

Aileron Servo Tabs

by Jeffrey A. LeTempt

I remember reading through some old DBFN articles before I got my Dragonfly that mentioned how the aileron control forces built up in the Dragonfly as the airspeed increased. Before I flew my Dragonfly for the first time I had the opportunity to fly in four other Dragonfly's. *(It is critical to get some flight time in a Dragonfly before you fly yours for the first time, but that is not the focus of this article.)* Each of these four Dragonfly's (and two more that I have flown since then) all exhibit similar flight characteristics, but because they are all built by amateur builders in their own shops, each one is unique.

If I had to make a short statement about the flight controls in a standard Dragonfly, I would say the pilot roll control forces take two fists and the pitch takes two fingers. The typical new Dragonfly pilot will probably consider the aircraft very sensitive in pitch and very heavy in roll. I am not an aerodynamic engineer, but in my opinion this is not ideal. Your Dragonfly may not exhibit these flight characteristics, but chances are if you build it according to the plans it probably will....but we can fix this without too much difficulty, even if your airplane is already done and flying.

The roll control forces are probably higher because the ailerons are inboard on the wing. The ailerons are probably inboard on the wing because this was the easiest way to do it. Unless you are an aeronautical engineer willing to do a major redesign of the aircraft, we should focus on effective retrofit fixes....enter the aileron servo tab. In leman's terms (the only ones that I understand), aileron servo tabs basically provide aerodynamic roll power steering.

If I was a mad rocket scientist, I might have a more detailed answer to the question..."**What is a Servo tab?** The classic definition goes something like this: A servo tab is a small portion of a flight control surface that deploys in such a way that it helps to move the entire flight control surface in the direction that the pilot wishes it to go, it is power steering for control surfaces. A servo tab is a dynamic device that deploys to **decrease** the pilots work load and **de-stabilize** the aircraft."

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The servo tab is going to be a passive (no pilot action required) un-powered system that (in its basic form) will be a fixed system. The servo tabs will deploy opposite the direction of the aileron; therefore will be assisting the aileron to travel in the intended direction. If you wanted to get fancy, you could incorporate your aileron trim into your aileron servo tab system as, but the focus of this article is going to be how to build a basic aileron servo tab system. For the purposes of this article I am going to assume that you have the ailerons removed from the wing and you have a basic understanding of working with composite materials.

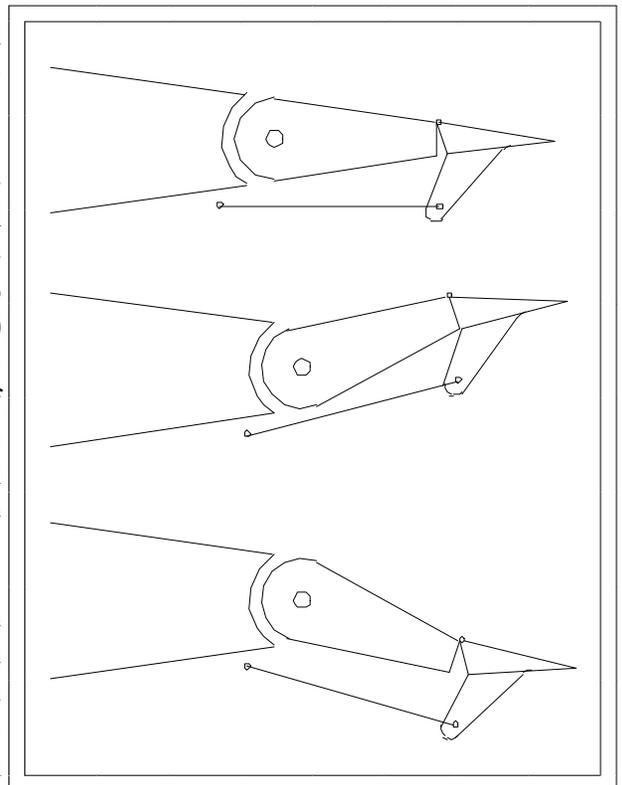
Here is a list of tools that I used for the project: Dremel ® tool with simple base and router base, reinforced cut-off wheels, spiral cutting bit, and small carbide bit for Dremel ® tool, hacksaw, countersink cage with #6 bit, 10-32 die, sander, about 18" of 3" angle (I had aluminum, but steel or even a wood block would work), basic epoxy mixing supplies, 4 clecos for #6 screws, and basic hand tools.

Here is a basic list of materials that you will need for the project: Four nylon clevis rod ends part # [2449K11](#) from McMaster-Carr, a 4' length of aluminum 1 1/2" wide (open width) piano hinge (rolled is ok...extruded is better), 16 stainless steel #6 screws 1/2" long with thin washers and lock nuts, about 16" of 3/16" aluminum rod, about 1/2 yard of 6 or 10 ounce BID, 16' of 3" wide fiberglass tape, epoxy, and flox.

What you are basically going to do is cut out about a 3" x 24" section on the inboard side of each aileron and make it so it hinges. You are going to make some simple control horns out of fiberglass and attach one of them to the tab and one to the underside of the wing. The control horns will then be connected with the aluminum rod and clevis rod ends. This project will probably take 15-20 hours to complete depending on your skill level and whether or not you already have the ailerons off.

I have done this conversion three times and have slightly modified the procedure each time to make the process easier and more effective. There are several different ways to make aileron servo tabs; this is just the method that I have chosen to use. I have flown my Dragonfly (second conversion) 130 hours with this modification and flew N142JE (third conversion) about 10 hours before I delivered it to its new owner. If your airplane is already painted, you will want to be extra special careful making sure that you clean up epoxy drips (watch for finger prints) and use masking tape on any tools that come in contact with the paint.

Mark out the aileron servo tabs on the inboard portion of the aileron on both the top and bottom of the aileron, I used a fine alcohol marker. The tab size I would use on my airplane is about 3 1/4" x 24". I used 3" x 24" on my Dragonfly and decided to increase the chord by 1/4" on N142JE to make them



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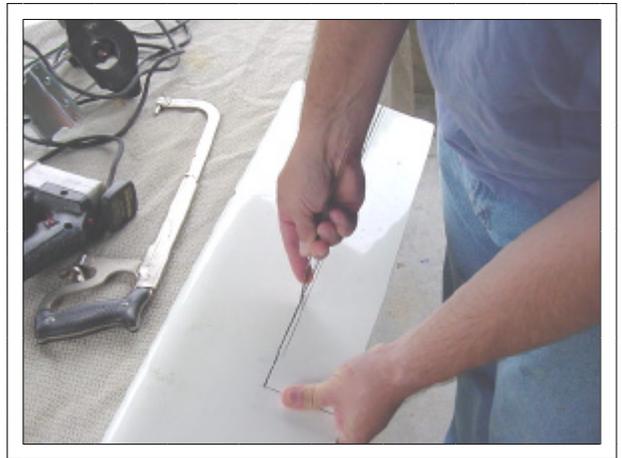
just a little more effective. There really isn't a need to mark out the long line on the aileron since the Dremel® router base will make the cut in the right spot, but I did it anyway.

I bought a box of 50 carbide bits from Harbor Freight for about \$10 a few years ago. The set included bits from about the diameter of a coarse hair to about 1/10th of an inch. The very small diameter bits will likely break if you put any pressure on them, choose a bit that is about the diameter of a pencil lead. Chuck the bit in the Dremel® tool and set depth of the bit so it will cut deep enough to cut the couple layers of fiberglass on the aileron. Set the router base so the fence is 3 1/4" away from the bit.



Go very slow with the cut through the end of the aileron because of the extra fiberglass, if you try to cut through this area too fast you will probably break the bit. Work the Dremel® tool down the length of the cut making sure the router base stays in good contact with the trailing edge of the aileron. Once you get to the 24" line just turn off the router and leave the tool in place until the bit stops. Flip the aileron over and repeat the cut on the bottom side.

There are several ways to make the chord cut. On my plane I used a jig saw with a very fine blade (lots of teeth per inch). On N142JE I used masking tape to hold a carpenters square in place and ran my Dremel® tool with the router base to make the cut. The high speed carbide bit is much less likely than the jig saw to chip your paint. Something else to consider with the jig saw is due to the shape of the aileron the blade will be further up the chord on the underside of the cut...if you cut all the way to the mark on the top, you will cut too far on the bottom side. With the jig saw you might also want to put down some masking tape to help keep from maybe getting some chips in your paint.



You will also have to decide how you want to make the short cut through the inboard end of the aileron/tab. It will be a few plies thick and there may be some flox, I have found that the reinforced cut-off wheel works well for this small task. Next thing is to take a hacksaw blade and cut through the remaining foam and the tab will separate from the aileron...too late to turn back now.

Now that the tab is free from the aileron and you have your Dremel® tool set-up with the router base, you may as well trim a little off the upper and lower surface of the leading edge of the tab. You will want to cut off enough material on the upper surface to make room for the part of the piano hinge that sticks up vertically. Basically you want to remove enough material so you will have a nice straight line on the aileron that extends right down the trailing edge of the tab.

You are going to have to remove some material from the leading edge of the underside of the tab to provide the space necessary for the tab to move through its entire range of motion. More material is going to have to be removed from the bottom of the tab, but you do not want to remove any more material than necessary, it is much easier to leave it too long and have to cut more off later. I recommend that you go ahead and leave the

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router fence set at the same setting for both the top and bottoms, you will be taking just the width of the vertical part of the hinge off the leading edge of the upper and lower surface of the tab.

Based on my experience I would certainly recommend leaving the inboard fiberglass end in place, it just makes the tab stronger. When it comes to the outboard end of the tab, you have 2 options. You can choose to completely remove the foam as I talk about in the next paragraph or you can elect to leave about 1/4" of foam in place. By leaving a little foam on the end you have a built in dam to prevent epoxy from oozing out of the end, but this will force you to be very precise with the length of the fiberglass tape that you will use to reinforce this area. It is really up to you how you do this, the last version that I did, I just removed all the foam.

The next step will be a little messy with polystyrene foam chips and dust. Take your Dremel ® tool and chuck up a spiral cutting bit and set the depth of the standard router base to about 1". You are going to route out the foam from the tab and the aileron to make room for the hinge. Due to the size of the router base you will not be able to remove 100% of the necessary foam on the outboard portion of the aileron, but that can easily be removed with a hacksaw blade or wood chisel.



You will have to experiment around with the correct speed depending on the exact type of spiral cutting bit. You will also have to figure out if it is better to cut clockwise or counter clockwise, depending on the rotation of your tool...you will quickly figure out a good technique. Due to the natural shape of the airfoil, the tab will obviously be narrower at the trailing edge so you will have to cock the router base a little to keep from forcing the tip of the spiral cutting bit from cutting through the fiberglass. Do not be worried much about this, you would have to really push hard to make this happen and you will have a noticeable sound when the bit is correctly positioned to just glaze right along the inside edge of the fiberglass.

Depending on your spiral cutting bit, you might end up melting some foam rather than just cutting it. In this case the foam will just build up on the bit and when you stop the tool the foam will be hot...do not try to remove this hot foam with your bare hands, do not ask me how I know this. The foam will almost immediately cool and get hard, hard enough that you will probably have to cut it off with a utility knife. This may not happen to you, it did not happen to me the first 2 times. I guess I had a slightly different spiral cutting bit the last time and this was a little annoying.



The technique that worked best for me was to work my way up one inside of the tab and then down the other side. Then depending on how your spiral cutting bit works, you can either choose to just use it like a router and remove all the foam by hogging it out. If you start having a problem with melting foam you will probably have better luck just making some cross cuts about every 1/4" - 1/2" up the tab and then just snap off the remaining foam with your finger. In either case you will want to take some course sand paper and make sure you have a nice flat bottom.

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Now repeat this procedure on the aileron. The only real difference is going to be that due to the router base you will not be able to completely remove the foam on the outboard portion. There will be about 1" of the foam that you will not be able to route out. You can just take your hacksaw blade and lay it down in the channel and slide it in to cut the foam.

With the channels all routed out you will want to take that course sand paper and smooth out any bumps in the foam and you will also want to rough up the inside of the fiberglass so you will get a good glass-to-glass bond. Once you get the foam and fiberglass roughed up a little, blow out all the foam dust with compressed air.

Next you will want to cut some strips of 3" wide fiberglass tape the length of the tabs, I used 2 plies in each channel and get ready to do some epoxy work. This process is a little tedious because you are working with some small parts, but good preparation will make the process easier. You will want to have some supplies standing by to clean up epoxy drips and you will also want to make sure you have a way keep the tabs and ailerons so they will stand upright (channel facing up). I used some bricks and 2x4 blocks, of course you will want to use some foam or rags to protect the paint if necessary.

You will probably only want to mix up enough epoxy to do 1 part at a time, especially if it is hot outside. Mix up some epoxy and then some runny flox. I use a small brush to paint the inside of the channel with epoxy and then paint some of the runny flox mixture at least on the fiberglass walls of the channel. The flox mixture will help hold the fiberglass tape in place. Once you have the channel all painted up with epoxy and flox, take the strip of 3" wide tape and fold it in half (so you have what looks like a 1 1/2" x 24" strip) and put it down in the channel. Use your brush to stipple the epoxy in to the fiberglass.

You might find it easier to wet out the fiberglass tape on a piece of plastic and then put it in the channel, you will still want to paint the channel with epoxy and flox mixture first. Once you are satisfied with the first ply you can put in the second ply. The fiberglass tape will stick up past the edge of the channel a little bit, so if you can keep the excess from getting epoxy soaked it will be less likely that you will get any epoxy drips on your pretty paint.

Repeat this process for all 4 channels and let it cure for a day or two (depending on the temperatures). While the channels are drying you can start working on the next step of the project, making the control horns...naturally out of fiberglass. I had 2 pieces of 3" aluminum angle about 1 foot long that I used for a mold, but you can use anything you may have laying around that will give you about 2 1/2 - 3" on each side of a 90 degree angle. It might be as simple as a scrap piece of wood 4x4 that you have handy.

Obviously you are not going to want the dried fiberglass to stick to the mold(s), so cover them with duct tape or plastic. Cut 4 plies of BID fiberglass cloth (6 or 10 ounce will work just fine) and one piece of peel ply about 5" x 12". Mix up some epoxy and lay-up the fiberglass cloth over the angle mold and then apply the peel ply. Let this appropriately cure.

Once all the epoxy is good and cured, you can start to mount the hinges. The first thing you need to do is trim off the excess fiberglass cloth on the tabs and aileron. What I have found works best for this task is a reinforced cut-off wheel in the Dremel ® tool. You should be able to rest your hands on



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the aileron or tab and get a nice smooth cut. You might have to smooth off a few rough edges with a sanding block, but that is easy.

Cut your hinge so it fits inside the channel with a little space on each side for wiggle room. I attached the hinge with eight countersunk #6 stainless steel screws (4 on the tab and 4 on the aileron). I came in about 1" from the end of the tab and then evenly spaced out the 2 other screws. I set the screws in 1/2" from the edge of the fiberglass. I drilled the 4 holes in the aileron with a #29 drill bit. While firmly holding the hinge (with the rounded vertical hinge part facing up) in place inside the aileron channel, mark one of the center holes with an alcohol pen. Center punch the middle of the mark and drill a #29 hole. Now set the hinge in place and hold it there with a cleco (ask one of your RV building buddies to borrow a few for the weekend). Now mark another hole and repeat the process for the three remaining holes.

The process for the tabs is exactly the same. After you have the hinge, aileron, and tabs and drilled you can use a countersink cage to countersink the fiberglass for a very nice finished look. Once you start putting the hinge together with the screws you will almost certainly need to put a piece of masking tape over the head of your boxed end wrench to hold the nut inside the small space, this is really necessary on the tab due to the limited space. So now you can actually see how the tab is going to move up and down on the aileron....let's now do some work on the control horns!!



There is probably a less time consuming way to do this, but the finished product weighs virtually nothing, it looks good, and it is easy to bond to the existing structure. Remove the fiberglass that you laid up over the angle mold and remove it. Take the peel ply off and scratch sand the exterior portion of the part (where the peel ply was) with some course sand paper. If you have one long piece of fiberglass angle, then cut it in half.

Now that you have 2 pieces of fiberglass angle that you are going to glue together using epoxy and a little floc. You are going to bond together 2 of the scratch sanded surfaces to make a T. Mix up some epoxy and a little floc slurry and glue the parts together. Clamp the angles, now a T, with some spring clamps. I clamped the T assembly onto a piece of steel and let it cure, but I am not sure this was the best thing to do. When I unclamped everything, it was kind of warped and twisted. I ended up having to clamp it in a reverse twisted position with a little heat applied for a few hours to get it all straightened out.

Next step is to cut out 4 control horns. Here is the shape for the control horn on the tab that worked for me to achieve the desired tab deflection. The tab attached to the wing is just a simple T shape about 1 1/2" wide rounded to an eye pleasing shape. In DBFN 51 MAJ Givins recommend against having the tab deflect more than 75% of the aileron to prevent flutter. My tabs deflect about 100% of the aileron control movement and I have not experienced any kind of flutter issues, but that is not to say that it can not happen. If this is a concern for you, then you will have to adjust the shape and placement of your control horns.

The top part of the T will be the part bonded to the aileron or tab (at the span wise center of the tab). The vertical part of the T will have a hole drilled in it to accept the clevis. Once you have the shape cut out you can sand and shape it with your sander or files. At this point I reinstalled the ailerons on the wing which I had laying upside down on a couple saw horses. I taped the T's to the aileron and tab and did some tests with a coat hanger (representing the clevis' and control rod).

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Something else that I did was to make sure the control horns were parallel to the relative airflow over (or in this case under) the wing. I did this with a 4' straight edge laid along the aluminum wing attachment fittings and then used a carpenter's square to represent the relative airflow. This is probably overkill, but I did not want to introduce any unnecessary drag.

Once you are satisfied that everything is going to work, you can bond the control horns to the ailerons and tabs. I traced the outline of the control horns with an alcohol pen and then I put down about 3 or 4 layers of masking tape to protect the paint just in case I slipped. What really worked the best was to chuck up a medium size drum sanding wheel in my Dremel® tool and then I just removed the paint and filler until I got to fiberglass. The thickness of the paint and filler was the same thickness as the 4 plies of fiberglass cloth, so it made for a very smooth transition. I put a slight taper on the part of the T that was not bonded to the aileron/tab so a little filler would make the T part of the horn disappear. I used epoxy and epoxy/flox slurry to bond the tabs to the ailerons/tabs and held everything in place with masking tape.

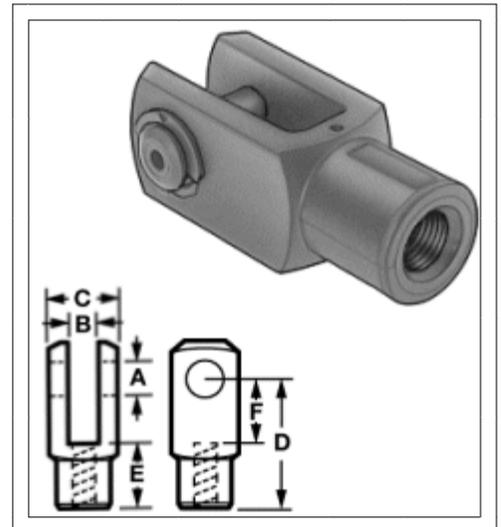
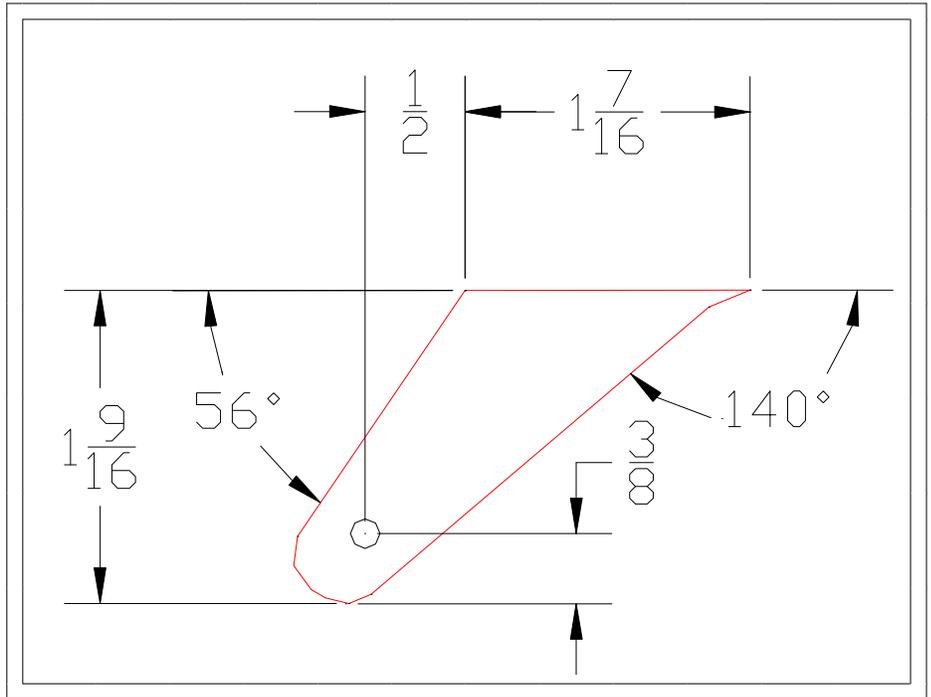
Before you mount the tabs, you will need to sand a shallow pocket on the outboard end of the tab and the inboard tab cut out on the aileron and put in a thin layer of micro to keep from having any exposed foam. The only remaining tasks are to install the control rods between control horns.

The little nylon clevis rod ends are very light weight as is the 3/16" aluminum rod. I cut the rod to length and used a 10x32 die to put about 3/4" of threads on each end. The length of the rod will vary with each installation. With the aileron installed and in the in-trail position (more accurately, the position of the ailerons while in your cruise configuration), position the tab in the in-trail position, and now you can determine the actual length of the rod with the clevis ends installed. A couple small plastic spring clamps will help you hold everything in place.

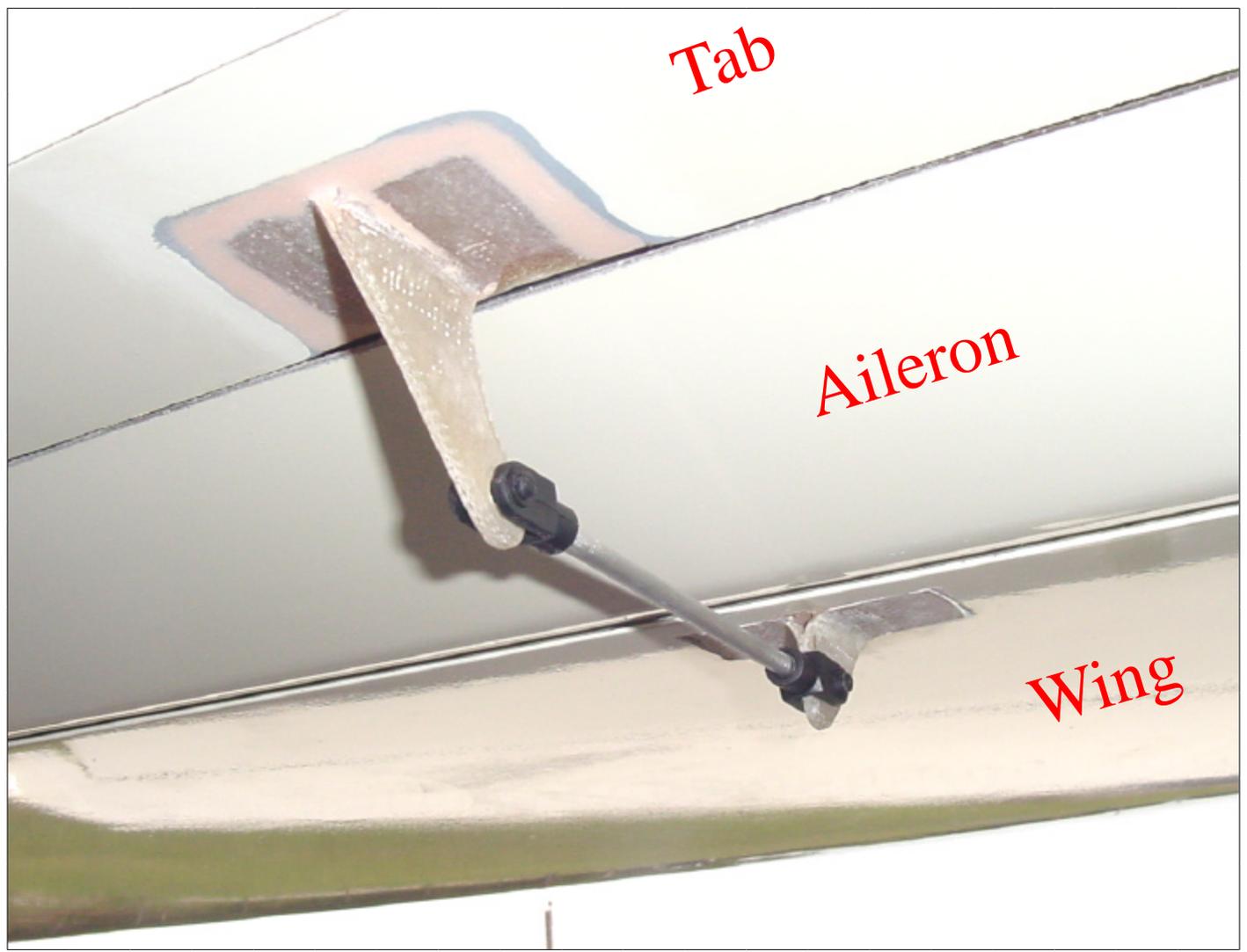
Nothing left to do now but go out conduct a test flight on the aircraft. You may have to do a little adjusting on the length of the rods if you notice any roll tendency. After everything is installed and test flown I would go ahead and put a little Loctite on the threads of the rods.

If you have a reflexor I would just set the aileron servo tabs so they should be flush in cruise flight in your most common configuration (weight and balance wise). I am sure that you will feel the results were worth the

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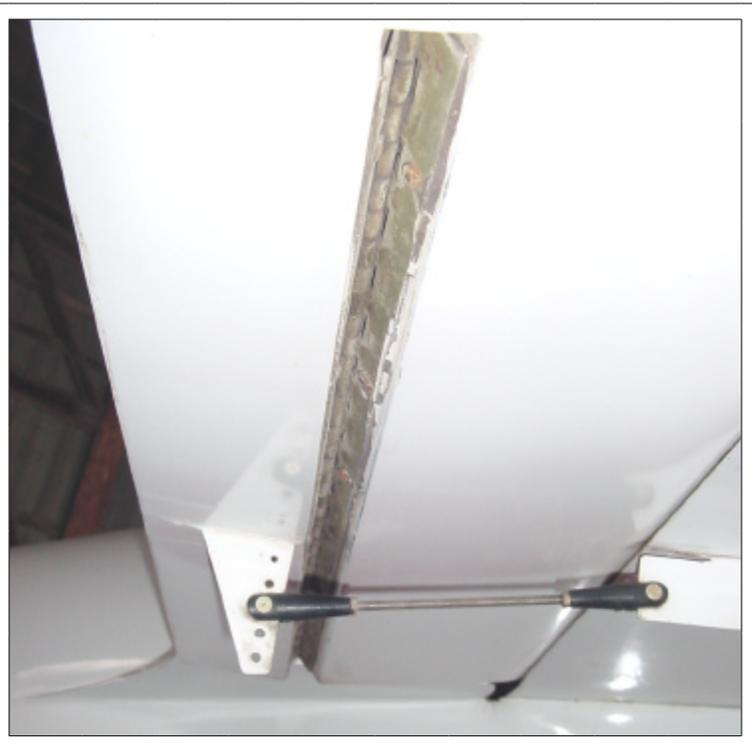


time spent on this modification. Here is a picture of the installation that I did on N142JE.

For reference I thought you might like to see a few pictures of other aileron servo tab installations. The method that I have described is not the only way to install aileron servo tabs. The method that I have described has worked well for me for more than 130 hours on N41GK and I expect many more happy flying hours!!!

Jeff





These pictures are of David Bourque's Dragonfly MK-II. I am not sure if David or a previous owner installed this modification. The design uses a piano hinge, but it is installed differently. The builder also drilled several holes in the control horn that would effectively change the ratio.

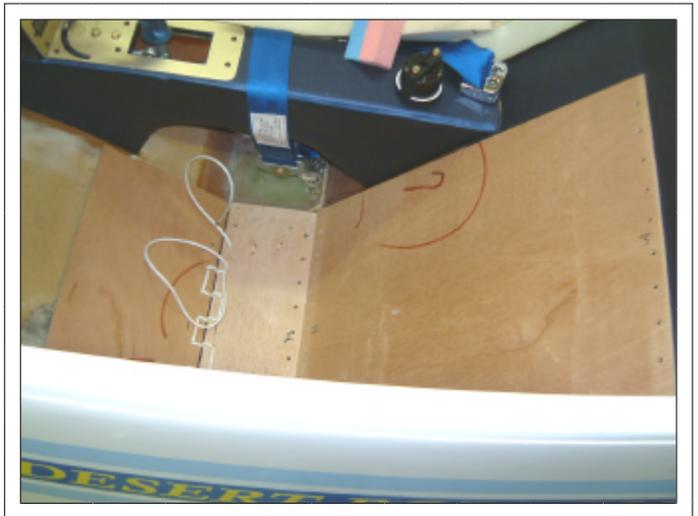


These pictures are of Steve Larabee's Dragonfly MK-II. Steve put his tabs on the outboard end of the aileron and his tabs are smaller. I have never talked to Steve about the effectiveness of his tabs. As you can see he used the same basic construction method with a piano hinge.

Additional Bob Johnson Photos

I published an article about Bob Johnson's Dragonfly journey in DBFN 122 and I promised that I would provide you some additional photos in a future issue. Bob has really incorporated some interesting and innovative features. I fully expect to hear from Bob any day letting me know that his long term project is officially an airplane!!!! I really have a great deal of respect for Bob's perseverance and dedication. Most "normal" people would have given up a long time ago. I am sure Bob will be rewarded with a very nice flying, capable, maintainable Dragonfly. Please keep us posted on your progress Bob.

Jeff



International Dragonfly Week

The Dragonfly is a very neat airplane; a very safe design that is economical to build and operate...but with only a few hundred spread around the globe it can be difficult to find another one to look at or get an orientation flight in one. If you were building an RV, there might be 2 or 3 on your home field, but you might have to drive 2 or 3 states to see another Dragonfly. I enjoy having something that is a little different than the guy in the next hangar has. Don't get me wrong, the RV family of aircraft is FANTASTIC, but it is neat having something different.

Unless you live in Tucson, AZ you probably do not have ready access to a Dragonfly builder and flyer support group. Your Dragonfly lifeline is probably this newsletter and the email list if you have a computer and internet access. Without readily available support (and motivation), it can be easy to loose focus and take some time off from the building process.

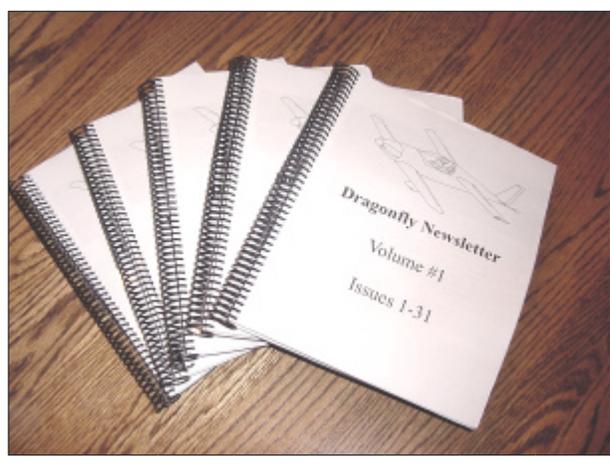
It starts off innocently enough...I am tired tonight, I think I will just sit down and watch some TV. Then the next night there is something else that comes up. Pretty soon a week has gone by and you have not worked on or even looked at your Dragonfly project. Then that week turns into a month and then a year...pretty soon you can not even remember where your project is located, except your spouse is probably nagging about not being able to park their car in the garage.

I am hereby proclaiming the week of April 1st, 2007 as International Dragonfly Week. At least once during the first week of April I want you to go out and work on or fly your Dragonfly. It might be something as simple as organizing your plans or you might go on the first cross-country flight of the year. I expect each and every Dragonfly builder and flyer to take a couple pictures and send them to me along with a paragraph or two about what you are up to. Please include the date and time the photos were taken. My email and snail mail addresses can be found on the back page of this newsletter. I am really looking forward to hearing what you are up to!!!

Hard Copy DBFN Archive

The hard copy archive looks great!!! The introductory price is going to be \$120 USD (just 97 cents per issue) plus shipping for all 124 DBFN issues. This introductory price is only good for this initial mass purchase. After this initial offering is complete (as of today I have 4 sets left), the normal price is going to be \$135 plus shipping for all 5 volumes. Please email me at jeffrey.letempt@us.army.mil or call me at work (573) 596-0165 or at home (573) 364-2545 (*before 2030 central time please*) with your address and I will calculate a total delivered cost for you. Personal checks and money orders are ok. I can not accept credit cards, but I can gladly accept PayPal payments for an additional 2.9% + 30 cents (this is what PayPal charges me).

You can use PayPal to pay with your credit card. Of course I would encourage everyone to take this opportunity to renew their DBFN subscription for 2007 at the same time.



Classifieds

For Sale: Dragonfly MK-IIIH. Engine: Modified HAPI/VW with pulley driven alternator, Airflow performance fuel injection, etc. Engine and airframe 170 hrs. The aircraft is located in Norway, all ways hangared and in good condition. For more information, pictures etc. contact Torvid Lensebakken via email lensebakken@telefonica.net



Wanted: Hapi accessory case. Contact Chuck Ufkes at (352) 347-0456

For Sale: NACA Flush Inlets designed for 1/2" sandwich structures. These make a good looking functional inlet to replace the hand carved per plans ones. Inlets are \$40 per pair, plus \$4.00 shipping. Note: Spinners no longer available. Contact Charlie Johnson, 2228 East 7875 South, Ogden UT 84405 (801)-479-7446 or email OneSkyDog@aol.com

For Sale: Composite spinners for the Dragonfly \$180.00. Call Tim at 310-386-8354 or email dflypilot@yahoo.com

For Sale: Polystyrene Blue Foam For Sale – Make offers – Some of the foams have already been professionally hot wired - canard, wing, rudder, elevator etc. Some are blank/uncut. Also have 1/2 " Clark foam Located at the South Lakeland Airport (X49) in Florida. Pictures and more detail available via email request. (863) 646-2612 or email at cgentry12@msn.com

For Sale: Dragonfly Fuselage For Sale -- \$600 Firm -- This includes fiber glassed sides, bottom, front and rear turtle decks, fuel tank/seat, engine cowl, motor mount and bulkheads. This would be a good start for someone. Just start putting it together. Located at the South Lakeland Airport (X49) in Florida. Pictures available via email request. (863) 646-2612 or email cgentry12@msn.com

For Sale: Dragonfly MK-I converted to hoop gear. Porsche 1800 engine (big VW) converted to 2400 with parts from Great Plains. Airframe complete & wings & control surface mounts are finished. Cleveland wheels & brakes. Ed Sterba prop. Nearly complete. Asking \$10,000. Call 815-397-1533 or email stiegrinding@aol.com



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