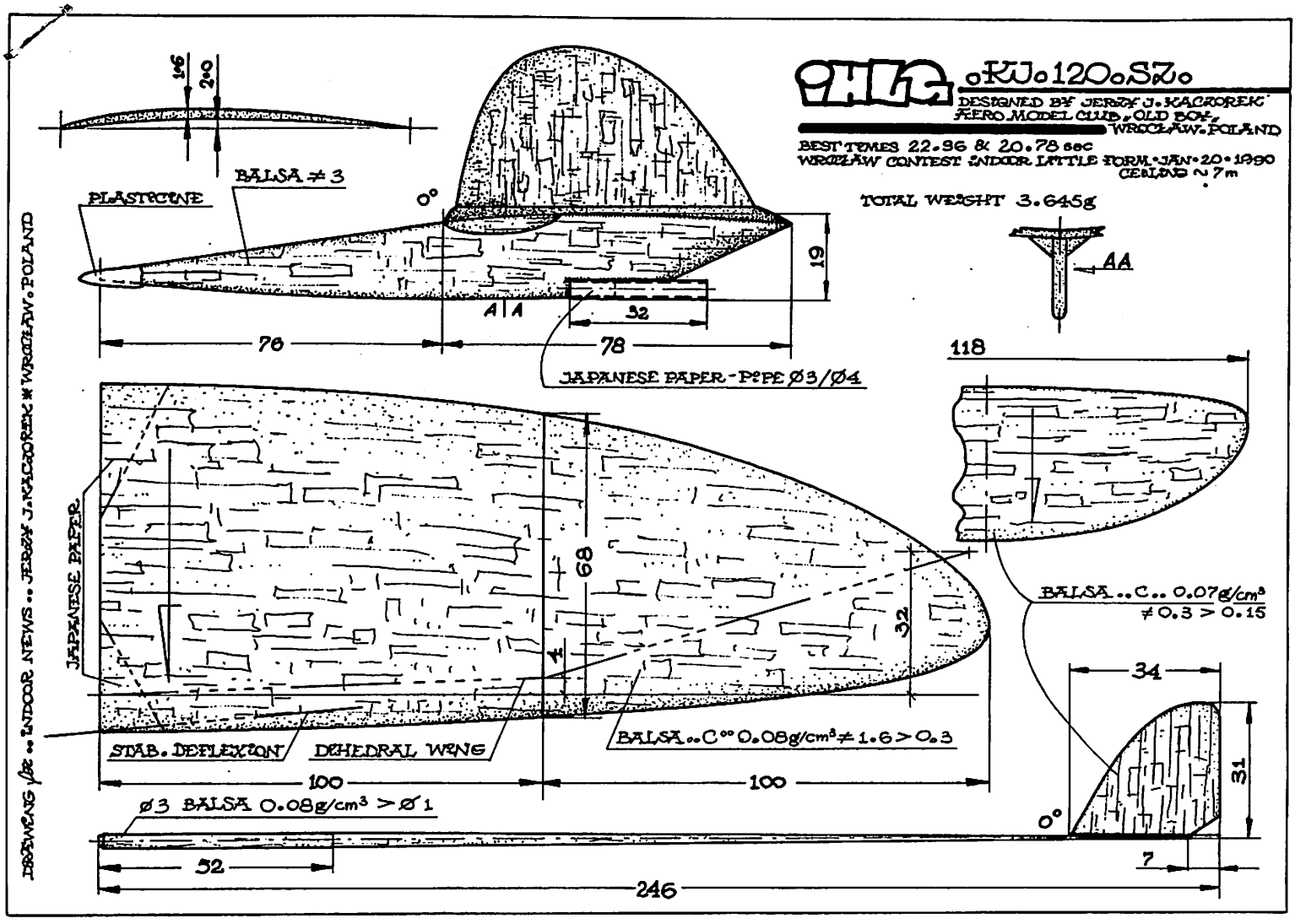



# Indoor News 2-89

Dear Friend,

Yes, that's right ... this is another issue of IN ...

It is mainly the work of Thedo André, NL, who has made an impressive item on the subject of stability of indoor models, including a computer programme for your convenience ... if you have a computer.

The F1D World Championships were as most people know now run at Johnson City, USA, at the beginning of June .... but I havent seen any results yet. It will be interesting to hear about the FAI TAN rubber if any used that stuff at the W/Ch ..?

As far as I know there have been very good batches and bad ones as well ....

BAD rubber bags .... Boyd Feldstead, AUS, tells that polyester oven bags are the solution to your rubber storing problems as they have no bad fumes which might harm your precious energy bundles.

Editor etc .....

Jorgen Korsgaard,
Ahornweg 5,
D-2397 Ellund-Handewitt,
West Germany

Phone: 04608-6899

3 issues a year (approx) will appear around March, July and November.

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STATIC STABILITY MARGIN OF F1D MODELS.

by Thedo André.

Bill Henderson's question about Neutral Point calculation in the last Indoor News coincides with the little discussion at the moment in Free Flight News about stability calculation. Free Flight News published my computer program based on Wantzenriether's method from Vol Libre 26. So I think it is appropriate to present the version for indoor models of this program to Indoor News. I will not discuss stability calculations in detail. A good basic explanation can be found in ref. 1. The other papers listed under the references may give more clarification (or add to the confusion!).

I will first give a translation of the original Wantzenriether article, then I will present the computer program with a compilation of results for a number of actual models and I will conclude with a description of the influence these calculations have had on the design of my own models. Further you will find a reprint of the American CMOS and INP stability calculation methods from Indoor News and Views October 1976.

The Wantzenriether article was published in 1982 as part of a series of articles about trimming Wakefield models. I tried to translate it as accurately as possible, so you can judge his assumptions on your own. The graphs presented are for Wakefield models only. The last part of his article discusses a number of different Wakefield designs. I omitted this, as it is of little interest to us.

NEUTRAL POINT.

by Jean Wantzenriether.

With a good formula for the Neutral Point (NP) one can determine the Centre of Gravity (CG) while being at home, and have a good chance to end up very close to the best glide position - both for performance and stability at the same time. There are two problems to solve: to find a formula which is more accurate than the one used by Beuermann, and to determine which static margin of stability (SSM) is suitable for Wakefield models. I herewith present you a formula - which you may modify as you want - and a study of a number of Wakefields based on this formula. This study allows you to make a first choice of SSM... it is up to you to find the most safe SSM in practice.

The neutral point, as you will remember, is the longitudinal aerodynamic centre of the model as a whole - like the 25% is the aerodynamic centre of a sole wing section: a small change in angle of attack does not change the aerodynamic moment of the model around this point. A model with the CG at this point does not have any stability and will glide as a dead leaf... One creates stability, called static, by placing the CG before the NP, at a distance which is named "Static Stability Margin", SSM (expressed as % of the wing mean chord, $C_w$). When the SSM is well-chosen, one obtains at the same time the dynamic stability, that is the ability to glide under all circumstances at the lift coëfficient ($C_L$) you want - for us this is $C_L$ of minimum sink.

Several modelling authors have studied the NP to our benefit: Beuermann, Crane, Bogart, Cole. The last two are more for low aspect ratio's, which is too simplified. Here we give the formula as used by Crane, Siebenmann, and before them Schäffler:

$$NP = 0.25 + \left[\frac{dC_{Lt}/d\alpha}{dC_{Lw}/d\alpha} \cdot \frac{S_t}{S_w} \cdot \frac{L_t}{C_w} \cdot \left(1 - \frac{d\epsilon}{d\alpha}\right) \cdot \frac{q_t}{q_w}\right] - \frac{h}{10 \cdot C_w}$$

Result as a fraction of wing mean chord $C_w$.

$\frac{dC_{Lt}/d\alpha}{dC_{Lw}/d\alpha}$ : ratio of tail lift gradient and wing lift gradient. The lift gradient of the tail section has to be corrected for the exact aspect ratio of the tail. Ditto for the wing. See next formula given. Schäffler suggests a gradient of 5 to 5.5 for the tail and 5.8 to 6 for the wing. I have used 5 and 5.5 for the tail, 5.8 for the wing, and moreover a value of 7 has been used for a tail with a cambered plate section of 6%. These figures are not expressed as $C_L$ per degree, but as $C_L$ per radian.

Why a constant value for the wing, when our wing sections are so diverse? On the one hand there are too few $C_L$ polars to be more accurate. On the other hand the design differences of our sections have very little influence on $dC_L/d\alpha$ because of the low Reynolds numbers. The same applies to the tail sections, but for the cambered plate, and for this alone, which has a very steep gradient. I took a gradient of 7 for the cambered plate, though the Göttingen 417a has a theoretical gradient of 8.7.... Its "practical" gradient is not known.... One can interpolate for other values of camber.

To calculate $dC_{Lt}/d\alpha$ from the $dC_L/d\alpha_\infty$ of the tail section and from the tail aspect ratio $AR_t$ :

$$dC_{Lt}/d\alpha = \frac{1}{\frac{0.35}{AR_t} + \frac{1}{dC_L/d\alpha_\infty}}$$

Same formula for the wing, of course.

$\frac{S_t}{S_w}$ : ratio of wing and tail area's. Several investigations led me to adopt for the wing the complete projected wing area, including fuselage width. For the tail the area is reduced by shortening the span 40 mm for a normal tail mount on a rolled fuselage, 20 mm for a classic mount on a glasfiber tail boom, and a non-reduced span for a tail mounted on wires above the fuselage. This way I tried to take into account the reduced lift of the centre of the tail: mounting plate, elastic bands, etc..

$\frac{L_t}{C_w}$ : ratio of the length between the ¼ points of wing and tail mean chords, and the wing mean chord.

$1 - \frac{d\epsilon}{d\alpha}$ : down-wash factor. The down-wash $\epsilon$ varies as a function of the distance from CG to tail centre of pressure, wing liftcoëfficient and wing aspect ratio.

For the graphs presented further on a mean $C_{Lw}$ of 1.15 has been used, and a tail moment arm of 750 mm (tail moment acc. to the french definition: distance between wing and tail). All this is worked out for aspect ratio's common to wakefield models. The down-wash factor varies around a value of 0.86, more precisely:

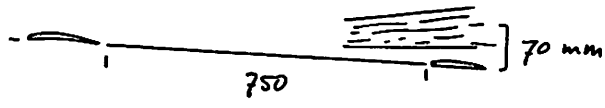
| $AR_w$ : | 10 | 12 | 14 | 16 | 18 |
|---|---|---|---|---|---|
| $1 - \frac{d\epsilon}{d\alpha}$ : | 0.825 | 0.855 | 0.875 | 0.890 | 0.905 |

This is the formula by which $d\epsilon/d\alpha$ can be calculated:

$$\frac{d\epsilon}{d\alpha} = \frac{0.73}{AR} \cdot \left[1 + \sqrt{1 + \left(\frac{B}{2 \cdot l}\right)^2}\right]$$

AR = aspect ratio; B = wing span (m); l = distance from CG to 50% of tail chord (m).

$\frac{q_t}{q_w}$ : ratio of wing and tail dynamic pressures. Dynamic pressure is $\frac{1}{2}\rho \cdot v^2$. When the tail flies exactly in the turbulent wing wake (not to confuse with down-wash), the air at this place will have a reduced velocity, which makes $q_t/q_w$ smaller than 1. For our "average" wake with 750 mm tail moment arm, $qt/q_w$ is 0.93, but only when the tail is 70 mm below the tangent to the bottom of the wing section. At this place the wake has a thickness of only 80 mm, and its influence rapidly diminishes towards its borders.




On the other hand the turbulence of the wake may improve the efficiency of the tail. So we may neglect $q_t/q_w$ in the NP calculation.

$\frac{h}{10 \cdot C_w}$ : influence of the vertical position of the wing above the CG. For our standard models this corresponds to a maximum of 0.5% variation of the NP, so we neglected this.

So this is the explanation of the general formula for NP. A graph has been made, which takes together several factors in the same way Beuermann has done:

$$F \text{ (correction factor)} = \frac{dC_{Lt}/d\alpha}{dC_{Lw}/d\alpha} \cdot \left(1 - \frac{d\epsilon}{d\alpha}\right)$$

This graph is subdivided for three tail sections: classic structure with gradients of 5 and 5.5 - cambered plate with a gradient of 7. For each section the graph is based on commonly used aspect ratio's. To find F you choose the type of section and the aspect ratio of the tail, and you follow this line to the vertical line corresponding to the wing aspect ratio. Example for a classic tail with aspect ratio 5.6 and wing aspect ratio 12: F = 0.65.

Using F you can calculate NP:

$$NP = 0.25 + F \cdot \frac{S_t}{S_w} \cdot \frac{L_t}{C_w}$$

Result as a fraction of $C_w$.

Do we now have the real position of NP? Probably not..... there are too many inaccuracies which multiply each other. But one has a valuable estimation of NP, and you can try other factors F and other variations of wing and tail area. All in all it is a more workable method than the simplified Beuermann method.

STABILITY MARGIN.

Having determined the NP position for a wakefield design, one has to place the CG at a correct distance in front of the NP - otherwise said one has to know the true SSM for a wakefield model. There is no such knowledge in the history of the international wakefield class.... it will be an exciting task to work upon this.

As an approach to this problem statistics have been taken from 50 modern wakefields. The average SSM is 0.47 $C_w$. But at the beginning of this article we have well seen that this margin is very important in order to obtain a good glide. However the extreme values are 0.18 and 0.74..... one wonders how to explain this! An analysis of these models will help. But first three remarks.

1. 0.47, that is quite a bit more than the mean values given by Beuermann. This is because of a different calculation method, and because Beuermann did not specialise on our wakefields with their long fuselages.

2. In practice the SSM is not a precise prescription, but a point around which you have to vary the CG depending on the flight results. For gliders Schäffler remarks: the most effective CG may differ up to 10% (0.10 $C_w$) before or aft of the calculated value. Note that a glider has a lot less drag and inertia than a rubber model, and these two factors increase the range in which to examine the CG. Siebenmann mentions by comparison indoor models, where the drag is even larger relatively (low Re), and where the CG can be varied even more without sacrificing dynamic stability. This is a remark which is generally applicable when using the NP formula. But when one specialises on one particular type of model, the process of optimising the SSM allows you to get within 3 or 4% accuracy.

3. Our calculations hardly are sufficiently reliable to compare models which are too different, like f.i. an Ostrogoth and an Aguin. But when one has been able to accurately determine the most favorable SSM for a model from one's own line, the same SSM can make it much easier to design and trim a new model of a similar conception, for example one with the same airfoil sections and different lifting surfaces. The calculation of NP and the knowledge of the most favourable SSM should allow us to make real progress in the design of new models.... there exists a clear tendency in glider design, that can be realised for wakefield models too (and Coupe d'Hiver's of course.... that is why I gave you the formulae).

..... Here Wantzenriether continues to discuss a number of known Wakefield designs, which is of little interest to our purpose.

BASIC PROGRAM TO CALCULATE SSM FOR INDOOR MODELS.

My program, written in Basic, uses the same SSM formula as Wantzenriether. I too neglect the $q_t/q_w$ factor and the influence of the vertical distance between wing and CG. This last factor is larger than the 0.5% Wantzenriether suggests, but its value is nearly equal for all designs. I have incorporated an estimation of $dC_L/d\alpha$ values for cambered plate indoor sections, see figure 1. The slope of the line is chosen to get easy to use numbers and is not based on any measurement or theory. This graph also shows the line Wantzenriether uses for outdoor sections. The program outputs a table of SSM for each combination of wing and tail camber. See example output.

Another facility of the program is the automatic calculation of wing and tail mean chords and their position relative to the root chord. Figure 2 defines the input parameters. For models with rounded wing or tail shapes you have to substitute this part by a tapered panel with the same area and an appropriate sweep-back. The calculated mean chords are mean geometric chords. In fact I should have used the mean aerodynamic chord, which differs from the geometric chord in cases of non-elliptical span loadings, see ref. 8. It makes little difference.

As a bonus the program also calculates the SSM according to the INP method (lines 420-440). See reprint elsewhere in this issue. The polish DS method is an exact copy of this method (ref. 9). I used the standard value of K (K=1.5), and did not bother to incorporate the formula presented on the INP graph.

Table 1 lists the SSM values for a number of modern microfilm models. Note the wide variation, from -0.06(!) to +0.37. And how much difference there can be between models of apparently equal design (Hunt/Pymm, Siebenmann/Butty). It is also clear that the INP graph gives inaccurate results for models of unusual design. The K-factor has to be calculated.

Do not treat the calculated SSM value as gospel, but use the program to discover the relative effects of different parameters. Tail aspect ratio f.i. is a very powerful way to influence the SSM. When you design your model around a SSM value of 10 - 25% you can be pretty sure of a good flying model. Only practice may lead you to the optimum CG position. But that would be the subject of another article! Not an article by me, as I found it very difficult to perform accurate flight tests. Who?

## SOME REMARKS ON THE MODELS FROM TABLE 1.

The figures from table 1 facilitate a better comparison of different designs. I will give some comment on the designs to give you something to think about.

The figures show that Richmonds Film Flam is only uncommon for its size and low wing camber. It has average proportions and a safe SSM. Cezar Banks' design raises a big question, negative SSM!. His later design has a larger tail (see ref. 10), but still has about zero SSM. Those who were present at the World Championships in Johnson City will surely remember his dramatic closing flights, which heavily stalled down. Of course his large diameter and highly pitched VP prop was the main cause for the stalling, but his low SSM did not help him. Richmonds decision to chose smaller than usual propellers and generous SSM brought him the WC title. Remember his winning flight in hurricane Charlie, Cardington 1986!

TABLE 1

STATIC STABILITY MARGIN OF F1D MODELS
Wantzenriether Method

| Flyer | Model | Source | Wing area sqdm | Tail area sqdm | % | AR wing | AR tail | Wing mean chord mm | $L_t/c_w$ | Wing camber % | Tail camber % | CG % | NP % | SSM % | SSM INP % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Richmond | Film Flam 86 | IN3/86 | 14.70 | 6.50 | 44 | 2.85 | 4.16 | 226.9 | 2.96 | *3 | *3 | 70 | 94 | 23 | 22 |
| Banks | Ordinaire 84 | KPB | 14.63 | 4.86 | 33 | 2.87 | 3.40 | 225.9 | 2.84 | 5 | 2.5 | 73 | 67 | -6 | 4 |
| Randolph | Top Cat | KPB | 14.67 | 5.47 | 37 | 2.85 | 3.82 | 226.7 | 2.97 | 4.5 | 3.5 | 72 | 79 | 7 | 12 |
| Hunt | Big Square | KPB | 12.52 | 8.06 | 64 | 3.11 | 5.21 | 200.7 | 3.51 | 4.5 | 4.5 | 133 | 158 | 25 | -3 |
| Pymm | #20 | KPB | 13.18 | 7.10 | 54 | 3.19 | 4.40 | 203.2 | 3.54 | *4.5 | 4.5 | 125 | 134 | 9 | -6 |
| Siebenmann | Archeopterix | FF7610 | 10.84 | 5.45 | 50 | 3.88 | 3.88 | 167.1 | 3.94 | 5 | 6 | 105 | 147 | 37 | 14 |
| | Bacillus | NF3/81 | 11.80 | 4.43 | 38 | 3.68 | 4.14 | 179.1 | 3.78 | 5 | 7 | 105 | 116 | 10 | -6 |
| | EC 87 | IN3/87 | 12.44 | 5.79 | 47 | 3.26 | 5.91 | 195.3 | 3.60 | 5 | 7 | *115 | 140 | 24 | -6 |
| Butty | Miracle 86 | IN3/86 | 11.65 | 4.99 | 43 | 3.60 | 7.70 | 179.9 | 3.86 | 5 | 7 | 116 | 153 | 35 | -7 |
| Ree | R65/11 | KPB | 12.18 | 4.75 | 39 | 3.44 | 3.04 | 188.1 | 2.70 | 6 | 3 | 62 | 72 | 10 | 18 |
| | Indooree 87 | IN2/87 | 13.20 | 5.50 | 42 | 3.19 | 3.36 | 203.5 | 2.87 | 5 | *3 | 77 | 82 | 4 | 10 |
| Orsovai | Hymenoptera | KPB | 13.33 | 5.40 | 41 | 3.12 | 3.75 | 206.8 | 2.55 | 5 | 3 | 71 | 74 | 3 | 8 |
| | Opole 87 | IN3/87 | 13.06 | 4.72 | 36 | 3.05 | 3.39 | 206.8 | 3.26 | 5 | 3 | 82 | 81 | -1 | 6 |
| Rodenburg | Ardea IV | IN1/87 | 12.45 | 4.94 | 40 | 3.49 | 3.57 | 188.8 | 3.38 | 6 | 4.25 | 85 | 95 | 8 | 9 |
| Kujawa | SK 87 | IN2/87 | 12.66 | 5.21 | 41 | 3.07 | 3.71 | 202.9 | 2.99 | *3 | *4 | 68 | 93 | 25 | 22 |
| Nore | Cardindoor | KPB | 11.77 | 6.09 | 52 | 3.50 | 2.76 | 183.3 | 2.77 | 4.5 | 3 | 72 | 90 | 17 | 23 |
| Nimptsch | Cat I | TS3/89 | 12.66 | 4.68 | 37 | 3.25 | 3.95 | 197.3 | 3.38 | 4.5 | 4 | 82 | 93 | 11 | 10 |
| André | A | | 11.45 | 5.30 | 46 | 3.65 | 3.66 | 177.0 | 3.61 | 5 | 5 | 92 | 120 | 25 | 15 |
| | E2 | IN1/89 | 14.61 | 6.20 | 42 | 2.87 | 3.12 | 225.8 | 3.27 | 5 | 4 | 86 | 89 | 2 | 10 |

Legend: AR = Aspect Ratio
$L_t$ = Tail length (¼ chord to ¼ chord)
$C_w$ = Wing mean chord
CG = Centre of Gravity
NP = Neutral Point
SSM = Static Stability Margin
INP = Stability margin acc. to Instant Neutral Point Method (for K=1.5)

IN = Indoor News
KPB = Korsgaard 1986 Plan Book
FF = Free Flight News
NF = NFFS Digest
TS = Thermiksense

Note: Values indicated with * were not given on the plan and are my own assumptions.

With their tandem designs Hunt and Pymm tried to get as much lift as possible from the tailplane (ref. 11). The limited wing span rule forced them to look at such a mean. Of course the model has to be trimmed such that the wing still flies at optimum incidence. This incidence is determined by a good combination of CG position and wing-tail decalage. Hunt's model has a larger SSM and thus a lower tailplane loading than Pymm, while both models have equal tail camber. Reducing his tail camber to 2% results in a SSM of 10%, still sufficient, while the tail still has the same loading, but at lower drag. Hunt and Pymm used the rubber motor to bring the CG aft and consequently had to use very small props. In ref. 12 Hunt shows that a reduction of prop diameter results in remarkably low efficiency loss.

Siebenmann was the first who examined tail plane design for indoor models. His article in Free Flight News 76/10 was an eye opener for many. He warned for models with a too large tailplane combined with a too forward CG. His Archaeopterix was designed for a highly loaded tail and optimum CG position. Flights with a test glider led him to an optimum SSM of 0.27 for best stability and glide performance. But in his computations he used the wing root chord instead of the mean chord. That is why the Archaeopterix has such a large SSM. He nevertheless achieved high performance at the 1978 World Championships. His Bacillus has much less SSM and also performed very well. The Swiss nearly beat the USA in West Baden. The latest Siebenmann and Butty designs again show different SSM values. Though the exact CG of Siebenmann's design is not known, his model has a comparable mass distribution to Butty's model. Personally I see little benefit from the highly cambered tail sections they use. It is very difficult to bring the CG further aft, certainly when one uses a suspended stab mounting. So you always arrive at a sufficiently large SSM to allow less tail camber.

The 1986 Ree and Orsovai designs had moderate to low SSM values, but on their 1987 models they further reduced the SSM while lengthening the tail moment arm. Apparently they were inspired by my design. May be they can tell something about the effects they noticed. Their results in 1987 and afterwards certainly do not show a performance drop!

Otto Rodenburgs Ardea IV is in my view the best "floater" there is. Till now at championships he has not had the luck to get his model often enough near to the roof, but his performances at Schiphol hangar (25 m ceiling) are outstanding. Note that the other models which have a SSM of 10 - 20% all are models with a good cruise performance.

## SSM AND THE DESIGN OF MY OWN MODELS.

The SSM calculation has been instrumental in the design of my own models. I built my first indoor model in 1974, a Super Penny Plane by Rol Anderson. Till 1982 I built Penny Planes, but I flew very little as my main interest was outdoor free flight. I always had stability problems, as I continued to try to fly with as big propellers as Dennis Jaecks used. I tried all tail shapes and tail sections you can think of. I even placed the tail 100 mm below the tail boom, attempting to control the power burst.

In 1982 Wantzenriether published his theories in Vol Libre and I tried them on my Wakefield. I cut the tail down to 3 $dm^2$ and achieved a much steeper and higher climb. On hindsight this improvement may have been partly caused by the faster and steeper launches which I began to dare then. But I got definitely interested in SSM. At that time I moved into an apartment of my own and took up serious preparations to build microfilm models. I knew I could build them, as I had already built a couple of "wobbly-floppy F1D-like creations" in 1976. My first designs were based on Siebenmann and Rodenburgs designs. See model A in the table. At first they performed well, but when my flight times reached 25 minutes also the power stalling problems appeared.

Otto and I had noticed that the tail always had a tendency to wash-out its tips considerably. This increased the incidence difference and rapidly led to a stall. I tried to reduce the washing-out by using a tail section with a far forward point of maximum camber (30%) and a straight rear part. The tail planform got a straight leading edge. These measures placed the pressure point more forward of the flexural axis and reduced the pitching coëfficient. My later designs still had this tailplane design (see Korsgaard Plan Book). The stalling problems diminished, but not sufficiently to be able to handle the large launch torques needed for high ceilings.

At that time, by the end of 1984, I had an eye on a team place for the next world championships. So I had to solve this problem. At the same time Indoor News and Views and Indoor News published the designs of the Nagoya winning American models. Their very wide wing chords took my breath and I realised I was dragging way, way behind. On a quiet autumn evening I took my calculator and tried to figure out, using Wantzenriethers SSM method, what a wide chord Bacillus-like model would look alike. I ended up with a compromise model with a SSM value between the values of Banks and Bacillus, and a fuselage length of nearly 1 meter! Note that the tail moment arm compared to wing chord has a mediocre value and is not extremely long. The wing chord was limited by the width of my model box. An estimation of the mass distribution indicated a CG of 85%. I estimated the weights based on my current models and figured a total model weight of 1.15 gram. With 20% more wing area this still gave me a 10% lower wing loading compared to most other people (except for the Americans), and I had something to strive for to get the weight further down. It then took me more then six months to get accustomed to the idea of me building such a model! I succeeded however, as the first model came out at 1.14 gram.

I saw a low SSM as a good mean to control the power burst (small incidence difference), but I also gave the model a drooped tail boom (5°). It had a 5% camber tail section, to allow as much load on the tail as possible. I had to wait till January 1986 to make the first flight under very turbulent conditions. The model immediately tail slid and did not recover. I had forgotten that a drooped tail boom aggravates a tail slide! So the droop angle was reduced as much as possible. The next flights were made in a low ceiling gym hall and showed a very shallow and relatively fast flight. The microfilm covering entered the tail leading edge very flatly, indicating a very low incidence angle. I then changed to a 3% tail section. On its first full flight at Schiphol in March the model did 29'28, without any power stalling, and got me on the team.

I will not tell you how hard I had to work in the following months to build and test and repair five new models. I wrecked 7 wings in all kinds of accidents, collisions, opening hangar doors, etc.. But all models showed the same flying behaviour and were able to handle a very high launch torque and hold a very steep climb angle. I had to test on 1/3 motors to stay clear from the ceiling.

After the championships I again tried a 5% tail section and a more aft CG. Though this model brought me a Cat. I world record, on later flights I was not fully satisfied with its flying behaviour and changed to 4% tail camber. I subsequently flew a model alternatingly with the wing at 85 or 80% CG position, also in Johnson City at the Indoor International, and got the feeling that this certainly brought no reduced performance. So my latest version is designed around a SSM of 10%. It has a high aspect ratio suspended tail and a tail camber of 3%. Best flight so far is 34'19 at Schiphol, already 18 months ago. We have had little or no opportunity to fly since 1988.

SOME CLOSING QUESTIONS.

I already said that the vertical position of the wing has an influence which can not really be neglected. The wing exerts a nose-up moment, moves the NP forward and reduces the SSM. The thrust of the propeller has the same effect, as long as the thrust line passes below the CG. In fact all indoor models effectively have upthrust, even those that use some down-thrust relative to the fuselage. The wing is mostly set at 1° relative to the fuselage, but the wing flies at about 5° incidence. A high wing position and propeller thrust tend to increase the wing incidence. This means that the optimum glide trim is not equal to the powered trim! Another effect is that the wing centre of pressure moves forward and further increases the incidence. How then can a climb be stable? Only when the thrust decreases, but then the model will tend to fly at a smaller incidence in the cruise. While you all have observed that a model will tend to pitch up in the last phase of the descent. Somewhere my reasoning is incorrect. So who can clarify the effects of power on trim and stability?

The phenomenon of the tail tips washing-out is well known. It can be noticed on almost every photo of a launched model. In ref. 13 Hewitt Phillips gives as an explanation that the tail tips wash-out due to a decreased loading, but that is in contradiction to the power effects just described.

Mass effects are not incorporated in SSM theories. Heavier models with larger mass inertia need a larger SSM. Another mass effect is the pendulum effect of a high placed wing. I could not find more information on these effects. Who can tell something about this?


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I do not have the original articles by Beuermann and Schäffler. This latest was published in Mechanikus 1966. Can anyone send me a copy?

Can anyone translate the other SSM methods given in ref. 9?


Thedo André,
Venusstraat 49,
7557WP Hengelo (O),
Holland.

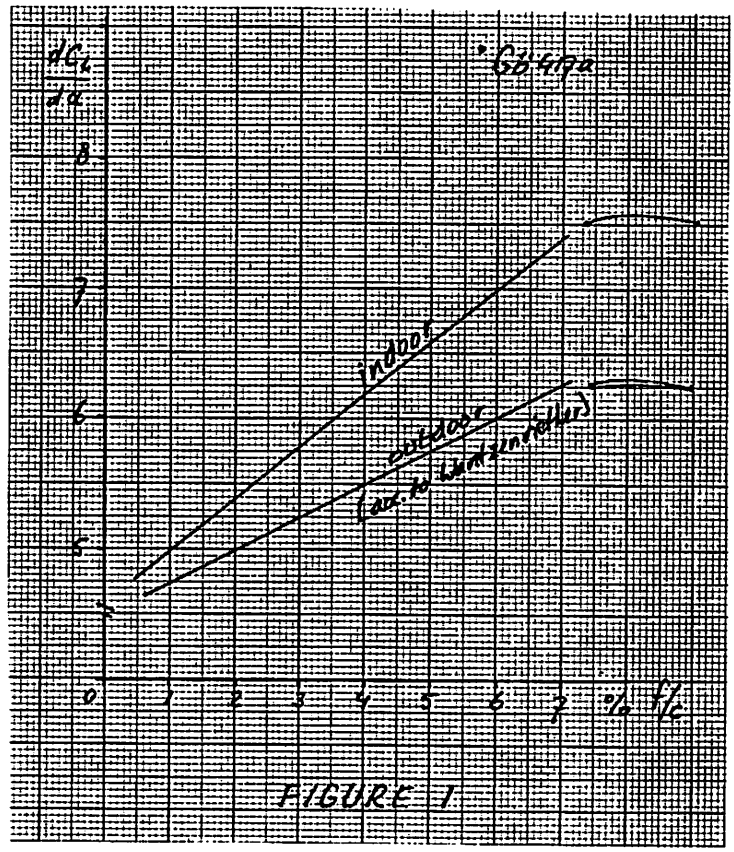




FIGURE 1

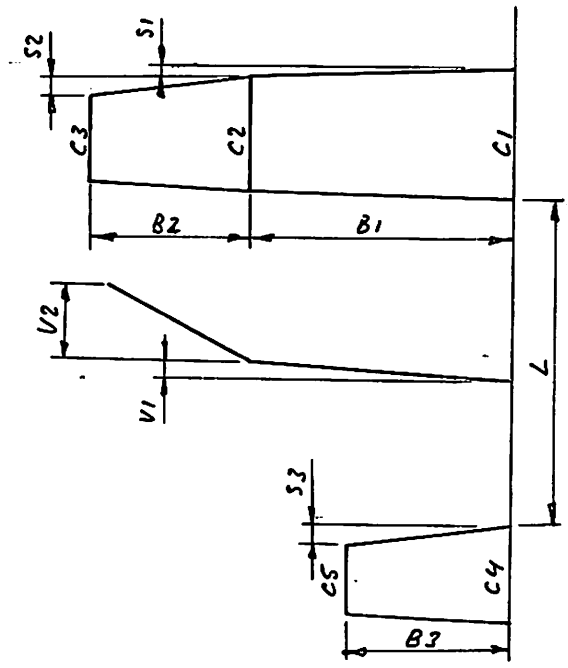



FIGURE 2

```
10 REM *** STATIC STABILITY MARGIN FOR INDOOR MODELS ***
20 REM *** Extended Wantzenriether Method, Vol Libre 26 ***
30 REM *** by Thedo Andre ***
40 INPUT "Model name";A$
50 INPUT "Root chord";C1
60 INPUT "D/H break chord";C2
70 INPUT "Tip chord";C3
80 INPUT "Inner panel span";B1
90 INPUT "Tip panel span";B2
100 INPUT "LE sweep at D/H break";S1
110 INPUT "LE sweep at tip behind LE at D/H break";S2
120 INPUT "Inner panel dihedral";V1
130 INPUT "Tip dihedral (vertical height above D/H break)";V2
140 INPUT "Tail root chord";C4
150 INPUT "Tail tip chord";C5
160 INPUT "Tail semispan";B3
170 INPUT "Tail tip LE sweep";S3
180 INPUT "Length wing TE to tail LE";L
190 INPUT "CG (fraction of root chord)";Z
200 AS=5.2
210 CLS
220 KEY OFF
230 PRINT "Model: ";A$
240 PRINT "C1:";C1;"C2:";C2;"C3:";C3;"B1:";B1;"B2:";B2;"S1:";S1;"S2:";S2;"V1:";V
1;"V2:";V2
250 PRINT "C4:";C4;"C5:";C5;"B3:";B3;"S3:";S3;"L:";L;"Z:";Z
260 B1=(B1^2-V1^2)^.5
270 B2=(B2^2-V2^2)^.5
280 OV=(C1+C2)*B1+(C2+C3)*B2
290 OS=(C4+C5)*B3
300 O=100*OS/OV
310 B=(B1+B2)*2
320 ARV=(B^2)/OV
330 ARS=((B3*2)^2)/OS
340 CV=OV/B
350 CS=OS/(B3*2)
360 M1=(2*S1*C2+C2^2+S1*C1+C1*C2+C1^2)/(3*(C1+C2))
370 M2=(2*S2*C3+C3^2+S2*C2+C2*C3+C2^2)/(3*(C2+C3))+S1
380 LV=(M1*(C1+C2)*B1+M2*(C2+C3)*B2)/OV-CV/2
390 M3=(2*S3*C5+C5^2+S3*C4+C4*C5+C4^2)/(3*(C4+C5))-CS/2
400 L1=C1-LV-CV/4+L+M3+CS/4
410 L2=(1-Z)*C1+L+M3+CS/2
420 T=L1/CV
430 Z1=(Z*C1-LV)/CV
440 I=.25+T/(1+1.5*OV/OS)-Z1
450 PRINT "Wing area=";USING "##.##";OV/10000;
460 PRINT " sq dm";
470 PRINT TAB(40) "Tail area=";USING "##.##";OS/10000;
480 PRINT " sq dm  (";USING "##";O;
490 PRINT "%)";
500 PRINT "Wing aspect ratio=";USING "##.##";ARV;
510 PRINT TAB(40) "Tail aspect ratio=";USING "##.##";ARS
520 PRINT "Wing mean chord=";USING "###.##";CV;
530 PRINT " mm";
540 PRINT TAB(40) "Tail mean chord=";USING "###.##";CS;
550 PRINT " mm"
560 PRINT "Tail moment arm/Wing mean chord=";USING "#.##";T;
570 PRINT TAB(40) "SSM INP (K=1.5)=";USING "#.##";I
580 PRINT "Centre of gravity (rel. to mean chord)=";USING "#.##";Z1
590 PRINT "*** SSM ***                                    Wing camber (%)"
600 PRINT "Tail        ";
610 FOR I=2 TO 7 STEP .5
620 PRINT "    ";USING "#.#";I;
630 NEXT I
640 PRINT "camber  (%)
---------"
650 FOR I=2 TO 7 STEP .5
660 AV=5.2
670 AS=AS+.2
680 PRINT USING "#.#";I;
690 PRINT "          ";
700 FOR J=2 TO 7 STEP .5
```

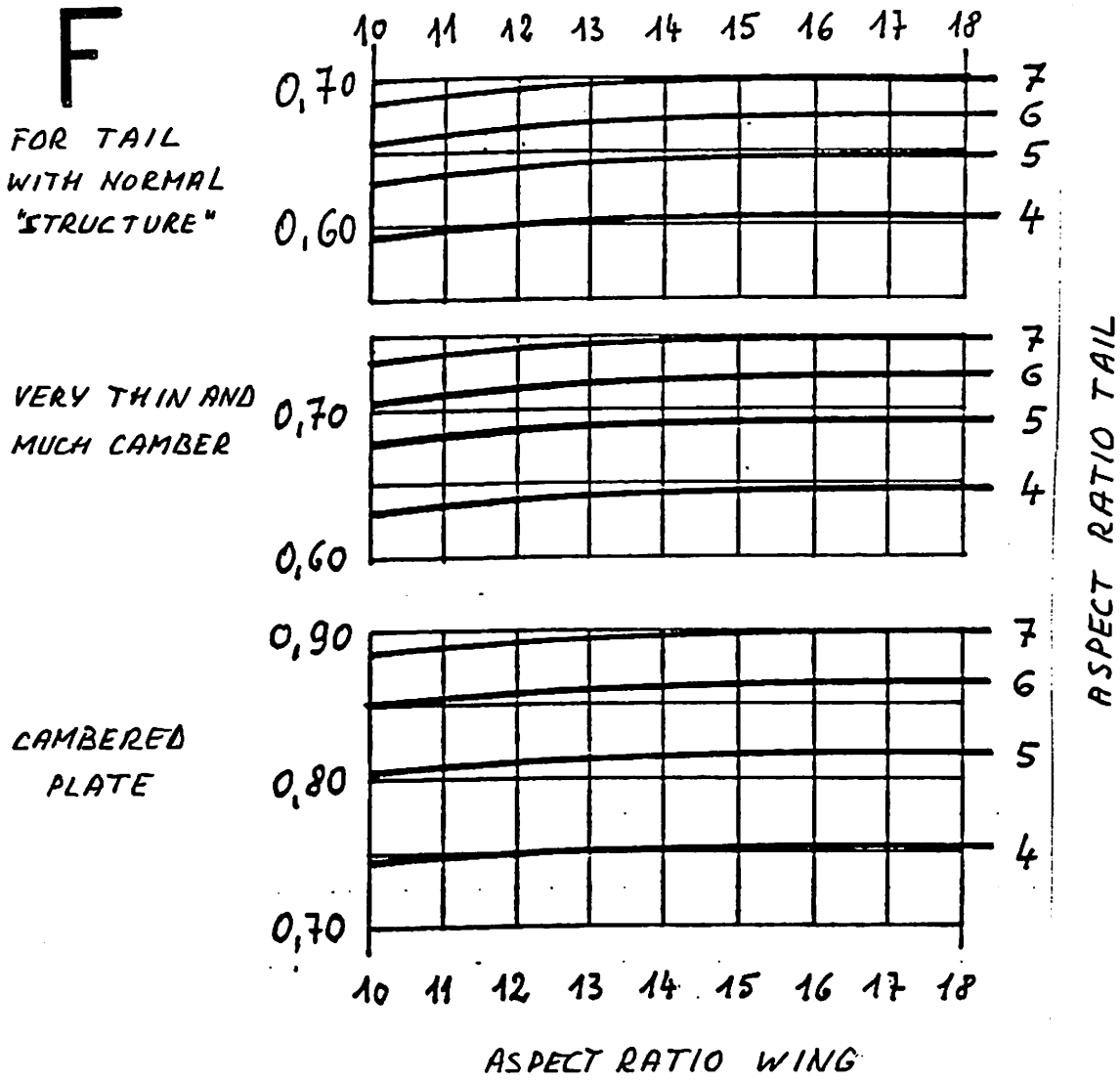
710 - 790
ON THE NEXT PAGE

```
Model: F1D 1986 Jorgen Korsgaard
C1: 220 C2: 220 C3: 185 B1: 220 B2: 110 S1: 0 S2: 25 V1: 15 V2: 45
C4: 140 C5: 100 B3: 220 S3: 25 L: 360 Z: .75
Wing area=13.72 sq dm      Tail area= 5.28 sq dm  (38%)
Wing aspect ratio= 2.96    Tail aspect ratio= 3.67
Wing mean chord=214.51 mm  Tail mean chord=120.00 mm
Tail moment arm/Wing mean chord=2.63   SSM INP (K=1.5)=0.04
Centre of gravity (rel. to mean chord)=0.75
```

| *** SSM *** | Wing camber (%) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Tail camber (%) | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 | 5.5 | 6.0 | 6.5 | 7.0 |
| 2.0 | 0.00 | -.01 | -.02 | -.03 | -.04 | -.04 | -.05 | -.06 | -.07 | -.07 | -.08 |
| 2.5 | 0.02 | 0.00 | -.01 | -.02 | -.02 | -.03 | -.04 | -.05 | -.06 | -.06 | -.07 |
| 3.0 | 0.03 | 0.02 | 0.01 | -.00 | -.01 | -.02 | -.03 | -.04 | -.05 | -.05 | -.06 |
| 3.5 | 0.04 | 0.03 | 0.02 | 0.01 | -.00 | -.01 | -.02 | -.03 | -.04 | -.04 | -.05 |
| 4.0 | 0.05 | 0.04 | 0.03 | 0.02 | 0.01 | -.00 | -.01 | -.02 | -.03 | -.03 | -.04 |
| 4.5 | 0.06 | 0.05 | 0.04 | 0.03 | 0.02 | 0.01 | -.00 | -.01 | -.02 | -.02 | -.03 |
| 5.0 | 0.07 | 0.06 | 0.05 | 0.04 | 0.03 | 0.02 | 0.01 | 0.00 | -.01 | -.02 | -.02 |
| 5.5 | 0.08 | 0.07 | 0.06 | 0.05 | 0.04 | 0.03 | 0.02 | 0.01 | 0.00 | -.01 | -.01 |
| 6.0 | 0.09 | 0.08 | 0.07 | 0.06 | 0.05 | 0.04 | 0.03 | 0.02 | 0.01 | 0.00 | -.00 |
| 6.5 | 0.10 | 0.09 | 0.08 | 0.07 | 0.06 | 0.05 | 0.04 | 0.03 | 0.02 | 0.01 | 0.00 |
| 7.0 | 0.11 | 0.10 | 0.09 | 0.08 | 0.06 | 0.05 | 0.05 | 0.04 | 0.03 | 0.02 | 0.01 |

Ok

```
710 AV=AV+.2
720 N=.25+((.35/ARV+1/AV)/(.35/ARS+1/AS))*(1-(.73/ARV*(1+(1+(B/(2*L2))^2)^.5)))*
OS/OV*L1/CV
730 S=N-Z1
740 PRINT USING "#.##";S;
750 PRINT "  ";
760 NEXT J
770 PRINT;
780 NEXT I
790 END
```




## INSTANT NEUTRAL POINT

The Jan. '73 INAV had a review and recap of the CMOS balance method. In the past two or three years, Hal Crane has been developing another system to locate the neutral point - or to put it another way, compute the static margin. It was pointed out in the CMOS article that the basic chart was developed for A-2 towline, and thus does not exactly fit indoor models. However, it does have a provision for different aspect ratio of wing and stab, thus allowing comparison of reasonably diverse designs. Hal's method can be adapted to various designs by using a different chart for each subgroup, but the chart shown on page 5 is "peaked" for low aspect ratio designs such as are now common in one gram FAI. PennyPlanes follow this same basic trend, and should also work well on this chart.

The CMOS method requires considerable computation and construction of a graph which is then applicable to all models built to that exact design. Hal's method calls for less computation, but requires several guesses. At this time, several years of experience with CMOS has pinpointed the best range of balance points, but this advantage can be rapidly overcome if people using Instant Neutral Point will give feedback on the results. Hal's own "best guess" is to use at least 10% static margin; that is, the C.G. should be at least 10% of the average wing chord ahead of the neutral point.

A couple of examples will illustrate the method of using INP. First, let's compute the static margin of a hypothetical model which has been completed and flown, to see how it <u>should</u> have been trimmed. This model will have the following design: constant chord wing and stab with 7" x 25" wing and 4" x 18" stab. Fuselage and tail boom dimensions, plus wing location, will be as shown in Fig. 1. The basic procedure is as follows:

1. Compute average chord of wing ($C_{w,\ ave}$) and stab ($C_{t,\ ave}$). Note that the example model has constant chord wing and stab, which is a special case. See the CMOS discussion (Jan. '73 INAV) for computing average chord of tapered wings

2. Measure (on existing model) or compute (on model under construction) $l_t$ (tail length, or tail moment arm).

3. Divide $l_t$ by $C_{w,ave}$.

4. Divide stab area ($S_t$) by wing area ($S_w$).

5. Refer to the INP chart (p. 5) and extend the line corresponding to the proper $S_t/S_w$.

6. Move vertically from the computed value $l_t/C_{w,ave}$ on the X-axis of the chart to the extended line, then across to the neurtal point (NP) on the Y-axis.

7. Compare the NP location with the CG location.

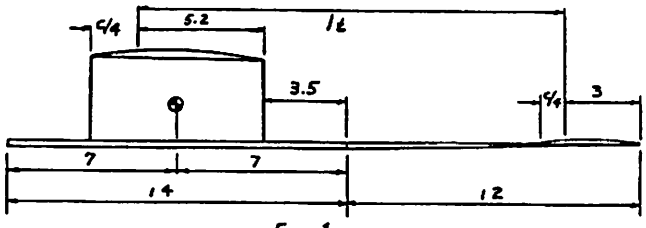



Fig 1

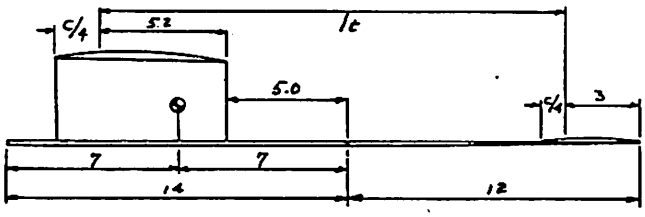



Fig. 2

Working with the specified dimensions of our "tested" model, the following figures come out:

1. $C_{w,ave} = 7$, $C_{t,ave} = 4$.

2. $l_t = 17.7"$. (From Fig. 1, note that $l_t$ is defined (as in CMOS method) as the distance from $C/4_{wing}$ to $C/4_{tail}$. That is from 25% of the average chord on the wing to 25% of the stab average chord. Thus, from Fig. 1 $l_t = 9 + 3.5 + 5.2 = 17.7$.

3. $l_t/C_{w,ave} = 17.7/7 = 2.53$

4. $S_t/S_w = 72/175 = .41$. Refer to p. 5 and note that the line corresponding to .41 has been extended (step 5). Note that this line is the same for all models built to this same design.

6. Following the light line, NP is shown to be 79.5% $C_w$. In other words NP is 20.5% or 1.43" ahead of the rear wing post.

7. Since the CG is 7 - 3.5 or 3.5" ahead of the rear wing post, the static margin is 3.5 - 1.43 = 2.07. Then, 2.07/7 x 100% = 29.4% margin. Since Hal recommends about 10% margin, the hypothetical model is trimmed too far forward; as a result both the flight efficiency and the rafter banging qualities will be impaired.

Fig. 2 and the following discussion will illustrate the trial-and-error method for proper wing location. From the example above, we can assume that the wing will have to be moved forward. Therefore, assume a wing location 5" ahead of the rear hook, or 1.5" ahead of the original location. Then the new $l_t = 17.7 + 1.5 = 19.2"$, and $l_t/C_{w,ave} = 19.2/7 = 2.74$. From the graph, NP = 82.4%, and NP is 17.6% of 7 or 1.23" ahead of the rear post. The CG is now only 2" ahead of the rear post (trial location) and the margin would be 2 - 1.23 = .77. .77/7 x 100% = 11% margin, well within proper limits.

Why another method to compute static margin? What is it with this guy, anyhow? Simply this: it is the personal belief of many top fliers that computation of static margin is one of the major shortcuts to high-level performance. Most certainly it is possible to trim models at other margins and get respectable performance. However, once anyone tries balancing models with some method of static margin rather than by some arbitrary CG location, they usually continue regardless of the bother of computation. It is a measure of my own conviction that this is vital that I take time to compute CMOS on all models presented. In the future, INP will also be given for all models with low aspect ratio wings.

## DESIGN FOOTNOTES

### Constant Margin of Stability

Since CMOS was introduced in the Jan. '69 INAV, most stick model 3-views in INAV have been accompanied by CMOS balance charts. Various questions about the method led to the development of an info packet on CMOS which was available upon request. This presentation is further explanation on how to use CMOS to design better models.

CMOS stands for constant margin of stability. The margin of stability of an airplane is a measure of how the model's stability differs from neutral stability. (A model with neutral stability has no tendency to recover from upset or un-natural attitudes.) With positive stability, the model tends to recover from upset, while with negative stability the upset will tend to get worse. By choosing an optimum margin of stability, it is possible to have a new model almost perfectly trimmed before it leaves the workbench. Certainly, it should never be necessary to move wing sockets or add ballast as sometimes happens with new models that must be flown that certain day!

In other words, models of similar design which have the same stability margin will fly almost the same, and after anyone "zeros in" on their favorite margin, they can build other designs with a minimum of adjustment problems to cope with.

The NIMAS CMOS Chart was designed by Hank Cole and was originally published in the Dec. '47 Air Trails. It was designed for A-2 gliders instead of indoor models, so it gives relative stability figures which are smaller than the absolute stability of the indoor model. Even though this difference may amount to perhaps 20% margin, the CMOS method allows direct comparison and can be used as if the results were correct.

Many people tend to shy away from CMOS because of the computations involved. However, if the balance diagram is furnished (as with INAV 3-views), it is simple to balance the model using CMOS. Assemble the model with prop and rubber motor on the complete fuselage/tail group and find the balance point as usual. Measure from the balance point to the thrust bearing - let's assume the distance is 8". If Fig. 1 is the balance chart for the model and we wish to use 0% margin, follow the dotted line up from 8" to the 0% line and across to the Y axis at 8.55". Thus, the rear post should be located 8.55" from the thrust bearing. If the stab tilt and wing washin/washout is OK, only incidence and thrust line should need to be set for a good flying model!

Calculation of CMOS balance diagrams is simpler than most people realize. Fig. 2 is the top of the CMOS computation form, listing wing and tail specifications. Beginning with span and area, the average chord (span/area) and aspect ratio (span/av. chord) are computed. Fig. 3 is the CMOS Chart (extrapolated to wing aspect ratio = 3). With a wing aspect ratio = 6.25:1 and stab aspect ratio = 4.3:1 both lines have to be interpolated; the intersection on the Chart is at .46 ($C_f$).

Tail moment arm is usually defined as the distance between 25% of average chord on the wing to the same point on the stab. As a beginning example, let's assume a wing and stab that are rectangular; the root chord will equal the average chord. Thus for the model with dimensions as defined in Fig. 2, 25% of wing and stab chords are 1" and .7" respectively. Since the wing and stab do not taper in any fashion, 0" is noted as the dimension between average chord and trailing or leading edges. With a tail boom 12" long, subtract 2.1" from 12" to reach the rear hook, then add the distance "Z" and 3" to define the tail moment arm.

The CMOS method is a graphical solution which eliminates several computations by defining a straight line. To do this, the aerodynamic center is calculated for two wing locations; in this example the wing will be 1" from the rear hook (Z = 1") and 6" from the rear hook. The formula for A.C. is shown solved for these two wing locations and values for X (distance from balance point to nose) and Y (distance from rear post to balance point) are plotted on Fig. 1, working from values in the box on Fig. 2.

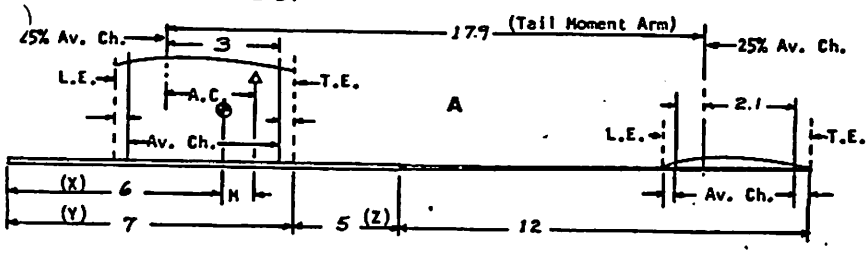
The computations discussed above were also made with the stipulation of 0% margin - the aerodynamic center and center of gravity are coincident. This simplifies the computation considerably. Note that Fig. 1 has three balance lines - +5%, 0% and -5%. Only the 0% line was calculated in Fig. 2, and the other two lines were established

by moving the 0% line .05 x 4 (4" avg. chord) in each direction. Three dotted lines on Fig. 1 show the effect on wing location that different choices of stability margin will have: rear wing post locations are 8.8", 8.55" and 8.3" from the nose as the margin changes from +5% to -5%.

The final factor to consider in CMOS computation is average chord. If the model in question had used a wing with parabolic planform, 25" span and 5.1" root chord, the area would still be 100 sq. in. and average chord would be 4" - same as before. The only change in computation would be that the wing is 1.1" wider at the root, half in front and half in back. The 0" dimension at the T.E. would then become .55", tail moment arm figures would change to 14.45 and 19.45. The slope of the graph and location of the 0% line will not change.

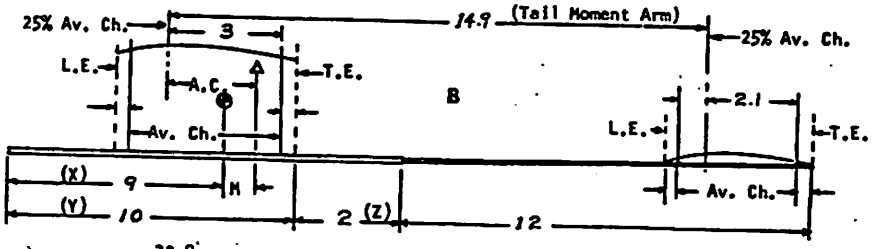
The location of the end-points of the average chord is obvious on wings symmetrical with respect to the lateral centerline. A shortcut for locating mean chord of wings with odd shapes is shown in Fig. 4. With a span of 25.4", root chord of 6" and area of 127 sq.in., average chord is 5". A scale drawing of the wing planform was used, and the T.E. dimension checked to be .25".

To figure stability margin on an existing model, compute the A.C. as before, then measure where the CG is with respect to the CG. Compute the margin according to the formula shown in Fig. 2. Fig. 5 illustrates this process on two models built to the design illustrated in Fig. 2, except that both models were built with fixed 70% CG. Model A balanced 6" from the nose and model B balanced 9" from the nose. The margin computation shows dramatically how much variation is possible between models of the same design which vary in balance point - the wing posts of model A might have to be moved as much as 1/2" to make it fly as well as model B!




A.C. = $\frac{32.8}{100}$ x 17.9 x .46 = 2.7 3 - 2.7 = .3; △ ← T.E.
1 - .3 = .7; CG ← A.C.

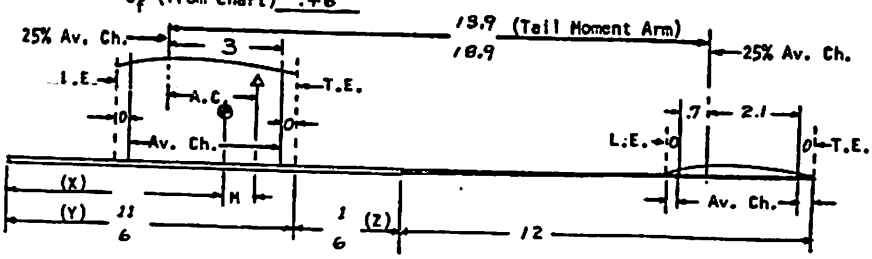
Stability Margin = $\frac{.7}{4}$ x 100 = 17.5%




A.C. = $\frac{32.8}{100}$ x 14.9 x .46 = 2.25 3 - 2.25 = .75; △ ← T.E.
1 - .75 = .25; CG ← A.C.

Stability Margin = $\frac{.25}{4}$ x 100 = 6.25%

MODEL SPECS: Wing Span 25 Wing Area 100 Av. Chord 4 Aspect Ratio 6.25:1
Stab span 12 Stab area 32.8 Av. chord 2.8 Aspect ratio 4.3:1
$C_f$ (from chart) .46




Tail Moment Arm = 12 - 2.1 + Z + 3

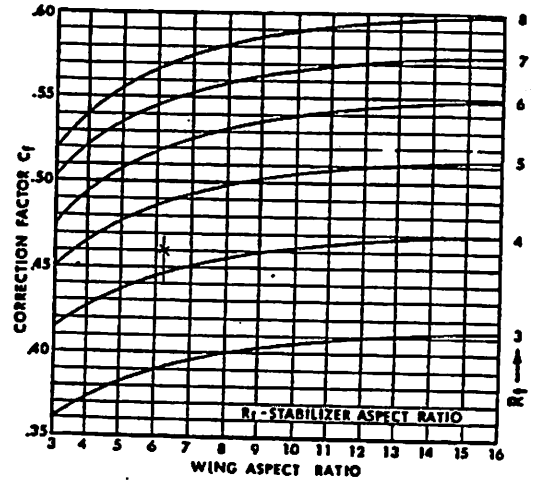
A. C. = $\frac{\text{Stab Area}}{\text{Wing Area}}$ x Tail Moment Arm x $C_f$ Stability Margin = $\frac{M}{\text{Av. Chord}}$ x 100%

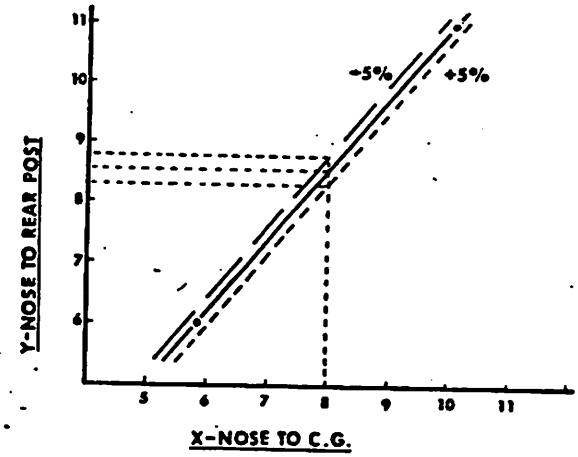
= $\frac{32.8}{100}$ x 13.9 x .46 = 2.1 (Z = 1) 3 - 2.1 = .9; A.C. ← T.E.
11 - .9 = X = 10.1
Z = 1, Y = 11, X = 10.1

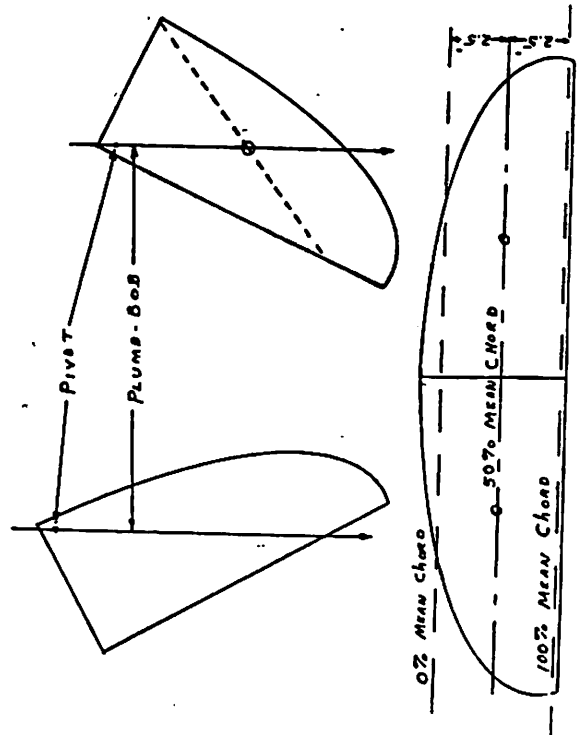
= $\frac{32.8}{100}$ x 18.9 x .46 = 2.85 (Z = 6) 3 - 2.85 = .15; A.C. ← T.E.
6 - .15 = X = 5.85
Z = 6, Y = 6, X = 5.85

Besides the benefits of more efficient flying and ready-made flight trim, models balanced near 0% margin by this system and adjusted with washin/washout wing trim ar usually excellent rafter-banging models. Also, and this is not yet proven, CMOS balanced models seem less affecte by light drift than models with high positive margin such as model A of Fig. 5.

Three final points regarding CMOS: First, $C_f$ remains unchanged so long as wing and stab dimensions and tail boom length remain unchanged. Changes in motor stick length can be handled by making a corresponding change in both X and Y dimensions. It is easiest to use projected wing area and build the wing to fit max span limits on FAI and PennyPlane models.

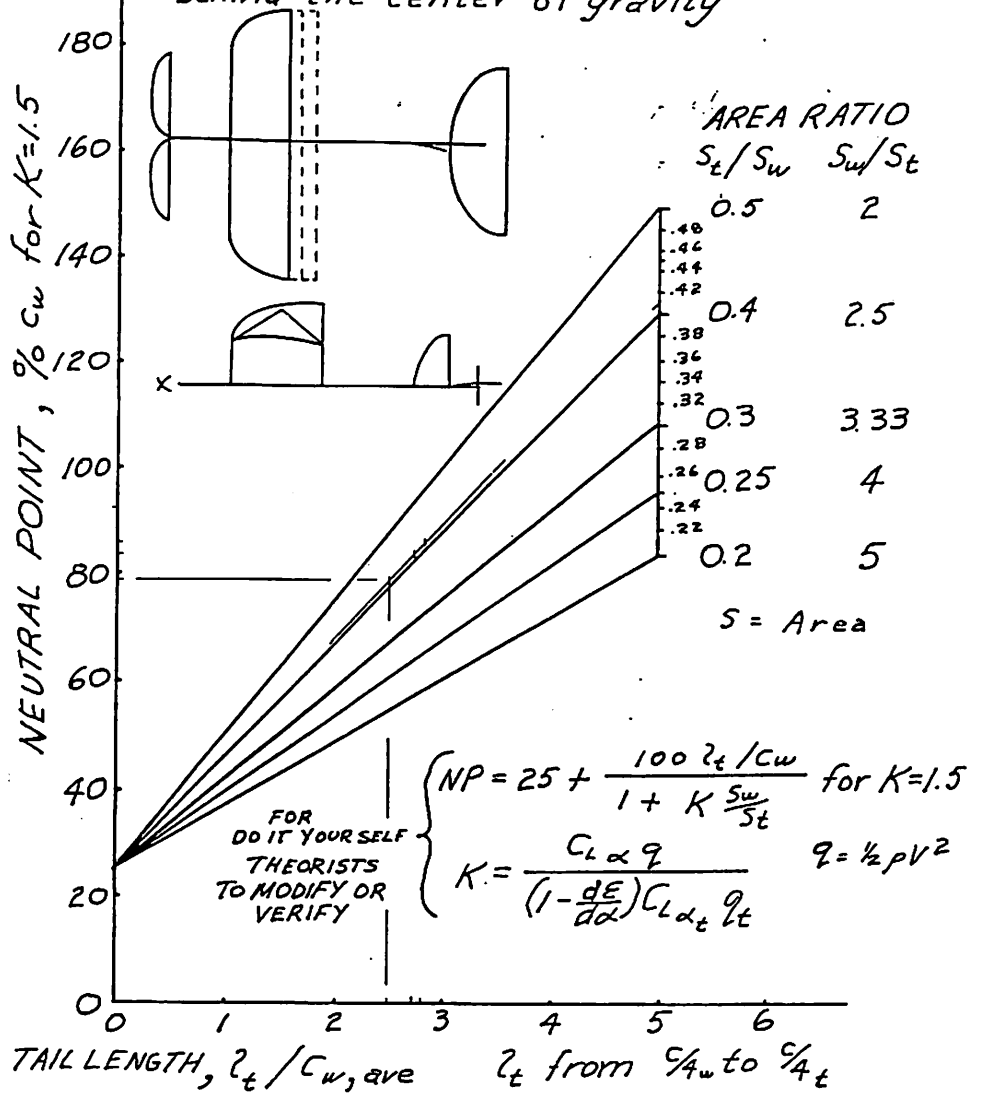


# INSTANT NEUTRAL POINT for INDOOR MODELS

Locate wing so that neutral point is 7/10 % $C_{w_{AVE}}$ behind the center of gravity




CIMAS

COLUMBIA INDOOR MINIATURE AIRCRAFT SOCIETY

Columbia Indoor Model Aircraft Society has now been organized as a formal club. CIMAS is offering membership to all those interested in being a part of this organization.

CIMAS periodically flys in the Low Library Rotunda located at Columbia University in New York City.

As a member of CIMAS you will receive notification of future club flying sessions. Members pay a $5.00 flying session fee. Non club members may also fly with the club for $10.00 per session.

For insurance purposes CIMAS requires it's members to belong to the Academy of Model Aeronautics (AMA).

TO JOIN CIMAS you should:

1) Make a $10.00 annual dues check payable to "FRED DIPPEL"

2) Provide us with your
   a. NAME
   b. ADDRESS
   c. PHONE #
   d. MODEL INTEREST
   e. AMA #
   f. IF YOU ARE AN AMA CONTEST DIREC

Please mail the above to: Fred Dippel
CIMAS Treasurer
2 David Court
Glen Cove NY 11542

Membership will be in effect on the February 18 Rotunda session. Future confirmed dates are March 4 and May 20.

New York Indoor Times will not be published in the foreseeable future. An independent newsletter will be available covering indoor modeling activity at Columbia and the east coast area. Contact Stan Fink 1810 Pine street Philadelphia PA 19103. $10.00 for a years subscription (five or six issues).

## Wigan Tech. 16th. Dec. '89.

This was the first NORWIND meeting to be divided in two, Fun-Flying and Contests, attendance was reasonable just before Christmas. Entries were low, just five in 'No-Cal' Scale flown for the first time. These simple Models proved difficult to fly, J.O'D's ultrafilm covered Fike 'E' was particularly so. Bill Murray with a 13 inch span FRED came out on top. P-15 Mod. with four entries produced some high times, the first flights over 5 minutes under a low ceiling. Prizes were all wrapped in seasonal paper making selection a lucky-dip.

| 'No-Cal' Profile Scale | (best two) | | | P-15 Modified | (best two) | | |
|---|---|---|---|---|---|---|---|
| Bill Murray | 1.08 | 1.11 | 2.19 | J. O'Donnell | 5.15 | 5.05 | 10.20 |
| D.Wolstenholme | 1.03 | 1.03 | 2.06 | Bill Murray | 4.15 | 4.48 | 9.03 |
| John O'Donnell | 0.46 | 0.46 | 1.32 | | | | |
| 1) Mike Colling | 0.28 | 0.37 | 1.05 | Mike Colling | 1.06 | 1.03 | 2.09 |
| 2) Mike Colling | 0.20 | 0.25 | 0.45 | Reg Boor | 0.00 | | 0.00 |

## South East Indoor meeting, 28th. January '90.

The annual Crawley event is too far for a day trip , however, this year a number of things came together , a removal job , the hospitality of a fellow modeller and a lack of employment ; making the journey possible.

Little over an hour after leaving Clayton Green, two NORWIND pensioners joined the M 6 in a snow storm, this turned to rain south of Warrington leaving the rest of the journey uneventful.

Crawley Leisure Centre is an excellent flying site, square with a floor area simular to Walsall the ceiling is around 30ft. and flat , the only obstructions are guide rails for dividing curtains , drift was minimal.

Four classes were flown in quite rigid time periods, Hand Launch Glider followed by 1.2 gm. E.Z.B., Open Scale and lastly Peanut Scale.

The H.L.G. entry of 21 was split into two circles, with four flights in each. Peter Frostick and the winner were well out in front, scores were very tight behind these two, should have had 'another' slice of toast.

Flying conditions for E.Z.B. were very good, just a few collisions and some drifting into the side , most of the trouble was low down due to people moving , Laurie Barr was an easy winner, the next three pushing each other for the minor places.

Scale judging produced several tied scores,strange,as this was used to decide final positions. Scale flying coincided with editorial lunch, so no comments on this aspect, sorry.

Gripes..with an attendance of well over a hundred, including spectators and children , floor discipline was hard to maintain , the Free-For-All between events was hetic, guarding models proved to be a full time job, the time slot allowed for your'favourite' class was always too short.

Last but definitely not least, many thanks to Trevor and Janet Grey who made us very welcome , they even said we could go again, must have been shell shock. To be serious, thanks again from John and myself (D.Y.).

## Results.

**Hand Launch Glider. 21 entries 19 scores.**
**Best 3 from 8 (two groups of four).**

| | | | | | |
|---|---|---|---|---|---|
| A.Jupp. | Elmbridge. | 25.9 | 26.8 | 27.3 | 80.0 |
| P.Frostick. | - | 23.7 | 28.1 | 26.1 | 77.9 |
| B.Beales. | Croydon. | 23.6 | 23.5 | 25.5 | 72.6 |
| D.Yates. | Wigan. | 25.2 | 23.8 | 23.0 | 72.0 |

**1.2 gm. E.Z.B. 22entries 18 scores.**
**Best two from any number.**

| | | | | |
|---|---|---|---|---|
| L.Barr. | Vikings. | 11.39 | 10.50 | 22.29 |
| J.O'Donnell. | C.M. | 9.41 | 11.17 | 20.58 |
| C.Hutchinson. | Chelmsford. | 10.35 | 9.57 | 20.32 |
| D.Yates. | Wigan. | 9.46 | 10.23 | 20.09 |

**Open Scale (S.M.A.E.) Co2, Electric.**
**16 entries, 15 static, 11 flew.**

| | | | Points Static | Points Flying | Total |
|---|---|---|---|---|---|
| N. Peppiett. | S.A.M. 35. | Sopwith Tabloid. | 3 | 3 | 6 |
| C. Strachan. | Impington. | Bristol Prier. | 5 | 1 | 6 |
| R. Preney 77 | Impington. | Fokker D8 . | 7 | 1 | 8 |
| A. Druce. | - | Puss Moth. | 2 | 9 | 11 |

**Peanut Scale.**
**21 entries 16 flew.**

| | | | Points Static | Time Sec. | Points Flying | Total |
|---|---|---|---|---|---|---|
| C. Hutchinson. | Chelmsford. | Farman Post Card. | 3 | 107 | 4 | 7 |
| C. Strachan. | Impington. | Bebe BD 4 . | 4 | 98 | 5 | 9 |
| P. Masterman. | Freebird. | Whitman Tailwind. | 12 | 120 | 2 | 14 |
| J. O'Donnell. | C.M. | Fike 'E' . | 15 | 155 | 1 | 16 |

## World News, 1)

Just like Butter , or should that be Low Fat Margarine these day's, our fame is spreading, the January issue of Jørgen Korsgaard's Indoor News has reprinted Reg Boor's article 'Pitch into this', ref. the effects of changing the pitch of small Plastic Propellers,more from Reg next time.

## World News, 2)

A recent meeting of the F.A.I. has given tacit approval for the A.M.A. to run the 1990 F 1 D. World Indoor Championships,these will take place at the Mini Dome (116ft) Johnson City, Tenneessee, 3rd. thru 6th. June, followed by the U.S. Indoor Championships. NORWIND will be there.

## Commercial, 1)

John O'Donnell tells me he still has several weights of Mylar available the lightest of these is between standard Condenser Paper and Harlan's Ultrafilm, very suitable for small Indoor models, P-15 Mod,and the like you can contact John at any NORWIND meeting or ring on 061 427 3711.

## Commercial 2)

Those of you who have been to any recent Indoor meetings will have seen Mike Collings Indoor Goodies Shop, Mike has lots of difficult to obtain items from Lew Gitlow and others, his stock was reduced at the Clayton-Green meeting where lots of Christmas money was spent, Mike has now re-ordered from the States 'NEW' stock should be in soon, place your order now to avoid disappointment.Mike sells at a discount to NORWIND members and ploughs all the profits back into our Assocation. This issue of the NORWIND NEWS has been sponsored by Mike's efforts. Thanks Mike (D.Y.).

## On Model Windmills and Autogiros 1

### 1. Random Successes and Failures.

In 1959 I designed and built a small autogiro powered with a Cox .010 engine. It actually flew quite well, which was pretty good for a seventeen year old farm kid from Iowa whose only information sources were model magazines purchased with pennies saved from milking cows! As I recall, the rotor blades were attached to the hub via some thin (0.032 in. Dia.???) music wire; the rotor blades would thrash about, but it did fly. Later I built an "improved" design with more rigid rotors; it would not fly at all! Thus began my love hate relationship with autogiros.

In 1986, twenty-seven years later, I was living in Rhode Island, and built a small rubber powered autogiro (windmill airplane???) to fly with the indoor crowd at MIT. It was easily trimmed and managed to do 1 min 56 sec before it was lost in the rafters. Power was a 7.7 in. loop of pirelli weighing 0.59 gms. with 900 turns. I think it had a rotor diameter of about 13 inches and probably weighed under 2 grams.

Following this success, I of course felt that I now knew all there was to know about rubber powered autogiros! For my next autogiro project I selected a peanut scale Cierva C-4; boy was I gonna show those guys down at Johnson City, TN next summer! With careful building the model weighed a mere 3.50 grams and had respectable scale detailing. Unfortunately this little beauty showed not the slightest inkling towards stable flight: Stall, dive, barrel-roll, etc. and crash! Several different rotor systems were tested, all to no avail. So to hell with autogiros.

In 1988, while living in Duluth, MN (yeh, it's cold and I do move around a lot!) I built another "sport" autogiro that weighed 2.79 gms. (see attached plan). This model flies quite well and will even ROG. The best time is 2 min 24 sec powered with 1400 turns on a 15 in. loop of pirelli weighing 1.5 gms. The angle of the rotor disk (relative to the direction of flight) is quite sensitive, but stability is very insensitive to changes in CG and stab incidence. The model can be trimmed to fly with the landing gear, then the gear can be removed and, without any trim adjustments, it will still fly quite nicely, despite the large rearward CG shift.

For my next autogiro project I decided to try a no-cal scale of Kellet KD1B. Again disaster; total lack of stability and consistancy.

### 2. Back to the Books.

Having experienced both random successes and failures, I concluded that I really didn't understand much about the aerodynamics, flight characteristics, and stability of autogiros. So I decided to stop building and read some books and articles on the subject. These references are given at the end of this article.

## 3. Some Significant Conclusions.

The following important points came out of additional experimentation and these readings:

1. For consistant stability, the blades of model autogiros must flap (rise and fall) as they rotate. The maximum and minimum should be limited by stops to about +15 degrees and -5 degrees. The ideal maximum angle depends on torque and determines the roll stability. However, this maximum angle should be no more than required for stability because as it is increased, the projected area of the rotor disk is decreased and this increases the disk loading. Also, increasing the maximum angle increases drag.

2. If the maximum angle is too shallow, there will be too much lift on the left side (viewed from the rear, rotor turning clockwise, and model turning in left handed circles) and the rotor disk will be angled towards the outside of the turn. In other words, the model will appear to be trying to roll out of the turn.

3. With flapping rotor blades, very little (if any) rotor tilt and offset is required. The center of rotation should probably be located over the center of gravity.

4. Townson's book (1) contains an informative chapter entitled "The Theory and a Discussion of the Autogiro". From this reading it became apparent that the rotors on my models rotated in a direction opposite to that found on full scale autogiros. The blades on my models rotated at a negative angle of attack; this is called "windmilling". The blades of full scale autogiros operate at a slightly positive angle of attack; this is call "autorotation".



Windmilling



Autorotation

5. The blades should probably function in an autorotation mode (positive angle of attack) and not in a windmilling mode (negative angle of attack).

6. It is necessary to use a reflex airfoil in order to achieve autorotation at a positive angle of attack.

7. Autorotation, or the lack of autorotation, is very sensitive to the angle of attack of the rotor blades.

8. Blades operating in autorotation mode revolve at a slower rate than do blades in the windmill mode. Thus, for a given model weight, autorotation produces more lift at a given RPM than will windmilling.



9. The blades should have a high aspect ratio. For full scale autogiros, low speed characteristics are determined by the disk loading. High speed characteristics are determined by the blade loading (ref 3). For model autogiros, we are only interested in low speed characteristics, therefore the disk loading should be minimized. For a given model weight , disk loading is reduced by increasing the disk diameter and using rotor blades with high aspect ratios. One of my rotors is 20 in. in diameter having sheet blades that are 0.65 in. wide by 9 in. long. Blade stiffness is important and can be increased by using boron fibers.

10. Young's excellent article(1) and some of my experiments seem to indicate that the autorotation force is increased by having a large nose radius on the rotor airfoil.

## 4. A New Rotor Head Design.

The attached drawing entitled "Blade and Rotor Head Detail" show a design that incorporates the above principles. This design is simple, easy to build, light weight, and well suited for small autogiros.

The blades are glued to the kevlar thread at the hub. This allows the blades to rise and fall as they rotate. The maximum upward and downward angles are limited by stops to about +15 degrees and -5 degrees. Steeper blade angles increase stability but cause more drag and less lift, therefore the blade angles should minimized. Roll stability determines the minimum allowable blade angles.

## 5. Current Results.

To date two models (see enclosed photographs) have been successfully flown. My primary interests in the current tests have been stability characteristics and not maximum times (1 min 06 sec in 35 ft clg). These tests have verified the points listed in above section 4.

The next phase is to build a light model (1 gm with 20 in. diameter rotor). There are still many questions to be answered concerning blade airfoils and rotor disk orientation.

Lester W. Garber PhD
2324 E. 5th Street
Duluth, MN 55812 Ph 218-728-6841

1) Young, Bill, "All About Autogiros", Model Builder, April 1987.
2) Townson, George, "Autogiro The Story of the Windmill Plane", 1985 Aero Publishers, Inc. 329 West Aviation Road, Fallbrook CA 92028.
3) Brooks, Peter W., "Cierva Autogiros The Development of Rotary Wing Flight", 1988, Smithsoniam Institution Press, Washington, DC.

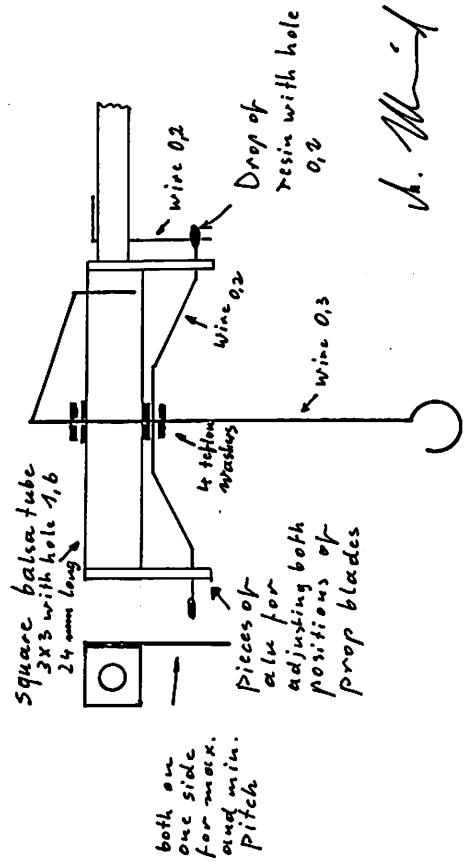
Joergen Korsgaard
Ellundt Handewitt

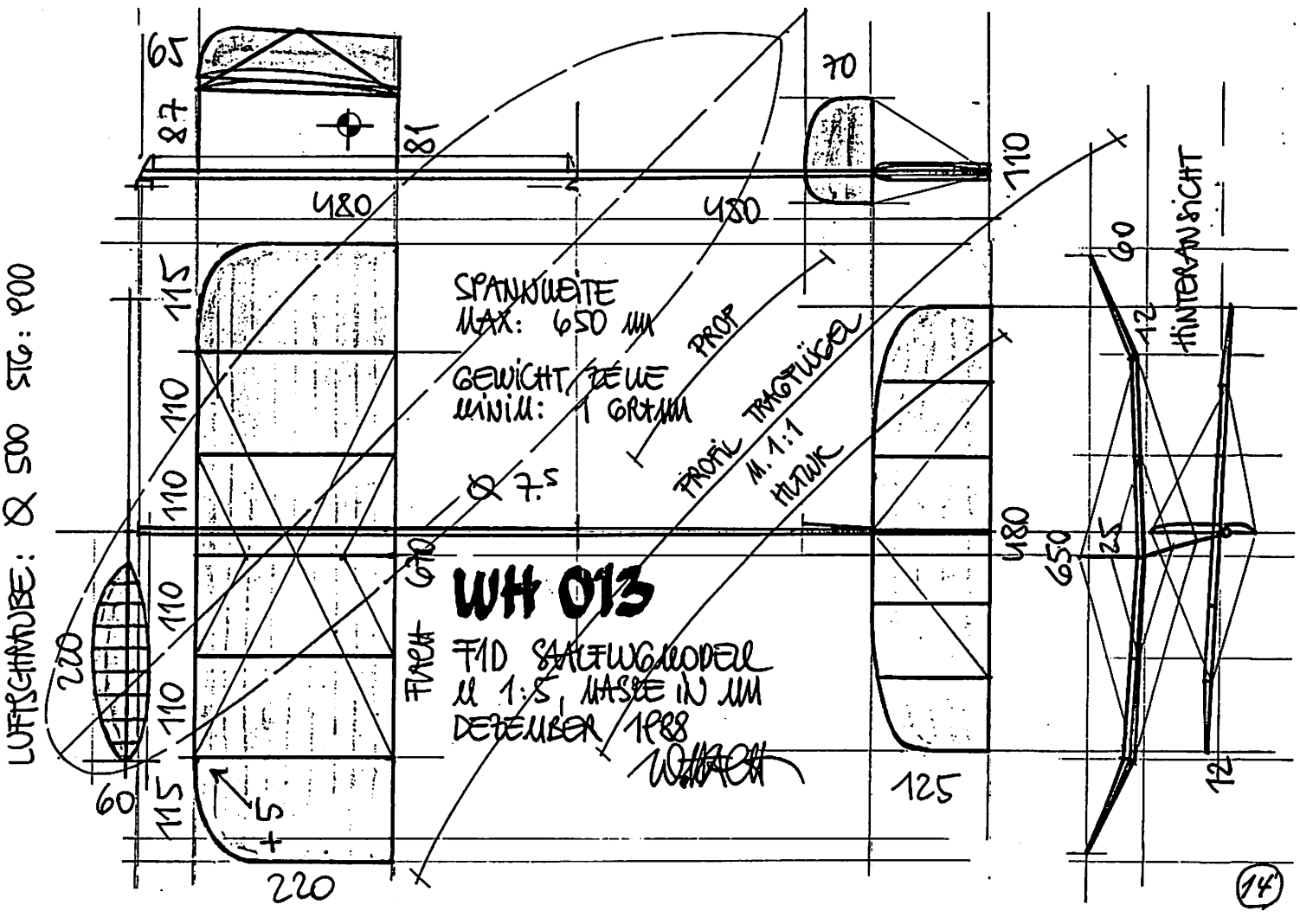
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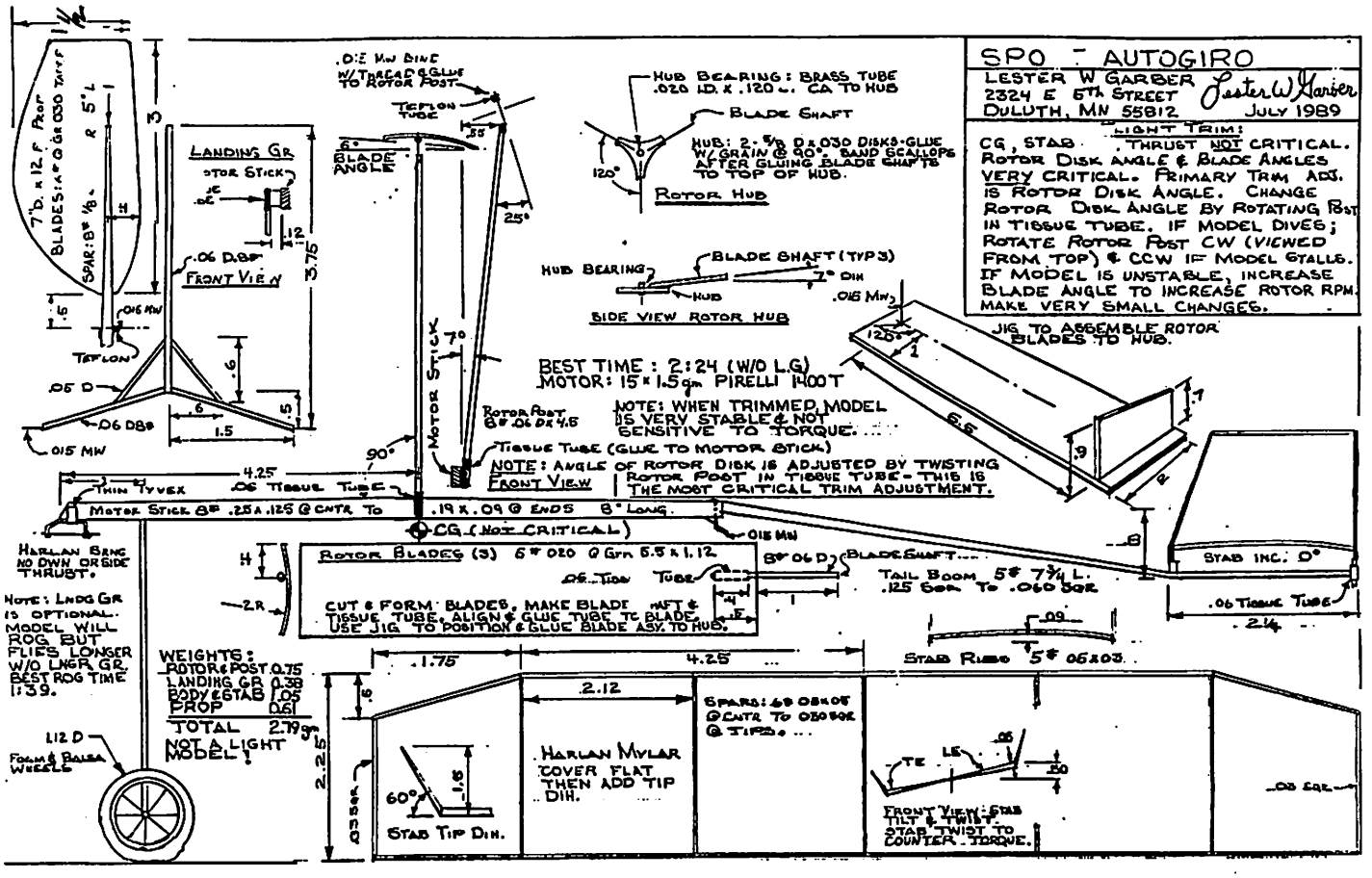
I send you a little drawing which you may use for Indoor News.

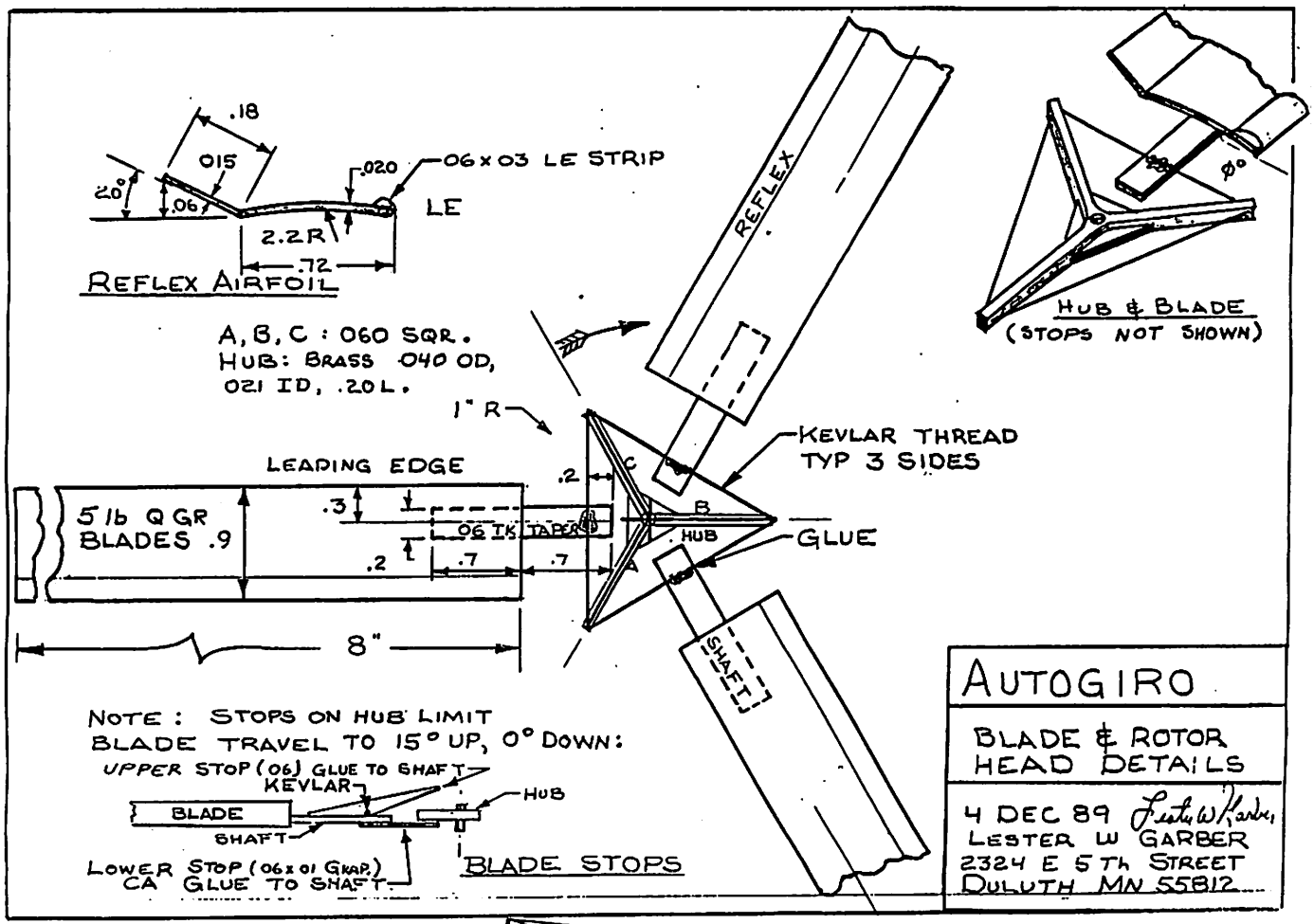
This varible pitch mechanic is very much like most used by now - with one fundamental difference: the tube in which the blades move is made of a square piece of 3 mm balsa. This makes many things easier: The alu pieces on the sides are easily glued on; the shaft runs in 2 glued on teflon washers; and the whole mechanic comes out with 6o mg! (Most others are between 8o and 12o for the heaviest).
The hole is made with a file of 1,6 mm dia., which you must of course introduce from both sides.
Instead of bending the wire for adjusting the pitch, I glued a small drop of resin on the end and drilled a o,3 mm hole for the small piece of wire which is in the blade.
I had no occasion yet to test the propeller on a model, but I tested it with 24 cm/g on a stand in my workshop. It runs well with about 4o rpm at the beginning and at the end, when the pitch goes down.
This pitch is adjusted between 65o minimum and 95o maximum on a 5oo dia. prop.

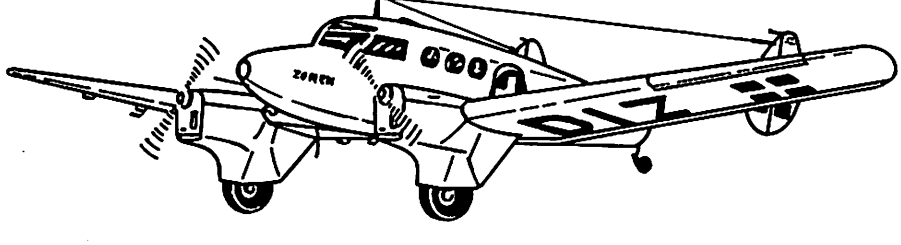
A. Klinck
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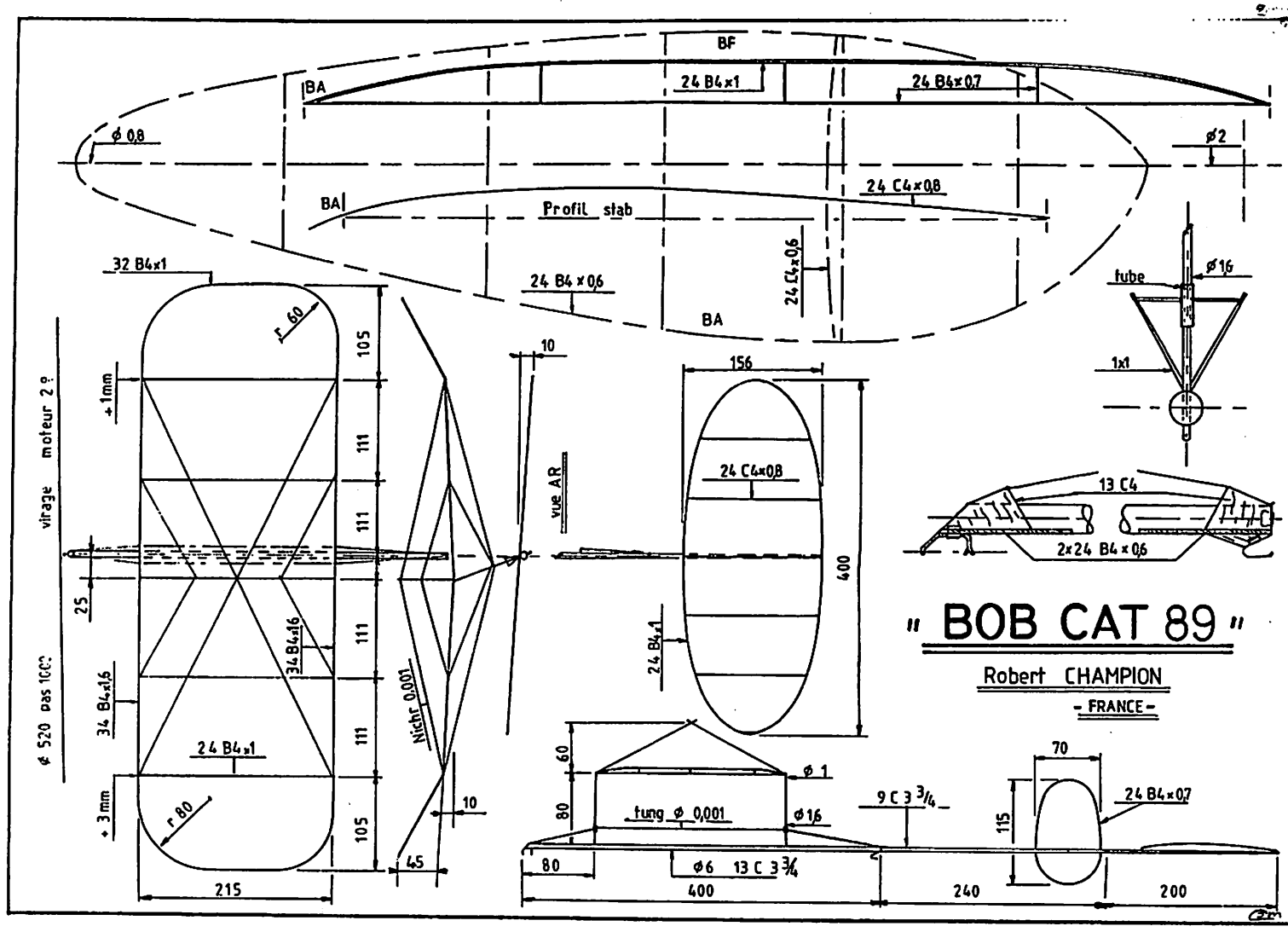



SPO AUTOGIRO
LESTER W GARBER
2324 E 5TH STREET
DULUTH, MN 55812
JULY 1989
LIGHT TRIM:
CG, STAB. THRUST NOT CRITICAL.
ROTOR DISK ANGLE & BLADE ANGLES VERY CRITICAL. PRIMARY TRM ADJ. IS ROTOR DISK ANGLE. CHANGE ROTOR DISK ANGLE BY ROTATING POST IN TISSUE TUBE. IF MODEL DIVES; ROTATE ROTOR POST CW (VIEWED FROM TOP) & CCW IF MODEL STALLS. IF MODEL IS UNSTABLE, INCREASE BLADE ANGLE TO INCREASE ROTOR RPM. MAKE VERY SMALL CHANGES.
BEST TIME: 2:24 (W/O L.G)
MOTOR: 15 x 1.5gm PIRELLI 1400T
NOTE: WHEN TRIMMED MODEL IS VERY STABLE & NOT SENSITIVE TO TORQUE.
NOTE: ANGLE OF ROTOR DISK IS ADJUSTED BY TWISTING ROTOR POST IN TISSUE TUBE - THIS IS THE MOST CRITICAL TRIM ADJUSTMENT.
FRONT VIEW
SIDE VIEW ROTOR HUB
HUB BEARING: BRASS TUBE .020 I.D. x .120 L. CA TO HUB
BLADE SHAFT
HUB: 2-5/8 D x .030 DISKS - GLUE W/ GRAIN @ 90°. SAND SCALLOPS AFTER GLUING BLADE SHAFTS TO TOP OF HUB.
ROTOR HUB
JIG TO ASSEMBLE ROTOR BLADES TO HUB.
LANDING GR
MOTOR STICK
TEFLON TUBE
BLADE ANGLE
TISSUE TUBE (GLUE TO MOTOR STICK)
ROTOR POST
MOTOR STICK 8" .25 x .125 @ CNTR TO .19 x .09 @ ENDS 8" LONG.
CG (NOT CRITICAL)
ROTOR BLADES (3) 5" .020 @ GRN 6.5 x 1.12
CUT & FORM BLADES, MAKE BLADE SHAFT & TISSUE TUBE. ALIGN & GLUE TUBE TO BLADE. USE JIG TO POSITION & GLUE BLADE ASY TO HUB.
BLADE SHAFT
TAIL BOOM 5" 7¾ L. .125 SQR TO .060 SQR
STAB INC: 0°
STAB RIBS 5" .06 x .03
HARLAN BENG NO DWN OR SIDE THRUST.
NOTE: LNDG GR IS OPTIONAL. MODEL WILL ROG BUT FLIES LONGER W/O LNDG GR. BEST ROG TIME 1:39.
WEIGHTS:
ROTOR & POST 0.75
LANDING GR 0.38
BODY & STAB 1.05
PROP 0.61
TOTAL 2.79gm
NOT A LIGHT MODEL!
FOAM & BALSA WHEELS
HARLAN MYLAR COVER FLAT THEN ADD TIP DIH.
SPARS: .09 x .05 @ CNTR TO .050 SQR @ TIPS.
STAB TIP DIH.
FRONT VIEW - STAB TILT & TWIST. STAB TWIST TO COUNTER TORQUE.


REFLEX AIRFOIL
.06 x .03 LE STRIP
LE
A, B, C: 060 SQR.
HUB: BRASS .040 OD, .021 ID, .20 L.
1" R
KEVLAR THREAD TYP 3 SIDES
GLUE
HUB
REFLEX
SHAFT
HUB & BLADE
(STOPS NOT SHOWN)
LEADING EDGE
5 lb Q GR BLADES .9
.06 I.S. TAPER
8"
NOTE: STOPS ON HUB LIMIT BLADE TRAVEL TO 15° UP, 0° DOWN:
UPPER STOP (06) GLUE TO SHAFT
KEVLAR
BLADE
SHAFT
HUB
LOWER STOP (06 x 01 GRAP.) CA GLUE TO SHAFT
BLADE STOPS
AUTOGIRO
BLADE & ROTOR HEAD DETAILS
4 DEC 89
LESTER W GARBER
2324 E 5TH STREET
DULUTH MN 55812

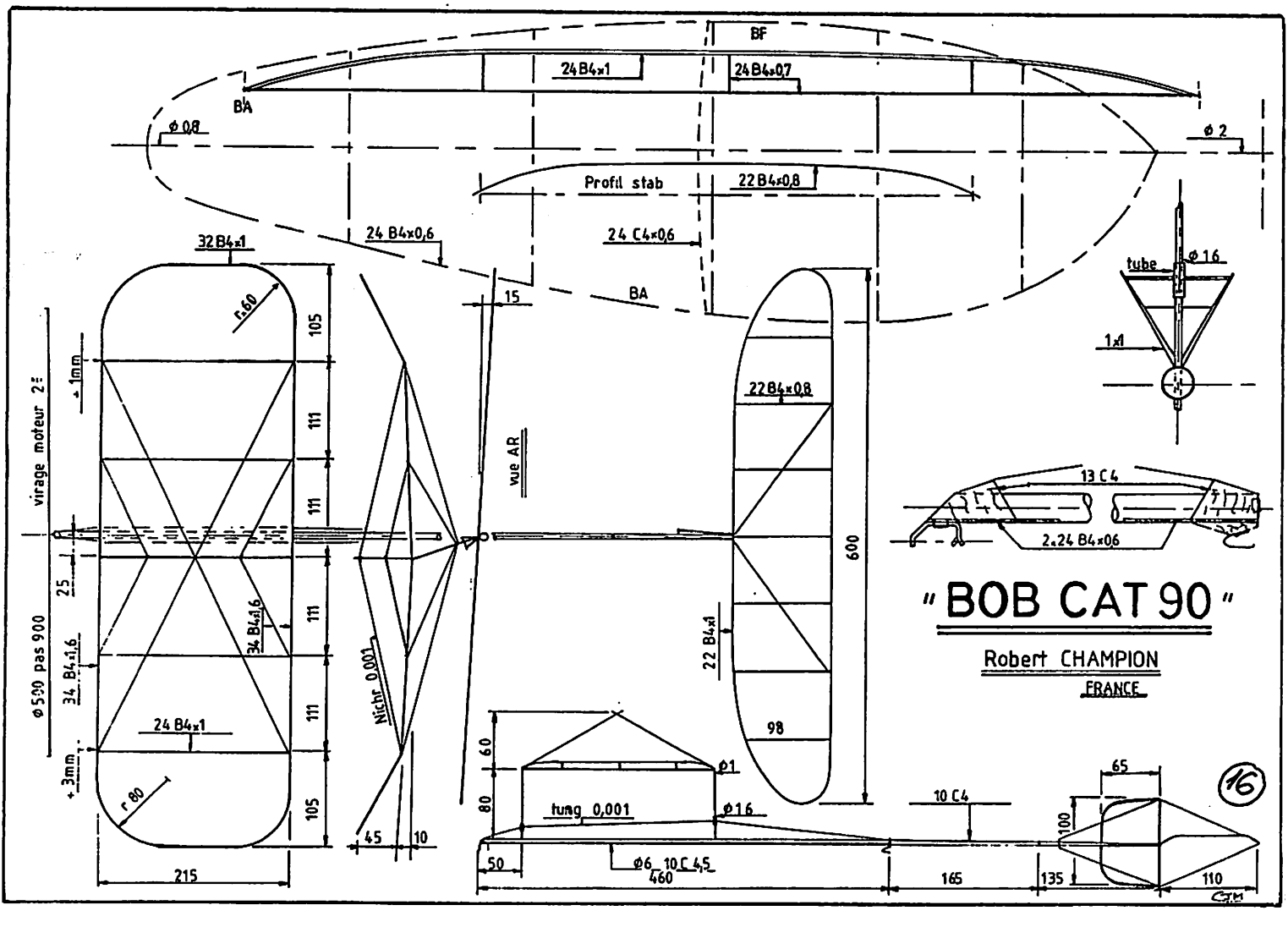





# " BOB CAT 89 "

Robert CHAMPION

- FRANCE -




# " BOB CAT 90 "

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