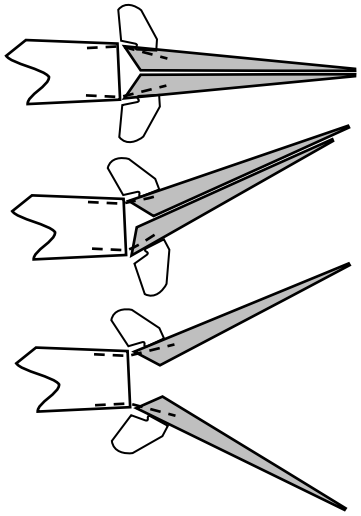
Split Rudder Airbrake

My latest version of the Midge has made use of a split rudder as an airbrake to assist in slowing the model down on landing. There has been quite a bit of interest in this, so I thought I'd provide you with the info so you can make your own.

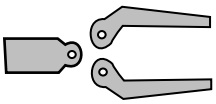
The main components for this are two rudders made half the thickness of the original one piece rudder. These need to be operated independently from two different servos either directly from the Rx with some electronic mixing, or via a mechanical mixer. I use electronic mixing through connecting one rudder as normal and the other by program mixing through an Auxiliary channel (Aux 1) to be controlled from the rudder stick on the Tx. These are then both mixed with the throttle stick (primary) to Rudder (slave) that's all there is to the mixing the two channels other than setting range of movement.

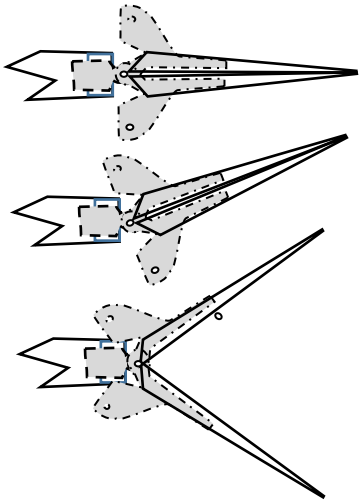


Two methods can be used for connecting these to the rudder post.

1. Alternative method: Two rudder halves chamfered from the outer edge and are hinged to the outer edge of the rudder post. Use of thin mylar hinges work well. However, this method does give some asymmetry to the installation given that when rudder is input (both rudders move in the same direction) due to the hinge not being in the same place the rudder halves slide against each other. Not a major problem, in fact this is probably the easiest method to use. It is functional, but for me, it just doesn't look good. I wanted symmetrical movement of the rudder halves.

2. Method used on the Midge: By using CAD and a CNC router machine, I have produced some hinges on epoxy board that allow for symmetrical movement. These use a central hinge system that pivots around a single piece of thin piano wire inserted through all three hinges from the bottom. The hinges consist of left and right plus a centre (rudder post) components. It took a few attempts to get the geometry right but it was worth the effort.





I also CNC'd the balsa rudder halves complete with the cut outs already for the hinge components. I sanded these to a tapered shape and also chamfered the hinge line from the centre, then vac bagged the rudder halves with 25g cloth and resin to stop the balsa warping. Once cured and trimmed, the hinges were glued into the slots. The rudder halves were then assembled with the rudder post hinge component and glued this into place in the rudder post.

A second servo was installed into the fuselage servo plate alongside the original rudder servo. I had to open up the original servo hole to allow for this. I also moved the Elevator servo off centre so that the rudder piano wire snakes (x2) did not interfere with the elevator control.

The thin piano wire snakes were cut to length and installed terminating at the rudder integrated control horn with a 90 deg bend and pushed through the horn on both sides of the rudder. These are secured in place by a small plastic ball with a hole in it. Actually it's a fishing accessory designed to hold swivels in place. Remember to glue the snake outers to the inside of the fuselage though, otherwise these will flex too much when push control is input.

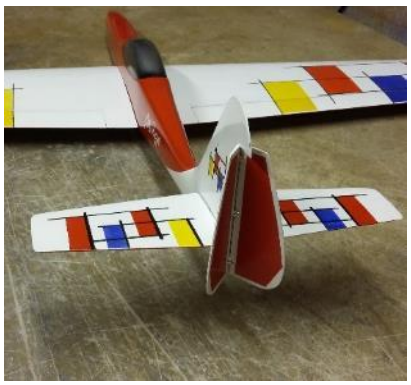
See youtube for a demo of this working.

Search for

"Midge SR slope soarer",

or

https://youtu.be/nq-p1PKoBfE

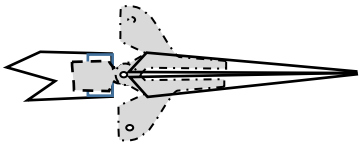


Additional building info:

Rudder
Vac Bagged Rudder halves. These are made from 3mm Balsa with a layer of 80g glass cloth and resin vac bagged on to the rear or mating surfaces of the rudder halves.

These will need to be carefully cut out of the surrounding waste material and lightly sand the edges. 3 slots are machined into the outer rudder face for the hinges, the order of these should align with the order of hinges cut into the Epoxy board.

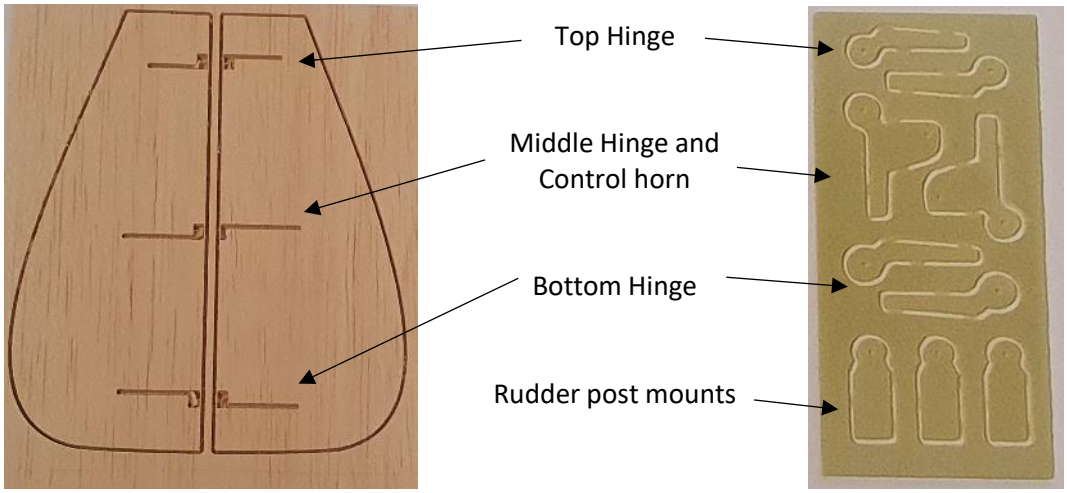
Before installing the rudder hinges, it is a good idea to chamfer the leading edge of the rudder at 45 degrees on each side so that when they are together, they form what looks like a normal centre hinge line of a control surface.



The rudder halves will also need to be tapered from the Leading edge (Hinge Line) to the trailing edge creating the tail end of the fuselage aerofoil shape. This can be done before assembly or after the hinges are glued into place as the excess part of the hinge will also need to be contoured to the streamlined rudder shape. However this is more difficult if the rudder hinges are glued in place. (The inside glassed area of the rudder halves do not need to be sanded to shape other than a light sanding to ensure the two surfaces mate perfectly and to key the surface ready for painting.)

Hinge:
3 components make up each hinge. For top and middle hinges: Left hinge / Rudder post mounting / right hinge.
For the bottom hinge, the order of components are opposite right hinge top / rudder post mount / left hinge bottom.

The hinge components are mounted on the epoxy board in pairs, do not mix these up as they are different sizes / shape. The rudder post mounts are all the same and are interchangeable. Note that the middle hinge also comprise of the integrated control horns. The exit hole for the rudder pushrod wire will need to be slightly above this hinge to allow for the wire to bend and pass through the control horn hole top to bottom.



Be careful as when the hinge components are cut from the CNC'd epoxy board they are small and can easily be lost.

A 1mm hinge pin is required to pass through all 3 hinges from bottom to top. This will help you aligned the hinges and also allow for the rudder removal once installed on the model.
(The inside glassed area of the rudder halves do not need to be sanded to shape other than a light sanding to ensure the two surfaces mate perfectly and to key the surface ready for painting.)

I used a piece of medium ¼ x ¼ Sq of balsa for the rudder post, sanded to fit the opening in the fin. DO NOT glue this in before installation of the tailplane bell crank, but can be dry assembles to check fit and alignment of the rudder assembly.

When you are happy with the dry assembled rudder halves and hinge components you will need to carefully glue the left and right hinges in place. I used epoxy resin for this task. Note the hinge material will be slightly proud of the balsa and will need to be carefully sanded back once secure and the resin set. The excess resin can also be removed when set, ensuring there is no interference with the other component when assembled.

Once the rudder assembly is complete and sanded, mount on to the rudder post and ensure correct operation before gluing to the post and into the aircraft. Again do not glue rudder post into the fin until the tailplane bell crank has been assemble and installed and is proven to work correctly.

Once you are happy with the functional rudder installation, then remove the rudder halves by pulling the centre hinge pin out. The rudder assembly is now ready for covering. I used 80 gram cloth and epoxy resin for this, but you could use other covering material.

Radio Set up:

One rudder will be coupled to the receiver in the normal way and the second will need to be connect into a spare channel (Aux 1) on the receiver. This should then be electronically couple in the Transmitter program on an Aux channel to operate from the rudder stick. You may need to reverse the direction of this to work opposite to the normal rudder channel to ensure they act like a normal rudder from the rudder stick. If they do not meet properly in the centre position then sub trims will need to be used to achieve this.

You now have two separate rudder halves that act together as a normal rudder. The secret now is to mix the throttle lever to operate both rudder and Aux channel so that when the throttle is pulled rearwards each servo pulls the rudder halves apart by the same amount to proportionally open the rudder for the airbrake. If you have this programmed correctly, with the airbrake deployed, when rudder input is made on the transmitter, then the opposite rudder half will move back towards the centre position thereby giving rudder control. When the rudder control is stopped then airbrake is restored to the chosen amount. Cancel airbrake by moving the throttle forward.

THAT'S IT…. Well, almost….
You may need a little down elevator coupling into the throttle movement as the deployment of the airbrake may cause the model to pitch up. The transmitter programming should permit you to input a small amount (1.5mm down) of pitch control proportionally and automatically as the throttle level is moved to open the airbrake. Even with this programmed in, if the airbrake is deployed abruptly then the model will pitch up regardless but should settle onto a level flight path. If you deploy airbrake in a slow and controlled manner, then you should achieve airbrake deployment with little pitch change if you have it programmed correctly. It may take a little trial and error to achieve perfection.

More magic……
I use a type of Crow Braking (sometimes called Butterfly in your TX programming) mix to manage height on approach to landing if necessary. Proper "Crow Brake" is where the transmitter is programmed to raise both ailerons at the same time as lowering the flaps, this achieves a slower approach and reduction in lift causing the model to reduce height and speed in a very controlled manner and can help with those very tight landing areas, but this has to be deselected prior to absolute touchdown as flaps tend to snag on the ground causing damage. This is normally also controlled via the proportional throttle lever. I will try to explain how I do it……

Given that the Midge does not have Flaps, (you could, but that's another story) then the same programming will just have the ailerons reflexing, which means they move up together by the same amount whilst still retaining aileron response. This serves two purposes.

1. Reduces lift causing a greater rate of descent (It is very effective!)
2. Creates "Wash Out" compared to the root portion of the wing, thereby reducing any tendency to tip stall.

So here's the rub. Create the Crow Brake effect for your aileron from the throttle lever, but have this selectable through an arming switch. This will allow just the deployment of airbrake only – normal operation, or when the switch is armed, then also Crow Brake – ailerons are activated allowing for the proportional reflexing of the ailerons through the throttle control. Additional auto pitch correction (4mm down plus any correction for the airbrake (around a total of 5mm – 5.5mm down)) will be required for this to work properly, mixed through the "Crow Brake" programming.. This functionality is very impressive in getting the model to have a high rate of descent whilst maintaining a flat normal aircraft attitude the rudder airbrake reducing the additional speed that is created by the reflexed ailerons.

A WORD OF WARNING: Remember deselect airbrake and Crow' before landing, if not, then it is likely that you will damage the controls. Also, with Crow Brake ailerons selected, it is likely that there will be a reduce roll control. (Ensure

that you do not over drive the ailerons, keep within the normal range of the servo) you may need to reduce some of the up aileron on Crow Brake to retain an acceptable level of roll control and this should be augmented by appropriate use of rudder . Yes use your Rudder! This still works with the Airbrake out. See the YouTube video in the link above.