On the ’Wing...

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Modifying the Richter R/C Alula *for separate elevator and ailerons*

Part 1

We’ve been working on our second *Alula*, alongside a few other projects, and wanted to keep *RCSD* readers apprised of our progress.

Our primary goal in building this *Alula* is to separate the elevon into outboard ailerons, each driven by Hitec HS-50 servos, and two central elevator halves to be driven by a single HS-55 through a divided pushrod.

Contrary to the construction of our first Alula, we decided early on to not spend a bunch of time “painting” the airframe. Rather, we’re simply going to add black to the bottom wing surface by means of a large felt tip pen.

The time saved by using this simple color scheme will probably be used to complete various modifications and to get the three servo control system installed and set up.

Because the *Alula* construction manual is readily available on the internet, we’re going to focus on “tips and techniques” which aid the construction process, and the specific modifications required to make this three servo version.

Initial construction

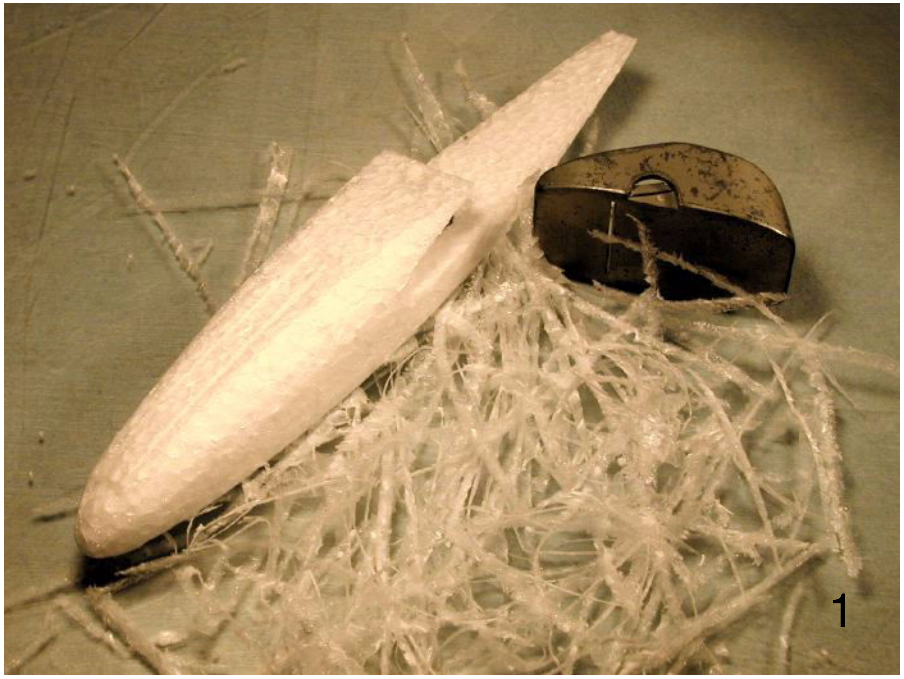
Fuselage shaping Figure 1 shows the rough shaped fuselage. Since the fuselage arrives as a simple contoured block, there is quite a bit of foam to be removed in order to obtain the desired ovoid shape. Rather than using large grit sandpaper, we opted to use a razor plane with a brand new double edged blade installed. As can be seen in the photo, this method removed a lot of material, and did so without tearing the foam. A small amount of finish work with 120 grit sandpaper completed the job in short order.

Servo placement The original *Alula* places the two elevon servos side by side in a cavity in the fuselage. The wiring is then threaded straight through a precut hole into the receiver/battery compartment. As we’ll eventually have a single servo in the fuselage to drive the elevators and two aileron servos in the wing panels, there will be three sets of leads (plus the antenna) which must be brought toward the conduit leading to the front compartment. The aileron servo wiring and antenna are in place in Figure 2, ready for the wings to be covered.

Wing covering In preparation for the packing tape covering to be applied, starting with the bottom surface, we set up the wing beds to firmly hold the wing halves in place, avoiding the potential for warping. Figure 3 illustrates the fixture with both wing cores in place.

The core surface to be covered needs to be facing upward of course, and the second wing core is used to support the underside of the fixture while covering the wing bottoms.

Control surface modifications Lastly, the elevons which come in the *Alula* kit have a precut outline which takes away from the area at the wing root. As this is going to be where the separate elevator halves are located, we needed to replace that area to maintain elevator effectiveness. We took some contest grade 3/32 inch balsa and, using the elevons as a template, carefully cut the glue line contour while leaving a bit of extraneous material to be trimmed off later. The completed elevons, with restored center area, are shown in Figure 4. The glue line has been enhanced to more clearly define the added material.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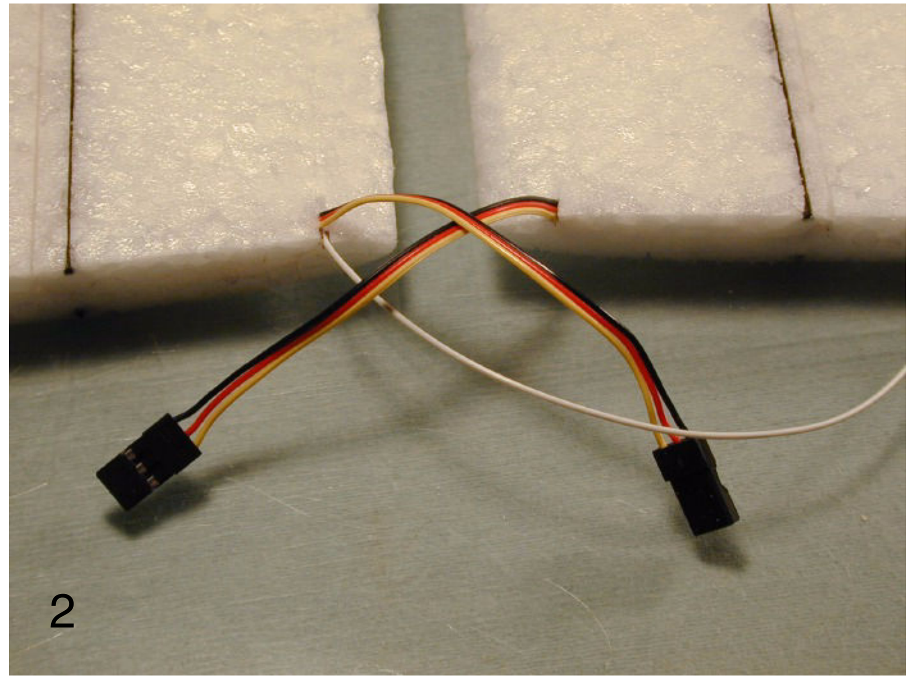
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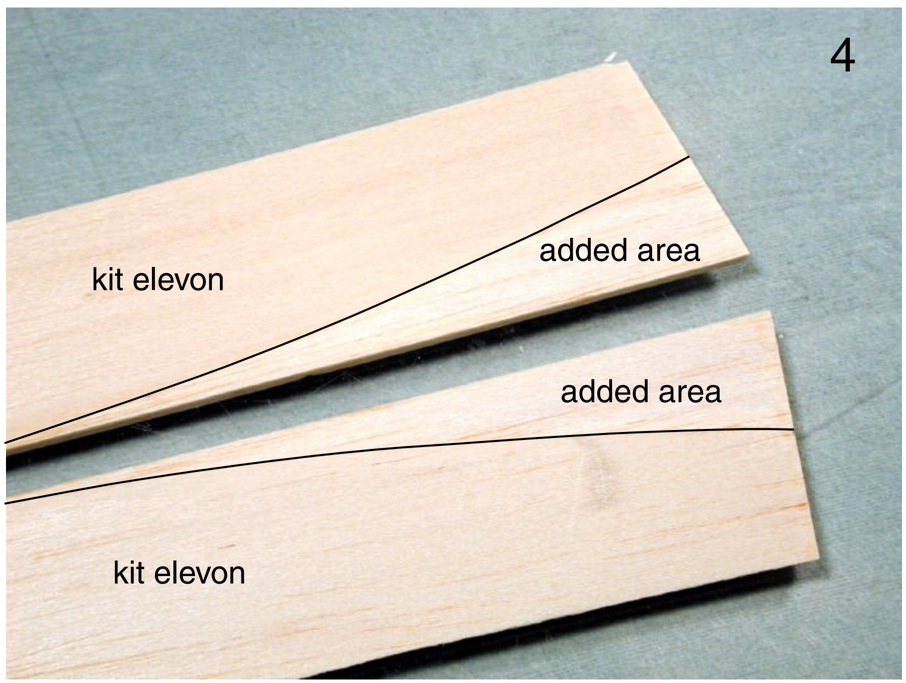
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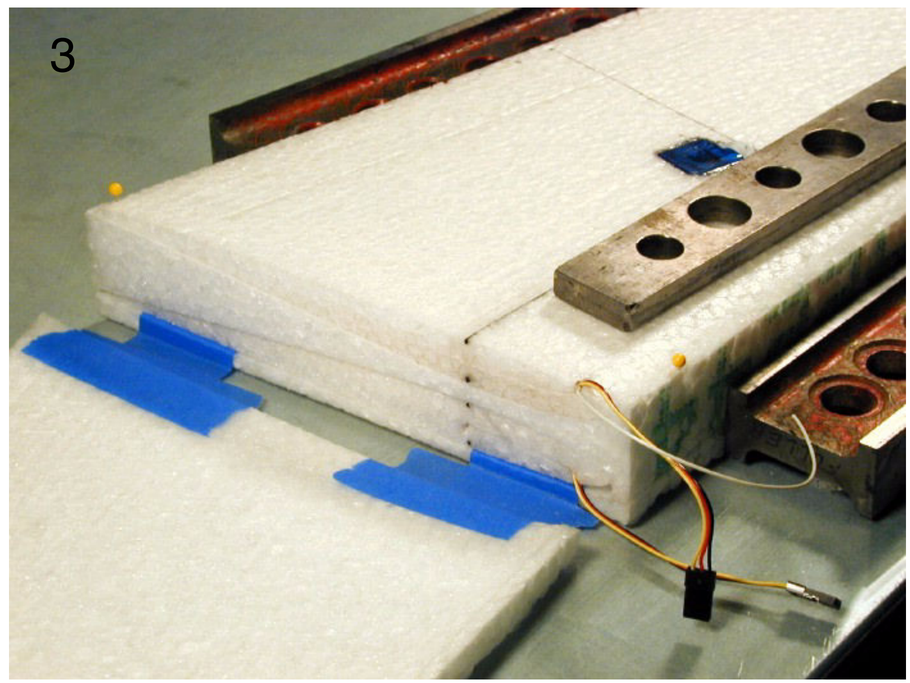
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Part 2

Quite a bit of work has been accomplished on our second Richter RC *Alula* since our last column. We've even done some initial test flying, but that particular aspect of this project will be covered in detail in a future column.

This time we're going to concentrate on some of the solutions we worked out for the unique aspects of the basic construction and the control system linkages.

Continuing construction

Fuselage One of the problems we had with our first *Alula* appeared during the first really hard launch - the fuselage fractured at the leading edge of the wing, carrying the battery pack and receiver in a long distance arc across the flying field.

Our solution to this problem started as temporary, but has been working well. We simply placed a piece of electrical tape along the left side of the fuselage. This is the inside of the throw during launch, and the small amount of additional strength has now held for a few hundred launches.

This *Alula* has two carbon fiber tows glued to the fuselage sides. We stretched the tow along the foam, held the ends down with masking tape, and used thin CA to bond the fiber to the EPP. (Photo 1)

Additionally, rather than attach the fuselage to the wing with hot melt glue around the fuselage perimeter, we stripped away some of the tape covering and then applied a very light coating of Goop to both the bare foam of the wing and the fuselage wing saddle areas. The fuselage was then slid onto the wing and the assembly was placed on a narrow elevated platform with a heavy metal weight placed over the glue joints. Left overnight, this created an exceptionally strong bond without adding excessive weight.

Control system hardware As mentioned in previous columns, this *Alula* incorporates separate ailerons, each driven by its own Hitec HS-50 servo, and coupled elevator halves connected to a single Hitec HS-55 servo.

The aileron servos (Photo 2) were mounted in wells cut into the wings as close to the carbon rod spars as possible. To eliminate any binding or resistance, the pushrods are aligned parallel to the control surface hinge line. This has additional advantages - it moves the servo inboard somewhat, slightly reducing roll inertia, it provides just enough servo wire to allow connection with the receiver without having to splice in additional wiring, and it moves the servo to a slightly thicker part of the wing.

It should be noted that the *Alula* wing is very thin, but we checked the thickness in the area of the aileron servo and found the wing was just thick enough to house the servo without having any bulges.

An X-Acto blade was used to cut a vertical slot in the wing leading from the servo location to the root of the wing. The wiring for the aileron servo was then pushed into the slot to a point below the surface so the foam closed over at the surface.

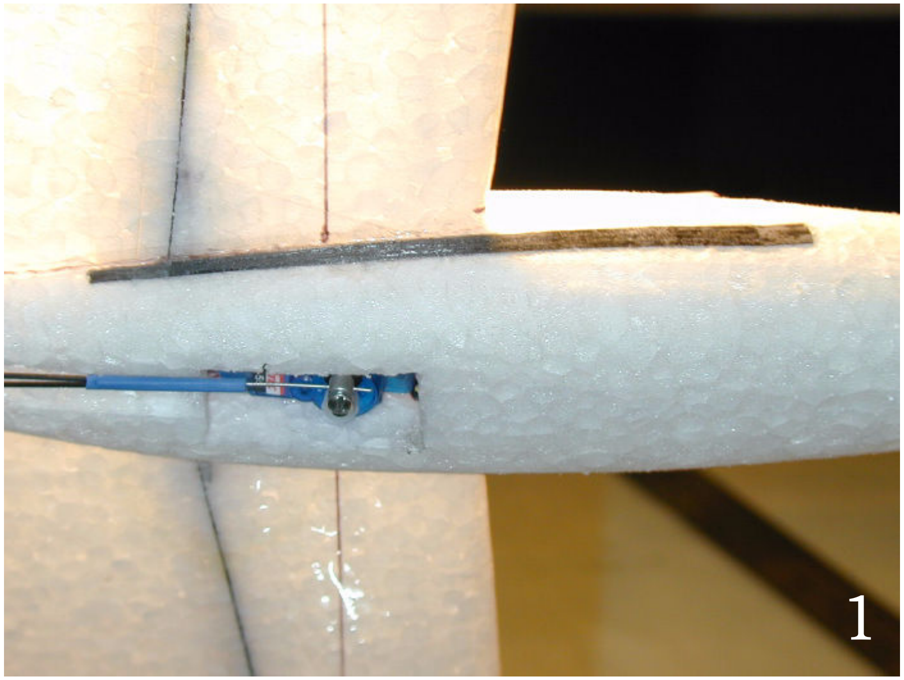
A the wing root, the wiring was inserted into the foam sufficient for the elevator servo to clear.

The carbon fiber push rods which Michael supplies with the kits is strong enough for the servo and aerodynamic loads, but it does not withstand the crushing force of the connector set screw very well. The rods tend to fracture as the fixture is tightened.

We cut the carbon rods an inch short of their full length and attach small diameter music wire to the carbon rod using a piece of small diameter shrink tubing and thin CA.

The elevator servo (Photo 3) is located in the central cavity which is precut into the fuselage. The servo is mounted front to back and is set off to side of the cavity so the servo arm hole is close to the fuselage centerline. There is some elevator differential with this type of set-up, but as the elevator servo will be adjusted for a very small throw, the resulting differential is not at all noticeable in practice.

As with the aileron system, the carbon fiber pushrod is modified to have a music wire end. Because there are two carbon rods coming together,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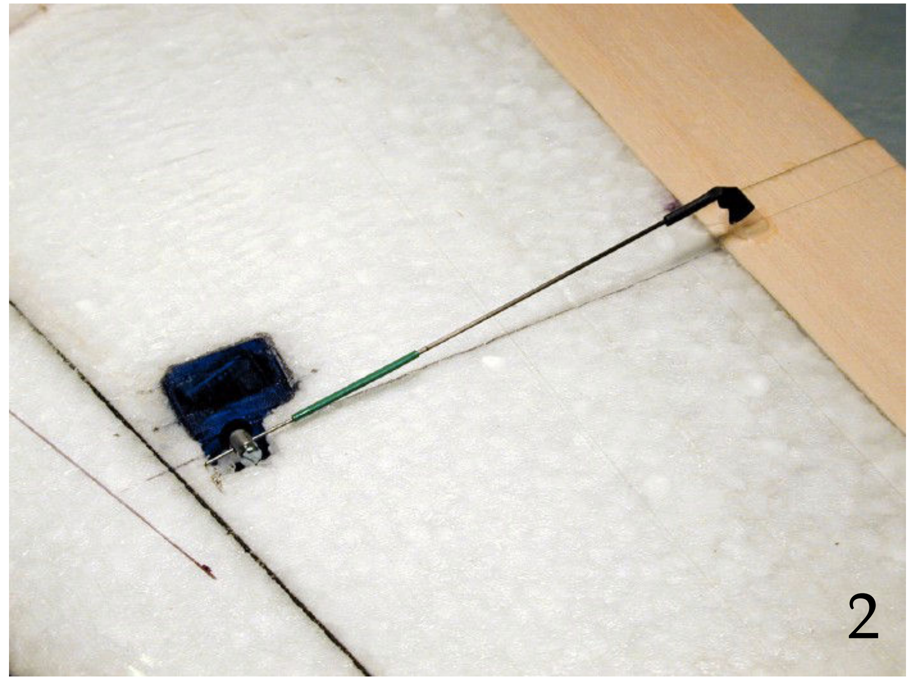
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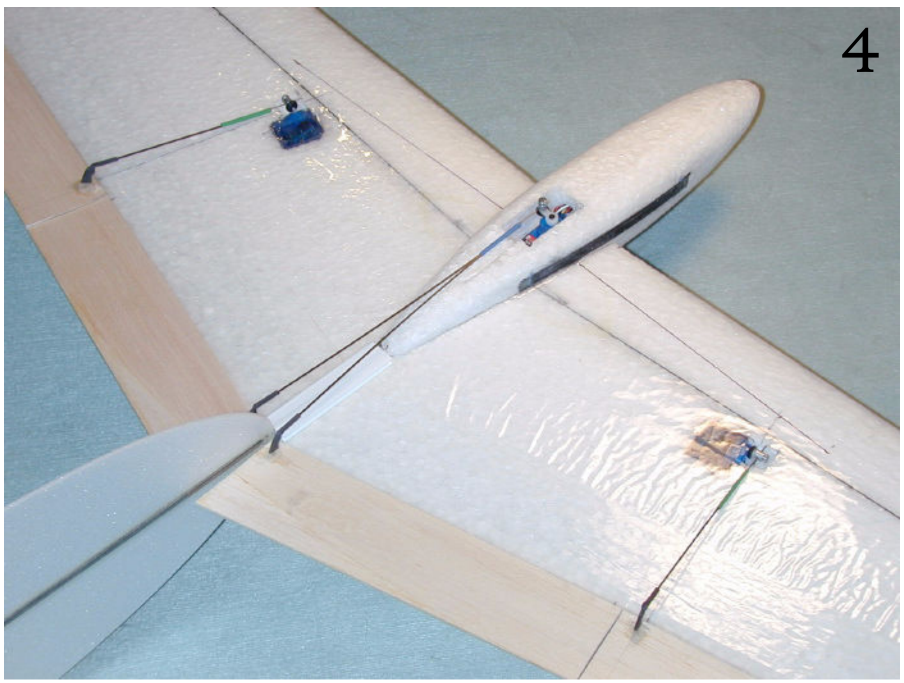
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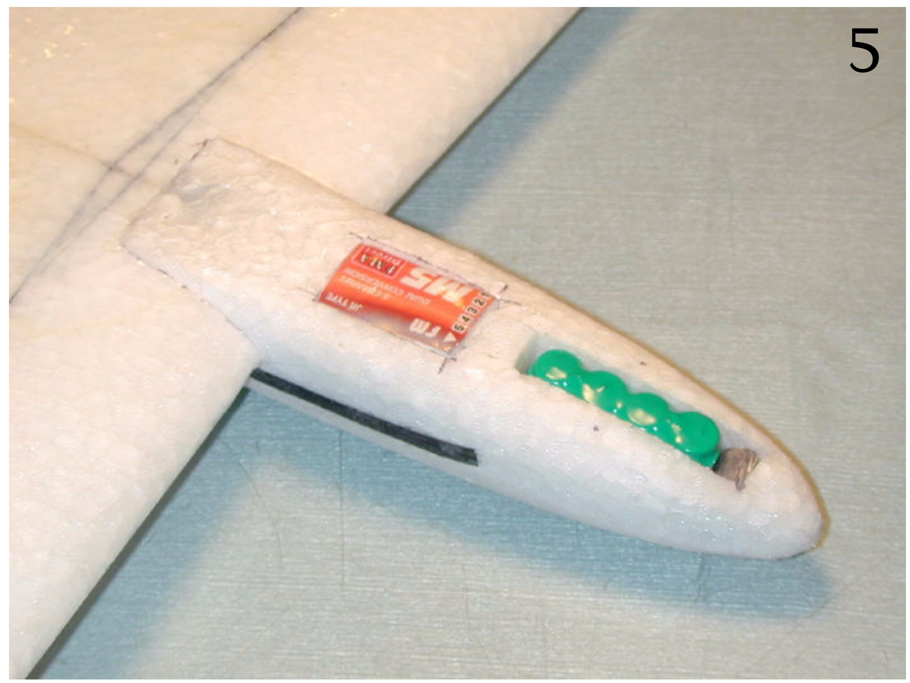
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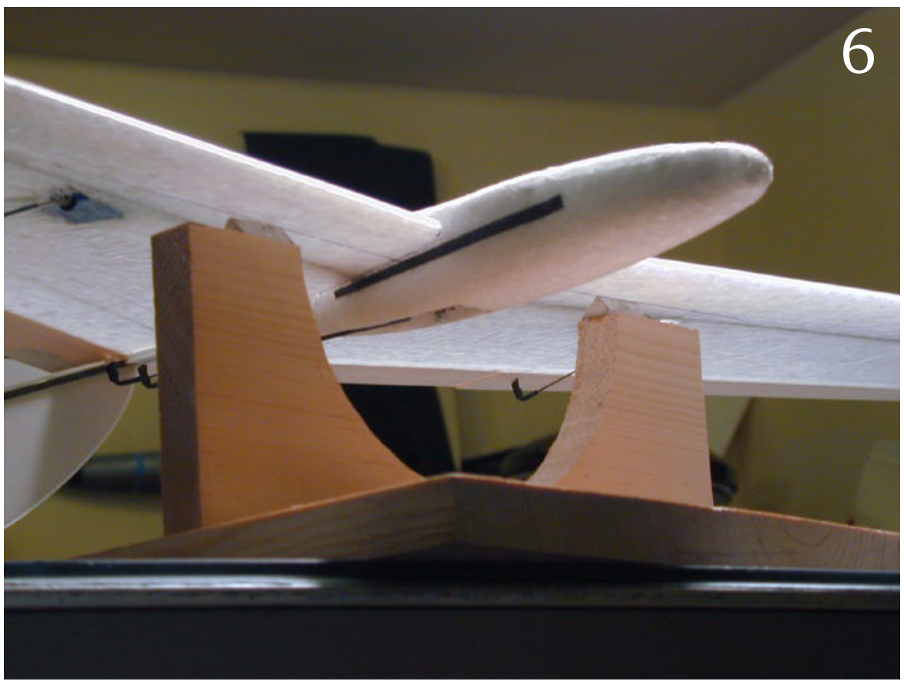
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the shrink tubing must be of a slightly larger diameter than that used for the aileron linkage. (Photo 4)

Completed airframe Our faithful FMA Direct receiver was placed in the reconfigured slot, and one of Michael's 210 mAh NiMH battery packs was installed up front. (Photo 5)

On the balance stand (Photo 6) the completed airframe with all components installed required only 14 grams of lead to have the CG placed at the point recommended in the instructions. As our previous *Alula* required 8 grams of weight for the same balance point, this came as a pleasant surprise.

The overall weight, ready to fly, is 4.8 ounces (136 grams). This compares quite favorably with the original *Alula* which flies extremely well at 4.4 ounces.(124 grams).

Because we decided to not color the wing bottom surface after all, the included photographs have more recognizable detail than would otherwise have been in evidence. We're still working on getting some sort of fuselage covering put on.

Part 3

Construction and preliminary test flying of our second Alula is now complete.

Before we talk about the test flying and compare this new 'ship, *Alula2*, with the earlier version, we'll go over the last of the fine points of the construction process.

Construction details

Spray adhesive Rather than 3M-77, we used Clearco 877 Adhesive Spray, an aerosol adhesive which does not use acetone in its formulation. We'd heard that Clearco 877 has a longer working time than 3M-77, but we didn't notice any difference in that regard.

Additionally, we found Clearco 877 to be noticeably less tacky than 3M-77, and the tape covering does not seem to stick nearly so well.

Also, the Clearco 877 does not seem to respond to low heat like 3M-77 does. That is, the adhesion is not reactivated to the same extent.

Hinge tape We initially used a medical tape to hinge the control surfaces, rather than the specially selected Scotch tape (Extra Strength Crystal Clear, 34-8505-5627-4) we've used before. This medical tape is much more stretchable and seems "soft" across the hinge line. While it sticks extremely well, it does not seem to hold the control surface in place as firmly. After initial test flying, the medical tape was replaced with the Scotch brand we've used previously.

Elevator system Because the elevator halves are driven by a single servo through a split pushrod, there was need for only one pushrod channel in the fuselage bottom. We made this a little wider than needed so it's right on the fuselage centerline.

As expected, the elevator differential is extremely small, not easily discernible to the eye and certainly not noticeable in flight.

Miscellaneous The control surfaces span the entire 17.25 inches of the trailing edge. Our *Alula2* has the inner 6.5 inches devoted to elevator, the remainder to aileron. The elevator span is therefore 13 inches, and each aileron spans 10.75 inches. There was no math involved in this proportioning, just what looked good when we made the decision.

All three servos were wedged into close-cut sockets and then securely held in place with small dots of Goop. We did not remove any mounting tabs, instead inserting them into appropriately placed slots in the foam.

Rather than using tape covering on the sheet balsa control surfaces, we opted to simply put on a coat of dope. This does not add much strength to the balsa, but it does make it resistant to moisture. We're toying with the idea of cutting slots at 90 degrees to the grain and inserting small pieces of hardwood to improve durability.

This EPP construction project is our first to incorporate Goop "paint" as the fuselage finish instead of an iron-on covering material. This method of finishing EPP foam was presented in the February 2003 issue of *RC Soaring Digest* in Gordy Stahl's "Gordy's Travels" column.

Our methodology is a bit different than that presented by Gordy. We used toluene to thin the Goop, starting with a very watery consistency and making each subsequent coat slightly thicker.

In all we applied eight coats at the front end and five coats at the rear. The thin initial coats filled the pores of the foam, while the coats of thicker consistency built up a rigid shell.

Once all of the painted layers dried, we put the airframe back on the balance stand. Three grams of lead were removed from the nose to keep the CG in the proper location. The overall aircraft weight remained at 4.8 ounces.

Test flying

CG location Our balance stand was put to use in order to get the CG correctly located. Michael Richter's instructions recommend the CG be at 25 mm behind the leading edge at the wing-fuselage junction. Initial tosses were

Catching the *Alula2* after a flight and getting ready for another toss into the skies above 60 Acres. The smile says it all. Photos by Brian Kloft.

performed with this CG location.

The trick to trimming the *Alula* is in balancing the CG location with the absolute minimum of reflex in the control surfaces. Ideally, the aircraft should travel in a nearly straight trajectory after launch and until momentary down elevator is given at the top of the climb to level out.

If the CG is even slightly forward, excess reflex is required to offset the nose heavy condition. On launch, the aerodynamic force generated by the reflex causes the aircraft to pitch upward.

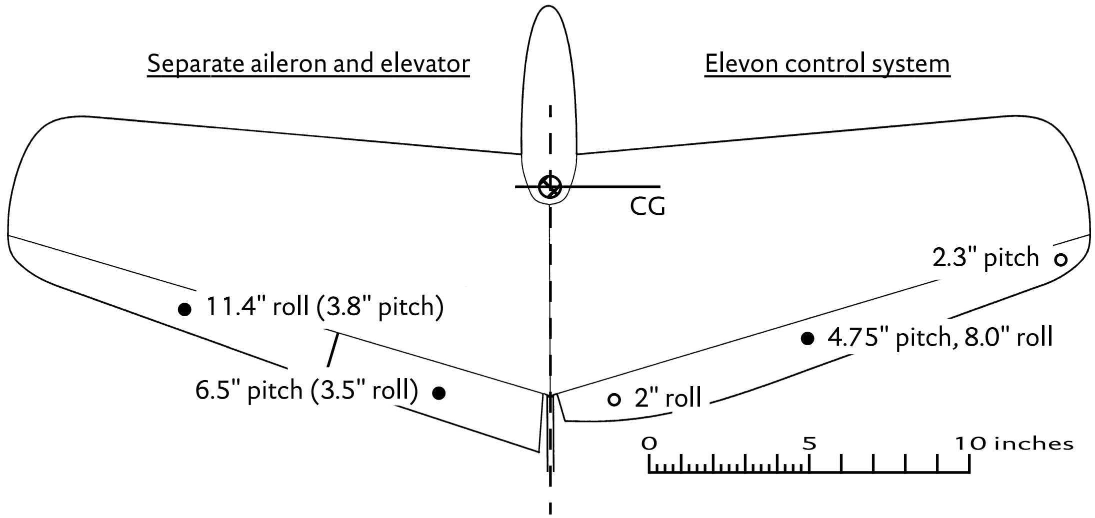
If the CG is slightly too far to the rear, the aircraft will pitch downward on launch and be extremely pitch sensitive.

The line between reasonable sensitivity and downright uncontrollability is very fine one on an airplane this small.

Transmitter programming

Our PCM 10 transmitter was set up so that channel 2 (aileron) controls the right aileron and channel 4 (rudder) controls the left aileron. Mix 1 puts channel 2 into channel 4, and Mix 2 puts channel 4 into channel 2. Channel 3 (elevator) controls the elevator alone, as would be expected.

This setup allows the right stick to control both aileron and elevator functions, while the left stick can be used to control the ailerons alone if desired. (See the part about post-launch vertical rolls later on in this article.)



Control surface leverage in pitch and roll

Since the *Alula* control surface hinge line sweeps forward, it is aerodynamically advantageous to separate the elevator and aileron functions.

Separating the control surfaces creates a larger lever arm for the elevator in pitch and for the ailerons in roll.

The elevon configuration creates excess drag with roll input as the inner portion of the surface has little leverage. The outer portion of the elevon is relatively ineffective in pitch because it lies so close to the CG.

As points of comparison, note in the table below the deflections of the control surfaces versus their relative areas.

Alula Versions Comparison

	Richter R/C Kit	*Alula*	*Alula2*	Jason Brinley's *Alula*
Control surfaces	Elevons	Elevons	Elevator & ailerons	Elevons
Aileron span (hinge)	44 cm, 17.25"	44 cm, 17.25"	27.25 cm, 10.75",	44 cm, 17.25"
Elevator span (hinge)	44 cm, 17.25"	44 cm, 17.25"	16.5 cm, 6.5"	44 cm, 17.25"
Servos	2 x Cirrus 5.4	2 x HS-50	2 x HS-50, 1 x HS-55	2 x Cirrus 6.2
Weight	119-130 g, 4.2-4.6 oz	127 g, 4.5 oz	136 g, 4.8 oz	122g, 4.3 oz
Wing loading	2.6-2.8 oz/ft^2	2.8 oz/ft^2	2.9 oz/ft^2	2.6 oz/ft^2
Elevator deflection	4-5 mm, $^1/_8$-$^3/_{16}$"*	5 mm, $^3/_{16}$"*	5 mm, $^3/_{16}$"* up, 4 mm, $^1/_8$"* down	7 mm, $^1/_2$"* with expo
Aileron deflection	10-12 mm, $^3/_8$-$^1/_2$"*	12 mm, $^1/_2$"*	10 mm, $^3/_8$"*	12 mm, $^1/_2$"* with expo

* These English System measurements are approximate; the associated metric values are more accurate.

Rather than make the Mix trims active, we left those settings on INH (inhibit). With this setting we can adjust the neutral of either aileron independently from the other.

Alula2 is currently flying with the ailerons exactly lined up with the elevator. Launches have just a hint of a climb, and it can cover a surprising distance with good cruise speed and a low sink rate.

Control throws Our original *Alula* uses the recommended elevon control throws — elevator 4-5 mm total, aileron 10-12 mm total. *Alula2* can use elevator throws 5-7 mm up and 4-5 mm down; aileron throws can be set for 5 mm to 10 mm with no differential. We usually fly with the lower elevator setting and a middle aileron setting which gives 7 mm travel up and down.

This means we're using the same elevator deflection and slightly less aileron deflection than recommended for the elevon version.

Launching Progressing from light hand toss to full power SAL took only a few trim clicks on the transmitter and no change in CG location.

Comparisons So, how does this modified *Alula* fly? In a word, "Fantastic!"

We now have over 400 flights on the airframe, and it's been piloted by an ever growing number of fellow SASS members as well as ourselves.

The roll rate is fairly rapid, but is still fine enough that four point rolls are possible.

In an impromptu "contest," pilots found two vertical rolls after launch to be pretty easy, three somewhat difficult but not impossible. With a true discus throw (the kind where all of the blood in your arm goes to your hand) we're fairly sure you could get four.

Our first *Alula* has the tendency to run out of elevator authority as the angle of attack increases. When this happens, the nose drops slightly and any turn quickly straightens out. The aircraft then drops down at about a 30 degree angle with the fuselage about level with the ground.

It is also possible to apply a little less up elevator and witness a rapid bobbing in pitch due to stall hysteresis.

The *Alula2* behaves in similar fashion, but everything happens in a much more predictable manner. Major differences? *Alula2* flies more smoothly and has better "legs" when covering distance.

Jason Brinley, a fellow SASS member, had just completed his *Alula* when we met with him at 60 Acres. Jason uses two servos which drive full span elevons, as per standard practice. He was having a grand time with his 4.3 ounce *Alula*, flip-flopping it around like a 3-D electric, doing pylon racing turns around willing collaborators, and pretty much having more fun than anyone is entitled to have with a $50 foamie.

We let him fly our *Alula2* and he was pleasantly surprised. While it won't do all of the fancy (and sometimes erratic) maneuvers his is capable of performing, Jason says it's a smooth flying airplane in comparison to his and will be a great thermal machine.

When flown together, Jason's is very slightly slower and has a barely noticeable better sink rate. Both of these characteristics are to be expected because of the slight weight difference and resulting wing loadings.

Dave Beardsley, who has flown all manner of sailplanes, electrics, helicopters and aerobatic aircraft, definitely prefers the *Alula2*, with its separate control surfaces, to the elevon version. He says it is far better in the areas of predictability and efficiency.

Long term wear and tear issues Our original *Alula* now has several hundred flights on it, and the tail began slipping out by a very small fraction of an inch on each launch. The tail boom flexes quite a bit on launch, so this is probably a matter of the boom "walking" out of the Coroplast socket.

This potential problem was virtually cured by rubbing bees wax on the carbon rods. This provides just the right amount of stickiness to prevent the slipping, but it doesn't at all affect removal of the tail for transport.

The Goop paint treatment has done an excellent job of protecting the fuselage. Gordy's article points out that one of the initial layers can be painted or covered, and then clear Goop applied over the colored layer. We'd like to hear from anyone who has a method for actually coloring the thinned Goop, particularly if the coloring can be transparent.

Still experimenting One trick we've been fooling is the use of the Snap Roll button on the transmitter during the initial climb phase after release. When the Snap Roll button is depressed, the ailerons are set for zero deflection and the elevator is set to 8% down. This gives an absolutely straight trajectory until the button is released.

Conclusions As you can probably tell, we LOVE this airplane! While the elevon version flies extremely well, we feel the three servo option, with separate aileron and elevators functions, is both a viable and exciting alternative, especially if you're a flat land flyer who wants to explore small newly formed thermals rather than perform megaradical maneuvers on the slope. The three servo version, by all accounts from those who've flown it, is noticeably more efficient while maintaining essentially the same maneuverability.

An *Alula* kit is $45 plus $5.50 packaging and shipping from Michael Richter at Richter R/C, <http://www.dream-flight.com>. If you plan to build a three servo version, make sure you order a second hardware set, too.

The kit itself is quite complete, with all necessary hardware included. Missing are tape, adhesives, and color. All you have to do is construct the airframe and add your own servos, receiver, and battery pack.

We do suggest you purchase a roll of covering tape along with the kit, however, as finding a roll of suitable lightweight tape on your own can be quite time consuming.

If you want to see the standard *Alula* in severe action, and in some interesting slope soaring environments, go to <http://www.lavawing.com> and download the "Pop Fly" QuickTime movie. This is a large file (17.6 MB), but it's well worth the download time required if you're on dial-up like we are.

Brian Kloft recently visited the Seattle area on a business trip and spent several Wednesday evenings at 60 Acres. Brian was able to use his digital still camera in movie mode and capture some video of our *Alula2* flying under the dark skies present at the time.

We've placed two of these videos (MOV and MPG) on the *RCSD* web site. The URLs are:

<http://www.rcsoaringdigest.com/videos/Alula2.mov>
and
<http://www.rcsoaringdigest.com/videos/Alula2.mpg>.

Is it possible to have too much fun with an *Alula*? We certainly don't think so.