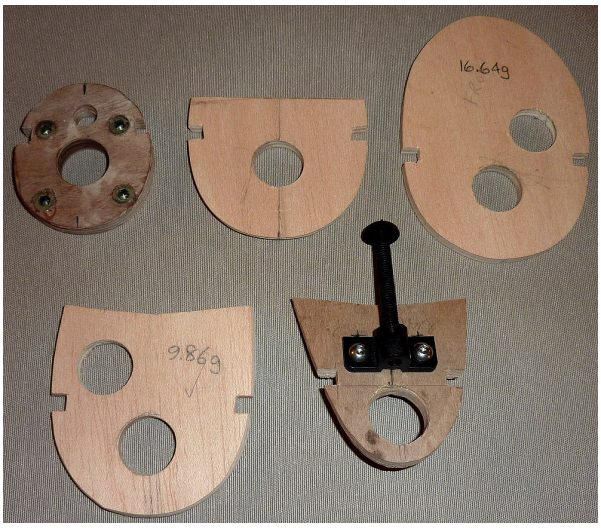
The skyscraper method for fuselages

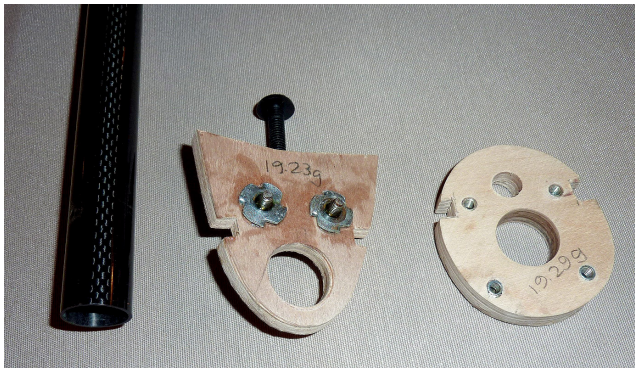
I decided to build a new motorised fuselage for 40 year-old 3 m Graupner Cirrus glider wings and tailplanes. It is a credit to the quality of the original kit that all were sound and true after years of storage. I fitted ailerons and airbrakes and covered with Hobby King film.

I decided to use a 20 mm round carbon fibre tube for the tailboom. I bought one that was made with epoxy resin rather than polyester so it would glue well with epoxy. It turned out to be exactly the correct length for the complete fuselage and was only 92 g.

This set me thinking about not cutting it but taking it right through forward to the motor bulkhead. I decided to use 6mm liteply formers. I love liteply! The only exception was the motor bulkhead, which I laminated from four layers of 3 mm birch ply. The five formers weighed a pleasing 48 g in total including t-nuts, threaded inserts and wing mounting bracket. The fuselage has a semi-scale curved pod at the front planked with 3mm balsa and then glassed using 24 or 48 g/m^2 cloth and Eze-Kote polyester resin. I couldn't use carbon fibre cloth as it would screen the receiver. Any minor damage to the shell can easily be repaired.

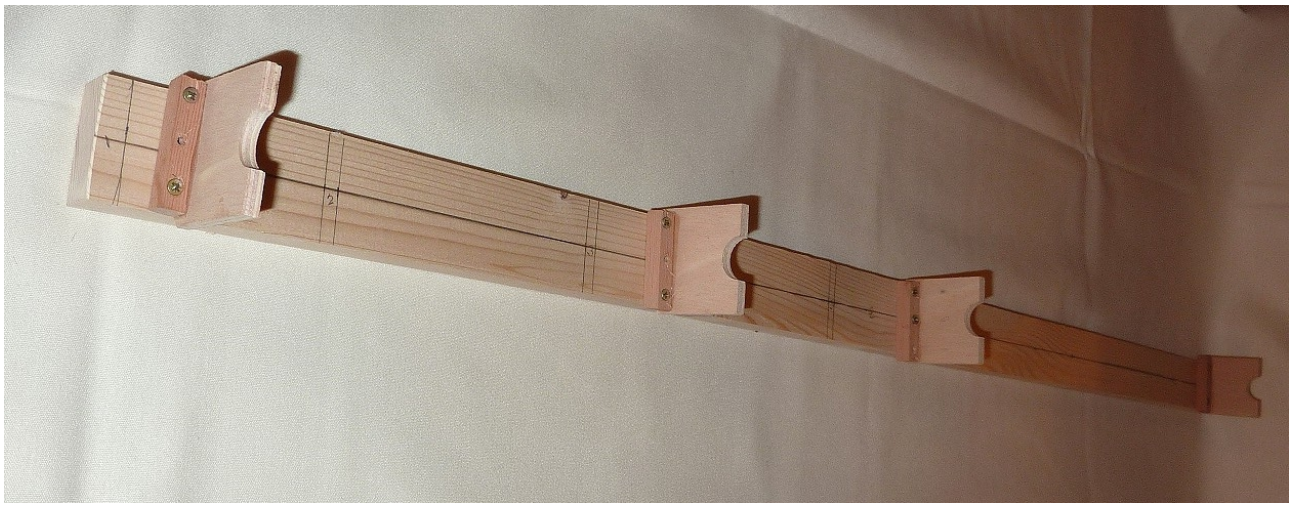


Formers



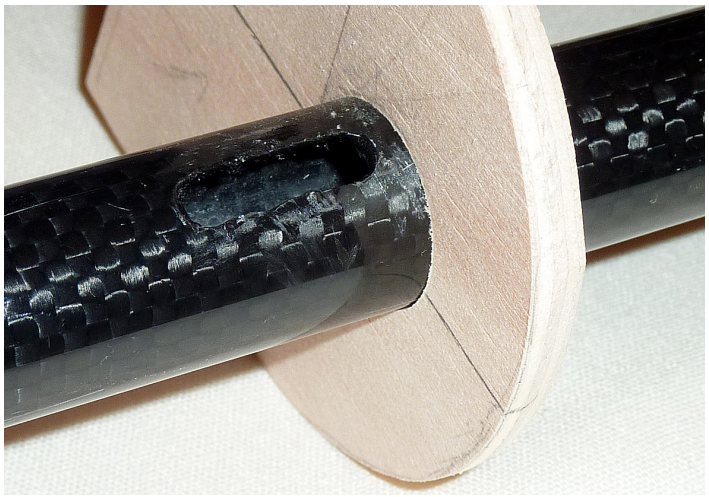
Formers and tube

I drew the formers on 1.5 mm card and cut them out to check that the curves would look good. I then traced them onto the 6 mm liteply and cut them using a Makita jigsaw with a fine blade, followed by sanding to exact shape with a belt sander lying on its side. I cut the 20 mm holes using a diamond holesaw in a bench drill press. I tested the shapes again for flow on a 20 mm wood dowel. I didn't want to scratch the polished surface of the carbon fibre by moving the formers around. I built a jig with cross markings to ensure lateral true and marks at top-dead-centre on each former to get them vertical.



The jig

One difficult decision was where to cut a hole in the tube for the servo leads which would go from the receiver to micro servos in the tail for the elevator and rudder. It will be a stress-raiser of course but I reasoned that a 5 mm smooth rounded slot cut in the side with a diamond holesaw in a bench drill press should only cause horizontal weakening that the longerons and the ply plate for the radio gear would correct. If I had any residual doubts I could sleeve it with epoxied 1 mm ply. I didn't need to. I smoothed the inside edges of the slot with a dribble of epoxy in case the carbon fibres wore the insulation away and shorted the wires.

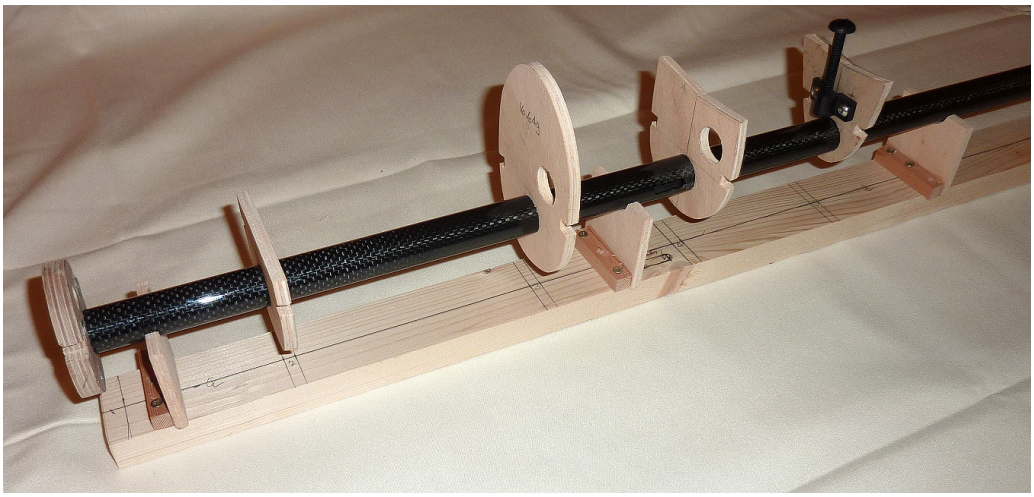


Servo wire slot

At the rear I drilled holes top and bottom, with another holesaw, for a 6 mm carbon fibre tube leading edge for the fin. I left the tube unglued until all the formers were in place so the bottom could drop onto the datum line on the jig to check that the formers were aligned with the fin.

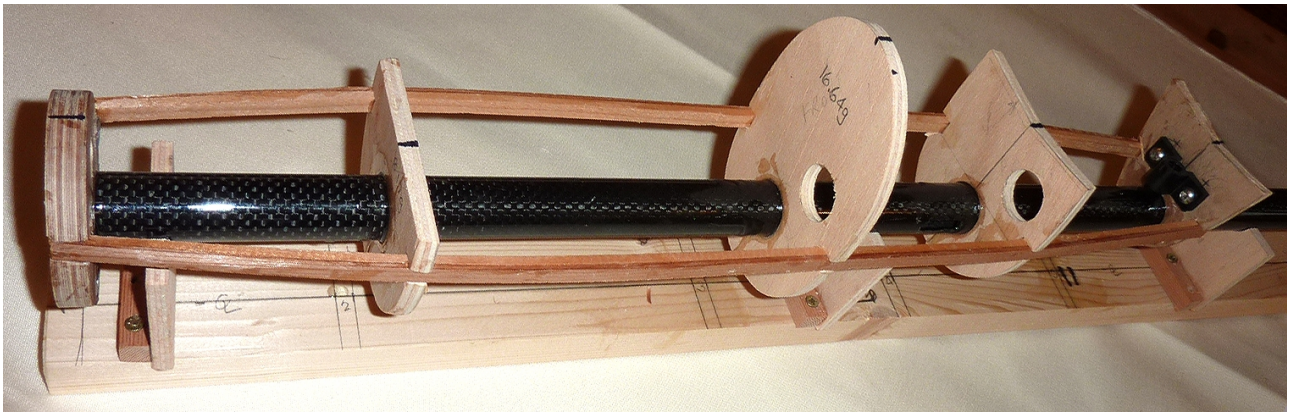
Installing the servo extension wires proved easy. I dropped them in from the tail end until I could see them through the slot then hooked them out with a wire paper clip.

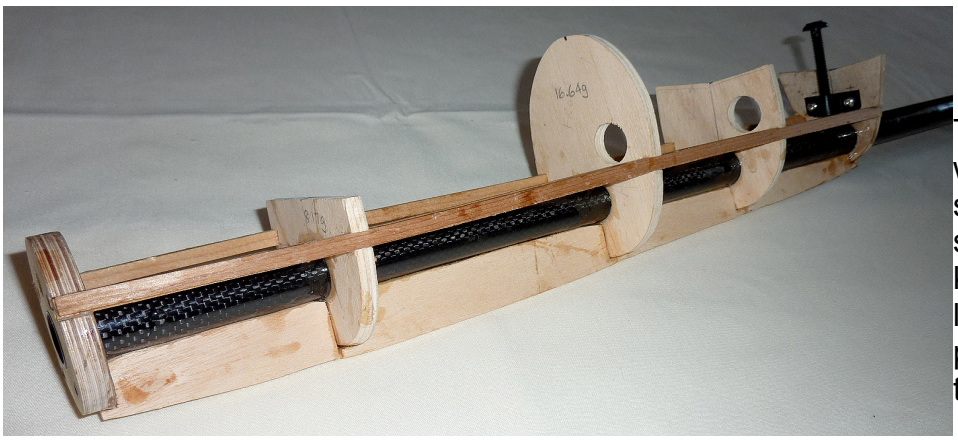
Unglued formers on the jig



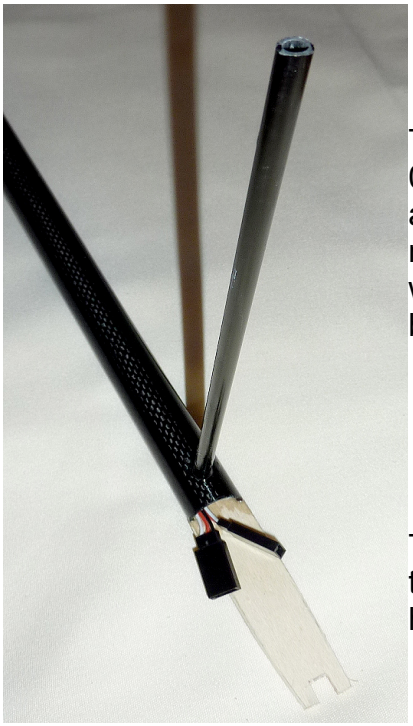
I glued the motor former first using a square, as this would determine the motor thrust lines and so had to be exact. After 24 hours, when the two-part epoxy had fully cured, I glued the others. To measure exactly the two parts of the larger quantities of epoxy needed for this I used a disposable cup on a balance. One big advantage of the tube is that angles of attack are easy to measure and set up and the fuselage is certain to be straight in plan view.

Once cured I fitted longerons made of two layers of spruce (6x3 and 6x1.5) to lock the formers in place, glued with white PVA. I will fit the mounting plates for the electronics to them.





To protect the planking when landing, and to stiffen the structure, I shaped and glued in a keel made of 6 mm liteply. It stands 3mm proud of the formers so the planking will be flush.



The fin leading edge is a 6 mm round carbon fibre tube with 0.5 mm walls. The 3 mm liteply insert helps to lock it in place and forms a fin rib. Because this reduced the space inside the main tube I had to install the servo leads before gluing. I wrapped the wires with plumber's PTFE tape to prevent them being glued. It worked a treat.

The rear of the fin is a 6 mm square thin-walled carbon fibre tube. I will use round pivot hinges for the rudder glued into holes drilled in the tube.

For a while I puzzled over how to get the fin perfectly aligned. Then I realised that two spruce spars clamped onto the fin uprights and the wing fixing bolt would do the trick. I was pleased and surprised to find that the spruce was straight enough afterwards to be usable.

The main tube takes up a fair bit of room in the pod. However the only electronics under the wing are a tiny FrSky X8R receiver and battery voltage and vario telemetry devices, so there is plenty of room. I put in a sloping plate under the canopy so the battery would be ejected in the event of a sudden stop. In minor bumps it is often the battery that causes damage, which in this case would only be to the canopy. Unfortunately the size of the tube ruled out a retractable wheel. I used an aluminium strip strake instead. I had hoped to use titanium but couldn't find any 6 x 2 mm strip.

I am pleased with my first major use of carbon fibre. It is light and stiff and does not change shape over time. One disadvantage is that all gluing must be done using epoxy, though possibly thick CA is an alternative. Not being water based, epoxy doesn’t get lighter

as it dries so you have to be as sparing as possible.

A cylindrical tube works well for a curved fuselage. I must try a square one for a square fuselage. It would make lining up the formers and forming a balsa shell very easy.

Why do I call it the skyscraper method? Such buildings now have a strong central core from which floors and walls are cantilevered. Then the glass is put on the outside. Apart from being rotated by 90 degrees my fuselage design is the same, as it has a very strong core with a light shell covered in glass (fibre).

Weights (g)	
Tube	92
Formers	48
All up with formers, longerons and keel	202

 Last edit 8 February 2017