Radio Controlled Soaring Digest

March 2005 — Vol. 22, No. 3

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Front Cover — Robbie Dissler, an incredible Swiss flyer, gets ready to toss his 7.5 meter sailplane off a mountain at Lavéy in Hahnenmoospass, Switzerland. Located between Adelboden and Lenks, south of Bern, Hahnenmoospass is a fantastic ski resort in the winter and a wonderful place to fly sailplanes in the summer. **PHOTO BY STEVE RICHMAN**

About *RCSD*

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

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In the Air!

The anxiety of an approaching deadline builds exponentially as the date comes closer, but worry is not productive and there are more constructive avenues for psychological energy.

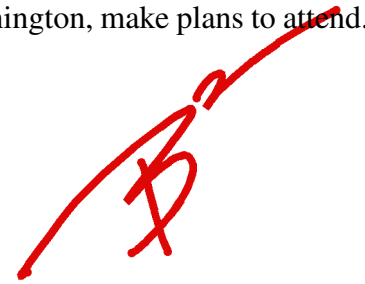
Although we have been editors of various newsletters and books, and should be more adept when it comes to submission deadlines, we've not been able to completely eliminate our concern over having insufficient material for an upcoming issue.

Our own travels were a complicating factor this month, as we were not able to keep track of submissions in the days immediately preceding the deadline. So our sincere thanks to everyone who contributed to our reduced stress level by submitting material for this exciting issue!

Don Bailey is a well known name in RC soaring circles, having written articles for other model aviation magazines and being involved in various soaring events, notably Soar Utah! Don's true love is aerotowing, and after his presentation at a Seattle Area Soaring Society meeting a few months ago, we asked if he would write a commentary to go along with some photos provided by Dave Beardsley. His positive response lead to his premiere article on aerotowing in this issue.

Don says when he writes about aerotowing the articles seem to write themselves, and he has offered to cover aerotowing events, present some material on large scale sailplane projects, and other related items for future issues. Welcome aboard, Don!

In keeping with Don's aerotowing article, you'll find information and a registration form for the Yakima Scale Aerotow Spring Fly-In in this issue on page 15. This is a huge event, attended by a large number of Northwest aerotow enthusiasts. If you're within traveling distance of Yakima Washington, make plans to attend. And be sure to bring a camera!



Don Bailey

Aerotowing!

Everyone loves watching a beautiful large-scale R/C sailplane as it flies gracefully along against the backdrop of a rich, blue sky.

With their long, thin wings curving gently into a banked turn, and their slender white fuselage and tall tail glistening in the sunshine, large-scale sailplanes can move even the most hardened landlubber to express feelings of amazement and awe. It is pure poetry in motion. What is particularly astonishing to a newcomer is how very much large-scale sailplanes appear just like their full-scale counterpart, as they march down final, spoilers wide open, and then drop gently onto the ground, with the long wings heaving and sighing as the massive sailplane rolls slowly to a stop.

And if they look real on the wing, then nothing can compare to how real they look when towed up behind an equally large radio-controlled towplane (often called a "tug" in aerotow parlance). In many ways, large-scale aerotowing is the very pinnacle of sailplane aeromodeling, combining all of the demanding skills of precision flying with the aesthetic appeal of scale modeling.

Aerotow events are like family reunions to those who regularly participate. Aerotow gatherings are typically regional events, and as such, they offer an opportunity to hook up with some old friends who may have traveled many miles for the occasion. It is a chance to showcase your latest new creation, and to sit and fly with some good friends of a like mind for the better part of the day. Most pilots bring along a good portable chair, and if the lift is good, they sit in groups while flying, and often stay airborne for an hour or more, while they chat about sailplanes and soaring. Since aerotow events are not usually contest-oriented, pilots can feel free to launch whenever they feel so inclined, and stay aloft as long as they like. Tow pilots are highly valued, and are considered worthy of free admission, for the valuable service they perform. Many tow pilots will also bring along their own sailplanes, for those times when they can get a break from all the towing. It is not unusual for a tow pilot to manage to get everyone else airborne, and find himself with nothing to do but spectate, until the next available tow pilot lands.

How it Works

Being towed behind a large tug is not really all that difficult to do, though some people pick it up right away and others require some practice before being able to aerotow without anxiety. To perform an aerotow, a 100-foot towline is strung from the tug to the nose of the glider. Both aircraft have servo-operated release mechanisms, but the tug release is only used in the event that the sailplane release does not function as it should. Once the airplanes are properly positioned on the runway, the tow pilot and the sailplane pilot stand next to each other behind the glider, and as the throttle is advanced, the glider and tug begin the take-off roll. Tug and glider can roll a hundred feet or more before first the glider, then the tug, leaves the ground, and the formation flying begins. The tow pilot directs the formation, and it is the sailplane pilot's job to keep the glider in good position behind the tug.

Once airborne, the tow pilot and the glider pilot will often talk to one another, to better anticipate when turns will occur, and to help maintain the appropriate relative positions as the climb ensues. Most sailplane pilots prefer the high tow position, above and behind the tug. As the tug turns, the glider is allowed to lag a bit, to keep it on the outside of the turn and thus prevent a slack line condition. Sometimes things get all out of alignment (called a "cross-up"), or the line goes slack, and the glider suddenly gets yanked as the line comes taught again. The only recourse when things start to get out of hand is to release early. Most glider pilots keep their finger on the release button, ready to release at a moment's notice should things go south. When a tow goes well, the tug and glider can climb pretty high, often to one- or two-thousand feet of altitude. When ready, the glider pilot releases from the towline and turns to the right. The tug pilot reduces the throttle and turns to the left, to maintain separation, and returns to the runway for another tow.

Facing page: Don Bailey shows off his new 4 meter span Aeronaut SHK at Mission, B.C. Photo courtesy of Don Bailey.

Frank Smith's Multiplex 1/4 scale ASH26 is towed off the field during the September 2004 Skagit Aerotow. This event was held at the Skagit R/C Club field at Lyman, Washington, and hosted by Lynn King of the SRCC. Photo by Dave Beardsley.

Free to Roam

Once free of the tug, the sailplane pilot has plenty of time to cruise around and explore the skies for good lift. Modern-scale sailplanes offer excellent aerodynamic efficiency, with long-ranging glides at a high L/D (glide ratio), and a low minimum sink speed. Vintage ships will usually come down a bit sooner, and cover less sky (particularly if there is a headwind to struggle against), but if there is lift, they, too, can stay aloft for long stretches of time. Often, a number of sailplanes will form a "gaggle" in the same thermal or region of lift, and midair collisions can become a potential hazard. By stacking up at different altitudes, and by turning in the same direction as the rest of the pack, the likelihood of a midair can be minimized.

It can be difficult to tell how high your sailplane actually is at times, and when the sailplane is particularly high up, it can be even more difficult to tell if the sailplane is climbing or sinking. Some pilots use on-board variometers with telemetry, to tell them when the glider is in lift or in sink. You will know who these pilots are by the telltale headset or earpiece. The greatest hazard at these lofty heights is overspeeding. Exceeding the structural redline of the model sailplane is easier than you may think, with no ground references to gage against, and sailplanes sometimes explode with the enormous stresses of too much speed. It is a good precautionary practice to open the spoilers or lower the flaps when gobs of altitude must be given back to the thermal gods.

Sailplane aerobatic routines have become more popular lately. Such aerobatic designs as the *Swift*, the *Fox*, the Lo100, and the Czech *Lunak* are favored for this type of flying, as they feature shorter wings, larger control surfaces, and stronger airframes for this expressed purpose. Often, pilots will attach colored smoke canisters to the wingtips and tail, for a colorful ribbon of smoke during the aerobatic maneuvers. Large loops, slow and graceful rolls, towering hammerheads, and low inverted passes are all part of the repertoire. Needless to say, these sorties are strictly for show, and are over in a few minutes, but the display is truly an admirable spectacle to watch.

Top: Steve Dentz' Pegasus tug, with DA150 engine in the nose. Pegasus kit available from Endless Mountain Models. Bottom: Bob Marchi starts the DA 150 engine on his Pegasus tug while Lynn King holds the airframe. Photos by Don Bailey.

Equipment

Most good tugs have much larger engines than their sport-flying counterparts, and the rule of thumb is to go with at least twice the horsepower than the design recommended engine size. Tugs require lots of pull-power, and big engines are the order of the day. Some tugs, like the Pegasus design (available from Endless Mountain Models), are non-scale designs which feature robust airframes and rugged landing gear, able to swing big props and handle the hard yanks of a bad tow. Other tugs, such as the Frisch Wilga or the Airworld Cmelak, are scale designs, which can be adapted to the rigors of aerotowing. Other popular scale designs for towing are the Piper *Super Cub* and the Piper *Pawnee* agplane, both of which are common workhorses in the full-scale realm of soaring. Engines for these big airplanes are almost invariably the large gasoline powered two-strokers, such as are made by Brison, Zenoah, Desert Aircraft, and ZDZ.

There are a number of absolutely gorgeous modern sailplane kits made in Germany, many of them imported into this country by EMM, Icare, and NSP (see contact info at the end of this article). Vintage and classic kits are more scarce, though the Flair Ka8b kit has become so popular it is becoming known as the Piper Cub of the Large-Scale set. Michael Tetzner is the current importer of this fine kit from England. Many vintage large-scale sailplanes are built from plans, or designed from scratch, and cannot be obtained on the commercial market as kits. Each of these models represents many long, hard hours of design and layout, part cutting, and building/finishing, before they are ready to present to the flying public. Many are works of art, like fine musical instruments, with high-gloss varnished plywood finishes and clear-doped fabric wings.

In the end, each pilot will discover his or her own preferences in the field of large-scale sailplanes, and learn new skills and develop new friends, in the process of getting involved in this exciting and addicting aspect of model aviation. If you love sailplanes, and admire scale fidelity, it doesn't get any better than this!

Dave Beardsley's 6.5 meter Duo Discus takes off from the SRCC field.
Photo Courtesy of Dave Beardsley.

(1) Bob Marchi's immaculate interior on his Pilatus B-4. (2) John Sandell's beautiful aerobatic Polish Lunak. (3) Steve Dentz' big 40% Grob Twin Acro. Note trailers to haul large sailplanes. (4) Typical line-up of sailplanes waiting for a tow. Photos by Don Bailey

Sources:

Endless Mountain Models
(Fine line of imported German sailplane kits, Pegasus tug)
<http://www.scalesoaring.net/EMM/rand.htm>

Icare
(Extensive line of scale sailplane kits of various sizes)
<http://www.icare-rc.com/>

Northeast Sailplane Products
(Imported scale sailplane kits from Europe)
<http://www.nesail.com/>

Michael Tetzner
(Krick sailplane kits, Flair Ka8b kit)
<http://www.mkrusa.com/>

Frisch Modellbau
(Wilga kits)
<http://frisch.flugmodellbau.de/alexfr.htm>

Airworld
(Cmelak kit)
<http://www.airworld.online.de/Deutsch/Motorflugzeuge/Cmelak/indexold.htm>

Desert Aircraft
(Two- and four-stroke gasoline engines)
<http://www.desertaircraft.com/>

Chief Aircraft
(Good source for gasoline engines)
<http://www.chiefaircraft.com/>

Lynn King's gorgeous 1/3 scale DG 1000, spoilers out and wheel down, comes in for a landing at the SRCC field. Photo by Dave Beardsley.

Gene Cope holds wingtip of Bob Marchi's big Pilatus B-4. in preparation for towing. Photo taken at Mission, B.C., Canada, by Don Bailey.

Tech Topics

Simple Templates for Foam Cores

David Register, <regdave@aol.com>

Over the past few months I've been getting the workshop better organized for a few projects. All of these involve building composite wings for flight evaluations. Consequently, there's been a flurry of template making and foam cutting.

Now most people consider making templates a real pain. I kinda like it. The method I use takes about an hour to complete a set of templates for a double-taper wing (6 pieces – upper and lower patterns for the root, taper break and tip). So making the templates is a small fraction of the total build time. But if the template isn't right, the wing won't be right.

Probably the best template available today is none at all. There are a number of automated systems, many of them home-built, that use computer control and stepper motors to precisely cut foam cores without a physical template. I looked into this approach and decided that the entry cost was a bit high for me. Someday this will be a fun project but not right now.

The traditional approach is using a computer program (such as CompuFoil) to generate a very accurate paper copy and then transfer that to a template material. Here we get into the 'just one swipe of the sanding block and it's a whole different airfoil' debate. I can't do much about that. Any template preparation requires a bit of experience and "art" but that's the best we can do. For the automated machines, controlling kerf, cutting temperature, backlash, foam density and foam uniformity will lead to similar issues. So let's keep perfection as a goal but not an impediment.

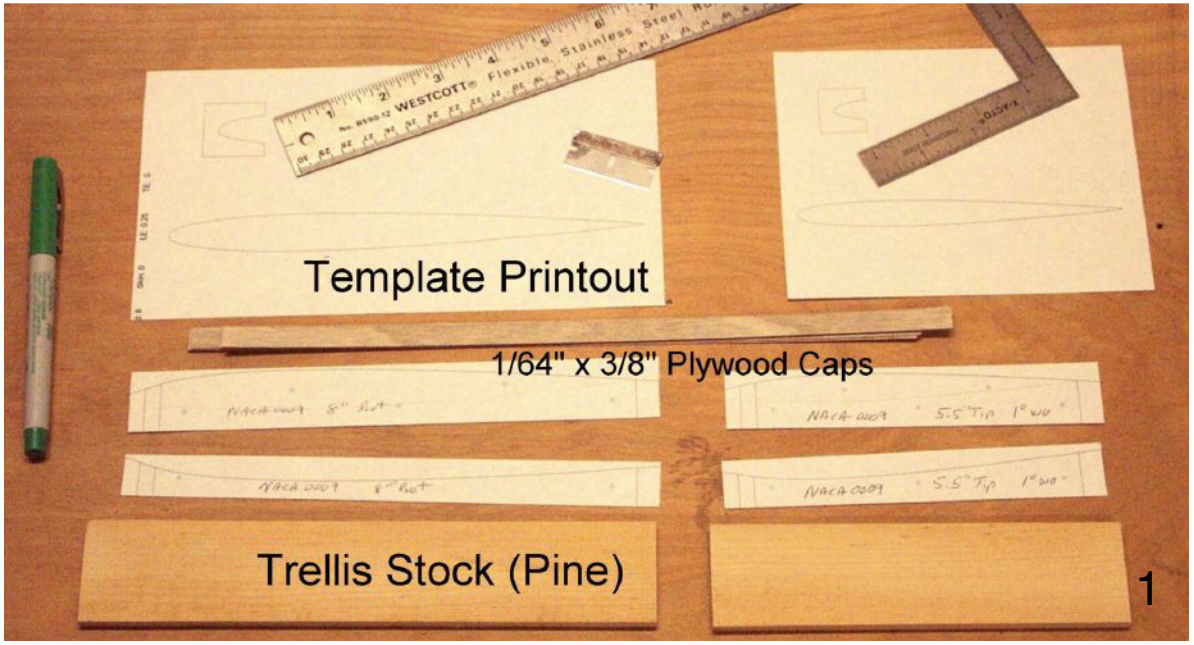
There are many choices for template material. Folks have used Formica (kitchen counter top material), phenolic (circuit boards), thin aluminum plates (from offset printing shops), plywood with Teflon tape and the list goes on. Phenolic is probably one of the more popular materials and can be found at electronic supply houses (not typically stocked at Radio Shack, however). You may be able to find Formica at a builder's supply – ask for broken scraps so you won't have to buy a whole sheet (~ $50).

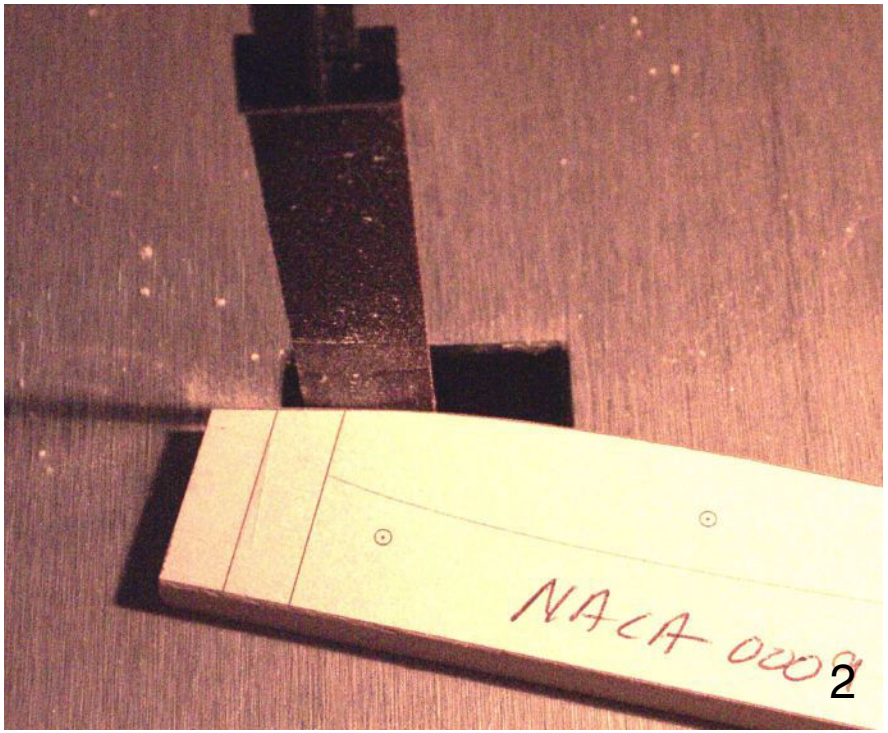
I've tried all of the above and have worked out a preference that meets my needs. Formica and phenolic were a bit brittle for me. Aluminum was a bit too hard to work. So I settled for a wood option.

Early on I used plywood and Teflon tape and that combination can work nicely. However, working with plywood and getting the surface wide and smooth enough for the tape was time consuming.

The next step was starting with a softer wood base – which was fine for making the outline but problematic for good rigidity behind the tape. So the last evolution was to replace the tape with a 1/64 plywood facing. 8 years later that's still my method of choice.

The most available source of good quality pine for the template base is trellis stock. It can be found at any Lowe's, Builder's Square or Home Depot in the country. It's 1.75" wide x 0.25"





thick and available in 8ft to 16ft. sections. Cost for a 16ft piece is about $6. Since there are usually many of these in stock, find one with uniform grain and no knots.

Using your favorite template software, print out your paper patterns. Using a straight edge and a sharp single edge razor, trim the base of the paper template as accurately as possible (Figure 1). The LE, TE and core surface of the template can be rough cut.

Now cut the trellis stock a little longer than the paper template. Pick the best edge of the trellis stock and use your belt or disc sander to make that edge as flat and straight as you can. This will be the template base so make it as square to your table top as possible.

Lay the base of the paper template along the base of the trellis stock (use an aluminum angle to help get it true), and then tape the LE of the paper to the wood. Repeat this for all the templates you're going to make.

Line up the soon-to-be templates on a flat surface (suitable for messy spraying), fold back the loose end of the template paper and spray both the wood and paper surfaces with 3M77. Once that's tacky, carefully fold the paper back down on the wood base – use the aluminum angle to help keep it true – and press out for good contact. A small wallpaper seam roller is a useful tool for this step,

At this point you should have the paper templates glued down to the wood base with the bottom side of the template already finished. If it's off just a bit, no problem - just hit it with your belt sander to bring the wood into good registration with the bottom line.

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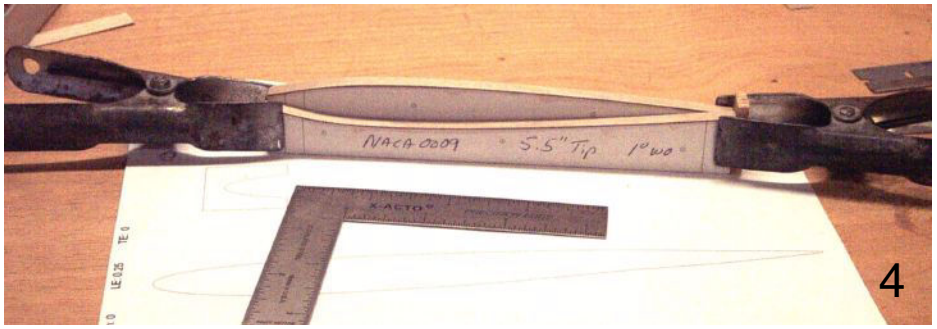

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Now cut out the template with a jig saw or coping saw leaving about 1/32" of excess material. If you have a jig saw, I highly recommend using Scrollsanders for finish sanding (Figure 2). These are available from Chris Adams and are a major improvement for the finish step no matter what material you may be using: <http://www.scrollsander.com>.

If need be, you can finish sand with a belt or disc sander but the lower surface template is difficult to do that way. A narrow belt sander (Dremel type) will work but the Scrollsander is SO much easier.

At this point, you've built all the accuracy you can into your template. Next step is to add a hard, smooth surface for the wire to slide on. For this last step, I use 1/64" plywood with the surface grain running along the template chord direction. 1/64" plywood is compliant enough to conform to just about any airfoil surface and sands to a fine finish that will not 'hang' the cutting wire due to a rough spot.

The only trick is getting the ply on the pine without attaching yourself to your work. If you do, experience indicates that a little bit of skin sands out nicely.

I typically cut 3/8" wide strips of plywood with enough length to hang over the ends of the template by 1/2" on both ends. Lay this strip down on the surface, lightly score the ply at the LE and then snap it so it goes over the end of the template but does not break off. Tape this tab to the LE with a small piece of masking tape.

Now hold the ply to the surface very tightly and run a bead of very thin CA along the edge on both sides. Hold everything in place long enough for the CA to "kick." If it misses in a few places, press down in those areas and run a little thin CA along the edge and it should work out fine. (Figure 3)

Please note the wisdom of cutting the ply too wide. I've become very attached to my work on occasion and have found a little excess width really helps keep you from becoming too engaged with the project.

Trot back over to your belt sander and trim off the excess ply width. Sand the ply surface with a fine grit paper (at least 200 grit) and be sure the edges are smooth.

One last little trick is to add a small piece of 3/8" x 1/4" spruce to the TE of the template. I usually leave about a 3/8" land at the TE and the spruce piece catches the wire when it pulls out.

I also align and then clamp each upper and lower pair after they are done and drill the mounting holes for both (Figure 4). One advantage of the trellis stock is that it's thick enough that the retaining nails will go in straight if you've drilled the indexing holes straight.

If everything has gone according to plan, you should have a set of templates that look like Figure 5.

Just remember to lightly sand the surfaces from time to time in case any foam is deposited from a dirty cutting wire. More details of templates and usage were covered in my *RC Soaring Digest* column of February, 1999.

Next time we'll look at a simple technique for cutting a highly tapered core – the ones that taper enough that you just can't get the ratios to work out right on a drop-arm (e.g. Feathercut) system. But in the meantime, it's off to Phoenix in search of some warmer flying weather!

Yakima Scale Aerotow Spring Fly-In

Date: 7-8 May 2005

Location: Glessner's Airstrip, Yakima, Washington An 85' by 1940' grass airstrip, this field is located 14 miles west of Main St. on Ahtanum Rd. There is a map to the location available on line at <http://www.soaringissa.org/maps_lodging/Yakima%20Flyin.htm>.

Event Information: No tasks, duration, or spot landings, just a fun weekend aerotowing scale sailplanes. Sign-in will start at 9:00am on Saturday with safety meeting at 9:45am. Flying will start at 10:00 and will continue till 5:00pm. Large powerful tugs will be on hand to handle towing. Tugs are currently on channels 17, 18, 22, 28, 33, 46 and 60. However, not all tug channels will be in use during the event so please check with the transmitter impound and have the frequency pin before turning on any transmitter.

Join us at a local restaurant for (no-host) dinner and camaraderie Saturday evening at 7:30pm. Sunday flying will be from 9:30am until 5:00pm. There are no food services in the area of the field, so bring something for lunch. Cold bottled water will be provided or bring your own beverage. Please no alcoholic beverages during flying hours. Please limit smoking to inside your vehicle.

Lodging: The following motels are located in Union Gap and are near a Denny's, Sea Galley, Applebee's restaurants, the Valley Mall, and Ahtanum Rd.:

- Best Western (1-800-348-9701) 2408 Rudkin Rd.
- Super 8 (1-800-800-8000) 2605 Rudkin Rd.
- Quality Inn (1800-510-5670) 12E. Valley Mall Blvd.
- Camping on site is permitted. No hookups are available.

Fees: Registration fee is $5, pre-notification requested with frequencies and dining option. This is to help curb frequency conflicts and provide the restaurant with an approximate total for dining. AMA or MCCR required.

Please make registration fees payable to: Gene Cope, 3203 1/2 Main St., Union Gap WA 98903-1847. You can phone at (509) 457-9017 or e-mail at gliderflier@charter.net

———————————Cut at line and return with Pre-Registration———————————

Name_____ Frequencies _____ _____

Address _____ State _____ Zip Code _____

AMA No. _____ Dinner option (Number of People) _____ Camping: Yes No

The Tool Room

Steve Richman
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A Review of Two Digital Servo Drivers

When B^2 Kuhlman and I first tossed around the idea of a Tool Room column, we decided the scope of topics discussed should be as broad as possible. We wanted to offer more than reviews of the usual collection of lethal and semi-lethal weapons we customarily employ to cobble together our prized bits of fiberglass, carbon and balsa.

So this month's column is a review of two digital servo drivers: the ServoXciter EF from Vexa Control and the Super Digi-Set 2010 from Aero Scientific Inc. A digital servo driver is simply an electronic tool that allows you to directly operate servos without a radio. I rank digital servo drivers in the same category as the Proxxon Disk Sander reviewed last month…a "wanna have" tool that became a "gotta have" tool in my shop.

Servo drivers are nothing new. They've been around in one form or another for years. However, the current crop of full feature digital servo drivers offers some important new features and benefits. They do a lot more than just wiggle servo arms. Let's talk specifics.

For starters, if you want to do a first class job of installing servos, it's important to set them up so the maximum servo arm throw operates the control surface throughout its maximum recommended operating range.

In other words, if your servo's maximum operating range is 60 degrees, you want to utilize as much of this range as possible to control ailerons, elevator, etc. This servo setup process entails determining how far out from the center of the servo arm and the pivot point of the control surface to attach quick links, cables or push rods.

In addition, for control surfaces like ailerons and flaps, you may also want to consider how much mechanical differential to include. This is typically done by setting the neutral point of the servo arm at an angle other than 90 degrees to the side of the servo case or pushrod. I find this process particularly onerous when setting up top-acting flaps in hollow molded wings.

These are situations where a good digital servo driver proves invaluable. Just plug the servo lead directly into the servo driver using a servo extension, operate the servo throughout its range and evaluate how effectively it drives the control surface connected to it. You can easily try out different control linkage combinations with the servo driver sitting conveniently next to the wing panel or fuselage until you get exactly the throws you want. It couldn't be simpler.

Sure, you could and probably do accomplish the same thing by plugging the servo into a receiver, wiring up a switch harness and battery, firing up your transmitter, insuring it's programmed appropriately while somehow keeping the transmitter from falling off your lap or falling over on your bench and punching a hole in a flawless Oracover finish or dinging your brand new, pride and joy $1,000+ moldie. It's just a heck of a lot safer and much more convenient to use a servo driver. And that's just for starters.

Not only does the servo driver directly operate your servos, it tells you exactly what transmitter signal pulse width is required for any position the servo arm is in. In other words, you now know the value of the signal pulse for

Left, the Super Digi-Set <http://www.aeroscientific.com>, and right, the ServoXciter <http://www.vexacontrol.com>.

the servo neutral point you've established (which may not be the true servo center) and you now know the exact values of the servo's end points (which are most likely different than the true servo end points).

Great…so who cares? Hopefully you will in just a minute. Sophisticated digital servo drivers like the Super Digi-Set 2010 and ServoXciter have another bit of important functionality. Not only does each have a connection for a servo lead, they also have a connection for a receiver lead. This makes programming your radio an absolute breeze.

Let's assume all your servos are installed and you've noted their respective neutral and end point values. Next step: with your receiver on your work bench, wire up a switch harness and battery and turn on your transmitter. Plug the receiver lead extension from the servo driver into the first receiver slot. Let's assume it's the left aileron slot. Operate the aileron stick while you view the digital display of the servo driver. You'll see the values change as you move the stick.

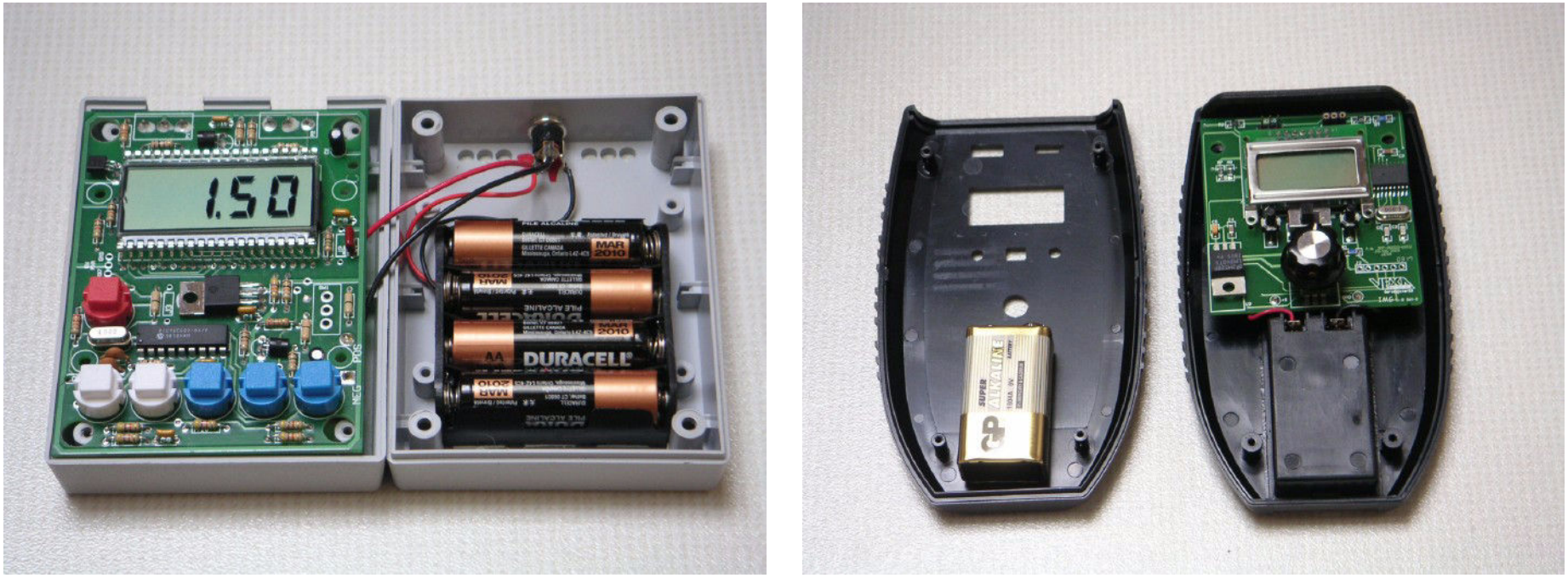
Make all the necessary transmitter programming adjustments so the end points and neutral point values of the left aileron servo displayed on the servo driver readout match those you noted for that servo. Voila…you've just guaranteed that when you plug the actual servo lead into the receiver, it will operate exactly as you expect: in the correct directions and with the exact throws to operate each control surface. In other words, no surprises like having your flap servo rip out of the wing or strip gears because the servo arm moved too far in the wrong direction the moment you turned your radio on.

I also find programming a transmitter a lot less painful when I only have to concentrate on it and the servo driver display. I don't have to worry about servos stalling, linkages binding, etc. Programming your transmitter can now done just about anywhere, even in front of the boob tube.

Still not impressed? OK, here are a few more benefits. If you're into scale sailplanes, sooner or later you're going to set up Schempp-Hirth style single or double acting blade spoilers. Now anyone who has dealt with these little beauties knows just how fussy they are. When retracted, the blades are down and locked. There's very little play in the locked position. The same holds true for the fully open position.

The servo driver makes programming this setup a piece of cake. It guarantees you won't destroy a servo or the spoiler because the servo stalled in the wrong direction. And if you're a nutsy-fagan perfectionist like me who wants both spoilers working in exact synch throughout their operating range, the servo driver makes programming a multi-point transmitter control curve very easy. The same considerations apply to setting up a retract servo.

Here's another bit of icing on the cake. All of us flying electric sailplanes are faced with the task of correctly wiring the motor controller and testing the drive system. Wire the controller incorrectly and the prop spins backwards. This is a real pain with non-programmable



Left, the open Super Digi-Set <http://www.aeroscientific.com>, and right, the open ServoXciter <http://www.vexacontrol.com>.

controllers. To test out the drive system, tack solder the three controller leads to the motor leads and insure they are insulated or prevented from shorting. Plug the motor controller servo lead into the servo driver and the controller power lead into the motor battery.

Exercising all the usual safety precautions with electric drive systems, turn on the servo driver and briefly operate it through its range. You'll quickly see if the motor is spinning in the correct direction. If you choose to operate the motor on a variable control, you'll also know what transmitter pulse values are required for slow, medium and fast motor speed. I perform this controller check without a prop attached for safety's sake and use a low voltage battery to avoid over-revving the motor.

Both the Super Digi-Set 2010 and ServoXciter have additional functionality, a few more bells and whistles most of which I never use. However, there is one other function I do find very useful. Each servo driver allows you to engage a sweep function that cycles a servo throughout its operating range. The Super Digi does this at a single set speed. The ServoXciter allows you to vary the cycling speed. I always test all new servos and crashed servos using this function using both slow and fast speeds to quickly identify problems that result in erratic servo movement. NB: this test process does not identify the cause of the problem e.g. faulty pot, broken gears, etc.

So which of these two full function digital servo drivers do I prefer? I bought the Super Digi-Set 2010 a couple of years ago and was very happy with it. About a year ago, I tried the ServoXciter and it quickly became my weapon of choice. While both do essentially the same things, I find the ergonomics and operating knob of the ServoXciter much more useful. It more closely simulates transmitter control movement. You can vary the speed with which you turn the knob to check for control movement, binding,

etc. With the Super Digi-Set, you effect servo movement by pressing and holding down one button to turn the servo arm in one direction, then release it and hold down another button to move the arm in the opposite direction. In either case it's at a single, relatively slow speed.

I do have two complaints about the ServoXciter. First, it's easy to plug servo extension leads into the front of the case the wrong way e.g. with the pulse lead of the extension connected to the negative contact of the servo driver. The proper orientation of the contacts should be clearly marked on the servo driver case. Second, when I first bought the unit, I e-mailed Vexa Control with a question. They never responded. While preparing this article, I e-mailed a second question just to see if their customer service has improved. Again, no response. That level of customer care hardly inspires confidence. *Caveat emptor.*

If you want additional information or are interested in purchasing either of these units, check out
<http://www.aeroscientific.com>
for the Super Digi-Set or
<http://www.vexacontrol.com>
for the ServoXciter.

The current web price of the Super Digi-Set 2010 is $114.95 while the ServoXciter lists for $85.00 and is currently on web special for $69.95. Neither unit is supplied with servo/receiver lead extensions.

Regards from the workshop, Steve

P.S.: I did eventually receive a response to the second e-mail I sent to Vexa Control. The reply came a full week after I sent the note.

Steve Richman's

Sportube Travel Tips — Part 1

Over the past three years I've made several trips to western states and three trips to Europe for sailplane flying vacations. Each time I carried most or all of my planes in Sportubes, telescopic plastic cases originally designed to hold snowboards and skis. I always check my Sportubes as locked luggage and have been lucky as none of my gear has ever been lost, stolen or damaged.

However, friends and acquaintances have not been so fortunate. A good friend checked his locked Sportube with the key taped to the case. Airport security opened the Sportube for inspection, then relocked it failing to engage the lock hasp in both sides of the case, something easy to do if you don't know how to properly lock a Sportube.

As a result, the two telescopic case halves were free to slide completely open or closed in transit. In my friend's case, the

Steve's Sportube with added stops to eliminate compressing and damaging the contents and a cable which prevents the case from opening and losing anything inside.

Left, several views of one of the fabricated stops, ready for installation on the Sportube. No machining skills needed, just the basic shop abilities.

Below, one of the completed stops mounted on the case.

Installing the stops on both sides of the case prevents the case from closing too far and compressing the parts inside.

two case halves slid closed crushing a couple of wing tips. Things could have been much worse if the case opened up allowing wing panels and fuselages to spill out in the plane's belly or luggage carrousel.

I decided not to allow that same misfortune to happen to me and came up with a couple of enhancements to better secure the Sportube.

First I made up some aluminum stops that prevent the case halves from closing any further than a predetermined point. I fabricated these stops from 1/8" thick strips of 1" and 2" wide aluminum stock available at the local hardware store. I used double back tape to hold them all together while I drilled three pilot holes. Then I separated the 1" end strip, drilled and tapped it for an 8-32 thread. I drilled out the remaining strips as a unit to allow an 8-32" button head bolt to pass through each of the three holes. The photos show all the details.

I determined the most likely maximum expanded size of the Sportube, locked the two halves together, located the stops on

either side of the case and drilled three holes for the 8-32 bolts. Then I assembled all the bits with the tapped 1" aluminum strip inside the Sportube as a nut plate and trimmed the length of the bolts flush with this strip.

To insure the case could not open completely, I consulted with my local hardware store and came up with the idea of using some cable, crimp-on closures and miscellaneous hardware as shown in the photos. This cable system can be easily opened and closed for inspection.

There was also an unexpected benefit from all these Sportube enhancements. Because I keep the Sportube expanded quite a bit, the case halves don't overlap very much. As a result, the Sportube tends to flex and bend when lifted from the middle or an end. Adding the stops and the cable have eliminated almost all this flexing.

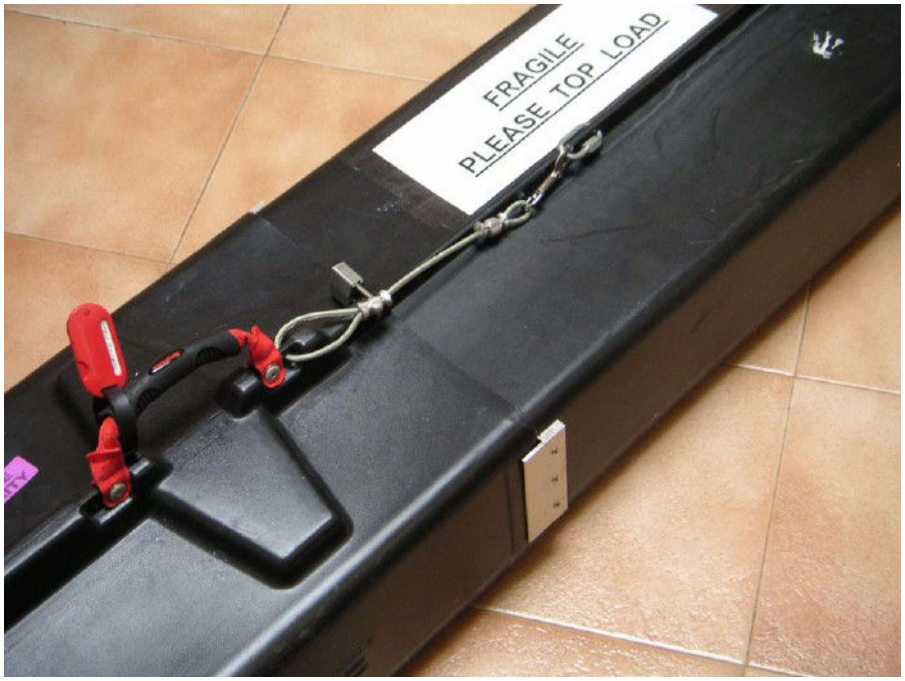
If you regularly close your Sportube at different lengths, you can drill additional stop holes through the case and relocate the cable closure as required.

Here are a few additional tips to make traveling with Sportubes safer and more enjoyable:

• Every airport's security system is different. I make it a point when checking in to explain I want to check the Sportubes as locked luggage. This usually means I follow them over to an inspection station where they are either x-rayed or otherwise inspected. If security asks to open the case, you're there and have the key handy. Needless to say you should allow a little extra time for this process.

• Check with airlines ahead of time to determine their luggage policy. Some like American are real stinkers and charge $85 per Sportube each way because they consider Sportubes "oversize" luggage. Needless to say I don't fly American any more.

• For international travel, call the airline at least 48 hours in advance of your flight and tell them you're planning to check a tall plastic case filled with sports equipment. I've never had any hassles with oversize charges



Right: Close-up photos of the cable system which prevents the Sportube from opening unexpectedly, eliminating the possibility that the contents will spill out and be lost.

with Lufthansa, Air France or other International Carriers.

• Be sure to attach a sturdy identification tag to help recover the case if lost in transit.

• Place a large “Fragile – Top Load” or similar sticker on the case. Hey, every little bit helps.

Next time I’ll follow-up with some tips on how to best pack planes in Sportubes and how to deal with these bulky plastic beasties once you’ve landed, picked up your rental car and face the challenge of transporting them to your final destination.

Happy travels!

Fred China uses a handmade storage box to carry his precious vintage sailplanes. Fred travels from his home in western Canada to a number of northwest states scale events each year. His models are impeccably created, and boxes like this one are necessary to maintain the finish and structural integrity. Fred’s aircraft truly deserve this sort of specialized care.

The Sloper's Resource

by Greg Smith of **slopeflyer.com**
<greg@slopeflyer.com>

Upcoming Slope-n Events

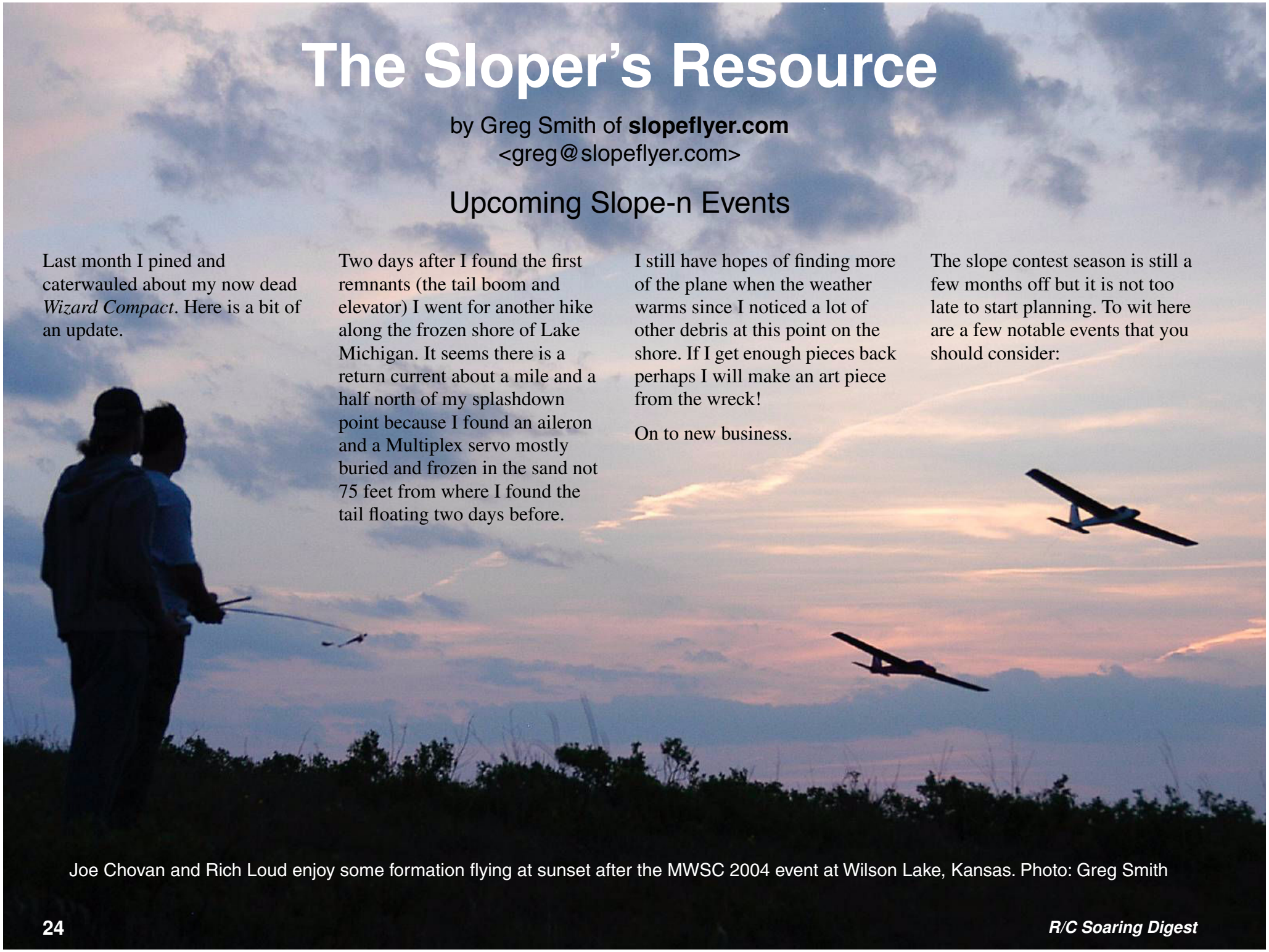
Last month I pined and caterwauled about my now dead *Wizard Compact*. Here is a bit of an update.

Two days after I found the first remnants (the tail boom and elevator) I went for another hike along the frozen shore of Lake Michigan. It seems there is a return current about a mile and a half north of my splashdown point because I found an aileron and a Multiplex servo mostly buried and frozen in the sand not 75 feet from where I found the tail floating two days before.

I still have hopes of finding more of the plane when the weather warms since I noticed a lot of other debris at this point on the shore. If I get enough pieces back perhaps I will make an art piece from the wreck!

On to new business.

The slope contest season is still a few months off but it is not too late to start planning. To wit here are a few notable events that you should consider:



Joe Chovan and Rich Loud enjoy some formation flying at sunset after the MWSC 2004 event at Wilson Lake, Kansas. Photo: Greg Smith

The Tri-Slope Six-Pack

The Mid-Columbia Soarers and ShredAir are proud to announce the second Tri-Slope Six-Pack event held at three of the best slopes in the world.

The three slopes are some of the most hallowed names in all of slope soaring. Eagle Butte, Chandler Butte and Kiona Butte. Each has its own distinct style and, as each is best suited to a specific flying style, the event categories will be split up between the three slopes based on which best suits a particular type of flying. The AMA sanctioned event will be held May 21-22, 2005 near Richland, WA.

The organizers have come up with a great format that will get any slope addicts juices flowing. Three venues/slopes plus six slope flying categories equal one really fun event!

Eagle Butte offers a fantastic site for Classic Scale Slope'n and Modern Scale Slope'n.

Note: the term slope'n is an attempt by Dieter from ShredAir to reconcile the fact that when we talk about sloping, we really should be talking about something sloppy not slope soaring related. I like it but have not picked up the habit of using the term. We'll see if it sticks!

Anyway, the slope at Eagle Butte faces predominately southwest and is about 400 feet high. Eagle Butte can provide phenomenal lift far beyond what one would expect from just the slope alone with wave lift enhancing the normal slope lift. The landing zone is huge and the approach is easy. This is why Eagle Butte is a prime site for large, scale gliders. Given the right conditions (a good at contest time), there hardly is a better place to safely fly big ships.

Chandler Butte is host to the two fast front-side categories Ballistic Slope'n and PSS Slope'n.

Chandler Butte is a west-facing, steep basalt cliff about 600 feet high offering excellent front-side compression lift with a sweet vertical component when the wind blows from the west, which is the predominant direction. Chandler can produce lift more powerful than Eagle Butte. Just what the doctor ordered for high-speed slopers. There will also be time allotted for formation half-pipe flying.

Kiona Butte is the spot for the diehard speed freaks and intense DS action. The 2000-foot grassy slope faces north to northeast and can offer huge dynamic soaring grooves. While DS at Kiona Butte remains largely unexplored, Kiona offers the possibility of huge DS, particularly for large, efficient planes. Years ago, Paul Naton set the first measured record of 174 m.p.h. here, which held until the DS-Fest in 2002.

Note that all slope are accessible by car.

For more information and insight into a well-planned and truly great event visit the web site information page at shredair.com. <http://www.shredair.com/3s6p/3s6p05.html>

Entry Fee: $20 with proceeds going to the Mid-Columbia Soarers.

Contact persons: Jay at <jsdecker@monkeytumble.com> or Dieter at <biz@shredair.com> with questions and/or comments.

The 8th Annual Inland Slope Rebels Spring PSS Festival

Each year on Memorial Day weekend the Inland Slope Rebels host the Annual Spring PSS Festival Fun Fly. Flyers from all over the United States come to experience some of the best slope soaring on the West Coast. The 2005 event is 8th annual contest and is slated for May 28th and 29th, 2005. There will also be an unofficial fun fly at Cajon Summit on the 27th and another one on the 26th at either Pt. Fermin or Skyline. This is a great opportunity for two unofficial days and two event days of Southern California slope flying action.

The Cajon Summit PSS site is centrally located in Southern California and easy to get to from the I-15 freeway. The soaring ridge is HUGE and over 1000 feet high! Come fly and show off your best PSS models. There will be open flying before and after the event. The PSS Festival always has an awesome raffle for all the pilots - Saturday after 5:00 p.m. Many sailplane vendors also attend to show off their latest and greatest (You might even get to try one!). Don't miss it. The emphasis is on FUN, and flying is what it is all about.

The contest is all about Power Slope Scale planes. The judging will be static with judging criteria including Workmanship, Colors

Jack Cooper launches his Leading Edge Gliders *Aircobra* during the Warbird races at the MWSC 2004 event. Photo: Greg Smith

and Markings and Accuracy of the outline. So that no "hangar queens" walk with a trophy, your plane must fly to be eligible for judging. To qualify as a PSS aircraft your plane must meet two basic requirements;

1. It must be a model of a REAL powered aircraft.

2. Your plane must look like the real plane. They are pretty generous on this rule. But don't forget the closer to a real aircraft your model looks the better it will do in the judging

Keep your eyes on the Inland Slope Rebels web site, <www.inlandsloperebels.com/>, for more information. At press time there was still 2004 info posted.

The Midwest Slope Challenge

After starting, championing and running the Midwest Slope Challenge for the past 11 years, the Lincoln Area Soaring Society (LASS) has decided it is time to pass the torch. Thanks, guys! The MWSC really is one of the premier events in the country.

Beginning in 2005 there is a new organizing body called Wings Over Wilson. It has been formed to carry on the great tradition started by the LASS.

The date for the 2005 edition of the MWSC will be June 9th through 12th, 2005. Note that this is a month later than the traditional date for this event. The decision to move the event to June is an effort to get more consistent wind conditions. If you've ever been to Kansas in June you will know this is a good decision!

Classes will remain largely the same as in the past with a few changes that are detailed in rules for each class. Start learning about the continued tradition of the Midwest Slope Challenge by reading the 2005 Pre Registration Page at: <http://www.slopeflyer.com/mwsc/html/2005_events.html>

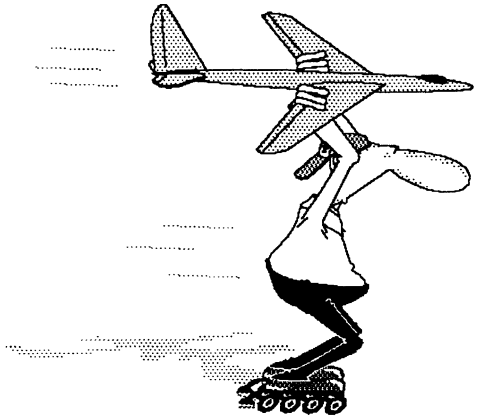
MWSC info:

Hosts: Wings Over Wilson
Sanction: AMA-sanctioned event
Insurance: AMA insurance is required.
Contest Director: Alden Shipp
Entry fee: Varies with the number of events entered.
Web Site Address: <www.slopeflyer.com/mwsc/>

So, I am planning on attending all three of these excellent events. Jack Cooper of Leading Edge Gliders and I are in the planning stages of a Slope Safari style road trip to the Tri-Slope Six-Pack and, a week later, the Spring PSS Fest with a whole bunch of slope flying in between.

Say Bye!

Jack David Day's *Tragi* racing in the Unlimited class at the MWSC 2004 event. Photo: Greg Smith



Gordy's Travels

Gordy Stahl
<gordysoar@aol.com>

Only the Shadow Receiver Knows!

A Sneak Peak at a Revolution in Receivers!

Not kidding! I am talking receivers as we knew them are a thing of the past!

My travels and fame has its advantages, and one is that I get to see new developments often before they are introduced. In this review I am going to tease you with just an introduction to the Shadow Series receivers by SombraLabs (Sombra means Shadow) of Canada.

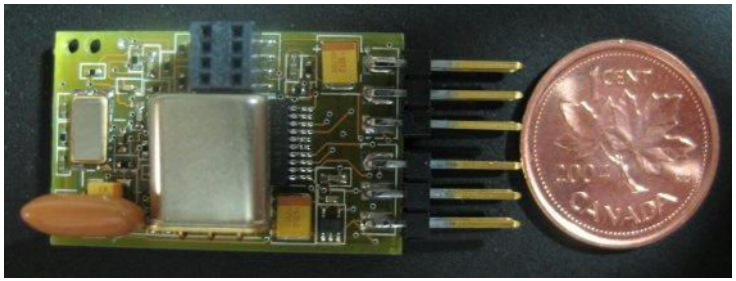
Here's the short line on things:

- No crystals needed or used! Synthesized!
- Programmable to 72 MHz for aircraft OR 75 MHz for boats and cars! Yes the same receiver! (A Euro version will be available soon for 35, 36, 40 MHz too!)
- Programming is done with a simple plug-in dual dial unit.
- And each servo slot is also programmable too.
- Cascade-able! Use two to make a 14 channel receiver!
- DSP smart!
- Matches any brand transmitter!
- About the size of a micro five channel!

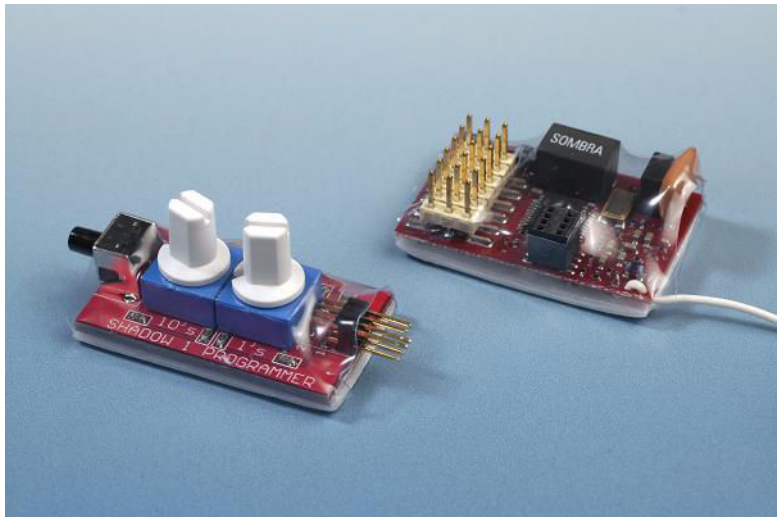
So what do all those features mean to us?

Crystal-less You can choose which channel you want to use, right at the field, right inside your sailplane! Just plug in the tiny programmer, dial the frequency to match your transmitter and you are ready to fly.

Programmable to air or ground use Plug in the programmer and dial up the right combination, no need to spend money on separate use receivers.



The Sombra Shadow 1 six channel receiver and a Canadian penny, and below with the Programmer.



The Programmer mating can be done by plugging it into the receiver or by plugging into an optional remote cable.

Assignable servo slots If you need channel 1, 2, 3, 4, 5, 7, 8… no problem, or any combination/ position is possible!

Cascade-able Since you can assign channel slots, you can assign one Shadow to channel 1 through 7 and a second Shadow on the same frequency programmed 8 through 14. The same as having one BIG 14 channel receiver but instead having two tiny ones!

DSP smart A smart chip in the Shadow initializes itself to the first transmitter that it "sees." That means it actually reads and uses your transmitter's unique signal "fingerprint." If there is interference from another transmitter or some other source, the Shadow will filter out any damaged information, yet will continue to operate using the good bits that are received.

NOTE: That is not the same as being able to operate your sailplane with two transmitters on the same channel at the same time! But it does mean that the Shadow is very resistant to another transmitter wrecking your model.

It's DSP programming and chip are very fast at recapturing the lost signal, unlike some prior DSP receiver brands. (PCM lockout would be an example of slow signal recovery).

Here's what SombraLabs has to say about their new receiver:

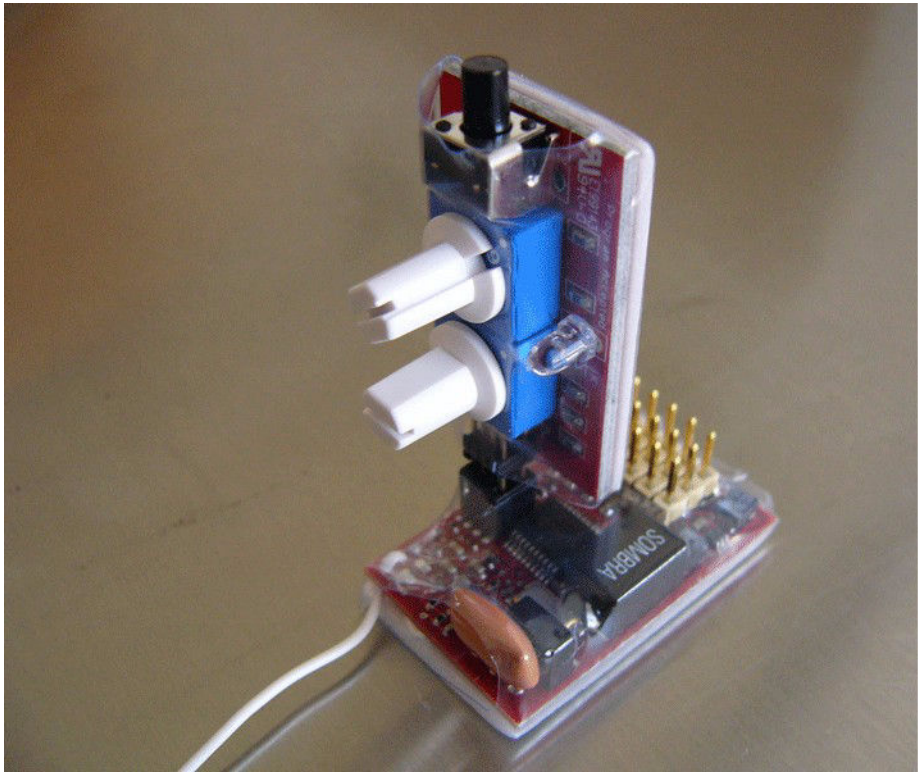
"The Shadow receiver is a dual conversion, fully synthesized receiver and can cover ALL R/C bands in North America. A modular rugged frequency programmer utilizing our patented technology is used to select different channels.

"The frequency programming is extremely simple and 100% reliable.

"The Shadow also offers advanced DSP technology to minimize glitching events. The transmitter recognition features further enhances the performance of our product and it can even recover from an episode where a different transmitter on the same frequency was turned on.

"In the case of no signal (transmitter off for instance) the Shadow will hold the servos in their position versus a standard receiver which often begins seeking information, this is shown in the form of the servos moving erratically.

"The Shadow 1 six channel receiver was the first entry by SombraLabs, and it is already history! Features continue to be added, the Shadow 1 will become a full seven channels and models will shortly include a micro 4, and a 9 channel model.



The Shadow 3 seven channel receiver with the Programmer in place.

"Prices are comparable to current crystal equipped receiver's and one programmer will work with all models of the Shadow series.

"Meets all AMA guidelines

"Dimensions: approximately. 36mm x 22mm x 14mm

"Weight: approximately 8 grams. with full length antenna"

Who the heck is SombraLabs? They have many innovations in "stealth" electronics, and have taken their expertise in other markets and applied that experience to ours — VERY MUCH to our advantage! (Thanks to Barry Kennedy's RC soaring experience! He has helped SombraLabs understand our specific needs and interests!)

You can find the Shadow receivers at Kennedy Composites <www.kennedycomposites.com>,

click on RC Systems in the menu bar, then choose Receivers.

You can find the Shadow receivers at Kennedy Composites <http://www.kennedycomposites.com>, click on RC Systems in the menu bar, then choose Receivers.

You'll find all the latest information on the new Shadow 3, seven channel version and information about the four channel version too, as well as pricing! But be prepared for back orders. Supply is limited because Sombra and Kennedy is in the middle of the end of the Shadow1 supply and the new series Shadow 3, seven channel receiver and the coming four channel super micro versions. Your smart move is to get your orders in the queue.

MY experience with the Shadow?

I put it in the new Kennedy Composites amazing molded DLG (discus launch glider), the Blaster. The Blaster is a full house sailplane which uses full span flaperons, a full flying stabilizer, and rudder function. In order for my transmitter to work two separate aileron servos that were also mixed to the flap stick, I needed channels 5, and 7. That channel assign ability was critical.

Since I travel so much, I can't afford to be "stuck" on a single frequency or even a choice of a few frequencies if I want to get in a day of soaring, so synthesized is a big deal.

Next and most important is size, and the Shadow dropped right in place where a few five channel crystal equipped models I had in the drawer didn't fit in the Blaster's pod.

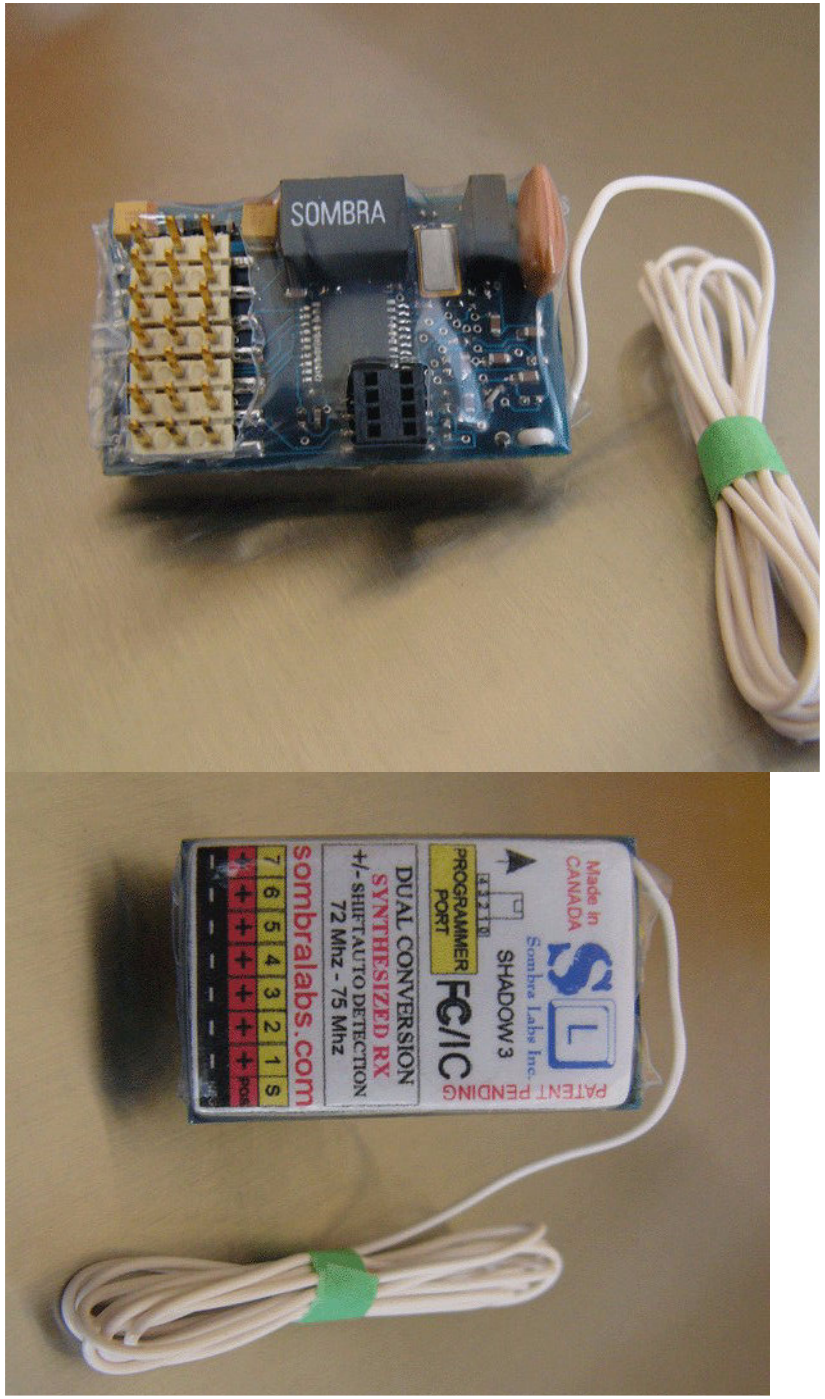
The final answer? It worked! How good is it? Well I had it lab tested by a friend and recognized industry expert and even he was extremely impressed by it specifications and performance. Want his name? It will cost you each $1,000! (I am lucky to have good, talented and smart friends!)

This is far from the end of the review of SombraLabs' Shadow Series amazing new receivers, so stay tuned.

Next stop for me? Madden Plains, Australia in my quest for my last LSF3 contest task!

See you on the road!

Gordy



The SombraLabs Shadow 3 seven channel receiver. The black eight pin female block in the center of the closer edge is used to connect the receiver to the Programmer. The bottom of the receiver notes its Canadian manufacture.

Shadow 3 Innovations

SombraLabs' DSP (Digital Signal Processing) features better noise rejection and glitch immunity while giving the lowest servo jitter and fastest servo output. These two parameters can be very critical in high performance models, excessive jitter can induce unpredictable behavior in a high-performance model, while excess latency can cause delayed control response from a model that can be catastrophic (e.g. in high-speed helicopters/cars, split second decisions need to be taken).

The DSP functionality of Shadow 3 is an extremely efficient adaptive noise and glitch filtering algorithm that dynamically takes into account the signal to noise ratio of the baseband signal. In simple English, we digitize the analog baseband signal and process it digitally with the help of a microprocessor. A simple analogy would be DVD (digital) versus a VHS tape (analog).

The DSP algorithm has multiple levels of filtering that is performed on the signal before it is allowed to be passed on to the servos. Here is what happens on the receiver upon power-up:

1. The transmitter signal recognition algorithm on the receiver analyzes the transmitter characteristics. It identifies among other things the shift of the transmitter, number of channels, frame rate, etc. From here onwards only frames matching these characteristics will be allowed to “graduate” to higher levels of filtering. You can see this in action by performing this simple experiment: Take two different transmitters on the same frequency (e.g one four channel, the other seven channel). Turn one transmitter ON and let Shadow register it, now turn the first transmitter OFF and turn the second transmitter ON, the second transmitter commands will be rejected even though it operates on the same frequency! To register the second transmitter, Shadow will have to be power-cycled. We call this basic sanity or transmitter recognition and Level-1 filtering.

2. Every incoming baseband signal is continuously sampled and digitized. Our custom and proprietary digital signal processing algorithms are applied to baseband and valid signals can be recovered and reconstituted even in extremely noisy environments. We call this Level-2 filtering. Once a frame is processed it is passed to Level-3 filtering. In Level-3, we do another set of tests that qualify the frame further, e.g. the servo output signals in the frame, the proper sync pulse of a PPM frame, the low and high-phases of each pulse, etc. All of these have to pass a rigorous qualification test before the signal is sent out on the servo pins.

All of the above happens at an extremely high processing rate. The benefits of our DSP algorithm to the user are an extremely reliable communication link, with the least amount of possibility of glitches, jitter and/or loss of transmitter control. We also provide the least amount of latency and processing overhead of any of the competing products on the market and this shows clearly in high performance models (e.g. helicopters and high speed RC cars have very low tolerance to latency).

Aroosh, SombraLabs

FAI has ratified the following Class F (Model Aircraft) record:

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Claim number: 9857

Sub-class F5-S (Aeroplane, electric motor (rechargeable sources of current))

F5: Radio Controlled Flight Category

Type of record: N°173: Gain in altitude

Course/location: Ponte Vedra Beach, FL (USA)

Performance: 3 418 m

Aeromodellers: Giorgio AZZALIN (USA) and Simone AZZALIN (USA)

Date: 02.10.2004

Previous record: 2'573 m (09.11.2003 - Raymond COOPER, Australia)

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FAI congratulates the aeromodellers on their splendid achievement.

On the ’Wing...

Bill & Bunny Kuhlman
<bsquared@themacisp.net>

Jim Marske’s Monarch G

We have been enthusiastic supporters of Jim Marske’s designs for two decades. The more we investigate the *Pioneer* and *Monarch* planforms, the more sense they make.

Simply put, Jim’s planform allows use of conventional sailplane control systems — elevator, ailerons, rudder and airbrakes — through straight forward linkages, producing an extemely safe aircraft. Additionally, performance of these sailplanes is very good, even when using basic construction materials and methods.

While the *Pioneer II-D* and the more recent *Pioneer III* are designed with the possibility of soaring competition in mind, the *Monarch* was designed purely to enjoy soaring with minimum expense.

The *Monarch* is light enough to be towed to soaring altitude by automobile using 3/16" polypropylene rope, certainly an inexpensive launching method. In practice, a strain gauge with remote readout is used in line with the tow cable. The driver simply starts moving the vehicle and maintains constant tension on the line (160 lbs.) by adjusting the throttle. (See the photo on page 33.)

Once off the tow cable, the *Monarch* pilot is free to explore the air in a way that enclosed pilots cannot. We talked with Mat Redsell about his experiences flying the Monarch, and he just beamed the entire time.

Being out in the open, the pilot can feel changes in air temperature and humidity, smell the pollen and other scents rising from ground level, and hear the environment without the sounds being blocked by a Plexiglas canopy.

Upon landing, Mat says that he often cleans numerous spider webs from his glasses and face as well as the leading edge of the wing and front of the fuselage and wing struts.

Mat is always enthusiastic about the ability of the *Monarch* to circle in tight lift due to its extraordinarily low wing loading. He’s come to call this sort of lift “micro” lift, sometimes to the consternation of others, but it does seem to us that the full size *Monarch* is perfectly capable of soaring in the same thermals as our own RC sailplanes.

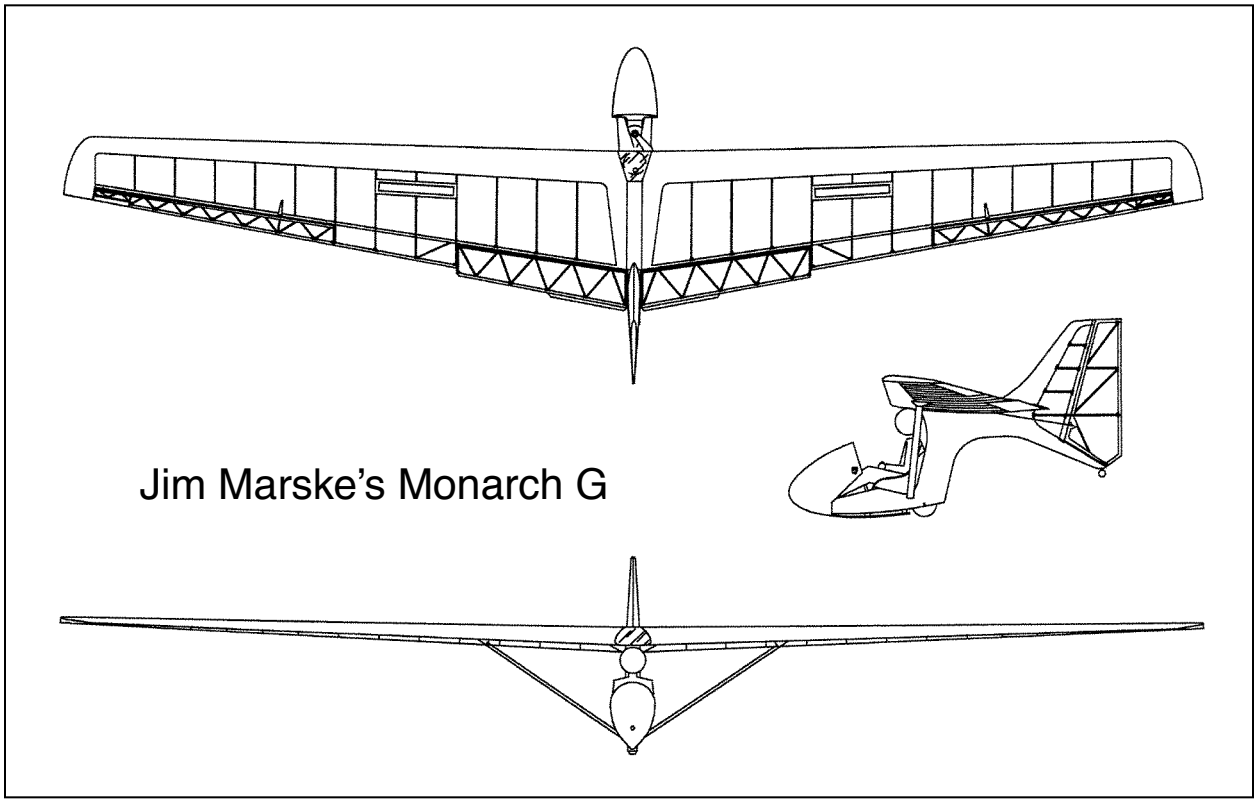
Because the *Monarch* is a relatively small aircraft (wing span just over $42^1/_2$ feet) a 1/4 size model would turn out to have a relatively small 10 foot 7 inch wing span. We would go with 1/3 scale, as the 14+ foot wing span will still break down into two panels of around seven feet each.

Model construction can be easily accomplished with an all wood wing and ’glass fuselage. The open wing structure lends itself well to this sort of construction, and the angled ribs within the control surfaces add significant torsional rigidity. Given today’s technology and miniaturization,

all of the servos can be enclosed within the wing and fiberglass fuselage structures.

One of the more interesting aspects of modeling the *Monarch* is the need to build a full body pilot. This is probably best accomplished with lightweight styrofoam and clothing of real fabric. Some ingenious person could more than likely develop a system whereby the pilot's extremities moved in unison with control surface deflections.

A large scale model of the *Monarch G*, complete with pilot and realistic fabric covering, would certainly be impressive. Anyone excited enough to build one?



	Monarch G	*Monarch G* (carbon)
Span	42.6 feet	42.6 feet
Area	163 sq. ft.	163 sq. ft.
Aspect ratio	11.1	11.1
Empty weight	180-200 lbs.	132 lbs.
Pilot weight	120-220 lbs.	120-220 lbs.
Flying weight	300-420 lbs	252-352 lbs.
Wing loading	1.8 - 2.6 lbs./sq. ft.	1.5 - 2.2 lbs./sq. ft.
Glide ratio	22 @ 36 m.p.h.	n/a
Minimum sink rate	138 ft./min. @ 30 m.p.h.	n/a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