David -

I looked in vain for you at S.n F. You would have wept to see me wandering forlornly thru the crowds mewling your name.

Personally, I much prefer the visual aspects of the Q-2 to the Tri-Q, but it sure as hell turns a tiger into a pussycat. Anybody can drive the three-wheeler, but the original got in the weeds with my partner twice, once wrecking

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Now sue me!

Larry Weishaar

(217) 544-6086 EVENINGS

a $1200 VASI light. Never got any from me, though (harrumph!)

I'd appreciate it if you would send me a little dab of money for this - I've been asking for $3.50.

NOTE: THIS RIG (by test) is 60% stiffer than the old GU. It could be made somewhat lighter and cheaper for a TRI-Q.

lw

OOO
XXX
Larry.

This was made up for Jim Masal after he bought his wrecked Q-2 for reconstruction. Hope no one is insulted by the bathroom language.

What follows is an attempt to answer your "how'd you do it?" inquiry re our home-grown "new" Q-2 canard.

About three weeks after we finished the "standard" GU airfoil canard for 'ol #2391, QAC came out with the new LS 4017(1) MOD canard. Sheeeit! They gratiously offered to furnish one and all the "plans" for the new surface, plus some tapered-cylinder carbon fiber spar material (which the builder still had to join at the center) for something over $700, if memory serves. One still had to buy all other materials (foam, glass, hardware, etc.) which meant maybe an extra $1000 you were obligated to put out <u>if</u> you wanted an airplane you could fly in a drizzle.

It rains occasionally in Illinois, so we thought we probably ought to have the new shape but were loathe to cough up all that extra coin. QAC mentioned a NASA report in which the dimensions and performance figures for the new airfoil were set forth. We made a search and were gratified to find the report was available on microfische from our State library. Since one of us is is a pretty highly qualified technician with an innate understanding of things physical and the other knows the multiplication table all the way up to elevensies, we decided to have a go at designing our own canard. Our hotshot mathematician also has an engineering degree in a nonaero field and recognized the canard as essentially a classic cantilever beam with a need for some resistance to twist snd to (drag) loads perpendicular to the primary axis. He also recognized the circular cross section of the tube-type spar as basically inappropriate to the application at hand since its bending strength is the same in all directions (dandy flagpole!) while by far the meanest stress on the canard is the flying and landing loads acting in the vertical plane only.

So, we blew about $10 on 5" carbon fiber ribbon and did some playing around with it. Using our normal clumsy hand layup procedures, we made a test piece ten laminates thick and cut it up for testing to determine, in a gross way, the tensile strength and elasticity of the material. This was a fairly heartening experience, since it indicated that even with our undoubtedly resin-heavy methods, we had a material with an apparent ultimate tensile 'way over 125,000 psi and a stiffness only slightly less than structural steel. We scaled these values back to provide a large margin of safety and proceded. We also had access to Draggin' Fly plans which provided another nebulous benchmark since their spar is also built up using 5" carbon fiber.

<u>Innyway</u>, we came up with a carbon fiber spar using a maximum of 11 plies on the bottom (tensile)flange and 14 plies on the top (compression) flange. This is much beefier than the Dragonfly, but one must remember that their "beam" is a good deal deeper, because they use a thicker airfoil, and this adds a helluva lot to its bending resistance. 'Course, their span is greater also, which makes the stresses commensurately larger. Convenience in building also dictated a "box-type" spar with two shear webs, as opposed to the single web in the QAC GU canard. The torsional resistance is provided by crossed UNI plies at 45 degrees to the direction of flight, exactly similar to the original canard. Also, two plies of spanwise UNI (in addition to the carbon fiber but not used in strength calculations) are used to harden up the skin. We've heard of people

dimpling the top surface of the new QAC canard by kneeling on it!

Well, how do you go about it? All you've got is that spotted, messy sheet showing airfoils at the three butt-line stations covered by the original GU plans. You've just got to have access to those plans, particularly for use in cutting and assembling your foam cores. These station airfoils are drawn with the trailing edge justified on the right, and with the middle airfoil the correct (vertical) spacing from the other two to be proportional to the 85-inch distance between them. You can generate a cross section for any station by connecting the tick points (or other corners, centers, etc.) of the BL-15 and BL-100 sections and finding points on those connecting lines that are the appropriate proportional distance between the root and tip. We used this method to make a drawing of the center elevator hinge bracket, and, in fitting our pants, we generated a section 7.3" in from the tip so we could wire-cut a contour that the lower canard surface would exactly match. Worked good! Incidentally, when we mounted the pants and drilled the axle holes, we aimed the axle bore at a point 2.5" forward of and 5.5" below the hole in the opposite pant. This gives a little more than a half-degree of toe-out and enough camber to make the wheeels bear vertically on the runway with a normal gross weight..

with canard upside down

The foam blocks are sized an cut just like those on the original plans - note the newsletter change that reduced the anhedral angle at BL-15. Cut out your templates as one piece from the leading edge back to and including the elevator slot core. Note there is a kind of double line defining the airfoils in the spar area; you want to trim to the inside lines. This makes at least some allowance for the two additional spanwise glass skins on this part. Don't cut out the troughs, or channels, for the spar caps at this point. You'll note they have separate tick points (A, B, C, etc.) and will be cut out later. When you've finished cutting out the five main pieces, cut off the leading edge and slot core portions of your templates. Also, now cut out the portions of the templates above the spar cap channel "floors." The width of these channels on the drawing are a little tight; extend them to about 5-3/8 inches. Reinstall the chopped-off templates on your main cores, lop off the leading edge/slot core portions, and recut the main portion for the spar cap depressions. In our (half) vast experience, we think it advisable also to 5-minute some straight edges to these cores before making the cap cuts because they may arch and bow a little when freed from the gross block of foam.

The elevator cores are made essentially the same as called for by QAC. Don't be put off by the fact that these are 10% thicker than the rest of the airfoil and won't line up exactly (vertically) with the it. This is deliberate and will not only minimize your hinge gap interference problems but will probably give you a 240-mph airplane because of reduced drag at that gap. You will also note some hatched areas on the top side at the trailing edges on the drawing. These are intended as guides for mounting the cores on a plane surface prior to glassing the under side. We cut straightedges from good quality 3/4" lumber to these approximate cross sections, laid the assembled elevator cores on the table with the leading edge tacked down with 5-minute and the tapered straightedges supporting the trailing edge (also 5-minuted to the core). This builds in the required washout and gives you a non-wavy trailing edge - something everybody looks for in judging composite airplanes. This is really all I'm going to say about the elevator construction - go to your QAC plans and try to figure out where they should be cut off spanwise and where that length fits on the canard.

Yup! we did

We cut ours too long in the root area and will have a bitch of a time making the root fairing - haven't crossed that bridge yet, but will probably end up trimming them back spanwise a little bit. One other thing; we made the skin-to-skin joint at the trailing edge on the top side of the surface (which requires that the bottom skin be applied first), but I think QAC makes theirs on the bottom. Trust you're smart enough to work this out for yourself. However, don't try for a sharp trailing edge - the airfoil isn't designed that way. Also, we've made up our own "sparrow strainer" trailing edge tabs to control the airfoil's innately large hinge moment (and inhibit flutter), but they don't agree completely with QAC's version. Ours are ground-adjustable and slightly smaller in area. Maybe when you get to that point we'll have some test data (or you will and can help us!).

They were too small *

Now then! I assume you have marked the level lines on all your cores and are ready to set up the main surface on the table and glass the under side. Use exactly the same measurements for anhedral and sweepback as QAC. You will, of course, have to make "negative contour" jigging supports of the proper heights. Again, we found the unsupported cores difficult to align properly and ended up with two 80-inch wood straightedges 5-minuted to the lower (top of airfoil) side of each 85-inch outer semispan assembly. We used 2-ply BID "ribs" at BL-15 and BL-48.8. These ribs are installed, cured and trimmed before the cores are joined endwise - don't forget the flox corners. Inspect the assembled cores and do any minor sanding necessary to make everything match up nicely.

You'll need at least three, and preferably four, guys to make these major layups. Start by magic-marking BL-0 and the ends of each carbon fiber laminate's on the foam. Also, about every two feet, magic-mark lines across the surface at 45 degrees to the direction of flight - two sets of markings at 90 degrees to each other. These will help a lot when you lay on the torsion skins.

Everybody go pee. Make up some micro slurry and squeegee a thin coat on the spar cap channels. Get out your precious carbon fiber ribbon (it takes about 270 feet total with no allowance for waste - buy more!). There will be eleven laminates on this under side and fourteen on the top. Each (except the final full length one) is cut "on the bias" with a slope of 8:5 on this side and 6:5 on the top cap. Following is a table of their limits. The first number is the BL station of the full-width laminate and the second is the station of its tapered end, i.e., BL-20/28 is a piece 40 inches long full width and tapered to 56 inches at the extreme ends.

* you need little airfoils about 11" long by 2 3/4" Mounted flat side up at a 27° angle with the top of the elevator, Mount them near the wing root and 2 1/2" behind the trailing edge. Go find a Q-200 to look at.

Bottom Cap	Top Cap
BL-20/28	BL-16/22
28/36	22/28
36/44	28/34
44/52	34/40
52/60	40/46
60/68	46/52
68/76	52/58
76/84	58/64
84/92	64/70
92/100	70/76
100 full width	76/82
	82/88
	88/94
	94/100
	100 full width

Lay out the lengths on your jig table and start cuttin', long ones first. Leave the plastic slip material in place until you pick the pieces up for laminating. Roll out the ribbon stock from alternate ends to take advantage of the bias cut on the previous piece. It makes no difference whether the points of the tapes are toward the front or rear of the wing, but lay them all the same way.

Our layup is at odds with QAC - They begin with the torsion skins and proceed to the spanwise laminates, longest ones first. We start with the shortest spanwise layups (each completely covers the previous one) and put the torsion skins on the outside. We also did our orignal canard this way, but be advised QAC told us this was improper. They just didn't give us good reasons why, however, and we feel our method has a definite advantage in that it completely avoids "frizzy" edges and permits a generally dryer layup, so we did it that way even in the face of their caveat. Their only justification was that one might sand through the top layer of torsion skin and compromise the strength of the wing in that axis. Well, shit! Don't do that! Anyway, you bin told.

So, begin your layup with the shortes carbon pieces, just the way they're stacked on the table. This stuff wets out nicely, but it's a little harder to judge how you're doing than it is with glass. Every third or fourth strip, use a squeegee to pull up the resin and make sure you have enough, but not too much. Don't forget to discard the slip material, Mortimer! Blow dryers are absolutely indispensable. Apply the resin with a 1½" brush - you should have two guys brushing, and have them change sides periodically to balance out differences due to technique. At least with the longer tapes, all four guys should pick them up, the two center guys adjusting the center of the tape over BL-0 and gently smoothing it down through the slight bend at BL-15. TRY TO MINIMIZE WRINKLES AT THIS POINT! Once the bend is made, the outer guy holds a little tension from his end and the inner guy guides the tape into the trough and smoothes it down.

When all eleven (or fourteen - I'm only going through this once!) layers are in, you're ready to micro slurry the rest of the surface, including both vertical shear webs. Now lay on two full-span lengths of UNI oriented spanwise. Have two guys grab the ends and, holding some tension, line the fibers up with corresponding points on the BL-loo chord. As they relax tension, someone nails the laminate at center span and everybody smoothes it outward keeping the fibers as straight as possible. The resin spreaders nail it down, and then it is trimmed off approximately at the top corners of the shear webs; that is, it doesn't drape down the webs.

Now you're ready for the torsion skins - one UNI at 45 degrees in each direction. The QAC plans tell you pretty much how to do this - the only things we've added are the guide marks on the foam (which can be seen through the spanwise skins) to keep the orientation more or less honest. The individual bias panels will not have to be as wide as the plans call for since the leading edge portion of the airfoil has been lopped off. Another tip; we find that after rolling out the yard goods and adjusting it so the warp threads are near 90 degrees to the main fibers, it helps to lay 3/4" masking tape along the 45 degree cut lines before cutting. This aids in keeping the panels from getting all whopperjawed in handling. Just split the tape with the sissors. Start laying these panels at one tip and work toward the other. as each piece is oriented on the surface and allowed to drape naturlally, immediately cut off the half-widths of masking tape so you can whopperjaw it as needed to correct its orientation and straighten the fibers. You'll make another cut later to the final trim line.

Work the resin in on the top surface and nail the cloth to both shear webs. When I say "nail," I mean substantially immobilize the fabric by wetting it down. Make the final cut as near as possible to the bottom corner of the web. When you've worked your way across the full span with these panels, turn around and start laying up the opposing 45-degree panels toward the first tip. Adjacent panels do <u>not</u> overlap - just butt them up to each other, but don't worry if there is an eighth inch gap or even a little more here and there -straight fibers are more important.

Well! Straighten up now and massage each others backs - you've probably been at it for nearly six hours. While somebody goes for beer, somebody else can stipple on some peel ply along the spanwise edges and on the shearweb faces.

Let things cure a couple of days and then follow QAC's instructions for bondo-ing on miscellaneaous lumber to rigify things, turning the surface over, and rejigging preparatory to doing the whole nine yards over again. Make sure your end level lines are level and parallel - last chance to build in a twist! The top is done just like the bottom except for the more numerous carbon laminates. Remove the shear web peel ply before you apply the top torsion skins. You should again peel ply the edges of the beam and that portion of the rear shear web that will be inside the fuselage - lots of junk gets attached there. Also, get two $1.75 string levels from the hardware store and bondo one on each axis at center span; this is much better to work with than level boards out on the wing.

At this point, we built a sort of tent out of black visqueen and cured the beam at 170 degrees or so for a couple of hours. We did this because we knew the shear webs would be insulated from the standard post-construction cure by considerable thicknesses of foam, and we wanted to be sure they got their share of the cure. Possibly this is unnecessary since we are probably redundant in shear strength anyway - just thought we'd tell you.

The next step is to jig the beam up vertically on the table, leading edge up. Find your leading edge cores and cut a flat face on the front of the center core by modifying the BL-15 leading edge templates and wire cutting. The minor extension of this face on adjacent cores can be done after assembly with a sanding block.

Install the leading edge cores, one at a time, on the front shear web with a liberal coating of fairly thick micro slurry punctuated by half-dollar-size dollops of 5-minute about every eight inches. The latter works fast enough that two guys can accurately position the core and simply <u>hold</u> it in correct alignment wile the stuff harden. Don't bother extending the "ribs" through the leading edge, but coat the mating faces liberally with micro slurry.

Now you have to cut some more bias panels of UNI long enough to wrap completely around the leading edges and overlap the top and bottom surfaces of the beam by about an inch - there won't be any overlap joint at the very leading edge as with the GU - pretty slick, huh? Use the masking tape trick again and cut the panels excessively wide so you can use the two-cut trim for final sizing. Maintain the 45-degree orientation as closely as possible and put on two opposing plies, just like you did on the main beam. In preparation for this step you will want to fill the inevitable little joint discontinuities with micro (dry) and, even before that, touch up the alignment with a long sanding board. Same goes for the slot cores, of course. You can also minimize the "frizzies" at the overlap line by stippling on some peel ply, although this isn't absolutely necessary.

Before we added the leading edges, we installed some tie-down anchors made of

.063" flat steel pop-riveted to the (locally reinfoced) front shear web. These plates have internally threaded steel bushing stock welded to them so that a small hole in the lower skin will permit eye-bolts to be installed when needed. The rivets are supplemented by vast patches of BID over the whole lashup. Of course, the leading edge cores had to be coped around these proturbances and the messy voids filled with dry micro.

When this latest disaster has cured, you rotate the (almost) canard and rejig it on the table with the trailing edge up. Run your brake and peetoe lines on the rear shear web and route out the face of the slot cores to accommodate them. We'll leave it to you do design your own pitot line terminal - just make something you can later mount an L-shaped pitot tube to. Leave a modicum of eacess length in both tube installations. Go through whatever agony is necessary to determine where the slot cores will be cut off and installed spanwise. Skin the slot core hinge wells a la QAC. Here again, it's smart to use some wood straight edges and 5-minute anchoring to line up the foam in both axes - they don't bend worth a dern once those skins harden up. After curing, install them on the rear shear web perzactly like QAC says.

actually 1½" forward

There, by gum! I think you're done. The wheel pants will be attached pretty much as prescribed by QAC, although the axles should be moved forward from the location on the original plans. Ours are ~~almost directly below~~ the rear edge of the elevator slot. It seems evident to us that at least part of the squirrelliness exhibited by the Q-2 on the ground is due to a lack of weight on the tailwheel and consequent poor steering traction. I'll try to include some photos showing our pants.

I apologize if I've either over- or underestimated your experience and need for detail in composing this sermon - be glad to discuss anything with you by phone (your nickel). You will have to work up your own elevator spars, hinges, phenolic bearings, etc. They're not too different from the original, but not interchangeable.

This next is not a recommendation but, for your information, we used blue polyester foam from the local lumber yard rather than the orange stuff used by QAC. We got 10" x 24" x 96" blocks for about $55 each. It's marked for use as boat dock flotation devices only and specifically says it contains no flame retardant. We burnt samples of both types and could see no difference in their flammability (both real flammable!). The blue weighs exactly the same (2#/cu. ft.) and has a somewhat finer and more uniform cell size.

Well, it has been really pretty enjoyable going through my head and putting all this stuff down. I've only done two rewrites, so I'm sure I'll immediately remember something of vital importance that I've forgotten as soon as I send it off. Anyway, I hope this will be useful to you; you gotta admit the price is right!