The EA9 Optimist – flight testing a promising prototype

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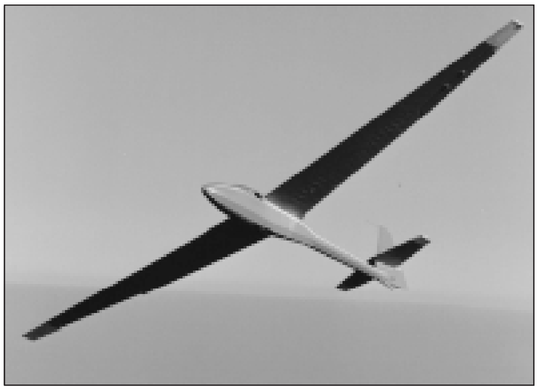


Derek Cattani

The Edgley EA9 *Optimist* kit sailplane prototype is now airborne in Britain and it promises to be an easy to build, maintain and repair, medium performance club sailplane at an affordable price. It employs a brand new way to use a proven composite material previously used mostly for floorboards!

The prototype had been brought to the Cambridge Gliding Club and, showing the manufacturer's faith in his product, it was made available to any reasonably experienced club pilot with a Bronze C and 50 hours. I reckoned I fitted the category, so on one of the last days in August 1998, and in spite of its unusual green and yellow appearance (it reminded me of an Australian rugby team), I hauled it to the launch point and got airborne behind the club's Pawnee. It happened to be the one day this year that the club's winch was out of service for maintenance so I wasn't able to see for myself what it was like on a winch launch.

Back to the beginning. The DI had shown me the unusual honeycomb Fibrelam board it was built of, and while the similarity to wood and fabric construction was apparent, there was no doubt that this was *not* wood. In fact, 80% of the 300-odd components are made from 6 mm and 10 mm Fibrelam. This is a very lightweight precured composite sandwich board with cross-plied fibreglass skins over an aramid honeycomb core. The same material is used in most airliner floors. It has a better strength to weight ratio than wood, and the end result is a strong aircraft, yet lighter than an equivalent in wood or metal. The material is not easy to cut accurately by hand, so computer controlled routing machines are used to cut the kit parts to size.

Indeed, you can choose the amount of pre-finished components you have in the three grades of kitset. The basic kit consists of the Fibrelam components ready to assemble, and while it includes the preformed hard skins for the wing "D" box, fin and tailplane, the wing spar has to be assembled and no hardware is included. The intermediate kit includes the hardware and the wing spar is assembled, but considerable fitting is required. The deluxe kit has the Fibrelam structure largely complete, all that's required is to put the fittings in and set up the control runs. The company (Edgley Sailplanes Ltd.) compares completing the latter kit to a major overhaul and refurbish of a con-ventional metal or wood framed sailplane. None of the kits include the fabric or finishing materials. The price difference is not inconsiderable, £9,995 ($28K) for the basic, £12,150 ($34K) for the intermediate, and £17,500 ($49K) for the deluxe version.

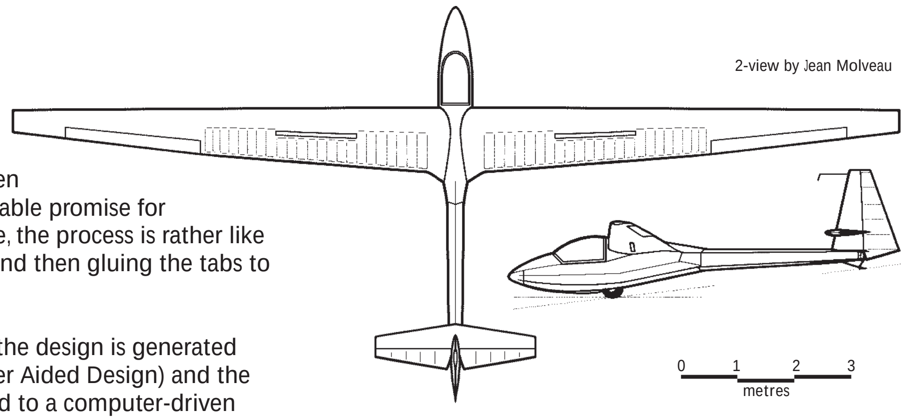
So what do you get for the money? For a start, you get a brand new glider (which doesn't have to be white) and you get a glider that is very pleasant and somewhat nostalgic to fly. It looks old fashioned too, with the fabric covered wings behind the spar and the angular fuselage dictated by the flat sheets of Fibrelam. It has a slightly bulbous canopy which vaguely reminded me of a K8. I'm told that it should have reminded me of a ASK-18 (I can only go by photos, and yes, it does have the longer nose and smoother lines of the ASK-18). This is because it was designed with the ASK-18 as a model, more as a proof of structural techniques than as a completely new design of sailplane. Still it is different, it has a shorter wingspan, (a most unusual 15.7 metres), and a Wortmann airfoil of more modern design than the ASK-18s NACA profile. Finally, the tailplane is mounted up the fin to avoid crops in outlandings. The performance is similar to the ASK-18 and several other of the somewhat older generation of sailplanes. But I am getting ahead of myself again.

Getting into the cockpit was easy, the side-hinged canopy opened wide. Once in (and being short) I felt lost, there was so much room in the cockpit. And in spite of my parachute keeping me forward enough to have the control column comfortably to hand without stretching, my feet were a good way from the rudder pedals. They are adjustable of course, and on the last position I finally found a comfortable spot which allowed full rudder travel. Clearly, a much larger person than myself could fit into this cockpit with ease. The maximum useful load is 135 kg! *(Since this flight, the pedals have been modified to be in-flight adjustable, the cockpit will now easily accommodate a 6'-6" pilot, and the canopy latching system has also been improved. ed)* With such an aircraft, there is no provision for water ballast so the load can all be pilot if necessary — for light pilots there is provision for 22 kg of ballast to be bolted to the floor between the pilots legs.

Once settled into the cockpit the launch got underway. The first thing to notice was the fact that with the light wing loading, it was off the ground very quickly. The trim was effective and it was only moments before I realized that the controls were beautifully balanced so that both ailerons and elevator felt completely natural, absolutely smooth and very effective. The Pawnee was feeling her oats that day, and it was not long at all before we hit a good thermal at about 1600 feet and I pulled off. ⇨ **p8**

The EA9 Optimist – design and engineering

John Edgley



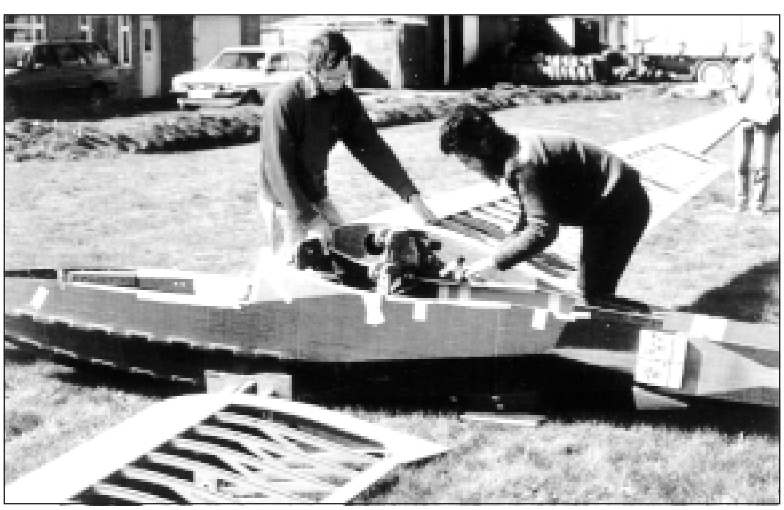
2-view by Jean Molveau

A new type of aircraft construction and assembly process has been developed which holds considerable promise for the homebuilt market. In essence, the process is rather like cutting out a cardboard model and then gluing the tabs to the panels.

In the case of the EA9 sailplane, the design is generated by a computer (CAD, or Computer Aided Design) and the computer data is then transferred to a computer-driven machine (CAM, or Computer Aided Manufacturing) which cuts boards of Fibrelam into the required components bearing interlocking tangs and slots. The components are assembled dry in a jig and then bonded together to produce an airframe. The assembly process is rapid and devoid of dust, odours and the hazards associated with resins and solvents. It produces a robust airframe which can withstand the weather and is as light as wood. The EA9 recently had further tests at the University of Bath School of Mechanical Engineering, where John Edgley spoke to *"Popular Flying"*.

"PF" Why did you choose to demonstrate this technology on a sailplane rather than a powered aircraft?

John Edgley I wanted to investigate the technology. The idea that we should do a sailplane as a proof of concept came later. In fact, when I applied for that first government grant, I only said we were going to build something using Fibrelam and it was on that basis that we got the first funding ... Of course, in investigations of this kind you actually have to build something. The first idea was that we would perhaps just build some wings for an existing aeroplane. Then on consideration, I thought it might be better to go on and do a full aircraft. I didn't really want to get into the business of engines and making engine systems work, because that wasn't the idea of the project.



Early rigging tests on the partly assembled prototype. Tabs along the fuselage panels that create the interlocking, self-jigging joints are evident.

So, I decided to go for a glider and went and interviewed Derek Piggott. We decided that we wanted to show we could build an aircraft which was as light as a wooden aircraft. That was definitely the target: can we build as light as wood? Ten years ago I did a historic survey of different kinds of aircraft construction and plotted it on a graph. It showed, as aircraft materials in use changed from pure wood to wood and steel tube to aluminum and glass fibre, each of these so-called improvements increased the weight and bigger engines were required...

The idea was born to use Fibrelam with which I had some previous experience, building as light as wood to prove the concept. I wanted to have some direct comparison with an existing wooden structure.

"PF" The EA9 is an all-Fibrelam aeroplane?

John Edgley Yes, the whole thing except the flying surface skins, which were similar but made with precured glass cloth. The only other material that I have been looking at is a carbon fibre pulltrusion which is made by pulling carbon fibres through a mould into which epoxy-resin is simultaneously squeezed. The mould is heated, so the structure is cured as it merges.

The Fibrelam material is supplied in sheets similar to plywood, and most of the Fibrelam we use is 1/4". We have used other thicknesses in small amounts.

"PF" I'm sure that, what will run through the minds of many when they read this, is whether or not Fibrelam is a suitable material for incorporation in homebuilt designs where they don't have a CAD/CAM setup.

John Edgley I think it would be perfectly possible to do it without CAD/CAM. The only thing I have to say is that you would have to make a set of cutting templates. Fibrelam *can* be cut 'freehand' but it is very difficult. You can cut it with a small circular saw, but by far the easiest way is to cut it with a lightweight router. If you are using a router but have no numerical control, you must use a template. You only need a very lightweight router — during much of our manufacturing process we used a very fast 29,000 rpm drill with a modified head. ⇨ **next page**

The Optimist – flight test

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The release is a "T" bar on a cable near the left leg, again like all of the controls easy to reach and operate.

Thermaling was a piece of cake, the controls allowed the selected angle of bank to be easily maintained and even in the turbulent lift of the thermals on that late August day the Optimist displayed the stable controls I had experienced on tow. The climb was rapid up to 5500 feet and I started to explore the penetration between thermals. A relatively slow 60 to 65 knots produced just the sort of sink that one would expect from a Ka6E or similar, at faster speeds it seemed just a little better. I don't think that inter-thermal speeds much over 70 knots would be a good idea, although Vne is a comfortable 125 knots.

I was able to fly beside an LS-8 for a while, and certainly at the lower speeds there wasn't much to choose in sink rate, but when the LS-8 stopped gawking at the green machine and went off, there was no doubt that the Optimist is in a lower performance bracket, similar to an ASK-23 or the -18. All three types are said to have a glide angle of 34:1 at about 41 to 43 knots, while sink rates are around 1.2 knots at 35 knots according to the book.

I tried a few stalls which were quite innocuous with nose drop at about 33–34 knots, although the book said 32 knots. Still, no problems. I conserved my height in the dying thermals, it was past 5 pm and the lift was getting weaker and further apart. In these conditions, I was able to outclimb an ASW-20 with winglets, but then I could fly slower in the narrow core while the glass ship waffled around the outer regions of the thermal.

How the Optimist compares

	Edgley Optimist	*Schleicher ASK-23*	*Schleicher ASK-18*
Vne	*125 kts*	*118 kts*	*108 kts*
Best L/D	*34:1 @ 41kt*	*34:1 @ 43 kt*	*34:1 @ 41 kt*
Min Sink	*1.2 kt @ 35kt*	*1.2 kt @ 35 kt*	*1.25 kt @ 40 kt*
Wing Span	*15.7 m*	*15 m*	*16 m*
Wing Area	*13.06 m^2*	*12.90 m^2*	*12.99 m^2*
Aspect Ratio	*18.85*	*17.44*	*19.70*
Length	*6.95 m*	*7.05 m*	*7.00 m*
Height	*1.72 m*	*1.48 m*	*1.70 m*
Empty Wt	*216 kg (476 lb)*	*230 kg (507 lb)*	*215 kg (474 lb)*
Max Wt	*335 kg (738 lb)*	*380 kg (838 lb)*	*335 kg (738 lb)*
Useful Load	*119 kg (262 lb)*	*150 kg (331 lb)*	*120 kg (265 lb)*

The view outside was good, although the rather high coamings around the cockpit made the outlook a little restricted unless some weaving was undertaken while checking below and towards the rear of the glider for other aircraft. There were plenty of gliders around too, as a nearby club had routed a competition task through the area. Masses of gliders in the sky does tend to concentrate the mind when it comes to keeping a good lookout.

I had been up about two hours when I realized that the slightly more upright seating of the Optimist compared less well with the French "Mistral" glider I had flown the day before. My tailbone was starting to feel the pressure of the more upright position, while in the Mistral after a pleasant four hour flight I had felt supremely comfortable. It may have been the difference between the two different parachutes, one acting as a better cushion. I used no additional cushioning in either ship, so it was either that or the seat shape that made the difference. Nevertheless, it was significantly better than the Polish Junior which I had flown a few days before, which left me nearly crippled because of its poor seating.

Finally, all good things come to an end, I decided I'd better try the air brakes as I was just about ready to land. No tendency to suck open, no judder, just good, honest and very effective airbrakes. Landing was absolutely normal and I did not need to allow it to go forward onto the small skid in front of the main wheel until it had almost stopped.

Overall impression, easy to fly, beautifully balanced controls, and absolutely great for local soaring. It would be no problem in flying cross-country, but it would only really fit into the Sports class for competition. Too much span for the Standard class and not enough performance. As a Sports class machine in New Zealand, it would be in with the Ka6E and similar machines, possibly slightly better, but it has a similar performance to many of the glass gliders too, so it would be quite a good match for the PW-5, Club Libelle, the Club Astir and some of the two-seaters.

Derek Piggott flew it in competition where it did quite well, although one wonders how much of that performance was the pilot in his case. It is a delightful aircraft to fly, and if you enjoy flying the fruits of your labours, then it would be an interesting aircraft to have. ❖

The Optimist – engineering

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"PF" Have you come across any particular problems of a structural nature during the course of construction that you hadn't anticipated?

John Edgley The whole thing is very experimental. We had to develop joint types and the whole business of attaching fittings. Typically, you have to insert some kind of metal ferrule into the Fibrelam in order to pick up the bolt loads, because the material has a very low sheer strength. You can't just drill a hole and put a bolt through. Fibrelam has been used with ferrules to fabricate the floors and galleys on commercial aircraft for some time. I suppose that one of the main difficulties is that there is very little data available. The material is temperature dependent to a certain extent. The regulations state that a glider has to be able to withstand its flight loads even at 56°C. The reason for that is the possibility of a heat soak on the ground while the glider is at rest, before someone climbs in at Alice Springs and goes flying. That is a pretty high temperature and we had to do a lot of our testing, including the joints, at an elevated temperature in order to do the strength tests. The strength can go down to about a quarter of what it would be at room temperature, particularly the joints, rather than the Fibrelam itself. Any composite tends to be weaker at high temperature.

"PF" If you wanted to adapt this technology to a powered aeroplane, such as a typical kit-built aircraft, what would you have to do next?

John Edgley I would like to do a kit-built aeroplane in this material. It is ideally suited to kit building because you end up with a kit of parts which is rather like building a model aeroplane. All the parts are cut out and ready to go. A lot of the tangs and slots simply slot together, so you know where items go. Items can only go together right where you have tangs and slots. In fact, many of the assembly jigs are the same. Many of them are made of plywood and were also cut out on the Numerical Control routing machine and go together rather like IKEA flatpacked funiture. With this construction technique you don't need a full mould as you would with a wet lay-up cloth. You simply need assembly fixtures, typically a number of frames to hold the shapes.

"PF" You have adapted an existing aeroplane shape to new materials. You knew before you started that the basic design was satisfactory.

John Edgley The EA9 is modelled on the ASK-18. Most new aircraft are, in fact, modelled on an existing design. We have our own wing section and fuselage section, so it's a loose comparison. But I did want an existing wood glider as the target, from the weight point of view, because I wanted to show that we could build as light as wood.

"PF" How would you define the advantages of this glider as a kit?

John Edgley Compared with a wooden glider there are far fewer components — I reckon about one tenth (depending how you regard a wing rib). The material is obviously much more robust than wood, especially as you can leave it outside. It will not absorb moisture.

"PF" The aeroplane is now here at the University of Bath School of Mechanical Engineering. What part does the University play in the project?

John Edgley During the early test flying we found that there were one or two things about the stability and control that were unsatisfactory due to lack of stiffness. This is probably in the fuselage, though the conclusion that everyone came to was that it must be wing torsion, though I didn't believe that. The early indications we have from Bath University agree with my instincts. It is probably just a bit of flexibility in the fuselage which is causing slightly strange control effects in terms of stick force per 'g', declining as you go faster. In any new design you can't expect to come out right first time unless you spend enormous amounts of money on the theoretical work. But Bath are doing a proper theoretical stability analysis of fuselage stiffness. You could argue that we should have done that, but the difficulty is that if you do everything you should, you would never finish... If we find out that it is just a question of fuselage stiffness, we can simply apply some carbon fibre tape to the Fibrelam and that should solve the problem quite easily.

"PF" Is there easy access to the fuselage interior?

John Edgley Yes. The fuselage boom can be detached with bolts from the forward fuselage at the wing trailing edge. We designed the aircraft that way because ground looping is quite a common cause of rear fuselage damage on a glider. If you smash the boom you can unbolt and replace it instead of making a complex repair. *(The boom is attached to the forward fuselage by 30 bolts, and the fin is also bolted on. ed)* The wings are covered with traditional materials which now means Ceconite or Diatex. People can work easily with that and mend it when damaged. It's much easier to repair than fibreglass.

"PF" Is Fibrelam an easy material to repair?

John Edgley We haven't had to repair it yet. It is probably as easy to replace a panel of Fibrelam as one of aluminum. There is no reason why you should not cut out a hole and put a patch in. The skin of the Fibrelam is only 0.5 mm thick so that, provided you don't mind a slight discontinuity on the skin, there is no reason you should not in effect do a lap joint repair. It would end up slightly heavier than the original, but the change in weight would be very low. We did some lap joints of that kind on the original design.

"PF" Assuming that you solve these minor materials problems, what will your next step be? Will the EA9 go into production?

John Edgley We have looked at the market and are sure that it would sell. *(Preliminary work on a two-seater has also begun. ed)* If somebody else wanted to produce it in quantity, we would be glad to help, either as consultants or possibly as a joint effort. I would be very interested to hear from anyone with the necessary experience and potential commitment to kits or complete airframe production.

"PF" Do you believe that a single-seat glider can beat the German manufacturers on price or performance or both?

John Edgley I could certainly beat the Germans on price. On performance, it is a mid-performance glider and doesn't pretend to be anything else. The mid-performance machines are nearly all old machines which have been built or licence-built versions of old designs like the K13. Compared with a wet lay-up or glass, I am sure we can beat them comfortably on price.

"PF" Are you a pilot?

John Edgley No. All the test flying has been done by Derek Piggott. We built the prototype at Thruxton, but had to move workshops, so we were not able to get a great deal of time in the air. But in August last year, Derek entered for the regional gliding competition at Lasham, even though the EA9 had only done six or seven flights. Typically, he flew four hour cross-countries and came third in his class. So, although there are one or two aspects about the aeroplane which require development, the fact that it did so well in the competition shows that we got probably 95 per cent of it right.

"PF" There should be considerable interest from homebuilders from the point of view of the structure and possibilities of kit production with this material.

John Edgley Yes. This kind of aircraft does lend itself very well to kit production, and I am inclined to think that compared with wet lay-up glass, even though you can't quite get the aerodynamic refinement out of it, you can potentially build a much more rugged aeroplane. Certainly it is lighter than wet lay-up glass. Because of the light weight, one can go for a slightly lower wing loading. There are definite trade-off advantages there. ❖