Diary

This edition is issued in conjunction with that of June 1979.
Diary details will be found on the appropriate page there.

MAY 1979 79/05

FFn

FREE FLIGHT NEWS

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A/2 DESIGN by D Siebenmann

(Editorial note: this series of articles was due to be published regularly when the first section appeared in August last year (78/08, pages 58 - 60). Unfortunately, a short section of the complete document was lost, and all efforts to trace it, or a replacement, took until now! Hence the hiatus in production, for which we have to beg your indulgence. We sincerely hope that all will be straightforward from now on, and that you will find the material interesting and stimulating. Any comments readers may like to make will be received with pleasure and will be published on completion of the series later this year.)

Part 2

Distribution of the total drag

It is interesting to examine the relative distribution of the total drag over the components of the model. This places in perspective the various aspects of design.

Profile drag (C_L = 1.2)	57%
Induced drag (λ = 19)	32.7%
Tailplane drag (C_L = 0.3; S = 4dm^2)	6.1%
Fin drag (S = 0.8dm^2)	1.1%
Fuselage drag (25mm diameter)	2.2%
External odds and ends	1.0%

Stability

By stability one means the ability of the model to remain in the direction of flight imposed by its particular trim and to return to this normal flight after disturbances. One may consider stability about the three axes of pitching, yawing and rolling. Stability is achieved at the expense of performance and so it is necessary to achieve a compromise between the needs of stabilty when the A/2 is flying and the quest for maximum duration.

Good longitudinal stability (ie about the pitching axis) is required particularly when releasing the model from the line. It is rarely possible to float the model from the line, on account of turbulence on the flying site, the difficulty of placing the model in the exact position for release, the effects of strong winds, and the possibility of catapult launching. The model may be released in an unnatural position and with a speed different from its steady glide speed; it must recover from these conditions with the minimum loss of height from the optimum. Longitudinal stability is the most important in this case and also when the glider encounters gusts.

The lateral stability (about the yawing and rolling axes) has a marked influence on the ability of the model to fly in a thermal and centre in the lift without flying straight out of it, or spiraling down.

The total stability of the model when being towed must be as near perfect as possible, so that the tactics during towing are not restricted.

Longitudinal stability

When the model is disturbed from its normal flight path, it must return to it with the minimum loss of altitude. This aim must be achieved with the least detraction from glide performance, as is caused by increased tailplane drag or reduced area of the wing which result from using a larger tailplane. We will investigate the best compromises for solving this problem.

The Moment of the wing

A change of incidence of the wing produces two effects which influence longitudinal stability. The centre of pressure (CP) of the wing (the resultant point of application of all the aerodynamic forces on the wing) moves backwards or forwards along the chord (figure 9). Secondly, the lift changes (Figure 10) in the sence that the lift increases when the incidence increases (Editorial note: when operating below the stalling incidence!) These two effects on the moment from the wing vary in their relative importance according to the CG position. For example, when the CP is a long way from the CG, the change in lift is more important than the movement of the CP, since the latter is a small proportion of the moment arm of the force (moment = force x distance).

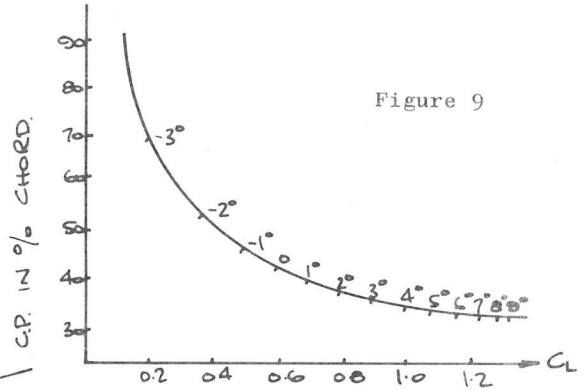


Figure 9

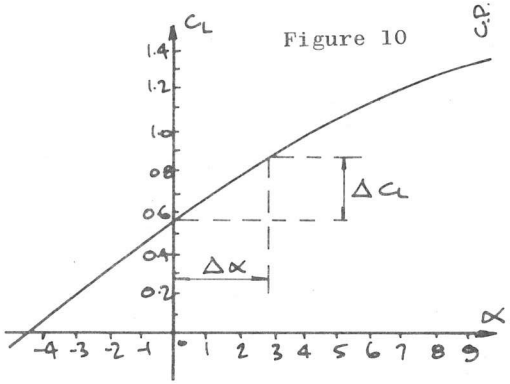


Figure 10

The variation of moment due to CP movement is independent of CG position and it is solely a function of the wing section. This is shown by the quantities

moments ΔM_1 and ΔM_2

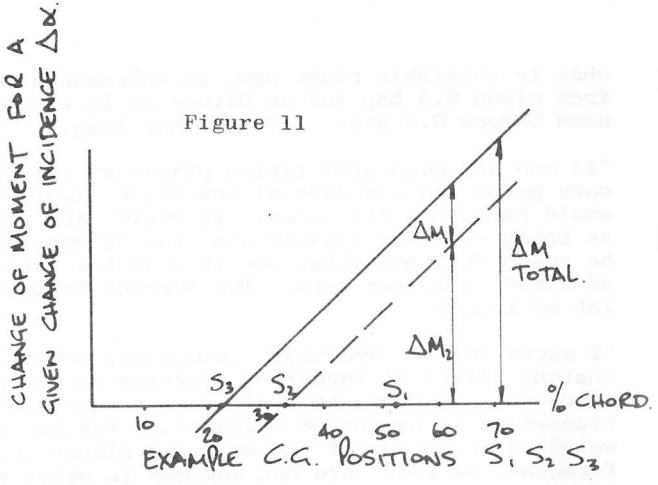
in figure 11, which are the two results of a change in incidence of

$\Delta\alpha$.

Most A/2 gliders have their CG in the rearward position shown as point S_1. In this position, the two moments as shown both work in the same sense, that is, to pitch up the nose. This is in the opposite sense to that required for stability (the model should pitch down when its incidence increases, so as to return the incidence to its normal value) and this tendency must be compensated for by the tailplane.

One can consider other CG positions, such as S_2, where the CG coincides with the CP and there is no pitching resultant from the change in lift. For a CG forward of the CP, if the angle of attack increases, the moment acts to pitch down the nose of the aircraft, possibly opposed by the effect of CP movement. There can be a point S_3 at which the two effects balance and this point is termed the aerodynamic centre of the wing at that condition. For typical A/2 cambered sections this is at about 23% chord. Figure 11 shows the relationship between the moments and the three CG positions S_1, S_2 and S_3.

Figure 11



This is one of the problematical areas in the subject of pitching moments; a more straightforward aspect is the need to achieve steady flight by equalising the moments about the CG. If the CP of the wing could always be placed at the CG then a tailplane would not be needed to give balanced flight. However, the only sections for which the CP does not move about with variations of incidence and speed are flat plates and these are unsuitable for our purpose on account of their poor

$$\frac{C_L^3}{C_D^2}$$

That is, they have high drag for the lift they develop. For a flying wing model, they are still inefficient, as are special sections which have smaller CP movement as a result of reflex camber at the trailing edge (Editorial note: one of the stated advantages of the Canadian computer-designed sections is that they combine high efficiency with small CP movements).

The equation for static equilibrium in flight is:

$$C_{Lw} \; S \; a \; = C_{Lt} \; s \; b$$

where C_{Lw} and C_{Lt} are the lift coefficients of the wing and tail respectively, S and s are their areas, a and b are the distances from the CG to the CP's of the wing and tail. C_{Lw} is typically in the range 1 to 1.25 depending upon the section and trim, while C_{Lt} may be between -0.1 and +0.4 according to the CG position.

One can easily measure the glide speed of the model from hand launches on a calm evening from a raised position. From this speed (V m/sec) it is possible to deduce C_{Lw} from the formula

$$C_{Lw} = \frac{22.8}{V^2}$$

If it is assumed that Figure 9 applies to the sections used, it is possible to apply it to predicting the CP of the wing and the tail. It is likely to be around 33% for the wing and 60% chord for the tail. From this, the lift coefficient of the tail is defined by

$$C_{Lt} = \frac{a \; S \; 1.1 \; C_{Lw}}{b \; s}$$

where the factor 1.1 makes some allowance for the drag of the wing.

Most competitive Nordics have tail lift coefficients between 0.15 and 0.4; a CG placed at 30% chord (S_2) would require zero tail lift and a CG at the aerodynamic centre (S_3) corresponds to C_{Lt} having a value -0.1. The latter means that the tailplane will be generating a downward aerodynamic force and the total lift of the glider will be less than that of the wing alone. A whole range of experimental possibilities suggest themselves here, but they may be inefficient - if you are thinking of a canard, forget the idea.

Moment of the tailplane

The variation of moment M due to the tailplane when incidence changes by an amount is given by

$$M = \frac{dC_L}{d\alpha} \; b \; s$$

where $dC_L/d\alpha$ is the lift curve slope of the tailplane (that is, the rate which lift increases when incidence increases). The variation of CP of the tail makes little difference to the moment, since it has such effect in comparison to the distance between the CG and the tail. This is thus neglected when examining the tail moment effects on stability.

Oscillations

All models have some mode of oscilliation about the pitching axis and, depending on design and CG position, these may be any of the following cases:

1) Damped oscillations. After a disturbance the model oscillates regularly with the amplitude of the oscillations dropping away more or less rapidly according to the damping in the system.

2) Undamped oscillations. The oscillations continue indefinitely after the disturbance without dying away.

3) Divergent oscillations. The amplitude of the oscillations increases continuously until the model reaches extreme attitudes and some other phenomomen taken over.

4) Divergence. The model is unstable and moves further away from its steady flight path after a disturbance, without recovering.

The only form of oscillation which can be tolerated in a contest model is the damped one (Item 1). The oscillations should die away

to leave the model continuing its steady flight with the minimum loss of height, normally after two or three cycles at most. It is possible to test this characteristic of an A/2 by releasing it from the towline flying fast (without any catapult aids) and thus draw conclusions about the CG position. If the model needs an excessive number of oscillations before settling down it has too little damping and it is necessary to move the CG rearwards and decrease the incidence difference between the wing and tail. Alternatively, Rapid recovery indicates that the CG may be moved forward with an increase in the difference of incidences. (Editorial note: the damping of oscillations is discussed here - do not confuse this with stability. By moving the CG too far rearwards the stability may become too low, leading to the unstable divergence of case 4 mentioned above).

WAKEFIELD, F1B by A Landeau

Alain writes:

In 1967 or '68 I decided, with Lepage, on the construction of a Wakefield according to the following principles: inertias generally reduced to the minimum; and surface areas distributed for maximum performance. The design thus had the characteristics of a long moment arm with a small tailplane, a short nose, and a helical propeller driven by 16 strands. The CG, at 50 to 55% is further forward than the position favoured by the Eastern France school.

Some initial encouraging results included a place on the French team for the 1971 World Championships in Sweden when two extra models were built in a record 1½ months. These were identical with the first model except for wing chords 110 and 125 mm. All three models were used for the seven flights in Sweden and with Louis Dupuis and Emile Gouverne the team managed second place behind the Danes, my individual placing being 19th. After that I concentrated on power flying, mainly because of the bad quality of rubber, until in early 1978 I tried some of the new Pirelli. It was a revelation, with astonishing power and robust enough for two motors to last for seven flights - Wake flying became a pleasure again.

Thus encouraged I flew in the curcuit of contests in Summer 1978. With a little luck all went well. At Assais I used 125 for all flights until the last fly-off at dusk, which gave first place. For the Championships of France and the Team Trials all three models were flown, depending on the weather. 100 is capable of a still air time about 30 seconds greater than 125.

SWEEPING CHANGES AGAIN

Ian Keynes' article on the possibility of changing the engine size for FAI power (Jan '79 FFn) has drawn a couple of thoughtful replies, the first from Peter Bayram:

"When one considers the history of the FAI Power class, it is possible to see that considerable changes have occurred. By taking a starting point as the time when the size and weight of the models settled to their current formula, and considering the bhp available then with what is available right now, an enormous difference is noticed i.e. from circa 0.3 bhp for an Oliver to in excess of 0.7 bhp now. How soon before 0.9 bhp? Probably not long.

"If one had suggested flying planes of the same size etc. but with 300% more power, in the days of the Oliver (which I well remember), then one would have been ridiculed. It would, at the least, have been suggested as being close to lunatic and also dangerous. O.K. it may now seem to be reasonably possible, but it none the less cuts the possible margins of error to almost zero. The current World Champ, for one, prangs a lot of models!

"I agree that an overnight change may not be desirable due to the instant effect of rendering existing machinery and expensive engines obsolete. However, it would seem reasonably possible to effect a transition by having an equivalency system, which could be initially weighted in favour of the existing planes and engines. Equivalency formulae, as such, are not unknown in other powered sports. For instance, existing Formula 1 motor racing had a system for running 3.0 litre normally aspirated engines alongside 1.5 litre turbocharged engines; for a while 5.0 litre stock block engines were also included in certain instances at National competition level.

"The easiest system in F/F is to restore equivalency by means of the duration of the engine run. By retaining the same overall size and weights as existing, but by increasing the engine run to say 12 seconds, the c.cs x seconds is virtually the same as current. Obviously the planes would be more handlable and docile, even so the bhp would exceed that of the Oliver Tiger at 0.3 bhp.

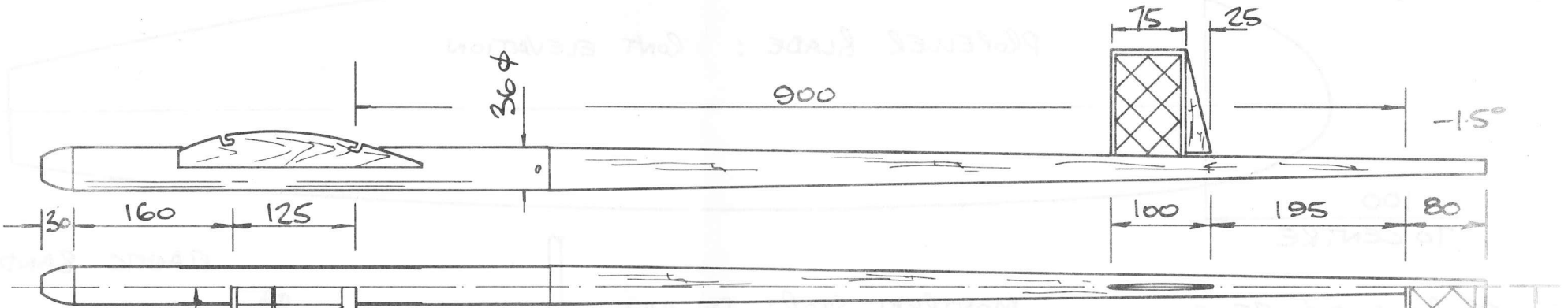
"Availability of engines should not be a problem - especially if the limit is set at 0.10 cu.in, or 1.6c.c., as there are two 1.6c.c. Schneurle motors from O.S. and Webra currently available, with a third due shortly from Super Tigre. To be totally competitive with current 0.15 cu.in. outputs it would seem, at first blush, that 0.5 bhp is required. However, there are other considerations. I would imagine that designs could be a) more streamlined, b) of higher aspect ratio, c) have smaller tailplanes, d) trimmed to be more consistent and finally e) an average higher percentage of the allotted motor run utilised per flight. Therefore, even with only the 0.35 to 0.4 bhp currently available, reasonable equivalency would seem possible.

"I believe that if there is no change to the FAI rules relatively shortly, then changes will occur via the backdoor, without any planning. At the moment we have Coupe D'Hiver, A/1 and ½A as smaller classes. Once ½A becomes an FAI class and then becomes very much more popular than full FIC, then FIC will become as dead as the Dodo.

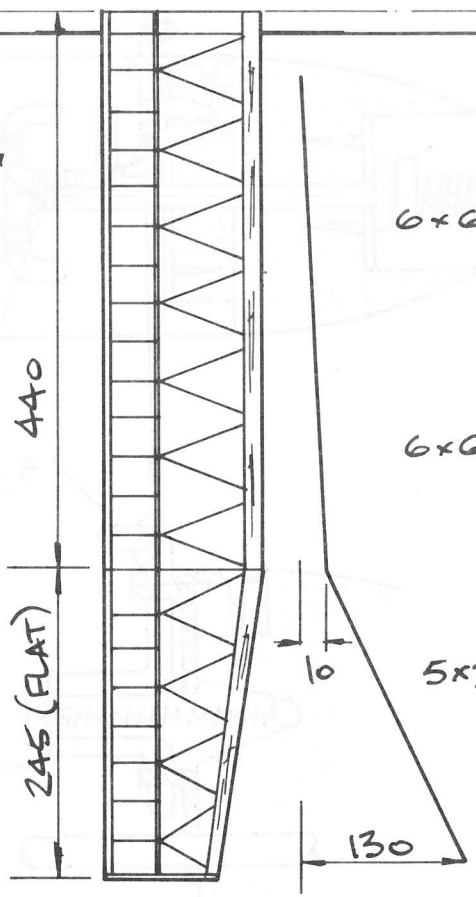
"The reasons, incidentally, boil down to similar ones that are contemplated by the C/L people - safety. Fortunately F/F tends to be self regulating in that respect, as fewer people will build planes that are unforgiving and self-destruct comprehensively. Only the most expert fly these models and logically, therefore, also fly them safely.

"Finally, perhaps consideration should be given to re-introducing

SCALE 1:6 ALL DIMENSIONS IN MILLIMETRES.

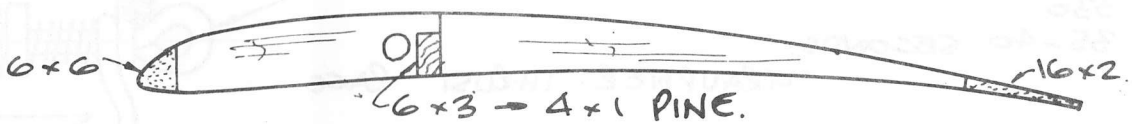


WING INCIDENCE
+3.5° LEFT WING
+3.0° RIGHT WING
FOR LEFT GLIDE



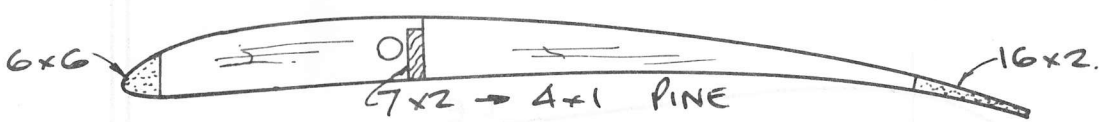
WING SECTIONS (FULL SIZE)

125



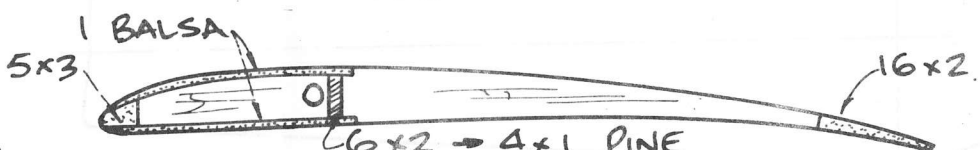
6×3 → 4×1 PINE.
2.5 ϕ JOINER

120



7×2 → 4×1 PINE
2 ϕ JOINER

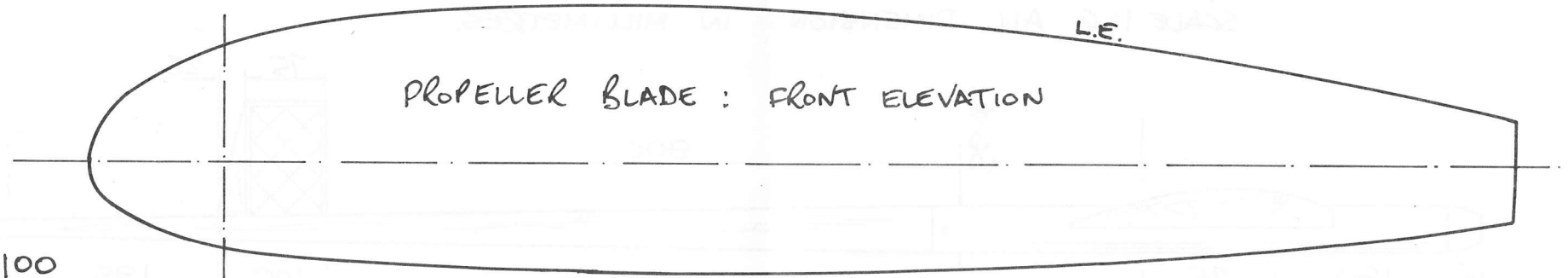
110



6×2 → 4×1 PINE
2 ϕ JOINER

TAIL SECTION (FULL SIZE)

F.1.B. by Alain Landeau.



PROP : 600 ϕ x 750. P.

POWER : 16 STRANDS 6x1

TURNS : 330

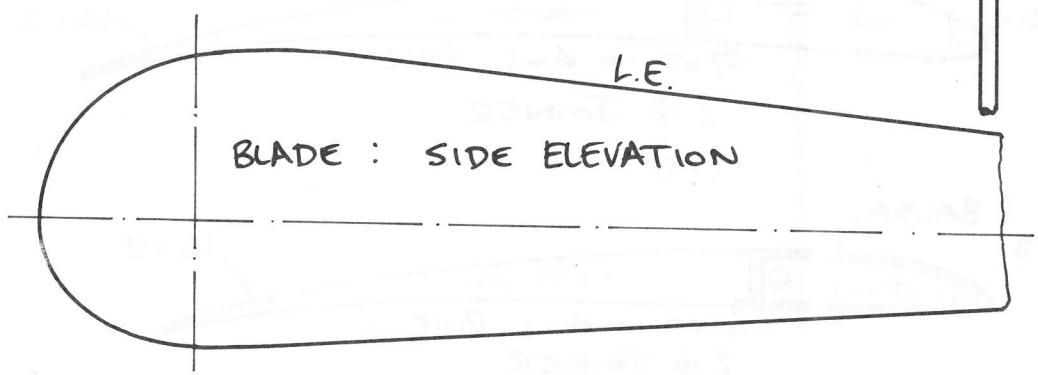
RUN : 35-40 SECONDS.

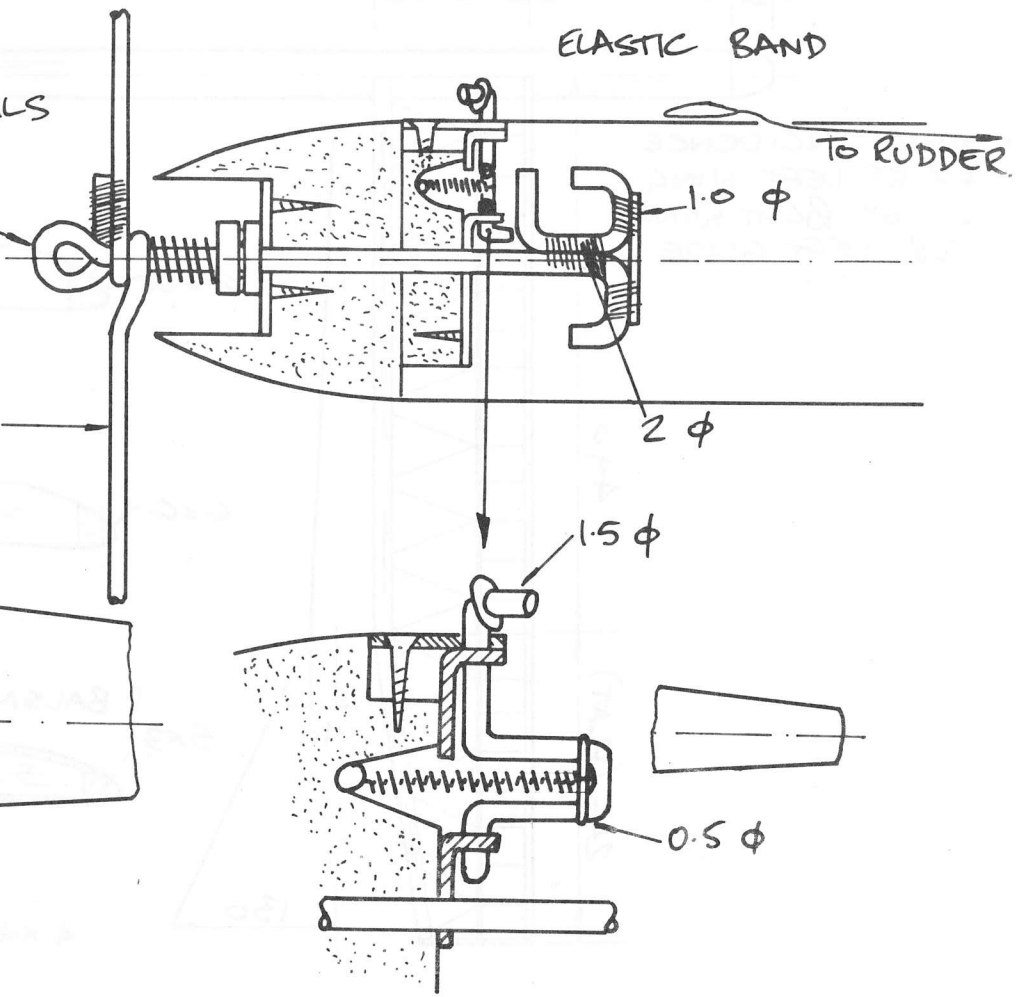
MONTREAL STOP : DETAILS

PROP SHAFT : 2.5 ϕ

GRAUPNER THRUST RACE.

ARMS : 2 ϕ





Propeller Full Size Details.

'pipes' for noise reasons. But this complicates the equivalency as logically a smaller engine size of say 1.25c.c. 'fits', and there are no engines at present of below 1.6c.c. that are modern production Schneurle racing engines. Perhaps 1.5c.c. piped motors and 10 second engine runs is the answer.

"Incidentally, I have flown FAI Power in the past - having built three Night Trains and having won Open Power at our Nationals with one of them. I also proxy flew for N.Z. at the World Champs once. So I have some experience in this area. I would be much more likely to build an FAI plane if the rules were made 'easier'."

Martyn Pressnell also sent us some reflections and ideas:

"In the UK, 15 or 20 years ago, a youngster or anyone else could go into his local model shop and buy a moderately priced diesel engine along with a simple kit duration power model, and within a week or two have an attractive model to enter in competitions, knowing at the outset that it was not completely outclassed. Indeed the sky seemed full of them - or is it just my memory, and a creditable performance they gave too, albeit with a full 15 seconds engine run. Can one do this today? Alas no. The FAI juggernauts and the big open models are not available in kit form, no doubt for economic reasons. It must surely cost £150 to equip oneself to put an FIC ship into the air (Surely not quite this much? - Eds.) and the number of modellers seriously competing is perhaps two dozen. Is this what we want?

"Now I am not arguing for a gross change to the FAI specifications - there are good arguments against that. But I am making a plea for a 'National Policy' aimed at encouraging new power flyers and developing them to the international standard. Indeed, with a good deal of respect to the hardworking SMAE technical committees and others, I think this is as important for the longterm well-being of free flight as, say, noise abatement and fighting bye laws.

"So what would I suggest:-

1 Introduce a national competition class for 1½c.c. diesel powered models. This should be the mainstream UK class, replacing current open events. It would be well supported with relatively cheap engines and kits available to meet the demand.

2 Introduce a 2½c.c. diesel class identical to FAI but with, say, 12 seconds motor run. These would be flown in National Comps to FAI rules alongside the current glo powered machines using 7 seconds.

3 Retain ½A power for the small and cheap glo motors available in the shops, hoping this will become really popular as modellers return to power flying."

The above thoughts come from two active flyers, and perhaps it is significant that neither fly class F1C, to the best of our knowledge. Although any changes which take place will not come until '83 at the earliest, perhaps it is time for the present day flyers to add their comments?

RUSSIANS, NORDICS & CATAPULTS, Part 4

Tom Hutchinson writes:

The recent exchange of opinions about the 50 foot Nordic zoom launch has aroused my interest, since I have just finished a paper on the subject for the NFFS Symposium. I have calculated the line tensions and launch velocities necessary to obtain a specified launch height, using the method proposed by Lou Young in the December edition of the Free Flight Digest. This method assumes that the model has to be generating enough lift to carry its own weight plus the towline tension at the moment of release. The most symplified trajectory assumes that the glider will fly vertically until the excess speed (over glide speed) is dissipated, then tips over into proper glide attitude. From this admittedly ideal condition, I obtained a line tension of 27.5 lb, with a resulting launch velocity of 82.7 ft/sec, as being necessary for a 50 foot zoom! (Matt Gewain made a slightly different analysis, equating the kinetic and potential energies at launch, and arrived at almost identical figures).

I also calculated the necessary velocities and tensions using a more realistic trajectory, with a climb angle of 30 degrees. In this way, I obtained a tension of 62.7 lb, and a launch velocity of 123 ft/sec to obtain 50 feet of zoom.

Even assuming that a model structure could withstand such line tensions, the launch velocities necessary are significantly greater than those measured for both hand launch glider (84 ft/sec was the maximum velocity measured by Young in his 1974 paper on HLG performance) and FAI Power launches (45 ft/sec maximum according to J Annis, 1977 NFFS Symposium). This latter velocity would be close to that expected for a model of A/2 size and weight.

Jim Thornberry has done some measurements of A/2 zoom height gain, and has sent them to you, I believe. Measuring the height gain is a tricky task, even with model rocket tracking instrumentation, but his measurements indicate average gains of less than 20 feet, with a 5 lb unlatch force, which matches quite nicely with my analysis. (Incidentally, using Lepp's 11 lb unlatch force would result in a height gain of from 20 to 25 feet, almost half of the 50 foot myth). I would tend to believe these instrumented measurements over crude estimates.

The theory shows that significant gains in launch height are possible, but the 50 foot figure is optimistic by about 100%, unless thermals are present. After all, 50 feet is the height of a 5 storey building!

Seattle flyer Jim Thornberry adds his comments:

Enclosed is a summary of my findings. The measurements are hardly definitive as there isn't sufficient data to do any statistical tests, but it is a start. I think Mike Segrave has the right approach in that some attempt should be made to measure the altitude gained. This can be done in a variety of ways. The D/T method I thought of was also proposed by Matt Gewain back in the June '75 edition of Model Builder. However what was published there was based on calculations that predicted a D/Ted Nordic would take

over 40 seconds to descend 50 metres. As you can see, it's more like 15 seconds on my model. Matt has done quite a bit of work on structures and zooms and although I'm not aware of the method used, he reports 30+ ft gains on zoom.

In any case, it is possible to have a net gain in altitude on zoom. A consistent net gain is something else again, as Per Grunnet pointed out. Finding lift still remains the most important factor. I agree with Tom Hutchinson: if you're sure it's in 'air', play safe and don't risk a hard zoom.

One potential problem with measuring glide time from full towline length is that the gain in altitude is a small fraction of the total altitude and thus a small fraction of the total time. The measurements are greatly affected if the air is less than perfectly 'dead', particularly if the lift begins about 150 feet up. The D/T method is less affected by this, and the triangulation method (mentioned below) eliminates this....

"Net Altitude Gain on Zoom Launch - (Jim's comments in Batsheet)"

... Before investing much design, building or weight in a super strong wing it seems reasonable to measure what sort of net altitude gain can be achieved.

The method should be simple and fairly precise. At 164 feet, a 10 foot difference is only 6% of the total. Net altitude gain should be measured; while a 30 foot zoom may look impressive, if it requires pulling in 15 feet of line to do it, you have gained only 15 feet and probably lost some consistency.

One evaluation is to use a short, 50 ffot towline and measure the extra duration achieved when the glider is zoomed, versus 'floated' off. Jim Walters has done some of this and finds he gains 10 to 12 seconds on the zoom launch. At a sink rate of 1.1 ft/sec this is about a 12 foot zoom. This method has the advantage of measuring the altitude gained when the model began gliding instead of the maximum altitude, and these may be quite different. The 1964065 Zaic Yearbook (p 118) indicates that a Nordic takes 30 seconds to settle into the glide. A drawback of this method is uncertainty about how well using a 50 foot towline corresponds to a 164 foot towline with its greater drag and stretch.

Another method, used by model rocket flyers, is triangulation. Using two optical tracking 'scopes separated by a measured distance one can calculate the altitude of the glider. The altitudes calculated at each tracker are compared and if they are within 10% of each other, the tracking is deemed 'good' and the two values are averaged. Using this method, the following data were taken: (Windspeed was 10 to 15 mph)

Flyer	Average 'floated launches'		Average zoom launches	
A	153'*	164'*		
B	167'	159'	181'	192'

Note* 5' of line remained in the flyers hand.

The average zoom gained by flyer B equals 23.5 feet height. While this method is versatile (ie. good for Wakefield, Power, HLG) it requires several people and special equipment that must be carefully aligned. Also, it measures the apex of the zoom. In one zoom, the glider recovered very poorly with a gross loss of altitude.

Finally, one can time the descent of a glider purposely D/Ted 5 to 10 seconds after release. Once D/Ted the glider falls at an essentially constant rate. The extra time to descend after a zoom represents the net zoom altitude gain. Using this method on a 164 foot line:

Non zoom launches	18.2*	16.0*	16.5	16.3	16.8	14.8*	16.2
Zoom launches	17.6	18.3	16.4	18.6			

Note* Poor launch or erratic D/T; data not used.

non zoom average = 16.45 seconds
zoom average = 17.73 seconds

Thus the average time difference was 1.275 seconds and at about 10 ft/second the zoom works out at 13 feet net gain. Although simple, this method has only worked in calm, dead air and requires a model with a consistent, smooth descent on D/T. It could be used for F1B and F1C.

In summary, not even close to a 50 foot zoom seems feasible but some altitude can be gained, perhaps even more so in the wind. A good recovery is necessary. Next time towline tension will be measured so that the theoretical calculations may be checked.

WORLD CHAMPIONSHIPS NEWS

New Zealand team: for the first time in very many years (if ever?) the Kiwis will be sending three full teams to the event at Taft. Membership comprises:

F1A: Paul Lagan, Malcolm Sexton, Ian Weston
reserve, Peter Wheeler

F1B: Paul Lagan, Ron Magill, Allan Barnes
reserve, Clive Gardner

F1C: John Ensole, Lynn Rodway, Rick Bain
reserve, Bill Forbes

We understand that the Team Manager's duties will be undertaken by two people: Martin Dilly will add experience from his numerous flying and spectating sessions at such events, and Alan Knox from New Zealand will be the local representative.

Australian team:

F1A: Peter Nash (Qld), Dave Simons (NSW), Peter Lloyd (Vic)

F1B: Barry Winter (Vic), Allan Edwards (NSW), Paul van Leuven (Qld)

F1C: Peter Nash, Bill East (NSW), Stan Hinds (ACT).

The team manager is Dave Tongway, who tells us he's spending four weeks in the US, and hopes it will be an aeromodelling ball!

NOTICEBOARD

Tailless: Ron Firth has full size plans of John Pool's tailless rubber models at 75p each. Ron's address is 22 Slayleigh Avenue, Sheffield, England S10 3RB. Just time to build one for the Nats!