Building the Voltij

See also Kevin Newton's web site for a review and building hints:
http://www.knewt.com/planes/aerobatic/voltij.htm

The Voltij is a revolutionary moulded glider intended for aerobatic soaring. It has a symmetrical profile designed to use four-axis control. This means it is as responsive inverted as upright. The controls easily permit rapid gain of altitude to facilitate aerobatic flying. When building, great care must be taken in assembling the controls since there must be no play to affect the precision needed for aerobatic flying. The controls have to be virtually rigid as indicated in the instructions.
The paintwork is a type of acrylic that does not react well to solvents. Alcohol & other solvents must be avoided; soapy water is best.

Estimated building time: 15-20 hours.

Technical specifications

Span	2020 mm
Cords	250, 110 mm
Surface	36 dm^2
Profile	MG 05 to 9%
Length	1250 mm
Empty Weight	1600 g
Ballast	200 g
Wing loading	44,50 g/dm^2
Radio	4 good quality standard servos 1 battery 4 or 5 cells, 1400 mAH

1.1. The ailerons

Aileron width is 7.5 cm (30% of the cord) at the center and 3.3 cm at the tip. The ailerons are full span and go to the tip.

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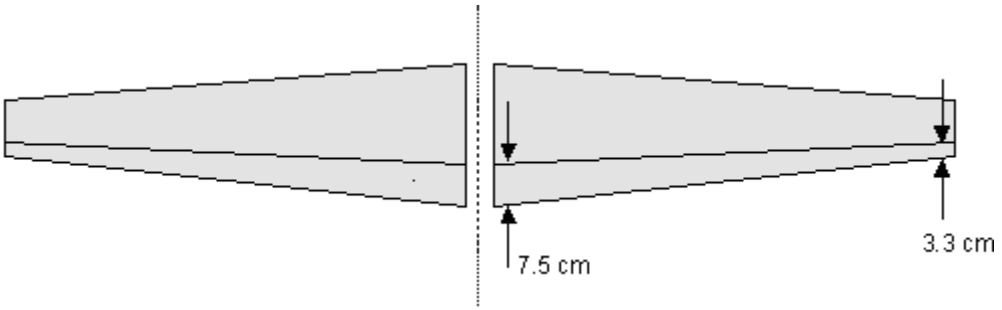
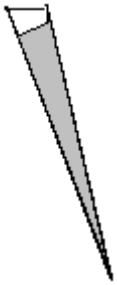
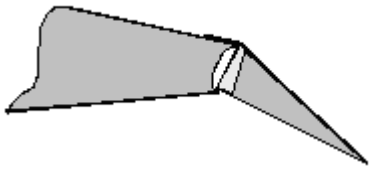


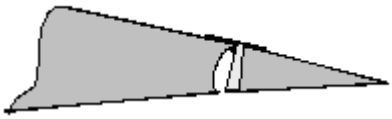
Scrape the foam out of the leading edge of the aileron to allow it to slide into the wing



Remove the foam from the aileron leading edge then fill the leading edge with resin and micro balloons to make it less flexible.
(A 4 to 1 mix of micro balloons to resin is about right).



Tape the aileron leaving only half a mm of play and check the clearance of aileron sliding into the inner part of the wing. If necessary, adjust until the aileron moves freely.



With the aileron folded to 90° on the outer edge, apply silicone glue to the hinge (about I mm diameter bead) then let the aileron dry in a neutral position.

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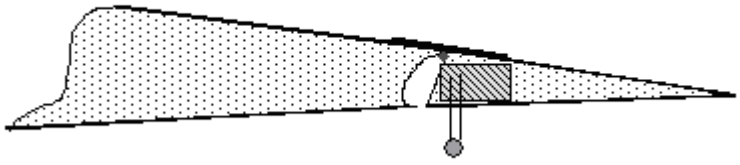
1.2. Installation of Aileron ball links

We recommend ball links to make assembly in the field easy, and to leave no play. For the ailerons, install a horn of 10 mm high placed at 20mm from the center of the wing and level with the hinge to avoid introducing an undesirable mechanical differential.

1.3. Installation of aileron servos

We recommend installation of both servos in the wing fairings. This part of the assembly is described in detail in the fuselage instructions.



1.4. Wing attachment

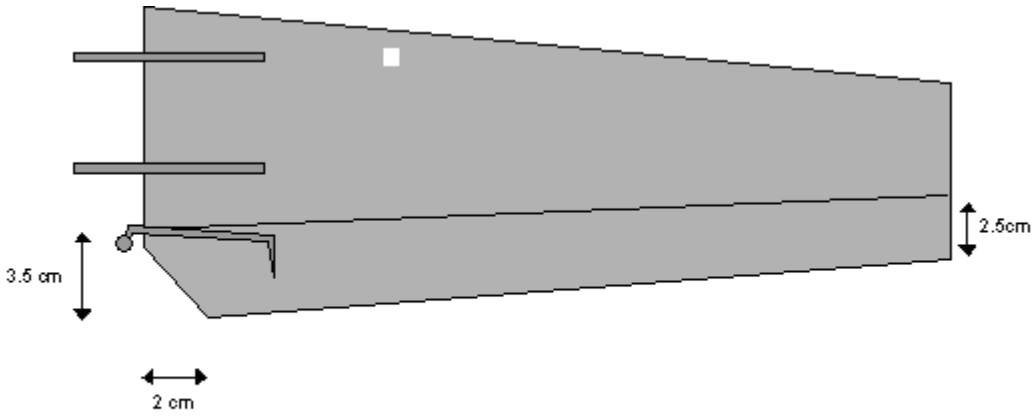
The wings can be secured during flight by using tape on the wing fairings, but it would look better to use two hooks and an elastic band.

2. The stabilizer

Can have separate elevators or be fully flying. The latter is easier, but some people prefer the linearity of elevators.

2.1. Separating the elevators (option for elevator stab)

For this, use the same method as for the ailerons, using the following dimensions

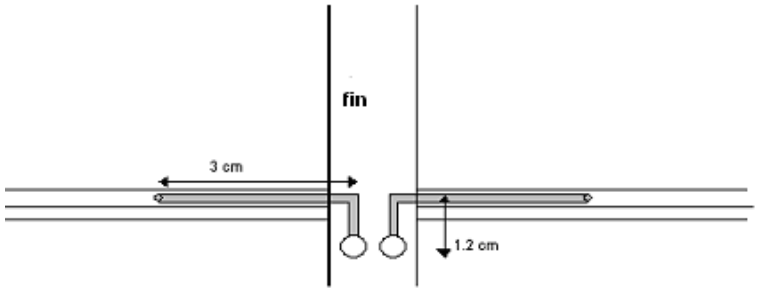


Install horns before sticking with tape or silicone.

2.2. Installation of elevator ball links (for stab with elevators only)

Use piano wire 2mm in diameter.
First cut two pieces of wire 6 cm long, bend at 90° at 1.2 cms. Press a ball link onto the bent end and glue or solder it. Bend the other end so that the horn goes into the elevator. Glue that end into the elevator with quick setting epoxy using a temporary hinge of tape.

Stabilizer control now looks like this:

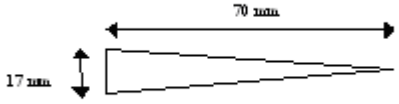


view from rear

3. The rudder.

3.1. Capping the base of the rudder

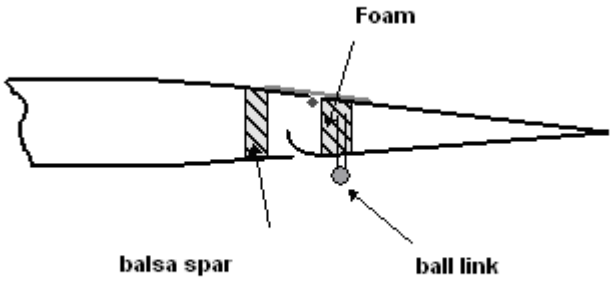
Cut a piece of 6mm balsa to the following dimensions,



and glue with cyano in the rudder, level with the base.

3.2. Installation of rudder ball link

The rudder horn should be glued in relation to the control you planned in the fuselage: to do this, make a small hole in the rudder, remove some foam and glue the horn with epoxy, completely filling the hole.



3.3. Rudder Attachment

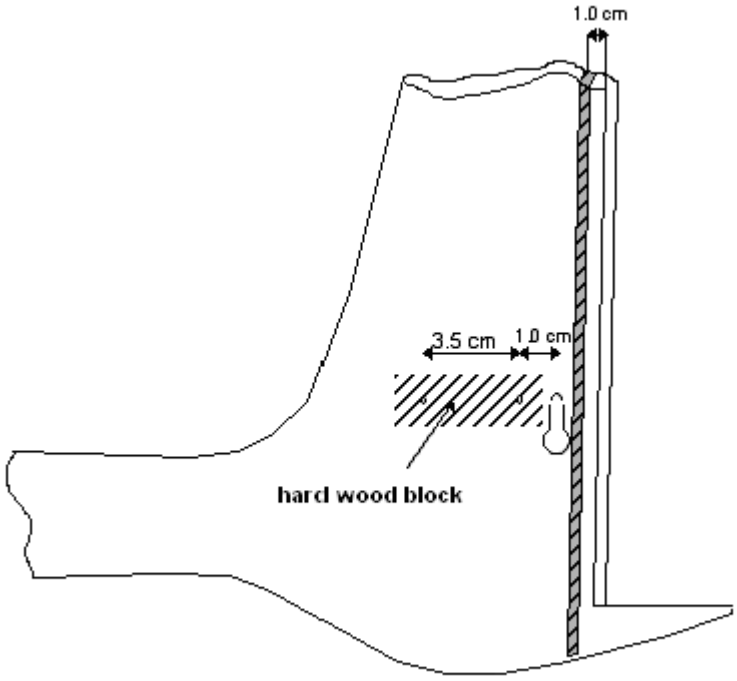
The rudder is attached by tape on the right hand side of the fin. You can also put a line of silicone on the joint to reduce play.

4. The fuselage

4.1. Installation of elevator linkage (only for stab / elevator option)

Make a hardwood block 50 mm x 16mm x 15mm

Glue it inside the rudder, level with the stab and clamp while setting to form a solid joint
Drill 2 holes of 3mm, through the rudder and the wood, at the places indicated on the left side of the rudder, being careful to keep it perpendicular to the plane of the rudder. If necessary use a drill press and hold the fuselage horizontally.
Cut two tubes from 3mm brass to the required length and glue these into the rudder with cyano.



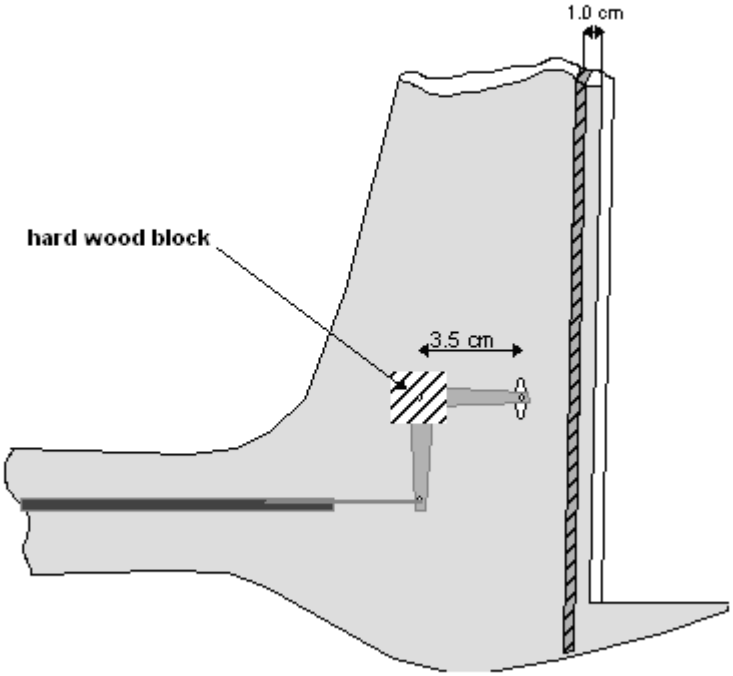
4.2. Clearance for control horns

If you want to insert the stabs when out in the field, you need to mill a passage sufficiently large to attach the horns from the outside.

4.3. Installation of stab linkage (for all-flying tail plane)

Make two small hardwood blocks 15mm x 15mm x 5 mm. Drill a 3mm hole through the center. Assemble the 2 pieces and the bell crank on a 3mm brass tube 18mm long. The tube should protrude 1mm on each side of the fin.

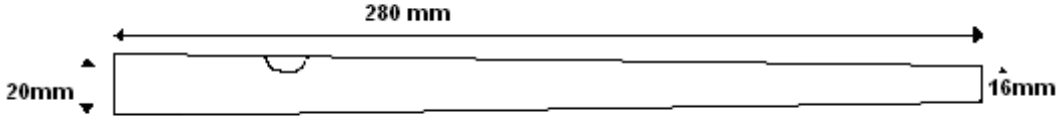
Make the 3mm holes at right angles through the rudder level at the mark on the left side. Scrape the interior of the rudder at the level of the stab so that the glue holds. Use epoxy to glue the little pieces of wood onto the bell crank.



Next mill a circular passage so the 2mm stab joiner can move freely.

4.4. Installation of rudder spar

Cut from 6mm balsa to the following dimensions



Using coarse glass paper, sand the inside of the rudder and glue the spar with cyano into the fixed part of the rudder 8mm back from the left edge once the bell crank, rods etc have been finished and installed.

4.5. Installation of wing joiners

This is tricky because the two wings must fit perfectly into the fairings of the fuselage. Glue both aluminium joiners inside the fairings in the following manner:

Draw the outline of the root of the wing by pressing it hard into a piece of A4 paper. This shows the outline and the joiner holes. The use the outline of the left wing on the right hand fairing and vice versa. Your paper will fit perfectly onto the fairing allowing you to mark the center of the joiner holes through the paper with a sharp point. Centering the paper on the fairing is easy enough on the vertical but be very careful that horizontally the holes are perfectly opposed.
Pre-drill 4 x 5mm holes and slip the rods in to check that they are parallel and perpendicular in all axes. Then slide tubes of 8mm outside diameter and 5mm interior diameter onto the rods and check they move easily within the joiners. Then enlarge the holes with a 9mm drill if they are nicely centered, or with a round file if there is some unevenness. The aluminium joiners must now be pushed in hard. Check the parallelism, perpendicularity and movement again with the wings mounted on their joiners.
Now glue the joiners with cyano to render them immobile. Then reinforce them with a mixture of chopped fiberglass and resin. Do this in two steps. Scratch the inside of the fairing with coarse glass paper so that the resin sticks, tape the exterior of the right hand fairing to prevent the resin from running, reinforce and leave to dry lying on the right hand side of the fuselage. Then do the same thing with the left hand fairing.

4.6. Attachment of Canopy

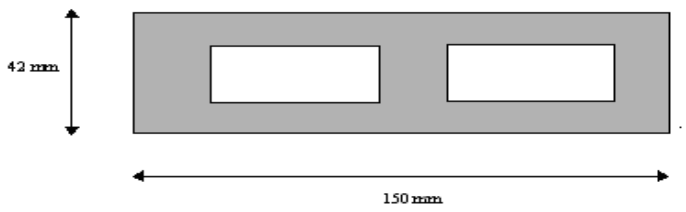
Use your preferred method, or a good way is to glue two small pieces of piano wire 2mm x 80mm fore and aft with epoxy. Sand for grip and fold the wires in a zigzag for better hold.
In this way the wire will protrude 2-3 mm being held under the edge of the fuselage and allowing the canopy to slide.

5. Installation of radio

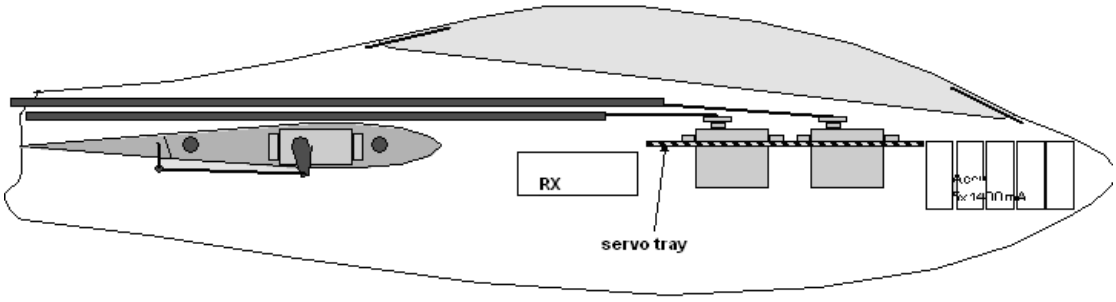
The fuselage holds the 4 standard servos for the stab, rudder, ailerons, receiver and the 4 or 5 cell battery (1400mAh). By placing the battery well forward in the nose, you should get the expected center of gravity with the addition of very little lead (less than 50 g).

5.1. Installation of servo tray

Make a servo tray from ply to the following dimensions:

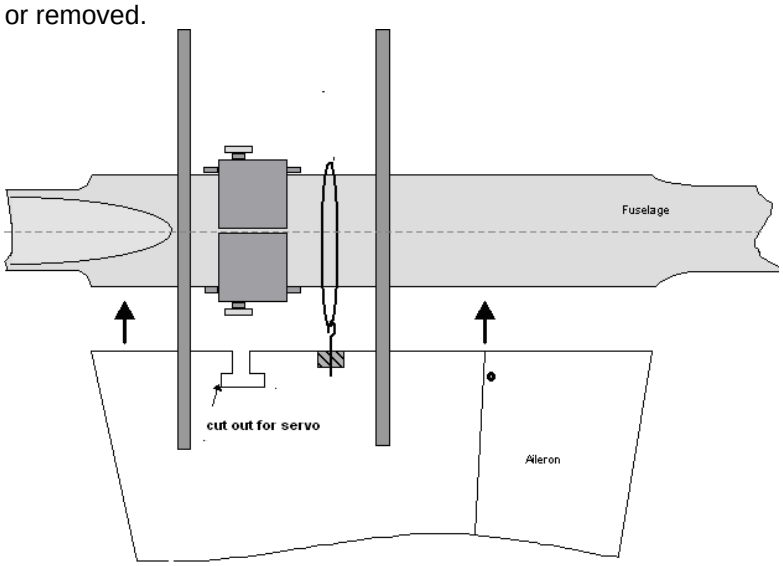


Scrape the inside of the fus so that resin epoxy glue adheres and holds the tray at the place indicated in the drawing. It is best to install the radio tray at the same level as the wing for better balance.



5.2. Installation of Aileron servos

The two servos are fitted in the fairings. The moulding is thick enough between the two joiners to allow direct screwing of a standard servo. Just ream the fairing and make four small holes in the moulding for the screws.
The tops of the servos stick out from the fairing into the wing panel, which must also be hollowed out to match. The inside skin must also be cut in a T to allow the horn to pass during assembly of the wing and during flight. The advantage of this type of installation is that it does not weaken the wing, avoids the need for a supplementary joiner and keeps the inertia in the center, which is important for flight. During mounting and dismounting of wings on the field the ball links may be easily attached or removed.



5.3. Control linkages

The links are simple threaded rods cut to the right length. Screwing and unscrewing the links will do fine-tuning.

The two links for elevator and rudder are made of carbon tubing 6mm diameter with rods glued to each end with epoxy. In the case of separate elevators, you must insert two threaded rods of the same length with two ball joints on the side of the stab to form a Y and thus control the two elevators simultaneously.

6mm dia carbon rods will be sufficiently stiff. If you like to fiddle, you can install a brace with 2 holes of 7 mm above the wing joiner of the back wing to guide the rods.

6. Centre of gravity.

Neutral is at 105 mm from the leading edge. With a 1400 mAh battery practically no lead is needed. For the first few flights, one can bring the center forward by 5mm, i.e. put another 30 g into the nose.

7. Control movement and mixes

Positive movements are downwards and are measured at the root of the control surface in question. As the glider is symmetrical, there must be equal up and down movements. The controls given here create a very agile glider on all axes. We strongly advise you not to use these controls without a lot of exponential (30-40%) to allow the necessary precision for a clean flight.
Use the flaps for 4 axis flying, i.e. the flap control is on a transmitter control stick, which you can modify by removing the return spring and making a detent to mark the center position
The Volij is specifically designed to use flaps so an elevator to flap mix should be used to get best results.

Stab with elevator:	+7 mm /-7 mm	
All flying tail:	+14 mm /-14 mm	
Rudder	+35 mm / -35 mm	
Ailerons:	+30 mm / -30 mm	no differential
Camber :	+6 mm	
Inverted camber:	-6 mm	
Snap flaps	+20 mm / -20 mm	
Elevator to flap:	+15 mm / -15 mm	
Air brakes:	-30 mm	
Elevator compensation with air brake:	+50%	

8. Flying

8.1. First flight

The first flight should be made without ballast, with all controls in neutral, center of gravity a 95mm from the leading edge. The wings are fixed to the fus by tape or elastic bands along the joint. We advise you also to do the first few flights with 50% Dual Rate on all 4 axes to accustom yourself progressively to the astonishing agility of this glider.
Because this glider is symmetrical it will tend to be sensitive in pitch in both upright and inverted flight. In either mode use the flaps to give a little camber for smooth flying.

8.2. Thereafter

Bring the center of gravity back by 100mm from the leading edge according to your feelings. A reasonable back limit is 105mm. Familiarise yourself with the glider before increasing the movement to the suggested values.

8.3. Ballast

Not terribly important in the Voltij. That's why no ballast tube has been provided for. Nevertheless in a strong wind the carbon wing joiners can be replaced by 8 mm steel rods, which corresponds to +/- 200g of ballast. This makes the glider fly more rapidly and the maneuvers become smoother and more ballistic.

Thanks to John Godwin for this english version.