

# Electric Flight

*The Magazine for  
Switched on Modellers*

International

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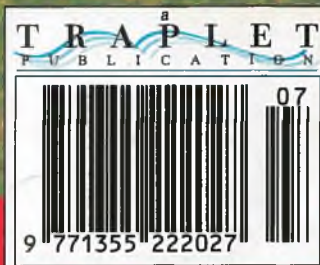


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# Editorial.

There was recently a lengthy debate on that excellent Internet mailing list 'Eflight' (see the Editorial in the March/April issue of EFI). Someone asked a question similar to that asked by so many beginners. It was the one like: "I have a Speed 400 motor that is rated for 7.2 volts but the kit says use seven cells, which is 8.4 volts. Should I use only six cells?"

## Information for beginners

After this question there was some immediate guidance but Matthew Orme of Aveox motors (that leading manufacturer of brushless motors, based in California, USA) stepped in quickly to say that a 'voltage rating' should not be quoted at all, it was far more useful to a beginner to be supplied with data like the Kv, Kt, etc., and let him determine for himself how many cells to use and what size prop.

"...the basic electrical relationships will give them a good feel for how motors can work. They will see very easily, that it is current that they need to be most concerned with.

"Most people are used to motors being rated by voltage, when it is almost useless, and just plain wrong. It makes them misunderstand the application. We need to stop doing it. You can see it easily with the Speed 400 motors, and even with AstroFlight motors. With ours, it would be pointless, since we have the same motor running from 7 to 30 cells in some cases.

Wow! our 1406/4Y is a good direct drive 7-10 cell motor, and a great geared 24 cell motor. How can we stick a voltage rating on it?

"The limits on any electric motor ARE rpm and current. Why should anyone rate them in another way? I can pick a voltage for a motor, and depending on the prop/gearing etc, it either may or may not exceed the safe rpm."

Immediately I jumped down his throat and told him he was getting far too complicated for most beginners.

The pair of us fired comments at each other for a few days (conversations are conducted at a very moderate rate by Internet when the other party is always asleep when you write your part!). Others on the mailing list from beginners to luminaries took sides. Both sides had support. I think I won by weight of numbers but as Tyler J West said: "To put an end to this... you are both right (both sides, I mean)".

Of course we were. What is

more extraordinary is that I determine what motor and battery I need by the method suggested by Matthew. And yet I opposed his suggestion? As an electric pilot with a long beard and as editor of this magazine I get a lot of similar enquiries. I always say: "This voltage rating is for general guidance, start here and with the recommended prop. You may get a better performance with a smaller prop and more cells, or with a larger prop and fewer cells, check the current, don't exceed the...

What's that you say? What, you don't have an ammeter? OK use the prop size they recommend in the kit and the number of cells too, even if it doesn't match the voltage on the motor, it's a 'ball park' figure, you can move each side of it if you want to."

If I drop any more names I will offend those I leave out but it is only fair to quote the origins. A lot of these 'arguments' I have said myself at one time or another but I don't want to look as if I'm the only guy who uses them.



## WHY NOT TAKE OUT A SUBSCR



Jim Bourke said: "Motors should be rated by their technical specifics, but named in such a way that the average modeler can immediately understand their intention." And at another time: "It would certainly help to have some recommendations on kit boxes."

Dick Burkhalter said (I paraphrase!) "Yes, Not only do they not know what a volt or an amp is, but they don't WANT to have to find out. They want to be told, right on the kit box, what size motor, what prop and what battery they need, to fly the plane. That's all."

Bob Sliff said: "My conclusion is that there is no proper way to initially come to a full understanding of the meaning of a word, especially one that you have never heard before. Only by exposure, by definitions, and by examples in use can we come to an understanding of what we have in our hand. ...we are all in the process of building a language of electric motors."

Bob put his finger here on the biggest problem that IC or glider pilots have 'converting' to electric flight. They should know half of it but we are talking a different language. It applies to newcomers too, how should they understand the language and the variables?

Tom Cimato (another brushless motor manufacturer) said: "You'll find that the motor specialists are best equipped to answer both the beginner and the expert..."

I'm sure he is right but that does not help the new flier to understand what he is doing. Before I get to sound like Matt, consider what George C Scrimshaw said: "I feel the beginner will walk away pronto if it looks as though he will have to think instead of just buying something to throw into the air and enjoy. If the beginner is technically inclined to start with he is more likely to apply his knowledge and improve it to better his ability to fly electric."

That is the crux of the 'problem' and I highlight 'problem' because WE have made it a problem.

There are two sides here. There SHOULD be two sides here. The solutions are in the answers quoted above and in Matt's statements and in my own state-

ment to Matt that started this furore (I paraphrase me too because I have to remember, I didn't keep a copy, I didn't think it would get this big!) "Beginners need simple information to get them in the air, don't confuse them with sums, they need to know which motor, which battery pack and which prop - not why."

That is one side, beginners and some pilots who only wish to fly. Some pilots forever wish only to fly. They do not want to build. They do not want to decide on components. They just want to buy and fly, but the nature of the model they need will change as their skills advance.

The other side is very technical, they spend months working out what motor they need, number of winds, how advanced the timing, how thick the flux ring, gear ratio, number of cells, capacity, prop diameter and pitch, wing section, wing planform, aspect ratio, flaps and ailerons or just ailerons, V or T or cruciform tail, or tailless or canard, wing loading, carbon or Kevlar or Spectra, balsa or foam, spruce or basswood or pine, tissue or silk, film or... You can get as deep as you like. Some of these guys do not even build any more, they just do sums, design models, do it again, and love it. There is lots of computer software to speed up the sums and some that saves you even asking the questions, you can get as complex as you wish.

These are two extremes, most of us start simple but not absolutely clueless and graduate towards the more technical, some go deep, some stop when they stop understanding more than they think they need.

You can change sides. You can stay in the middle. Don't think that competition pilots have to be superior designers or engineers or mathematicians, or all of these.

Do I hear someone say "This guy is drifting now, it has gone to his head."

I will give Matt Orme almost the last word: "I don't think that you will ever reduce the electric modeling hobby to the point where E-Calcul, Kress's program, or Aero-Comp will be superfluous. That's where you have to aim for to make it a non technical hobby. It will never happen."

David Palombo (He is Aveox and Matt's boss) said: "Look at our web site and download our literature. There you will find a table with the airplane type running down the left column and the performance on the top row. Where your airplane intersects the desired performance, the box tells you the motor, battery, thrust, RPM and current."

Another guy said: "But manufacturers have an obligation to provide technical details to customers that need or want them, so I don't know why the editor is throwing cold water on this concept." By editor I think he meant me. But Russell, I didn't! THAT is what I said.

I do dislike it when folk try to turn an art into a science. Model flying (all flying come to that) started as too much of an art form with too little science. The Wright brothers turned that round but applying very sound self-learned engineering, beating an American scientist at his own game and hundreds of enthusiastic Europeans with too much art, some science and little engineering. Don't distort things guys. All this learning and computer manipulated science and engineering is very valuable but we have to APPLY it. Those of us that want to that is. Some just want to go out and fly.

## This is where we came in

If any potential fliers want to know what to start with - tell them. If they want to buy a model that flies, suggest one. Don't specify the ten year apprenticeship that you had. Get them flying. If they are interested they can find out 'How' and 'Why' later. If they ever wish to build models they can discover that later too. Encourage them, don't baffle them with science, they may never need it. It has never been easier to start flying and in relative terms (I'm not talking chuck gliders and rubber models, or denigrating them) it has never been cheaper. Help them to start, we all benefit.

# Diary Dates

This has its own page but one event is worth mentioning here and one is not even in the 'electric diary'. August is a 'holiday month' for so many, so if you are thinking of visiting the UK or are here anyway, consider a visit to Woburn Abbey, Bedfordshire, on August 10. The BEFA Electric Fun-Fly is there but so much else goes on at Woburn that this can be a great visit for the whole family, and you can fly, or watch. Read more on the Diary dates page.

As electric fliers we value the quiet nature of our models. A 'non-electric' event has gone electric too. The 'Jet World Masters 97' event is at RAF Wroughton, Wiltshire, this year, a few miles from Swindon and the M4. It has gone electric part-time. After each day of roaring gas turbines and screaming IC engines, silence will fall at 6pm. Well, almost silence, from 6 to 8pm each day only electric ducted fan models will be permitted to fly. Some of the big names in model jets also fly electric jets. We expect to see there Jean-Paul Schlosser and Ralf Dvorac with their excellent small fast models and some of the British ducted fan pilots too: Chris Golds with his B-52 and possibly other models, Dave Chinery with his Boeing 777, Kurt Grosse, Kevin Saunders and more we hope. There will be a WeMoTec 'shop' there if any of you are thinking of purchasing fan units or models, there will be a Traplet stand too. The event opens on August 30 but expect to see electric models flying each evening from Wednesday, September 3 until Saturday the 6th.

# ADVERTISEMENT? - SEE PAGE 30 FOR A GREAT OFFER!



Model flying clubs and especially Electric Model flying clubs all over the world have FLY-INS for electric models. The format is similar: their own club members and visitors too are welcome to fly any type of electric model, for fun. Sometimes low-key competitions are organised for duration, vintage, aerobatic, scale, et cetera and awards made. This sort of event does not discourage model fliers reluctant to compete; it does encourage a spread of information and the convivial atmosphere does much to further electric model flying.

# Cover Story.



*Fred Taylor, of the Skelmersdale club, flew his 'Short Scion' twin. It uses one Astro 05, ten years old with straight cut gears, and one brand new 05 with helical gears, both are the same ratio, both motors perform exactly the same which Fred thinks says a lot for Astros, that the 10 year old is still as good. Both drive 12 x 8 Master Airscrew wood electric props at 4,300 RPM. Model weight is 7lbs (3.2kg), and what looks like undercarriage suspension units is not so. Springing relies on the piano wire UC legs attached to the fuselage. Wingspan is 67" (1700mm) and this model was built from a scaled up plan by C Rupert Moore for rubber power. The original had a very complex rubber drive system, Fred's model was built to original plan outline but with new construction technique. Take-off, flight and landing was all very civilised and realistic to scale.*

## Cover model

This article is not devoted to this excellent model but to the event at which it was first flown publicly. (Its first flight, the previous day was almost 20 minutes long.) The model on the cover is a Chet Lanzo 'Super Rocket' built by John Norris. The model design is almost seventy years old. Wingspan is 96", wing area is 1300 sq.in. Total weight is 10.5lbs, 4.5 lbs of which is the airframe. An Astro 60 on 24 x 1700 cells and a Sommerauer 85A speed controller, drives direct a 13 x 8 prop. Wheels are DuBro.

The Blackpool and Fylde RCMS 'All Electric Fly-in' on 25 May 1997 was typical of such events. Their flying site is a close-mown circle of grass about 50 metres in diameter. The ground falls away a little on three sides and on the fourth side and on the same level is a copse of trees, 20 metres away. This copse is their car park and beyond it and out of sight is a village, so they do not fly on that side at all – all very

# Club Fly-ins





**Chris Martindale designed and built 'Whizz 2'. Wingspan is 50" (1270mm) and power is a Graupner Speed Gear 2.7:1 700, 9.6V Neodym driving a Zinger 12 x 8 wood prop on 12 x 1700mAh cells. Take-off is brisk and it can roll too fast for the eye to follow it. Throttled back, it was very civilised and Chris loves to pilot it and claims it is so easy to fly. We will see more of this model.**

sensible. The sea, out of sight too, in the same direction, is a few miles further away. It is very quiet, you might say: "It's in the middle of nowhere." It is a very nice flying site.

At about this time of year, for several years now, the Blackpool and Fylde club has hosted this electric fly-in. Last year we were 'rained-off' after a few hours and it was windy anyway. This year the

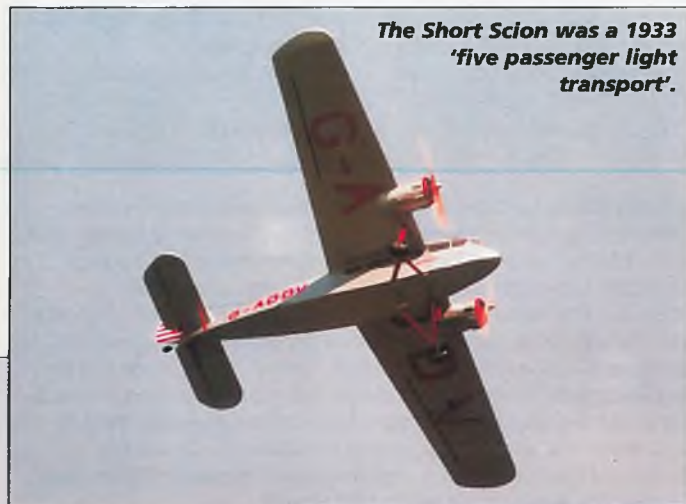
weather was superb and your editor, much in need of the practice, arrived almost two hours earlier than the scheduled start to check out an electric glider not flown for eight months and this time on the 'wrong' transmitter.

His high-tech Tx had obviously read its own manual's warning that the lithium cell for program memory lasts five years so it displayed a lot of uncalled-for remarks when switched on the day before. That loss or memory will take days of programming and experimental flying to replace. Another lesson learned: next time, write down the stored settings.

For this early flight there was no wind and throughout the day it was never more than a light breeze, changing direction as the thermals decided. Many spectators unfamiliar with this site were model fliers without their models, which they regretted. Next year it will be busier.

**After a 'practice' landing approach (Peter forgot to lower the undercarriage), another circuit and a very smooth landing, a helper carries back the Lancastrian, displaying the retracts.**

**Peter Wilson brought along three very similar looking models, all different sizes, a single, a twin and a three. This is the three motored model with three 400 7.2V motors. It was built as a twin and Peter flew it that way for a year but wanted "just a little bit more" so he installed another motor in the nose. With an additional motor and the same 7 cell 1700 battery pack the model achieves flights about one and a half minutes longer than with two! It is obviously consuming the power more efficiently. He throttles back and cruises for longer. The model has an open structure, built as light as possible and is covered in Fibafilm; span is 58" (1473mm), weight is 47oz (1330g). The last prop is a black Master Airscrew, all the others are grey Graupner ones but all 6 x 4. Flights are usually about seven and a half minutes. In the air the model looks fast and efficient, the wing section is an Eppler 3021.**



**The Short Scion was a 1933 'five passenger light transport'.**

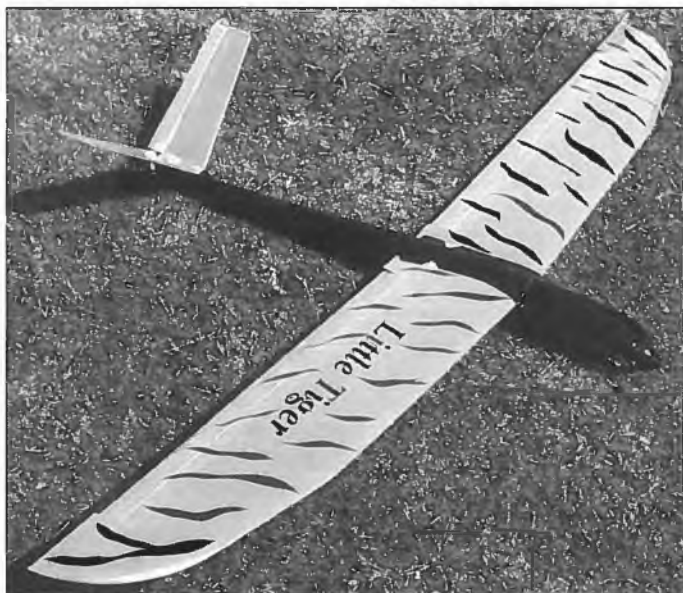


**This Avro Lancastrian was Peter Angus' other winter project. This was a 1943 "fast long range transport" version of the Lancaster bomber for 9 passengers and a crew of 5. In peacetime it was used by BOAC with 11 passengers seated side by side and facing sideways. The steward had to step over 22 legs to get from front to back.**





**Peter Angus' Valiant** has motors projecting from two of the four identical jet pipes. In the air it is fast and sounds like a swarm of bees. A hatch in the bottom permits access to the battery. The wing and tail are fixed and for transportation the entire rear end unplugs just behind the wing.



**The Lancastrian** uses 4 x 400 7.2V motors with 6 x 4 Master Airscrew props, running on 8 x 1700mAh cells. Weight is 5lbs 4oz (2380g), wingspan is 58" (1473mm) and the retracts are 'Lion' with an HS101 servo for each leg. The ailerons are glued in (fixed!) "It flies better that way. I've got a Lancaster with ailerons and no rudders and it struggles with adverse yaw and this one shows no such tendencies. This one responds better to rudder and elevator than the other does to ailerons." says builder Peter Angus.



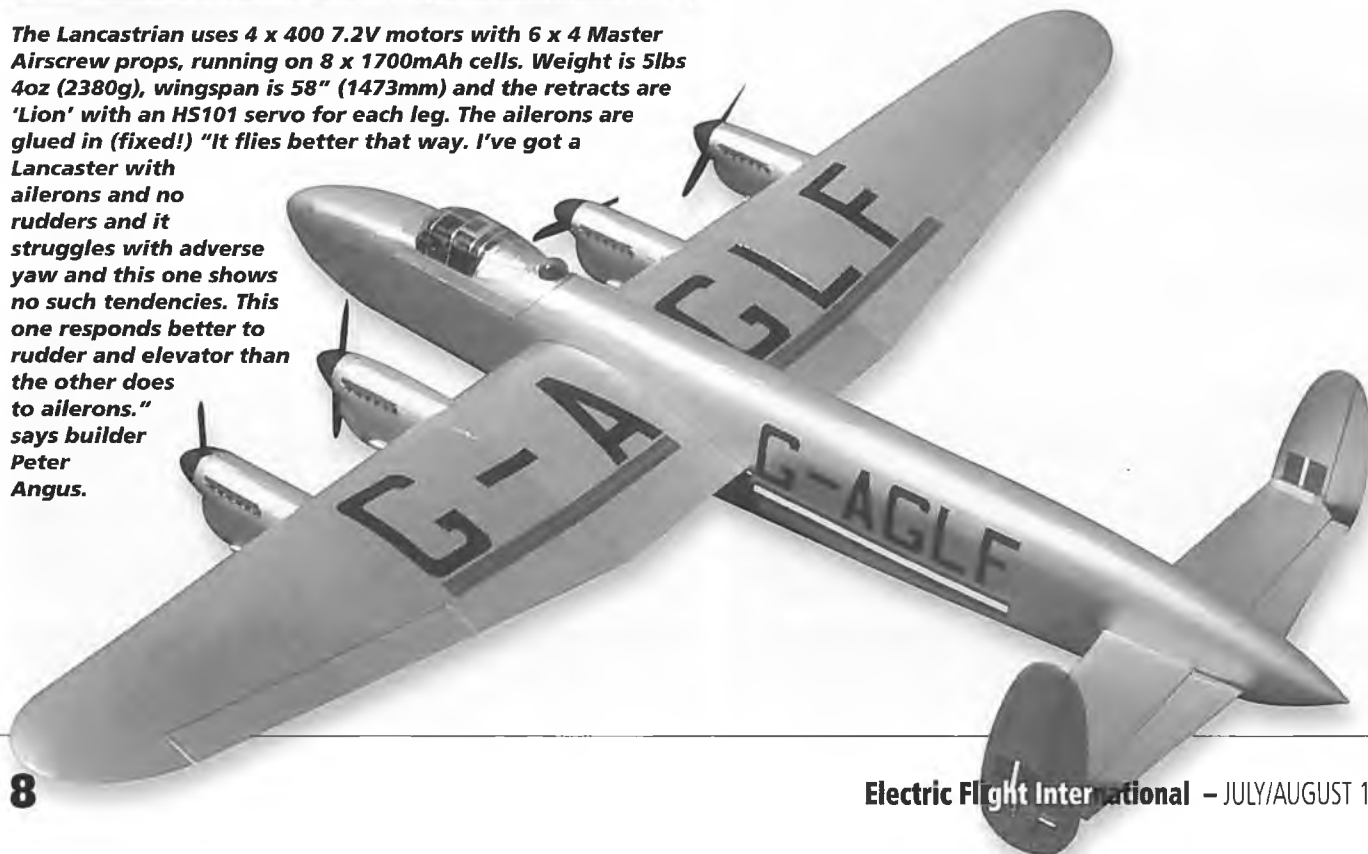
**Peter Angus** vanishes each winter, discloses nothing and emerges in the spring with a very interesting model. This year he brought out two new ones. He could not remember the wingspan of his **Vickers Valiant** and I did not bring a rule but it was about 50". It is powered by two 400 7.2V motors driving 6 x 4 Master Airscrew props on 8 x 800mAh cells. Weight is 40oz (1130g) and construction is all balsa. Control rods to separate elevators on swept tailplanes are always a problem; Peter fitted a snake up the 1/4" sheet fin, with piano wire 'spring clips' round each elevator to cope with the sweep.

As should be expected, model variety was broad and probably typical of the UK electric scene; there were more electric gliders than any other type and this reflected the two organised competitions: a '30 minute seven cell' event and an 'All Up Last Down' that lasted almost 73 minutes. Other awards made for

things like 'best aerobatics' and 'best vintage' and 'best scale', were judged discretely and the builder-pilots probably did not even know by whom or when.

Events like this do a lot for electric flying – encourage some of your doubting IC flying friends to attend.

**Left: Modellhaus 'Little Tiger'** (the 'hot' version of 'Little Tinker') Mega Mini 7 motor with 2:1 Kruse Intro gearbox and Falco 13 x 8.5 prop. The wing section is the S7012, span is 1.5m (59"), weight is 1420g (3lb 2oz) and wing loading, 21.5oz/sq.ft (66g/sq.dm). There is one servo to each flap and the model is very manoeuvrable, Pete Barrow made it look good for aerobatics and F5B. The wing is pressed with unidirectional carbon cloth under 0.6 mm obechi veneer and has a full depth plywood spar, the carbon extends farther back than the aileron hinge line so when these are cut out their leading edges have a carbon spar, there is a glass skin on top. The fuselage is glass and kevlar.





# Structures for 400 Electrics

George Stringwell

*One thing which became readily apparent when I started to become involved with 400 size electrics was that my forty-odd years of background in the design and construction of 'conventional' light weight aeromodelling structures was going to be very useful indeed.*

*Certainly, commercial models, especially multi-motor ones such as the Dash 7 and Hercules make innovative use of cut or moulded foam structures, but for the average modeller producing a one-off model, the good old balsa and liteply airframe was going to be the way to go not only for 'power' models, but definitely for E400 soarers.*

## Technique

Everyone who does a lot of model building develops favourite techniques for solving various structural problems. My own favourites, some or all of which will crop up in just about any model I design (and will usually get incorporated, via modification, in models built from kits or other people's plans) include:

- Full depth slotted wing spar webs with top and bottom booms, either separate or integrated with surface sheeting. The spar web is pre-assembled with the centre section and dihedral break braces, or in the case of a multi-part wing, has the wing joiner tubes and supporting structure attached to it.

- Thicker than normal bottom sheeting over the front part of the wing to enable the leading edge upsweep to be carved in. For most normal wing sections this permits the wing to be built absolutely flat on the board without any packing pieces.

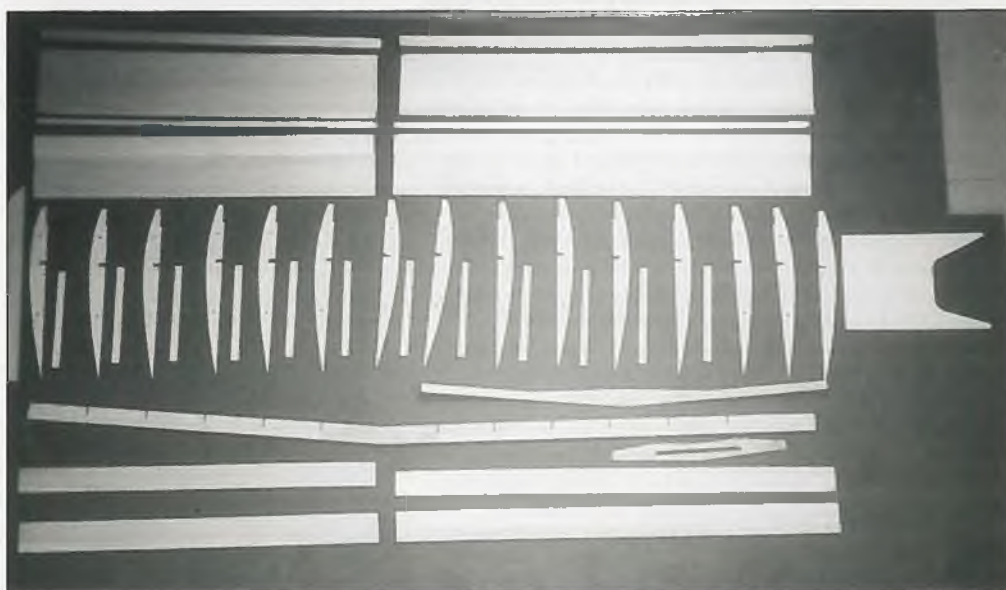
- Use of a 'false' leading edge in 'D' box wings.
- Use of hardwood 'hard edging' on wing trailing edges.
- Use of cap strips on open frame wing areas.
- A light but strong and stiff structure, specifically developed for all moving tailplanes, but adaptable to elevator types, which uses opposing diagonal surface strips and is built flat, the section being provided by a thin hardwood spar which carries the main pivot wire tubes and is inserted after the main structure is removed from the board

- 'Shrouded' rudder hinges with top and bottom pivot pins.

- Rolled ply motor mount tubes.

- 'Click on, click off' wire hatch catches.

- Use of a fuselage 'crutch', either a full length one where complex cross-section fuselages are involved, or a short reinforcing one for more conventional box structures which gives a ready way of integrating important items such as motor tubes, servo mounts, wing bolt plates and tow-hook mountings into one unit, whilst providing reinforcement to the nose area and assuring accurate line-up of the fuselage structure.



Complete layout of pieces for one half of the 'Clubman' wing illustrate the writer's standardised structure for light 'D' box wings.





First stage of construction shows composite bottom sheet, cap strips, trailing edge, centre sheeting and false leading edge for centre section panel pinned flat on board.

Later stage of construction with all top sheeting of centre panel except top centre section sheeting in place. Note that this is being built onto already completed tip panel which is propped up to dihedral angle. Note also centre braces and plate/block for wing mounting bolt.



- Use of hardwood corner longerons in box fuselages, and diagonal balsa cross-braces to obviate the 'starved horse' appearance which unsupported thin (1/16") sheet balsa sides otherwise adopt after assembly..

- Putting on top and bottom sheeting on box fuselages with the grain at 45 degrees to the lengthways datum, in opposite directions on the top and bottom.

- Slotting 1/32" ply strips into the leading and trailing edges of sheet tail surfaces to provide ding-proof edging, and a line to carve and sand to when shaping the surfaces.

Most of these practices have been picked up over the years from other people's models I have built, adapted and modified to suit; the only one which I think is entirely original, is the all moving tail structure, which came to me in a sudden revelation whilst musing over the tailplane of a new 100S sailplane almost twenty years ago. It may have been triggered by some unconscious memory of something I had seen on a plan (I am an incurable plan browser), but if so I cannot recall it. However, taken together, they do produce a structural 'style' which will be readily apparent to anyone building from any of the 'Sunfly' plans. They also, perhaps fortuitously, are all techniques which are very useful in producing the light, rigid structures which are so necessary in building successful 400 powered electric models.

It is very easy to build a light weak structure, and not too difficult to build a heavy strong one (which might still have unacceptable local weaknesses), but building a light

strong one takes care in the design stage, and even more care in materials selection and construction. One of my pet hates is models which have to be 'babied' as they are liable to suffer structural failure if highly stressed, as for example when leaving a strong thermal. A surprising number of electric soarers, including some kit and RTF models, fall into this category. Hence, anything I design myself has to be more than strong enough for all reasonable emergencies. Note that we are not attempting the impossible, that is the design of a crash proof model; as I wrote in my earlier EFI article on Mylar covering, any such attempt is doomed to end in failure, the aim is a model which will shrug off in-flight stresses caused by heavy handed pilots or unusual atmospheric conditions.

The secret is to build in the strength in the highly stressed areas, and keep everywhere else as light as possible. To illustrate this with an example; a 'conventional' foam/veneer RC power model wing (which is, effectively, a 'distributed spar' or 'stressed skin' structure), if built with skin thickness to give adequate strength at the wing root, will be vastly over strength, and hence overweight, at the wing tips. This is doubly bad news, since excess weight at the extremities is particularly to be avoided, if the crispest possible control response is required. The answer is local reinforcement, tapering of load carrying structures, and a covering medium which will help by providing some torsional stiffness effect.

There are three key areas to producing a structure which

gives the best possible strength/weight ratio: DESIGN, MATERIAL SELECTION, CONSTRUCTION.

## Design

As touched upon above, the secret here is to design each part of the structure to be strong enough to withstand the highest loading which we can reasonably expect to place upon it, and no stronger, and integrate it with neighbouring structure in such a way that there is a smooth transition of strength with no potential break point caused by a large and sudden change of strength.

As a rule, model aircraft, at least radio controlled model aircraft, in particular power models, tend to be over-engineered - i.e. stronger and hence heavier than they need to be to do the flying part of the job - to a greater or lesser extent. This is because our 'design' process does not generally have the benefit of mathematical analysis of the expected loads, as is the case in the full-size world, and most designers tend to err on the side of caution when choosing material sizes and numbers of components. Mind you, now and again, bits tend to fall off full size prototypes, so maths and computers are obviously not a complete cure-all! Another 'design' factor which leads to heavier than necessary airframes is the use inefficient types of structure for ease and speed of construction - for example, a solid piece of 1/2" x 1/4" balsa for a spar will have a cross sectional area of 1/8 square inch. An 'I' beam spar built out of two pieces of 1/4" x 1/16" and one piece of 3/8" x 1/16" balsa of the same grade will have a cross sectional area of just under 3/32 square inch. Even allowing for the weight of adhesive, this is going to be lighter, and just as capable of doing the job. If we start to contemplate the addition of sophisticated materials such as carbon fibre to the basic spar, it is possible to produce an item of vastly superior strength for the same weight as the solid equivalent. It is, however, more time consuming to build itself, and to integrate with the structure - it just depends how far you want to go.

Many people, when looking at plans of one of my models for the first time say "What a lot of bits!" True, perhaps, as



compared with some similar designs, but I do not include a lot of bits just because I enjoy cutting them out - they are there because the result is either a stronger structure for the same weight or a lighter one of the same strength as the alternative methods. When first working out the structure, give careful consideration to what each component is going to actually do. Is it really necessary? If the answer is "yes", does it need to be as big as that - or, if it is solid, can it be built up instead and made lighter/stronger? Can you use liteply instead of ply? Or balsa-ply instead of liteply? Are the centres of those formers serving any useful purpose or can they be removed? Would a laminated strip of softer material be better than a solid one here?

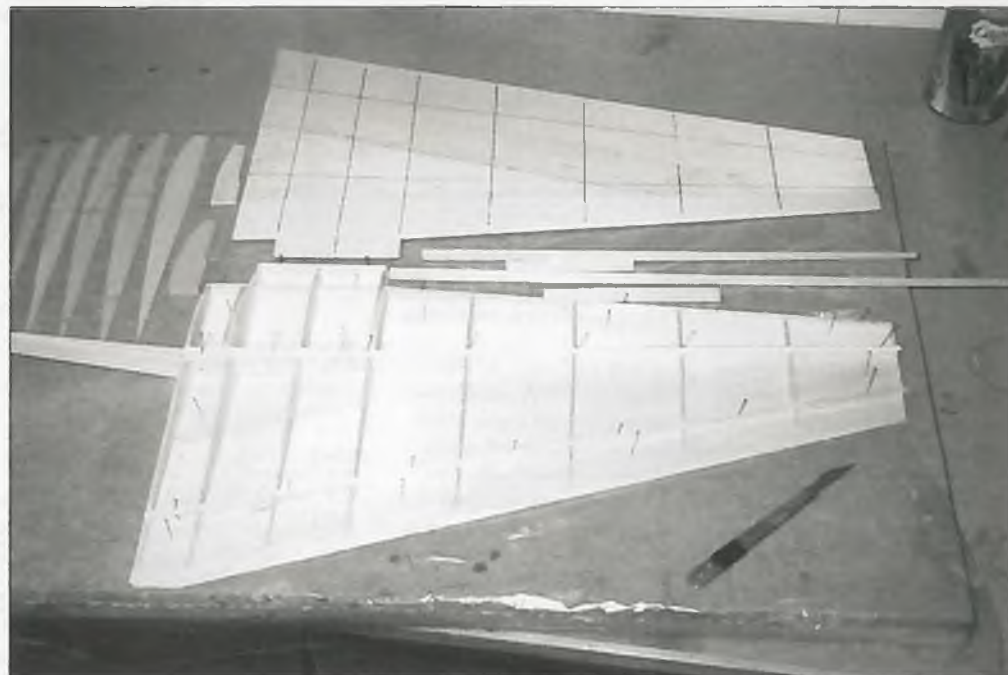
Think particularly about highly stressed areas such as the wing centre section - it has to be strong enough, but all that extra strength which the braces and/or joiners supply will be useless if it all stops in one place, creating a strong point at which the wing can (and will!) happily snap. Taper the extra strength out.

Give careful consideration to the thickness of material being used. For example, there is rarely a good reason for using thicker material than 1/16" for wing ribs - if worried about the strength of the ribs, just turn them into 'I' sections with cap strips.

## Material Selection

This is really all about that most variable of all our materials, balsa wood. It is a fact that the overwhelming majority of balsa which can be found in any model shop is virtually useless for light, strong airframe construction. Take 1/16" sheet for example; I have found sheet in this size for sale with densities varying between 5 lbs per cubic ft. and 25 lbs per cubic foot!

Consider a typical E400 geared soarer. Weight, say 28 ounces (794g) ready to fly, of which fifteen ounces will be hardware. This leaves 13 ounces (370g) for the airframe. Subtract, say, two ounces (57g) for the finish and the bare airframe needs to weigh 11 ounces. On a model such as this about 6 ounces of that 11 will probably be components cut from 1/16" sheet. If they weigh 6 ounces made from the 'proper' grade - firm 6 lbs per cubic foot quality - make them all from 18 lbs per cubic foot sheet - a grade commonly found in model shop



racks - and they are going to weigh 18 ounces - and the finished model is going to weigh 40 ounces! If it flies at all, the performance is going to be 'orrible!

The only way to accumulate a decent stock of usable wood is to go through the rack every time you go into the shop, and buy any decent bits there and then. After many years of practice, you could achieve this pretty well by eye and touch; however, it is better to rely on a set of electronic postal scales to carry out the initial sorting (ignore the funny looks from the proprietor and other customers!), based upon the sheet weights shown in the table in this article, and then carry out a further selection by hand and eye from the ones which meet the weight criteria. It is perfectly possible for two sheets of the same basic weight to have totally different properties - one will be soggy and 'lifeless', the other firm and springy. Needless to say the latter is the stuff for you. It is also not uncommon for the density to vary quite widely from end to end or even side to side of a sheet. Often you will go through the stock and find little or nothing worth buying (I have probably been there first!), but on other occasions you will hit 'pay dirt' in the form of a whole series of good sheets next to each other, obviously cut from the same chunk of timber.

There are other factors to consider - the 'grain' of the sheet

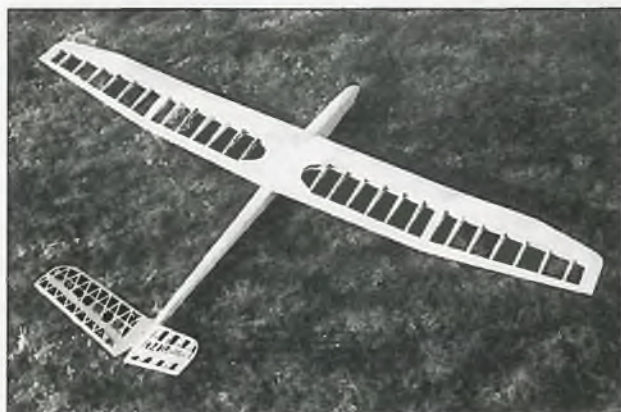
Very different wing shape illustrates flexibility of the system; this wing for a 38 inch scale twin, a DH 'Hornet F1' is fully sheeted but otherwise identical in principle.

for example. Some cuts of sheet will be very flexible across the grain - ideal for wing sheeting, for example. Others of the same weight will be much stiffer - 'quarter grain' - a very desirable property for ribs and other similar components. Basically, when talking 400 models, you will be looking for 1/16" sheet of 5 to 7 lbs per cubic foot, flexible for sheeting, quarter grain for ribs, with some rather harder 8 to 10 lbs per cubic foot - for fuselage sides, trailing edges etc. When it comes to strip wood, rather than buying ready-cut strips from the model shop, it is more economical - and can produce more consistent results - to buy harder sheet (10 to 16 lbs per cubic foot) of the various thickness and use a good balsa stripper to prepare your own. Needless to say any thicker sheet (3/8" and 1/2") or block which you might be using in the model needs to be the lightest you can lay your hands on. Some 1/2" x 4" sheets I saw last week in my local shop would have made excellent floor boards, but I cringed at the thought of incorporating them anywhere in any model aircraft, let alone a 400 size one!

The answer then is - be selective. Don't just pick up any old balsa, and don't wait until you need a particular sheet before looking for it, otherwise you will probably be forced into accepting a compromise.

## Construction

First of all, think adhesives. Rule one: glue (except cyano) is heavy. Rule two: large amounts of glue are very



Completed framework of a 'Sundancer 60HL-G' miniglider weighs 7 ounces as shown, and is very strong. Wing structure identical to that described.



heavy. Rule three: large amounts of glue might fill the gaps between poorly fitting components, but the result is a weak, heavy, joint.

When the writer started building model aeroplanes, the choice of adhesive was simple; you used balsa cement, unless the thought of boiling up fish glue in a pot turned you on, that is. Last week I did a quick inventory of the sticky shelf in the workshop: four kinds of epoxy (five minute, fifteen minute, twenty-four hour and finishing resin), polyester resin, three kinds of PVA, aliphatic resin, thin cyano, thick cyano, two kinds of contact adhesive, RC Modellers glue, Stablit Express.....oh yes, and balsa cement!

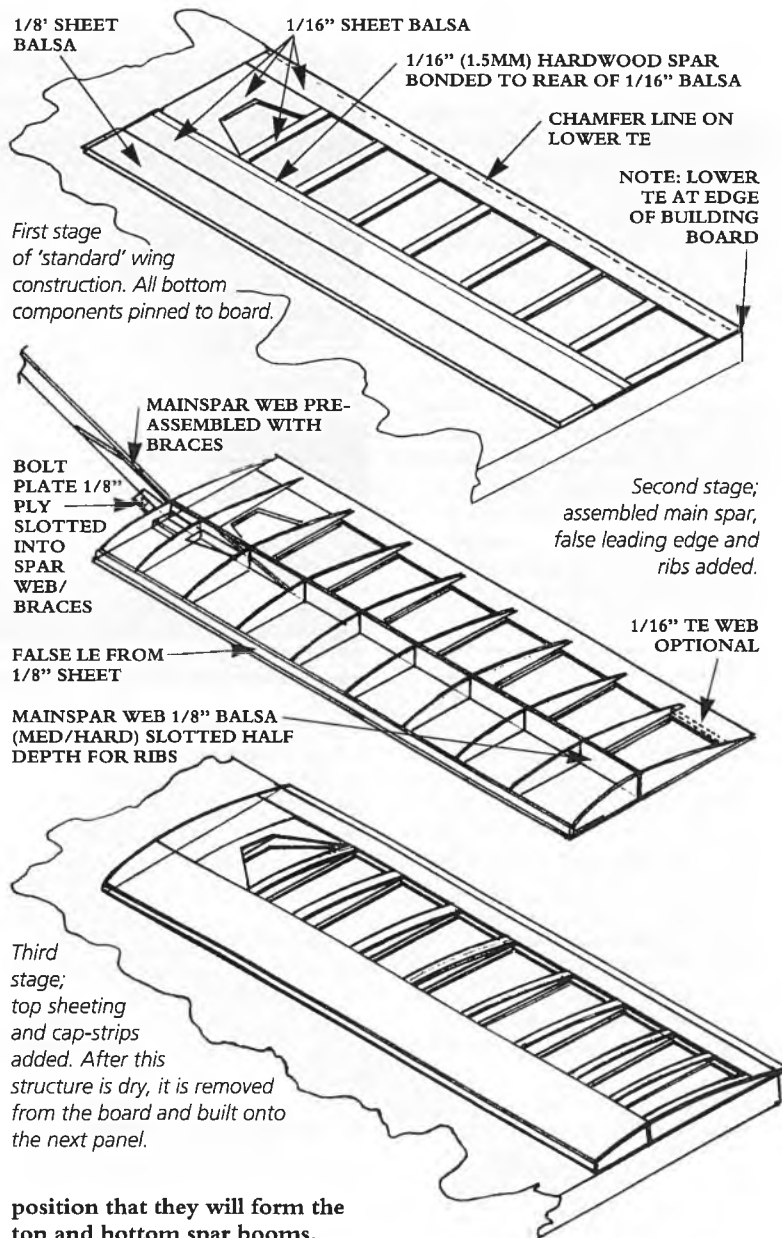
Not that you need all these. The vast majority of my building is done with one or other of the PVA adhesives, (as I am semi-allergic to most cyano glues, if I was not I would use them more, but not exclusively), or aliphatic resin, with epoxy for special areas and contact adhesive for fitting larger area doublers, although I do still find quite a lot of uses for balsa cement. For example, there is nothing better for joining 1/16" sheets for wing skinning; pre-cement the edges, then 'hinge' the sheets with tape, re-cement the edges then fold them together and pin and weight the sheet down flat on polythene, sanding the joint when dry (balsa cement, in general, sands much better than most PVAs). Balsa cement makes very good balsa/balsa joints indeed provided both surfaces are pre-cemented and allowed to dry before re-cementing to make the joint - it dries quickly and is LIGHT. The cyano is, in my case, for special restricted uses where I need to 'tack' components in place, whilst the specialist glues are for materials such as plastic (Stablit Express) and acetate sheet (RC Modellers Glue).

Returning to the first paragraph of this section; since glue is heavy, only use as much as you must. Take extra care in cutting and fitting components to minimise gaps, apply glue sparingly and make sure it is in the right place. I use a syringe for PVA; not only is this a good way of metering glue to get the right amount, it is also very useful for getting into awkward places and putting the adhesive just where it is required. A small squeeze bottle with a long spout would work just as well.

Moving from the general to the specific, the drawings illustrate what I now consider to be my "standard" wing structure for small electrics. The photographs show two very different versions of this under construction - one a 'Clubman' lightweight direct-drive six cell model and the other a fully sheeted DH 'Hornet' scale twin for two direct drive 400s. Despite the considerable difference in the models, the wing construction technique is the same.

The basis of the wing is a spar web cut from firm (12 lb/cu. ft.) balsa, slotted half depth at the rib stations (tip; two worn junior hacksaw blades cyanoed together under pressure form a saw which will cut a perfect 1/16" slot. Mark the rib positions on the web, mark the depth mid point at root and tip and clamp a steel ruler to the web with bulldog clips between the two marks. You can then saw down at each rib mark, the steel ruler will stop you at half depth.). The spar web is assembled with suitably tapered braces at the correct dihedral angle (the whole web in both the illustrated models, as these are one piece wings. For a two part wing the main joiner tubes and blocks are assembled to the web, then cut through at the centre, using a joiner when building to ensure perfect line-up.). If the spar is 'bent' in plan view (as it was in the case of the 'Hornet'), this can be achieved by using laminated 1/32" ply braces and clamping the web/braces unit up to a 'jig' cut from thick sheet whilst it dries.

The wing sheathing is prepared next, assembling the bottom sheathing with 1/8" front portion and 1/16" rear portion (full skins for the 'Hornet', leading edge "D" box sheathing for the 'Clubman'). In the case of the soarer, 1/16" thick lime or spruce spars are bonded to the rear of the upper and lower leading edge sheathing in such a



position that they will form the top and bottom spar booms, fitting on the web. These hardwood spar booms are only on the centre panels of this particular model, due to it's small size; the fully sheeted 'Hornet' wing, thanks to the low aspect ratio, is strong enough without any hardwood spar booms. Centre section sheathing is cut to size, gluing it up as necessary.

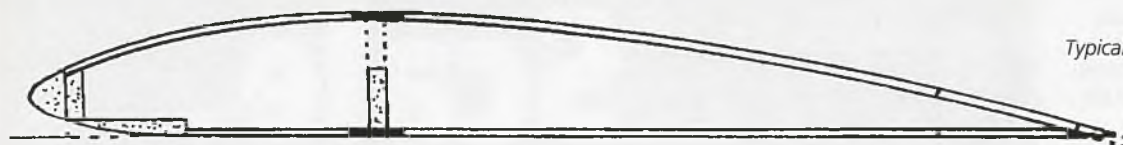
All the ribs are cut out. With a constant chord wing such as the 'Clubman', this is easy; the extreme taper of the 'Hornet' wing ribs is coped with best by the use of a reducing photocopier, then cutting each rib individually. The spar slot in each rib is half the rib depth. (You will no doubt have worked out that, if two thicknesses of worn junior hacksaw blade cut a 1/16" slot, then four will produce a 1/8" one!). The false leading edge is cut from 1/8" sheet, and, if a web is to be used at the front of the trailing edge,

this is cut in one piece from 1/16" sheet. For both these items the root and tip measurements (if the wing is tapered) are taken from the actual ribs.

Both top and bottom 1/16" trailing edges are cut 1/4" narrower than full chord. The top one has a 1/4" x 1/16" strip of lime, spruce or similar straight-grained hardwood bonded to it. The lower one has a chamfer sanded on it over the last 3/16" of it's width, tapering it down to nothing.

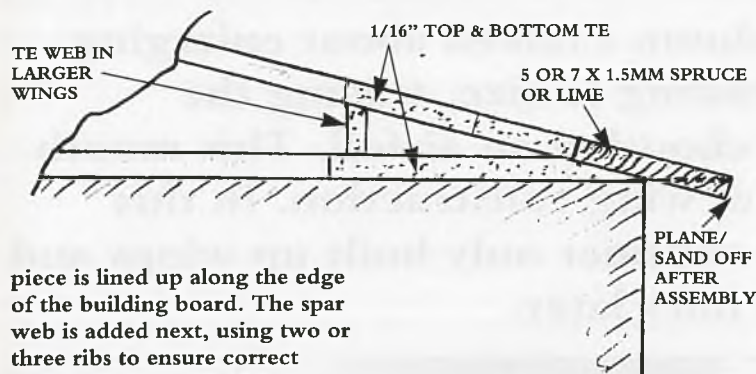
All the bottom components (i.e. on the 'Hornet' the bottom skin, with rib and spar positions marked on it, for an open frame wing like the 'Clubman', the composite lower 'D' box skin, the bottom cap strips, bottom centre section sheathing and bottom trailing edge) are pinned down, glued to each other as necessary. It is important that the rear of the bottom trailing edge





Typical cross section of finished wing at a rib.

Enlarged cross section showing assembly of 'hard' trailing edge.



piece is lined up along the edge of the building board. The spar web is added next, using two or three ribs to ensure correct positioning, then the false leading edge.

All the ribs are added next, then the trailing edge web (if used), cutting this off 'sausage fashion' to fit in between individual ribs.

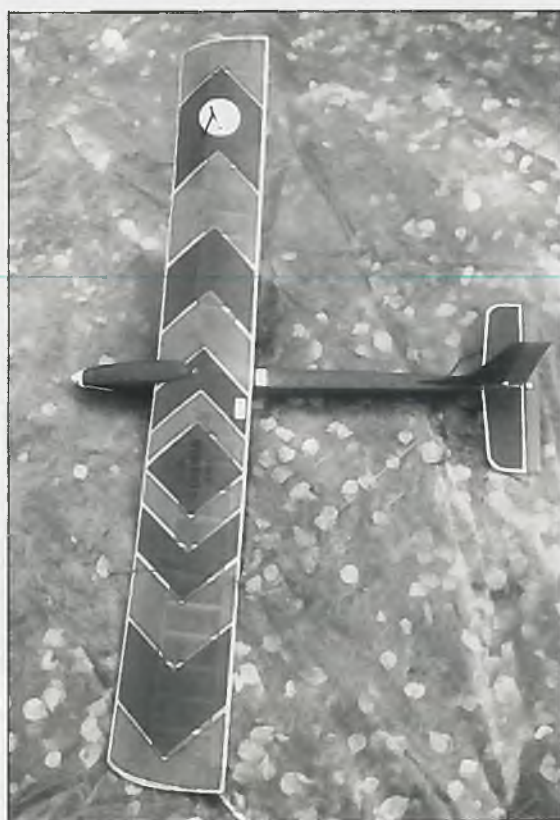
When all this is dry, a gentle sanding to remove any inconsistencies is followed by the addition of the top components. The top trailing edge overhangs the bottom one, and the edge of the building board.

Repeat the sequence for each wing panel, building each one onto the one before to ensure

accurate joints, propping up the finished panels as necessary.

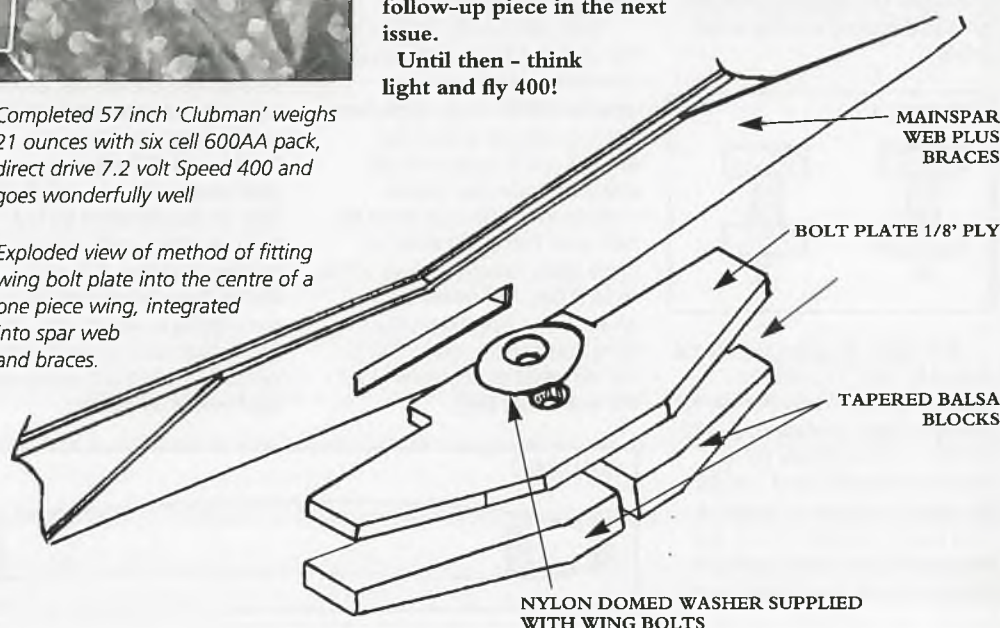
When everything is dry, it only remains to fit the leading edge proper (on this size model it is cut from medium (10 to 12 lb/cu.ft) 1/4" sheet, then plane and sand off the bottom of the hardwood trailing edge as shown in the sketch and shape the front portion of the wing using a straightedge and ply templates to check for accuracy. Wing tips of your choice complete a light, rigid, full 'D' box wing with 'dig-proof' trailing edge to resist those attacks of 'hanger rash'.

One other item which should be mentioned is integration of the wing fixing/wing joining



Completed 57 inch 'Clubman' weighs 21 ounces with six cell 600AA pack, direct drive 7.2 volt Speed 400 and goes wonderfully well

Exploded view of method of fitting wing bolt plate into the centre of a one piece wing, integrated into spar web and braces.



'hardware' into the structure. On one-piece E400 wings I use a single 5mm nylon bolt, which has always proved to be adequate and has the advantage of allowing the wing to pivot in the event of a "chinese landing" (wun wing lo!). The plate in the wing for the bolt is good quality 1/8" ply. This has a tongue which fits into slots cut in the spar web and joiners. The space between the plate and the bottom sheet is filled with tapered sheet packing pieces. The centre ribs are relieved to fit around this plate, and it is drilled at the centre to take the 5mm bolt, complete with the nylon recessed washer which is supplied with it. I inset 1/16" ply into the top sheeting and cut a hole in this to clear the bolt head, the ply avoids damage to the wing surface when (as is inevitable!) the screwdriver slips. Most 400 models are small enough to use a one piece wing; on the my bigger E400s, the 'Sundancer 74' and the latest 80 inch one, I use a two part wing with a carbon fibre joiner. The tubes for this are built into an assembly which is bonded to the front of the spar web/joiner structure, whilst plates to take TWO 5mm bolts, one for each half, are fitted to the back, the ply tongues extending through the web and braces into the tube assembly. Once again, this set-up has proved itself entirely reliable under the sorts of extreme stresses involved in descending from some very strong thermals

There is nothing dramatically new in this type of wing structure (although there may be to the many modellers I know who have only ever built foam wings!), but if you standardise it makes it very easy to work out a specific wing of whatever planform you require, and, once used to the sequence, the building can be very quick indeed. Obviously, if used for a wing section which is other than flat bottomed with a limited degree of upsweep on the leading edge, it needs to be amended and components will have to be packed up off the board. However, the vast majority of 400 models - soaring, sport and scale - will use one of the popular sections such as E193/205, SD3021 or RSG29, which are all basically flat bottomed.

I think that this particular article has rambled on long enough, so, with Editor Stephen's indulgence, I will cover topics such as laminated structures, the lightweight tailplane unit, knuckle rudder hinges, the use of short and long fuselage crutches and so on in a follow-up piece in the next issue.

Until then - think light and fly 400!



# Quiet Scale.

**S**cale modellers are usually very concerned about the fuselage because that is the most distinctive part of the aircraft and the most recognisable. Exceptions are the Spitfire and the Stuka, but you get the idea.

Unfortunately, with a flying model, it's the wing that flies the plane!

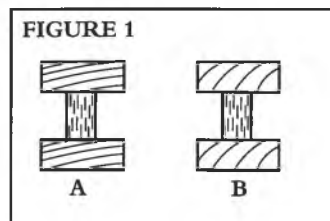
While the airfoil can be crudely classified as undercambered, flat bottomed, semi-symmetrical or fully symmetrical, the wing structure can be categorised as 'open', 'D-tube', or fully sheeted. Which method we choose depends on the original's wing but more importantly, how we want to fly the completed model.

As a rabid scale nut, it would be easy to say that you must duplicate the original's surface. When we can, that is the best way but in the real world (the everyday sport flier's world) there may be other considerations. More of that later.

## Spars

The strength of the wing is in the spars. I use spruce for all my spars now. Several years ago, when I built my 81" PZL, I weighed the spar caps once they had been cut to length but before gluing them in the wing. They weighed 3.5oz, just 10% of the total wing weight. I might have saved an ounce by going to balsa but I would have been terrified to do more than fly circuits. Don't bother with anything but spruce or basswood for spar caps.

When selecting your spruce, check the end of the strip and look for a grain pattern like 'A'. Chances are you will have to settle for 'B' (see figure 1). The idea is that the grain of the wood acts like a leaf spring.



(See figure 1) Spar caps should always lie 'flat' i.e. with the greatest dimension chordwise, for strength. Don't confuse this with the final spar assembly being vertical. Unless the spar is solid, the spruce caps are as drawn. A 'real world' consideration is that because of poor wood quality, it may be to your advantage to go a

**In the last column I talked about enlarging your scale drawing to size, tracing the outlines and choosing an airfoil. This month we will look at wing construction. In this issue we will consider only built up wings and look at foam ones later.**



little thicker, even towards square caps, just to be sure.

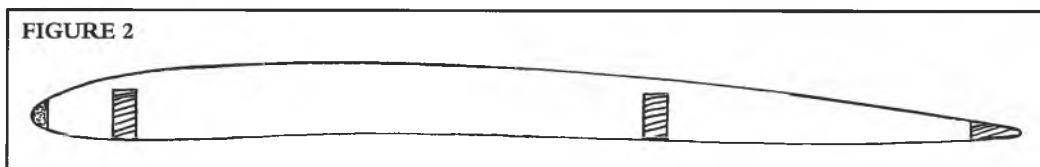
Spars are usually located in the scale positions when possible. This eases strut placement whether for lift struts, interplane struts or cabane struts. The ailerons and flaps are usually attached to the rear spar or sometimes a false spar aft of the rear spar. You might want to move spars forward or back a hair to facilitate your mounting arrangement but always think of tying struts to the spars. This is the strongest arrangement, (and the most scale-like).

## Undercambered Airfoils

Early aircraft wings have thin sections that are difficult to build with adequate spar sections for cantilever structures (i.e. no bracing). All of these wings are open construction, i.e. no sheeting. They are not meant to go fast. True scale sections usually require full, functional rigging. This causes electric fliers some problems in that such rigging is very draggy. This means that more power is required just to fly around and manoeuvres need even more power.

If this is the type of section you wish to use you have several spar options. (Nearly all of these wings will have a forward and a rear spar, for all but the smallest models). The first option is the quickest to do but is a little finicky if it is to be done well.

(See figure 2) This type of construction is usually used in smaller airplanes where the other spar arrangements are less practical but it can be used on larger models with a spruce/balsa/spruce laminated spar where the balsa is the web and runs parallel to the spar caps. (This







**Wing front spar and LE, built as in figure 2.**

is one time when a solid spruce spar would be a little heavy.) There are a couple of cautions with this. The top rib web over the spar cut-out has to be deep enough not to break during handling which means that the total spar depth is less than is optimal. The spar is also against the lower surface covering and will show. It will also need shaping to be flush or a gap in the rib line will need to be filled or it will show under the covering.

(See figure 3) This is a variation on the first section but with the addition of a cap strip on the lower surface. This locks the rib to the

spar better and makes the rib stiffer side to side. It does make the spar depth a little less but we can cut the slot a little deeper to compensate because the cap strip will strengthen the rib. The big (scale) 'plus' about this method is that the lower covering doesn't touch the spar. I have drawn a laminated spar for this rib. The core is balsa and the caps are spruce or basswood. This cuts some weight from the spar but still keeps the strength where it belongs, at the top and bottom.

(See figure 4) This is the 'classic' WW1 wing construction where ribs are slid onto the spar and glued in place. If ribs are cut from sheet, either they will be very weak or the spar depth will be too shallow for a cantilever wing. The solution for expert builders is a built up rib (figure 4b) but not many sport scale builders want to spend that much time or effort. It requires a jig and a combination of strip stock and sheet pieces.

(See figure 5) This is good sport construction. The spar caps are as far apart as possible and if they are fully webbed with vertical grain balsa, the wing is quite strong. The only problem with it is that the



**Laminated spar with full cap strips. Compare with figures 3 and 6.**

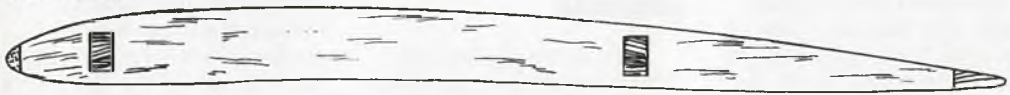


**Buried spar, as in figure 6.**

**FIGURE 3**



**FIGURE 4**



**FIGURE 4B**



**FIGURE 5**



**FIGURE 6**



covering will touch/stick to the spars and that doesn't look as 'scale' as it might.

(See figure 6) This is a little more involved than the previous rib, but the spar caps are a good distance apart, the cap strips keep the covering off the spar and smooth the rib side to side. They also stiffen the rib side to side. This is my preferred method of building wings of this era.

## Flat bottom airfoils

While all the undercambered sections are open framed, flat bottomed airfoils can be: open, D-tube or even fully sheeted.

If the wing is open framed, the construction options are the same as for the undercambered sections.

(See figure 7) This would be appropriate construction for a sport scale WW1 model.

If the wing is for an airplane built after the mid 1920s, chances are that it has a thick section, (12% or more) and had at least leading edge sheeting. This is an opportunity to add considerable strength and stiffness.

Two points here. First: the thicker the wing, or more precisely,





**D-tube leading edge with vertical webbing. the rear spar is submerged below the fabric line by the cap stripping.**

**FIGURE 7**



**Wing built as in figure 7.**

the farther the spar caps are apart, the stronger is the wing. Second: a sheeted leading edge can tie into the webbed spars to form a D-tube. A D-tube is a great way to add torsional rigidity ahead of the wing CG and so dramatically reduce the likelihood of wing flutter. It also

makes single spar wings a practical option in larger models, (50" to 60" spans).

(See figure 8) This is a good, simple, light design for a single spar wing. (The two spar caps are parts of a single spar.) It will also be quite warp resistant thanks to the D-tube leading edge.

It's a little hard to hang ailerons

on this type of wing. Strip ailerons might be OK but I would worry about the structural strength. The usual solution is a substantial aileron spar/false trailing edge. Most scale models have 'barn door' ailerons so a double spar wing is easier in the long run.

(See figure 9) We have the leading edge sheeted and a second spar added. Cap strips top and bottom tie the ribs to the spars and stiffen them at the same time. They also make a smooth transition from the sheeting to the rear of the wing. It's a lot easier to sand than

would be the edges of the ribs. This is a good all round wing structure that works with most models. A variation on this is to sheet the rear of the wing. At this point you might want to just sheet the whole wing. This might be appropriate for a large, 'heavy metal' fighter but watch the weight!

(See figure 10) Going in the opposite direction, we can also go with small spars towards the leading edge. This is faster and lighter than the D-tube but not as stiff and so we need to keep the speed down. For slower aircraft, say 40MPH to be safe, this works well.

## Semi-symmetrical airfoils

Generally we use the same construction for semi-symmetrical (and symmetrical) airfoils as we do for flat bottomed sections. They are a little harder to build

accurately as the rib will want to 'rock' a bit. Some designers flatten the bottom of the airfoil section from the main spar rearward to make building easier. In a lot of non-critical situations it probably doesn't matter too much, but the airfoil was designed with a specific so changing it willy-nilly will change it's flight characteristics. I prefer to go to the extra trouble of keeping the section as designed.

(See figure 11) There are three common methods to choose from when building non-flat bottomed airfoils. One is to use a wing jig which uses a pair of steel shafts to suspend the rib over the board while you glue on spars and sheeting.

(See figure 12) A second method uses tabs on the bottom of each rib to support it so that the spars are clear of the building surface. A couple of the computer plotting programs will add these tabs to the ribs as they are plotted and even adjust them to build in wash-out right on the building board.

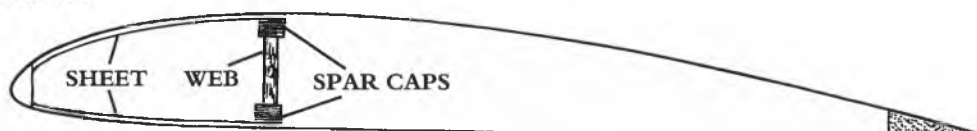
(See figure 13) The last method uses shims under the spars and leading and trailing edges.

Generally a semi-symmetrical airfoil is selected because sport aerobatic performance is wanted. This usually means a faster model than is necessary for just flying around. Built with an open framework it will have to be flown with an eye on its top speed or flutter will develop. Keeping the wing stiff will help prevent this, (along with control surface considerations - but that is another column!). For this reason, the D-tube design is a good choice - strong, stiff and fairly light.

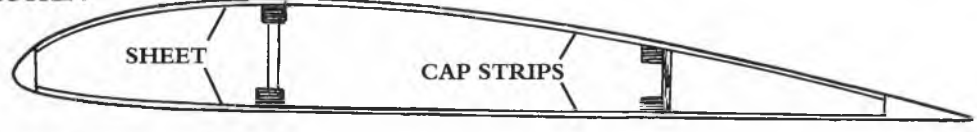
## Spar locations

As was noted earlier, spars for open framed models should be placed where the original's were located. Some aircraft have just a little sheeting between the leading edge and the forward spar, perhaps 10 or 15% back. This creates a D-tube leading edge that approximates to a torsionally rigid tube - nice and stiff. When building a D tube wing with a single spar, our spars are not likely to be where the full size aircraft spar would have been. The general rule of thumb is that the spars are located at the point of maximum thickness or about 1/3 the way back from the leading edge. Obviously there is more sheeting and a stronger, but slightly heavier wing will result.

**FIGURE 8**



**FIGURE 9**



**FIGURE 10**

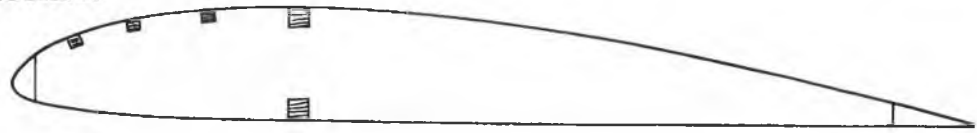




FIGURE 11

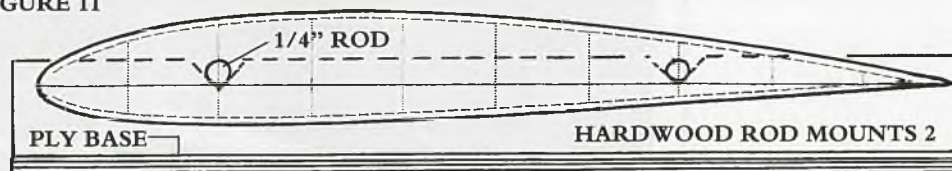


FIGURE 12

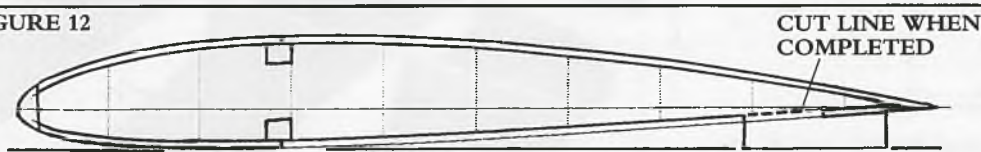


FIGURE 13



## Webbing

I am a firm believer in webbing spars. I can't think of anything that adds as much strength for so little weight. Yes, it does take a little time but get into the habit of adding them to every wing.

Webbing for non-laminated spars should be glued in place with the grain running vertically as balsa is strongest in this direction. Many people make a 'C' section with their webs as opposed to an 'I' section. This is easier than trying to fit the webbing between the spars but relies on the glue joint to maintain its integrity whereas the 'I' section uses the glue just to locate the web and the end is the strength. With a D-tube wing however, the 'C' spar does make the tube the largest it can be and so the stiffest. Among some members of my club, this can spark a discussion every bit as hot as 'down wind turns'!

(See figure 14) Another option is a spar webbed front and back so as to form a box spar. This is most similar to full size practice. As with the D-tube wing, it is approximating to a tube which is very torsionally rigid. (Give a cardboard tube a twist for an demonstration.)

## Leading edges

There are a number of options for dealing with leading edges and the one you chose will depend on your personal preference as much as anything else. They can be divided into those for open framed wings and those for sheeted.

(See figure 15 for open frame) #1 is simple and is fine for airfoils that are flat from the leading edge back. If there is any 'Phillips entry' i.e. the lower surface rises as it approaches the LE, then this leading edge needs to be shimmed

FIGURE 16 D-TUBE AND FULLY SHEETED.



up to the level of the ribs. I also find that it is difficult to plane/sand to this section without knocking the ribs and usually break several before I am done. This can be alleviated by putting a strip of masking tape on the top of the rib to protect it during sanding.

#2 can be pinned flat during building. The rear edge doesn't need much sanding as it is flush with the rib and the forward edge is fairly easy to sand as the curvature where it meets the rib is considerable. Unfortunately it results in a 'starved horse' look and needs nose, or half, ribs to try to

maintain the airfoil. I've used this type but was never really happy with the way it looked although it worked fine.

#3 is more common as a free flight leading edge and I find it is quick to shape. It is sometimes considered a poor choice as an impact will tend to split the rib. I haven't found that. In fact a split rib is easier to repair than a crushed rib as might occur with #1.

#4 is not one I have used but it intrigues me. Airfoils are supposed to have a radius at their leading edge so a small dowel makes sense. A 3/16" diameter dowel weighs about the same as a piece of hard 1/4" square. I am not sure how smooth a joint I could manage between the balsa rib and the birch dowel, but someday I will give it a try.

FIGURE 14

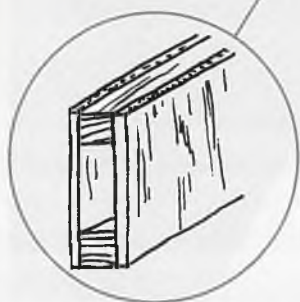
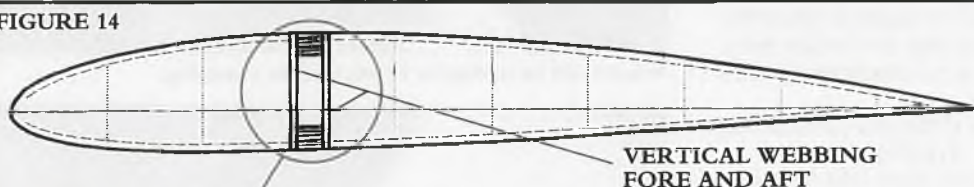
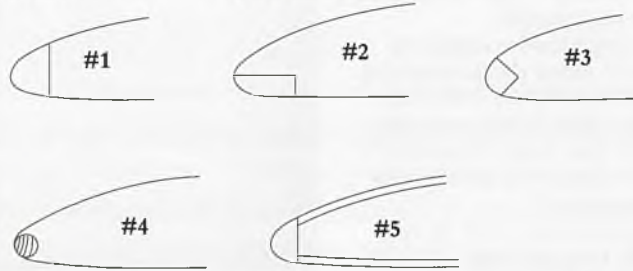


FIGURE 15

OPEN FRAME.



#5 is not a sheeted wing but a wing with fully capped ribs. With heavily cambered ribs, it may be difficult to get the caps to bend without breaking. There are a couple of things that may help. Use soft wood, pre-curve them with a dowel roller, glue the leading edge first, (CA), and gently pull the strip as you bend it into place. I like this construction for a number of reasons and it makes getting a neat leading edge joint fairly easy.

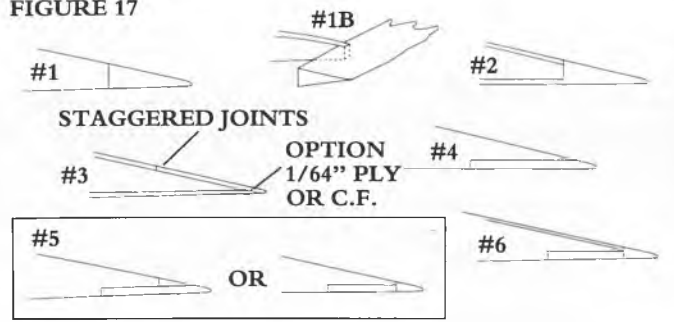
For all of these, a lot of strength and some torsional rigidity can be added without weight by notching the leading edge. Generally notches should be equal to half the thickness of the rib, 1/32" for 1/16" ribs, 1/16" for 1/8" ribs etc. The notches allow a little leeway fore and aft and, as they are glued on the three sides of the notch, (a 'C' section), they add stiffness to the structure. All this and no weight increase!

(See figure 16 for sheet) #1 is the simplest and looks easy, until you try to build it accurately! It relies on a straight joint between the sheet and the leading edge. You need to make very sure that the edge of the sheeting is cut perfectly straight and that it doesn't get 'wavy' in between ribs.

#2 adds a false leading edge of 3/32" or 1/8" sheet. This is easy to cut straight and supports the sheet between ribs. The glue joint is 'L'



FIGURE 17



shaped and if it isn't perfect, the false spar still allows a strong joint. Usually the leading edge 'cap' can be a little thinner than you might otherwise make it.

#3 is a little simpler but requires the wing to be removed from the building board before the bottom sheeting is added, so that the leading edge bevel can be razor planed. This could be done before glueing in place, with care. When the leading edge is planed and sanded to section, this joint will be tapered. I have had more luck with Amberoid or Siment balsa cement for this type of joint as the CAs all leave a hard edge that is difficult to feather out.

## Trailing edge

As with the leading edge, the trailing edge is as much one of personal choice as what is a good approximation of scale.

(See figure 17) #1 is the simplest and usually the weakest. It can be strengthened a lot by notching as noted above. It is best razor planed to shape before glueing ribs. If you try to do this on a completed wing, you may find it warping up, especially if you sand it to shape. For thin wings, instead of a large piece of balsa, I like making this out of 1/8" x 1/4" spruce or basswood. As long as it is notched and the ribs are not too thin, it is a strong and satisfyingly delicate looking trailing edge. It looks great under a semi-transparent covering.

#2 is a variation on the first but with cap strips. It strengthens things as the cap strips will prevent side to side flexing. The rib will be quite skinny as it is thinner by the thickness of the two cap strips. This may make cutting the ribs tricky because of flexing. You might want to consider a female master for cutting ribs which may be awkward if you are building a tapered wing.

#3 is an all sheet version. Usually it is made from 1/16" sheet. It is very light and warp resistant. It does need to be wide

enough to allow adequate rib strength. Consider using two different widths, say 7/8" on top and 1 1/8" on the bottom. This avoids a stress riser. It's minor, but every bit helps. If you need a particularly sharp or durable TE, a strip of thin carbon fibre between the two pieces will help.

#4 uses a single thicker strip to form the TE. This is an easy and strong method but is not very warp resistant. It also causes problems when covering as the covering tends to stick to the wood between the ribs. This is less of a problem with iron on coverings.

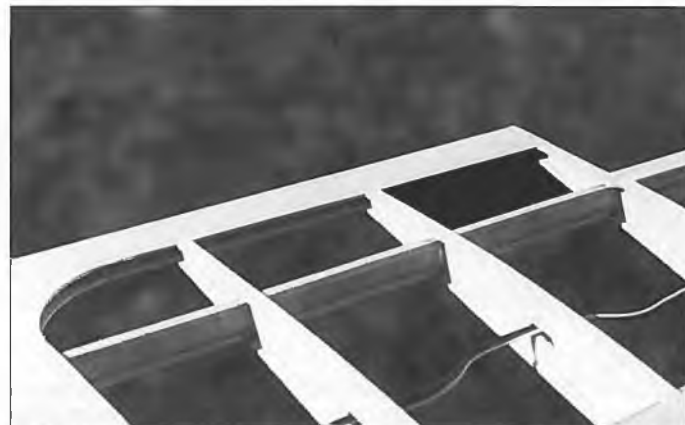
#5 is an improvement on #4. The addition of the small strip increases warp resistance a little but also lifts the covering clear of the main trailing edge member. When covered with an opaque covering, just a thin strip shows at the TE on the top surface, and no one looks underneath!

#6 is #5 with cap strips added. Scalloped trailing edges present an interesting problem. The original aircraft had trailing edges made of cable stretched from root to tip and anchored to the trailing edge of each rib. On a model thin ply may be the best solution. A thick TE will need shaping between the ribs to accommodate the sag of the covering, but this results in a loss of the distinct rib line which should go right to the trailing edge. But perhaps this is getting too complicated for sport scale!

All of the above are time tested ways of dealing with wing structure. It just scratches the surface of wing basics so if you have a method that works well for you then use it. This is meant only as a starting point.

I enjoy looking at plans as there is almost always something interesting in them. Every scale model seems to have some little puzzle that needs solving and it's fun to look at how each designer deals with it.

Martin Irvine, 1331 Rockwell Drive, Kingston, Ontario, Canada, K7P 2M8. Email:



'Submerged' rear spar and sheet TE, compare with figure 6 and figure 17, #3.



Nieuport 12 lower wing built as in figure 6 (but with a single spar). The LE is as in figure 15 #3 and the TE is as in figure 17 #5.



Wing built as in figure 17 #6, before covering.



Wing built as in figure 17 #6, after covering.



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EF01/97





Monarch EX fresh out of the box. Note the pre-sheathed wing panels and stabs and the fiberglass wing tips. Those pre-made wing tips sure save a lot of time carving and sanding!



Comparison of a Monarch '93 HLG fuselage and the EX fuselage. The black band is a piece of heat shrink tubing that is used to keep the hatch in place instead of using tape. Great idea! The EX fuselage has the nose and LE bulkheads already installed and the whole fuselage weighs only 1.8 ounces (51g).

**I** was excited to receive in the mail a DJ Aerotech Monarch EX kit and quickly popped the box open to look over the contents of the kit. As many of you out there flying RC Hand Launch Gliders know, the Monarch series of RC HLG models are some of the most competitive models on the market today and the sheer numbers of them at contests, both large and small, attest to the Monarch's capabilities. Joe Hahn and Don Stackhouse have been constantly tweaking and

# DJ Aerotech

# Monarch

## kit review



Tidy tail end of Monarch. Note the molded saddle for the V tail-stabs and the clean installation of the pushrod wires and control horns.

**Mark Nankivil  
builds and  
reviews  
this**

**versatile  
very pre-  
fabricated**

**59 inch (1.5m)  
span electric glider for direct  
drive 400 motors, named  
after and finished like this  
well known American  
butterfly.**







Those are thin 'foils! Developed by Don Stackhouse, these airfoils transition across the span. Root chord is 7.5" (190mm), 6.375" (162mm) at the panel break, and 5" (127mm) at the tip for a total wing area of 387.5 sq.in (25sq.dm).

## Pre-fabrication

The kit comes with pre-sheated wing panels and V-tail stabs, a fiberglass fuselage with the bulkheads already epoxied into place, fiberglass wingtips, strip balsa for the wing and stab leading edges as well as flapperon and ruddervator facing material, and a bag of accessories such as wing mounting plate & bolt, wire pushrods, fiberglass tape, flapperon hinging material, etc. When I first pulled the wing panels out of the foam core beds, I was struck by the exceedingly thin, almost free flight shape of the airfoils used. If I didn't know better, I would

and sand them to shape, checking the shape with the LE templates found on the drawing I would suggest care and caution with this step as the balsa used for the leading edge stock is quite soft. Slow yourself down and use 400 Grit sandpaper and a light touch, checking often. The wing panels already have the dihedral sanded into the ends so joining them is fairly straightforward. Just be sure to check for symmetry in joining the panels.

The V-tail stab halves also are pre-sanded for joining. I cut away the ruddervator surfaces from the fixed surfaces and joined the fixed surfaces together. I then proceeded to attach these to the fuselage, checking and double checking the alignment. The fuselage has a stab saddle molded in so in joining the V-tail stab to the fuselage, I inverted the fuselage and rested the wing saddle on a piece of scrap spruce resting on two identical,

*Completed model at rest and rarin' to fly. Completed model weighs 20.5 ounces (582g) with direct drive motor/speed controller set up.*

inverted cups so as to square the fuselage up with the table top. The

V-tail stab then is tack glued into place and the alignment checked by resting the stab tips on the table top, before 'glassing' the V-tail stab permanently to the fuselage. The photo probably explains the process better than I can.

I then started to carefully cut away the flapperon surfaces from the wing panels by Using a very sharp razor. You will actually cut through the balsa skins and some fiberglass reinforcement under the skins. Go slow so as to not distort the wing panels or flapperons. The hinge line for the flapperons is actually an 1/8" inch wide gap and this gap is spanned by the hinging material - the idea

*The plastic coupler that joins the inboard/outboard flapperons. It's a plastic inverted vee with tabs that glue onto the upper surface of the flapperons. Take care installing it!*

have thought that the wing panels were bagged with too much pressure! Having looked at Joe's Monarch C at the '96 LSF/AMA Soaring NATS, I was prepared for it and I look forward to seeing how they work out in practice. For those of you with an aversion to V-tails there is a drawing for a convention rudder/horizontal stabilizer set up.

## Building

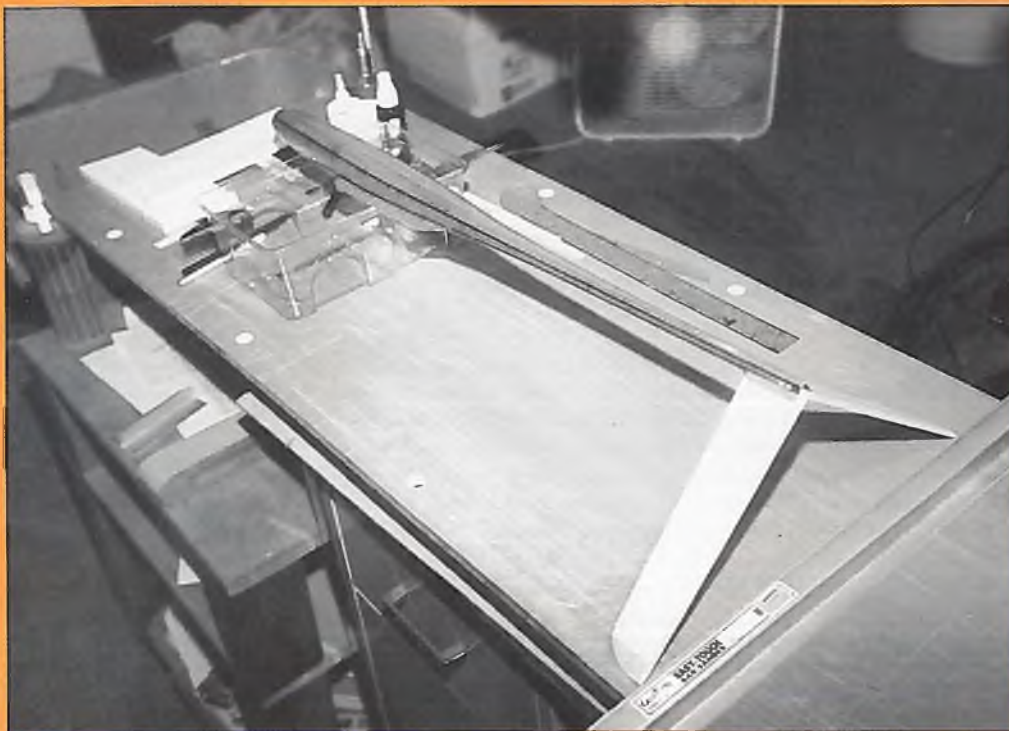
After looking over the drawing and instructions carefully and visualizing what would need to be done, I started by putting the leading edges on the wing panels and stabs and the tip blocks for the stabs. After the glue had dried, it was time to razor plane

improving the breed and have yet to hit a plateau when it comes to improvements.

They have now turned part of their attention to the Speed 400 size electrics with a model that mates the wing and tail of the Monarch C HLG to a new fuselage that has the room to take a motor, speed controller, and motor pack The electric version of the Monarch comes in either E or EX versions with the E being the polyhedral version while the EX is set up for flapperons.







Partially completed airframe. Note the huge flapperon surface and the fiberglass wing tip on the left wing.

being that when the flapperon is moved away from neutral there is not a sharp break at the hinge line that will induce flow separation. I first saw this done on a HLG model Joe Wurts flew at the '95 LSF/AMA NATS and the reasoning sounds right to me. In practice it seems to work well enough. When the flapperons are cut free, clean up the edges with a sanding block and then glue the facing material to the exposed edges. When all the wing parts are completed, I joined the fixed portion of the wing panels, again checking alignment and dihedral, by tacking the panels together with foam compatible CA. After double checking alignment again, I used the supplied fiberglass strip to reinforce the joint, taking care to use only enough epoxy to wet out the 'glass and no more.

## Patience!

Once the wing is joined and in one piece, I made the decision to seal the balsa wood, using Deft semi-gloss clear wood finish sprayed on in light (and I do mean light!) coats. With that dry and done, the hinges and gap seals were installed. When it comes to installing the hinges, just follow the construction notes and you'll do fine. Installing the flapperon couplers takes a bit of finesse to get it right. This plastic coupler is an inverted vee with flats on the open end of the vee. These flats are what gets glued to the upper surface of the flapperons

and thus join the outer and inner flapperon surfaces so they can be driven by one servo attached to the inboard surface. Be patient here and do one surface at a time. I got cocky and tried to do both surfaces at once and had a mess on my hands. Luckily there was a third coupler in the kit and I was more patient (read chastened) the next try and it worked out fine.

## Finishing

With the general construction essentially done, it was time to decide on the final finish. I had made my mind made up early on that I would do the butterfly finish and for that I used 21st Century Space Age Paint in orange for the base color, a strip of flat white paint on the trailing edge and a small portion of the leading edge of the wing for the white spots, and black permanent markers for the black portion of the butterfly markings. This all worked out pretty well though I am sure it added a bit of weight. Oh well, I like the way it looks! I left the fuselage as is because I was a bit uncomfortable putting a black finish on a fuselage with such a light lay up and turning the fuselage into jelly sitting in the sun.

## Fitting

When it comes to fitting the radio equipment and motor bits, the drawings and notes show a 6 cell pack being fitted. I planned on using a 7 x 500AR cell pack for

To ensure the V-tail stabs are installed square to the fuselage and wing, I inverted the fuselage and levelled it across the wing saddle. When the V-tail stabs are tacked into the stab saddle, you can check alignment and then epoxy and 'glass them into place.

competition and sport use so I had some concerns about fit and balance. Also, the drawing shows the receiver located directly behind the motor which to me is dicey due to the electrical "noise" these motors put out. I much prefer to separate the receiver and the motor as much as possible so the receiver ended up back under the wing instead. I also had to take into account that I will later try out a Graupner Speed Gear 400 geared motor and the gearbox will take up a bit more room up front. I used HITEC HS60s in the fuselage driving the ruddervators and HS80s in the wings to move the flapperons. As you can see in the photo, it indeed all fits and rather well at that. Up front is the back plate of the Speed 400 6V motor with the attached JETI JES 10 Compact speed controller. This is a very nice speed controller with both prop brake and BEC that is perfect for Speed 400 models direct or gear drive. Able to handle up to 10 amps, it attaches to the motor tabs with two set screws (instead of directly soldering the unit to the motor like the Robbe RSC 210 on-off switch) which allows for rapid removal and swapping of the motor/speed controller with other models/motors. Nice! Behind the motor and speed controller are two Hitec HS-60 servos which drive the V-tail surfaces. Light and small, these were the best choice for this location as I needed a bit more room up front for the possible installation of a geared motor at a later date. Behind the leading edge bulkhead, a lightened JR receiver resides followed up by the 7 cell 500 AR motor pack. This pack is set up as two rows of 3 cells with a single cell across the end, opposite the connectors. The cells are directly soldered to each other - no straps between cells except the single end cell. All up weight for my Monarch EX is 20.5 ounces (580g), quite reasonable for a 4 servo model with the Monarch butterfly finish. I might later swap the receiver and install a MFA Direct Micro 2000 receiver and save another 1/4 ounce of weight. Control surface throws were set up as recommended in the instructions



and this seem to be dead on for my set up. Only time and more flying will see whether I modify the throws. I would highly recommend that you stick to what is noted in the instructions and adjust only after flying the model a number of times. Balance was right in the center of the recommended CG range - a rarity for me!

## Flying

Initial flights have been with a Robbe 6 x 3.5 folder and the climb is quite brisk as long as the airspeed is kept up. With a direct drive set up, you are better off using a shallow climb with good air speed whereas with a geared installation, the climb can be a bit steeper and slower. This makes sense when you think about what the propeller is doing in each case. The model senses lift well and circles tightly without fear of tip stalling. When slowed down too much, the Monarch gets mushy and obviously isn't flying at its best - it's easy to see when that happens. Keep a decent turn of speed and you will be rewarded with a nice climb rate. When you have established the lift, crank in a little flapperon and watch the



elevator going up!! When it's time to leave the lift and head out, neutralize the flapperons and start moving. If sink is encountered, a little bit of negative flapperon helps to pick the speed up and let you escape the sink zone. I will continue to refine my use of the flapperons to open up the flight envelope of the Monarch EX. This is a model that I will continue to find fun and challenging to fly.

I would recommend the Monarch EX to anyone looking for a competition level Speed

Monarch innards for all to see. Up front is Speed 400 6V motor and JETI speed controller with BEC followed by 2 x Hitec HS60 servos. Behind LE bulkhead is a lightened JR receiver and a 7 cell 500AR motor pack.

400/Electroslot model. The cost is higher for the kit than say a Voyager, Mini Challenger or other pure kit, but remember that the level of pre-fabrication of the Monarch EX is much higher too. I would still be building it today if it weren't for that level of pre-fabrication! Another plus is that you can swap the wing to a Monarch HLG fuselage and let it do double duty for you! Contact Joe Hahn and Don Stackhouse at: DJ Aerotech, 719 Fisk Street, Piqua, OH 45356, USA Tel: 513/773-6772

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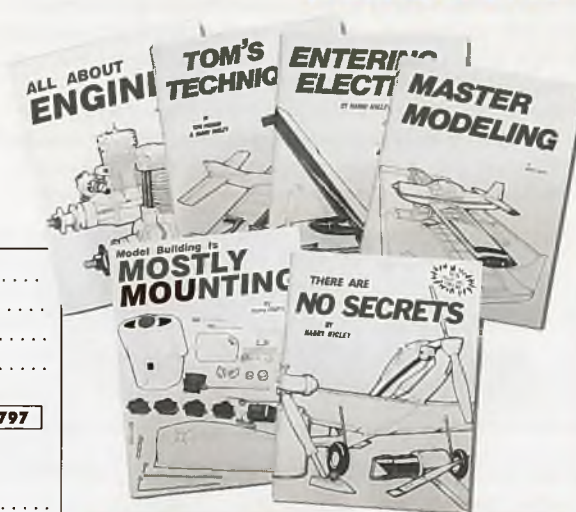
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*Gernot Neuböck's intention in designing this Heinkel 162 was to get a scale-like electric ducted fan model for his own-designed EDF-700 fan unit, the plan for which was published in the March/April issue of EFI. This is the first of several plans we will be publishing of scale designs of Gernot's that use his fan unit, or if you do not have time to build your own, you can use one of the commercially available fan units.*

# Heinkel He 162 Sa plan and construction

**T**his is not a beginner's model but anyone who is experienced in flying with ailerons will be of capable handling it without any problems. The Heinkel is quite easy to build because it is all conventional balsa and plywood construction. Before the building process can be started, there are some things to consider. It is essential that you use the lightest balsa and plywood. The entire aircraft is constructed using CA glue wherever possible. The target weight, with motors, fans and radio installed is 2.5kg. The lighter the better!

## Numbers and sizes

The EDF-700 fan unit delivers a thrust of 12 Newtons (about 1180g, or 42 oz), has an efflux velocity of 32m/s and consumes 25A when running on 16 cells (Sanyo 1700SCR). Therefore, in order to get a good performance the maximum weight of the plane should not be over 2.5kg (88oz). Before I decided on the Heinkel I searched through lots of plane books for the right model but most of them had long air ducts or too small inlet cross sections. To prevent thrust problems caused by the air ducts and to get an easy fan installation, I finally selected the Heinkel 162. Accompanying the two sheet plan is a 'Parts List'; every airframe component is listed, named

and wood size specified and quantities for each component are given. The original model was constructed from metric dimensioned wood sizes, Imperial equivalents are provided.

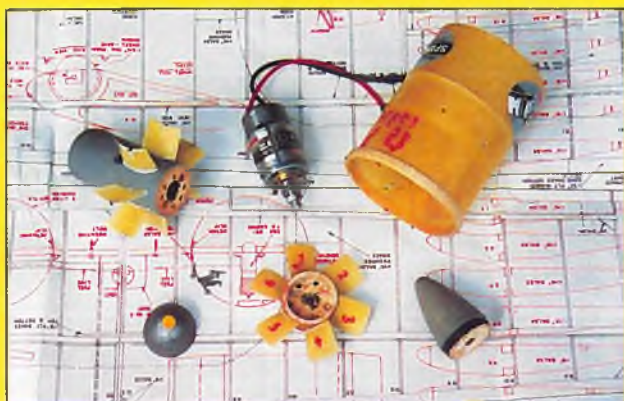
## The wing

The wing is build in two symmetrical halves that will finally be glued together. Wing dihedral is 5 degrees. I selected the Clark 'Y' airfoil, because this gives any airplane very smooth flight characteristics. After cutting out the bottom wing sheeting (parts: 61, 73, 97, 63) and the wing and aileron trailing edge (71, 74) they have to be pinned on the plan. You have protected your plan with wax paper or plastic sheet, haven't you?. Then the aileron sub spars (75, 77, 78) have to be glued to the right position. Two sets of wing ribs have to be traced and cut from light balsa by the use of the rib templates (56, 69). After glueing them onto the bottom sheeting with CA, the vertical

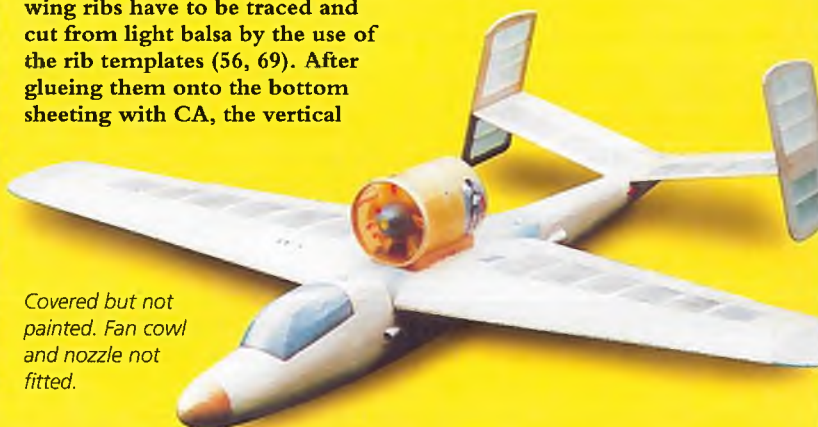


Preliminary assembly. This is the original tailplane without balsa sheeting.

grain webbing (59) is fitted between the wing ribs. Before the upper wing sheeting can be fitted, the aileron servo mount (64, 65, 66, 68), the balsa block for the wing bolt and the dowel (53, 54, 62), the sub leading edge (58), and the aileron horn mount



Component parts of the EDF-700 fan unit.



Covered but not painted. Fan cowl and nozzle not fitted.



Landing slowly with 20° flap.



(note the right angle to ensure proper alignment). In order to get a stable frame for planking the fuselage sides (51) must be fixed with CA and epoxy.

The wing support parts (13, 14, 15, 18, 19), the elevator servo mounts (16, 17) and the canopy support have to be added as shown on the drawings. The still open fuselage surfaces have to be planked with 10mm wide balsa strips. If liquid CA is used for this job, it will be very easy to get a smooth curvature. In order to keep the structural weight down and to ease the sanding, it is necessary to use for the nose block (10) the lightest balsa available. The rear part of the fuselage (8, 9, 42-47) is built up as previously explained. After glueing the rear and the front parts together the entire fuselage is sanded carefully to shape. For the canopy I used a vacuum formed Cellon part. The canopy hatch (48-50) consists of a 2mm balsa sheet to which the pilot and instrument panel are attached. After sanding

# amander

(79) have to be attached. For glueing the upper wing skin and the wing leading edge (57) the use of thick flowing CA is recommended because this type is slower setting.

The wingtip is a massive and therefore ultra light balsa block has to be attached to the wing with five minute epoxy and sanded to shape (beware of all the dust!). After the final sanding of the two wing halves, glue them together with CA (ensure that wing dihedral is 5°). To reinforce the wing joint I applied a 60mm wide strip of glass cloth with epoxy resin on the lower and upper surface. Epoxy glue the wing mounting dowel (8mm diameter) into the reinforcing block (62).

## The tailplane

The horizontal 'stab' consists of two balsa strip frames (86-96) that are covered with 1 mm balsa sheets in order to get a torsion resistant construction. Especially in high speed flight the tail tends to flutter if there is no sheeting (I saw this on the prototype). After sanding the whole tailplane to shape, the balsa tri stocks for vertical fin support have to be attached. For joining the two tailplane halves I also used glass cloth strips and epoxy resin on lower and the upper surfaces. The tailplane dihedral is to 30°.

## Vertical Fins

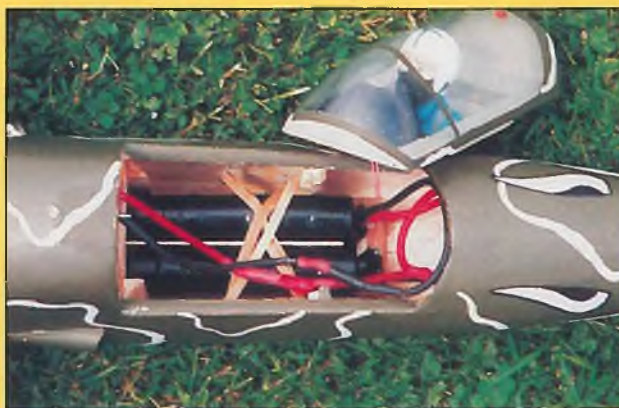
The fins have the same basic construction as the tailplane. The only difference is that planking is not necessary. In order to get enough strength, an exact fit of the balsa strips is essential. Finally all the edges are sanded round.

## Fuselage

The fuselage is a modified box construction of liteply and balsa. Because of its length (1200mm), it consists of two main parts that will be glued together last of all. First the bulkheads (1-9) must be traced out on liteply. After cutting out the bottom sheet (11) relief cuts to accommodate the bends are absolutely essential. The bulkheads have to be attached in the right place with liquid CA



Wing off to show radio gear.



Canopy off for battery access and location.





Man and machine. Gernot and He 162.



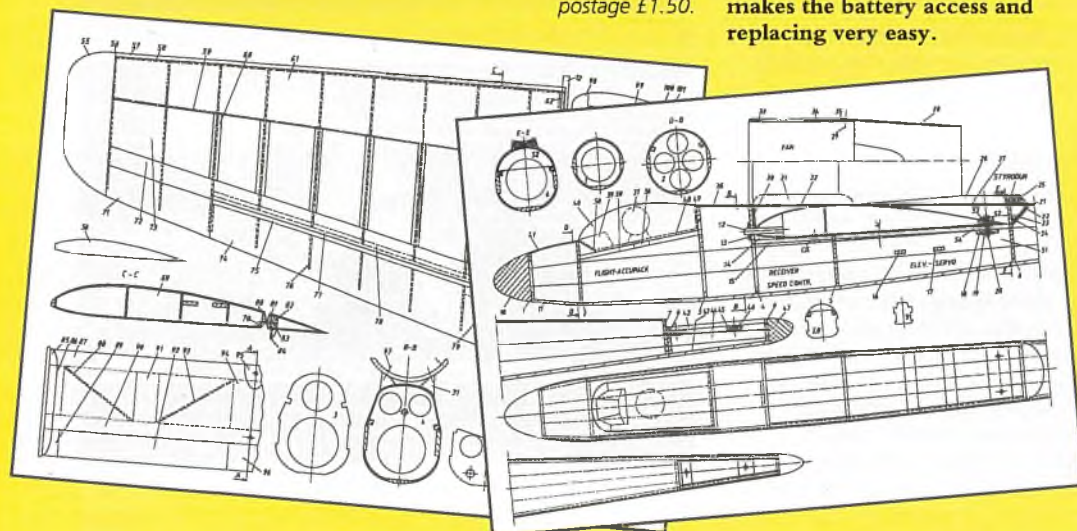
Hand launch firmly.

and painting them the canopy is fixed with CA. (To keep the canopy glass clear, beware of the flow of glue.)

## Fan Mount

After fixing the wing onto the fuselage with two Nylon screws, the parts (30-32, 21-27) have to be glued on the wing with CA, except part 25 that has to be attached with

Copies of this plan, No. MW2592 are available from Electric Flight International (Plans service), Traplet House, Severn Drive, Upton-upon-Severn, Worcestershire, WR8 0JL. Price £7.50 plus UK postage £1.50.



epoxy. In order to get a simple fan casing the parts 33, 34, 35 are directly glued onto the fan housing. The nozzle (28) consists of trapezoid balsa strips that are glued together with CA and finally rolled up. To get a secure fan mount, the threads for the four fan fastening screws (97) in part 31, need to be strengthened with liquid CA.

## Finish

After painting (transparent nitro dope) and sanding the entire aircraft three times, I applied one layer of covering tissue with dope as well. After three more painting and sanding sessions the plane was coloured with polyurethane paint. Finally, details like exhausts, intakes, numerals and insignias should be added.

A marking pen can be used for panel lines, or use another finishing technique of your choice. For example, the use of covering film is also recommended because of its low weight.

## Radio installation

The use of micro servos is not absolutely necessary because there is enough space for standard servos but it helps to save weight!

The aileron servos should be fastened with an aluminium shackle to the parts 65 and 66 with two screws. The elevator servo can be directly screwed to parts 16 and 17. Receiver, speed controller and the radio battery should be located between the bulkheads 4 and 5 in order to get the centre of gravity in the right position (as shown on the fuselage drawing) the motor power pack has to be positioned under the canopy with balsa blocks and rubber bands. This makes the battery access and replacing very easy.

## Flight performance

The model is hand launched. If you can program your Tx and both ailerons are set fifteen degrees down and with a little up-trim on elevator, the launch causes no problems even without any headwind. The He 162 is an extremely stable aircraft. Aileron control is smooth and predictable and rolls are easily performed. The model does not drop a wing when it stalls; it just 'mushes' and drops its nose. Loops are easy to execute, with a slight dive to pick up the needed additional speed.

Once in the air there is one thing to consider. A ducted fan plane will only perform well if it is flown fast. Therefore tight turns are best avoided. Level flight can be maintained with a 40% throttled down motor. Owing to its high lift airfoil, the glide is flat when the fan is off and the ailerons are set 15 degrees downwards.

The climb rate is very convincing. Because of its weight, the model can be flown even in a strong wind. When landing it is necessary to pay a little attention to the structural sensitivity of the vertical fins. So the landing speed should be as slow as possible. Except for this, the whole aircraft is very robust.

## Conclusion

My intention to create a scale like single engine electric ducted fan sport plane was a great success. On account of the motor used (Speed 700 BB Turbo 9.6V), the self made ducted fan unit and the built-up airframe, whole plane is a low-cost jet.

Another advantage of this model is that it is completely demountable. Therefore it will fit in any car's luggage space. Another special feature is the sound of an electro fan - almost scale like but very quiet. I hope that everyone who wants to build a duplicate of my plane enjoys it as much as I do.

## Technical specification

wingspan	1280mm (50.4")
length	1185mm (46.7")
weight	2.5kg (5.5lb)
airfoil	Clark Y
wing loading	70g/sq.m (23oz/sq.ft)
wing dihedral	5°
flaps (launch)	15°
flaps (landing)	20°
aileron	±15°
elevator	±30°



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## Battery packs

Cells must be reliably connected to each other, for a transmitter or receiver you cannot rely on spring contacts in a battery holder. For a power pack for a motor you need a connector that will carry however many amps. Some packs that you buy are welded. The merit of welding is that the cells do not get hot enough to do any damage; the disadvantage of thin welded metal strips is that these are fine for low current work but if you use more than 20 amps you need thick strips and multiple welds. If you do it yourself you have to solder and you can use connectors as thick as you wish. The disadvantage of soldering is that you may overheat the cell and damage the seals, so you solder quickly and you have a much more reliable connection. Competition packs are always soldered.

### START HERE

You need: A soldering iron  
Solder  
Flux  
Links  
Cables  
Connectors  
Heatshrink sleeve

The size of a soldering iron is critical to us, 'size' or 'power' being how many watts it consumes. Every iron's power is rated in watts. You will find somewhere on it, or on its label a legend like '240V, 25W'. Irons as small as 10W or 15W are fine for electronic circuitry and might be used for soldering connectors and tabs, but 25W to 50W would be better. If you are soldering direct to cell cases or to the positive terminal, a 100W iron is better still, and if you can afford the choice, choose a 'temperature controlled' one.

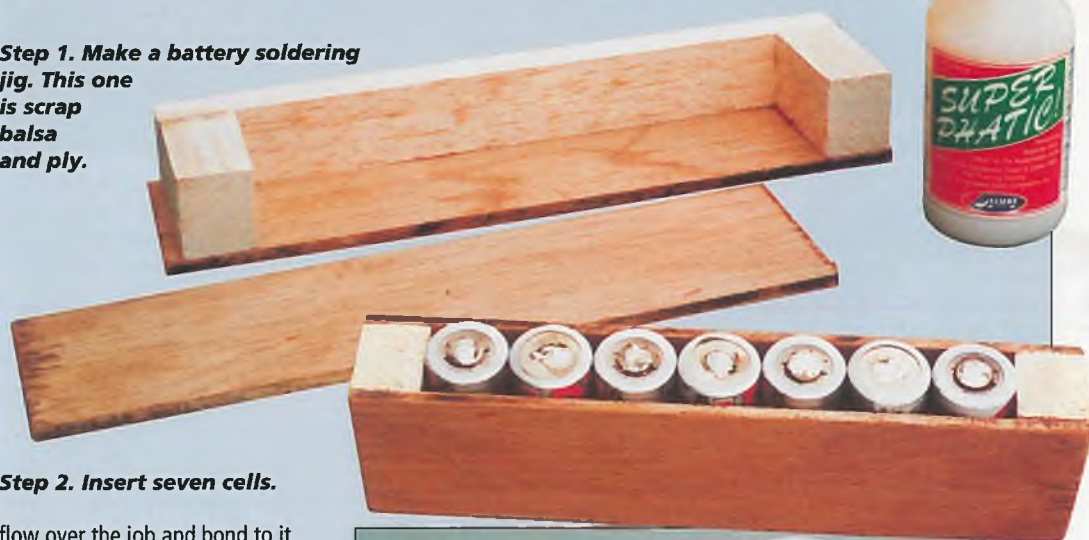
A low power iron with a big bit is actually more use to us than a high power (lots of watts) iron with a small bit. The reason for this is 'cooling'. When you contact the bit with the solder and the item to be soldered a lot of heat is conducted away. (All three components are metals remember, good conductors of heat and the melted solder provides excellent contact for heat transfer.) A big bit has a big reserve of heat to do the job without much temperature drop.

The solder you get will probably be 'multicore' or 'rosin'. This means it already has several minute strings of flux (rosin) inside it. Flux is a sort of cleaner and lubricant. It enables the solder to

# How To... Solder up a battery pack

**This is for beginners... to soldering. So many experienced electric fliers still buy their battery packs. Soldering is easier than building model aircraft. You just need to do it the correct way and you cannot go wrong. You need a few tools and the right bits.**

**Step 1. Make a battery soldering jig. This one is scrap balsa and ply.**



**Step 2. Insert seven cells.**

flow over the job and bond to it (the parts we are trying to glue together). It actually prevents oxidization. Oxides are corrosion. Corrosion stops solder sticking to other metals.

For our connector and battery size components, don't use the 0.8mm (1/32") solder, use 16 SWG (1.6mm, 1/16") or 14 SWG (2mm, 3/32"). Solder is like glue, it holds metallic components together and it conducts electricity. To apply it you need to have the two components close together, heat them with the iron, and feed in the

**Step 3. Clean cells and links.**







**Step 4. 'Tin' cells and links.**

## 'Tips & tricks'

A 'jig' for the battery pack makes the whole operation much easier. A hardwood one will last longer but this one was built in minutes from scrap 1/2" balsa sheet, balsa blocks and 1/8" building quality plywood. You can make it for 7 cells or more and use spacers.

The components must be clean. Before you try to solder, clean them with fine sandpaper or a file or wire wool, or a lightly used sanding drum in a mini power tool. If the solder does not flow, clean the parts again.

For an easy join, 'tin' each component first. This means (with

the solder flows and take away the iron immediately. Wipe with a (water) wet rag, to cool it. Repeat at the other hole in the link for the other cell. Wash off any residual flux.

If this reads like a three handed operation, it is! But pressure on the link can be applied by a piece of balsa gripped by two fingers and the solder is held by one of these fingers and another in the same hand. This is easy if you eat with chopsticks.

If you have problems, just use blobs of solder when you tin the components and don't hold the solder mentioned in the last para.

Look at the tinned part (and after joining, look at the soldered join too), is it shiny? Good. If it isn't, if it is dull or even like fine sandpaper, it may be what is called a 'dry joint'. This is like a bad glue joint, the two parts are only just held together and may even not conduct electricity, or not much. The reason was: not hot enough, or not enough flux (probably both). Practice first, then solder connectors to cable.

Timing is important. You need a high temperature component before you solder. High temperature at the cells can damage the internal chemicals and it can distort leaves of metal inside and it can damage plastic internal seals under the positive cap. You need to use your hot (big) iron for a very short time. Solder melts and flows, and the cell conducts away heat before it can damage. If your solder won't flow after one

second, take away the iron, cool the cell, clean it and try again, always cool the cell after soldering (or attempting to solder), a wet rag is easiest.



**Step 5. Solder links.**

the iron and solder, and flux if this is separate) put a little solder on each component, battery and link. Each now has a skim of solder over the parts to be joined.

Solder to solder is an easy join, but the flux has already done its job and burned away. Next time, for the real join, use multicore solder again. Put the two tinned parts together, applying a

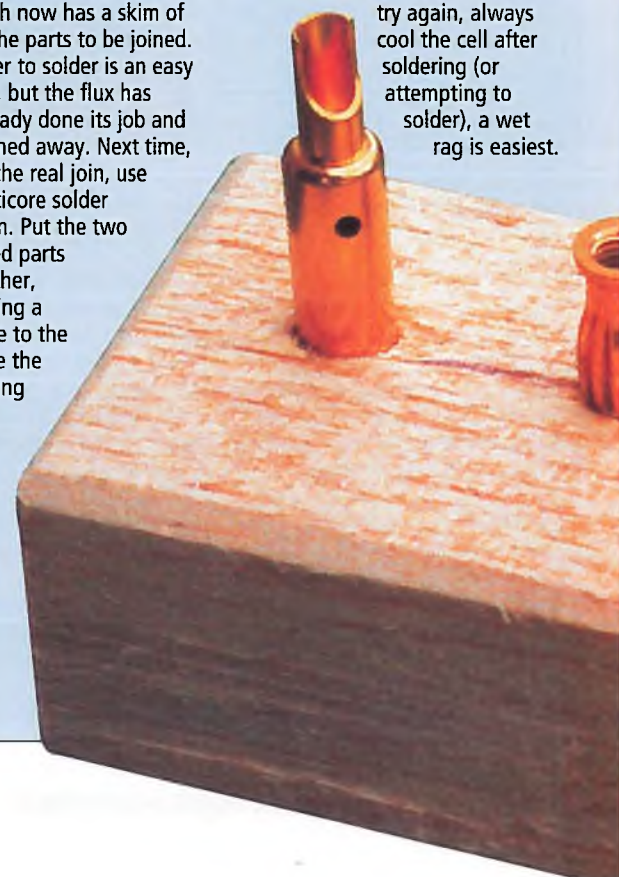
little pressure to the link and have the solder touching it too, in or near the hole in the link, touch the link with the iron until

**Step 6. (above) Up-end cells and solder links.**

solder. As the solder touches the iron it melts, and flows onto the already hot components. Pull away the iron and the solder and the two components that you are soldering will quickly conduct away the heat. Everything cools, the liquid solder solidifies and the two components are glued together by solder. Now try it, connectors to cables is a good start, full directions later.

The pack assembled here uses the 'Infinity IN 7716 Economy Battery Building Kit' parts as offered in the special subscription offer in this issue. This or 'IN 7715 Deans Pro Battery building kit' is the easy way to get all the parts you need. It is close to the "You need" list above. The differences are: (1) no connectors are included, this is wise, you will have your own preferred connectors. (2) polyethylene rings or washers are included, this is wise too, they provide safe extra insulation at the positive end.

**Step 7. Drill a connector jig.**







**Step 8. Solder connectors.**

components with machine turned and gold plated 2.5mm diameter pins and sockets are available as part: 2980 and are claimed to be safe for 50 amps and not damage from continual connecting and disconnecting.

There are other 2mm and 4mm gold plated 'banana plug' connectors. Some are available as 'kits' with insulating sleeves. 2mm are good for 400 size motors and up to 20 amps and the 4mm size is good for the larger motors (this writer has used them at 100 amps). Fit insulating sleeves wherever possible and colour code them red and black.

When you do want to solder these small pins and sockets, you need a jig. A block of wood is the simplest way. Drill holes the same diameters as the pins and the socket outside diameters. Insert the pins (or sockets) into these holes.

**Step 9. Sleeve connectors.**



## Connectors

Most small ready-wired motor systems and their batteries come with Tamiya or Kyosho type plugs and sockets. They have been used for years with cars and there are so many six cell packs readily available that it seems a pity to change. You may fly safely with these, on low power systems if you treat them carefully. Inside the foolproof (you cannot connect them the wrong way

round) plugs and sockets, are slim rolled metal pins and sleeves. These are a good fit when new, but eventually wear loose and give you a bad connection. Using more than single numbers of amps soon worsens this and reduces power. Very similar Graupner

The ends to which you need to solder are now upright and will not move until you pull them out.

Incorrect connection (positive/negative) or plugging in at the motor end can ruin a speed controller. The type favoured by all the world class pilots and available to anyone who wants them are the 'professional banana' gold plated 4mm plugs and sockets. Your



**Step 11. Fit heatshrink.**



**Step 12. Shrink with heat gun, not to hot or too close, a hair dryer (run hot) will do.**

dealers have access to all these heavy types; you may consider them 'over the top' for 6 & 7 cell operation, and you may be right, but if you end up flying the more powerful models you may wish to standardise on one type.

## Safety

A stand for the soldering iron, will safeguard your workbench and any plastic sleeved cable on it. Needless to say you must not pick up the iron other than by the handle.

Keep a wet rag or sponge nearby or in a pot in case you need to quickly cool any component. Only use identifiable coloured cables and sleeving for connectors. It is standard practice to use red for positive and black for negative.

Don't ever solder with the 'other ends' of cables connected to anything live. If you make accidental

connections with the iron the molten solder can spatter dangerously. The possibility of spattering makes the wearing of safety goggles a wise precaution anyway when soldering.

If you can obtain a unit with clamps on flexible 'fingers' this is useful when soldering; you do not have enough hands of your own. You can make your own 'Dereck Woodward Soldering Widget' as described in the September/ October 1996 issue of EFL. These simplify soldering as much as the wood block 'plugs and sockets jig' mentioned above, they hold the components whilst you hold the iron in one hand and the solder in another. One human does not have enough hands for soldering.

**Step 10. Solder cables.**





## Dortmund

Ducted fans are catching on. This F-16 by Jean-Paul Schlosser is all moulded and expected to fly very fast, more details when the model is sorted out for limited production, purchasers will need to buy complete, the model and integral fan unit.



On display was this 'Black Shadow' built by Horst Resinneck, 3.2m (126") span, weighing 5.3kg (11lb 12oz) and powered by a Plettenberg HP355/40/5 Evo.



The real one has been around for years and now everybody is modelling 'Pushy Galore'. This one is by Andreas Dehn and we should have more information on it soon. Span is 800mm (31"), weight 1200g (42oz) and power is a Speed 600BB 7.2V.



Wolfgang Kaiser exhibited his EMB-312 Tucanno, 2.4m (94") span and 11kg (24lb), powered by a Plettenberg PB500/40/6 and two 24 cell packs.



Several manufacturers are getting ready for 'Formula One' racing – fun models for the rest of us. This is by ABC Modellsport.

## What a Show!

If you ever get the chance to go, do so. The latest goods are on offer and the competitive market means you can save enough on your year's models to pay for the trip. Seven exhibition halls are devoted to different model disciplines. The largest single hall was model flying, as many dealers as some countries have – all in one hall. The big manufacturers who had been at the Nürnberg Toy Fair were there but exhibiting not selling.



The Airworld Constellation for four direct drive 400 motors comes in a box in just three parts (all very light mouldings) and already finished in Lufthansa or TWA livery, 1900mm (75") span.

*One is bound to compare the Dortmund Show with the Nürnberg Toy Fair, both are in Germany, both contain a lot of what is new for flying models. Similarity ends there; Nürnberg is a trade fair, Dortmund is an enormous market and exhibition of models. Hundreds of models were on static display, from vintage to the latest and of many types. Pride of place went to the spectacular ones, big, colourful and mostly IC powered. IC is long established and used in the larger models. But what the hundred or so dealers were selling on their stalls was nearly all electrics or gliders.*

# Interm



FVK kits are available for this Zlin 12 club trainer from the 1950s, wing-span is 1m (39") and it is for Speed 300 and 400 motors.





Kontronik have gone the easy route for fliers who do not wish to program their own controllers (great feature of their regular range). The 'Easy 1000' and 3000 and 5000 come ready programmed to suit most applications and at very competitive prices. The UK importer/dealer is F2A Supplies, 01908 260858.



This JR Models Fun-Flyer comes in 3 sizes as 'Micro-Drop', 'Mini-Drop' and 'Drop', for 400, 500 and 700 size motors at wing-spans of 700mm (28"), 950mm (37") and 1200mm (47").



DC-3 by JR Models for two direct drive speed 400 models.



1240 wing-span DH Mosquito by JR Models for two direct drive 400 motors. Fuselage, wing centre and nacelles are moulded and wing outers are veneered foam. On seven cells weight should be about 1250g (44oz).

## Dortmund, Germany

### Variety

There is only enough space to show you what is new. Wherever you are, ask your dealers for the products you desire. As well as the big manufacturers who had already released new products at Nürnberg, Dortmund contained a lot of smaller manufacturers and dealers were selling goods from even smaller cottage industries, too small themselves for Dortmund.

The new emerging interests were on these stalls, bigger manufacturers cannot afford to risk new ventures. If you are into new ways with electrics or just wish to improve what you have, it is worth looking at the smaller dealers, there were new and useful items everywhere.

The powerful Volz 'Zip' was in the last issue's Current Affairs. This 'Kolibri' is the same 'works' deliberately de-rated for indoor or very light models and fitted in a lightweight vac-formed case to reduce weight to under 8g (0.3oz). 'Twins' is a pair in one case weighing just 14.8g (0.5oz).



Do you fancy a 400 powered scale model with retractable undercarriage? These are pre-production mouldings from a USA manufacturer and enable you to use servo operated nose, main or tailwheel retracts.



Remember the micro receiver in the Jan/Feb Current Affairs? It is now produced as a 4 function Rx (weighing 8g) by CETO. Here it is in a small CO2 powered model.





# B-52c update

*The last issue contained designer-builder Chris Golds' own account of the design choices, decisions and construction methods for this magnificent eight engined ducted fan model. Ducted fans? Eight motors? This would be an ambitious venture for any electric modeller but it was this guy's first serious electric model! He knew nothing about electrics when he started but he is learning very fast.*

Chris didn't say that model size was determined by the space in his car but the wing centre section just fits in the back of his estate, the B-52's nose is alongside his own and the wing outers, field box, etc., fit around all these.



*Almost together, March 22.*



Ready to go, March 22.



**T**he editor witnessed the first successful (sufficient power) flight of this model on March 22, as noted at the end of Chris Golds' article "Who wants to fly bombers anyway?" in the May/June issue of EFL. Previous to that it had flown – just – and struggled to stay airborne. What had Chris done to improve it?

## "It's your fans"

This B-52 had hopped on 16 cells and just made a circuit on 24. Chris is a very good pilot and maybe he was lucky. All his attempts and his good flights too have been recorded on video tape. I have seen all the early videos (anxiously!) and the first successful flight. Photos taken that day are on these pages and more here have been taken since then to record the improvements in the model and the advances in its flying success.

The big change which culminated in success on March 22 had been the replacement of the earlier fans with WeMoTec Mini Fan 480 units. The original units were from the early days of electric ducted fans and not purpose designed for model aircraft. Changing fan units is more work than changing just a motor in an electric model.

Shrouds (the outer 'pipe' in which the fan rotates) must fit well with smooth clean entry and exhaust. If the size or attachment method is different you have a problem, it takes time. Chris had eight to change – not a quick job.

Drop tanks fitted for the camera were removed before flying on March 22.



Climbing well after lift-off, March 22.



Away on its first long (three minute) sortie.



On finals, March 22.







Taking off on May 6 1997. This is the climb-out angle. 'Break ground' time is 5 seconds after full power is applied.

Chris was advised to fit WeMoTec Mini Fan 480 units. This new unit uses the existing EJT 400 shroud and a new one-piece rotor/impeller/fan designed to utilise the greater power available from motors like the Graupner Speed 480 Race, Kyosho AP 29 and LRP Super 400 motors. The 480 Race delivers a lot of thrust for its cost, the 'economy route' for small jets (times eight for a B-52!).

## Improvement one

March 22 saw the B-52 with new 'Mini Fan 480' units but with the model's original Speed 400 7.2V motors. Cheap motors times eight are not so cheap. Chris wanted to first prove that the fans were an improvement for the model – they were. The power pack was 30 cells and the motors wired series/parallel to the speed controller so each motor was running on 7.5 cells. These fans on long 2.3mm shafts are not a good idea; low cost motors are not so well dynamically balanced and even with carefully balanced rotors they often suffer vibration periods that you have to avoid or 'drive right through'. But the model flew and it flew well.

## Improvement two

Graupner Speed 480 Race motors with their 3.17mm shafts were the next obvious step. Stiffer shafts and a lot more power but what were the liabilities? More power means more amps means less flying time – or does it? The Speed 480 Race motors deliver more power when



Short finals, May 6.

you need it, for take off, then you can throttle back to cruise. Static tests and flight tests show that to achieve a reasonable altitude, before cruise, takes less

time with the 480s – you would expect that. What is not so obvious (and not *always* the case) is that more amps for less time can get you up there for a total

View from underneath B-52, of drag 'chute bay. Red line is main cable to chute lines. Mini servo both streams (by opening door) and jettisons (by withdrawing rod through loop on red line).



Brake 'chute streamed during landing, May 6.





expenditure of less energy. Some draggy models get up quicker but take a lot more energy to do it. This B-52 saves power getting there (if you see what I mean! – 400s take too long) so it can indulge in a longer cruise too.

The next discovery (perhaps a surprise) is that 'cruise' with 480 motors achieves the same thrust for less amps. This goes to show that the 480 fan rotor is more suited to the 480 motor, so the designer might be indignant if you show surprise.

Chris does static thrust tests in his studio (he paints aircraft too but when he is not painting, it is a workshop). The rigged/assembled model sits on a table and fights the kitchen scales. On these static tests he uses an ammeter so that he can see how much energy he is using relative to throttle settings at the Tx. Of course the motors will 'unload' in the air but this gives him a 'ball park' figure to estimate power consumption and safe flight time. Chris is a very experienced pilot of RAF single place combat aircraft and a builder of scores of scale models (which usually have a poor glide performance) so he knows he needs a reserve of power for landing. He always has a 'talk man'/co-pilot watching the clock.

'Ground running' can sort out a lot of potential problems. The 400s gave a satisfactory performance on 30 cells and the model was well able to carry this weight so early static tests with 480s were on 30 cells. Problem one was that the speed controller 'tripped out' as the ammeter went off the clock at 50A. This may not be a problem in the air as the motors unloaded but it could deliver problem two; a 15lb (7kg) model with motor failure and 'deadstick' seconds



*Hound dog missile, made from hollowed blue foam. The weight of a pair (including pylons) is 7oz (200g).*

after take-off (the most likely time) could be hazardous.

### Improvement three – model state #4

Thrust at less than full throttle was so much better than ever before, so six cells were removed from the power pack. To quote Chris after the first flight on 24 cells on 3 May 1997: "LOADS of thrust, I throttled back to an estimated (by position of throttle lever on Tx) 22-25 amps where previously I have needed 30A to maintain cruise. I will do a bench run to see how long I can maintain that throttle position prior to die-back then subtract about 30 seconds to give me sortie length. The new cowls worked well."

These new cowls were another search for increased efficiency and more thrust. Original 0.4mm ply simple cowls were big and 'open backed' and did not fair-in the neat Mini Fan 480 units. The model was tested for thrust without cowls; there was another half kilo of measured thrust! New cowls were tailored to fit the Mini Fan 480 shrouds and supplied intakes, plus a tapered tailcone. I think Chris used truncated paper cones but Oliver



*Original 0.4mm ply simple cowls but with 480 Fan units fitted.*

of WeMoTec recommends a MacDonalds plastic cup cut to size, the angle (and the weight) is just right. The weight increase of new cowls for old is 1oz (28g) for the whole model. Measured thrust is 91oz (2580g). With the original cowls it was 72oz (2041g). The new 'cleaner' cowl must behave better in the air.

The 480 motors each weigh 32g (1.1oz) more than a 400 but so much weight was saved by removing 6 cells that Chris had some weight to use elsewhere if he wished. He did. In the interest of saving weight he had not fitted a steering nosewheel. B-52 fore and aft wheels do not permit rotation, the pilot of a model or full size has to wait until it literally 'lifts off'; long take-off runs sometimes lead to the model veering out of the headwind. Also, 'hard' wheels had been fitted to reduce rolling resistance, good for take-off but the 15lb model rolls a long way after landing, so he decided to fit a drag 'chute like the big one – another scale feature! Chris enjoys 'decorating' his models – insignia, nose art, and any hardware they may carry externally. He had already built long range tanks for it. I didn't weigh them but they seemed to register nothing in the palms of my hands. Now he has constructed a pair of 'Hound Dog' missiles for it too. The steering works, nose wheels use twin tiller arm steering and are effective taxiing in strong cross winds (big fin wants to weathercock). The 18" (460mm) drag 'chute works too, operated by a mini servo for streaming and jettisoning. Chris has fitted quieter soft tyres now that he has the power to overcome early roll resistance. Each motor now runs on 6 cells and they burn about 60 amps at full power, on 24 x 1700mAh cells (motors are 4 in series, parallel with 4 in series). Two scale 3000 gallon drop tanks on underwing pylons have flown, Hound Dog missiles have not yet flown.

The flights are conducted according to behaviour on bench tests. Static, the pack gives 30 seconds at full power (to the top of the climb), throttle is pulled back to 23 amps for a cruise of 5 minutes until the battery runs down. This would probably be better in the air but Chris runs a "sortie max limit 4.5 mins total" for very safe flights. You want to see it? Chris will be flying it in the evenings of the 'RC Jet Masters 97' event at RAF Wroughton. The event is August 30 to September 7 but the B-52 will probably be there from Thursday (4th) to Saturday (6th).

*Most recent cowls with Mini Fan 480 and 480 Race motors.*





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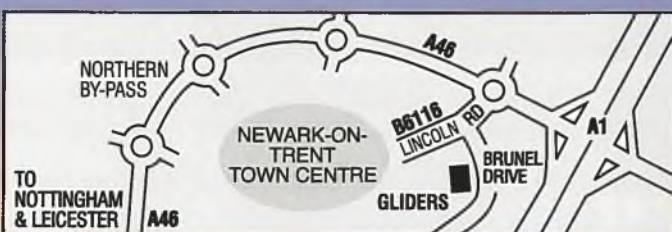
Model	BEC/PCO	Cells	Amps
RSC210 .....	Y	6-8	10
RSC750 .....	N	6-20	50
RSC810 mP .....	N	6-8	12
RSC835 mP .....	Y	6-12	35
RSC860 mP .....	N	7-30	60
RSC890 mP .....	N	7-30	90

## CHARGERS

MFA timed charger 5/6/7/8 cells .....	£16.95
MFA 10-16 Cell Conv.-lead .....	£9.95



ULTRA DUO PLUS II	
(Max. Charge rate now 5Amp) .....	£236.95
MC-ULTRA DUO PROFI .....	£336.95
MC-ULTRA CONTEST .....	£459.95
ULTRA POWER 150 Power Supply .....	£159.95







*Disassembled for transportation.*



*Balance point check.*



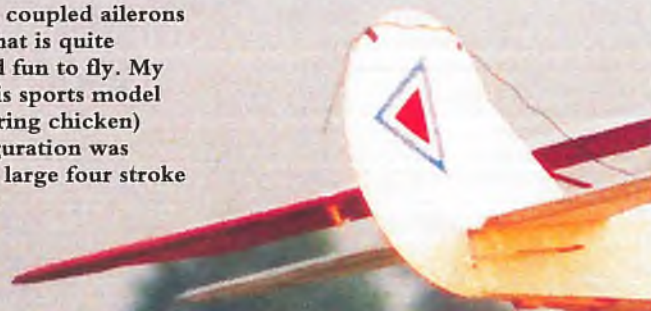
*Fuselage construction almost complete.*

**I**n a mad period of inspired drawing, designing and construction last winter (95/96) I built three models for the approaching flying season. All were planned around the 'Speed 600, 3 to 1 gearbox, 12 x 8 folding prop' combination with a 1700mAh power pack.

First to come off the drawing board was a 15% larger "Lazy Bee" which is a superb flyer and an ideal rudder trainer. Second was a streamlined and beefed up 'Heron' with coupled ailerons and rudder that is quite acrobatic and fun to fly. My third, was this sports model 'Poussin' (spring chicken) whose configuration was inspired by a large four stroke design called 'Rooster' which caught my

eye in an American magazine way back in 1985. My model? Very pretty I think and quote: 'A pleasure to fly' (John Bennett, local Ace). Although not a beginners model it shouldn't pose any problems for the average builder. The general theme is as usual, to add lightening holes and use the lightest wood wherever practical.

*Construction completed, everything is assembled to check-fit.*





As originally flown with a Speed 600 7.2V and 3:1 gearbox and 12 x 6 prop.

## Construction Highlights

First things first. I like to build my models with not too many hold ups in the building sequence, so I tend to make any building aids that could be required, before starting construction. Two aids that are essential, are the laminating jigs for the outer woodwork for the rudder and tailplane tips. These are simply pieces of 1/4" ply profiled to the inner 'form' shape, tacked down to a flat off-cut of 1/2" ply. Cover the forming face with Sellotape. (The balsa strips are easily shaped by dunking in boiling water in a roasting pan and left until supple. Then apply glue to one face, pull and hold the laminated strips around the shape of the ply form with strong elastic bands and leave to set and dry for a couple of days.) Another



aid I made was, a wooden form block for the curved decking for the removable hatches behind the motor. Not essential it's true but so much easier and neater than planking. The final aid was a simple jig to accurately

locate and solder together the wire cabane wing support. This was a flat piece of 1/2" plywood with four holes matching the wing 'pin' pitching, with a softwood block sliding under the forward and rear wire cabane struts to maintain the parallel dimension from fuselage to under wing requirement.

## The Fuselage

Cut out all liteply and balsa formers, profiling the aperture in F1 to suit your own motor/gearbox requirement. Glue cabane locating ply sections to formers F3 and F4. Over the plan make the two basic fuselage sides ensuring that the slots for the formers are clear and accurate. Glue the 1/8" x 3/4" doubler in position to top longeron (insert temporary 1/16"

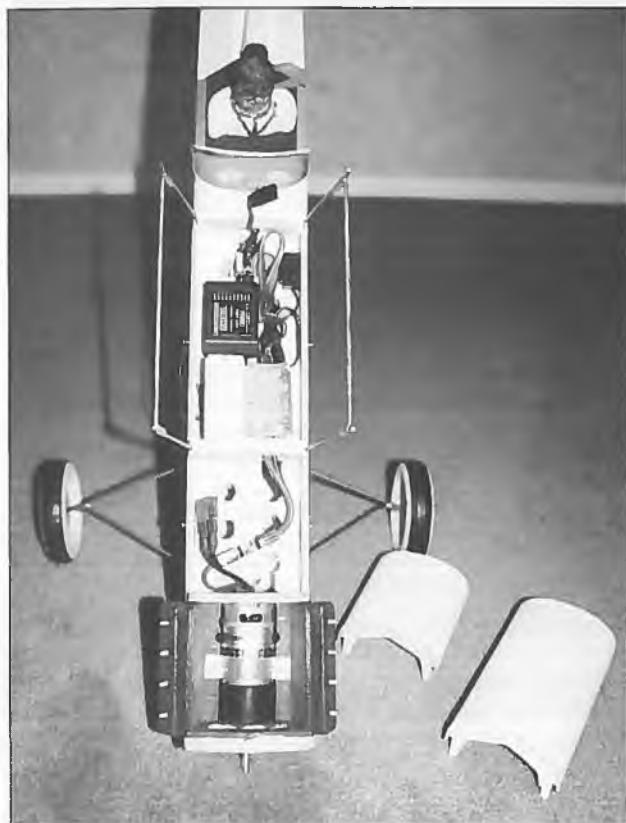
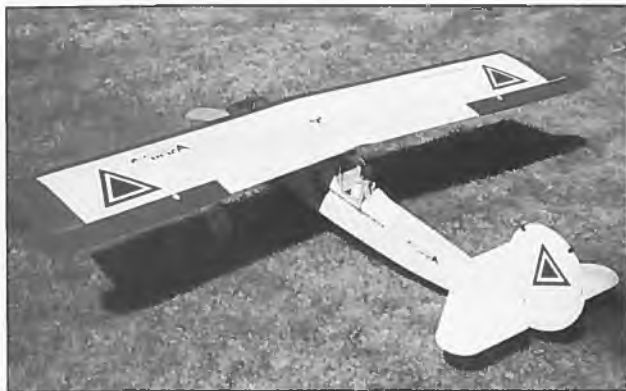
packing to one side to make a pair). Sand sides. I usually nest and clamp my

*Plan review and construction guide. Designer Allan Pointer describes for you how to build his 'could be scale, about 1920' type parasol monoplane for geared 600 size motors. Wing span is 61.5" (1560mm), wing area 545 square inches and weight of the prototype 54 ounces.*

# Poussin

## plan and construction guide





Where (almost) all the electric bits fit.

motor/gearbox in a liteply crutch and it was at this stage that I dry fitted the latter to give the suggested  $1\frac{1}{2}^\circ$  side and  $1^\circ$  down thrust. Cut, fit and glue  $1/16''$  sheeting to the sides, chamfering the end that finishes on the diagonal. Cut all cross members to length. Jig up and assemble fuselage sides, motor nest, formers and cross members over the plan packing up the rear end to bring top longeron parallel with the building board to ensure correct alignment. Add top rear balsa formers,  $1/8''$  square stringers and sheeting under headrest. Remove from board. Add  $1/8''$  balsa, liteply and stringers to fuselage bottom. Also glue in local spruce undercarriage retaining blocks. Make and fit battery door. Bend to shape and solder, wire cabane assembly and spring into location slots in formers F3 & F4. Epoxy and clamp F3a & F4a to their respective formers to sandwich the cabane structure in position. (I did this using the base of the soldering jig to maintain accurately the wing location pins.) Make both hatch frames, insert in top of fuselage, add cockpit former F5 and check and 'fair in' if necessary all formers to a straight line. Glue sheet decking to formers and removable hatches (ensure that the hatches are a neat fit as this assists in rigidity of the wire cabane struts). Make and fit the dummy radiator relieving the back face as necessary to house front of

gearbox. Shape and fit pilot's head rest and dummy V8 motor. (This is simply four carved cylinders of blue foam glued together, a balsa cylinder head added with white cocktail stick spark-plugs and sliced through to give the appropriate 'V' angle.) Bend and solder wire undercarriage and tail-skid. Make cockpit sheeting removable if like me, you put your servos beneath the pilot's seat.

## The Tail

The fin, rudder and tailplane are basically prefabricated  $3/16''$  flat plates with leading and trailing edges sanded to aerofoil section, pretty standard once the laminated bits are formed. As these tend to distort a little in the gluing up process, I cut the laminations a tad wider than needed, then when glued and

half in the usual sequence laying down bottom spars and trailing edge, adding ribs, (pack ribs one & two) leading edge and top spars etc, omitting the balsa sheeting to the centre section. Make the opposite wing half but don't glue the main spars to rib one at this stage. (This makes it easier to thread the ply doublers though into the opposite wing half.) Construct both ailerons, mine are balsa sheeted blue foam cores with the upper curved surface of the 'ears' being uncovered, but use the usual riblet method if you prefer. Glue both ply doublers and assemble both wing halves together on your flat and true building board (no dihedral). Add liteply reinforcements W1 & W2, spruce location blocks, LE balsa doubler and sheeting to

*See the attachment of wing, wing struts and undercarriage.*



dry, true one side before sanding parallel and to the required aerofoil section. Also to keep the main spars true and probably stronger, I make these from two pieces of balsa glued together, kept straight in a simple clamping jig.

## The Wing

This too is pretty straightforward. Using the accurate Formica templates that you have made, cut out all the wing ribs. Number each set from one to twelve. Position ribs one to eight over the plan, mark off and drill holes for aileron push rods, reinforcing edge of holes with a touch of cyano. Cut the spruce bottom spars and the top balsa spars to length,  $1/16''$  ply doublers to shape and sheet trailing edges. Glue ply doublers to one pair of main spars. Assemble one wing

bottom centre section. From rib 8 thread in the bellcrank pushrods from each side, bind and solder the wire joiner and servo hook. Box in to suit the servo you are using, add top sheeting to centre section making an access door to the servo. Complete the bellcrank assembly and add rib caps. On the underside of wing, accurately drill cabane location holes (I used my cabane solder jig to do this). Make two spruce wing struts as drawn.

## Hinges

I make strip hinges from two pieces of Solartex stitched together, trimmed to width and length, afterwards these are ironed down to the Balsaloc surface - neat and simple. If you use more traditional methods you will have to add local reinforcing blocks to suit.



## Wheels

These are also made, and are simply two pieces of liteply glued together, profiled to the required diameter. Add lightening holes, a commercial nylon hub, stick blue foam to each side and 'turn' to shape in a pillar drill - again, simple and light.

## Covering

On this type of model nothing gaudy please! I like and use Litespan on most of my models I initially struggled with it until I purchased one of those little temperature gauges. (I found my iron fluctuated 40° on the same setting.) Once you get the temperature somewhere handy it's great and contrary to some opinions I find it doesn't sag or change in different conditions.

## Electric bits

The plan shows where I positioned my gear but if you are using anything but mini servos you will have to move forward the servos under the cockpit seat, to get the CG right. Final adjustment comes of course with the positioning of the battery pack, which I nest between pieces of blue foam with plenty of ventilation incorporated.

## Final assembly

The fin is 'stuck' straight on the tailplane which in turn is 'stuck' to the fuselage. The wing is clamped to the cabane structure with small nylon saddles and 3/8" PK round-head screws as is the UC. To improve the integrity of the saddle screw holes, apply cyano to the holes and retap for the screws. The rear UC saddle is loosened to accommodate the bottom wing strut clip, the other end being screwed into the wing location block. A pilot is essential with the traditional scarf to complete the right effect. Mine's just a carved block of blue foam, coloured with felt tip pens and a strip of yellow tissue tied around the neck. To aid assembly on the flying field I invert the model onto a piece of 3" thick polystyrene profiled to the wings upper section shape.

## Flying

With the CG as shown, an all up weight of 54oz, a wing loading of 14oz per sq ft and in the hands of local 'ace' John Bennett, 'Poussin' flew off the board with a just a click of down to maintain level flight 'Poussin' is a sports model and will perform most sporting manoeuvres, albeit a little slowly at times. This can be improved by the usual preceding shallow dive. This model, with zero dihedral will go where you put it, and with



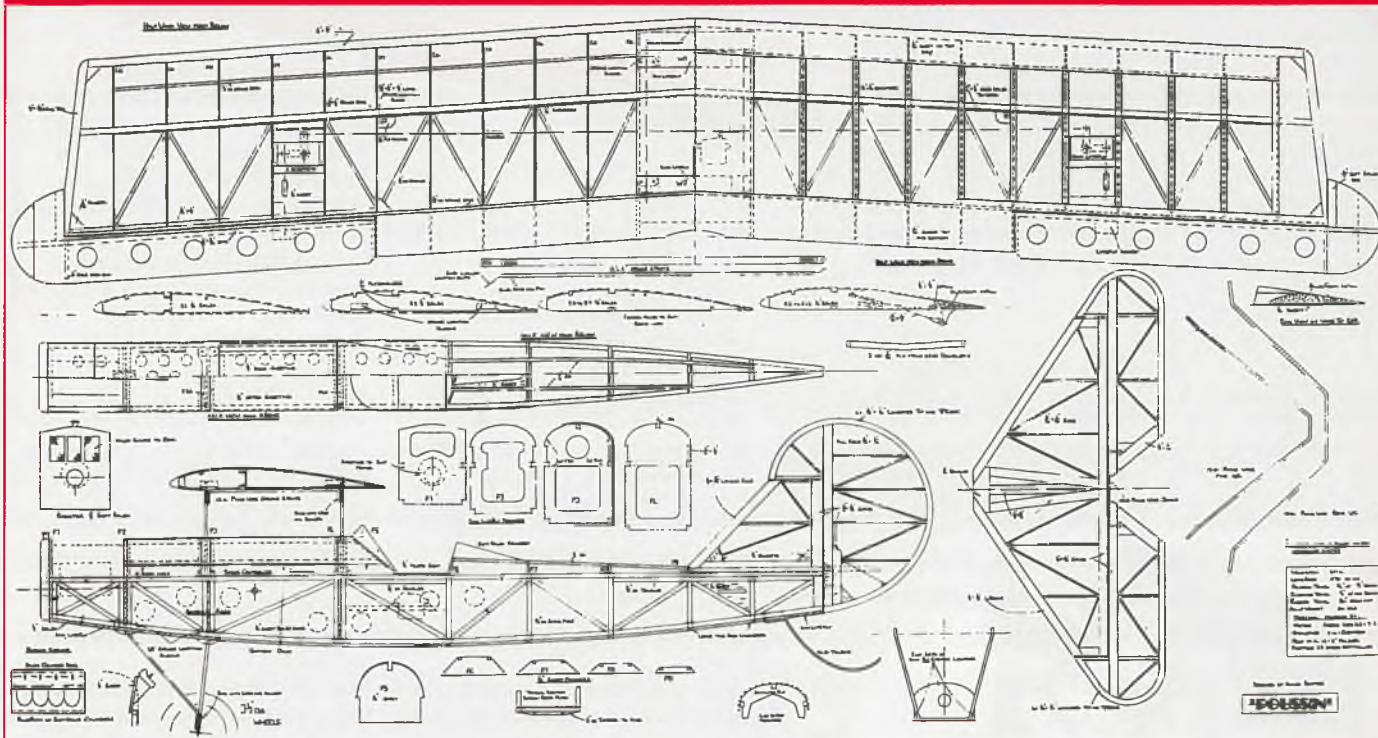
Speed Gear 600 BB 8.4V and Master Airscrew 12 x 8 installed. Motor cooling is no problem!

its wide track will easily ROG on short grass. I prefer to hand launch to conserve power. Landings are a doddle if lined up correctly and under a little power but 'dead stick' is not a problem provided you keep the airspeed up. One thing everyone agrees on is, it looks great on the ground but really super in the air.

I've been flying it with a 7.2V BB Speed 600 but recently I went mad and splashed out on a Speed Gear 600 and installed it in 'Poussin'. I haven't re-flown it yet but tests have shown it's developing more thrust and drawing 6 amps less. It's more expensive but if you are looking for a longer and more sprightly performance, this is an option you might consider.

I intend enhancing the appearance of my next 'Poussin' even more by fitting closed loop controls and rigging wires etc. But that will have to wait, I am too busy right now. Although I've drawn a 400 powered vintage junior 'Buccaneer' I'm building a 71" span B-36 with 6 Speed 280 pusher motors. Interested?

Copies of this plan, No. MW2591 are available from Electric Flight International (Plans service),  
Traplet House, Severn Drive, Upton-upon-Severn, Worcestershire, WR8 0JL.  
Price £6.50 plus UK postage £1.50.





# Let's make aeronautics

**Design/Build/Fly Contest, Sponsored by the American Institute of Aeronautics and Astronautics, reported by Dereck Woodward.**



The line up at Ragged Island, Maryland, on 26th April 1997. These are the teams who made it through all the requirements to earn the right to step up and fly. That huge blue and orange aircraft on the right is the University of Illinois' winning entry – capable of flying for over 15 minutes on the kind of breads we know well. As one sponsor said: "Those that came, learned".

*I don't think this article's title is the motto of the American Institute of Aeronautics and Astronautics, but for a while in April it could have been. The ALAA's contest was flown on a calm and warm Saturday, April 26th, the final phase of a Design/Build/Fly event, where University teams were invited to create electrically powered unmanned aerial vehicles, or UAV (a much posher title than 'model aircraft'!).*

Teams had to submit documentation from a 'proposal phase' before the contest was anywhere near. These are aspiring aircraft designers after all. Executive and management summaries, conceptual, preliminary and detail design sections rounded off by a

**F**irst off, the power source was set at an obtainable and affordable weight – an over the counter 19 cell nicad pack was about it, driving an electric motor that would fit in on any model club site. Team members had to be students from the same university, though teams were allowed to recruit a pilot from outside the school – a good move, some of these competitions have floundered on great technical expertise that couldn't actually fly their creations. In addition, entries and pilots had to meet AMA standards for model aircraft and membership.

Well, that sounds simple.

These guys from Los Angeles tried, tried and tried again – they ran down the runway as the contest ended at 6pm, to no avail. Pusher direct drive Mega motor was in contrast to the more popular geardrives. Well made aircraft featured removeable and different sized wing tip panels for differing conditions. There should have been a 'Tryers Trophy' – this team would have pushed hard for it.



Did I mention the 7.5lb steel payload?

Looks different now! Aircraft had to take off, clear a 10 foot height ribbon within 300 feet, fly a course with 180° turns 700' apart and perform 360° left and right turns on the first downwind leg. Landing had to be back on that runway, before a set point and stay on the runway right up to coming to a halt.

Now it's really looking like fun!

## Onward and Upward

You don't think that the teams just got away with running up an aircraft and flying it, did you?

manufacturing plan – all carried points towards teams' final scores. If a team decided that their initial proposal was likely to sit up and beg rather than fly, they could pick up extra points in an extension of the Design Report detailing what they had changed from the initial proposal.

## Craft and graft

There wasn't much sawing and sanding. As teams that rolled up their sleeves – they also rolled out the composites. While the motors, batteries and ancillaries are the same as any dedicated electric flier might use; the aircraft were high tech composite structures, with vast wingspans and many novel, though subtle, features. For an exception to the rule, the Texas A&M entry was about all balsa



# utics fun!

and proud of it! As they came third, there's obviously life in the old techniques yet. Most designs were of fairly conventional layouts, with tails at the back and long, high aspect ratio wings. They weren't small either – the shortest wingspan was around eight feet.

## For small aircraft

- You need a small runway. The event used one on a small island! BAI Aerosystems, a big player in the unmanned aerial vehicle business, provided theirs for the event. Ragged Island, just offshore in the Chesapeake Bay, has a runway bisecting it, a large guest house to provide accommodation, an operations base and undercover repair facilities. A modellers' heaven! Fly landplanes off your own

their trip when the batteries ran down and touchdown became inevitable.

The Texas A&M team did it all their way. An all balsa aircraft, powered by an aggressive Aveox brushless motor and 3.7:1 Robbe gearbox, was flown by Robert 'Rip' Rippey in spectacular fashion. A full power climb to the upwind position, steep turn to downwind, fly the lap on a fast glide to back over the start point. Power on full again to repeat the climb/glide pattern, energy management by using full power in short bursts. This technique took them to third place with a ten lap best flight. Rip had put in

some long practice on this pattern, seldom got off his line and put their eight foot span white model down accurately on the narrow strip.

In contrast to the Texan's three man team, Virginia Tech. came in force – I counted eight of



Team Illinois check out 'Flying Illini' between rounds. This one just took off and stayed up longer – sixteen minutes on 19 x 2000 mAh cells. MaxCim geared brushless would be ideal for larger sports electric models.

them! They went for the duration approach with a model combining aesthetics with performance. The V tail, winglets and spats added to the distinct look of a low winged design with a spatted undercarriage. For practicality, flaps helped the big bird up and 'crow' braking eased landing her precisely. Well worth the effort, with steep, slow landing approaches to touchdown.

The University of Illinois team flew in crushing style. A long winged bird, with constant chord wings, it just stayed up! Their winning flight covered twelve laps, then they flew a twenty lap flight lasting sixteen minutes but ran off the tarmac for a zero score. Their aircraft spanned twelve feet, the twelve inch chord featured a Clark Y section – so much for hi-tech – and eighteen pound of aircraft flew at around 25 MPH.

For structure, they used foam and balsa for the wings while the fuselage was wooden beams as structure with a cover made by the 'lost foam' technique – carve the shape from a block of foam, glass skin the foam, then dissolve the foam out with acetone.



The Virginia Tech team and classy looking model with V tail, spats, winglets and flaps that coupled in with ailerons for crow braking. Kevlar, fibreglass, carbon fibre, foam, wood – they used it all!

Chesapeake Bay sunset off a deck about the size of a small aircraft carrier!

## The Flying

As the competition was slanted towards duration, most entries were long winged designs. That narrow runway felt even narrower when the aircraft had to stay on it to avoid a zero score for running off on landing. The big winged floaters became a handful when trying to hit a small stretch of tarmac – accurate flying was at a premium. Pilots really earned



## Power Plays

The heart of Illinois' machine was a 'MaxCim' motor, a stock 15-13Y with a Model Electronics Corp gearbox of 3.53:1 reduction turning a 15 x 12 prop. MaxCim also made up the 19 cell pack of RC 2000 cells. If ever there was a demonstration of an ideal set up for a larger sports type of electric powered model, eighteen pounds of model cruising around for over eighteen minutes was it!

West Virginia showed that the brushed motor is still viable – their Astro 40 powered model with blue foam structure and extensive carbon fibre clocked ten laps. They were one of the first teams I met – I was floored by an English accent! Eleanor Taylor is a trainee pilot with the Royal Air Force and is over here on a university exchange programme. Their aircraft was a little slower than the Tucano she flies in England.

The team from Texas went the other way in every respect. Instead of a cruising flight style, pilot 'Rip' – who also built much of the balsa airframe – flew a pattern of a short flat out climb under full power followed by gliding the rest of the course. An Aveox 14/12Y and Robbe inline gearbox powered the nine foot span aircraft – Aveox are the leaders here for all out power, their brushless motors being slanted more to the limited motor run events that need spectacular but short power bursts. With that modern power unit in front, the wing section was none other than RAF 32! Rip and co-designer/builder Shea Parks drove all the way from Texas, as their third team member had to stay home with a newborn baby.

None of the entrants who made it to Ragged Island had an easy day – all had to wrestle with the problems that highly strung and experimental machines have tagging along as normal.

The team from the University of California at Los Angeles – probably the farthest travelled – worked all day on their pusher twin boom design. As the last minutes ticked away, they cured sticking wheels that held them back on the ground. Even as the contest ended, they tried one last take off run, but with batteries flagging their aircraft wasn't about to fly. If these four guys maintain the persistence they showed that day until next year's event, they will be a force to be reckoned with. Incidentally, coming from the same state as Astro Flight and Aveox, they chose a Czech Mega motor on direct drive.

## Sunset -

Over the Bay would be worth the trip, but the day belonged to the event. Events like this don't just happen; this one is nearly a year old when the competition flying starts. Cessna and the Office of Naval Research – a major

*Washington State fielded this elegant T tail entry. Model suffered damage in transit, was repaired in BAI's repair facility to take sixth place.*



*West Virginia do a little major re-work of their undercarriage! Hiding coyly under a very American ball cap is Eleanor Taylor – a very British RAF trainee pilot!*

player in the Unmanned Airborne Vehicle field – weighed in as sponsors, helping provide \$5,000 in prizes split between the top three teams. Greg Page from the AIAA's Aircraft Design Technical Committee was everywhere organising, while Michael Selig scored laps on an abacus made from dowels and plastic shower curtain rings, while many others did the jobs that make it all possible.

If you've ever heard of 'Total Aircraft People' – these folk

define that phrase. The professional UAV fliers and builders fly all kinds of models and many have private pilots' licences as well. Take Chris Bovais, a noted model glider pilot, for example. He has a small electric soarer that fits in a shotgun case to take on field trips for after work relaxation – 'work' being a UAV engineer and pilot – and his car's licence plate reads 'UAVAV8R'. Chris does plenty of what he loves!

For information on the AIAA, check out their extensive web pages at:

**HYPERLINK**  
[HTTP://WWW.AIAA.ORG/](http://www.aiaa.org/)  
[HTTP://WWW.AIAA.ORG/](http://www.aiaa.org/)

The 1998 Design/Build/Fly rules and details should be there as you read this. Are we going to see any competitors from England, Europe or even farther overseas next year?

A total of eleven teams made it to the field. The rewards of getting there went beyond the kudos of winning – Brian Richardet, representing event sponsor Cessna Aircraft, summed it up well. "Those who came and tried learned. Those who didn't – didn't".



# Electric Flight

International

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*The full size Collegiate Porterfield is a very popular two seater light aircraft amongst the private pilots and is very similar at a quick glance, to a Piper Cub. Obviously due to its pedigree and aerodynamic layout, Kyosho have now produced a semi-scale version of this rather sweet looking cabin monoplane, reviewed for you here by Chris Martindale.*

### The model

I have been in aeromodelling for a good number of years and have been successful in designing several of my own electric powered aeroplanes, building 'from scratch' on every occasion. Upon opening this Kyosho kit it was immediately obvious that yours truly was in for a massive culture shock! Remove the lid and wow! a nearly complete aeroplane. Yes, the Kyosho Porterfield M36 is an ARTF of the highest order, it comes pre-built in balsa & plywood and pre-finished in white 'Super Monokote', it is complete with motor, gearbox, propeller, pushrods,



*It comes out of the box like this, built for you.*

decals and a hardware pack to finish the aircraft. All the components are packed in poly bags and secured in place in the box with card packings. The only items required to get the model into the air are glues, a four channel RC outfit with three servos, an electronic speed controller, flight pack and suitable charger.

I have tried to approach the assembly of this kit as if I were a novice and relied on the guidance of the manual for the correct sequence. The instructions are bi-lingual, the principal language being Japanese, with English subtitles. The bulk of the information is conveyed to the builder by the use of very self explanatory

pictures set out in a sequence for assembly, showing all the necessary parts in 'Airfix' fashion and indicating the types of glue to use on each joint (epoxy or CA). They also bring to attention, all of the areas of coverings that require trimming away from the proposed glueing joints. It is most important to heed this advice if you don't want your pride and joy to suffer premature structural failure. However, there are some points I wish to bring to your attention which may be potential pitfalls for the novice. So, let us begin!

### Wing

The assembly instructions first take us through the wing construction, commencing with hinging the ailerons to their respective wing panels with the supplied hinges. A nice little touch here is that all the control surface hinge points are slotted during manufacture leaving the builder the task of just inserting the hinges and securing with CA glue. You may need to ease the odd hinge slot with a scalpel in order to insert the hinge and I would suggest to do a 'dry assembly' of all control surfaces prior to committing glue to the job.

Anyway, back to the ailerons. The assembly instructions do not mention that dry assembly is required but I would advise this as I found that the ailerons on the



review example were too long. This was easily corrected by trimming the ailerons to the correct length. The only other work required here is to drill a 1.5mm hole and cut a slot to let the torque rods into the edge of the ailerons.

Insert all the hinges into the ailerons dry and prepare a mix of fast epoxy and work it into the hole/groove for the aileron torque rods. Fix the ailerons into position complete with dry hinges and slide a piece of Solarfilm backing between the torque rods and the wing trailing edge and then tape back over the aileron to avoid excess epoxy oozing out, into the wrong places which could result in a permanently fixed aileron. Once the epoxy has cured remove the Solarfilm backings and go round and secure all the hinges with a couple of drops of CA glue.

We are now in a position to get the wing halves joined together and this is where I encountered a minor problem. The wing joiner is made from two laminations of 2.5mm liteply epoxied together which, unfortunately, are a rather loose fit in the wing joiner boxes which are 6mm wide. This was cured by cutting an additional lamination of 0.8mm ply to fill the gap. As shown in the assembly instructions, both wing panels and the wing joiner were epoxied together. Care must be taken here to make sure that the wing panels are correctly aligned at their roots, fixing with pins and tape until the epoxy has set. This is easy to do as the wing section is flat bottomed so it is a simple matter of making sure that both wing panel under surfaces are aligned with each other.

All that now remains is to epoxy the front wing dowel location plate into the pre-cut slot in the underside of the wing. During a dry fit I found that when the plate was pushed fully home into the slot, the hole in the plate which receives the fuselage mounted locating dowel did not line up with the dowel. I would suggest here that the plate be epoxied into place and not pushed fully home and the following sequence of operations carried out:

Fix the wing in position onto the fuselage with the fixing bolts provided and the hole in the front plate located onto the front dowel in the fuselage. Whilst the epoxy is workable, press home the wing leading edge until it is firmly seated on top of the

fuselage and then carry out the wing to fuselage planform alignment as described in the assembly instructions.

Epoxy into position the aileron servo mounting rails and fit the servo. The assembly instructions provide excellent guidance in fitting your servos etc and coupling up to the control surfaces with the supplied hardware.

## Tail/fin & fuselage assembly

Progressing on to the tail surfaces, these are ready built and covered and only require fixing to the fuselage. The assembly instructions clearly tell the builder to ensure that the tailplane is set horizontally true and the fin set 90 degrees vertical to the tail. It helps here to fit the wing to the fuselage in order to 'eyeball' the whole assembly.

The fuselage is a ready made unit built from 3/16" square 'sticks' in a traditional manner with local liteply reinforcement and front bulkheads. The cabin front is an ABS moulding fixed into position during manufacture. Motor mounting is provided by two aluminium saddles which clamp around the motor which then in turn is fixed to liteply beam mounts in the fuselage. The motor beams have down and right side thrust angles during manufacture. The fuselage is pre-finished as the rest of the airframe (white Super Monokote) and is very light for its size.

I unfortunately found an inaccuracy in the fuselage construction in that the tailplane seating was not true to the horizontal and required a considerable degree of sanding to level it out prior to fixing the tail. The fin requires a small 45 degree chamfer cutting at its base on the hinge line in order to allow the elevator joiner free movement. Once the tail and fin are glued in place all that remains is to hinge the control surfaces. As with the ailerons all hinge slots are pre-cut and only need assembling dry with the hinges and then secure with a couple of drops of CA glue on each side of each hinge.

Mainwheel and tailwheel undercarriage units are almost complete, the builder is only required to put the wheels on the main undercart, securing with the push on nylon collets supplied and fixing the whole unit to the pre-grooved hardwood mounts in the bottom of the fuselage with the

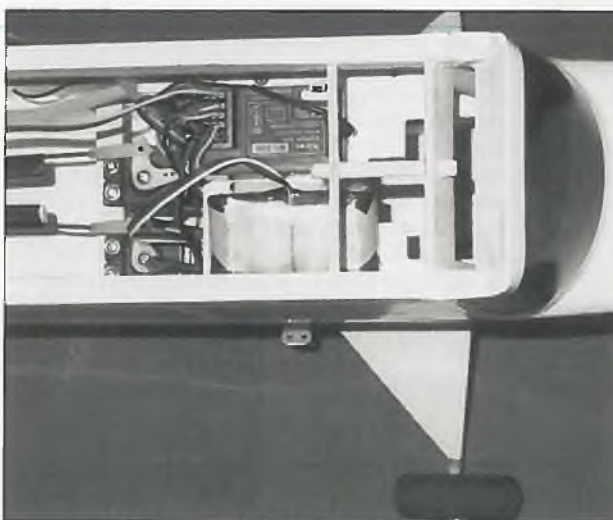
aluminium saddles and self tapping screws supplied in the hardware pack. The rear undercarriage saddles are extended and double up as the anchor point for the wing struts. Tailwheel assembly is a steerable unit as seen on most taildragger models and only requires the final bend on the wire to pick up the drive from the rudder, the whole unit being fixed into place with self tapping screws and the drive pick up wire securing to the rudder with epoxy. To complete the fuselage the only requirement now is to fix the self adhesive window and cheek line decals provided and secure the ABS cowl moulding with three self tapping screws.

## Radio and electrics installation

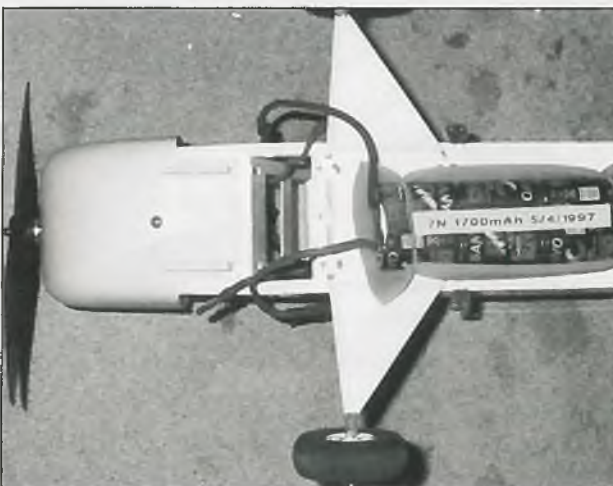
The assembly instructions give clear and concise guidance on how to install your radio equipment, all hardware is supplied in the kit (i.e. ready made pushrods, aileron control wires, horns and clevises) and only requires you to provide RC equipment.

There is ample room in the airframe to install standard size gear and I have gone down this route to prove the point so that prospective builders are aware that they do not have to go out and specifically purchase mini or micro equipment.

The manufactured servo rails are epoxied to the fuselage longerons spaced to suit your servos, all that is required then is to bend offsets in the pushrods to exit the fuselage at the rear, screw on the supplied clevises and cut to length at the servo end and connect. A similar exercise is carried out with the ailerons and their respective wing

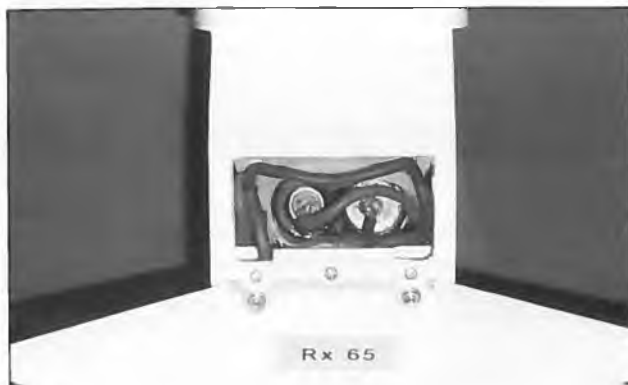


*There is ample room in the airframe to install standard size gear.*



*The power pack, the slot into which it inserts, vertically and the hatch.*





Power pack installed and plugged in.

mounted servo. All control surface movements were set to the recommended values in the instructions.

The receiver and speed controller are mounted onto a platform fixed above the servos in the fuselage. It appears that it is the manufacturer's intention that you use a speed controller with BEC as there is no indication for location of a Rx battery. As I do not possess a BEC speed controller I attached a 380mAh Rx battery to the upper side of the Rx platform with servo tape and mounted my speed controller to the underside of the radio plate.

The power train comprises a Kyosho LeMans AP36 motor, a unit with which I have had past experience in my Kyosho Concept EP helicopter. This is a powerful ferrite motor and is supplied already fitted with suppression capacitors and is coupled to the long established open frame 2.33:1 gearbox driving a Kyosho 9 x 6 propeller. The kit supplied motor leads (complete with 30A automotive fuse) were used but I replaced the battery connectors with 4mm gold banana type connectors, because this is what I use on all my own battery packs.

The flight battery pack is inserted into the fuselage vertically through a hatch in the underside and is prevented from moving around in the fuselage by the fact that the top end is restrained by the cut out in the Rx platform and the flight pack is wrapped with thin foam rubber (also supplied in the kit).

It is only possible to install a 7 cell pack of 1700mAh cells in the fuselage, eight cells will not quite fit. Battery bay hatch is retained by a small nylon catch secured with a self tapping screw into the front UC block. I liked this method of installation of the flight pack because the mass of the battery has more chance of being ejected out of the

fuselage in the event of a heavy arrival, rather than tearing through the fuselage and its contents, like an out of control brick!

The technical specifications state an all up weight of 3lbs, my example turned out at 3lbs 5oz (1503g), this is probably due to the fact that I used standard radio gear and a speed controller without BEC. However, I wouldn't think that an additional 5oz on a model this size would make a great deal of difference to the performance.

With all the gear installed in the airframe and everything double checked it only remains to get charged up and go fly the beast!

## First flight

I took the Porterfield to my local club field at Widnes for its test flight. We are fortunate enough to have a large field with a hardstanding facility for take-off and landing. My first priority when testing out a new model is to do a range check with motor running to make sure all the RC gear is functioning okay with no RF interference from the motor. The wing was then rigged with the operational struts provided in the kit, these being anchored at the wing by means of a Z bend in the wire at one end of the strut which locates in a pre-drilled hardwood block in the wing, the fuselage ends fixed with clevises to the rear undercarriage extended saddles.

With a freshly charged 7 cell 1700mAh pack in the model and the sort of weather conditions we modellers fantasize about in this country I had no excuses but to "Go For It". I placed the

Porterfield on the strip, facing down the longest stretch (there was so little wind about it didn't matter a damn which direction we took off). The throttle was gradually opened and the Porterfield made a spritely trip down the hardstanding, tracking very straight, a tad of up elevator had the model lifting off in a steady but shallow climb. I initiated a right hand turn with the ailerons and as she came round I experienced slight crabbing to the left.

However, this was not particularly troublesome and I continued to climb out for the trimming flight, "What Trimming!", just a touch of down trim and left aileron and she was there. Throttle back to half power and the model cruised around quite sedately, making flying shots somewhat easier for my cameraman (Dad) because I was able to come in on some very slow low passes for the camera.

With respect to the stall characteristics of the aeroplane I have to report that you have got to be an absolute animal on the elevator to get into any trouble. I have flown in a straight line at height and gradually applied full 'up' elevator, the model achieving a horrendous angle of attack before dropping its nose into a dive to build up speed. The recovery from the stall is very quick and uneventful.

After flying circuits for a while I noticed that I was losing power due to a run down flight pack and, therefore lined the Porterfield up for a first landing. The descent was steady and slow with no tendency to drop a wing, a small burst of power just prior to flare out and a touch of up saw the model do a perfect two wheeler and roll to a graceful halt.

The crabbing mentioned earlier was cured by adding a little more right thrust and is further improved by flying with more co-ordinated turns, i.e. use of rudder in the turn. The flight duration is around four and a half to five minutes depending on how much you use full throttle, this can be extended to seven or eight minutes if the model is taken to good height and the motor set to a 'tick over' for extended glide.

The box label states that this model is suitable for beginners through to experts, so, as I am at the moment tutoring a new member of my local club, what







better test than to get the transmitter in his hands. Peter is, at the moment learning to fly on a Flair Cub which is a very stable and easy to fly model. After flying the Porterfield he reported that the flying characteristics were very similar to his Cub and that he felt completely 'at home' with the Porterfield. Take-off and landings were performed by myself because Peter is only just getting into this stage of the learning curve and I want to preserve this model for the Fly-ins.

I would agree that a beginner who has had a small degree of wet flying under his belt could get on with this model. However, just one point to watch would be with take-offs, as we quiet flyers do not have the massive reserves of power in our drive system to let our

models leap into the air and climb out at ridiculous unscale-like angles of ascent.

Now that I am used to the flight characteristics of the Porterfield I have discovered that it is mildly aerobatic. Loops are a snip with a little speed built up from a dive and rolls are possible, again with a shallow dive before entry into the manoeuvre. However, you would not see the full size aircraft do this sort of stunts, after all this is a semi-scale model and should be flown in a manner befitting its credentials.

## Conclusions

Kyosho have yet again got it right! This kit is well presented, very nicely built and finished, complete with a comprehensive array of hardware to achieve completion of the airframe. I think that some additional decals/lettering would enhance the aesthetic appeal and the marketability of this aeroplane. The assembly instructions are very concise and understandable regardless of what language you speak/read because all information is pictorial. The flying characteristics are very

good, it is a sedate model to fly once trimmed out and would be ideal for anyone who wants to get into electric-powered RC flight quickly.

For what you get in the kit, (a complete aeroplane only requiring RC and flight battery) I think this represents good value for your £199.99 considering that you could feasibly buy today and fly tomorrow. The three minor problems highlighted in the review are insignificant when weighed up against the advantages gained from a ready-made model which flies very nicely. Also, because this model is made from traditional aeromodelling materials, should you be unfortunate enough to have a prang you will have greater chance of effecting repairs.

## Acknowledgements

My thanks to the following: Traplet Publications and the editor of EFI for the opportunity to do this review, Dad (the cameraman) and Peter my novice guinea pig. This model kindly supplied by Ripmax.

## Model Specifications

wingspan	1280mm (50")
length	960mm (38")
wing area	27.7sq.dm (430sq.in)
projected AUW	1.4kg (3lb)
actual AUW	1.5kg (3lb 5oz)
motor	Kyosho LeMans AP36
gear reduction	2.33:1
propeller	Kyosho 9 x 6
cells	7 x 1700mAh
RC functions	aileron, elevator, rudder, throttle
price in the UK	£199.99



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**Include wherever possible: name of event, date, location, type of event and contact names and numbers.**

**In the list below, unless otherwise stated, the event and address is in the UK.**

One event that was included in the last issue, has started but not finished is the "97 Electric Duration Challenge", to be conducted between 15 Jun '97 and 15 July '97 so you still have time to enter. All events are continuous motor run flights in three categories: 1, nicads only. 2, alkaline only. 3, anything other than 1 and 2. See below.

Good news for UK electric fliers and visitors to the UK in August is the first BEFA fly-in at Woburn. This site must be about the prettiest model flying field in the UK and gets you close to other facilities at Woburn. Flying format will be our usual one of fun flying plus casual scale and vintage and an AULD over lunch. What is different is the entrance to the site. Entrance to the grounds only (not the house or other attractions) is normally £5 per car, but for this event the production of a BEFA membership card will gain free entry for the whole car, and flyers only pay a £4 registration fee. Non-modelling members of the group can then visit the other attractions as they wish. We hope to set up a membership table just outside the gates so that non-members can join as members and immediately save £5 of their £15 joining subscription (providing they are already members of BMFA of course).

**June 15 to July 15.** '97 Electric Duration Challenge. For more details contact Jerry Smartt, Rt.3 Box 300, Warsaw, MO 65355, USA. Tel: (816) 438 5682, fax: (816) 438 9573, or Dave Durnford, 2 Meadow View Road, Hayes, Middx, UB4 8EZ, UK.

**June 28th/29th.** The Fourth BEFA International Festival of Electric Flight. The Museum of Army Flying, Middle Wallop, Hampshire. Saturday 28th: BEFA League Competitions only, no fun flying. Pre-entry only. Sunday 29th: Fun-Fly day with informal competitions and prizes. All frequencies available. Airfield admission charge payable plus small entry fee for competitions. Traders Mini-market area. Contact Gordon Tarling - TeleFax 01895 251551 for further details.

**June 29.** Chester MFC Electric Fly-in, Rhoddey Racecourse. Competition entries on day, open duration vintage, scale and aerobatic, extended sports flying. Contact: C R Filtness, 26 Raymond Street, Chester. tel: 01244 378476.

**June 29.** Montrose Electric Fly-in. Contact Ian Morrow, tel: 01674 840452.

**July 6.** Ebor Electric Fly-in and Electroslot. York Racecourse (Knivesmire). Contact Eric on 01904 422615 or Mike on 01904 489386.

**July 6th.** BEFA Fly-In, Sunbury (Hayes site) General Fun-Fly + Carrier and Scale Carrier events. Contact: Dave Chinery 0181 573 4687.

**July 6.** Malvern Soaring Association, open thermal and 100S plus 7 cell Electroslot. Upton-on-Severn, Worcs. Contact: Nick Neve, Eynhallow, The Purlieu, Upper Colwall, Malvern, Worcs, WR14 4DJ. Tel: 01684 561160.

**July 12/13.** Wings and Wheels

Model Spectacular. North Weald Airfield, Nr Epping, Essex. (J7, M11). Displays, market, food, family entertainment. Pilots contact: Derek Foxwell, 0181 647 0607, Trade and admission enquiries: Traplet House, Severn Drive, Upton-upon-Severn, Worcs., tel: 01684 594505, fax: 01684 594586, evenings/weekends: 0836 297168, email: [traplet@dial.pipex.com](mailto:traplet@dial.pipex.com)

**July 19/20.** Haverfordwest Model Club's 'Model Extravaganza' at Scolton Manor Country Park, Haverfordwest, Pembrokeshire. BBQ & music Saturday night, camping/caravanning full services, flying and static displays, trade stands. Contact: Reg Strudley, 01437 767800(day), 01834 861836(evenings), or Derek Minchin, 01437 768165.

**July 20.** F5D, RAF Odiham.

**July 20.** Clyde Valley Flyers Electric Fly-in, Paisley (barbecue and refreshments) Electroslot and Electrobatics. Contact: Colin Sparrow, tel: 01505 850242, email: [csparrow@clara.net](mailto:csparrow@clara.net)

**July 26/27.** Nexus Silent Flight Days, Old Warden.

**July 26/27.** The White Sheet Aerotow and Fun Fly.

**August 2/3.** Scottish Soaring Nationals, thermal soaring plus Electroslot and 30-Minute electro. Sports Centre, Pitreavie, near Dunfermline. Contact: John Walter, tel: 01292 560341, or Colin Sparrow, tel: 01505 850242, email: [csparrow@clara.net](mailto:csparrow@clara.net)

**August 2/3/4/5.** AMA Electric Nationals, Muncie, Indiana, USA, at the Acadamey of Model Aeronautics (AMA) National Flying Site.

**Saturday Aug 2.** A Sailplane and B Old Timer.

**Sunday Aug 3.** B Sailplane and A Old Timer.

**Monday Aug 4.** all provisional events, 1/2 A Texaco Old Timer, 1/2 A Sailplane, and Speed 400 Pylon Racing. Contact: Doug Ward, NEAC coordinator.

'National Electric Aircraft Council' is the special interest group that represents electric flyers to the AMA.

**August 3rd.** BEFA Electric Fun-Fly. Manor Hall, Sandy Lane, Leamington Spa. Scale, Vintage, All Up Last Down, Sonata 'E'. Contact Gordon Tarling, Telefax 01895 251551.

**August 9/10.** Nexus Vintage Weekend - Old Warden, Beds.

**August 10.** BEFA Electric Fun-Fly. Woburn Abbey. Fun flying all

day with some informal comps. Contact Ken Nixon 01949 875240.

**August 16/17.** Plumpton Family model and Craft Show, Plumpton Racecourse, Lewes, Sussex. Contact Dave Bishop, D.B.Sound, 17 The Square, Tatsfield, Near Westerham, Kent, TH16 2AS. Tel/fax 01959 577550, mobile 0850 752061.

**August 16/17.** Inter-Ex 97, Nederweert, Nederland. Contact: Modelvliegclub Nederweert, p/a Schoolstraat 6, 6031 CW Nederweert, Nederland. tel: 0495 634180., fax: 460044, internet: <http://www/jel.vissers@pi.net>

**August 17.** Greenacres MAC Electric Fun-Fly 97. Walsall Airport, off Bosty Lane, Walsall, West Midlands, signposted from Junction 9, M6. Food and refreshments on site, trade stands welcome. Contact: 01922 404658 & 448873.

**August 23/24/25.** BMFA British National Silent Flight Championships, RAF Scampton, Lincoln.

**August 23/24/25.** Elvington Air Spectacular (see May 25/26). September 7. Aberdeen & District Soarers Electric Fly-in. Contact Norrie Kerr, tel: 01224 3244722.

**September 7.** North London Radio Control MFC, RC Electric Day, Baldock, Herts, Ins. reqd. Contact: Brian Downham, 30 southbury Ave, Enfield, Middx, EN1 1RL. tel: 0181 363 7528.

**September 13/14.** Nexus Festival, Old Warden, Beds. September 14. Cumnock Electric Fly-in, contact Keith Reid, tel: 01290 550055.

**September 19/20/21.** KRC, Queen City Airport, Allentown, PA, USA.

**September 21.** F5D, RAF Wittering.

**September 21.** Linlithgow Open Thermal and Electroslot. Contact Tom Preston, tel: 01505 630573.

**September 22 to 29.** SAM champs, Las Vegas, USA.

**October 18/19.** Nexus Autumn Gala, Old Warden, Beds.

**November 16th.** BEFA Electric Flight Technical Workshop. Royal Spa Centre, Leamington Spa, Warks. Informative lectures, specialist traders. Tickets in advance only. Contact Gordon Tarling, telefax 01895 251551.

**December 6/7.** Elvington Christmas Show (see May 25/26).

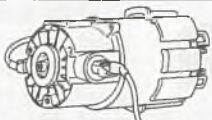
For full details of the BMFA F5B League events from Mike Proctor, 8 Church Rise, Holtby, York. YO1 3UE.



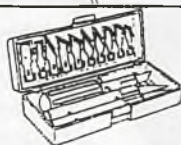
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# Hortens

## The final word by Theo Gordijn

*Theo Gordijn translated builder-pilot Erik van den Hoogen's own story of his one third scale model of the Horten Ho-XII, that was in the last two issues. Theo knows a bit about flying wings. He has built several flying wing models too. Theo insisted on having "the final word".*

**E**rik is such a devoted specialist in Horten type flying wings and so wrapped up in them that he seems to forget that most modellers do not know the essential facts. A short incomplete explanation seems appropriate.

The Horten brothers' goal has always been to design the perfect flying wing. No fuselage, no fins, nothing but a wing which would fly efficiently and could be controlled perfectly. They were not interested in aerobatics, just good flying. Speed, speed range, glide angle and sinking speed as well as safety and stability were paramount. What is different about Lippisch, Northrop and other tailless designs lies in the lift distribution along the wing-span and consequently the need for fins and rudders for stability and control.

The B2 has no fins but is essentially a computer stabilised system which flies not because it is a stable design but because the electronics are continuously preventing disasters. I admire the technology but don't feel the aerodynamically unstable design has anything to offer for flight safety. Any juggler balancing a broomstick can keep it upright, but no broomstick can do this without outside help. I know some people who do not agree with this, but that is the way I feel.

Horten designs are based on a bell shaped distribution of lift along the wing-span (see figure 1).

"Everyone knows..." (many modellers) must have heard that the most efficient wing lift distribution pattern should be elliptical and nothing different can be as good. I don't wish to present mathematical arguments 'pro and contra' but I will explain for average clever modellers how a Horten wing is different and the very clever thinking behind it.

Essentially for each Horten wing, there is:

- Large root chord and small tip chord (ratio is 6:1 to 8:1).
- Wingsweep
- Nearly all neutral pitching moment of all cross sections

of the wing along the span (i.e. pitch moment in no lift situation).

The tip section is always symmetrical, usually NACA 0009 often NACA 0010. The root section was based on a Horten designed (reflexed) camber line which gave practically neutral stability. The camber could be chosen to fit the designed speed and lift. The 'trick' is that the small wingtips give only a little bit of lift or even negative lift (pushing the tips down). For this reason the tip vortices are very small.

The very big sections have advantage of Mr Reynolds and his

(in)famous number working very well for the wing centre section. In other words, Horten wings lose some lift at the tips but gain very much at the wing centre. Lack of lift at the tips has the advantage of smaller tip vortices (drag) which is good. The clever thing is that to generate this small amount of negative lift from the small (narrow) wingtips, they have to fly at a relatively high negative angle of attack.

Look at what happens to a plane with a conventional wing when the pilot uses ailerons to bank the plane: The inside (of the turn) aileron moves up, lift decreases, drag increases, which causes the wing to go down and slow down. Now look at the outboard wing: The aileron goes down, lift increases, drag increases too. The increased lift causes the wing to rise, the increased drag tries to slow it down.

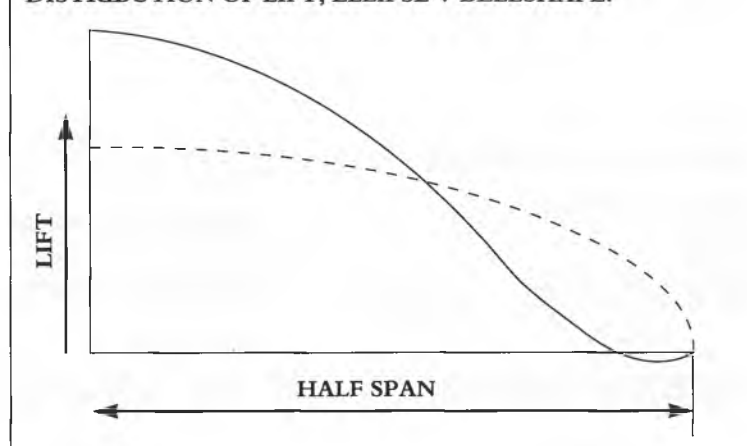
This is the opposite of what we wish. The wing needs to speed up to fly the longer distance of the wingtip on the outside of the circle. We tend to use differential aileron movement and have to use rudder to fly turns without side-slipping.

Drag rudders and Frise ailerons are solutions to cope with the increased drag at the wingtip on the outside of the turn, by adding more drag to the wing on the inside of the turn.

Look at a Horten and 'see the light'. The inside aileron goes up, more negative lift and more drag. Both are effective to lower the tip and slow it down. The outside aileron goes down, less negative lift causes the wing to rise and because the total angle of attack decreases the drag decreases with the negative lift. This causes the wing to 'speed up' which is what we really want.

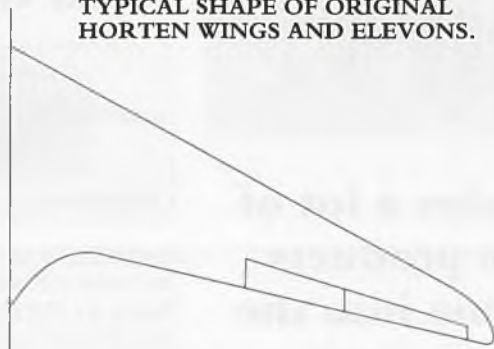
For this reason a well designed Horten wing will not side-slip.

FIGURE 1:  
DISTRIBUTION OF LIFT, ELLIPSE V BELL SHAPE.

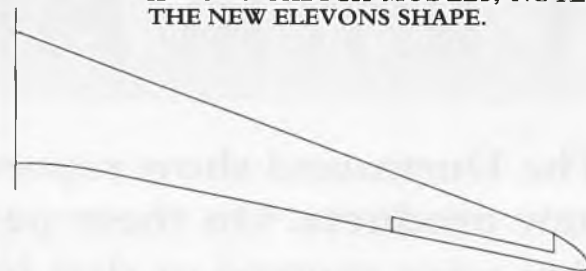




**FIGURE 2: TYPICAL SHAPE OF ORIGINAL HORTEN WINGS AND ELEVONS.**



**FIGURE 3: MODERN HORTEN TYPE WING OF ALFONS GABSCH MODELS, NOTE THE NEW ELEVONS SHAPE.**



Erik's Ho-XII has short moving flaps at the very end of the wing. Rudder control means lowering the outside flap only. This gives a slight increase of lift and decrease of drag (vortex) causing a beautiful flat turn.

With aileron: banked turns. With aileron plus elevator: very tight turns. With rudder (control) only: nice flat turns. What more could one hope for?

It must be said that after Reimar Horten came up with the short balanced elevons, the control of his designs improved greatly. The long elevons of the Horten V and VII were definitely not very good compared with the later version of the Horten IX (elevons were 2 parts moving very differently) and the latest very short versions which he promoted during the last years of his life.

This is the type of control surface Alfons Gabsch is concentrating on and which makes the Ho-XII model such a wonderful plane to fly.

Calculating a Horten lift distribution is possible with the proper computer program - don't ask me I don't have it and cannot do it! - but I can see the logic of it.

When you know the shape of the wing root and tip sections, the local sections can be found for each rib. Knowing each section and knowing the amount of lift we want at that particular place (station) of the wing, the angle of incidence can be found for each rib. Having done this, one has to decide which is going to be the straight spar of the wing. Because the twist of the wing is non-linear, there can only be one straight line. For the long elevons of the Ho-VII this had to be hinge line. Consequently the mainspar, leading and trailing edges are curved.

When we chose to go for a straight mainspar, both leading and trailing edges showed a peculiar 'S' bend. This can be confusing for those who do not know why this is so and easy to

see why somebody may think that the old surviving Horten glider wings have warped from old age, seeing them at Farnborough.

To complicate matters the effect of two swept wings meeting in the centre causes loss of lift. Horten called it 'centre effect'. He used a greater chord at the centre line to compensate for this loss of lift. It is useful to squeeze a pilot into the Ho-IV and Ho-VI. Recent calculations have proved it can be done better than in the original Hortens. Also the experts can now

tell how much is lost by having a big canopy like the one on the Horten Ho-XII.

The perfect flying wing can only be models like those of Alfons Gabsch or huge so that nothing sticks out in the breeze...

I hope this little sermon unveiled a bit of the mystery of the genius of Reimar Horten and his designs.

PS

Some of the 'Horten models' we see in magazines often have 'invisible' transparent fins. When this is necessary to make his model fly I feel sorry for the builder. His model is not a Horten! The best one can say is: it looks like one but it is a sort of lookalike mongrel... Sorry about that. Theo Gordijn.

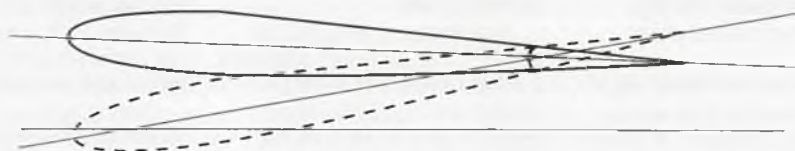
**FIGURE 4A: INSIDE WING AILERON MOVES UP.**  
 • MORE NEGATIVE LIFT.  
 • MORE DRAG.  
 • WING SLOWS DOWN AND GOES DOWN.



**FIGURE 4B: OUTSIDE WING AILERON MOVES DOWN.**  
 • LESS NEGATIVE LIFT.  
 • LESS DRAG.  
 • WING SPEEDS UP AND RISES.



**FIGURE 5: OUTSIDE WING AILERON TIP MOVES TO SLIGHT POSITIVE ANGLE (LESS THAN WASHOUT).**  
 • MUCH MORE LIFT THAN FIG 4B.  
 • EVEN LESS DRAG THAN 4B.  
 NOTE: ONLY ONE AILERON IN THIS POSITION CAUSES OUTSIDE WING TO RISE AND ACCELERATE. THE EFFECT IS LIKE RUDDER CONTROL.  
 OUTER PART OF NEW TYPE AILERON



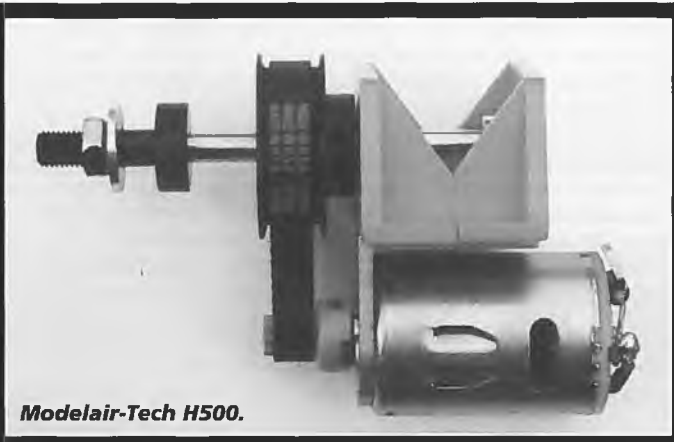


# Current Affairs.

**The Dortmund show report contains a lot of new products. On these pages are products that were spotted or that have come into the office since then.**

## Belt Drive

Belt drive reducers are not the most compact gearboxes but they are quiet and it is easy to change ratios. The one here is the H500 for motors up to 600 and 05 size, by Modelair-Tech, PO Box 12033, Hauppauge, NY 11788-0818, USA. These are available in the UK from Gordon Tarling. Price in the USA: \$49.95 and with prop adaptor: \$54.95.



Modelair-Tech H500.

## Small Gearbox



MGB-50.

The MGB-50 is for 400 size motors and comes with a ratio of 2.14:1. Price in the USA \$24.95, available from Modelair-Tech or Gordon Tarling.

## WONDER XXS

This little fun machine with a span of 670mm (26") is for direct drive 400 motors and 6 or 7 cells (brave pilots have used Speed 480 motors and more cells!). All components are CNC cut for incredible accuracy and ease of construction. The photo here of the uncovered model shows just how simple it is. Control is aileron, elevator and motor and there is not much an experienced pilot cannot do with it.

Available in Germany from Modellflugbedarf Höllein, 09561 8121 82 and in the UK from The Electric Aeroplane Co.



Wonder XXS for 400 motors.

## SMALL MOTOR

*The Astro 020 Brushless motor and its speed controller weighs 93g.*



The dedicated small model enthusiast (not indoor!) has to be interested in the new Astro 020 Brushless motors. There are available, so many small motors at the right price and some better ones too for a little more money. Now there is available a small brushless motor suitable for model flying. The Astro 020 Brushless has been mentioned in the pages of this magazine before but the few mentioned were development items.

The one you see here is one of the first production 020s with its discrete speed controller, in fact it is 'hard wired' to the motor. I know

that several different 'winds' or 'turns' have been used experimentally and this production motor is a 'seven turn' as revealed by the Astro part number: 602-7T.

Weight is about the same as a 400 motor and with the controller is 93g (3.3oz), diameter is 0.95" (24mm) and length 1.75" (44.5mm). The motor shaft is 1/8" (3.17mm) and it comes with the prop hub you see with a 3/16" (4.76mm) shaft.

Performance is what you pay for. On 7 cells it will turn a Robbe 6 x 3.5 at 14,700 RPM on 16.1A (120W) and 12oz (340g) static thrust, or a 6 x 3 Cox at 16,100 RPM on 14.6A (110W) and 13oz

(370g) static thrust. At 100 Watts input the brushless 020 delivers 33% more power to prop than the Speed 400.

The same motor with a micro gearbox (not shown) and on the same cells and at the same input power will turn a 12 x 7 prop at 4,500 RPM and 20oz (570g) static thrust, or an 11 x 7 prop at 5,000 RPM and 18oz (510g) static thrust. The gearbox adds one ounce (28.35g) weight and has a 1/4" (6.35mm) shaft. Lower number turn motors may become available for use with the gearbox.

Tests at Astro with the WeMoTec 480 ducted fan unit have given the results below:

V	A	W	RPM
7.5	8.6	64	18,500
8.0	9.3	75	19,200
8.5	10.1	86	20,000
9.0	10.8	97	20,800
10.0	12.3	123	22,400
10.5	13.1	137	23,000
11.0	13.8	152	23,700

So 8, 9, or 10 cells would be great for small jets. The 020 is available in the UK from West London Models, 214 High Street, Harlington, Middlesex, UB3 5DS, tel: 0181 897 2326, fax: 1081 759 8259, for about £180.00.



# WeMoTec Mini fan 480

What was the EJT 400 ducted fan unit has had its multi-component rotor replaced by a one piece five blade rotor that is able to use the greater power of the Astro 020 Brushless, Graupner Speed 480 Race, Kyosho AP29, LRP Super 400-E and Plettenberg 200/20/6 motors. According to motor used and running on from 6 to 10 cells the WeMoTec Mini fan 480 is able to deliver up to 5.5N (19oz) thrust.

The external diameter of the shroud (without intake lip) is 72mm and the rotor diameter is 68mm, making this a compact and powerful unit for small models.

Available from most model shops world-wide or contact: WeMoTec, Viersener Strasse 180, D-41063 Mönchengladbach, Germany. telefax: 02161 898492.

**WeMoTec Mini fan 480 components, assembly including motor takes a few minutes.**

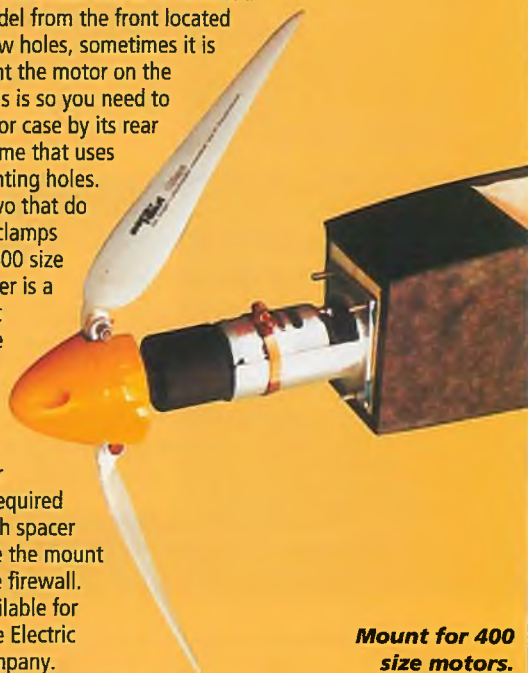


## Motor Mounts

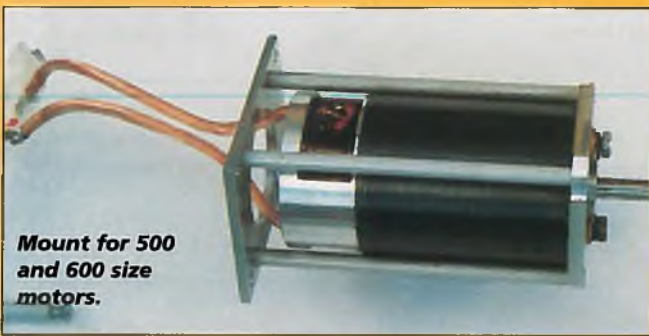
Sometimes it is not convenient to mount a motor in a model from the front located mounting screw holes, sometimes it is better to mount the motor on the 'firewall'. If this is so you need to 'grab' the motor case by its rear or fit a sub-frame that uses the front mounting holes.

Here are two that do just that, one clamps the case of a 400 size motor, the other is a sub-frame that attaches to the front of a 600 size motor. With both it is possible to adjust down or sidethrust as required by packing with spacer washers where the mount attaches to the firewall.

Each is available for £9.90 from The Electric Aeroplane Company.



**Mount for 400 size motors.**



**Mount for 500 and 600 size motors.**

## Minicraft Fretsaw

Even for modelling, machine tools make it quicker and easier. The Minicraft 12V Variable Speed Fretsaw is good for awkward cutting jobs.

It will cut hardwood or plywood up to 13mm, softwoods up to 30mm, balsa up to 40mm, plastics up to 6mm, non ferrous metals up to 3mm and ferrous up to 1.25mm. And free with the fretsaw is a 100w disc sander that makes sanding ribs and formers easier too.



**Minicraft Variable Speed Fretsaw.**



'DB Sport & Scale', the long established British kit manufacturer is 'going electric'. They have manufactured kits for IC powered models for years and recently released electric versions of their Moth kits as the DH Cirrus Moth 20E and 40E. These are now joined by the Sopwith Pup 'E' for geared 600 motors and seven cells.

The kit includes a spun aluminium cowl, pre-cut parts, pre formed wirework, plan and building instructions. The power pack is loaded through the front of the cowl and in the event of a heavy 'landing' can eject the same way as it went in. Extras available from DB are a latex pilot, scale wheels and computer cut decals.

Price in the UK is £55.00 plus £5.00 P&P from DB Sport & Scale, 24 Pine Copse Close, Duston, Northampton, NN5 6NF, tel & fax: 01604 751311.

## SOPWITH PUP 'E'



Sopwith Pup 'E' by DB Sport & Scale.

1997 MPS catalogue for electronics.



## Maplin Catalogue

For those amongst you who prefer to build you own equipment, the 1997 Maplin MPS Complete Catalogue for Electronics is available now at WH Smith, John Menzies, or any Maplin shop or Mondo Superstore for £3.45, or call 01702 554000 and they will post it to you for an extra 50p.

Component orders are despatched on the same day as received, orders over £30 in value are delivered free in the UK mainland and this catalogue contains over £50 worth of discount vouchers.

## HURRICANE

Pete Nicholson of Model Designs' latest plan is for a Hawker Hurricane. As with all his plan models it is light and flies so well on a regular Speed 600 motor and 7 or 8 cells. Wing span is 1170mm (46"). For more information contact: Model

Designs, 3 Middle Ground, Cricklade, Wilts, SN6 5JQ.



Model Designs Hawker Hurricane.

## Bigger Micro-Star

The Gordon Tarling Micro-Star 10 and 20 speed controllers (with and without BEC) are in common use with pilots of 400 powered models. Now Gordon has started to manufacture a 40 amp controller with a multitude of 'user programmable' and other features. Settings are stored until you wish to change them.

The Micro-Star 40BEC/B is for 6 to 10 cells and up to 40 amps. User programmable features are: brake/soft brake/no brake, auto or manual arming, auto or manual cell count adjustment and a choice of BEC warning or no warning. Other features are: an audible 'motor armed' signal, overheat warning and protection, motor softstart, safe power-up, glitch suppression, failsafe and 40 amp max current rating for 2 minutes. Size is 50 x 37 x 10mm and weight 45g (without leads), 'on' resistance is 2.5 milliohms and HF switching is 1200Hz.

Introductory price: £60.00, for more information contact: Gordon Tarling, 87 Cowley Mill Road, Uxbridge, Middx. UB8 2QD, tel& Fax: 018195 251551, email: gtarling@ndirect.co.uk





# Lightweight Speed Controllers

These speed controllers for conventional brushed motors must be amongst the lightest available at their current handling capacity. They are marketed by and carry the labels 'West London Models' but have been designed by Steve Neu (six times a member of the USA F5B team). The product names are: 'M-40', 'M-60' and 'M-80' and the numbers specify their maximum ampere handling rate for 30 seconds; their continuous rating is half that. This is sufficient for almost all uses, running at say 80A would flatten 1700SCRC cells in little more than one minute. Most of your fun flying is probably carried out at half

## West London Models speed controllers.



## Reverse side of a West London Models speed controller.



throttle which usually consumes energy at a quarter of your maximum power. All may be used with BEC on 6 to 12 cells and without BEC on 6 to 18 cells. Prices: M-40 £63.99, M-60 £68.99, M-80 £80.99.

# ASTRO GEARBOXES

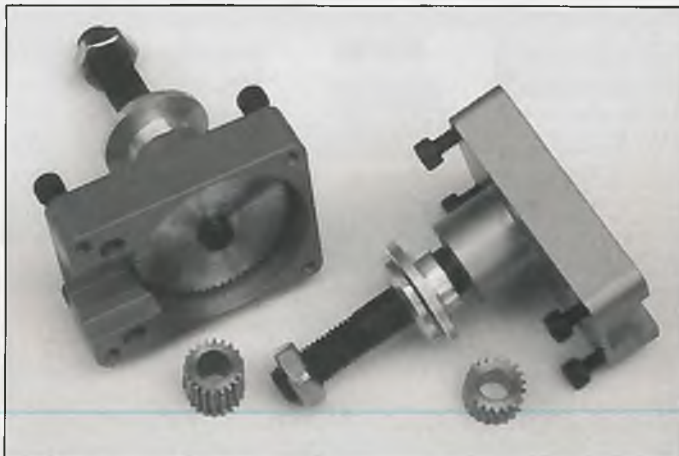
Two more of those simple robust gearboxes are available for Astro motors (or any others they may fit).

The model 713 is for Astro 25 and 40 size motors and the helical gears give a ratio of 3 to 1 and permit the use of props up to 18 x 10. Recommended price in the UK is £46.99.

The Model 714 is for Astro 60 and 90 size motors and available with 22 and 20 tooth motor pinions to provide ratios of 2.8 or 3 to 1 and prop sizes up to 24 x 10 and 28 x 14. Recommended price in the UK is £52.99.

Available from Astro Flight Inc. 13311 Beach Ave, Marina Del Rey, CA 90292, USA, phone: (310) 821 6242, fax: (310) 822 6637, Web site: <http://www.astroflight.com> or in the UK from West London Models.

## Astro gearboxes for 25/40 and 60/90 motors each come with four tapped mounting holes for securing to firewalls.



# BIG MOTORS



## There is a lot going on in an Aveox brushless controller.

Aveox motors have been available for a few years. Now they are available in the UK at West London Models. Aveox motors come in all sizes except small, so 'big' covers from 'middle sized' to 'enormous' and max powers of 500W to 3500W. Prices too vary from £139.95 to £659.95 but don't be frightened off! Most of them are under £200 and compare favourably with the neodyms. Aveox or other brushless speed controllers are essential, High voltage ones (14 to 32 cells) cost £206.95 and low voltage ones (6 to 16 cells) cost £164.95. Total cost need not be more than for a neodym or cobalt brushed motor plus a speed controller. Illustrated here is the 'F27 F5B' motor with '3.7:1 Planetary' gearbox and beside it the 'Hybridrive H60 uP' controller. This motor is as used at present by the USA F5B team and is rated to operate at up to 65A. The speed controller is 'user programmable'. Expect to see static tests and assessment in an airplane in the next issue of EFI. Available from Aveox Electric Flight Systems, 31324 Via Colinas #103, Westlake Village CA 91362, phone (818) 597 8915, fax: (818) 597 0617, email: [info@aveox.com](mailto:info@aveox.com) or in the UK from West London Models.

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## Aveox 'F27 F5B' motor with '3.7:1 Planetary' gearbox and beside it the 'Hybridrive H60 uP' controller.





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