Ornithopter Modeler Society Newsletter

WINTER ISSUE 1987

flapper facts

VOLUME 5 NUMBER 1 ROY & SHIRLEY WHITE Ed.

Well '86 is gone and there has been some good Ornithopter flying. Al Rohrbaugh set a new Cat IV (4) record - 11 min., 18 sec. Also Frank Kieser set a new Cat III (3) record at the Niagra Falls contest - 8 min., 26 sec. I'm sure Frank will do better with a good Cat III ceiling.

Cat I 4 min., 59 sec., and Cat II 7 min, 08 sec. are held by Ray Harlen. Frank Kieser has done 5 min. + under a Cat I ceiling. I built two of Frank's Canard Ornithopters. My best time under 22 feet was 4 min.

Al Rohrbaugh's 84 Ornithopter was accepted by the Smithsonian National Air and Space Museum and will be on display in 1987. Also, Frank Kieser's Canard Ornithopter was selected by the NFFS as one of the 10 best models of 1986.

GOOD NEWS

No membership dues for 1987. We have about $250.00 in thé treasury, so everybody that is in good standing will get a free '87 membership.

Frank Kieser is starting a Q & A column in hope that it will create some interest in Ornithopters.

The 1987 Nat will be held in Lincoln, Nebraska. A tentative schedule shows no official Ornithopter flying, so write to your Vice President and also to Vince Markowski (Nat Manager) at the AMA headquarters and ask why not.

36 Ornithopter
al Contest

e are he r... the 1985-1986 International Ornithopter Postal
ntest:

	raw time	ceiling height	ceiling factor	contest time
1) Philip Watson Victoria, Australia	7:35	38 ft.	1.62	12:18
2) Al Rohrbaugh Ft. Wayne, Indiana	10:51	180 ft.	1.00	10:51
3) Warren Williams Claremont, California	10:01	100+ ft.	1.00	10:01

Model specifications

model	config.	model weight	rubber weight	span/ length	total area
Watson "Tetrapterullis"	biplane tractor	.67 gm.	.060 x 11" 0.7 gm.	38 cm. 38.5 cm.	712 cm. sq.
Rohrbaugh	biplane tractor		.069 x 17 pirelli	26 in. 22 in.	1420 cm. sq.
Williams "Pushy Bi"	biplane pusher	.054 oz.	.060 x 18	25 in. 19 1/4	

While participation is noticably down from the previous contest, the standard of building has clearly continued to rise. Now it is necessary to be able to do 10 minutes in an unlimited ceiling to have a first-class flight.

David Erbach, 71 Brixford Crescent, Winnipeg, MB R2N 1E1, Canada
13 September 1986

QUESTION & ANSWER COLLUMN

To stimulate contributions by our members to this newsletter, we have decided to try a question and answer collumn. Submit any question you have pertaining to ornithopters to me and either I will answer it or find someone to answer it. If anyone has a different answer from the one presented, give us your thoughts. In this way, we hope to provide some interesting discussion and add to everyones' knowledge and understanding of ornithopters. Send your questions to - Frank Kieser 2219 Gordon Ave. Jacksonville Bch, FL 32250.

To get yhe ball rolling, the following is a question excerpted from a letter I received from Les Garber and my answer. The question concerns the flap rate of his Butterfly I which appears in this issue.

My question is this:

Why does the flapping rate decrease as the crank radius increases? (Note that the flapping angle remains constant because the ratio of (Crank radius)/(CL distance crank to pin) is also constant)

I don't think that this is a question about aerodynamics, rather it is a mechanical engineering question about the design of mechanism. My muddled thinking is this:

1. The delivered torque (moment) from the rubber is constant for both model I and model II.

2. Aerodynamic forces from the wings times the crank radius must equal the delivered torque.

3. If the crank radius is bigger the aerodynamic forces must be smaller. (Aero Force)X(Crank Radius) = Constant = (Delivered Torque)

4. If the aerodynamic forces are smaller the wing must be moving at a lower velocity.

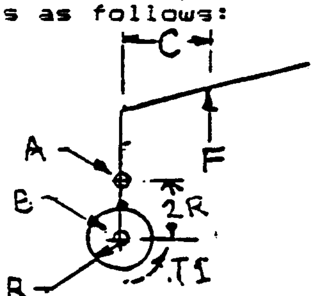
5. Therefore for a constant value of delivered torque the flapping rate must decrease as the crank radius is increased. (fixed flapping angle)

In other words, with a constant value of delivered torque, what happens when you change the scale of a mechanism?

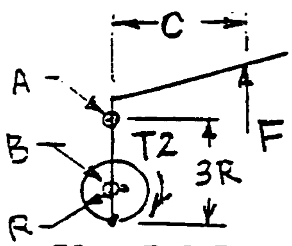
My answer to Les' question was this:

Each time I think I understand your linkage, I see it differently. First of all, I don't agree completely with item 2 of your explanation of why the flap rate changes with crank diameter. As I see it, item 2 as you state it <u>only</u> applies to the crank position where the conrod is perpendicular to the crank which corresponds to the wing full down. In this position ~~and this position only~~, the ~~[illegible]~~ TENSION forces in the conrod, which are a component of the wing lift, produce a moment about the crankshaft which is resisted by the motor torque. Since the conrod is perpendicular to the crank, any bending loads in the conrod are reacted only by compression in the crank and produce no moment about the shaft. Thus your statement that the moment is proportional to the wing lift times the crank radius is true at that crank position.

I analyzed two other crank positions, crank up (0 deg) and down (180 deg) which corresponds to the wing full up positions as shown below. In these positions, the bending forces in the conrod are reacted by the torque in the motor. Using your dimensions and taking moments about the pin center A and the crank center B, I find that the crank torque crank up (0 deg), T1, and crank down (180 deg), T2, is as follows:



T1 = F*C



T2 = F*C/3

This would say, at these two positions, the crank torque is independent of crank radius and one would expect that the crank angular velocity for ~~these two positions~~ DIFFERENT CRANK RADII is the same.

At crank positions between those discussed above, the crank torque applied by the wing must be at some value between being independent of crank radius and proportional to crank radius. The net result will be as you describe, that a larger crank gives a lower flap rate but it won't be as strong a function of crank radius as an extension of your analysis would predict.

BUTTERFLY I

Butterfly I is my latest and most successful ornithopter design.

Aerodynamically it follows the principles that have been evolved by Frank Kieser. These can be summarized as follows:

> Flapping wings are very inefficient for lift generation.
>
> A canard can be used to generate lift to support the weight of the model. The canard operates in relatively undisturbed air and is an efficient lifting surface. Hence a canard configuration is inherently more efficient than is a tractor design. The canard should be as large as possible (close to the legal limit of 50% of the flapping surfaces).
>
> To increase the wing loading on the canard, the center of gravity should be as close as possible to the center of lift on the canard and as far away as possible from the center of lift on the flapping surfaces. On Butterfly I the wing loading on the flapping surfaces are about 20% of the wing loading on the canard. The canard actually carries about 70% of the model weight while the flapping surfaces carry the remaining 30%. This means that the flapping surfaces are used mainly to produce thrust.
>
> An over-under biplane flapping configuration should be used. As the upper and lower wings flap towards each other they push air rearwards in a bellows like effect. My experience shows this configuration to be vastly superior to monoplanes or to my previous fore-aft biplane configurations.

Mechanically, Butterfly I is very simple in design. Torque reaction on the motor stick flaps the lower wing while a pin and slider mechanism flaps the upper wing. The canard does not flap because it is mounted on thin thread pivots (I use a few strands of unwaxed dental floss).

By comparison, the typical biplane design has 4 connecting rods and 16 pivot points on the wings and connecting rods. Butterfly I has only 1 connecting rod and 2 pivot points.

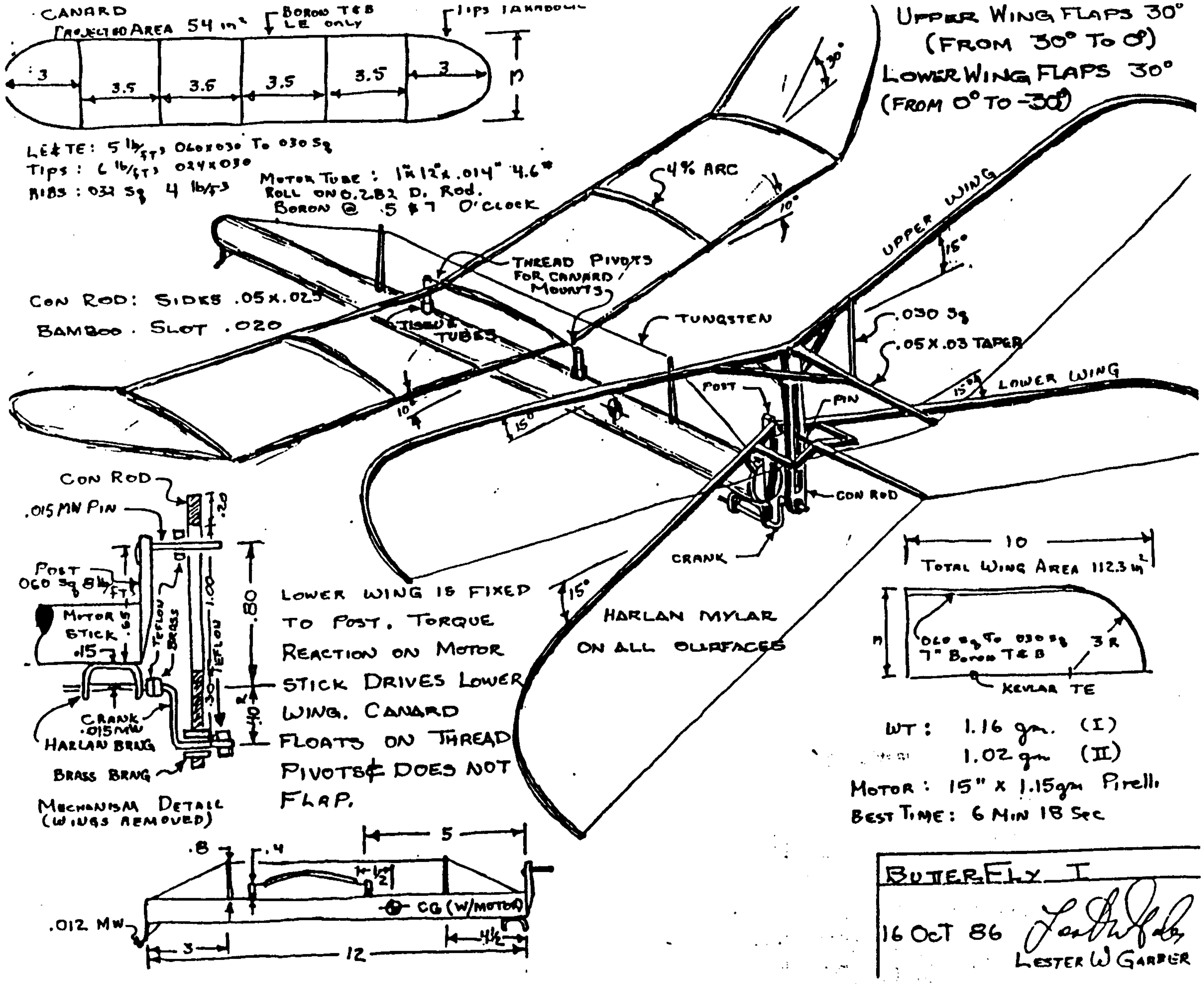
The flapping angle is determined by the crankshaft radius and the centerline distance between the crankshaft and the pivot pin:

$$SIN(FA) = R / D$$

R = Crank Radius   FA = Flapping angle
D = CL distance crankshaft to pivot pin

To date I have built two models of this design. Their weights are 1.16 gm and 1.02 gm. Both have ample strength and stiffness. The design could probably be built to 0.9 gm if the canard were covered with microfilm.

Lester W. Garber   October 23, 1986


CANARD
PROJECTED AREA 54 in²
BORON T&B LE ONLY
TIPS LAMINATED
3
3.5
3.6
3.5
3.5
3
LE & TE: 5 lb/ft³ .060x.030 To .030 Sq
Tips: 6 lb/ft³ .024x.030
RIBS: .032 Sq 4 lb/ft³
MOTOR TUBE: 1" x 12" x .014" 4.6#
ROLL ON 0.282 D. Rod.
BORON @ .5 & 7 O'CLOCK
CON ROD: SIDES .05 x .025
BAMBOO. SLOT .020
THREAD PIVOTS FOR CANARD MOUNTS
TISSUE TUBES
TUNGSTEN
4% ARC
10°
10°
15°
15°
15°
15°
UPPER WING FLAPS 30°
(FROM 30° TO 0°)
LOWER WING FLAPS 30°
(FROM 0° TO -30°)
UPPER WING
LOWER WING
.030 Sq
.05 X .03 TAPER
POST
PIN
CON ROD
CRANK
HARLAN MYLAR
ON ALL SURFACES
CON ROD
.015 MW PIN
POST
.060 Sq 8 lb/ft³
MOTOR STICK .15
TEFLON
BRASS
TEFLON
1.00
.80
.30
.10
.20
CRANK .015 MW
HARLAN BRNG
BRASS BRNG
MECHANISM DETAIL
(WINGS REMOVED)
LOWER WING IS FIXED
TO POST. TORQUE
REACTION ON MOTOR
STICK DRIVES LOWER
WING. CANARD
FLOATS ON THREAD
PIVOTS & DOES NOT
FLAP.
.8
.4
5
1 1/2
CG (W/MOTOR)
.012 MW
3
12
4 1/2
10
TOTAL WING AREA 112.3 in²
.060 Sq To .030 Sq
7" Boron T & B
3 R
KEVLAR TE
WT: 1.16 gm. (I)
1.02 gm (II)
MOTOR: 15" x 1.15gm Pirelli
BEST TIME: 6 Min 18 Sec
BUTTERFLY I
16 OCT 86
LESTER W GARBER