R/C
Radio controlled
SOARING DIGEST
THE JOURNAL FOR R/C SOARING ENTHUSIASTS

March, 2004
Vol. 21, No. 3

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The Soaring Site

RCSD on the Web
http://www.b2streamlines.com/RCSD.html

Over 20 years ago, a sailplane enthusiast and dedicated columnist for several major magazines, Jim Gray, saw a need to provide information to the aeromodeling community on the subject of RC sailplanes. So he created the *R/C Soaring Digest (RCSD)* in January of 1984.

It was in 1988 that my first poor attempts at desktop publishing caught Jim's eye. He convinced me to type set *RCSD* in December of the same year, and he convinced me in a way that only Jim could imagine. He mailed me a big envelope stuffed with letters, notes, clippings, and the like, all on the subject of soaring, of course, and I *didn't* know it was coming. This was obviously a challenge. Needless to say, I didn't refuse.

Times have changed since then, and *RCSD* is now in its 21st year. At its peak, we had 2200 subscribers. Today, less than 200 of you are reading what will be the last hard copy, printed and snail mailed, of *RCSD*.

It was February 24th of this year when the *RCSD* team first broached the subject that ultimately led us to the conclusion that it was time to put *RCSD* on the Internet. Today, as many of you are aware, both the January and February issues are available for downloading free of charge from the *RCSD* web site <http://www.b2streamlines.com/RCSD.html>, and this issue will soon be available as a pdf as well.

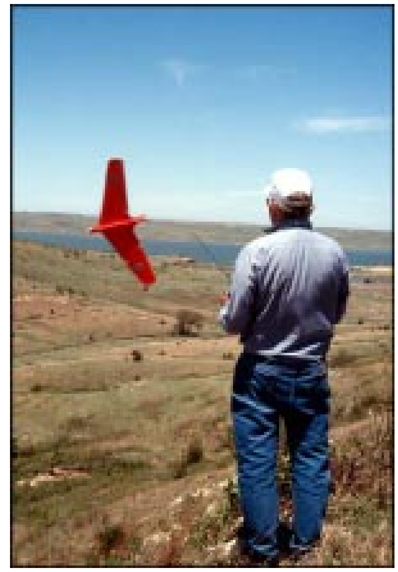
Additionally, the *RCSD* Team is already working toward providing services and items not available in the print medium, and investigating creative ways of presenting information within the new format.

A new era has begun through a lot of last minute teamwork on the part of our authors and their wives, who put up with the flurry of clicking keyboards long into the night. Special thanks go to Bunny & Bill Kuhlman, Adele & Dave Register, Kris & Gordy Stahl, Paula & Dave Garwood, Bobby & Lee Murray, Nancy Heath & Tom Nagel, and Cheryl & Mark Nankivil. The transition to web publishing would not have happened if not for them.

Our current plan is to make an announcement on the *RC Soaring Exchange (RCSE)*, the *Model Airplane News* e-mail list, as new issues are available for downloading, as we believe that many if not most of you are members of the forum. Since we do not know if any of you will have difficulty downloading or getting a copy from a friend, we have included a short survey note in this issue. Each of you also have the opportunity to ask for a refund on the balance of your subscription, or make a contribution to help defray the costs of the conversion to electronic publishing.

Any and all comments will be appreciated! And, we'll try to make this work for all of you. It is thanks to each of you that *RCSD* is still publishing today!

Judy Slates
RCSDigest@aol.com
http://www.b2streamlines.com/RCSD.html



Alden

Alden Shipp of Lucas, Kansas flys a Dave's Aircraft Works Messerschmitt Me-162 Comet in slope lift over over Wilson Lake, Russell County Kansas during Midwest Slope Challenge 2000.

The Power Scale Soaring (PSS) model is built from tough EPP-foam and covered with Ultracote heat-shrink covering. Elevons are controlled by two servos mounted in the wings, with transmitter mixing of the aileron and elevator function.

The Me-162 was a rocket plane, designed late in WWII to rapidly intercept attacking Allied bomber formations; then fuel spent, it would glide back to base.

Photograph taken on Ektachrome 200 slide film with Minolta SRT-201 camera using a 200 mm lens by Dave Garwood.

How to Photograph Slope Sailplanes

Charlie Richardson's and Dave Garwood's Fun-1 racers battle it out at Wilson Lake KS in the ODR race at MWSC-2000. Rich Loud made this two-plane action photo by knowing the fundamentals of camera operation, anticipating where the action would be, lots of waiting and a little luck.

Prepared for
RC Soaring Digest Online!

by Dave Garwood
March 7, 2004

Here are some techniques my flying and writing buddies and I use to get improved-quality photographs of slope sailplanes. Some of them are slap-your-head easy, some involve a little study, and some require preparation, persistence, and luck.

First, get to know your camera. Learn its capabilities so you can use them and learn its limitations so you can work around them. The camera's instruction manual is the natural place to start, and camera manufacturers have begun to make manuals available online in case you're deciding on your next camera.

The body of technical knowledge required to make good photographs is

Dave Garwood's Fun-1, built from a CR Aircraft kit. Dave's static photo made with a film camera, on a plain background, positioned so the sun is coming from behind the photographer.

Blank sky background not to your liking? Try shooting with the horizon and some terrain in the frame. Most times the plane shows up better against the sky than the ground, but you may have to ask the pilot to fly lower to include the horizon. This image by Rich Loud.

surprisingly small. Just as all you need to memorize to pass high school geometry can fit on a single 3x5 card, all you need to memorize to get technically good photographs can fit on one 3x5 card. They are physical laws of optics and a smattering of chemistry. (Film chemistry for film photographers, and characteristics of the CCD light-collecting device for digital photographers.) The rest is observing the light and working with the subject, the sailplane pilot in this case.

The core things to learn are the effect of shutter speed on subject motion and camera motion, proper exposure, depth-of-field to know what's going to be in and out of focus, film sensitivity and the size of film grain (or "noise" in digital cameras). That's it. Honest.

Learning basics of composition will also help to give you "Wow, great shot!" type results. Every library and bookstore I've been in had one or more how-to books on photography. In the sidebar are four books that I have found helpful. Each of them has excellent example photographs to measure your increasing success against.

Here's a composition with a sailplane, the Mohawk River and hills as a background, and the pilot to add interest. Location is Jeff Blatnick Park in Niskayuna NY. Another image by Rich Loud.

Learning to hold the camera steady at the moment of exposure will greatly add to the sharpness of your photos, film or digital. A current TV ad that shows a photographer holding a camera at arm's length, snapping a photo from a speeding ski boat is bogus. Take it from me, a really sharp photograph cannot be taken at arm's length, no matter how much money you spend on a camera. "Grab shots" can be

Although it takes preparation and cooperation between pilots and photographers, capturing two or more planes in the frame can give us a memorable photo. Here Charlie Richardson and Dave Garwood fly Fun-1 60-inch ODR sailplanes for the camera with the spillway of the Wilson Lake Dam in the background. Photo by Rich Loud.

Dave's substandard attempt at a plain-background in-flight shot. He got the non-distracting background, and the sailplane is in focus, but it's too far away for a really crisp image. This image was blown up and cropped for this presentation, but it lacks the detail needed to be a primo photo.

taken at arm's length, but that's not what we're seeking. We want "money shots." Instead, press your camera against your forehead, while you bring your arms in close and press them against your chest, and hold your breath while you release the shutter.

Another important fundamental is proper exposure. Yes, we can compensate for some under and over exposure in the film processing lab, and with digital manipulation of images after they're pulled out of a digital camera, but proper exposure still delivers the best results. We get the best results on film by capturing detail in both highlight and shadow areas; the best results in digits by avoiding loss of detail from overexposure and digital noise from underexposure.

Most of the time, the light meter inside the camera is all we need. In tough-to-meter light conditions I use a hand-held exposure meter to verify or refine the exposure setting. Sometimes I meter from a close object that is lighted like the distant sailplane, and pre-set the camera exposure, when I want to expose for detail in the sailplane and not have the meter fooled by non-standard lighting conditions.

OK, lecture on technical basics is over. We all know now (or will soon, after reading a book on photo basics) what we need to get a static "record shot" of a sailplane on the ground: composition, light from behind the photographer, an f-stop that gives generous depth-of-field so we get both wing tips in focus, and hold the camera real steady while releasing the shutter. Let's tackle in-flight photo technique.

One of our secret weapons is working closely with the pilot, whom we ask to put the plane where we want it in the sky for that killer shot, taking into consideration what's in the background and the available light. For one, we want to avoid photographing the plane in its own shadow, so we ask him to fly "down-sun." For another, we may want a plain-sky background or a terrain background. The most important thing we do is encourage the pilot to fly in close, so we can fill the frame with the airplane. Yes, you can get a larger image of a distant plane by mounting a longer lens, but for me any telephoto over 200-250 mm on a 35mm film camera is difficult to hold steady.

I tell a pilot flying for the camera, "Remember, YOU are the aircraft commander. I will be asking you to 'fly lower,' 'fly closer,' 'fly slower,' but I'm looking through the camera and I can't see the whole scene. YOU are responsible for spectator safety and for preserving the model."

Soon after he launches I begin telling him: "Fly lower, fly closer, fly slower" and start burning film. One very cool thing with slope flying, is the pilot can repeat the pattern, and the photographer can take more than one shot. Believe me when I tell you you'll generally need more than one shot. Typically, 3600 frames are exposed for the 20-30 images you see in a typical *National Geographic* article. When going for the "money shot" you have to expect some discards. Another secret is we don't show the discards.

The cover shot on this issue of *RCSD* is an example of these tips and techniques in practice. I used a camera that I've made several thousand photos with. We had excellent lighting – bright sunlight from behind, an experienced pilot flying a familiar sailplane on a familiar slope. Alden Shipp made probably 50 circuits with me urging, "Lower, closer, slower" while I shot a roll of 36 frames. Put all this together with an interesting background, and you have a keeper of a photograph.

The highest form of sailplane photography to me are the true action shots. Note that up to now I've talked about static shots and fly-for-the-camera shots. To get the lead photo for this article Rich Loud had to know the basics, had to select a camera position, and had to be ready when the action unfolded. He did it, and that's why it's the lead photo.

These are the basics on how New York Slope Dogs Rich Loud, Joe Chovan (FEB 2004 *RCSD* cover) and I prep for a "money shot." Sometimes they become magazine cover shots. The rest is practice, and practice truly helps in this endeavor.

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A Recommended Photography Basics Reading List

KODAK Pocket Guide To 35MM Photography
ISBN 0-87985-769-2
This compact book has all the basics most will ever need.

The New 35mm Photographer's Handbook
Julian Calder ISBN 0-517-578255
Exceptionally complete coverage of lenses and equipment.

Learn Photography in a Weekend
Michael Landford ISBN 0-679-41674-9
A structured program to take you through the basics.

A Complete Guide to Aviation Photography
Peter M. Bowers ISBN 0-8306-0924-5.
For full scale airplane photography, but much applies to models.

All four were available from www.amazon.com when I checked on March 8, 2004.

on the Wing

B²

P.O. Box 975
Olalla, Washington
98359-0975
bsquared@appleisp.net
http://www.b2streamlines.com

Diva, Part 2

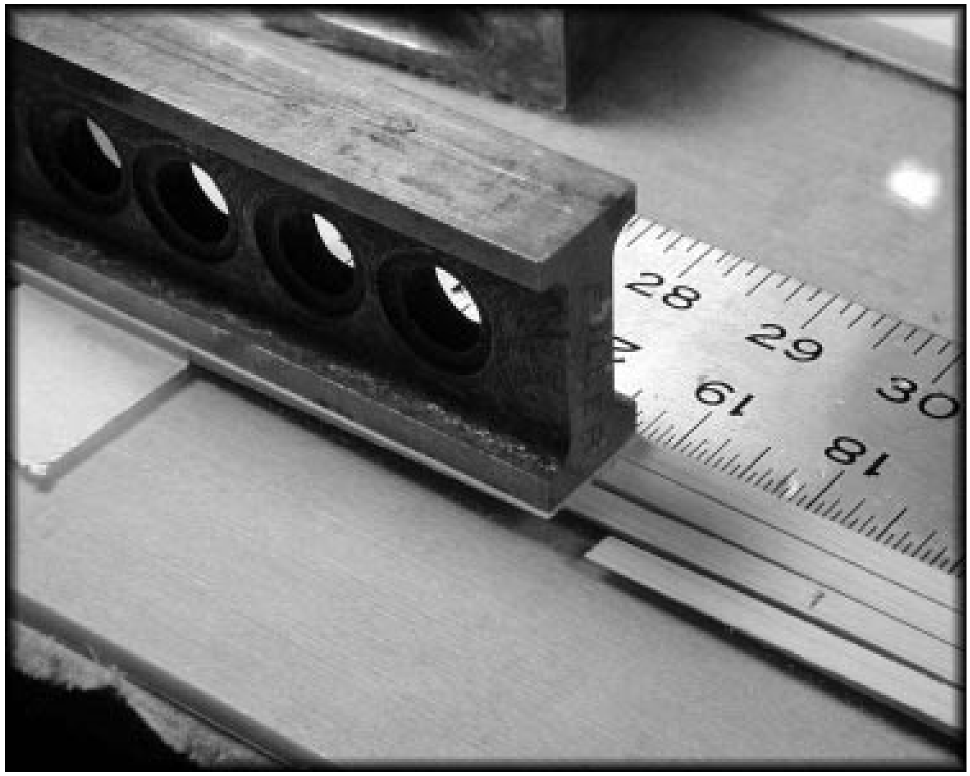
Changes, changes, changes...

Plans for Diva are now fairly complete, but several changes have had to be made as construction has progressed. This month's column will be devoted to examining the major changes which have been made.

Spar details

The spar location was chosen with structural considerations at the forefront. The leading edge of the wing is a straight line which comes off the fuselage perpendicular to the centerline. The triple taper of the trailing edge, together with the geometry of the leading edge, forces the quarter chord line to sweep forward at incrementally smaller angles toward the wing tip.

We placed the rear edge of the main spar at the 25% chord location at the root and the tip. The rear edge of the spar is a straight line, so the location of the rear edge goes back to 30% chord at the first taper break, and to 31% chord at the second break. This is an acceptable compromise as the leading edge D-tube follows the same line and all shear webbing is at the rear of the spar. This arrangement has the benefit of strengthening the wing at the taper breaks without producing unacceptable local focused stress risers.



This photo shows the 12 inch spar extensions being glued on to the main spar. Both the main spar and the extension have been tapered over the last three inches to form a scarf joint. Thick CA is applied to the extension, and it's slid under the steel block to exactly fit against the end of the main spar.

This photo shows the wing upside down with both spars in place. The upper surface of the leading edge D-tube is already bonded to the upper spar. This image has been retouched so the joints between the three spar components are more sharply defined.

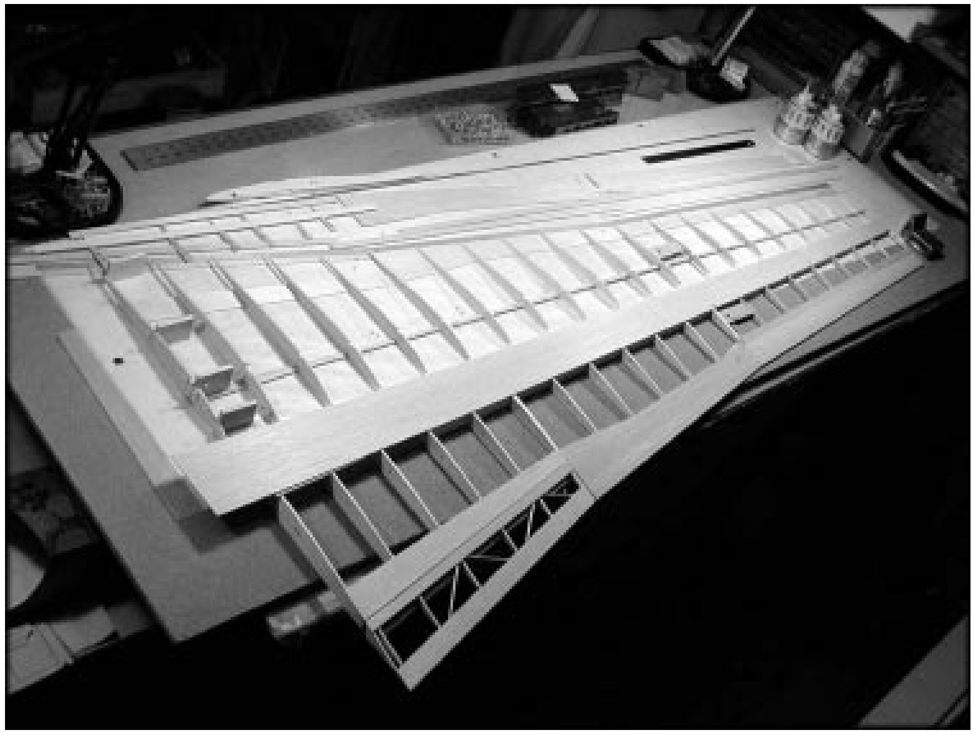
Additionally, it must be kept in mind that while the spar is swept forward, the wing rod does not. To allow enough fore and aft space for the wing rod, the spar width must be expanded in the forward direction. This additional piece is tapered so that the local spar leading edge is parallel to the wing rod and covers two wing bays. Another spar addition is located behind the main spar piece. It's tapered across three bays so it does not end in unison with the front spar addition.

Aileron servo location and mounting

Alyssa's idea involved placing the servo near the wing root and running a music wire pushrod out the wing to a bellcrank at the inner edge of the aileron. Unfortunately, this servo location is directly within an area which is fully sheeted, top and bottom.

We engineered a lockable sliding platform to allow access to the servo for maintenance or exchange. The servo slides out through the wing root on a drawer fixture which is held in place by pressure from the fuselage wing root fitting. Such a mounting method, however, requires a large number of wood pieces which need to be cut to close tolerances.

If the servo is moved out to the third bay, which is open, it can be glued to a piece of plywood mounted between the two wing ribs. There's enough vertical area in this bay, so we're almost certain our decision will be to move the servos to this more outboard location. If, at some time in the future, we need to access the servo for replacement, we'll simply cut through the covering material.



Right wing nearly completed, left wing being glued together. The balsa blocks at the left wing root have been cut to the dihedral angle so the rib will be exactly square with the center section of the wing which is an integral part of the fuselage.

Elevator control linkage

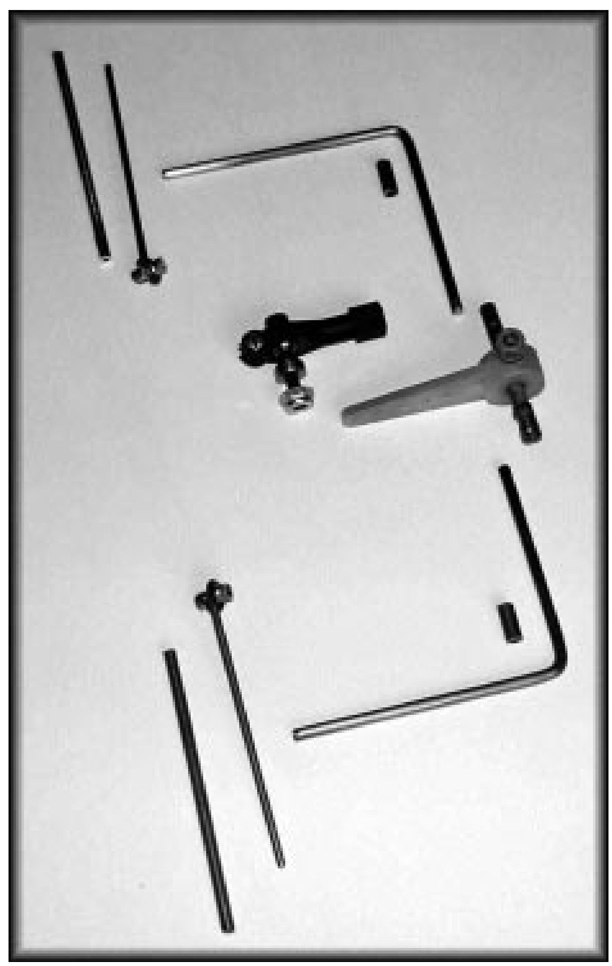
In Part 1, we described a nifty little fixture made by Sullivan Products which is designed for use in aerobatic aircraft with stabilizer anhedral and other situations where separate elevator halves are necessary. We've reconsidered this option and have instead decided to use what was originally designed to operate flap systems on conventional sailplanes.

The mechanism consists of two L-shaped pieces of 3/32nd inch music wire which are connected by soldered brass tubing within the fuselage. A special nylon control horn is slipped over the brass tubing and held in place with a set screw. These rods extend from the fuselage through and angle to the rear, and are then connected to the elevator halves by means of 1/16th inch wire pins which are inserted into brass tubing receptacles in the elevators. Because these pins must be free to slide along the 3/32nd inch music wire rods as the elevator moves up and down, they encircle and are soldered to brass tubing sleeves.

Brass tubing bearings which are epoxied to the fuselage sides keep the elevator control horn from sliding side to side within the fuselage.

Fuselage construction

The fuselage will be constructed according to our standard practice. The forward fuselage sides are of 1/8th inch plywood, spliced to 1/8th inch sheet balsa rear panels. Triangle stock will be used to connect the plywood sides to the balsa sheet bottom and balsa block canopy.



The elevator control system. The two small brass tubes at the left will be placed in the elevator halves. The 1/16th inch music wire pins will fit into those receptacles and be free to move along the actuating arms by means of the brass tubing sleeves to which they're attached. The L-shaped actuating arms will be soldered to the brass tubing and the control horn will be locked in position with its set screw. The two small brass tubing bushings will be epoxied to the fuselage sides and hold the mechanism in place side to side. The heavy duty ball link will be mounted on the left side of the control horn so it's slightly to the left of the fuselage centerline.

The wing center section, which houses the main wing rod bearing and includes the generous filleting at the trailing edge, is to be epoxied to the fuselage wing saddle, using the tow hook mounting block as additional mating surface.

The elevator and rudder servos are to be located directly in front of the wing center section. The forward elevator servo is mounted at the same height as the rudder servo which is behind it.

The rudder pushrod crosses the fuselage as it traces back to the rudder so that the rudder pushrod servo connection is on the right side and the rudder connection is on the left. The pushrod can exit the fuselage side at a more rearward point, and at a steeper angle, making for a more streamlined installation.

The elevator pushrod is connected to the servo arm on the left side of the fuselage and to the elevator control horn just off center by means of a heavy duty universal joint.

Wing tips

We had originally considered some sort of framework for the wing tips, much like those on our version of Dave Jones' R-2. Because Diva's tips are of a different shape, more like those of Dave's Blackbird, the decision has been made to construct them in similar fashion. Duplicates of Rib#19 will be made and glued to the existing tips. Upper and lower tip surfaces of 1/16th inch balsa will then be shaped to conform to the added rib, and brought to the outline where they will be laminated with a 1/64th inch plywood rim. There's not much weight difference either way, so we've chosen what we believe will be an easier construction process.

Construction progress thus far

We started construction with the wings. The 21 wing ribs were cut out using templates made from aluminum flashing material. All of the tapered trailing edge pieces were cut from 1/16th inch balsa sheet at the same time to assure uniformity.

The main spar was extended by addition of 12 inch lengths of spruce of the same cross-sectional dimensions. This joint was made by tapering the ends of the two pieces over a length of three inches and then joining the two pieces with thick CA while using heavy steel blocks to weight the complete assembly. Once this joint was cured, the outer portion of the spar was tapered to the proper width (1/8th inch) with a heavy duty "razor" plane and a PermaGrit sanding bar. The additional front and rear spars were then glued on using thick CA.

Both left and right wings and control surfaces have all ribs in place; the spars are glued in position and the shear webbing has been added; all trailing edge sheeting is installed; the upper surface of the leading edge D-tube has been glued to the spar; and the control surfaces are cut away from the main wing and are nearly complete.

We still need to get the main wing rod system and aileron servos installed, along with the aileron pushrods and the elevator pin receptacles. We'll get into more detail concerning the wing construction process in Part 3.

Readers with topics for future "On the 'Wing..." columns can always contact us at P.O. Box 975, Olalla WA 98359-0975, or at <bsquared@appleisp.net>.

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GORDY'S TRAVELS

Gordy Stahl
Louisville, Kentucky
GordySoar@aol.com

Teaching Modelers to Fly

It can't be done. No matter how hard he flaps his arms he ain't gonna fly.

Okay, kidding aside, how about this one, "Get a trainer airplane, it's easier to fly." Or, "Get a full house ship, that way you will be able to fly anything."

Controlling RC model aircraft takes training; the *real need* is to find someone that can explain how to control model aircraft, not fly 'em. When your dad took you out to learn to drive a car, he didn't try to teach you to roll. Instead, he taught you what everything in the car did. Since the consequence was pretty serious, he made it very clear that you understood what a brake was for and how to use it.

So how do we start teaching people to control model aircraft? Why not start by learning what does what on aircraft? Oh, you already know? Then read no further!

For those that aren't sure or don't know, read on. If you don't know how to explain the functions of each surface, how can you expect to explain it to a guy without your years of experience?

Want proof that after all these years you may not know what the surfaces do? Take this test:

1. What single surface on any airplane causes a clean directional change? ("Surfaces" is defined as ailerons, rudder, and elevator, since that is what most airplanes have.)
2. Since it is a fact that airplanes in flight can't be 'turned', and some airplanes can't ever be 'turned', what device is needed to make some of the airplanes be able to turn and when?

Okay, so some of you flunked. Let's discuss the surfaces first.

Those of you who guessed ailerons, take a pencil, point it toward your nose and hold it parallel to the floor, then rotate it. Did you see it change direction, or attitude?

Anyone guess rudder? Rudder does nothing cleanly. It can't since if for no other reason there is only one half of it on the plane. I mean there are two wings, two sides of the horizontal and one side of rudder. Using it causes roll, pitch and yaw. Not to mention that if it did anything right, more model planes would have them, and the left stick of our radios would get used. Here's a hint for answering number two; yaw is not the same as 'turning'.

That leaves us with Elevator. Yep, that's the answer. Pull back on the stick and the ship changes direction, push forward on the stick and the plane changes direction. Cleanly.

Sooo, what's this thing about turning? Well if you yaw a plane it doesn't change direction, it just flies sort of sideways. So how is it that some planes can be 'turned' and what device is it that allows them to do that? The nose or tailwheel, and that means the only time that these ships can be 'turned' is when they have friction with the ground.

At this point, some of you should understand more about RC models than ever before, and you have the tools to teach them to trainees.

Roll, yaw, and pitch - these words should be the only words used during the instruction process. The confusion starts when you say first,"Roll right." Then next time, "Bank right." Then, "Go right." Then... Well, you get the point. It's the process of learning anything without the problem of making the trainee guess as to what you mean each time.

Most sailplane trainees are always porposing from stall to dive. The instructor invariably tells the student, as the ship raises its nose toward a stall, to 'level' the ship out. Yet he has not explained what 'level' means or looks like. Why not start by holding the ship above your head, so that it's level to you, then explaining that when you say level the ship, it means it should look like that. You know, come to an agreement on terms.

I do an interactive, instant feedback ground training school. That means explaining the radio's controls, as well as graphically explaining what the model's surfaces do. That means I hold the model in my hand, the trainee holds the radio and is instructed to move the stick to cause roll, pitch and yaw. He moves the stick and I make the model *do what it is being told* to do.

I teach him to control the model going away, coming toward him and then even have him do a loop, roll and inverted. He moves the sticks on my command and I make the model react as closely as I can to his stick commands. The radio is held *below* his waist and *tipped* with the *antenna down* so I can *clearly see* his stick movements.

I call it Shadow Flying. The trainee gets a full 15 minutes of stick time controlling a model and he has learned all the correct terminology for the actions of the surfaces, and he does it without the fear of crashing.

I teach the "low wing" system for getting trainees immediately comfortable with controlling the model when it is flying toward them. That means simply move the radio's aileron function stick under the low wing to cause it to level the ship out.

A trainee taught to control model aircraft won't be stuck with a 'special' starter model, but will be able to control any model. Sure he will need air time to train his thumb to listen to his brain, but you will find that it is not necessary for trainees to crash every plane they build.

The neat thing is that once the trainee is put through the flight control program, he will become an instructor himself. He can now explain the surfaces and controls, as well as move the model in response to the guy's stick movements. Teach model aircraft control; it comes in handy while landing!

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Drag in Circling Flight

By Greg Ciurpita

The November 2003 *RCSD* titled *Numerical Understanding of Planforms* showed how the Vortex Lattice Method and the UIUC Airfoil database were used to calculate the lift and drag at each point on the wingspan. It showed how the calculated values of lift and Cl can be related to measured values of Cd from the UIUC database. That result is then used to calculate drag at each point across the span and finally the total profile drag. It does not discuss *induced* drag which is proportional to lift. This article will complete the discussion by considering circling flight.

The previous article focused on the steps involved in the analysis, not a valid comparison of planforms. It very crudely compared tapered and non-tapered planforms, showing little (<2%) difference in total drag between the two. However, this comparison may be misleading since it was only done at a single airspeed.

Table 1 shows values for each planform at several other airspeeds. These additional airspeeds do not produce lift equal to the weight of the aircraft. It shows that at two airspeeds, the non-tapered planform actually has less drag than the tapered planform, and one was used in the comparison in the previous article.

The reason for the varying results in the table is the non-linear behavior of drag, especially at lower Reynolds Numbers. (See Figure 1 for the Airfoil Polar of the SD7037 airfoil used in the comparison.) In other words, a slight change in airspeed may lead to significant changes in drag that are not proportional to the change in airspeed.

This same behavior applies to a tapered planform where even though the airspeed is constant across the span, the Reynolds Number varies because of the varying chord length.

Figure 2 illustrates the drag distribution for various airspeeds for the tapered wing planform. Notice how the drag decreases near the wing tips as chord length and Reynolds Number decrease. For non-circling flight, the airspeed is constant across the wing-

Table 1 - Total Drag Comparison vs Airspeed

Airspeed	Tapered	Non-Tapered	Delta
15	.0269	.0275	-2.2%
20	.0385	.0399	-3.6%
25	.0519	.0518	0.2%
30	.0661	.0672	-1.7%
35	.0826	.0816	1.2%
40	.1012	.1014	0.2%
45	.1202	.1218	-1.3%

Figure 1: SD7037 Airfoil Polar

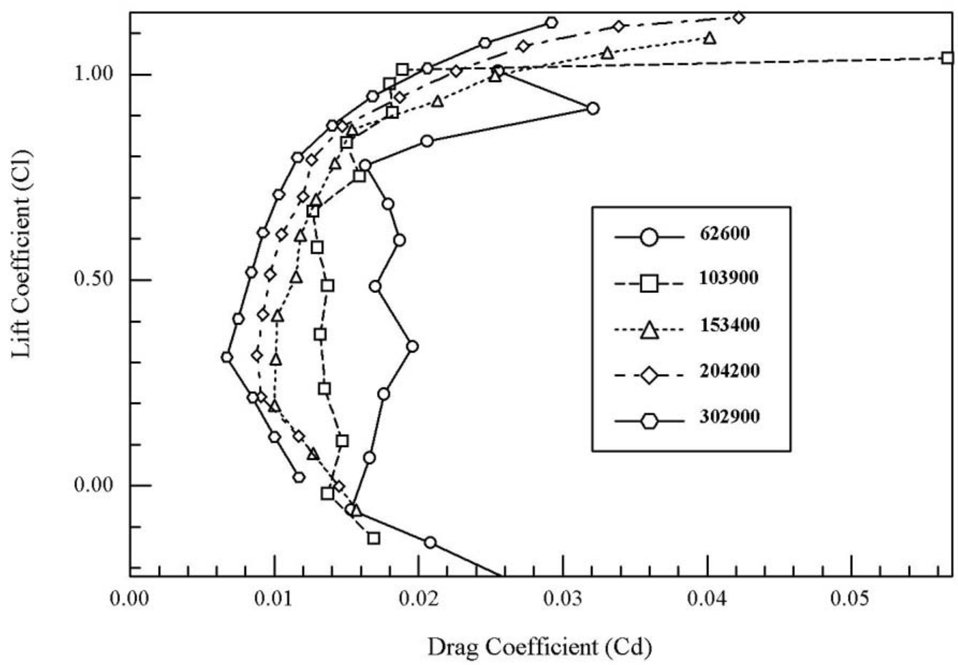
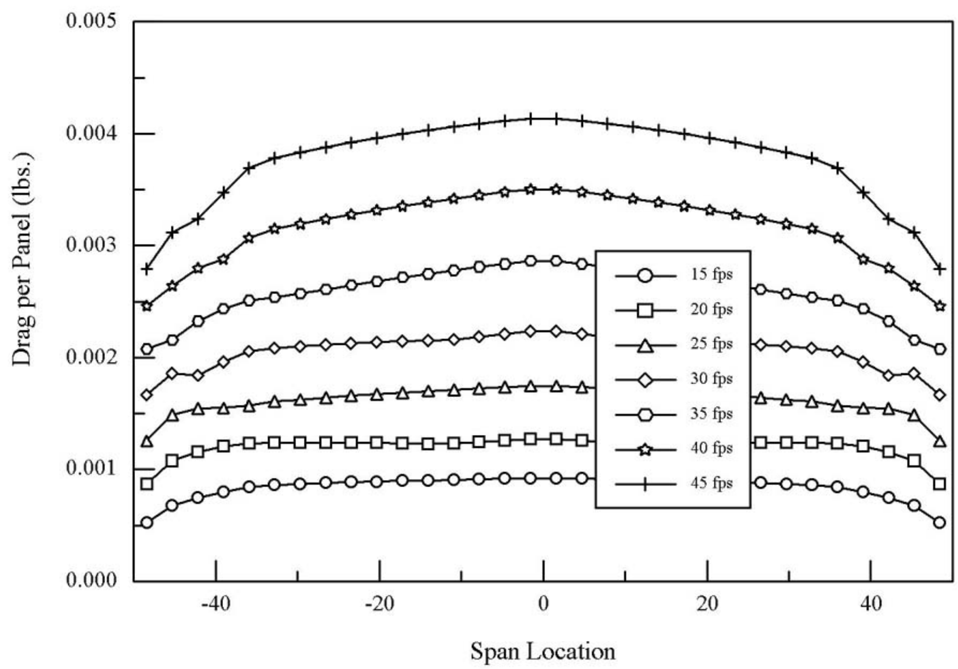


Figure 2: Spanwise Drag Distribution vs Airspeed



span and the curves are symmetrical.

For the results shown in Figure 2, the wing is divided into 32 panels, each panel representing a section of the wing from leading to trailing edge. The indicated drag is the total drag corresponding to a panel. The total drag produced by the wing is the sum for all panels. (roughly 32 times the average value of a particular curve). Even though the drag coefficient generally improves (decreases) as airspeed and Reynolds Number increase, the total drag will increase since it is proportional to the square of airspeed.

The above digression in drag variation with airspeed leads naturally into circling flight where the airspeed across the planform is not constant. This article considers a wing at five bank angles: 0, 15, 30, 45, and 60 degrees. In this analysis, the comparison between the different bank angles keeps the average airspeed constant. If the airspeed for the aircraft at zero bank angle generates sufficient lift to support the weight of the aircraft, then at any bank angle greater than zero, there will be insufficient lift to support that weight. This, therefore, compares non-realistic flight conditions, and is only useful in this comparison of drag.

In this analysis, the aircraft is banked to the left, the left (inner) wing tip is lower than the right, and the aircraft is circling counter-clockwise. The airspeed of the inner wing-tip is therefore slower and the outer wing tip is faster than the average airspeed.

Figure 3 illustrates the drag coefficient (Cd) across the span for the tapered planform at each bank angle. The zero bank angle case is symmetrical and serves as a reference. The drag coefficient increases near the wing tips as the chord length and Reynolds Number decrease.

As the wing is banked to the left, the left wing tip travels more slowly and its Reynolds number decreases. Its drag coefficient therefore increases. The drag coefficient improves on the right wing tip as its airspeed and Reynolds Number increase.

While five bank angles are considered, only four appear in the plot because the data is the same for bank angles of 30 and 60 degrees. The airspeed

Figure 3: Cd Vs Bank Angle

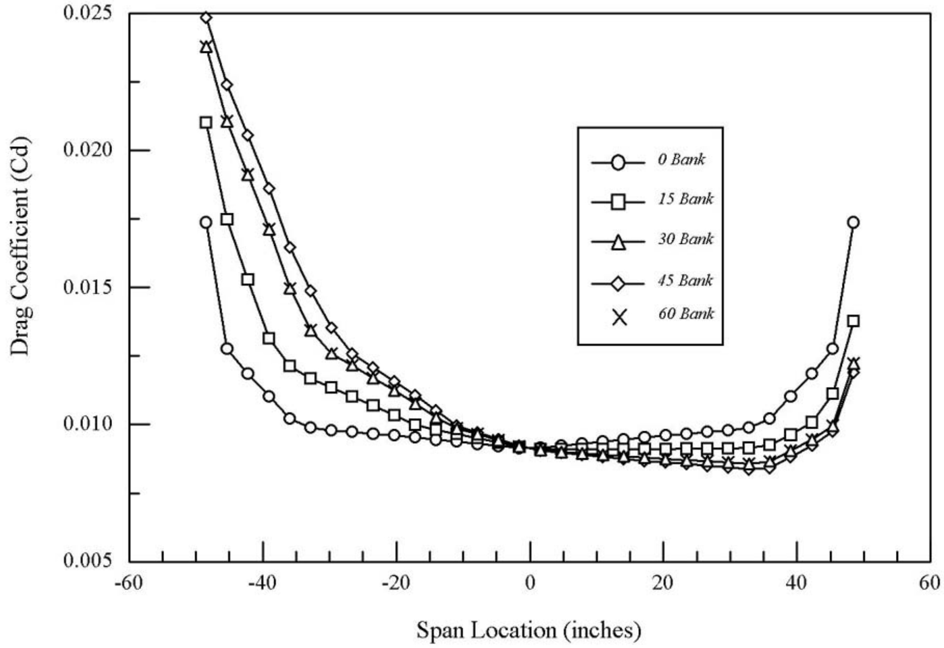


Figure 4: Drag Distribution vs Bank Angle

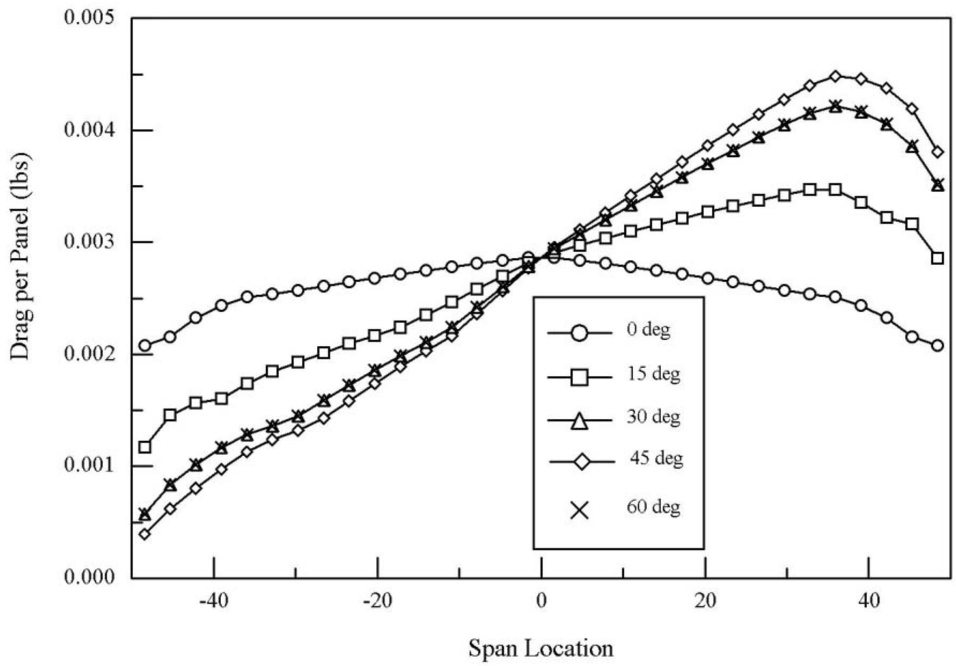


Table 2 - Banked Drag Comparison		
Bank Angle	Tapered	Non-Tapered
0	.0826	.0816
15	.0841	.0846
30	.0861	.0874
45	.0871	.0885
60	.0861	.0874

difference at the wing tips is a maximum at 45 degrees, and reverses once the bank angle is increased past 45 until it is again constant across the span at 90 degrees.

Figure 4 shows the total drag per panel, which is proportional to drag coefficient, airspeed and panel area. It shows that even though the drag coefficient increases at the left wing tip as the bank angle increases and its airspeed slows, the actual drag decreases because it is related to the square of the airspeed and panel area, both of which are decreasing.

The total drag on the outer wing is generally increasing. But at least for this planform, it appears that the combination of improved (decreasing) drag coefficient and decreasing wing area near the wing tip results in less total drag near the tip than more inboard. So while the aircraft is circling counter-clockwise there is more drag on the outer wing, even though it may be more efficient in terms of Cd.

Table-2 compares the total drag at various bank angles, and between the tapered and non-tapered planforms. The tapered planform has less drag than the non-tapered planform for all bank angles greater than zero that are shown. It also shows the symmetry around the 45 degree bank angle, where the total drag is the same for bank angles of 30 and 60 degrees. And it also shows that the drag increases with bank angle, increasing by roughly 5.5% at 60 degrees.

However, while the above table serves as a reference of how drag is affected when the plane is circling, it does not model realistic flight conditions. While maintaining a constant airspeed maintains the total lift, this lift is no longer vertical as the bank angle increases. Greater lift is required as the bank angle is increased to support the weight of the aircraft, and most likely will result in even greater drag.

Further, more realistic comparisons are complicated by the number of possible mechanisms that can be used to establish stable circling flight. These include changes in airspeed, angle-of-attack and trailing-edge deflection (flap and/or aileron). And even though the airspeed is different on each wing, both wings must produce equal lift to prevent rolling. Aileron, dihedral and aircraft yaw asymmetrically affecting the angle of attack on each wing, can all be used to balance the lift on each wing.

This and the November article present some aerodynamic concepts in ways that at least I have not seen before. This may help some people better understand these concepts. For the examples used, it showed which concepts had the greater affect (drag coefficient vs. total drag), but also, in many cases, how little the difference may be. I'd like to thank Dave Register and Lee Murray for their encouragement and help in this and previous articles.

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Wax-paper 'Glassing

Mark Drela

From: Mark Drela <drela@MIT.EDU>

Dick,

I've discovered a good variation to your wax-paper glassing technique described in the CRRC site article.

I first prepare "glassing stock" by very lightly spraying a sheet of wax paper with 3M-77, sticking it down onto laid out glass cloth, then trimming around the wax paper. Since this stock isn't sticky, it can be stored in a large envelope for future use.

To use, I first cut the right size patch from the stock. I then spray the patch's glass side with 3M-77 again, more heavily this time, apply to the item, rub down, and peel off the wax paper. The glass is now firmly stuck down and ready for epoxy.

This method works especially well with 0.75 oz glass, since there's no need peel the flimsy glass off the wax paper "in mid air", which tends to make a mess. There's never the risk of having the glass deform and/or stick to itself.

When applying to a compound-curved surface, the wax paper is peeled off gradually as the glass application proceeds. Still very easy and no chance of having a sticky mess.

- Mark

TECH TOPICS

Dave Register
Bartlesville, Oklahoma
regdave@aol.com

Wash-In? Wash-Out?

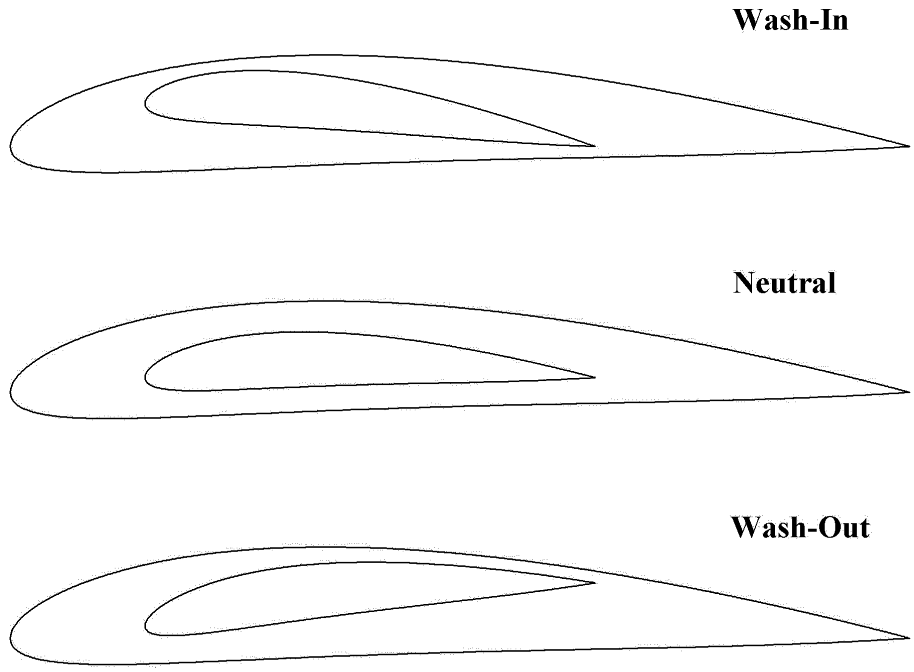

Figure 1: Examples of Wing Twist

A few weeks ago we were flying at our local slope and one of the guys let me try his EPP racer for a bit. It's a fun plane to fly and will be a kit review in the not too distant future.

While trying to execute a high speed turn to the left, the plane snapped hard on the inboard wing tip. Hmmm. Interesting – and a little exciting. A few minutes later, a loop into the wind also gave a hard snap stall to the left.

"Looks like you've got a bit of wash-in on the left wing," was my comment. The discussion that followed suggested a review of the topic might be helpful to others as well.

Wash-in or wash-out refers to the twist at the wing tip relative to the wing root. Sounds like a pretty dry subject but if you've ever had a plane that stalled real hard to the left or right during a launch, or did 'the spiral dive of death' in a thermal turn, or a sloper that really snapped when you banked and cranked, you've probably got wash-in and you need to deal with it.

I'm not sure where the terminology came from. Maybe a frustrated house-husband - on laundry day? Whatever the genesis, the effect is real and can be quite dramatic.

First, what does it look like?

Figure 1 is a drawing of a wing airfoil with the wing tip projected onto the wing root. The upper example is a case of wash-in while the lower represents wash-out. The middle example is the neutral case.

Wash-in refers to a situation where the wing tip is twisted 'up' relative to the wing root. Wash-out is just the opposite.

Your sailplane should have either the middle or lower example (neutral or wash-out). You NEVER want wash-in!

Why not? Simple - the wing tip flies less efficiently than the wing root and has a tendency to stall first. If the airfoil at the wing tip is flying at a higher angle of attack than at the wing root, you're almost guaranteed to stall the tip first. That's the case of wash-in (upper drawing in Figure 1).

No one intentionally designs a plane with wash-in. But it can creep in during construction or during the life of the airframe due to wear and tear, storage conditions or weathering.

At the flying field, a severe condition can be spotted pretty quickly. It's noticeable as a tendency to consistently stall to one side or the other.

A related tendency is for the plane to bank to one side with neutral ailerons and rudder. Or a plane that just seems to turn better in one direction. If you experience any of these conditions, there's a relatively simple way to see if it's severe enough to need correction.

Launch your plane to a decent altitude and establish straight and level flight. If you've got the room at your field, have the plane start off nearly overhead but flying away from you.

Gradually slow the plane down until it's really mushing along. You want to do this over a period of several seconds. A rapid pull-up won't tell you much.

Tweak in a bit more up elevator until the plane stalls. Watch what happens when it stalls and recovers.

If the wings are well aligned and balanced, the stall should be straight ahead. The nose drops and the plane picks up speed and recovers. That's what you'd like to see.

If there's wash-in on one wing tip, the plane will generally stall in the direction of that wing tip. The left wing (for instance) will drop suddenly and the plane will enter a spiral dive to the left. (I *did* suggest you have pretty good altitude to try this!)

Another effect that goes with wash-in is the tendency of the plane to turn away from the 'bad' wing. Let's say the left wing has wash-in. That means the left wing tip is flying at a higher angle of attack than the left wing root. That normally means the left tip is at a higher angle of attack than the right wing root and right wing tip as well.

So the left wing is generating more lift, which will tend to bank the plane to the right.

Consequently, a signature of a washed-in wing might be a tendency to bank in one direction but stall to the other. Seems contrary but it makes sense. There can be a lot of other things going on with your trim settings and controls so this type of flight signature may not always be present. But a consistent stall to the same wing tip is a pretty good sign there's a wash-in problem.

To check it out, take a look down the wing while facing the offending wing tip – as in the accompanying picture. Align your eyes with the bottom of the wing at an angle where you can see most of the bottom of the wing. Gradually tip the wing towards yourself so that eventually you can no longer see the bottom of the wing. For wash-in, when the bottom of the wing disappears from sight at the root, you can still see the bottom of the wing near the leading edge at the tip.

Using an incidence meter is the best way to measure the actual amount of twist but you can do a pretty good job by using the old Mark-1 ocular interface. Just keep in mind that if the leading edge of the wing tip appears to have an 'up' twist relative to the root, you've probably found your culprit.

Let's say you've found the left wing has some wash-in and you'd like to convert it to wash-out. How do we do that? How much do we need?

First the 'how much'. My general rule of thumb is that 1 degree of wash-out is about right. Much more and you may have the wing tip trying to tuck at high speeds. Much less and it's a little hard to tell by eye if you've got it in there.

If you want 1 degree of wash out on a 3.5" wing tip, that's about 1/16" of twist. If you'd like to put a calculation to it, a good approximation is:

Twist (inches) = Tip chord (inches) * Wash-out angle (degrees) / 57

The amount of twist you calculate can then be used to block up the trailing edge of the wing at the tip.

Lay the wing down on a flat surface. The trailing edge at the root should be in contact with the surface. The trailing edge at the wing tip should then be about 1/16" above the surface for this example.

Adding wash-out depends on both your construction and the covering method. For a built up wing (and most EPP slopers) using film covering such as Monokote or Solarfilm, just twist and heat.

I've found that you need to put in about twice as much twist when you heat the wing since it usually springs back a bit when it cools.

With the wing firmly supported on a table (or in a pinch, held between your knees), grab the tip and twist it so as to push the LE down and the TE up. Use your heat gun to shrink out the film wrinkles on both the top and the bottom surface. Remove the heat and hold the twist until the film cools. It's important for the film to become fairly rigid before you let go.

After things cool off, check the wash-out on a flat surface again to see if you achieved what you wanted. Don't agonize over an exact amount. What's more important is to be sure that the amount of twist is about the same in both wings. A little trial and error will get you there a lot quicker than you think.

For a composite wing, the chore is tougher. Most thermoset materials (epoxies and polyesters) will plasticize a bit when heated. It just takes more force and more time to get the job done.

I reviewed a way to do this a few months back when discussing the Great Planes incidence meter. The easiest way I found was to assemble the aircraft and mount it on the back of a couple of chairs. Use the all purpose handy-man's tool (duct tape) to secure the wing roots solidly to the chairs. Then clamp a piece of aluminum channel to the offending wing tip. I used EPP strips around the channel and clamps to keep from damaging the wing surface.

Now hang some lead weights on the end of the channel to get about twice the twist you actually need. Heat the wing tip with a heat gun (top and bottom evenly) until the weighted end of the aluminum channel starts to move. Turn off the heat gun and go have some form of liquid libation for about 20 minutes or so.

Once the surface is completely cool to the touch, remove the clamps and see what you've got. The incidence meter is a major asset here. If the wing looks like it has twist but the meter says no, you had too much libation.

Although the objective is to have a slight amount of wash-out in both wing tips, I'll again emphasize that it's just as important to have about the same amount in both wings.

The proof of the process is to take it back out to the field and give it a try. If you've done your homework properly – and it's not that hard to do – you'll find that you have a much more forgiving and thermal friendly sailplane. Or a more stable slope ship that will hang on a tip very nicely in a high speed turn

If it ain't broke, don't fix it. But if it is, hopefully this discussion has given you a few ideas to try.

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TEMPEST

by Garth Warner
gwarner@cox.net

Garth & his Tempest.

The TEMPEST is a new molded Thermal Duration sailplane offering from Mark Treibes, formerly of RnR products. Mark now operates ACME Flying Machines, and offers several ARF slope and electric planes for sale.

The following is an excerpt from Mark's website:

"All of our planes exemplify the latest in composite fabrication techniques. Features include skin-hinging and custom color gel-coating. The planes come pretty much ready to fly: control surfaces are totally hinged and gap-sealed, torque rods, horns, pushrods, and linkages are installed, wings and stabs are mounted to the fuselage. Basically, install your radio equipment and motor (for the electrics) and you're ready to go. Call or e-mail for more information and current pricing."

Specifications

Name:	TEMPEST
Class:	Unlimited Contest Thermal Duration
Manufacturer:	ACME Flying Machines
Suggested Retail Price:	$1095
Pilot Skill Level:	Advanced
Wingspan:	127"
Root Cord:	9-1/4"
Aspect Ratio:	16-1
Fuselage Length:	60"
Wing Area:	1000 sq in est.
Airfoil:	MH-32
Weight:	78 oz as tested 84.5 oz stock est
Wing Loading:	11.23 oz / sq ft as tested 12.16 oz / stock est.
Control Functions:	Ailerons, Flaps, Rudder, and Elevator
Construction:	All Molded, (stock)
# of Radio Channels:	6 channels with mixing radio
Available From:	**Acme Flying Machines** 9038 Descendant Drive Elk Grove, CA 95758 USA
Phone:	916-752-3831
Fax:	916-684-0898
E-Mail:	acmeflyingmachines@attbi.com
Home Page:	http://home.attbi.com/~acmeflyingmachines

A few months ago I, and a few friends from the Torrey Pines Gulls club, ran into Mark at the Southwest Classic in Phoenix. While waiting for gale force winds to die down during a stop in the contest, we had an opportunity to take a close look at what Mark was flying. Mark has the most bilious (brilliant?), green molded thermal duration sailplane any of us have seen. Despite the color, the plane's redeeming features included a fairly generous wingspan, huge flaps, clean lines and a really clean plug-in V-tail. In the pit discussion Mark stated that he was going to turn out a X-tail version in addition to the V-tail that we were looking at. Between the four of us, we each ordered one of the X-tails on the spot and were given a delivery date of approximately three months. We all wanted something that would be versatile enough to handle the wind.

Now shift a couple of months down the road to the Fresno Classic. Mark is flying a TEMPEST. The Friday before the contest it had been raining and Saturday morning opened partly cloudy with sparse but defined lift and a steady breeze from 10 to 15 mph out of the North/West. The lift continued to develop strongly during the day. The key here was to punch out way upwind to pick up a standing wave over a ridge, hang in the wave long enough to snag a passing thermal, and follow it downwind to the limit of visibility over the valley. Oh yeah, you had to come back to land. By midmorning conditions were so strong that you could launch, sky out and be close to three quarters of a mile downrange five minutes into a ten minute flight. Several of us had to make the walk of shame downwind to recover aircraft that we flew too aggressively and/or optimistically in the wind. Between that strong thermal action there was some serious strong sink. No problem for the TEMPEST. Besides being a great pilot, Mark was able to drive this thing all over the sky, and punch back upwind to get back to the field for those landing points. I will say this flat out, when this thing gets up on step, it goes a long, loong, looong way, without sacrificing very much altitude.

Now let's shift ahead again to about mid May. UPS drives up to my front door, tells me he has a box. Sure enough this in the package I've been waiting for. Inside I find the wings, stab, fuselage, wing joiner, and a small parts bag all snugly secured in bubble wrap. Instructions consist of a single sheet of basic setup information with a recommended CG (center of gravity). The wings are really clean with an immaculate finish equal to any that you could find on today's European ships. They appear to be gel-coat and glass over Rocell. The root end of each wing is open (no root rib), similar to the old RnR ships. The Spars appear to be carbon tow top and bottom with a significant amount of splooge (mixture of epoxy and filler material) bonding them to the skins. Each wing also has a 1/8 inch aluminum index pin splooged in at the LE (leading edge), and mounted into a hardwood block on the TE (trailing edge). These mate with the pre-drilled holes on the wing fairings of the fuselage. Flaps are bottom hinged with tape and have an inside silicon joint. Hard shell wipers are built in on the face of the flaps. The flaps open a true 90 degrees with very little resistance. Flaps are top actuated with what looks like the Mutiplex/Hobby Lobby style screw-in eyes. The Ailerons are skin hinged and are very stiff (more on that later). The Ailerons have thin flexible Mylar wipers over the bottom opening. Predrilled screw holes for the above mentioned control horn eyes are located on the bottom surfaces. Both wings have cut outs and covers for the flap and aileron servo openings. Wing wiring is pre-installed to each servo cutout with fairly heavy gauge straight stranded wire in the JR colors of brown/red/orange. The wiring for both the ailerons and flaps exits the wing forward of the spar at the root. On my sample the wings weighed an average of 19.75 oz each out of the box using an admittedly cheap postal scale.

The molded stabs are color matched to the wing and have a 5" x 1/4" inch OD carbon main pivot tube and a 1/8" aluminum index rod to keep everything lined up. The stabs were fairly heavy at 3.25 oz total without the joiner rods. On my model the root of the stabs were relieved to match the curve of the fin.

The molded rudder is color matched to the bottom of the wing and came pre-attached to the fin with tape. The rudder was also fairly heavy at .9 oz. The rudder is actuated by a piano wire pushrod bent 90 degree "up" into brass tube buried vertically in the side of the rudder opposite the hinge.

The fuselage consists of three pieces. A slip on nose cone slides on over a closed deck radio compartment that is factory bonded to the main body of the fuselage. The back of the radio "deck" is open into the body of the fuselage to accept a RX (receiver). The radio deck also matches the color of the bottom of the wings. Piano wire pushrods with housings are already installed in the fuselage. They come pre-attached along the inside of the fuselage down to the rudder and to a hefty fiberglass G-10 bellcrank mounted in the fin. The pushrod housings are left loose at the front of the radio compartment to be affixed by the builder after installing your servos. The side of the main fuselage has a LE and TE holes pre-drilled on each side of the airfoil fairing to index the wings. The wing joiner hole is already cut to size. The wing joined to the fuselage with a massive 1/2"x 1/2" x 15" long square solid carbon joiner rod that fits without any dressing or fitting required. The joiner has a built in 5-degree bend to it. No cutouts for wing wiring are provided on the fuselage and it will be up to the builder to determine where these will be required. Overall the fuselage is very stiff. Mine weighted 14 oz empty with the nose cone. The slip-on nose cone fits well with a join line that matches the "seam line" on the top of the fuselage. No tow hook is provided although this ship screams out for an adjustable hook similar to the ones used on various European sailplanes.

Construction

Assembly would be a more accurate description as most of the major work is done. I started construction by filling up the inside tip of the nose cone to provide a "stop" at the tip of the nose of the radio tray. This prevents the nose cone from slipping back over the fuselage on sudden stops. I put about three coats of wax on the nose of the radio tray as a release agent and then dropped marble size slug splooge into the nose. Slip the nose cone onto the radio tray and line up the seam on top until the epoxy cures with the fuselage nose down. A sharp twist and a pull released the nose cone and resulted in a perfect fit. Be careful not to overdo the amount of epoxy or it will never come off. You want about a dime size contact patch. The next step was to install a removable nose skeg. I have several sheets of 3/32" thick G-10 circuit board material from a local supplier. I made up a couple of receiver boxes and skegs for both my own ship and for a friend. This technique was covered in *S&E Modeler* a couple of years back. The skeg box fits up into the very front of the nose of the radio tray from the high point in the fuselage in front of the battery location and forward at a slight angle. You may need to relive a little splooge in the tip of the radio tray to get it to sit square and tight. The box is installed through a cutout I made in the bottom of the fuselage and rests against the inside top of the fuselage as indicated above. Since it was going to be smothered in epoxy and lead shot anyway I just tacked it in place and ground off the excess below the bottom of the radio tray. Once the box was in and cured I slipped the nose cone on, measured out the proper distance and drilled a small pilot hole to locate the opening. Once open, you can use a small flat file to dress the edges of the hole in the nose cone to accept the skeg. I generally make up a long and a short nose skeg for various conditions (long, for thick grass and short for hard pack dirt).

After obtaining a tow hook from my "spares box" and ordering one of the new "V" flap skegs from **www.superskeg.com,** I was ready to work inside the fuselage. I cut two sections of 1/4" birch ply 2-1/2" long by 3/4" wide. One of these is for the tow hook and one for the skeg. Sand these ply pieces half round on the bottom to match the interior curve of the fuselage. The skeg I mounted right under the flaps, and the towhook was mounted per the setup sheet at 1/8" in front of the recommended CG. In reflection I would recommend moving the skeg back an inch or two as the bottom of the skeg is now regularly biting chunks out of my right index finger when I launch with my hand centered under the towhook. For the towhook and skeg plates, I pre-drilled the holes in both the fuselage and the blocks. Use CA glue to tack glue a long balsa "insertion" stick to each plate, splooge the bottoms of the plates, and insert each plate individually into the fuselage to be cinched down by its own hardware. When satisfied with the placement, leave everything to cure and come back later and break off the sticks.

I am a longtime fan of JR servos and used them again in the TEMPEST. Because I wanted to be able to swap out servos quickly during a contest if needed, I took the trouble to solder female plugs on the ends of the servo wiring runs in the wings. JR 368 Digital servos were used for the flaps and the new JR 168 Thin Wing Digital servos were used for the ailerons. All servos were indexed with the radio, then lightly scuffed and glued into the wing with a minimal amount of five-minute epoxy and micro balloons. Surfaces were attached to the servos with short pieces of 2/56 all-thread and Sullivan brand gold clevises. CA glue was used to secure one threaded end of each connector to eliminate any "play". Dean's 6 pin plugs were used to mate the wing wiring together at the root on each side of the fuselage. A 1/4" x 3/4" rounded slot was cut into the side of the fuselage on the wing fairings between the wing joiner hole and the forward index pin to allow the wiring to enter the fuselage.

For a RX battery I had ordered a 2000 Mah Nimh pack from **www.batteriesamerica.com.** This was configured in an AA off-set pack (diamond shaped when viewed from the rear) that fit nicely in a cutout I made in the nose of the radio tray. Immediately behind the battery I cut offset openings for a JR 9411 elevator servo and a Hitec HS-85MG rudder servo in a tandem arrangement. My scrap box provided some spruce rails that I glued in under the deck to screw the servos to. The remaining section of deck in the rear was opened out just a bit to accept a Hitec Supreme 8 ch RX wrapped in foam. A piece of thread was glued to the end of the antenna and pulled down through the fuselage and out the tail. A 1/4" section of the thread was glued with CA to the exterior bottom of the fuselage and the rest was cut off. This keeps the antenna straight and prevents it from clumping up against the RX on repeated hard landings. Here again, servos were indexed with the radio and connectors were soldered to the ends of the pushrods. A Dremel tool was used to cut relief notches in the sides of the fuselage and the pushrod housings were epoxied to the sides with a small amount of Micro Balloons to lock everything in place. At this point, excluding balancing and set-up, you are basically done.

TPG Mod

Being the 2nd member in our club to build one of these ships I had some insight on how much lead was going to be needed to balance this aircraft with the stock stabs and rudder. The stabs and rudder are beautiful pieces of work, but they are heavy. To lighten this ship up I substituted a built up carbon and balsa stab I had purchased a while back from Paul Trist at Planes Wings & Things (**www.planes-wings-things.com).**

Sadly, Paul's website indicates that due to conflicts with his real job, he is no longer able to keep up the business on the Internet. Another distributor may pick up this product in the future. The original stock stab weighted 3.5 oz, the replacement weighted 1.33 oz, saving 1.92 oz. For a new lighter rudder I raided my old balsa bin and slapped something together to match the dimensions of the original. The original rudder weighted .9 oz, the replacement weighted .35 oz, saving .55 oz. Overall these modifications saved 2.47 oz on the long end of the moment arm. With these replacement items in place, I balanced the aircraft at 5" forward of the TE. (Note that this is behind the recommended CG location of 5-1/4" forward of the TE.) Stick-on lead strips can then be added or removed as needed along the battery compartment to adjust the CG to the recommended location, or to match personal taste. A pre-measured amount of lead shot, epoxy and Micro Balloons was poured into the nose of the radio tray, completely burying the nose skeg box. This locks the skeg box permanently in place and prevents it from breaking free in a hard dork.

With the above modifications this brought the total weight of the glider up to 79 oz. Out of curiosity I replaced the built up stabs with the original stock stabs and taped an empty baggy to the nose. I had to add another 5-1/2 oz to the baggy to bring the CG back to the recommended location. That would have brought the stock weight up to 84.5 oz. After flying it for a few weekends I have removed 1 oz from the nose. This has moved the CG back to 4-15/16" from the Trailing Edge. (Don't start with your CG here as it starts getting twitchy and tucks at speed if you move back any further.) The overall weight is now down to 78 oz and it flies super at that weight with the MH-32 airfoil. Mark has stated that the V-Tail version comes in a little lighter at 74 to 76 oz in the stock configuration.

The only other concern I had with this ship is the ailerons. As I mentioned somewhere above, the ailerons use "live" skin hinges. Unfortunately these are really stiff. Stiff enough that it took significant force to deflect them even 1/2" up and down. Now I like lots of aileron movement, probably more than I really need, but I need them to move.

Falling back on a fellow club member's solution, I taped a metal straight edge to the top of the wing, and marked a pencil line 2" in at the root of the aileron and 1-3/4" at the tip of the aileron. Leaving 1" at each end, and about 2" in the middle I used a Zona Saw to cut down through the skin hinge along the side of the metal straight edge. Work slowly with small strokes and you will end up with a nice clean fine cut. When done, clean off the debris and apply a tape hinge over the top. This did a great job of freeing up the ailerons and the aileron servos now sounded much happier.

Flying

I made arrangements with another Torrey Pines Gulls member, who has a TEMPEST, to meet me at the club field in Poway on a blazing hot Sunday morning here in Socal. After taking several precautionary pre-flight photos, we range checked the radio, and everything looked good. I gave it a hand toss across the field into the non-existent wind. It needed several clicks of down elevator as well as more down elevator compensation for flaps, which were promptly entered. Although I had programmed the radio with the recommended launch preset, I prefer to launch a new ship the first time without any camber or preset. Stepping up to the winch I tensioned the line, gave it a good toss and up it went. No surprises and it was rock steady all the way up and off. I spent the first flight dialing in the aileron differential and further adjusting the elevator/flap compensation. On the next flight I dialed in the recommended launch camber and elevator preset, tensioned the line and gave it a good heave. It immediately rotated 90 degrees and took off straight up! 80 or 90 ft up the winch line snapped like kite string and things started getting a little tense. I was able to roll over the top and out to the side to avoid the line and land safely behind the winch line. We repaired the winch line, dialed out a little elevator preset and launched again with a little less line tension. This time it went straight up, got a decent zoom off the top and made a clean transition into glide like it was on rails. Wing flex on launch is minimal even at very high loadings. This is one ship that I'm going to have to be careful of breaking winch lines with. Zooms with this ship are breathtaking. It's like the Duracell Bunny. It just keeps going and going and going. I spent the rest of the flight scooting from one small early morning thermal to another. Make no mistake; this ship/airfoil combination is not a floater. It will not perform well dragging the tail around the sky. A small amount of camber (1/8") slows it down into a decent thermal turn, but it will fly a little faster than you might be used to. It seems to be very versatile from wide flat turns to small wingtip circles; it just flies like it's on rails. It is both very precise in its handling and very neutral. It will signal lift well for the initiated eye and is simply awesome in its ability to come back upwind.

On the next weekend I got out to one of those days where you just can't do anything wrong. Launches were hard and high. Zooms of the top were awe-inspiring. Thermals were everywhere, big thermals, little thermals, and everything in between. This ship is sweet! I got over an hour of flight time in three flights, only because I wanted to shoot some landings in between. The TEMPEST cores well, climbs with the best of them, and effortlessly punches back upwind through sink. I put about 1/16" of trailing edge reflex in my transmitter but have not played with it much yet. At the final CG I ended up with, it moves right out on step and I really haven't yet needed any reflex.

For landing you need to use proportional flaps to adjust your landing approach just like any other ship. The only down side is that these flaps are HUGE, and the TEMPEST really slows down when they are deployed. Because of the overall weight of this ship, when you deploy full flaps and are low to the ground you are done. There is no "stretching" the last few feet if you are short. Overall though, landings are very predictable and repeatable. As an example I was able to make five of my first six landings in the 90+ range on a 25 ft landing tape. The sixth flight dropped into the 60 range because I slowed it down too early.

Wrap Up

Finally, the nicest thing about the TEMPEST is that it is not a "chore" to fly. You want to go from over here to over there, and it goes. You don't have to saw on the control sticks trying to get it to perform, it just does it. That is the truest mark of a well-balanced design. If I had it to do over again would I buy another one? You Bet! But I might try the V-tail for a little lower weight. (And sorry Mark, but it wouldn't be green.)

The End