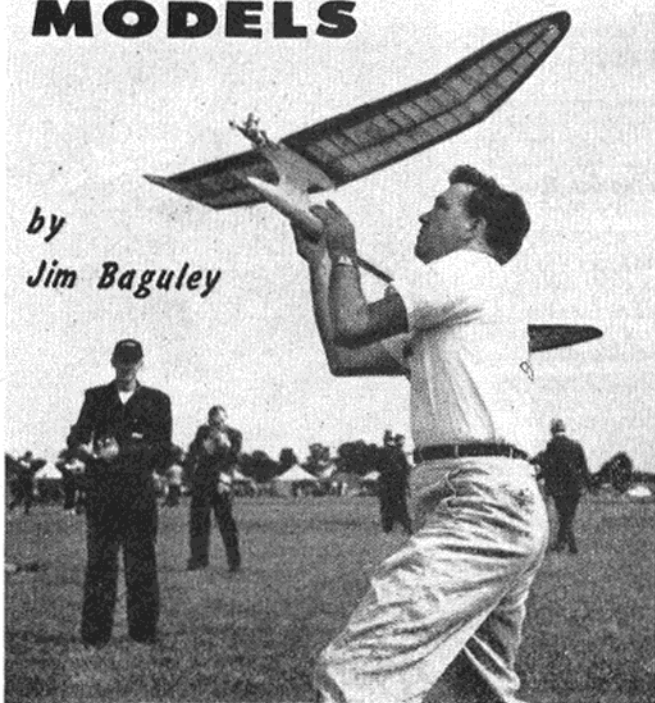


POWER DURATION MODELS

by
Jim Baguley



PART 3

One of the U.S.A. team members in the 1958 World Power Championships, Carl C. Perkins, carefully checks his timer as he prepares to launch his Oliver powered high thrust line model.

Model Size and Airfoils

These two considerations are closely allied. Whatever layout or airfoils are chosen the characteristics of wing and tailplane airfoils should be similar, as explained previously.

Many contradictory things have been said concerning airfoils. Some, with which people declare they could not even get a decent glide, are consistently hailed by others as being the "tops." Much of this is due to one's natural way of building and trimming a model, i.e. one will always tend to modify even when duplicating another person's design.

Examples of this are people who declare they are using "such and such" an airfoil, but on inspection it will prove to have a smaller, or larger, nose radius than the original, or the trailing edge inclination will be different, or maybe even his method of building will have produced distortion. The intention may have been to reproduce the original airfoil but the builder can easily, and quite unconsciously, alter it just by sanding the leading edge profile to a shape with which he is more familiar. Some airfoils will work with some layouts and loadings but not with others, which makes life rather awkward. Generalisations can be made, however—has anyone ever had an excellent glide from an 18 per cent. symmetrical unt section on a F/F power model?

Model size is also quite a debatable point. Some say design for the climb, others for the glide, and yet others compromise, but why not try for both? A large, light, clean model with very low drag will obviously climb nearly as fast as a smaller model, and will probably be far easier to trim, as well as having an excellent glide.

A small, again light and clean model, but with airfoils of higher lift coefficient and consequently higher drag will also climb fast, and can have an excellent glide if designed carefully. Its advantage is that although it may take more trimming, and be more susceptible to warps, that important little extra height can be gained on the climb. Being relatively compact it will not be thrown around so much in bad weather conditions and therefore may actually be

safer if a tolerant trimming method is used. I prefer this latter approach as it makes the models and their trimming far more interesting and a climb of respectable speed can be had from an inferior motor.

My past experience concerning airfoils can roughly be summed up—avoid "peculiar" airfoils—they may have peculiar habits. Stick to your own personal preference—you should know how to make it work. Avoid very sharp leading edges—you may experience pull out trouble. Avoid airfoils with the highest point of the upper camber very far forward—you may suffer breakaway and a non-existent glide. Avoid camber too far back—the resulting glide will probably be far from consistent. Avoid too highly cambered airfoils.

My own pet airfoil is a several times modified version of Kneeland's modification of a Goldberg section and bears hardly any resemblance to the original! It can be claimed that this airfoil (Fig. 9) has yet to show any vices, but many power fliers looking at it would probably say it is too thick.

As far as actual model weight affecting the glide is concerned, any model has a best gliding weight and will not necessarily have its best potential glide performance if it is built lighter. The climb is a different story, however, as extra weight will affect the rate of ascent. The solution would seem to be to put as much power into a model as can be handled, and at the same time keep the weight consistent with that needed for the best glide performance. The limitations being, safety of one's design and trim, and in being able to build down to the best glide weight which is usually very difficult. I often wonder if it is worthwhile trying to keep weight down. If one starts with a typical ball race 2.5, the engine, prop, timer, and tank system comes out at around 9 oz. which leaves only 7 oz. for the airframe!

Very thin, low-cambered airfoils, i.e. low lift, low drag, should only be used where the parasitic drag (fuselage, etc.) is kept to a minimum. Large light models should generally use these sections where the parasitic drag will be fairly low in relation to the airfoil drag.

Model Layout Types

This subject has already been dealt with in some cases, e.g. the Bethwaite type, because, in describing a particular



STATION	0	1/25	25	5	10	15	20	30	40	50	60	70	80	90	100
UPPER	7	24	35	5	68	8	89	98	97	9	8	64	48	28	8
LOWER	7	0	0	2	6	1	16	21	25	26	26	23	16	8	0

FIG. 9

trim, the layout exclusively associated with that trim had also to be described. The high thrust line models have also been dealt with in preceding notes.

All of the pylon model types seem to lend themselves to the trims previously described for pylon models and the various types of pylon model are, in any case, only derived by the use of different proportions and airfoil sections.

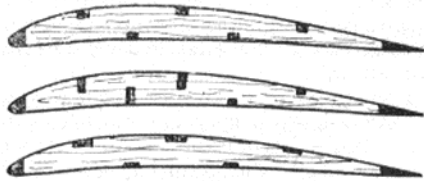


FIG. 10. MULTISPAR CONSTRUCTION.

Some Examples of Designing Pylon Models for a Particular Flight Pattern. (The following should only be taken as general)

The near vertical climb with high rate of roll

Use of the following features will help to achieve this although the model produced may be unsuited for a different flight pattern.

- (a) Very low aspect ratio to increase rate of roll.
- (b) Fairly high polyhedral with panels of near equal length.
- (c) Very large rear fin area.
- (d) Pylon of normal height.
- (e) Highly washed-out tips with wash-in/wash-out of inner wing panels.
- (f) Reduced drag at tips, i.e. taper, etc.
- (g) Very long moment arm.
- (h) Large tailplane.
- (i) Normal, low cambered sections.
- (j) Balance of areas in slipstream above and below thrust-line as Norman Marcus suggests.
- (k) Very little longitudinal dihedral.
- (l) Tail tilt or auto rudder for glide turn.

The only possible snag with combining all these features, which are in any case not all necessary, to produce this climb pattern is that the pull out into the glide may well be poor, and spiral stability in the glide may be lacking.

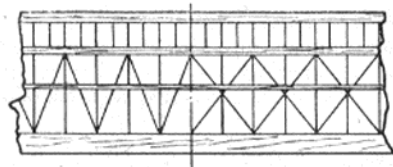


FIG. 12. GEODETIC & WARREN GIRDER + RIBLETS.



FIG. 13. TORSION BOX L.E. & T.E.

The near straight slowly rolling climb at high angle (three turns in 15 sec.)

- (a) Moderate aspect ratio.
- (b) Moderate polyhedral.
- (c) Large rear fin area.
- (d) Moderate moment arm.
- (e) Slight wash-in on inner wing panel.
- (f) High wing and tail incidence relative to thrust line.
- (g) Glide turn by tail tilt or auto rudder.
- (h) Other features normal.

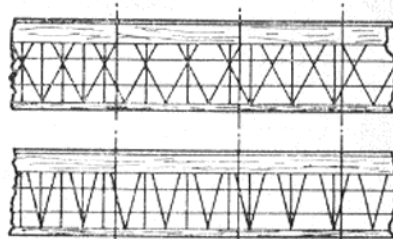


FIG. 11. GEODETIC & WARREN GIRDER CONSTRUCTIONS.

The foregoing is only intended to illustrate the way in which knowledge of certain effects can be used to design a model incorporating the desired characteristics, and does not mean that the trims cannot be attained in any other way.

Structural Design Considerations

Wing requirements

- (i) Torsional.
- (ii) Adequate strength in bending (not necessarily rigidity).
- (iii) Easy construction.
- (iv) Easy repair.
- (v) Resistance to crash impact.
- (vi) Fuel and waterproof.
- (vii) Required aerodynamic shape.

Sufficient torsional rigidity to prevent warping due to any reasonable load being imposed upon the structure is essential if a trim is to be kept. Permanent warps (i.e. those not induced by flight loads which occur only in flight) may be caused in several ways, for example. External loads applied for a limited time, or "unbalanced" and inadequate construction warped by covering tension.

Some form of constructional triangulation is usually necessary, especially with a thin wing section, if warping is to be prevented. Three forms of triangulation are (a) geodetic; (b) Warren girder; (c) cross braces, either in the form of part depth struts or full depth ribs. The complexity of the construction will depend upon how much effort the builder is prepared to put into it.



FIG. 14. UNBALANCED STRUCTURE.
CENTRE OF SPANWISE BENDING
RESISTANCE BELOW CENTRE OF COVERING TENSION BENDING
-CAUSES BOW.



J. O'Donnell is here seen launching a Eureka, a Norman Marcus design. The geodetic bracing of the wing and tail structure is clearly visible.

It is not usual to carry the diagonal ribs or riblets to the leading edge unless leading edge sheeting is used, for it is generally accepted that the first part of the airfoil, at least, should be relatively smooth. The diagonal ribs would, where sheeting is not used, normally extend as far forward as the front spar on the upper surface and riblets would be used ahead of the spar (see Figs. 10, 11, 12). It is a good thing if the triangulation ribs are at the surface for covering attachment, even if they do not extend to full depth.

While torsion box leading edges (see Fig. 13) possess great strength they are not advised if they are so rigid that they make the wing too resistant to bending. (This point will be amplified later.) A better arrangement is a number of spars equi-spaced, alternately top and bottom, as this will almost certainly provide a balanced structure.

To describe an unbalanced structure it is best to give an example, such as is shown in Fig. 14. This, it can be seen, will warp upwards if the tissue is at all tight and in doing so will almost certainly twist. The reason for the warping upwards is that the upper covering



FIG. 15. NEARER BALANCED STRUCTURE.
CENTRE OF SPANWISE BENDING
RESISTANCE NEAR CENTRE OF COVERING TENSION BENDING
-PREVENTS BOW.

surface tension has a greater moment about the constructional neutral axis than the lower covering surface tension. If, however, the spar is re-arranged as in Fig. 15, the moments of upper and lower covering surface tensions will be more nearly balanced, as the neutral axis of the construction will be moved upwards and will, in the ideal case, balance. The positioning of the spars across the chord will also have some bearing on the matter.

The reasons for having several spars are numerous; for example, smaller tissue panels (preventing twisting), more joins and shallower spars, less rigid in bending as ribs will also flex slightly, greater likelihood of achieving a balanced structure, better covering support, etc. If the wing section is of reasonable thickness the spars should be shallow but wide, rather than deep, as there will then be less chance of rib distortion. A great help in producing greater torsional rigidity has been found to be the addition of cement gussets on all joints.

HEIGHTS RE-PLOTTED ON NEW BASE

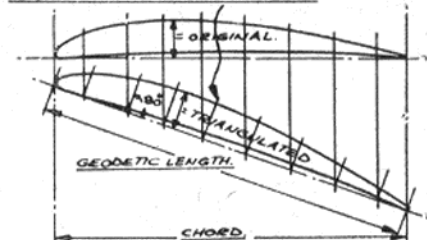
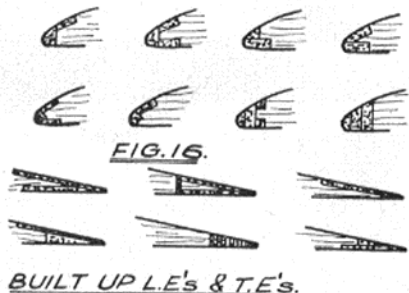


FIG. 19 PLOTTING "TRIANGULATED" RIBS.

The reason for not having a rigid wing structure in bending may be explained as follows. Imagine two wings, one having 3 units force per unit tip deflection and a maximum deflection to breaking of 10 units, the other having $1\frac{1}{2}$ units force per unit tip deflection and a maximum deflection to breaking of 20 units; the first being the rigid wing, the second being the flexible wing. Both wings will obviously have a force at breaking of 30 units at the tip but while the energy absorbed by the first will be 300 force units \times distance units, the energy absorbed by the second will be 600 force units \times distance units. It can be seen that while the constructional weight of the first will be almost certainly greater, it will be unable to absorb more than half the energy.

This was brought home to me when wings started folding on power and on powered d/t. The reason was the use of torsion box leading edges which, although they took a large "dead weight," were unable to absorb the energy of a suddenly applied load. My later wings are much lighter and will withstand a d/t under power.

Strength of a wing in bending is also best "tapered off," as the bending moment imposed at a section will vary at least as the square of the distance of the section from the tip, even assuming even lift distribution which is not true.



BUILT UP L.E.'s & T.E.'s.

The tapering off should not be carried too far, however, as there are other stresses such as covering loads to be considered. Dihedral braces and bandage should always be used to strengthen the centre of a power model wing where there is a central dihedral break and the wing is in one piece.

If considerable complication is to be allowed in order to prevent twisting and keep weight down, there are no end of structures which can be used. One may even finish up with the classic case which uses built-up ribs with Warren girder inner construction, multi spars with Warren girder bracing running between them from upper to lower surface of the construction, and geodetic surface ribbing in each "panel"—or would you rather be a happy modeller? It is suggested that with a reasonable degree of care the simplest of constructions may suffice—once more we turn to George Fuller's models!

It should be remembered that any extreme complications will render field repairs impossible. Built-up leading and trailing edges of the type shown in Fig. 16 are worthwhile, as they are reasonably easy to execute, save weight, and are repairable with little trouble. Cap strips (Fig. 17) are worthwhile, as they enable a lighter rib to be used and give great covering support; they may also raise the covering above the spars. Built-up ribs as in Fig. 18 may be used and present a very quick construction, the only snag being that if the model hits a tree gliding downwind it usually

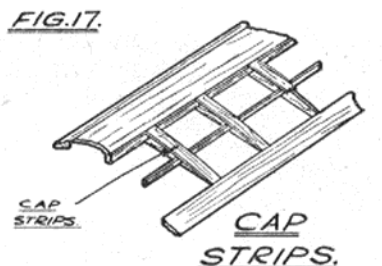


FIG. 17. CAP STRIPS.

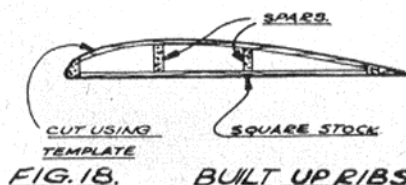


FIG. 18. BUILT UP RIBS.

crumples chordwise if the ribs are of thin section, due to the short grain at the leading edge and trailing edge! An easy method of producing geodetic or triangulated ribs is shown in Fig. 19 which is self explanatory. Part ribs can also be produced in this way. This method is as precise as one's drawing!

A tapered or elliptical tip planform is useful constructionally, as it tends to reduce the likelihood of tip warping but is an added complication, the strongest outline being a laminated one. A two-piece wing is not advised due to the extra weight and greater likelihood of warping. Waterproofing and fuel-proofing is usually accomplished by using fuel-proofer, my personal preference being clear "Valspar."

Tailplane

The tailplane is subject to virtually the same requirements as the wing. Its strength in bending need not be as great as that of the wing since it is lower stressed and is, in any case, frequently of lower aspect ratio. It should, of course, be kept light, for inertia and balancing considerations.

To be concluded next month.

Zdenek Malina, of Czechoslovakia, adjusts his engine timer prior to making a flight in the 1958 World Power Championships at Cranfield. The model is M.V.V.S. powered and employs simple structure and wing struts. Note also the sheet underfin

