Flapper Facts

Newsletter of the Ornithopter Modelers' Society

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How to Join OMS: If you are reading someone else's copy of Flapper Facts and want your own membership, you can join now by sending $9 ($14 outside the US) to the address above. Payment should be made to "Nathan Chronister."

1995 Nats

The latest US Nationals saw some impressive flight times in the indoor ornithopter competition.

1	Lawrence Coslick	St. Louis, MO	18:22
2	Eugene R Joshu	Red Bud, IL	12:22
3	Mike T Palrang	Mt. View, CA	12:07
4	Warren J Williams	Claremont, CA	8:31
5	Herb Robbins	Los Gatos, CA	8:24
6	Ken Johnson	Granada Hills, CA	?

Records

Dick Quermann tells me that some new records have been set recently. On 6-1-95, Ray Harlan set a cat. 4 record of 18:13, soon to be followed by a 19:44 on 7-3-95. Up 2 minutes from last year's record! Congratulations!

I'm still working on the *Design Manual*, so I would love to hear from any of the above modelers regarding the designs they are using. What are the phase differences between left and right, upper and lower wings? What type of mechanism? How much weight? Thank you very much for any information!

The Aerobike Enterprise

This letter invites your participation in a new technology and enterprise.

"To go on stubbornly in spite of opposition, importunity, or warning." This is the nature of my character. "Sweet Persistence" has always carried me on my path to become light. I dwell daily in a world of the future where man has learned to fly like the birds. And now time has caught up with what I saw in the future ten years ago. The ark of my vast imagination has brought forth a significant change in the flight of mankind.

Humans will fly, because it once appeared impossible and yet it's actually very simple. I learned this by sitting in a 30 knot wind tunnel and filming a trained bat named Mad Max, who was flying in front of my Actionmaster High Speed camera.

Since that time, 1979, I've persisted with a revolutionary vision, in secret and loneliness. I've seen clearly and held out on showing the world, because people, materials and investors were not ready for true flight. I wanted to enjoy my youth and freedom. It's been a long road, but filled with adventure. In fifteen years of having a lot of fun, I have never found anyone who has realized what I learned from Max. I wouldn't have seen it myself if I hadn't been a surfer.

Now, with changes of millennium, materials and spirit, I realize, people want to see the impossible. People would love to see a culture of humans flying like birds. I can produce this.

When this happens, this project has potential to stun the world and produce a vast interest for the US Government. A new field of aerodynamics will emerge. Fringe markets in surfing, windsurfing, snowboarding, jetskiing and parachuting will open. For this reason, it is most important to realize the nature and dramatic effect of this proposal. After the design is recorded, a production team will be formed to create a motion picture docudrama.

This is a simple proposal of cooperation. I'm asking for contributions of anything over $50 to form a corporation. This company will be run on a corporate format. I'm selling stock certificates, at $50/1, to inaugurates the

formation of a group of individuals offering abilities, or services in a joint venture. With this working capital, a company will be formed to produce, market and enterprise a series of simple, inexpensive products based on the premise of humans becoming light, moving freely and safely upward through the air.

Original stockholders hold a valuable investment in this new frontier of true flight. I'm trained as a producer and that's what I'll be doing. Your investment is safe and should grow rapidly for five years. With individual product design potential in sailboarding, surfing, snowboarding, skindiving and human powered flight, I can't afford to make this a small business venture. I'm confident in what can be done and the market is a wide open door.

Our first designs will be produced in Maui; built, tested and developed in secret, then shipped with pilots and a photographic team to Mike Waltze's Fiji Island resort. There, products will be documented extensively as pilots learn to fly. Marketing, stock sales, networking, instruction tours and publicity will begin when the first pilot sustains level flight.

I can produce a human 'flying fish' in six months and have a pilot 'lift off' in a year. With film in hand, I'll recapitalize and retrofit products will be marketed for the free form sports. The second year will be dedicated to development, pilots sustaining level flight, movie/media production and capitalization of original patents. Original stocks will be sold as needed for one year and divided on an annual basis thereafter.

I wouldn't ask for your help if I wasn't extremely confident and sincere about this incredible adventure. Please join me in pioneering the future of true flight.

Dave Terry
PO Box 238
Paia HI 96779

Another Letter from Matt Foerschler

I recently visited your web site (which, by the way, I must congratulate you on) and found that we share many of the same interests including ornithopters, radio control modeling, artificial life research, and nanotechnology.

Let me give you a little background on myself. By day I am a senior programmer analyst with a major US electronic brokerage working on research and analytical software for use by equity traders and portfolio managers. By night I have many interests including autonomous robotics, telepresence, analog and digital design, and programming. I tend toward the bleeding edge of technology in always hoping to push the limits of what can be done. (My biggest problem is keeping my kids out of the "neat stuff" in my work area!)

My interest in ornithopters is to create autonomous robotic agents controlled by evolving neural networks for use in a variety of areas. I also have interests in the telepresence use of such devices for experiencing things from a "bird's eye" point of view. I hope *Flapper Facts* will give me some valuable insights into the construction of these machines.

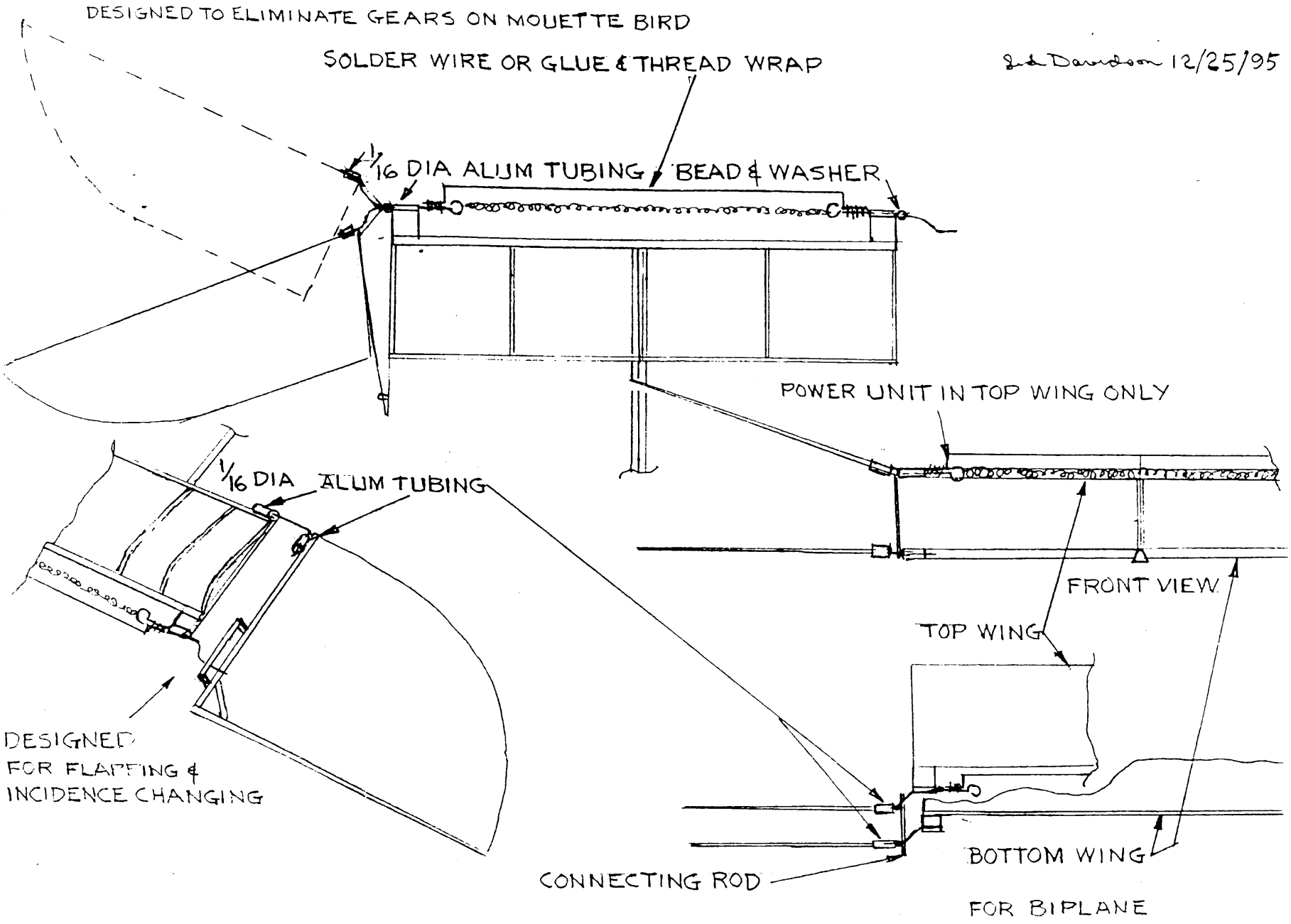
If there is anything you or any of the members of OMS need that you think I may be able to help with, contact me at my e-mail address or by snail mail. [mattf@tyrell.net, or 3900 Monterey Ct. Lawrence, KS 66049]

Sid Davidson Plans

"In my design [a circular-flapping design based on George Chaulet's Mouette] we may get a twisting of the wing due to torque of the rubber band; this will cause a turning moment which will have to be compensated for by a long moment arm to the stabilizer. Fortunately we have a lot of weight in the front (the rubber band and the motor stick plus the wire). The stabilizer can also be tilted which will cause a turning action to the high side."

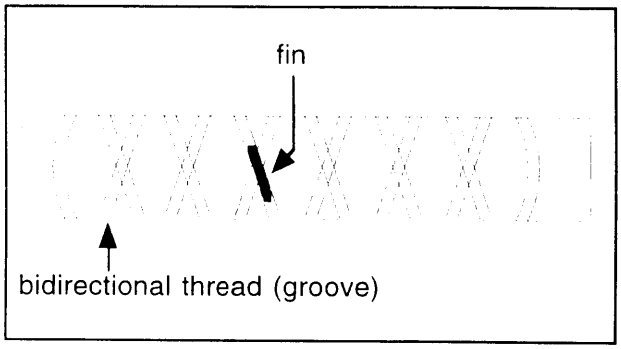
Gearless Flapping Revisited

In the previous issue, we saw Larry Burks's proposal for an engine powered ornithopter with no gears. His idea was to use a rotating bolt to drive a nut back and forth, thus flapping the wings. This would require reversing the engine's rotating at the end of every stroke, which may be possible with Cox reed valve engines. However, I received two letters, from


DESIGNED TO ELIMINATE GEARS ON MOUETTE BIRD
SOLDER WIRE OR GLUE & THREAD WRAP
L. L. Davidson 12/25/95
1/16 DIA ALUM TUBING
BEAD & WASHER
POWER UNIT IN TOP WING ONLY
1/16 DIA ALUM TUBING
FRONT VIEW
TOP WING
DESIGNED FOR FLAPPING & INCIDENCE CHANGING
BOTTOM WING
CONNECTING ROD
FOR BIPLANE

Peter Smelser and Bob Meuser, suggesting an alternative which would avoid the necessity for engine reversal. Meuser wrote:

"The level-wind mechanism on fishing reels and a similar mechanism that drives the print head on some small printing calculators might be a viable way of converting rotary motion into oscillating motion along with some speed reduction. I doubt if the speed reduction (flaps per rev) is sufficient for a 'gas' engine or electric motor; some additional gearing might be required.



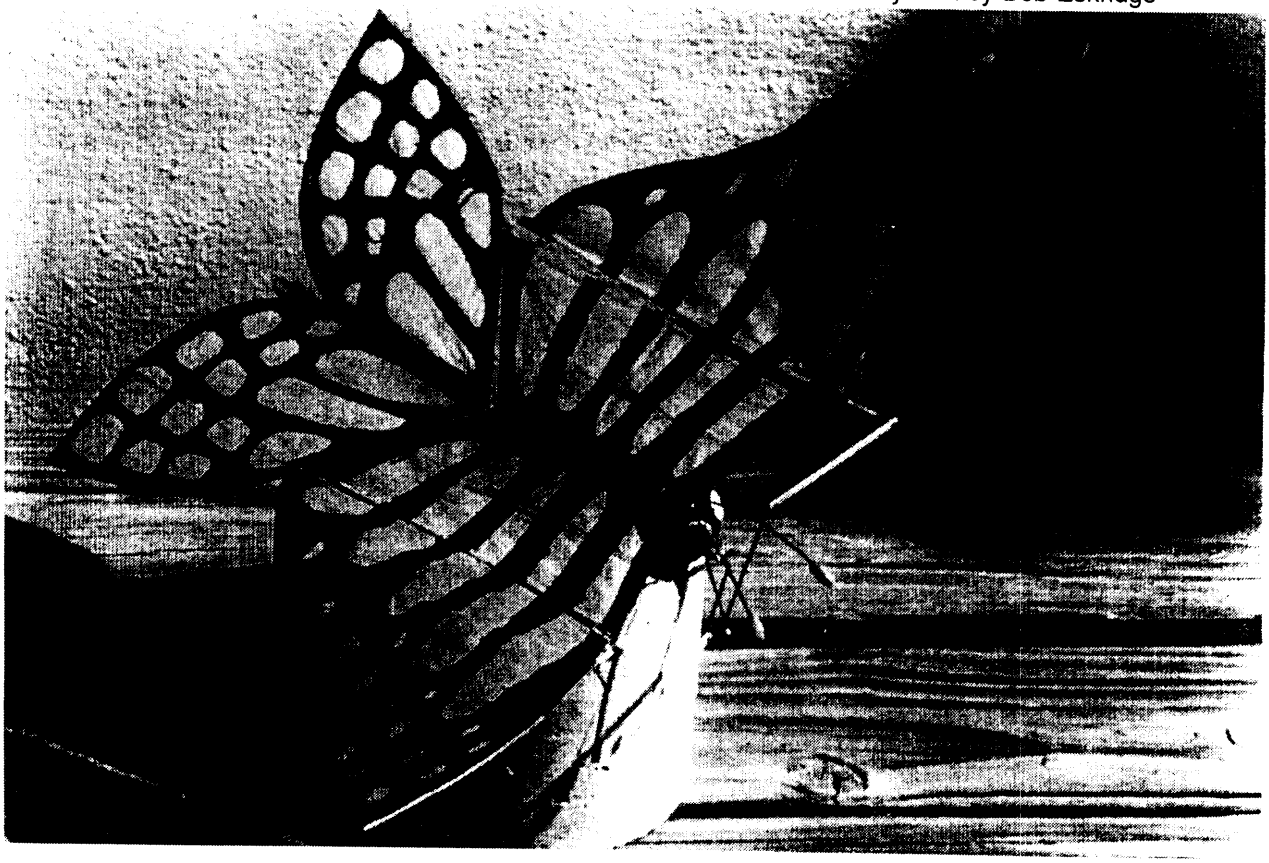
"The 'nut' has a pivoting fin that rides in the groove. The fin is wide enough to pass over the crossing without getting on the wrong track."

This is very interesting, Bob. Maybe someone who has one of these reels can tell us what the reduction ratio would be, and whether or not the device looks like it could be used in an ornithopter. If the reduction turns out to be inadequate, that is a minor problem, given the commercial availability of gear units for electric and gas motors.

Butterfly by Bob Eskridge

This comes by "snail mail" because I wanted to enclose the snapshot of my Ken Johnson butterfly ornithopter. I mentioned that it flies erratically, darting hither and thither much like its real life counterpart. I think that may be because of the antennae which are flexible lengths of plastic broom straw, with weights on the outer ends molded from bits of clay and coated with cya glue. As the wings oscillate, the flexible antennae flop up and down, shifting the CG with every movement, which probably results in the darting up and down, really quite like real butterflies. The eyes I used are 2 white thumbtacks, inserted into the carved balsa head, and seem to balance the little craft about right. [The Butterfly, designed by Ken Johnson, is available through the Model Builder plans catalog.]

Ken Johnson Butterfly built by Bob Eskridge



OUR ORNITHOPTER FLIGHT-RESEARCH PROJECT

by Francis Reynolds

"Ornithopter: a heavier-than-air flying object deriving its chief support and propulsion from flapping wings." Many crude sets of wings for humans were built and tried (sometimes fatally) throughout history. There have also been a number of engine-powered man-carrying ornithopters built. To date none have been successful. Does this discouraging history tell us that man-carrying ornithopters will never fly? Not at all; but it does tell us that the design and construction of successful ornithopters is not easy.

The successful pioneers of flight didn't take long to figure out that there were easier ways to fly than flapping the wings like a bird. Man couldn't make the kinds of structures, configurations, control systems, and power plants that birds and insects have; but man could make and power propellers, which nature does not do. And fixed wings were much easier to design and build than flapping wings.

SUCCESSES AND FAILURES

Birds, bats, and insects can do things in flight which man, with all his technology, cannot duplicate. The endurance record (seventeen minutes) for man-made ornithopters of all sizes is held by a model ornithopter powered by a rubber band. Rubber power for ornithopters has the great advantage of needing no transmission system. The very high-gear-ratio transmissions and flapping mechanisms required in engine ornithopters are almost prohibitively HEAVY.

Dr. Paul MacCready's big pterosaur model ornithopter was badly underpowered. It didn't succeed in gaining altitude by flapping, but it was a most impressive-looking lazily-flapping glider.

James DeLaurier, Professor at the Institute of Aerospace Studies, University of Toronto (who spoke to us in October 1994), and his engineer partner, Jerry Harris, have been successful with an internal-combustion-powered radio-controlled model ornithopter after nearly twenty years of effort. The video tape of their successful flights is most impressive. DeLaurier wrote two technical papers and DeLaurier and Harris wrote one on their ornithopter work. These were published by The Royal Aeronautical Society.

Percival Spencer, the designer of the Republic SeaBee, spent the later years of his life in ornithopter development. Three engineers in Germany, Horst Rabiger, Karl Herzog, and Horst Handler have also had some success in radio-controlled ornithopter development. Those are about the only successes. All successful ornithopters to date have been significantly different from each other. The field is in its infancy-- so the writer has jumped in. Why?

Because it is a fascinating challenge!

ORNITHOPTER AERODYNAMICS

Rubber-powered ornithopters traditionally use zero-thickness butterfly-like membrane wings with no trailing edge member. The flapping produces required twist in the wings, but the efficiency of such a wing is low. The modelers who build and fly such models adjust the tension in the wing membrane by trial and error, to get adequate but not excessive twist angles.

The DeLaurier/Harris RC ornithopter, and a few others, have wings employing moderately-thick airfoils. These are far superior to the membrane-type wings. The thrust ("Help!-- where is the propeller?") is developed by the flapping of the wings. The vertical flapping velocity in combination with the forward velocity tilts the resultant vector forward, providing a component of thrust. The incidence remains constant at the roots, but since the vertical velocity of the wing due to its flapping is maximum at the tips and zero at the body, the incidence of the wing must be changed cyclically. The wing is twisted such that as we progress toward the tips the incidence goes more positive on the upstrokes and more negative on the downstrokes.

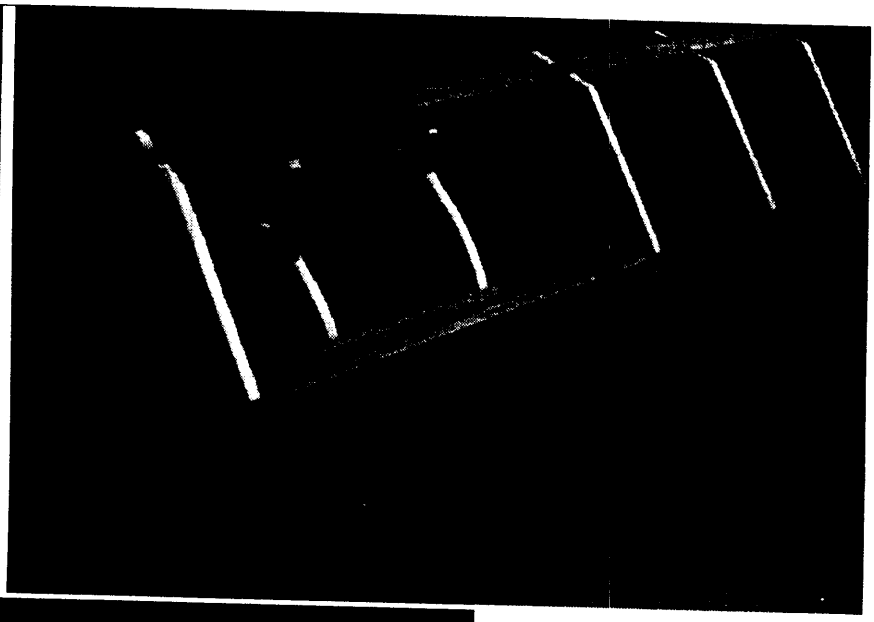
Prop blades have a twist for the same reason; but on props the twist is fixed since they do not reverse direction-- do not flap. You may recall that the greater the diameter of a prop, the greater its efficiency. The "diameter of the prop" on an ornithopter is the entire wingspan of the bird, which helps provide good propulsion efficiency.

THE PACIFIC-NORTHWEST SECTION FLIGHT-RESEARCH ORNITHOPTER

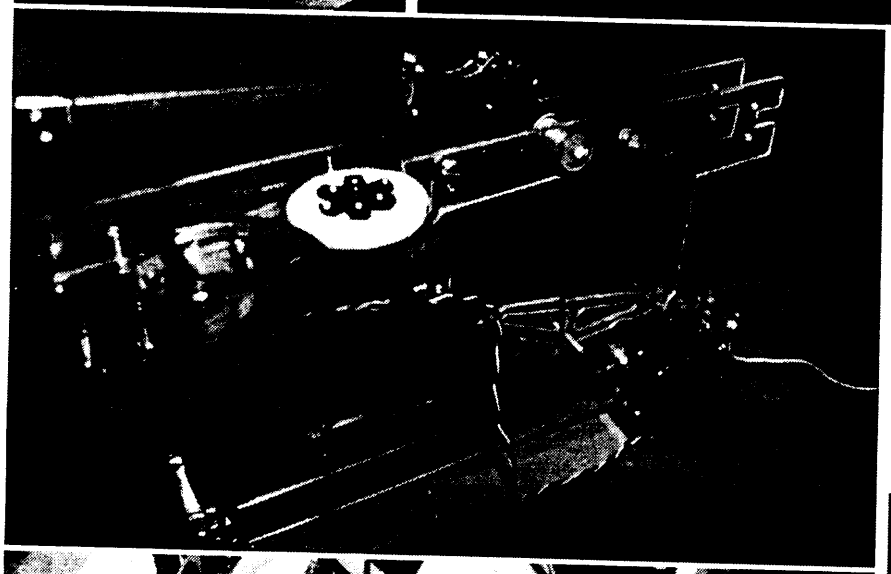
In May of 1995, the Flight Research Committee of our AIAA section accepted the ornithopter efforts of the writer as a Flight Research Project. Before getting into the details, I wish to acknowledge the valuable help I have received from: Nathan Chronister at Bucknell University. DeLaurier and Harris. Retired Boeing engineer Rob Jenny. Professor Emeritus Bob Joppa, Dept. of AE, U of W. Will Kuhnle, an engineer and mathematician in Texas. Horst Rabiger of Germany. & Professor Michael Selig, Dept. of AE, University of Illinois.

In all known ornithopters to date the necessary wing twisting is approximated "passively" by mounting the wing spar well forward of the center of pressure to provide a pitching moment on the wing in flight, and by tailoring the torsional compliance of the wing structure such that the resulting pitching couple gives an acceptable wing twist.

By contrast, in the ornithopter I am building, "RCGull", the cyclic wing twisting is provided by a powered mechanism which is synchronized with, but 90 degrees out of



Iron bird



Engine

Pitch control system

Iron bird, installed

Wing leveling motor

Design Manual and Backissues

The revised *Ornithopter Design Manual* and the bibliography are not available yet, and I expect that they will be substantially delayed. I just don't have time to work on them right now. The *Flapper Facts* backissues 1983 through 1995 are available for $25 ($33 overseas).

phase with, the main flapping system. The amplitude of the twist can be optimized in flight by radio. Forty-some computer spreadsheet studies have been of great value in optimizing the wing flapping angle and frequency, transmission ratio, twist angles and distribution, span, area, flight speed, and other parameters.

Another unique feature of this ornithopter will be its full three-axis control. With the usual aerodynamic or passive twisting, the incorporation of "ailerons" would be difficult; but with the mechanical twisting mechanism, differential pitching of the spars for roll control was easy to implement.

The tapered round tubular ten-foot-span carbon-epoxy wing spars are very rigid in both bending and torsion. The spars are flapped and pitched by the mechanisms; and most of the Selig 4233-section ribs are free in pitch with respect to the cyclically-pitching spars. The root ribs are attached to the body and therefore have a fixed incidence. The outer ribs will be rigidly attached to the spars and will therefore receive the maximum pitching angles.

The photos show: The 1.0-hp, 15,000-rpm engine. The 104/1 transmission system. The flapping mechanism. The wing twisting and roll-control mechanisms. Part of the radio control system. And a wing-leveling system.

"Wing leveling" is necessary for the glide after the engine is throttled back or if it should stop in flight. This feature is also unique to this engine-powered ornithopter. (Other experimenters have had crashes due to the engine dying when the wings stopped flapping at unstable dihedral angles.) The power for wing leveling is provided by a small electric motor and battery, and the leveling operation is automatic.

The complete assembly is shown mounted in an "iron bird" for test purposes (but my iron bird is made of wood). All mechanical systems are complete and have operated satisfactorily in the iron bird, while flapping and twisting the bare spars. After flapping tests with the completed torsionally-soft wings, all of these mechanisms will be transferred to the flight airframe, which is laid out but not yet built. First flight tests within a year.

Francis Reynolds is a retired Boeing Aerospace engineer, an Associate Fellow of the AIAA, an inventor, and an RC airplane modeler.

1170 words