Ornithopter Modeler Society Newsletter

SPRING 1985

flapper facts

Volume II Number II — Pat Deshaye, Editor

THE WILD FRONTIER

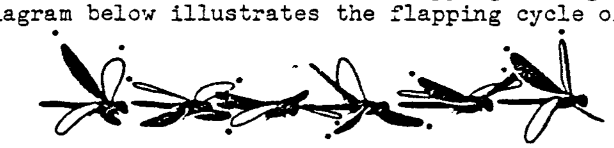
Lest we all become discouraged and look with envy and despair upon the accomplishments of others, thinking there is no way we can make a mark in the isolated but nevertheless carnivorous world of man-made flapping objects, take heart! Why not try making the most beautiful and artistic flapping creation you can, and then let's see who can sell one for the most money... could be a bit difficult to beat Ken Johnson on this, though. We have, as a group concentrated almost exclusively on indoor-- what about outdoor machines? And I don't mean indoor models flown outdoors; I want to see big, ugly, noisy flapping monsters! What about ROG ornithopters? What about articulating wings, like real birds? Have you considered putting an engine in one? Well, have you?

And another thing... many of you are receiving this newsletter without having paid your $7.00 dues to Shirley White. Either cough it up or this is the last one, got it?

True,
Pat

MEMBER NOOZ

Hewitt Phillips has submitted a ten-page dissertation on how and why a flapper fuselage bobs up and down during flight. (This issue is also addressed in Kieser's article.) Send an SASE (large envelope) if you are technically-minded and would like a copy. One must take exception to one of the statements found in his paper, however: "Nowhere in nature are seen counter-flapping configurations with four wings..." The diagram below illustrates the flapping cycle of a dragonfly.



Roger Schroeder has experimented with an articulating-wing machine, attempting to phase the inner and outer wing panels. To make a long story short, the wing sections sort of cancelled one another out and the craft exploded. Proof he's a pioneer!

Dan Garfinkel wants to build a friction-drive powered ornithopter. Get in touch with him if you'd like to discuss it.

Ken Johnson as usual, is making big bucks with beautiful ornithopters... how's $3,142.00 for a motion picture prop sound? The movie is called, appropriately enough, "Birdy." No slouch in duration, Ken has also broken six minutes with a biplane design, that with "hitting the wall at 20 feet and walking down". He is also experimenting with a "reaction flapper" concept, where the "wing flaps the tail". He is also thinking of starting his own flapper club... hey, can we talk?

Frank Kieser has broken six minutes with a biplane canard design based on his crank analysis system. Part II of his article is given in this issue to show the sort of analysis he can do of a mechanical design of your own. Just send him the mechanical dimensions of your design and he'll run one for you.

Al Rohrbaugh's design, presented in this issue with complete plans and construction article, has been chosen as "Special Category Model of the Year". Congrats, Al.

PRESIDENT'S CORNER by FRANK KIESER

We are off to a good start in '85. The organization of our Society is complete. Registration and dues from most members have been received by Shirley White. We ask the few remaining to get their application to Shirley as soon as possible.

In 1984, we saw Al Rohrbaugh demolish practically all existing ornithopter records. 1985 should be the year that we challenge Al's new standards. It won't be easy since Al himself is probably planning on bettering these records. To me, Al has proven that the right combination of design parameters can make the ornithopter an efficient flying machine. What are these critical design parameters and what is the theory behind them ? So far, I have seen very little documentation of the subject but I am sure we must have theories and concepts even if not detailed analysis. One of the purposes of the Society is to advance the technology of ornithopters. Therefore, I would like to see this newsletter used as a forum for for discussion of what makes an efficient ornithopter. I hope to present some of my ideas in future issues, and I would like to see them challenged and other views presented. Let's all contribute and really get a handle on the problem.

******** INTERNATIONAL ORNITHOPTER POSTAL CONTEST ********

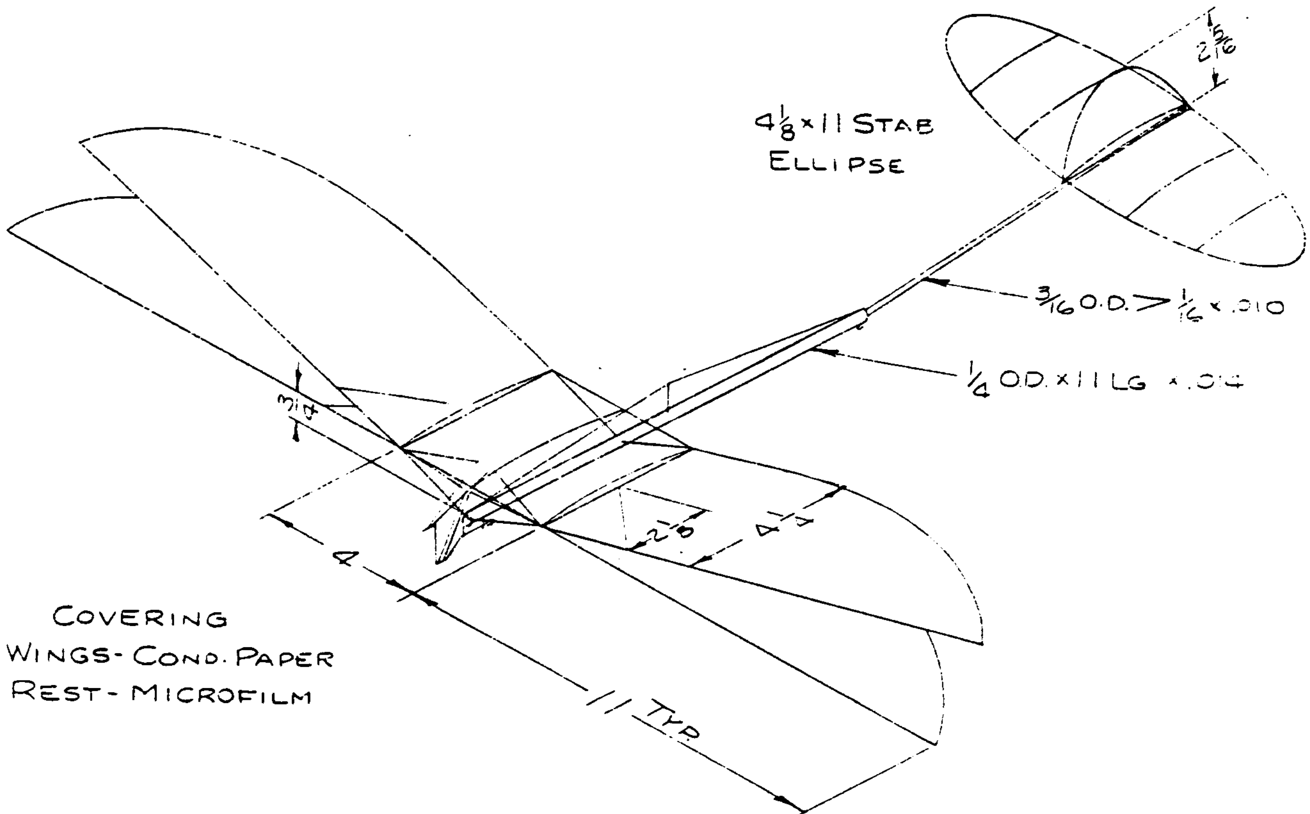
As previously announced, the Society will sponsor an ornithopter contest. We hope to have the details finalized and the formal announcement prepared in time for the next issue of this newsletter. The main features as we see it now are listed below. Your suggestions and comments would be appreciated so that we can consider them for the contest.

1. No entry fee for OMS members. Others welcome with an entry fee.
2. Cash, merchandise and trophies as prizes. Contributions of prizes would be appreciated.
3. Rules for entries will be similar to Dave Erbach's 1983 contest.
4. Flight time - June '85 to December '85
5. Allowance will be made for ceiling height. A multiplying factor will be derived for lower ceilings.

Send all entries to Dave Erbach.

1984 Records

Date	Category	Duration
5-19-84	IV	7 Mins. 51 Secs.
6-30-84	III	8 Mins. 17 Secs.
7-22-84	IV	8 Mins. 49 Secs.
9-11-84	IV	10 Mins. 25 Secs.
9-30-84	II	6 Mins 05 Secs.



Ornithopter 84
Al Rohrbaugh

ORNITHOPTER '84

My experience with the 1984 series of high time ornithopters started with the addition of two more wings to my standard two winged record ornithopters as tried by others: John White, Parham, Deshaye. The concept of 90^{o} out of phase crank throw was especially attractive because the additional flappers utilize two sectors of the 360^{o} crank throw which, otherwise, is lost. A significantly more important gain is the reduction of stress on the system. That snap in the two winged versions occurring 180^{o} apart, which results in catastrophic failure, was now virtually eliminated. This was the breakthrough. Reduction in flapping component sizes, and thus weight, was now feasible. I used braced spars to reduce weight on the old flappers with mixed results. Spar twist resulting from a combination of aft bend and vertical bend renders the system ineffective. I found that spar strength fore and aft shares equal importance with vertical bend strength. Too much aft bend results in the flapper having zero pitch in the propeller analogy. This, in turn, results in high beat rate with minimum thrust. Too little aft flex results in insufficient angularity, or pitch, of the covering resulting in insufficient thrust. It's a fine balance to achieve; maximum forward speed with minimum beat rate. The conclusion is that an inherently strong spar is needed in both bend axes, but not too strong, to provide proper pitch angle. Bend tests and experimentation are required for precise spar material and size selection. Boron was used for rigidity but it can be dangerous, so use cautiously.

With respect to wing sizes, my early (1982) record flapper models with two wings were based on fixed center sections with eight inch wings. Bigger wings resulted in frequent destruction because of excessive power requirements. For these reasons, my first four wing models had ten inch wings with 24 inches overall span. Weight was approximately 1.9 grams. After house testing (7-1/2 feet ceiling), the model then flew twice at Akron (May 19, 1984) 6 minutes plus, and 7 minutes, 51 seconds, CAT IV

Records. I put the model away. Another model was built, this with 11 inch wings and lightened to 1.6 grams. This proved to be the consistent record setter. It has flown ten times; four flights at West Baden (6/30/84), 8:17 CAT III; two flights at Akron (7/22/84), 8:49 CAT IV; three flights at Akron (9/11/84), 10:25 CAT IV; one flight at Chanute (9/30/84), 6:05 CAT II. CAT IV altitudes have been 120 feet.

The tail shown proved to be adequate. It follows standard indoor construction practice with hollow tapered boom. Left rudder with canted stab provide turn adjustment. Pitch angle (approximately -5°) is determined by tests with power, as loop length has an effect.

Cabane structure must be strong enough to resist crank action imparted to the flappers, with gradual lightening of the structure to the trailing edge. For the same strength reason, the cabane must be carefully glued to the motorstick with no twist.

As the foregoing indicates, craftsmanship with lightness is all important. Experiment for crank throw (approximately 3/4 inch) and optimum flap angle. These considerations cannot be overstressed in their importance to successful ornithopter flight.

Al Rohrbaugh
January 29, 1985

SPRINGTIME FLAPPERPETS

A couple of classic outdoor machines from the '50s are included in this issue, both designed by Parnell Schoenky. They only fly for about 30 seconds, but machines like these can be a lot of fun in the sunshine. Be careful, though... they tend to get attacked by swallows. Try one!

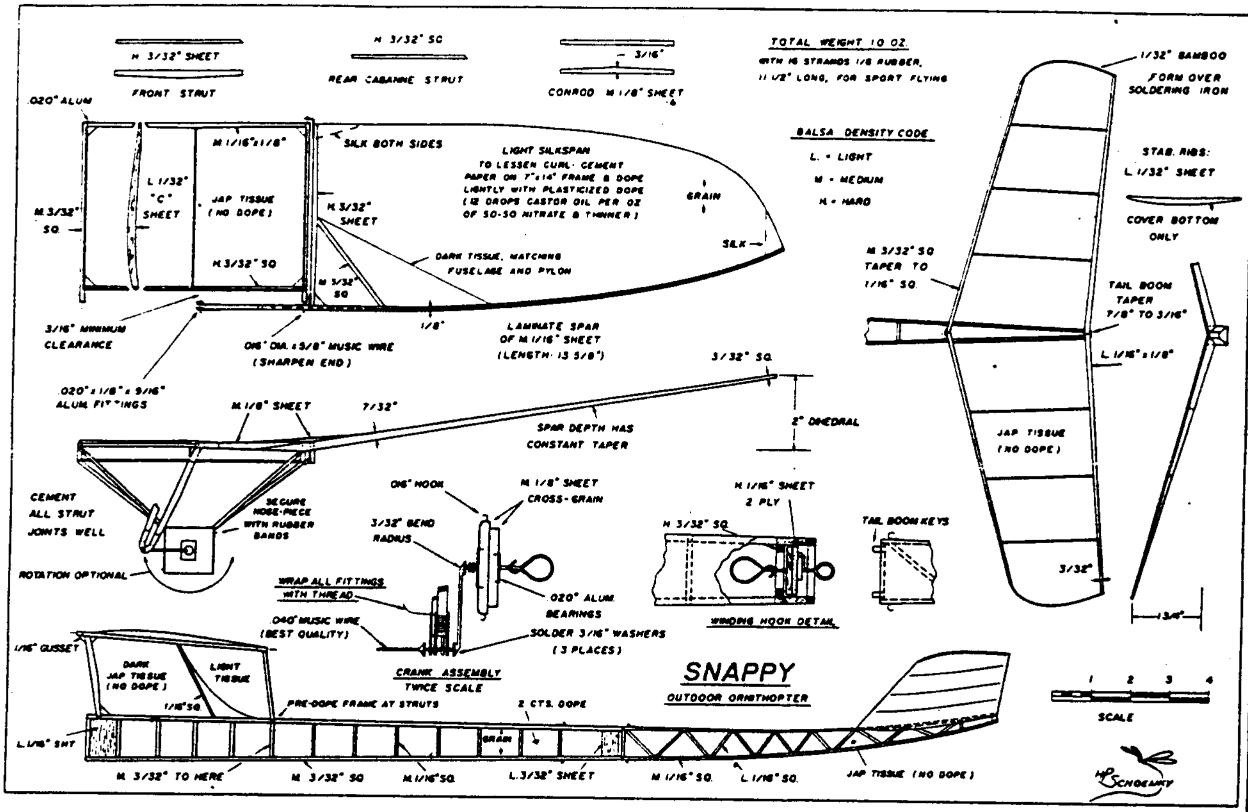
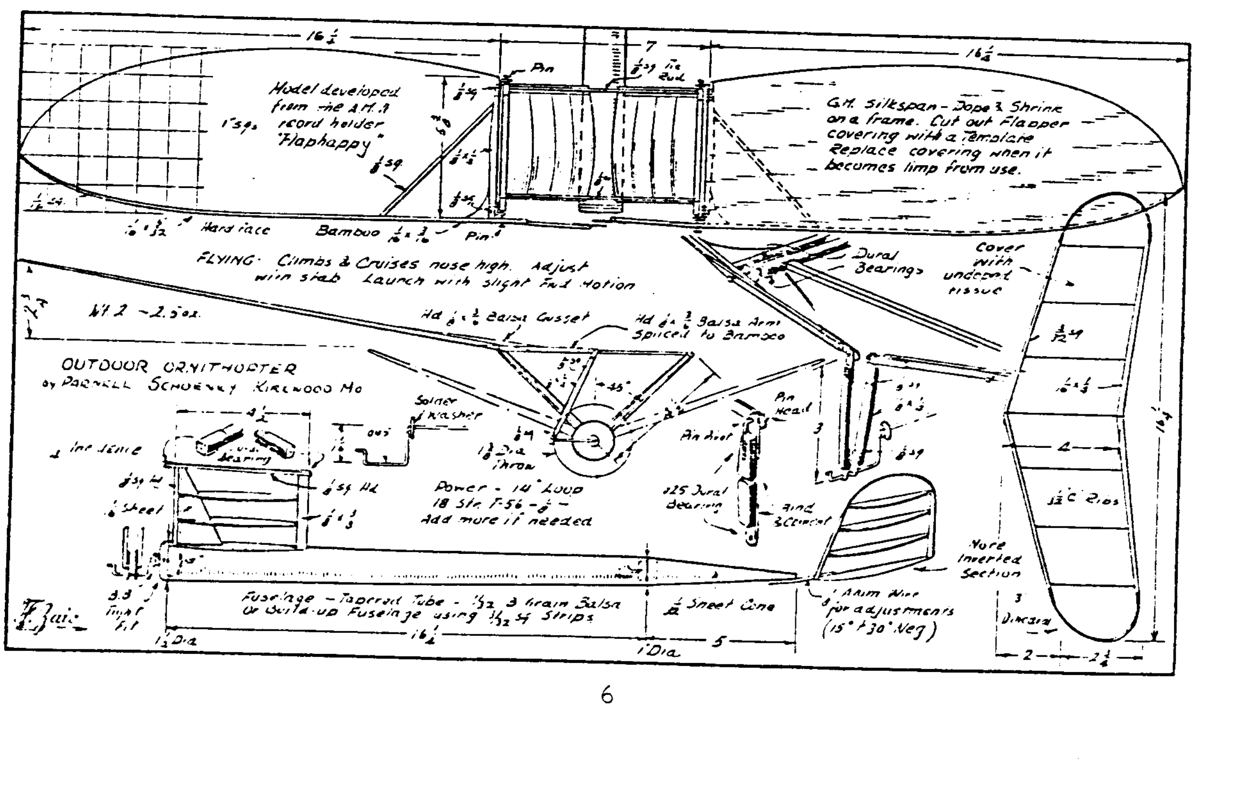
A mysterious tailless plan is also included; one of a batch of strange Japanese plans imported by Warren Williams. A little elevator at the rear appears to pop up as the wing flaps down. You have to work up the mechanical dimensions yourself, but it appears to flap more anhedral than dihedral. If anyone builds this thing, please inform the Facts about its performance.

A REMINDER A REMINDER

We would like to print plans, articles, notes, etc. from every member if we could. Our reproduction facilities are very limited, however, so: if you submit an article, please be concise! after this issue, no articles over two pages in length will be printed... if you have more to say, please make reduction copies to condense your typescript. If you submit plans, please draw them up so they fit on 8 1/2" x 11" paper. Let's give everyone a chance to distribute their plans and concepts through the newsletter. And again, if it isn't typewritten, it won't be printed.

We are collecting a library of technical papers and informative articles which may be distributed to members on an SASE basis. This will include reprints of old but important magazine articles. A list of what we have to offer will be included in the next newsletter.

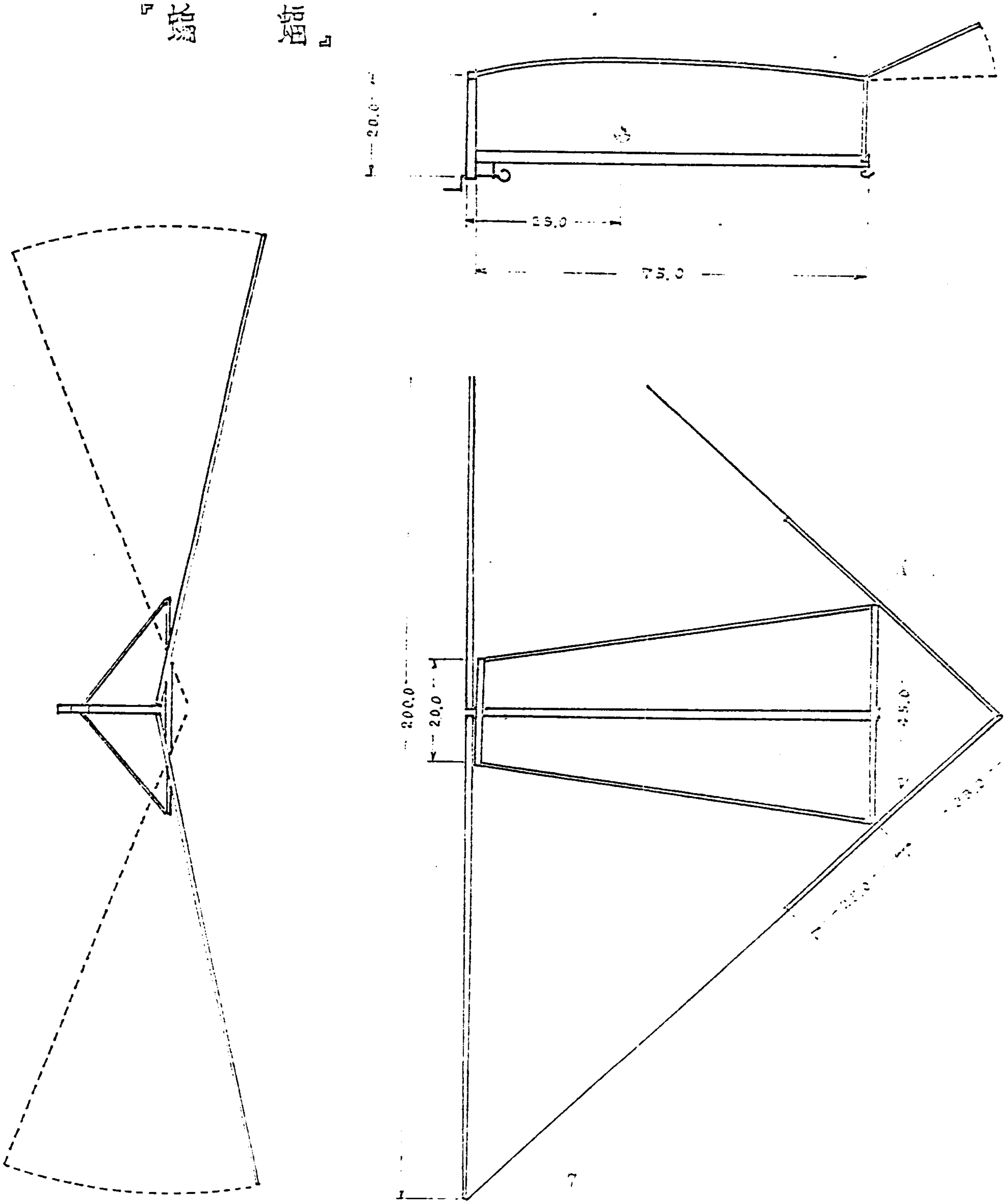
Many thanks from your editor for your continuing support and enthusiasm.


SNAPPY
OUTDOOR ORNITHOPTER
TOTAL WEIGHT 10 OZ.
WITH 16 STRANDS 1/8 RUBBER, 11 1/2" LONG, FOR SPORT FLYING
BALSA DENSITY CODE
L - LIGHT
M - MEDIUM
H - HARD
FRONT STRUT
REAR CABANNE STRUT
CONROD
SILK BOTH SIDES
JAP TISSUE (NO DOPE)
LAMINATE SPAR OF M 1/16" SHEET (LENGTH 15 5/8")
SPAR DEPTH HAS CONSTANT TAPER
2" DIHEDRAL
CRANK ASSEMBLY TWICE SCALE
WINDING HOOK DETAIL
TAIL BOOM KEYS
1/32" BAMBOO FORM OVER SOLDERING IRON
STAB. RIBS: L 1/32" SHEET
COVER BOTTOM ONLY
SCALE

OUTDOOR ORNITHOPTER
by PARNELL SCHOENKY KIRKWOOD MO
Model developed from the A.M.A record holder "Flaphappy"
G.M. Silkspan - Dope & Shrink on a frame. Cut out Flapper covering with a template. Replace covering when it becomes limp from use.
FLYING - Climbs & Cruises nose high. Adjust with stab. Launch with slight fwd motion
Wt. 2 - 2.5 oz.
Power - 14" Loop 18 Str. F-56
Add more if needed
Fuselage - Tapered Tube - 1/32 8 Grain Balsa Or Build-up Fuselage using 1/32 sq Strips
Dural Bearings
Cover with undoped tissue
Nore Inverted Section

自動安定翼式

無尾翼はばたき機

『蝙　　蝠』



THE DESIGN OF ORNITHOPTER LINKAGES - PART II

In part I we showed how to derive the precise linkage dimensions to give a selected wing motion with a given crank center and wing pivot center. Now we will discuss a computer evaluation of different designs. The programs used are not given since they are quite long and complicated, however a print out can be obtained by writing to the author at the address at the end of this article. Also if you have a specific linkage you want evaluated, the evaluation curves for that linkage will be furnished. The computer programs are written in Basic for the TRS-80 Model III and a CGP-115 graphics printer.

The first program, "LINKO", calculates wing angle and wing angular velocity as a function of crank angle for any selected crank angle increment. Thirty degrees is the usual increment used since it gives good accuracy without being unduly long. The program is run separately for each wing. The second program, "DISTO", combines these outputs and plots the wing motion curves. The program then calculates and plots the relative crank load due to the wing flapping and relative values of the roll, vertical and horizontal forces on the body as a function of crank angle. Before presenting the results of several evaluations, the assumptions used in the analysis will be discussed.

Most of us who fly ornithopters know that at the maximum up and down positions of the wing, the crank goes through dead center with a noticable increase in crank rotational velocity. This also means that there is very little torque required to rotate the wings at these points thus wasting some energy in the rubber motor. It was for this reason J. S. White in the early 1950's originated the biplane ornithopter with wing motions that are out of phase. But even in biplane designs, this crank load may not be completely uniform as will be seen later. Another solution would be a flywheel on the crank, but for endurance models, the weight would be prohibitive.

A second problem is caused by the wing flapping that so far seems not to have been given much attention. Besides giving thrust, the wing flapping generates other forces on the craft which cause cyclical disturbances from steady flight and waste energy. For this analysis, only the roll, vertical and horizontal disturbances are considered as they are believed to be the major ones. The fact that they exist can be seen by holding the craft lightly at the tail in pendulum fashion while the wings are flapping and watching the oscillations. Oscillations in flight can also be noticed if watched carefully from the right viewing angle.

The complete dynamics of the ornithopter is an extremely complex problem and to my knowledge has not yet been analyzed. McCready will probably do it as part of his Smithsonian project. My analysis makes a number of simplifying assumptions which I believe are valid for a first order comparative evaluation. The basic assumption is that the force required to rotate the wing is proportional to the square of the wing rotational velocity. The crank rotational velocity is assumed constant and the crank load is the torque required to rotate the crank at that rotational velocity. A number of things such as the mass and elasticity of the elements and the craft and the tightness or looseness of the wing covering are not considered. The programs calculate only relative not absolute values of the crank load and disturbance forces, but this is adequate for a relative evaluation of different linkages.

The measure of merit for a linkage design is that the crank load is nearly constant while the roll, vertical and horizontal forces are a minimum. As will be seen, when one of the items is improved, another may suffer so that any design is a series of compromises. Also the evaluation of merit depends on which items we consider most important so that it can become very subjective. Never the less, it offers an analytical means of evaluating a linkage that can be iterated and optimized before the model is built. Finally, the optimum linkage design may not be optimum from all standpoints such as weight.

Figure 1 shows a sample of the input data for a typical biplane design and the tabular output data. The geometry of four separate designs is shown in figure 2 and comparative performance curves are shown in figs. 3 and 4. The four designs are Lew Gitlow's "Flapper", Pat Deshaye's "Bibitte", Philip Watson's "Radical Chick" and finally a modification of Watson's design. There are three striking characteristics to Gitlow's design which are representative of most monoplane ornithopters. First is the crank load that is almost zero at two points. This has already been discussed. Second we see a large vertical reaction because the two wings are nearly in phase. They are both going down or up at the same time causing a large opposite force. This can be reacted and damped by a fixed wing between the flapping wings or by the inertia of the craft, but there will still be some bounce in flight. Third, there are cyclical roll forces due to the wings being slightly out of phase. This can be minimized by modifying the linkage to be more in phase, however, then the crank load at dead center will be even closer to zero.

Next, looking at Deshaaye's design, we see that the crank load is quite uniform and the roll and horizontal reactions are near zero. The vertical reaction, however, is quite large due to the fact that the upper and lower wings are only 90 degrees out of phase and there are periods in the cycle when all four wings are moving up or down together. Deshaye has said that he got improved performance with the wings 120 degrees out of phase. A run was made of this configuration and the significant results are overlayed on the 90 degree curves. Although the peaks of the vertical reactions are only reduced by about 10 %, the area under the curves is 15 to 20 % less. This configuration results in an increase in the variation of crank load of about 15 %. This might lead one to conclude that minimum vertical reaction is more important than very uniform crank load.

Watson's design is conceptually different in that the upper and lower wings on the same side are 180 degrees out of phase, but the left and right sides are 45 to 60 degrees out of phase. This results in a crank load that is almost as uniform as Deshaye's, significantly less vertical reaction and some horizontal reaction. There is however quite a lerge roll reaction during one period of the cycle. A model was flown with the Watson linkage and the roll was very noticible in flight tending to confirm the analysis.

The final set of curves, KCD-4, is a result of an attempt to improve on the Watson design. The changes consisted of raising the wing slightly, decreasing the lower wing radius and increasing the wing offset angles. The result was a significant decrease in the roll, vertical and horizontal reactions with only a moderate increase in the crank load variation. The flight test of this design will be interesting.

So there you have a summary of the work of several months. Comments and opinions on this approach will be welcome. If anyone knows of a comparable or more complete analysis, I would like to hear of it. As mentioned previously, if you have a specific design that you would like evaluated, send me the complete dimensions. Also, I will be glad to furnish a listing of the computer programs if they will be of use.

Frank Kieser
2219 Gordon Ave.
Jacksonville Beach, FL 32250

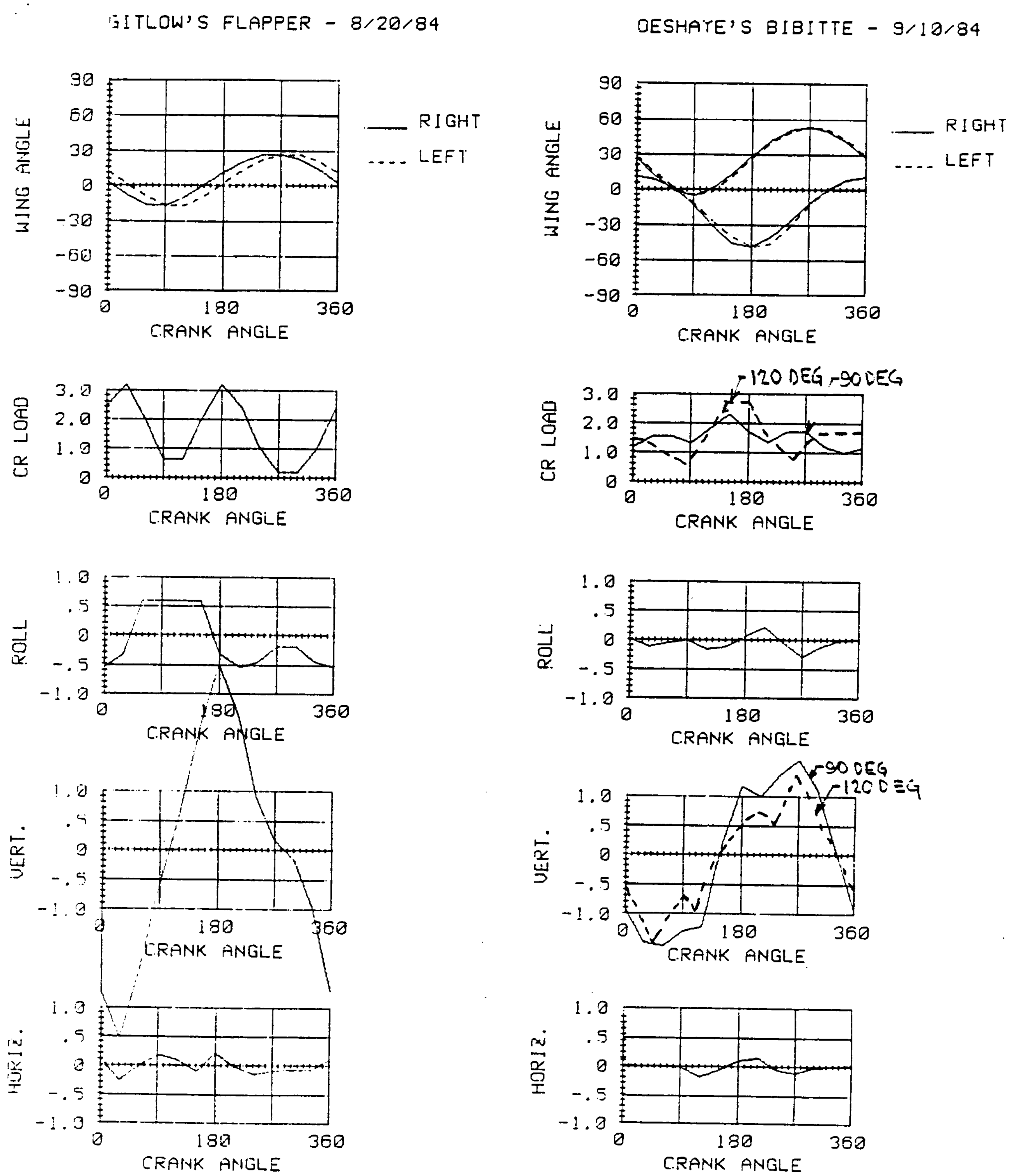
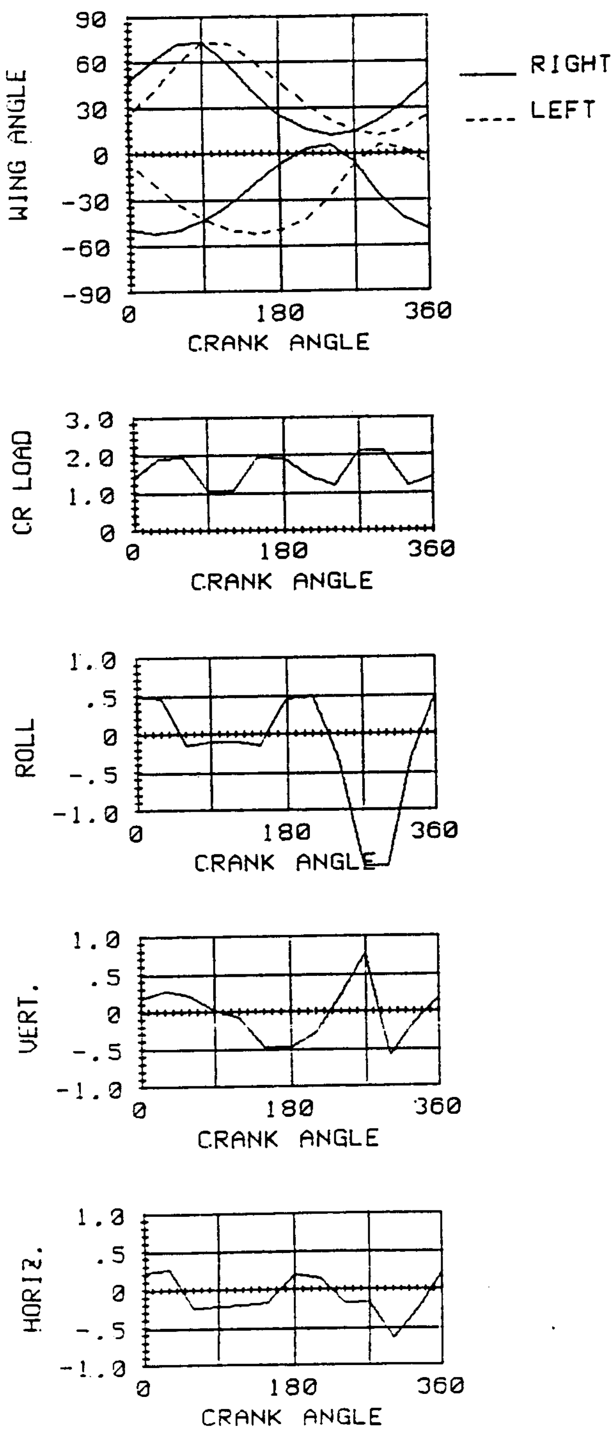

GITLOW'S FLAPPER - 8/20/84
OESHAYE'S BIBITTE - 9/10/84
WING ANGLE
RIGHT
LEFT
CR LOAD
ROLL
VERT.
HORIZ.
CRANK ANGLE
120 DEG
90 DEG
90 DEG
120 DEG

FIGURE - 2

WATSON'S RADICAL CHICK - 9/10/8‹



KCD-4 LINKAGE - 9/10/84