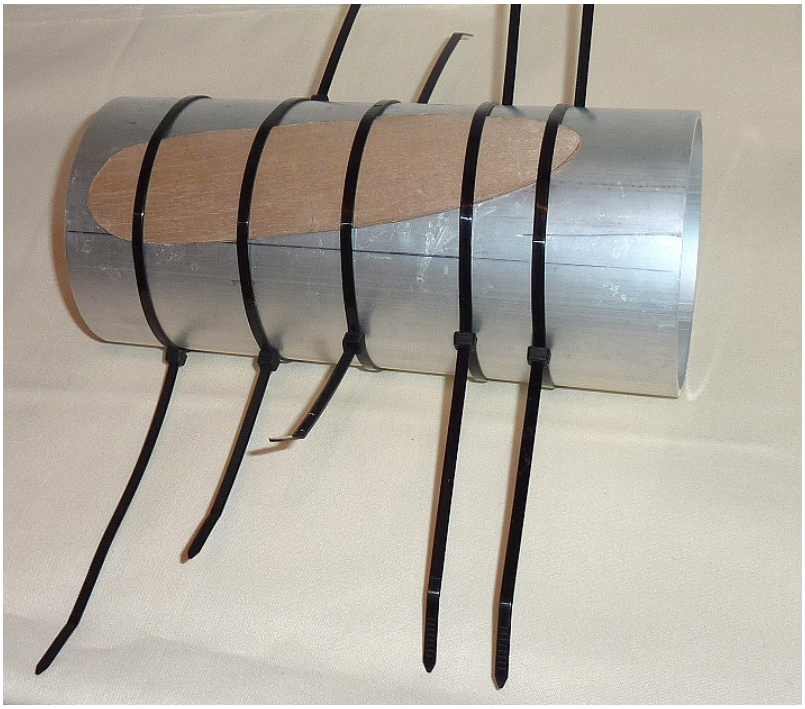
Propellors for indoor flying

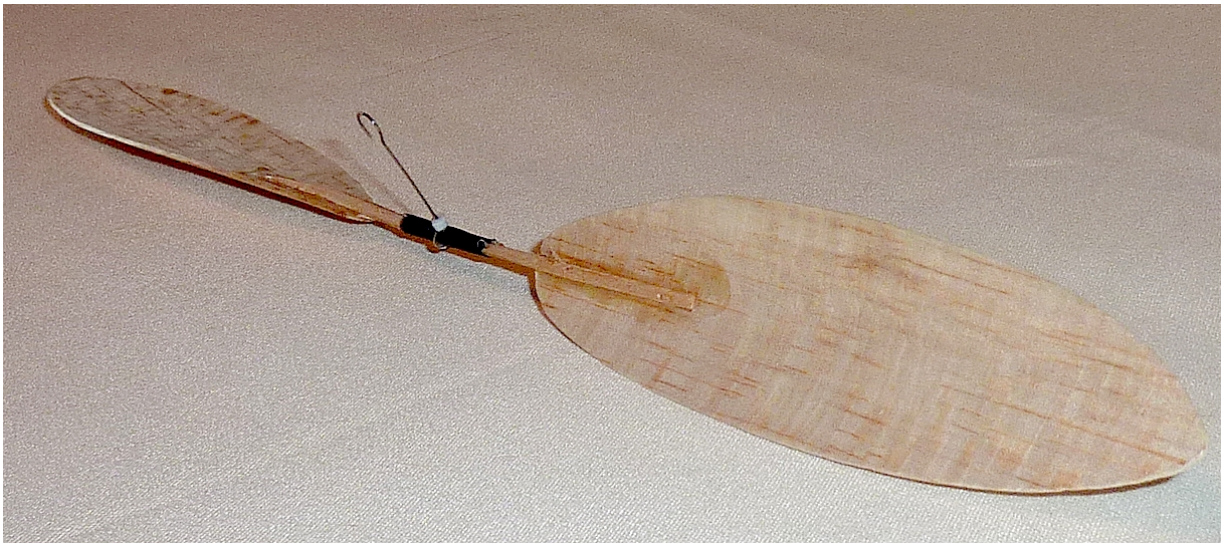
For now I have reached the duration limit for my Lumen 3. The reason is that the propellor turns too fast so uses up the turns too quickly. It is also inefficent. My target is a four minute flight in the Stalham sports hall which has fairly low ceiling. So far I have achieved a little over two.

The current propellor is made of shaped blanks of quarter grain 0.8mm balsa. I soak them in water for ten minutes then strap them round a 115 mm diameter aluminium tube at an angle of 15º to the axis.



Baked in the oven at 150ºC for about half an hour, the result is stable blades. I make the hub out of glued tissue tubes wrapped round a 1.6mm drill. I can then play with the pitch to get an intuitive best angle.

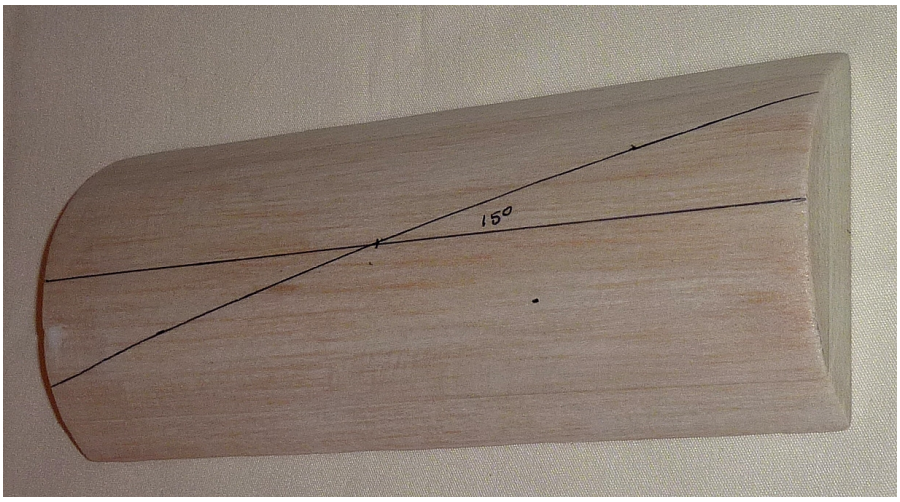
Here is a picture of the current prop.



The problem is that, though twisted correctly, the blades are fairly flat so are not efficient. I need built-up blades, with an aerofoil section covered with film, that will turn more slowly. I can then use more of the turns and hopefully use longer and probably thinner motors.

I have never built such propellors. My first thought was ‘on what will I build them?’. The prop will be built up from ribs and curved strips so will need pinning whilst drying. In his book ‘Building & Flying Indoor Model Airplanes’ Ron Williams shows a clever design jig design using eight plastic protractors which can be individually rotated in slots on a baseboard. Each has balsa glued to its straight edge, into which pins can be pushed. Maybe I’ll try that later. It seemed very clever but complicated.

The lightbulb moment was ‘a curved building board’. I glued two rectangles of 15 mm balsa together. I made a card carving template to fit the aluminium tube. Then with a David plane and sandpaper I shaped the curved surface to match the template. I decided to harden the surface with a couple of coats of Eze-Kote. Here is the result. I will try cling film stretched over the curve to act as a release agent for the glued joints. I have marked the correct angle to give the required twist.



My propellors will not be as flimsy as the ones for FAI models. I should be able to build the outline around a template on the curved building board then remove the template and add the ribs. I will then glue the whole onto the propellor spar in a jig. I will also use the carving template as the starting point for marking out a sheet aluminium template for cutting the ribs.

Size of blades

I think I have been making them too small. Hence they spin too quickly and burn off the turns. An analysis of several models in Williams’ book give the following averages:
Total propellor diameter about 90% of wing span
Each blade length about 40% of wing span
Blade maximum chord to blade length about 20%
Based on a wingspan of 600mm I went about 20% smaller.

Next I needed a former around which to form the propellor outlines from soaked balsa. I sketched out the shape and cut it from 1.5mm card. Then I cut out three of these shapes from 1mm birch ply. After soaking them in water for 10 minutes, I strapped them around the115mm aluminium pipe, at 15º to the axis, using cable ties. I then baked this in the oven at 150ºC for 30 minutes. Finally I glued the three pieces together using PVA and strapped

them back on the tube as one piece to dry overnight. It should fit perfectly on the curved building board.

The next stage is to soak and bend 0.8mm square balsa to form the outer shape of the blade. Then the former is removed and the outer frame returned. The spar and the ribs are added. The covering is 1 micron mylar fixed by spraying the blade frame with Scotch 77. Here are the two blades in a protective box. They are push fits into a tissue tube hub like the one shown above, allowing optimisation of the pitch.

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