

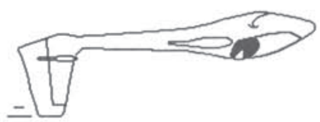
"There are four basic loops: inside loop (upwards) from upright flight; outside loop (downwards) from upright flight; outside loop (upwards) from inverted flight; inside loop (downwards) from inverted flight. You should be able to do all four."

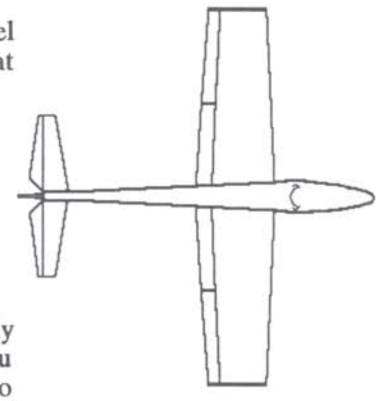
The famous aerobatic pilot Detroyat put them together into one grand maneuver (which I have modified slightly to make it work better with gliders): do an inside loop upwards, and at the bottom do an outside loop downwards, then do a half loop down which gives you the speed to do an outside loop upwards, which you follow with an inside loop downwards. You exit inverted. Doing this in one smooth maneuver is very pretty. It was first flown about 60 years ago! There are also square loops, hexagonal loops and more in the category of loops, but let's go on to rolls.

ROLLS

The nomenclature for rolls is more confusing







than that for loops because there are so many types: axial rolls, slow rolls, snap rolls, vertical rolls, aileron rolls, barrel rolls, cobra rolls, point rolls and so on.

Axial rolls are what most people mean when they say that a plane has flown a roll. The wings rotate around while the fuselage stays pointed in the same direction and on the same line.

A very sloppy roll can be flown by just picking up speed and applying full aileron. However, the aircraft will lose altitude when it's on its side and inverted and you can end up in a dive. Better is to use a little down elevator when it's upside down. Best is to also use "top rudder" so that when the plane has the left wing up you have left rudder and when the right wing is up you have right rudder. This helps keep the fuselage horizontal.

You cannot do a slow roll (defined for full-size planes as taking 15 seconds; for models, six seconds is hard enough) without using all the controls in a coordinated manner.

Some people do an axial roll by first pointing the plane up a bit as they start to compensate for the falling off later. This is not a bad idea, but if it is done too obviously a judge will downgrade the maneuver. If you point the plane up about 30 degrees and roll as it arcs over, you are doing a cobra roll. Here the trick is to come back to your original altitude exactly as the wings come level. You can do two or more rolls during the arc (so long as you call 'em before you do 'em); it's all in the timing.

EVERYTHING BUT KAISER ROLLS

Point rolls are axial rolls where you stop a number of times as you go around. A four-point roll is performed by stopping the roll (1) with the wings vertical, (2) when inverted, (3) with the wings vertical the other way, and then (4) back in upright flight. Here, coordinating rudder and elevator with aileron is essential. You can have any number of points. I've seen Bob Hoover do clean (if slightly cobra'ed) 16-point rolls in his Aero-Commander. Three pointers are really hard.

Point rolls (like most kinds of rolls) can be done vertically upward or downward, on a 45-degree slant...and so forth. You can roll from inverted to inverted, or half roll from inverted to upright or vice versa. There are hundreds of possible rolls. When you practice, make sure you can do them both clockwise and counterclockwise.

A vertical roll is one done straight upwards. The roll part is easy since it's done with ailerons alone, it's getting the plane pointed straight up without losing too much momentum that takes the expertise.

> **"Doing precision aerobatics gives you a feeling of confidence in your ability to fly your airplanes. You know how it will handle in any attitude, in any situation. You will also get to know your planes and the air with a degree of intimacy unexcelled by any other phase of the sport. It's also damn impressive to watch."**

You have to plan what you are going to do when you reach the top before you start. Your options are many: hammerhead, tailslide, pull out on top inverted or upright, and so on. Or you can just push over and downward (a humpty-bump) and even do another roll on the way down. A roll when you are going straight down is called an "aileron roll" since it needs nothing but aileron (and lots of both altitude and fortitude) to do it.

The barrel roll is what you usually get if you manage to do a gradual rudder-elevator roll with a thermal ship. The fuselage does not stay on a line but moves around in a circle. These are not much preferred in competition.

The most distinctive roll, and one much used in competition, is the snap roll. It is spectacular and often gets gasps from spectators if they are not familiar with it. It is accomplished by stalling one wing of a plane while the other keeps on flying. The plane goes around in a wild gyration very quickly. Many gliders will do it by just giving sudden full up elevator and full rudder from level flight. Some planes require elevator first.

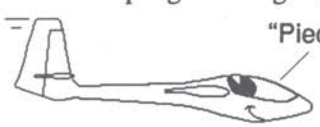
The snap roll can be done at almost any speed. The trick is to come out when and where you want to; some ships are helped by a bit of aileron, others are not. It's great fun to do snap rolls but it takes a lot of practice to master them. Outside snaps are done with down elevator and rudder. Ask a hot pilot to do an outside snap from inverted to inverted for you. Try it yourself. Your aerobatic glider doesn't have rudder? Well, it's not fully aerobatic and snaps are out of your repertory.

COMBINATION MANEUVERS

So far I've only described a few kinds of loops and rolls, but there are thousands of combinations of the basic elements which include straight flight, turns, loops, rolls, and snap rolls. There is a wonderful dictionary of aerobatic maneuvers, which was created by the famous aerobatic flyer, Colonel Jose Luis de Aresti Aguirre. His method of notating and scoring them is called the

"Aresti System." It was published in 1961, and while this compendium is great for finding interesting maneuvers to fly, its scoring system is inappropriate for gliders.

As Aresti documents, there are many combination maneuvers. An Immelman starts in upright flight, and consists of half a loop followed by half a roll. You end up higher and going the other way.



If you have plenty of altitude, you can do half a roll and then half a loop. A very pretty maneuver is an Immelman followed by half an outside loop (which puts you at your original altitude, inverted) and then half a roll, which makes the plane rightside up again. The inside and outside loops have to be the same radius and the two rolls directly above one another. The famous Cuban 8 (well described in the AMA regulations on page 105 of the competition rules, 1988) looks great, isn't very hard, and can be done by aileron-and-elevator sport aerobatic planes.

Another thing to practice is inverted flight. Roll or half-loop inverted and learn to fly around upside down. Again, all you need is aileron and elevator to get started. Rudder-elevator planes can get inverted, but most are rather "iffy" about turning. Do 360-degree turns to right and left while inverted. Make sure that you have plenty of altitude when you start to learn this, the plane can get out of hand very rapidly. At first you have to remember which way to push the stick, after a while (and, in my case, after a few crashed airplanes) it becomes natural. I sometimes spend whole flying sessions with the airplane upside down (except for landings). I need the practice.

CONCLUSION

Doing precision aerobatics gives you a feeling of confidence in your ability to fly your airplanes. You know how it will handle in any attitude, in any situation. It will improve your ability to fly combat, increase your speed in racing (you'll be able to hold to your line more easily), and even improve your winch tows and spot landings since you will handle the controls better. You will also get to know your planes and the air with a degree of intimacy unexcelled by any other phase of the sport. It's also damn impressive to watch.

Barring bad luck or jobs that take me out of town too much of the time, I hope to be running some aerobatic fun flies and contests during 1990 in cooperation with the San Francisco Vultures club and with *Slope Soaring News*. If there's enough interest, maybe we can put together an informal school for slope aerobatics; I'll donate my time and there are other, better fliers who I am sure will help out so it could be done at no or very low cost.

See you on the slope!

Miss Go-Fast Saga Continues...

Foil Plotting, Wing Incidence and Foam Meltdown

By Pete Marshall

For those dedicated seekers of Miss Go-Fast, I left you in a previous issue with your completed fiberglass fuselage perfectly sanded and ready for paint. IMPORTANT! If you haven't yet cut a hole or hatch in your fuselage, DON'T until you read on. Let Miss Go-Fast hang out for a while with the foam plug still inside.

Since our one-piece wing will sit on, or in, the fuselage, we need an accurate wing root airfoil template to cut the wing saddle into the fuselage. Of course, we'll also need root and tip templates to cut our blue foam wing cores using the hot-wire method.

"How do you create root and tip templates with the desired chord length? There are three good ways."

At this point, you have decided which airfoil you want, and you have unrolled your full-size plans. As you look down on the plan, or top, view of the wing, you measure the root and tip chord, jotting the numbers down on a scratch pad. For the purposes of this article, we'll say that the root chord is nine inches and that the tip chord is 7.25 inches. You have decided on an Eppler 374 thinned to 7.5% (This airplane will really cook!) or a Selig-Donovan 6060 thinned to 8%.

Three Ways To Wing It!

How do you create root and tip templates with the desired chord length? There are three good ways.

1. Best and easiest way (also high-tech): Computer-generated airfoils.

For this you need a computer, printer and an airfoil-plotting program. Hey, Charlie has one! Give him a call! (Just kidding.) Seriously, find a buddy or a friend-of-a-friend and get to it.

The computer will need to know the following specifications.

A. Airfoil name (SD6060)

B. Chord length (9.0 in.)

C. Skin thickness (1/64 in.)

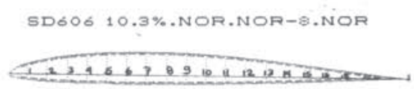
D. Section thickness, expressed as % of chord (8%)

E. Chord station lines, expressed as % of chord) (5%)

F. Chord datum line, yes or no? (Yes)

G. Mirror image option, yes or no? (Yes)

Type in this information, and a few minutes later, your profile zips out of the printer looking like this:



SELIG DONOVAN 6060, 10.3%, THINNED TO 8%

Number the vertical chord stations which divide the chord length into equal sections, as shown. Start numbering from the leading edge to the trailing edge, which is the direction of your hot wire cut. Keep the numerals inside the airfoil profile so they won't get trimmed off when you cut the profile.

Now, it's off to the copier to run off at least a dozen copies. Run off a few more for your buddies.

These airfoil plotting programs are truly amazing! For instance, you could ask the computer to use the upper surface of the Eppler 374 (7.5%) for the lower surface of the airfoil as well as the top and, voila! A fully-symmetrical airfoil of about 11%. Wild!

2. Another Easy Way, Sort Of: The Expanding Photocopier Method

Find an accurate reproduction of your desired airfoil in a magazine or technical manual. Before using the photocopier, carefully draw in a chord datum line from the exact trailing edge to the leading edge. This line will be the datum from which you will set wing incidence and foam-cutting incidence (wash-out).

Next divide the line into 20 equal lengths (every 5%). Mark each 5% chord datum line with perpendicular lines, just like the computer-generated airfoil. Number the vertical station lines starting with the leading edge. Keep the numerals inside the profile.

Finally, it's time to find a photocopier that has enlargement/reduction capabilities and expand or shrink the profile until it matches your root and tip chord lengths. Run off a few copies of the correct root and tip chord lengths, mark them and keep all the copies, even the incorrect ones. You never know when you might want some different chord lengths.

Don't worry about allowing for the 1/64 inch plywood skin thickness; the wire burn will take care of that.

3. The Longest, Hardest, "I Did It My Way" Way Of Plotting Airfoils: Plot 'Em Yourself!

You're sitting at your kitchen table looking at this table of ordinates, wondering how to create an airfoil from this jumble of numbers. Well, it's easier than it looks, and it's about as much fun as watching epoxy cure.

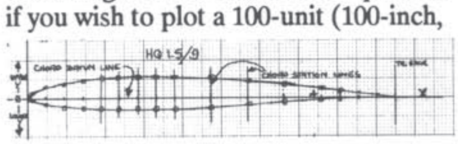
First, buy some graph paper with a fine grid pattern (10 squares per centimeter or 20 squares per inch). Notice that the tiny squares are overlaid with a coarser grid of heavier lines. Orient your graph paper so that the root chord will fit, and label the top of the sheet with the airfoil name and number. Scribe a dark vertical line over the first heavier line on the left side of the paper. This line will mark the leading edge of both your airfoils. Now scribe a second dark line horizontally, about three or four inches from the top of the page, once again, over the top of a heavier grid line. Looking at your sheet of paper, you should see a "T" shape, lying on its side.

SD6060 Ordinates (8% thickness)

Station	X	Y upper	Y lower
1	0.000	0.000	0.000
2	1.000	0.897	-0.745
3	2.000	1.608	-0.950
4	4.000	2.429	-1.278
5	6.000	3.041	-1.497
6	8.000	3.531	-1.654
7	10.000	3.942	-1.777
8	15.000	4.712	-1.979
9	20.000	5.232	-2.094
10	25.000	5.609	-2.148
11	30.000	5.764	-2.172
12	35.000	5.840	-2.160
13	40.000	5.800	-2.121
14	45.000	5.651	-2.056
15	50.000	5.395	-1.967
16	55.000	5.040	-1.851
17	60.000	4.602	-1.708
18	65.000	4.105	-1.532
19	70.000	3.555	-1.327
20	75.000	2.961	-1.097
21	80.000	2.333	-0.851
22	85.000	1.685	-0.597
23	90.000	1.047	-0.345
24	95.000	0.452	-0.118
25	100.000	0.000	0.000

The horizontal line will be the chord datum line, and you will plot the "X" numbers along this line. The vertical line will be the starting point. You will start your measurements along the chord datum line from the vertical line.

Back at the table of ordinates, nothing has changed. The ordinates are perfect if you wish to plot a 100-unit (100-inch,



100 centimeters, etc.) chord. Hopefully, your chord lengths will be different than this, so you must draw your own table of ordinates for the length required.

Whip out your trusty calculator, and punch in your chord length as a percentage of 100. In other words, a nine-inch chord is 9%. Key that in as .09 on the calculator. Our tip would be 7.5% or .075. Save this number in the calculator's memory, so that you can multiply the entire list of ordinates by it without having to rekey it each time. Simply take your list of ordinates and multiply each one time "memory" and build a new table of ordinates for your new airfoil.

Hold The Phone!

Hey! What about the 7.5% airfoil? These ordinates are for a full-thickness (10.9%) Eppler 374. Okay, okay, I was getting to that.

How do we get the 7.5% thickness? Easy. First, crunch the "X" ordinates for your nine-inch airfoil. Now, we're going to fool the system. We crunch the "Y" ordinates using a fake, smaller chord length. If you plotted your chord stations for a nine-inch chord, multiply nine-inches by 75% (9 X .75 = 6.75). Enter 0.0675 into memory, and calculate the upper and lower "Y" ordinates.

Looking at this can of worms in another way, you've calculated the thickness of an airfoil 6.75 inches long, and then stretched it to nine-inches long. Get it?

The Plot "Thickens"...

Finally, you get to plot your numbers into an airfoil shape!

Start at the left side (from the vertical line you drew) and measure along the horizontal line. Mark each "X" (chord) station with a fine vertical pencil line. The last line should be exactly nine inches from the leading edge, or the vertical line of the "T." Mark the last station chord as the trailing edge.

Now, let's plot the upper "Y" ordinates at the specified distances above the horizontal line of the "T." Mark each point with a fine dot. Make a tiny circle around each dot so you can find it later. Check off each number on your list of ordinates as you go along.

Now plot the lower "Y" ordinates in the same way, except of course, they'll be located below the datum line.

When that's finished, carefully join the tiny dots using a French Curve (a curved ruler available at art or stationery stores). Your airfoil should be perfectly smooth with no bumps or hollows.

If you have plotted your airfoil manually, you must still mark the vertical station lines at 5% chord intervals. (It's used during the actual cutting of your foam core.) Now make six copies of each airfoil.

Beauty And The Beast

Gently explain to Miss Go-Fast why you took so long to get to this next important step. Play down the fact that you're close to slicing into her sleekness with a vicious Dremel cutter. Instead focus on how good she'll look with her wings looking like they just grew out of her fuselage.

Since every hole or hatch you cut into your fuselage is a potential weak spot, it makes sense to have only one hole. Of course, have no holes would be better, but it makes it difficult to get the radio gear in and out!

Your fuselage is probably deep enough to combine the wing saddle with the radio access hatch. The drawing shows a top-mounted, shoulder-wing saddle/hatch. Your hatch may be on the bottom if you've designed a low-wing aircraft.

We want to cut the hatch so that it creates a 30- to 40-degree ramp from the leading and trailing edges to the top (or bottom) of the fuselage. This ramp will allow the wing to pop off in the event of medium to heavy impacts with minimal damage to each part. The wing will be held on with only two 8-32 nylon panhead screws. These nylon screws have great tensile strength yet shear easily, dividing the total inertia of the aircraft into two separate pieces. The separated parts then stand a better chance of survival. I hate talking about this stuff, but let's face it, sooner or later, every airplane dorks in. Since we have already put so much time and energy into Miss Go-Fast, let's design some survivability into her, too.

Don't go to heavier screws or use more than two of them. A few years back, Ken Stuhr of VS Sailplanes was clocked at 147 mph at a slope speed contest. His top-mounted wing was held down by one 6-32 nylon screw at 25% chord and one 4-40 nylon screw at the trailing edge. (He won the event, by the way.)

First Cut Is The Deepest

Before you slice into your fuselage, cut two paper templates from your root chord copies. One must be a mirror image of the other, so flip it over and carefully scribe the datum line on the blank side.

Now, we'll position the paper templates on your fuselage. Take your time, and do this very accurately according to your plans. Block up Miss Go-Fast on her belly on a flat surface. Set the fuselage angle to the attitude you want for straight and level flight (usually, a slightly nose-down attitude looks good). Measure from the table to the fuselage sides, and scribe pencil marks at the leading and trailing edge positions. Measure from the nose back along each side and mark where the leading edge should intersect the fuselage.

We're setting the incidence of the wing (the angle of the chord datum line relative to the fuselage datum line). We want to set 0-degrees incidence, so the leading and trailing edge distances from the table should be equal.

Although our chord datum line, or angle of attack, will be 0-degrees in straight and level flight, the wing will still produce lift due to the asymmetrical airfoil. So, don't worry about having to fly your plane around "nose-up" to fly straight and level. (You will have to fly slightly nose-up while inverted, however.)

Glue the templates onto the fuselage, lining up the chord datum lines with your pencil lines, using secretarial rubber cement. Check the measurements again and make sure the fuselage is vertical while the glue dries.

Now scribe lines on the fuselage radiating out from the trailing edges to the top (or bottom) at the 30- to 40-degree angle. It's hard to get these lines to meet properly at the top of the fuselage, so try this: Lay six to eight inches of black plastic tape on a flat surface and cut off 1/32-inch strips. Stick one strip over your ramp line. Now stick a strip on the other side and wrap it over the top to see how it lines up. Peel it off if it doesn't match perfectly, and try again until it does.

Grab your Dremel tool and carefully cut along the airfoil lines. Pull the little airfoil templates and fiberglass off the foam plug and chuck 'em in the trash. Now, cut the breakaway ramps using the plastic tape as a guide. Save this piece to use as your fairing/hatch cover.

Meltdown Time!

Now it's time to dissolve the foam from inside the fuselage. Do this job outdoors because the blue foam turns into blue goo that sticks to everything and anything.

Renew the acetone from time to time, but don't let the fuse sit around for long periods of time. Eventually, the stronger solvents will soften the fiberglass, especially where it's thin.

When the acetone has done its job, wash out the fuse with warm, soapy water, rinse and let 'er hang out to dry.

If you want to reinforce it with Kevlar, now is the time. Sand the inside to smooth the rough surface left by the dissolved foam. Cut your glass and Kevlar to the required shape. Stack the lay-ups in the order of use. The first layer should be two-ounce glass after wetting the interior with resin. Kevlar doesn't form well around bumps as well as glass does, so the two-ounce lay-up will provide a cushion or filler layer.

When the initial layer of two-ounce 'glass is all wetted out, lay in the Kevlar. Wet the Kevlar thoroughly using a disposable paste brush to work the resin into the weave and force out any air bubbles. Kevlar definitely takes more time than fiberglass to wet thoroughly. Then, lay up more 'glass on top of the Kevlar (remember: Kevlar works better in a "sandwich").

Even if you don't use Kevlar, beef up the wing-saddle area with three or more layers of two-ounce fiberglass. An ounce or two of epoxy should be enough for all the layers. This wing saddle area is the weakest spot in your fuselage, so it should be well reinforced.

NEXT MONTH: SETTING UP TO CUT THOSE CORES!

Scraps...

Turn n' burn!
The Combat Models video *Jets* features outrageous footage of both models and the real thing!

VIDEO MADNESS!

The illustrious Byron P. Bruce, entrepreneur, model manufacturer and afficiando of power scale slope jets, has produced a video. And ya know, it's not bad! In fact, I watch it several times each month just to get a flying "fix" on those dark evenings or working weekends when I can't actually get out to play.

It's called *Jets*, and along with an impressive demonstration of the Combat Models power scale slope jets – MiG-27, A-4, A-10 and F-16 – it includes some outstanding footage of full-scale jets in action at the Miramar Air Show, home of Top Gun.

High-G pullouts that produce vapor on top of a Navy F-14 or Blue Angels F-18 are included along with some amazing slope soaring shots from the Kona Coast where Byron and flying buddy Rick Edris stage a vacation fly-in each fall.

For only $13.95, plus $2.55 shipping (California residents please add 7.25% sales tax), you too could turn n' burn vicariously in the comfort of your own home. Contact Byron at Combat Models, Inc., Fightertown USA, 8535 Arjons Drive, Suite R, Miramar, CA 92126; 619/536-9922.

VINTAGE SAILPLANE INFO

Looking for scale documentation for a vintage sailplane project? Check our want ad section. I've picked up a couple of the ads we run in *Bungee Cord*, the Vintage Sailplane Association newsletter, one from the VSA and one from *Model Aviation* magazine columnist, Byron Blakeslee.

DOUBLE ZIMMERMAN

No, that's not some new Aresti aerobatic maneuver. We're talking about Dave Zimmerman's Hobby Hutch, 310 E. Orangethorpe Ave., Unit C, Placentia, CA 92670; 714/996-7060 – no, wait, make that Hutches – he's just opened a second store at 553 West Arrow Highway, San Dimas, CA 91773; 714/394-1191.

So, how come he's not a *Slope Soaring News* dealer (twice!)? When you drop in to check out the new shop, ask him for me, will ya?

HOLD THE KIPPERS!

Planning a trip overseas? Perhaps you'd like to see some original British power-scale slope soaring... Alan Hulme, editor and chief-do-it-all at the Power Scale Soaring Association, published a calendar of events in the most recent issue, and he's given us permission to reprint it here.

April 29 The Ribble Valley PSS Fly-In at Pendle Hill, near Clitheroe, Lancashire. Full information available from Brett Bond, 68 Warwick Street, Church, ACCRINGTON, Lancs, BB5 4AL. Telephone: 0254 391208.

May 20 Rivington Soaring Association's PSS Fly-In on or near Rivington Pike, near Horwich Lancashire. For full details, send a SASE to Tom Speakman, 29 Old Vicarage Road, HORWICH, Lancs. Telephone: 0204 696986.

September 8-9 Barry Aeromodellers two-day PSS Fly-In on Bwlch Mountain, near Bridgend, Dyfed. It's the first national meeting for this group. More information is available by sending a SASE to Dave Williams, c/o Skytime Soarers, 25 Romilly Park, BARRY, South Glamorgan, CF6 8QR. Telephone: 0446 737179.

September 22-23 Leek and Moorlands Gliding Association two-day PSS Fly-In at the "Mermaid" site near Thorncliffe village, LEEK, Staffordshire. For further details, contact Simon Cocker, 67 Peel Street, MACCLESFIELD, Cheshire, SK11 8BL. Telephone: 0625 513382.

October 7 The Great Orme Soaring Association PSS Fly-In at Llandudno, North Wales. A first open PSS meeting for this newly formed club. Send a SASE to Ray Hodgkinson, Lynton, Llwynon Road, Llandudno, Gwynedd, LL30 2QF. Telephone: 0492 70714.

October 21 The Hole of Hocum Autumn PSS Fly-In. For more information, send a SASE to Michael Kitchen, Tall Timbers, Sutton-in-the-Forest, YORK, YO6 1DY. Telephone: 0347 810685.

MORE BRIT BITS

Also in the most recent PSSA Newsletter is a nice story with a few photos about Brian Laird and Paul Masura's Slope Scale planes. Brian and Paul are Bluff Cove regulars here in SoCal, and it's neat to see 'em appear in an international publication!

Anyone remember seeing the photo of Simon Cocker's huge, 13-foot B-52 sloper in the November 1988 issue of SSN? Dave Williams has taken over kitting rights for several of Cocker's designs including a smaller 106-inch version of the B-52 and a 1/8 scale Gates Learjet (approximately 66-inch span). The B-52 is available for £99, and the Learjet for £89. His next kit, due later this year, will be a 140-inch B-29 Superfortress. For more info, contact Skytime Soarers, 25 Romilly Park, BARRY, South Glamorgan, CF6 8RQ. Telephone: 0466 737179.

I highly recommend PSSA membership to power scale enthusiasts. For membership information, please contact Alan Hulme, 52 Mountway, Waverton, CHESTER, CH3 7QF, ENGLAND. Telephone: 0244 336472. When phoning, please remember that they are seven hours ahead of us (in other words, if it's 7:00 p.m. here, it's 2:00 a.m. tomorrow morning over there!), so don't call England in the evening, or you'll probably wind up talking to a very cranky bloke who's just had his beauty sleep interrupted!

NSP NEWS

That catalog we've been hearing about from North-East Sailplane Products is finally here, and it was worth the wait! Offered at mailorder prices are sailplane kits and accessories from more than 33 different manufacturers. Plus, there are short articles dealing with such details as "Lift, Drag and Performance," "The Schuemann Planform" and "Slope Soaring at Inland Sites with the NSP Gang." At only $3 for the 80-page catalog, it's a bargain, and that cost is refunded with your first order. Send your three-dollar bills to North-East Sailplane Products, 16 Kirby Lane, Williston, VT 05495; 802/658-9482. Say hi to Sal, Stan and Jay for me!

SLOPE POOL TO RICHLAND

Looks as if there will be quite a caravan of SoCal slopeheads who'll make the drive up to Richland, Washington for Wil Byers' Memorial Day Weekend Tri-Cities Scale Slope Fun Fly. Want to join us? If you need a ride, or another guy to share the driving in your vehicle, or a roommate to share the hotel cost, or if you just want to join the caravan, give me a call.

The group plans to leave on Wednesday evening, May 23, sometime between 5:00 and 7:00 p.m. (One last rush hour before we get to enjoy the remote beauty of southeastern Washington!)

Phone *SSN* at 213/494-3712 and either talk with Charlie or leave a message on the recorder stating your needs and/or intentions.

International Modeler Show contest winners. No, the infamous Hawaiian Airlines 737 pictured above isn't a glider, but it was built by well-known RC sailplane pilot/manufacturer Larry Jolly for the movie. It won the Grand Prize at the IMS contest. Excellent workmanship! Richard Jarel's new Shogun ATF (now available in kit form!) won the Slope Glider/Aerobatic category. Charlie Morey's Jet Hanger F-86 won the Slope Glider/Scale first-place trophy.

SHAFTED!

We printed some specs on the JRS350M servo that weren't entirely correct. It *does* have metal gears, but not *all* of them are metal.

The motor-shaft gear is metal, but the next two are plastic. All the rest are high-quality brass with the exception of the output shaft. High loads will break the teeth off the output shaft, a "weak link" to prevent damage to the motor, case, etc. The problem is that you can't buy just the replacement output shaft—it comes only in a complete $7.00 gear set. Thanks to Bill and Bunny Kuhlman (who own seven of the servos and think they're great but need a few shafts) for the info. How about it JR? Can you give 'em the shaft?

AERODYNAMIC ANSWERS

Reynolds Numbers, Separation Bubbles and Sharp T.E.s

By David Fraser, John Donovan and Michael Selig

In the June 1989 issue of *Slope Soaring News*, there was an article on the SD6060 airfoil. The article was quite informative, but there are a few points that need amplification and a couple that were wrong. Hopefully, we can clarify those points here.

First is the statement that "[Reynolds number] refers to the number of air molecules flowing across the wing. Simply put, the larger the number, the more air flows over the wing." This is not correct.

Reynolds number, usually abbreviated R, Re or Rn, is a measure of the ratio of the inertial forces in a fluid (air, for example) to the viscous forces. Osborne Reynolds was a hydraulics engineer in England in the late 1800s. While investigating flow characteristics in channels and pipes, he discovered that the dynamics of a flow were independent of size or speed provided a certain quantity—now called Reynolds number—was held constant. This was a major discovery. It meant that it was possible to investigate virtually any size fluid flow without having to construct full-size models, provided the Re of both the full-size and the model flows were the same. The actual quantity which he discovered is described by the following formula:

$$Re = \frac{\text{Density} \times \text{Length} \times \text{Velocity}}{\text{Viscosity}}$$

For a wing, the length is usually taken to be the chord, and the velocity, that of the airstream. The density and viscosity are, of course, those of the fluid—air, in our case. If we use feet and feet/second for the length and velocity and assume the standard sea level conditions for the air, the equation reduces to the following:

$$Re = 6365 \times \text{Velocity} \times \text{Chord}$$

The important point for modelers is that if two airfoils are operating at the same Re, it doesn't matter what the actual wing chords or speed are. In fact, it doesn't even matter if the fluids are the same. The wing might fly in air, but the model could be tested in water. Consequently, those of us who test in tunnels can use a single, standard chord for all the models and vary the air speed to get any particular Re. In other words, it isn't necessary to duplicate the exact chords of model wings (or full-size wings) as long as the Reynolds numbers are the same.

In the Princeton wind tunnel, we used a 12-inch chord. To get a Re of 100,000 at standard atmospheric conditions, the airspeed had to be 15.7 feet per second—or about 11 mph—as shown by the formula below:

$$V = \frac{100{,}000}{6365 \times 1} = 15.7 \text{ ft./sec.}$$

If your wing has a six-inch chord, you would need to fly it at about 22 mph to get the same Re. And, because of the similarity of the flows at constant Re regardless of the actual physical size (scale), your wing would behave exactly the same at 22 mph as our test section did in the tunnel at 11 mph. That is, the drag coefficient (Cd) at any given lift coefficient (Cl) would be the same. The wing would stall at the same Cl, and any other flow-related characteristics would be the same. So, the results from the wind tunnel are directly usable, even though our sections don't have the same chord as yours. All you need to do is match the Re.

The second point is an amplification. At Princeton, most of the models were tested at five Reynolds numbers, not just three—60k, 100k, 150k, 200k and 300k (where k = thousand). Some airfoils were not tested at all of the Reynolds numbers.

The third point concerns the flow in and around the "laminar separation bubble." As the article stated, the flow at these low Reynolds numbers "breaks away from the wing somewhere near the high point of the airfoil."

When the flow leaves the surface, it is laminar. It later becomes turbulent, and for most airfoils, this turbulent boundary layer reattaches long before the trailing edge. The extent of this separated flow is strongly dependent on the Re—the lower Re, the longer the detached region.

At 60k, the separated region might be as long as 40% of the chord, but at 300k, the separation could be as small as two to three percent. In addition, the air under this separated region is not turbulent as the article says. It is almost stagnant. Turbulating this stagnation region with air blown through small holes in the wing is one way of tripping the flow. This method is sometimes used on full-size sailplanes.

The problem with separated flows is that they eventually make a transition from laminar to turbulent flow in a way that sucks up comparatively large quantities of energy, energy which must be supplied by the sailplane and shows up as drag. In an attached, turbulent flow, the thickness of the boundary layer, and hence the energy contained in it, grows steadily but comparatively slowly. However, when a separated laminar layer transitions to turbulent, it becomes a thick, highly-energized layer that contains far more energy than the equivalent turbulent layer.

Another way to consider the drag due to the separation bubble is as follows: If the separation bubble were not present, the reduced pressure on the upper surface of the airfoil would recover smoothly (that is, it would increase to the ambient pressure) as it approaches the trailing edge of the airfoil. However, this stagnant region stops this smooth recovery for the length of the bubble, thus the pressure under the bubble is lower than it would be without the bubble. This low pressure, together with the shape of the airfoil, acts to pull the airfoil backwards which increases drag.

We investigated two different ways to alleviate the separation bubble problem. The first was by designing the shape of the airfoil to minimize the extent of the bubble and to keep the separated layer thin. A shorter, thinner layer absorbs less energy that a longer, thicker one when it transitions and therefore produces less drag. The second method was to "force" the laminar layer to transition before it separated by using a trip—typically a strip of tape about .020 inch thick on the upper surface of the wing located somewhat ahead of the point where the separation would have occurred without the trip. Turbulent air is "stickier" than laminar air, and it tends to stay attached to the wing. So, even though turbulent air has higher drag than laminar flow, it has much less drag than separated flow.

Both methods work. If an airfoil has a large separation bubble, a trip will usually improve its performance, at least at Reynolds numbers below 200,000. In our book about the experiments—*Airfoils at Low Speeds* (Soartech #8)—you can see an excellent example of this: the drag of the Miley airfoil was reduced by a factor of four by using a trip, although this kind of dramatic drag reduction is not typical of the popular RC soaring airfoils.

If an airfoil which is prone to large bubble losses is properly reshaped, that reshaping will usually reduce the drag, and it will do so without incurring a penalty at high Re, something that can be a problem with a trip. It was reshaping that was used on the SD6060. And while the change to the surface might not seem like much, it's important. In fact, it's a good illustration of the necessity of accurate building. Little errors in the wrong places can have significant effects!

Finally, there seems to be some confusion between the "squared-off tailends of race cars" and the trailing edges of airfoils. The last thing a race car—or any car, for that matter—needs is a long, thin tail. Such a shape produces lift and decreases the load on the rear wheels. Race cars are squared off not to reduce drag, but to reduce lift. The increased drag (of a squared-off tail) is accepted because the loss in traction (with a long, thin tail) would be catastrophic at the speeds these cars travel. That's also the reason they frequently use airfoils lifting downward over the rear wheels—to get better traction.

For an airfoil (or a car), the drag is less with thin trailing edges. The difference isn't much, and it only shows up at the higher end of the low Re regime, but it is measurable, and we measured it.

Hopefully, this discussion will help everyone understand some of the practical points of airfoil testing. We realize, like everyone else, that it's easy to fall prey to the "airfoil of the month" disease, but we think that some of the newer designs will, in the long run, prove to be better than the older ones. After all, what we now call "older" was once brand new, too.

AIR MAIL

The Modelers' Advantage

Hey, American radio-control modelers, we have an opportunity here, but we're just letting it fly by us. The opportunity I'm talking about is the Modelers' Advantage, the ability of one man to develop a conceptual idea, take that idea to the drawing board and produce a detailed design. Once the plans have been made, he can construct and finish his idea. Then, he can go out the same day and fly it.

The whole span from conceptual idea to flying structure can take as little as two weeks. Do you have any idea how important this advantage is in researching and developing new types of air frames and lift-creating devices? Can you imagine the price Northrup or any other full-size aircraft company would give to achieve this? They'd kill for it!

But what do we radio-control modelers do as a whole? We constantly search for new ways to refine the P-51 Mustang or make another replica of the world's latest fighter aircraft. Then we are so bold as to put the emphasis on building the design instead of the design of the build.

In this technical and highly-specialized age, it takes the full-size aircraft companies hundreds of departments with thousands of people to produce a flying structure from a conceptual idea, not to mention five to ten years and a lot of gold.

Let's look at the expense advantage we as modelers have over the big guys. If I want to experiment with an idea, I like to build it in the slope soaring glider format. That eliminates the need for an engine, gas tank and landing gear, which greatly reduces the cost of the project. Building the experimental plane as a glider will give test data that's more accurate and it'll add fewer variables to the plane's flight characteristics.

You don't need to be an engineer or a draftsperson to make detail plans for your idea. All you need is a nice, flat surface large enough to draw your plane to scale. You don't need all the drafting gadgets, either; just use a combination straight-edge scale and a 30/60/90 triangle.

Now, you need to know a little about aerodynamics, wing and fuselage design. Don't get hung up on thinking you need to use some standard type of Eppler airfoil, or your plane is doomed before it's completed. All you need is an idea of the type of airfoil that will suit your needs—flat-bottom, semi-symmetrical or symmetrical—or your own shape which incorporates all of them. Don't let anyone tell you it won't fly; just try it. This is what designing experimental aircraft is all about: having the foresight and imagination to do what other people have not done in the past.

As I stated earlier, we have gotten so caught up in placing our emphasis on creating new building techniques that we have just lost interest in creating new techniques for aircraft design. If, for example, we limit ourselves to using only three types of airfoils (flat-bottom, semi-symmetrical and symmetrical), we haven't changed since 1942. When we design our wing planforms, we stay with the tried-and-proven backswept design. Big Brother (the full-size aircraft companies) tried to use forward-swept on the X-29 and complained that the plane is unstable. We hear it takes three onboard computers to make the plane fly level, so we blindly conclude that forward-swept wings are unstable. We think that if they spend $50 million on one aircraft, what chance to I have of making the idea work? I personally think that we have a much better chance of making new ideas work.

Think back to the days when two brother had a conceptual idea and were able to build it themselves. We got the first airplane. It wasn't constructed by a Harvard mathematical graduate, but by two clever bicycle mechanics who had a lot of faith in themselves. Have faith in yourself. Don't be afraid to fail.

Remember, you don't have to ride in your experimental plane. That's one of our biggest modelers' advantages. Let's start exploiting these tremendous modelers' advantages. If we apply this theory to our own model making, we can become the new leaders in producing new advancement in aircraft technology.

Michael St. John
Long Beach, CA

SORRY, JEF

I'd like to apologize to Jef Raskin for my comment about flying pattern ships, etc. After rereading his original comments and his letter in the Dec./Jan. issue, I understand his point and apologize for my remarks.

As he stated, there is room for all kinds – scale, precision aerobatics, sport aerobatics, racing or whatever. I don't fly them all, but I do enjoy them all, and it's guys like Jef that bring the variety to us.

I'm sorry for the remarks. Please accept my sincere apology.

Jim Metzger
LaVerne, CA

PRECISION ART

The Europeans have been flying full-house aerobatic slopers for many years. Fully-symmetrical airfoils, rudder, elevator and ailerons are par for these planes. Aerobatic soaring is a precision art, and the planes must be highly refined to perform in that element.

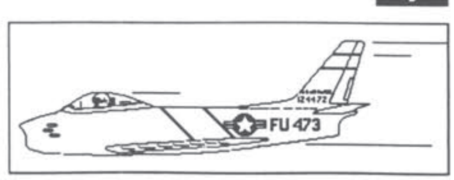
The truth is that there aren't any full-blown aerobatic aerobatic soarers in the U.S. market. Most of the planes sold here are designed for the newcomer. That isn't to say that there aren't any gliders that can perform, but most of these planes are a compromise for stability, light-lift conditions, comfortable speed envelope and fair-to-good inverted performance.

No one said that slope aerobatics is the goal of every slope flier, but if pure aerobatics is your game, then there is only one choice. Sunday fliers who enjoy an occasional loop or roll shouldn't be so quick to condemn the person who wants a plane that will snap, spin, roll and loop with precision.

I support Jef Raskin and his ideas and hope that in the near future, slope aerobatics will become as popular as power scale and scale.

There is an excellent book on this subject called Radio Control Slope Soaring by Dave Hughes. I obtained mine from Zenith Books, P.O. Box 1, Osceola, WI 54020. The product number is 107617A, and it sells for $24.95.

Jon Weyl
Royal Palm Beach, FL



Want Ads

MODEL DOCUMENTATION

Color photos, 3-view, Randolph color code and owner information on the following types: Grunau Baby IIb ($10), Eon Olympia ($10), DFS Rhoensperber ($10), Kirby Kite ($10), Kocjan Orlik II ($10), Schweizer TG - 3A ($10), Go 3, Minimoa 38 ($15), Rubik Cimbora ($10), Laister Kaufmann TG-4A ($10).
Scott Airpark, Rt. 1, Box 239, Lovettsville, VA 22080

LOOKING FOR SCALE MODEL PLANS AND DOCUMENTATION?

Send me a business-size self-addressed stamped envelope, and I'll return a list of Cliff Charlesworth's quarter-scale plans and a list of Scale Model Research's Photo-Pak documentation packages. Byron Blakeslee, 3134 Winnebago Drive, Sedalia, CO 80135.

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