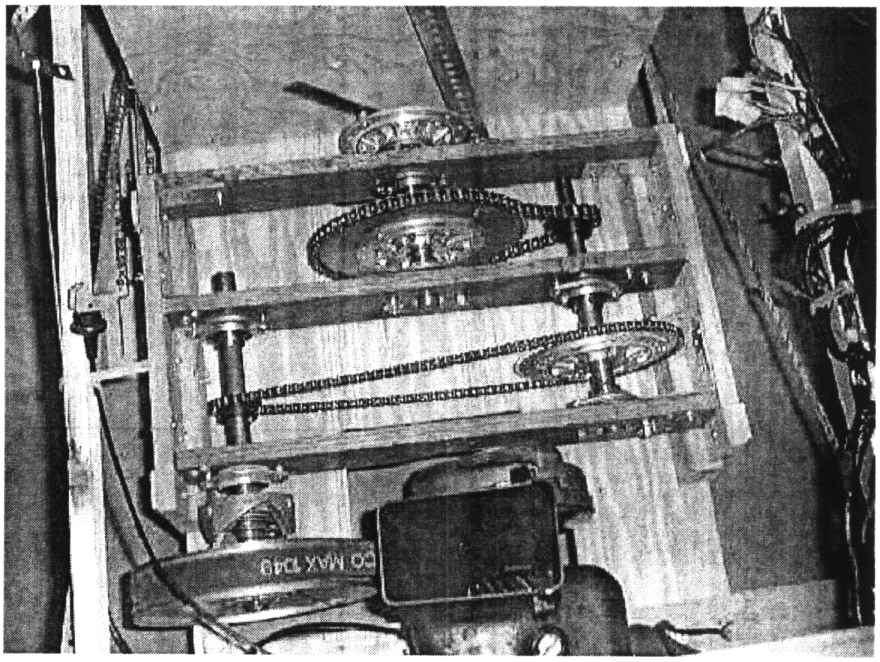
Spring 2000

Flapping Wings

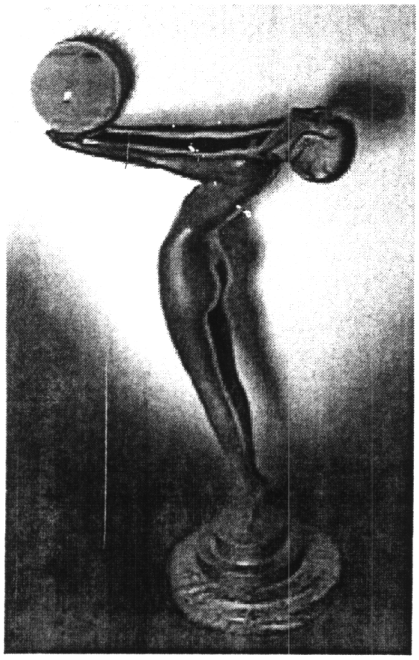
THE ORNITHOPTER SOCIETY NEWSLETTER

Manned Ornithopter Round-Up

As we approach the centennial of the Wright brothers' first controlled flight of an airplane, several teams are working on manned ornithopters right now. Because it seems likely that one or more of these projects will succeed in the near future, this issue of the newsletter gives an overview of some of the work that is going on in the words of those who are involved.



Ken Bowers High Flight 1 under construction.



OS Founder Patrick Deshaye has offered this prize for the first successful manned ornithopter.

Tony Baker: The Birdman Transmission

Hello ornithopter enthusiast. I have purchased a DA-150 engine. It weighs 8.4 pounds, has 14 hp, and reaches 8,500 rpm. Take a look at the heart of an ornithopter - go to www.desertaircraft.com/engines.html. I have decided to build the transmission for the 150 cc two-cycle to help aid in the development of different wing types or styles. The gearbox will have a changeable system of gearing (40/1, 80/1, 120/1, 160/1, and 200/1) if need be. It will be a two-stage gear setup. Grant Smith helped with the logic of a belt drive for the first stage. This drive can be reduced 1, 2, 3, and 4/1 ratios, then into a gearbox of 40/1. This will help in case we misdesign the frequencies. We can change gear ratios without redesigning the whole gearbox. It would also lend itself to other wing types or styles, which would use different frequencies. The 40/1 gear box will have the final drive ratio on each side of the gearbox, the left and right sides. This allows for dual oscillation points, splitting up the loads and stress using dual flappers that are timed together internally. At this time, I have already run into a problem of finding a timing belt drive system that will take the rpm and horsepower at the drive end of the engine and stay under 3 inches. I have been looking into a v-belt drive. So far the timing and v-belts have the same problem; they are as heavy as the engine. I am looking into having them engineered or maybe go with a chain and sprocket setup. I will soon have

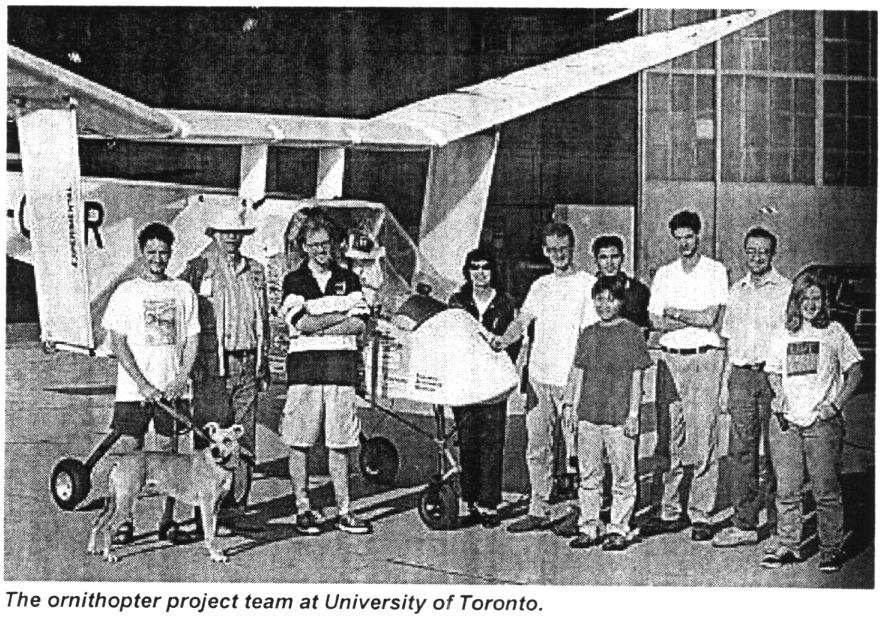
web pages at www.naturalflight.com devoted to my concept, the Birdman project. If anyone would like to be posted about my progress or become involved, my e-mail address is tony-baker@naturalflight.com.

Ken Bowers: High Flight 1

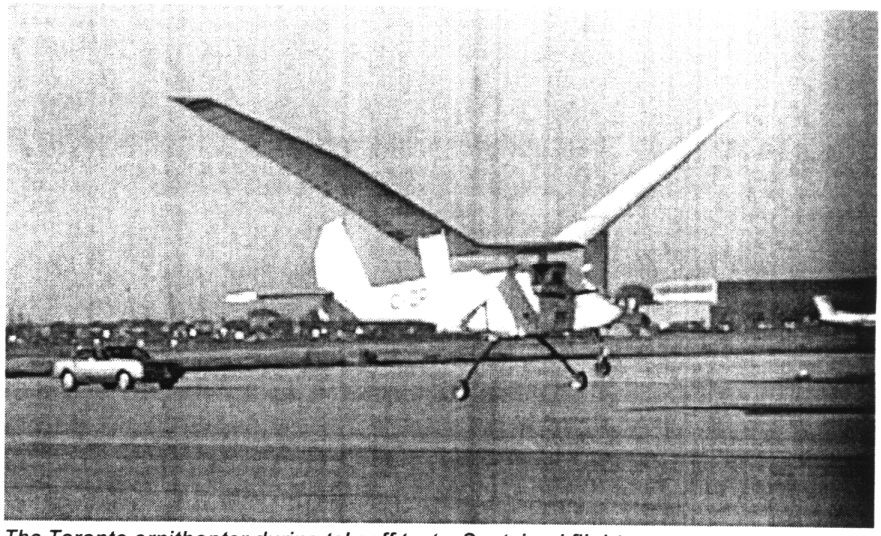
A manned, engine powered prototype named High Flight 1 is under construction in Phoenix, Arizona and should be ready for flight testing this summer. It has a 32 hp Yamaha snowmobile engine and a 15 to 1 gear reduction unit. The machine has a single wing that flaps due to a harmonic oscillation in a front strut. Flapping has been demonstrated in a ground test. At present, the machine still lacks its rear wheel and a tail. Flight controls are also not yet built. The machine is the subject of a US patent and is described at: clubs.altavista.com/ornithopter. Anyone who wants to attend the initial effort to fly should join this club; the member list will receive an invitation.

Jim DeLaurier: Project Ornithopter

The purpose of this project is to achieve humanity's most ancient aeronautical dream: flight with mechanical flapping wings. This work was started by Jerry Harris of Columbus Ohio in the late 1960s, and proceeded as a team effort with Jim DeLaurier after they met, in 1973, while both working as research engineers at Battelle Memorial Institute. When DeLaurier moved to Canada to teach at the University of Toronto, the team effort continued. This involved calculations, laboratory testing, and flight tests with a 10 ft span, engine-powered, remotely-piloted ornithopter, which culminated in successful sustained flights on 4 September 1991 at Newton-Robinson Ontario. At all times, only solutions that were applicable to a manned aircraft were considered. That is, care was taken to develop wing designs, drive trains,



The ornithopter project team at University of Toronto.



The Toronto ornithopter during takeoff tests. Sustained flight was not attempted.

and flight-controllable configurations that were sensible for scaling to larger sizes. For that reason, the 1991 ornithopter was considered to be a ¼-scale proof-of-concept technology demonstrator.

The technological foundation that was established by the unmanned testing allowed a feasibility study to be performed for an engine-powered piloted aircraft. The crucial questions concerned required power, wing performance, and structural strength. It was found that the patented shearflex wing design would give very efficient behavior at large scales, provided the spar strength was adequate. Therefore, a program was initiated to study this with sample spars loaded to test elastic characteristics and ultimate strength. This also served to refine construction methods. At the same time, Jerry Harris was undertaking the formidable task developing a drive-train design.

Construction of the aircraft began

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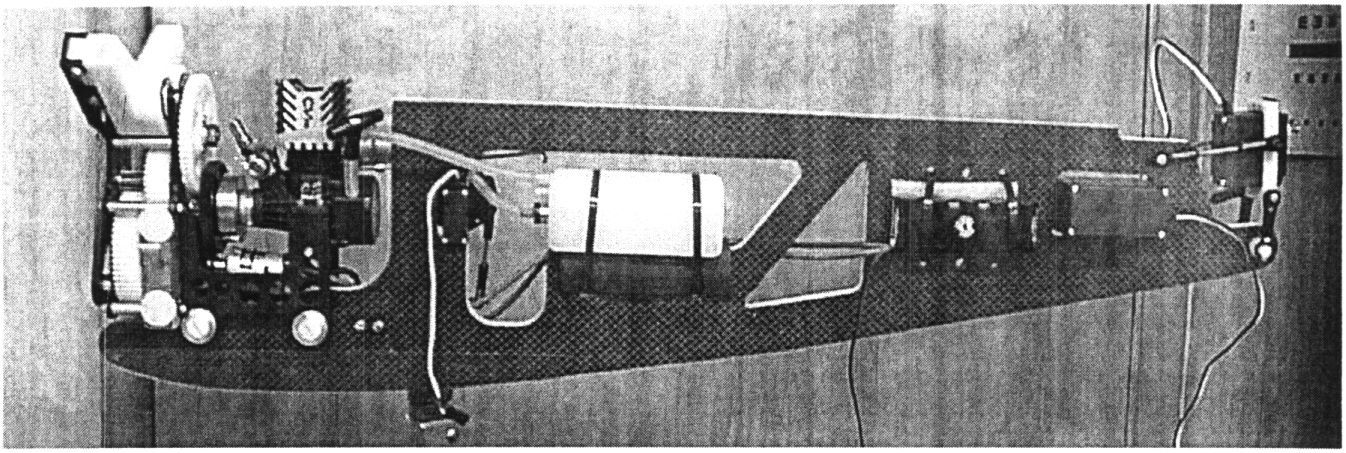


SkyBird Photos

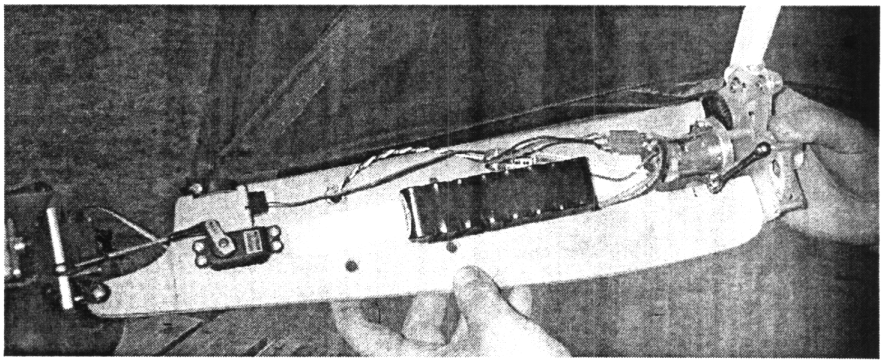
Sean Kinkade has been shipping SkyBird RC ornithopters to people all around the world. The high-performance design features a carbon fuselage, 8 foot wingspan, precision-machined mechanism, wing leveling motor, and birdlike tail control. Find out more about the amazing ARF kit on the Pteryx Model Aircraft web site, www.pteryxinc.com. Sean also has an electric RC ornithopter flying.

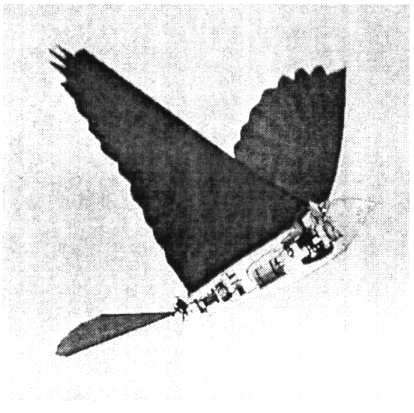
Just got back from the flying field. Flew the bird two times. It flies beautifully. Man, I was so pumped after the first flight, I was hopping around like a rabbit and hugging everybody. What a neat experience! Everyone who sees the SkyBird is truly amazed with it, and then when they see it fly, they really get excited and say things like, "Where did you get it?", "Who made it?", etc.

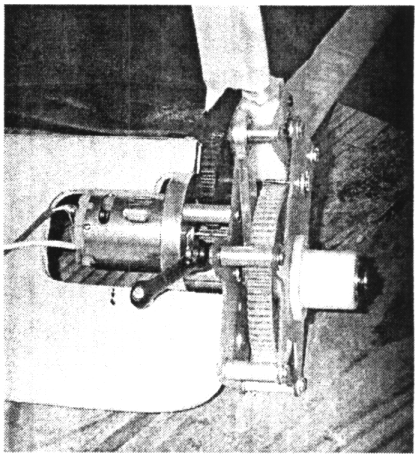
– Emery Wayman

I flew a model airplane the other day for the first time in years. It was a standard low-wing plane that belonged to a friend. It made me nervous because it flew so fast and yet was boring because the wings didn't flap! I said, "Take this plane and gimme back my SkyBird!"

– Sean Kinkade







E-Bird Video

Now on the OS web site, www.catskill.net/evolution/flight, there is a video of Nathan Chronister's new micro electric ornithopter, E-Bird, climbing out rapidly from a hand launch. E-Bird has a 60 cm (2 foot) wingspan and weight under 60 grams (2 ounces). Soon, instead of watching birds fly around in your back yard, you'll fly an E-Bird there!

(Continued from page 2)
in fall of 1995. Besides Harris and DeLaurier, the team now included a group of dedicated students and engineers from University of Toronto's Institute for Aerospace Studies. In an amazingly focused effort, the ornithopter was completed in September 1996, and made its first taxi trials in October.

The story of its design, construction, and testing is documented in a Canadian Aeronautics and Space Institute Journal article: "The Development and Testing of a Full-Scale Piloted Ornithopter", June 1999. In summary, the major issue to date has concerned ground handing during high-speed runs, leading up to takeoff. Although the three-panel wing (also patented) provides some flapping balance at the fuselage, there is still more net force during the downstroke than during the upstroke. In fact, one may look upon this as a plus-and-minus 300 lb force superimposed on a mean lift that grows with the aircraft's speed. When the ornithopter had a level orientation on its wheels in 1996 and 1997, speeds above 40 mph gave a mean lift greater than 400 lb. This caused the 700 lb aircraft to begin bouncing, which ceased acceleration and caused overstressing. The solution was to give the aircraft a nose-down attitude to suppress the mean lift buildup, as well as additional nose-wheel damping. By 1999 this was well sorted out and the ornithopter regularly self-accelerated on level pavement to 50 mph and greater. A few purposeful lift-offs were attempted where, at high speed, the throttle was reduced and the aircraft was rotated. The purpose of this was to provide the pilot, Patricia Jones-Bowman, with some brief takeoff and control experience. A picture of this is available on Ms Jones-Bowman's website: www.ornithopter_pilot.com.

On October 15, all was ready for a flight attempt. The target takeoff speed was 57 mph. The acceleration went well up to 56 mph. At that point, a wing-support strut buckled and the aircraft was damaged, bringing the season of testing to an end. What happened was clear in retrospect. The nose-down attitude caused compressive loads in the struts, which normally take tensile flight loads. Even so, the theoretical compressive strength was 1000 lb, which shows the kind of internal structural forces experienced by an ornithopter.

The ornithopter is being repaired and modified. The whole team, including Ms Jones-Bowman, is anxious to complete unfinished business. However, because of the volunteer aspect of the project, it may be a while before the aircraft is back on the runway.

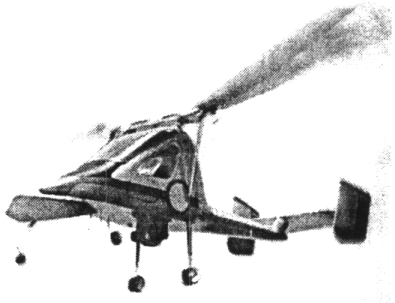
Boris M Doukarevitch: Experimental Flapping Wing Aircraft

The main principles that the project is based on: Fixed wing flight (gliding, soaring) and active flapping-wing flight are two sides of the same medal; the former is a simple particular case of the latter, with zero flapping frequency and motor turned off. Future Experimental Flapping Wing Aircraft (EFWA) must be based on a modern high-Q glider and retain all the basic glider performance. EFWA must be supplied with a motor (about 50 hp max) and with a standard hydraulic system. Control over attitude is conventional. Wing flapping frequency is as low as 1 to 1.5 Hz, max. Control over flapping wing motions uses hydraulic boosters that reduce the pilot's efforts but offer control and necessary feedback. EFWA is designed, as well as methods of tests, pilot training, etc. The creation of the first flying sample - in fact, an alteration of a usual glider - will be very cheap, by aviation measures, and therefore accessible even to a group of experienced homebuilders. Web page: members.xoom.com/bmdouk/FlapPlane.htm. E mail: bmdouk@arstel.ru.

I ought to make EFWA with my own hands, like the Wright brothers did. However, since I have no modern glider as a necessary base for EFWA, I have to crop medals and diplomas at international exhibitions and to bother busy men instead. Alas! The embodiment can be started immediately when and if I find "the second Wright" experienced in gliders and having a small workshop.

Valentin Kiselev

I have developed a project of the experimental flapping wing aircraft to be piloted by people that is able to make independent takeoff and fly over the English Channel, traditionally the barrier for new type aircraft. This craft is designed in two variances: with mechanical driver of flapping wing and with hydrodriver. In last case the position of the wing flap plane and kinematic parameters of the wing can be varied, and this experimental flapping wing aircraft can make a vertical takeoff and landing. The successful flight of a radio-controlled demonstration model supports the designed aircraft.



Kiselev's manned ornithopter concept.

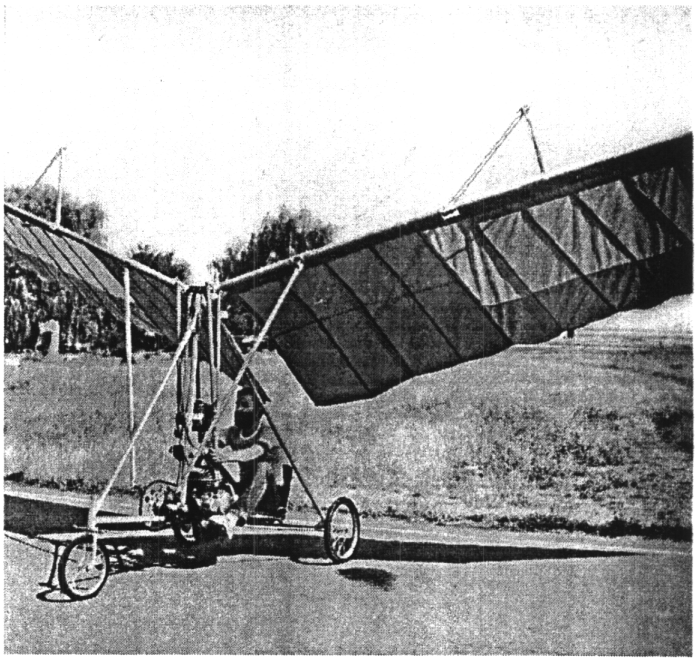
Vladimir Savov

I live and work in the city of Sofia in Bulgaria. Some of my ideas on the essence of the flapping flight are published on my page: www.geocities.com/Eureka/Boardroom/9483, where there is a video on the experimental manned ornithopter. Its span is 8 m, weight 75

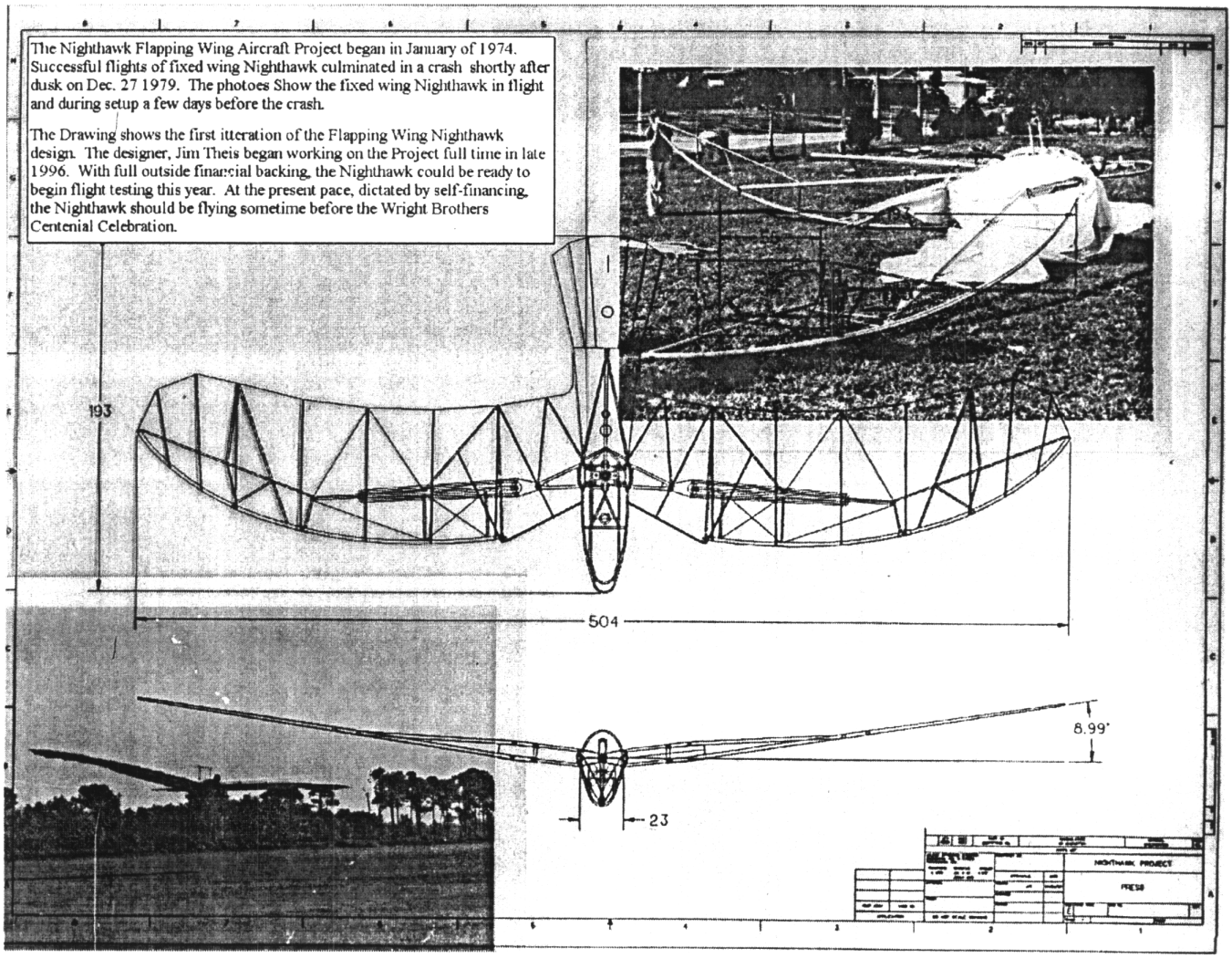
kg. The engine is a 20 hp motorcycle one. Control levers that change the angle of wing position realize the control of the ornithopter. The traction vector is changed as a result. The wings consist of two sections connected by hinges and elastic elements. With the tests made on the ground, the ornithopter showed notable traction, speed of 20 km/h, and efficiency in control even at this speed. I stopped working on it for objective reasons. Now I'm working over improvement of a radio-controlled model of the ornithopter with 2 m span and 1.7 kg weight. Tests are due in the weeks to come.

Jim Theis: Nighthawk

Jim Theis's work on the Nighthawk ornithopter is described in the accompanying illustration.



Right: Savov's manned ornithopter.
Below: The Nighthawk project of Jim Theis.



MILLENNIUM
INTERNATIONAL ORNITHOPTER POSTAL CONTEST

This year, for the first time in almost two decades, builders of flapping-wing aircraft will have an opportunity to compete internationally. In fact, the Millennium Ornithopter Postal Contest allows you to compete with people around the world without leaving your own town. Entries will be flown locally and their flight times will be sent by mail. Typically, contestants will fly their models at a local or national indoor contest and have the local contest director sign the entry form to verify the flight times, but other forms of evidence (witness signature, videotape, etc.) may be accepted at our discretion. There is an Open category for any flapper-propelled aircraft and a special Flapper Lift category for aircraft that meet certain restrictions on fixed wings. We wish you luck in this exciting and unique competition.

GENERAL RULES

- There is no entry fee.
- Each entry must include:

1. Entry form, completed and signed. The local contest director's signature is required unless the contestant provides other proof of flight duration (e.g., videotape) deemed suitable by OS postal contest director Nathan Chronister.
2. A scale 3-view drawing or clear 3-view photos of the model, with pertinent dimensions of model and motor.

- All entries must comply with the Design Requirements.
- The OS contest director has final authority to decide on compliance with rules.
- Flights must be made in the year 2000 and entries *received* by 15 Feb 2001. Send to Nathan Chronister, PO Box 376, Arkville NY 12406 USA.

SECTION 1: TO BE COMPLETED BY CONTESTANT

Name: _____
Address: _____
Name and date of local event: _____
Organization sponsoring local event: _____
Name of local contest director: _____

☐ Category A (open) ☐ Category B (flapper lift)

SECTION 2: TO BE COMPLETED BY LOCAL CONTEST DIRECTOR

I certify that the contestant named above flew an ornithopter (flapping-wing aircraft) for a duration of ____ minutes and ____ seconds, and that the same ornithopter met the Design Requirements below. Signature: _____ Date: _____

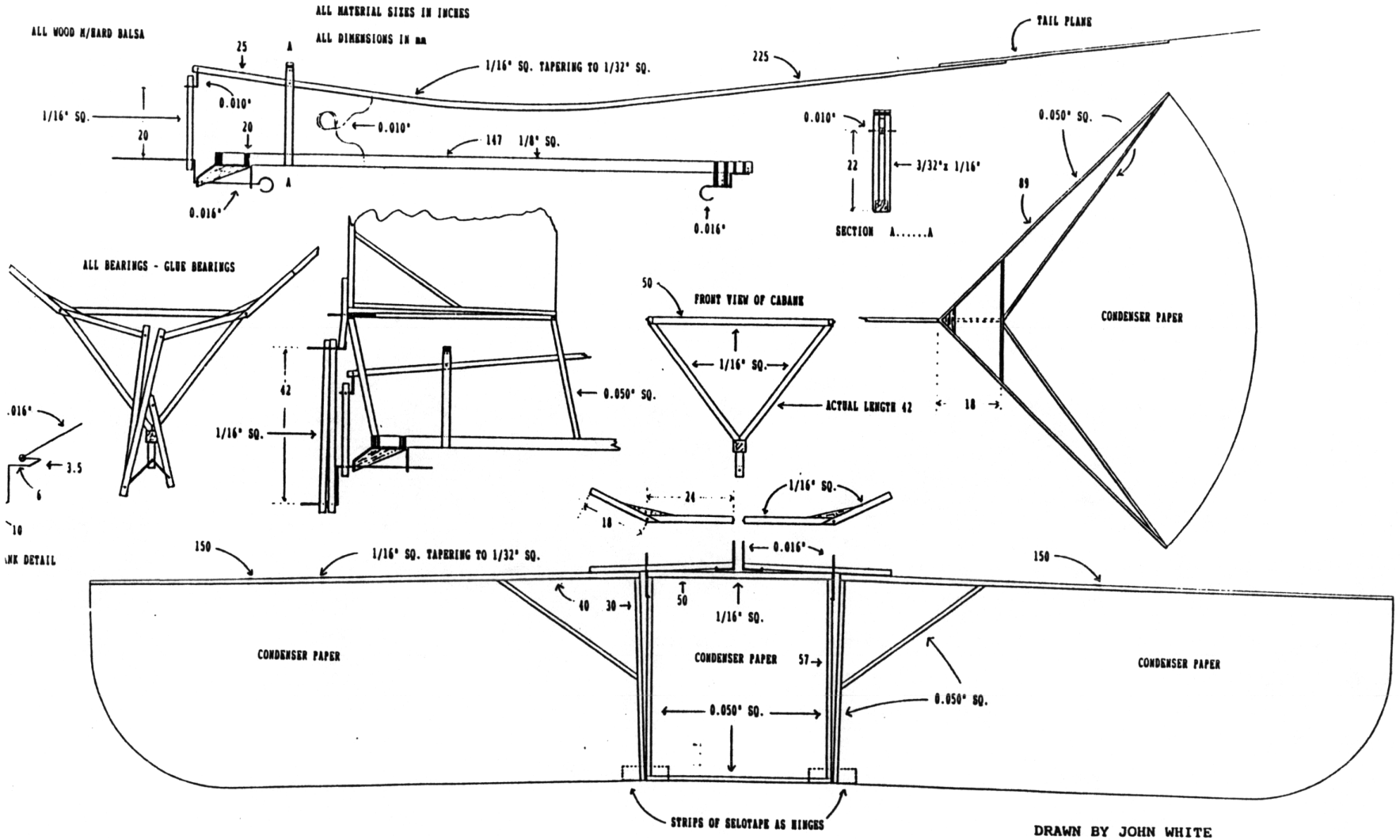
DESIGN REQUIREMENTS

- An eligible model is propelled solely by flapping wings or small flapping fins.
- Models must be flown indoors and launched by hand within two meters of the floor.
- Power must be provided by a rubber motor.
- If the entry is for *Category B*, the following *additional requirements* must be met:
  - All non-flapping lifting or stabilizer surfaces must be aft of the rear motor hook. This applies to stabilizers, fixed wings, fixed portions of flapping wings, fuselage structures that could produce significant lift, etc.
  - All wings must have the same flapping rate and roughly the same range of motion.

THE ORNITHOPTER SOCIETY

' MOSQUITO '

DESIGNED BY JOHN WHITE



DRAWN BY JOHN WHITE

Industrial Evolution
PO Box 376
Arkville NY 12406 USA

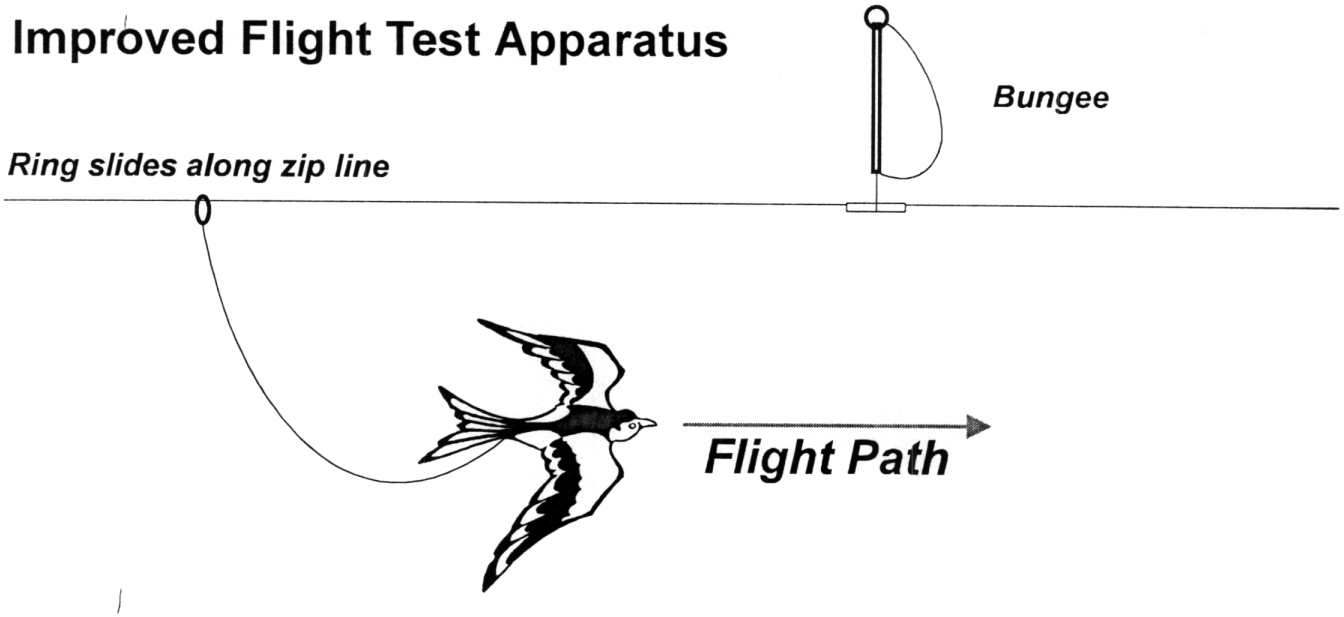
Ornithopter Society Membership Info

Join the Ornithopter Society or renew your membership: Dues are $12 per year in the USA. Dues outside the USA are $17 US per year. Checks are payable to *Industrial Evolution*.

Get published: Nathan Chronister, editor of *Flapping Wings*, invites you to send your articles and photos to be published in this newsletter. Send your material to the address above or E mail it to evolution@catskill.net.

www.catskill.net/evolution/flight

Improved Flight Test Apparatus



The zip line system shown above is an obvious evolution of the flight testing apparatus I described in the last issue. Because the ornithopter is suspended from a nylon zip line of arbitrary length, the improved system can be used for long outdoor test flights as a way of eliminating ground contact. The ornithopter drags behind it a thin kevlar line tied to a lightweight plastic ring. The ornithopter is unimpeded in flight until it wanders too far from the zip line or the ring catches on the braking mechanism. The braking device is a plastic tube attached to the ceiling or a tree via a rubber bungee. Being able to test and adjust electric ornithopters with no risk of damage has greatly accelerated my development program.