WINTER 1999

Flapping Wings

THE ORNITHOPTER SOCIETY NEWSLETTER

Fun with Freebird

I built a Freebird 2 over the weekend, with great success. It only took me a couple of hours to build, and I was amazed to see how well it flew — beautifully. It looks pretty much like a dove, very elegant. I was wondering how the wings flap slowly enough to avoid shredding the whole construction, but as soon as I got it going it was obvious: air resistance slows the wings down. I wanted to send you a photo. I mentioned to you before that this would be a good addition to the site, to show the completed model as well as the diagrams, but I see today that you have added just this. I wanted to thank you anyway.

I had difficulty getting good climbing flight from it. My materials were all as specified, so it shouldn't be heavy. It was a little nose heavy, so I added about 2 inches to the fuselage, which gave me more power, but mainly this made more duration. Trimming it to change the flight path was tricky. I found that it would thrash about a bit on landing, probably changing the careful bends and tweaks made prior to the flight, so two flights were never the same. Any tips on making it climb better?

I'll try the mosquito next I think. When I'm paid, I shall have to join OS and have a look at your manual. Unfortunately, I can't find any more online plans.

— *CharlieTait*

I'm in the midst of constructing a slightly modified version of Freebird 2: motor stick and pylon extended to 6-inch length, and span increased from 16 inches to 20 inches. I'll let you know how (or if) it works out. Smokey, my Siamese cat housemate still hasn't caught a Freebird. That hasn't been for lack of trying, however! He still thinks that an ornithopter is solely for his amusement.

— *Benjamin Hartley*

I've been tinkering a lot with Freebird 2 and have had some interesting experiences. Since you asked, I'll list them. It will be a bit long, so here we go:

I find the plans simple and easy to follow. Had no difficulty at all getting the first one built. And the mechanical setup — I must call it elegant, very simple and efficient. The rubber motor I use is 1/8 by 1/32 inch size, and eventually I figured out to double it up (2 loops) to make Freebird 2 climb. A single loop is too weak and the best I can manage is a slow decent.

Most of what I improved is just to lighten the ornithopter. I find that lightening the 'thopter makes it possible to use less strands of the motor because of the smaller torque required, so there's also less strain on the frame. My fuselage is now chopped down to 1/4 by 3/32 thick, and the stick between the fuselage and the wing hinges is 3/16 by 3/32. I used epoxy with some extra reinforcements at stress points. I also removed the 1/8 square stick just below the wing hinges and just

Member Directory

Want to know who's doing what in the study of flapping flight? Want to get connected to others in the field? Some dedicated OS volunteers are putting together a directory of society members. The OS Member Directory will have contact info and details on what each member has accomplished.

You can be included in the directory just by sending back the survey on the back of this newsletter. You can also fill out the form online, at www.catskill.net/evolution/flight/osform.html. All members are encouraged to participate. If you have made significant contributions to our field, this is a good way to be recognized. More importantly, it's a way to get in contact with people doing similar projects.

Ornithopter Society Membership Info

To join the Ornithopter Society or renew your membership: Dues in the USA are $9 per year. Dues outside the USA are $14 US per year. Checks are payable to:

Industrial Evolution
PO Box 376
Arkville NY 12406 USA

Newsletter: Nathan Chronister, editor of *Flapping Wings*, invites you to submit material for the newsletter. Send items to Nathan Chronister at the address above, or E mail your articles to evolution@catskill.net.

OS on the web:
www.catskill.net/evolution/flight

loosely tied the end of the wing to the end of the wire that you attach the tail to, using string. I suspect the little bit more play allowed the wing to give better lift, but that is not obvious because this change also lightens the 'thopter.

The string is just long enough to float the wing in its original horizontal position. When the wings are flapping at full speed, the motion somehow keeps the wing almost completely horizontal, though it collapses a tiny bit on the up stroke. I attached the string with two small pieces of clear tape. One on each side of the wing tissue. The tape spreads the stress and I've never had problems with a ripped wing or the string coming loose. It should be simpler to build it this way, just one knot and two pieces of tape.

I've also simplified the body construction. It's only made from two pieces on my Mark III Freebird, the fuselage stick and the vertical piece with the wing hinges on top and the crank hinge on the bottom. I didn't use any thread wrapping because the connection between wing hinge and crank is now one piece and quite strong plus I used epoxy for all metal-to-wood connections [might not work with superglue]. As for the fuselage-to-riser joint, with a large enough piece of clear tape, sticky side up on the table, I just applied the glue to the joints, pressed them firmly together, and pressed them onto the tape, and then just waited. This works with both epoxy and white glue and the tape peels off easily after the glue dries. And it's also easy for a beginner, I think. For reinforcement I just piled a bit of epoxy at the corners; for white glue a small triangular piece of balsa in the corner should do the trick.

My wing spars are 3/32 square with reinforcement where they are pierced by the wing hinge wire. All this makes a big improvement because I can now use 1 normal loop plus 1 thin rubber band to get great climbing power.

I also tried a bent wing design, where there's a hinge at the middle of the wing that allow the wing tips to bend down but not up. The idea is that when the wing swings down it remains straight, and when it swings up the mid-wing joint bends down to reduce the wing area. This is supposed to increase lift. It doesn't work though. To make it work I had to add a rubber band on top of the wing to pull the wing tip up, and the rubber band had to be so stiff that the wing tip doesn't bend down much at all. The extra weight and angular momentum of the wing makes this not worth the while.

I did figure out something good from it though. I found that if I make the wings rigidly bent down (15 degrees, haven't tried other angles) at the midpoint like the wings on birds, the wing tissue will bend down a lot more on the upstroke and maintain its shape on the downstroke. This gives significantly more lift with negligible weight penalty. It also makes the wing stroke look a lot more like a bird than an insect (straight wing). If you haven't tried this already, then try it. You'll like it. [Editor: I have used a curved spar to achieve the same effect. If the balance point is just right and you have friends in high places, the model will fly without a tail, or with only a vertical stabilizer. I've never tried it with Freebird, but it worked my Tim.]

As you suggested, I built a biplane Freebird like a dragonfly. The mechanics are a lot more complex, and that means more weight and less efficiency. I can't get any climb out of it, but hey, it looks neat. It will be the novelty version Freebird I guess. [Editor: Dedicated biplanes hold the record for indoor ornithopter duration! They have a more efficient upstroke and less load on the crank, allowing flights about twice as long.]

I used a single rubber motor with a lever transferring power to the rear pair of wings. It was modeled after the dragonfly, with the two pairs of wings aligned front and back. The phasing was 180 degrees front and back, and 0 degree left and right, as dictated by the setup. I had no problem with stability, but problems with power. It was heavy and the balsa lever with the end wires flexes a lot, perhaps losing 40-50% of the power in the transfer. And the best it can do is a slow decent.

I'm experimenting with a 'thopter with a 10 inch motor stick right now. But I got the balance right by moving the wings back about 3 inches and driving them with an axle [Editor: an alternative to using a lifting tail]. The interesting part is how to join the motor wire to the transmission wire. I don't know if there's a name for it, but here's what I did: Both the motor wire and the trans wire have identical cranks. Both cranks have two conrod connection points; each point is the same distance from the hinge and 90 degrees out of phase. Two conrods connect the cranks such that the rods are always parallel as the cranks turn. If that's not quite clear, here are the bending instructions for the cranks (wire originally points up): 10 mm south, 4 mm up (conrod 1), 14 mm north-east, 20 mm up (conrod 2). This joint doesn't give perfectly smooth transmission of power like gears or pulleys, but it's much lighter. I would estimate that about 80 to 90% of the power is sent back, but haven't dreamed up a way to measure that yet. It appears to be a lot more efficient than the lever power transfer, but still adds quite a bit of weight. It will also let me try biplane setups with arbitrary wing phasing. I'll have to see what I can make of it.

— Qin Liu

Lippisch-Like

by Steve Morris

I've been working on small spy planes for the last year and haven't done too much with ornithopters, but I did build one interesting model. It has a 115 cm span and flaps the outer 50% of each wing panel, just like Alexander Lippisch's rubber powered ornithopter from the 1930s. I used a DC motor with 100:1 gearbox that I purchased from Hobby Lobby (Mabuchi 280 motor I think) and a 5 cell, 110 mAh nicad pack. The flapping frequency was a little under 2 Hz. The model had a conventional fuselage and tail. My best flight was 35 seconds, where the model circled around me and looked like it would have climbed higher if it weren't turning so tightly. It was hard to adjust the turn because it was caused primarily by flapping asymmetries between the two wings, due to a floppy linkage. I was pretty happy just to see it fly at all, but the gearbox didn't last very long and I've retired the model.

Servos Reconsidered

by John White

Georges Chaulet's article on servo-powered models I found very interesting as it reminded me of an experiment I conducted many years ago. I built a module that linked a servo, a nicad battery, and an electronic circuit that had at its heart a crystal oscillator — the crystal embedded in the CMOS chip. The output of the circuit mimicked the signal from a transmitter swinging the servo from one limit to the other and back again. The number of signals was controlled by a 4-way DIL switch which acted as a timing device. A 2-pin DIL socket acted as a charging point. The module was put in a model based on Alexander Lippisch's layout. Trim pots in the electronic circuit controlled the frequency of the wing beats and two others controlled the limits of the wing sweep.

When launched with stationary wing-tips, the model had a good glide. When the 4-way switch was operated to give a 30 second motor run, the wing-tips beat quite strongly, but when launched they stopped beating as they lacked the power to operate correctly. I abandoned the experiment, as the power-to-weight ratio was obviously too low. A more powerful servo would require heavier batteries. It appeared a no-win situation.

To the Editor

Hi Nathan! I got the latest *FF* [*Flapper Facts*, previous name of this newsletter] yesterday. I enjoy reading it as usual, but it's still the same old theoretical pontificating, even though I have proved the success of the Spencer membrane wing beyond a shadow of a doubt.

It seems that OS is more an intellectual club rather than a material "hands on" club. I do find this mildly annoying. I have tried to contact *FF* contributors in the past but they haven't reciprocated. Yesterday I phoned Dr. Petrovich and left a message but he hasn't called me back yet. He lives 4 hours from me by car. Are these people afraid of me calling their bluff?

Petrovich's design appears unclear and idealistically ambitious. He seems like the reincarnation of James LG Fitzpatrick! He's put the cart ahead of the horse in getting a patent without even building a *flying* model. In my opinion, it's OK to dream and come up with conceptions of futuristic ornithopters as long as you disclose that, but do your homework first before implying you have a guaranteed workable design. And homework includes working, flying, prototypes! Basing an ornithopter design on Pemrams is like designing a flying saucer whose success is contingent upon the development of anti-gravity.

Petrovich is the fourth man I've learned about that is seeking investors to build man-carrying ornithopters. There are DeLaurier, Jim Theis, Kiselev, and now Petrovich. Do any of them have models that fly over ten minutes? I don't think so. How do you expect to build a full scale machine if you can't get a model to stay in the air? Are these people serious? Has even one of them contacted me for some practical insight? The answer is no.

What we, the ornithopter community, need is not more theory. What we need is the equivalent of a modern day ornithopter Wright brothers. There were all kinds of mathematical theories on flight floating around in the late 1800s, but who changed history? Two bicycle repairmen! It was not the intellectuals of the day.

I'm very surprised by the lukewarm response many of the *FF* contributors have expressed towards my VT models. When I saw the Spencer footage, my reaction was just the opposite. I saw what obviously worked and focused my designing in that direction. TR Quermann states that the VTs prove "practical" but then speaks for the ornithopter community by saying that there must be a better way. I agree. But I also say "put up, or shut up!" It's like saying in 1903 "yeah, the Wright Flyer proved practical but there must be a better way". You got a better way? *Prove it*! Forget all the numbers and figures and formulas and sketches. Let's see your "better way" in a flying model on video!

The ornithopter community needs to come back down to earth and get some models up in the air!

— Sean Kinkade

Goose Attack

by Scott Leatham

The basic machine was close to the Freebird in design. I used a Styrofoam Japanese Zero rubber-band-powered model for the fuselage and some Styrofoam wings from a simple wind-up monoplane. I formed a crankshaft from some aluminum tube stock and fashioned the cranks from super-stiff yet flexible fiberglass/resin rod. I used alum-tubes as runners to control angle of the cranks. I used a plastic transmission from a wrecked Styrofoam (large) airplane model (made by a Japanese firm who also made the Zero. The transmission was switchable (during pre-flight) between two power/speed ranges and came with an extra gear to allow two more ranges. This helped extend flight duration or performance depending on the program you wanted. I've timed flights as long as 90 seconds. If the wings happen to stop at level or with a slight dihedral, the plane was an OK glider as well, although I never really got it balanced for gliding. Lots of labor cutting and shaping resulted in a model about of 18 inches wing span. It was all very, very light. It flew well after several false starts and minor modifications.

The geese event came after I noticed that flying a toy ornithopter (bought at the Seattle Science Center — they still sell them) in my yard resulted in the local swallows trying to attack it in flight. I took the toy to a field to fly it near some geese. They seemed only slightly interested. I then built the larger machine and tried again. This time the geese took flight when my craft flew over them by about 25 feet (I set it to circle); one bird tried to meet it in flight, then diverted at the last second. Later that day, a straight flight off a small hill near a mall under construction resulted in the plane gaining great altitude over a large parking lot as it continued over a freeway then straight over a large lake (Lake Sammamish). I think it hit a thermal over the pavement. I lost sight of it due to large Cottonwood trees at the lakes' edge. When I made it to the lake, the plane was nowhere to be seen.

I'm thinking about building another one, but the local hobby store no longer sells the type of Styrofoam planes I used. However, I was in Japan last year and happened by a hobby store in Akihabara that had the exact plane I used for parts. It was twice as expensive, and I only had enough money to buy a digital camera that I'd been eyeing for some time. I'll see if I can find the planes on the Internet (especially the plastic transmission which was way cool). Have you heard of any of this stuff? It's a Japanese firm, does a great job on foam models.

I had a Wham-O-Bird when I was a kid (about age 7). It was a hand-me-down from one of my older brothers. Of course it didn't survive the onslaught of the 4 techno-logically advanced boys in my family. I barely remember what it looked like (although recently I was reminded when I saw the web page showing someone found one).

Flippy Floppy Plans

by Don Slusarczyk

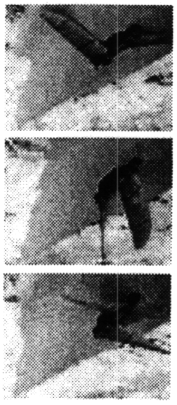
This is basically my version of Frank Kieser's "Fancy Girl", which was the first ornithopter to break the 10 minute barrier. It is a very good design for learning how to build ornithopters, and the model flies excellent. This model holds the senior cat. I, II, III, and IV indoor records. [See facing page.]

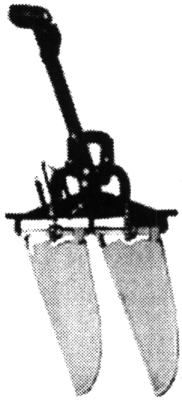
Flapping Kayak

Hobie has announced an unusual manned flapping vehicle. "The Hobie Mirage, a sit-on-top kayak powered by the ingenious new Hydro-Sail Drive, easily skims along at speeds equal to or better than a paddled kayak," according to the company's website at www.hobiecat.com. The kayak offers a full-body workout since it can be pedaled and paddled at the same time. Construction is anodized aluminum with stainless steel fittings. The self-cleaning mechanism resists wear from sand and dirt. The flapper unit can be removed for transport and storage. The kayak weighs 25 kg without the 3.6 kg flapper.

Roy Clough reports seeing another flapping-foil watercraft in a newsreel. Unlike the ones in the Spring 1997 issue of this newsletter, the one he saw had the operator facing 90 degrees from the direction of travel. Two hydrofoil floats were worn like skis; by shifting his weight from one foot to the other, the operator moved the foils up and down, resulting in sideways propulsion. The foils may have been mechanically linked to each other. If you know more about this machine, please contact the editor.

Below: Underwater views of Hobie's flapping-foil kayak reveal the action of the blades.





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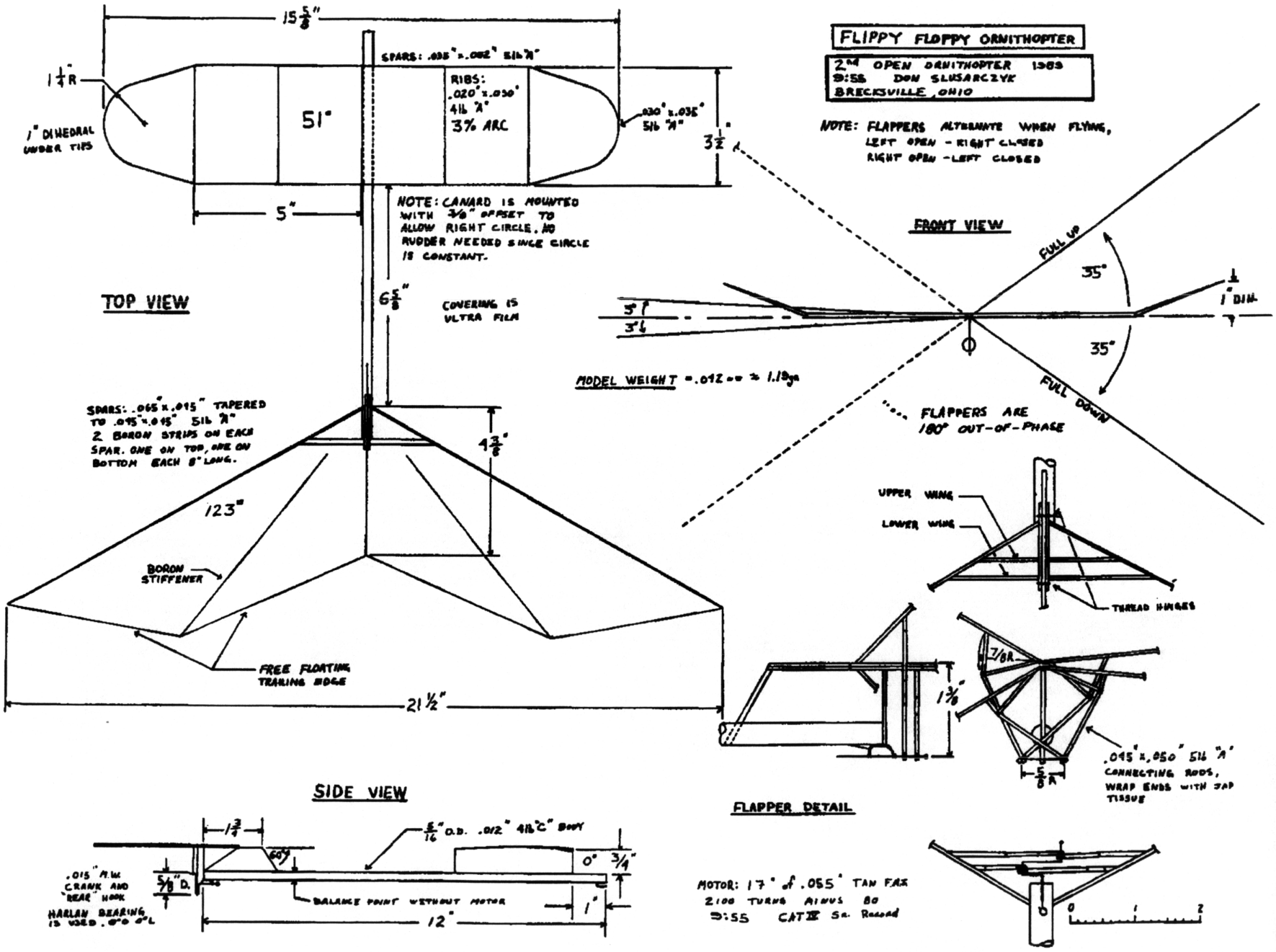

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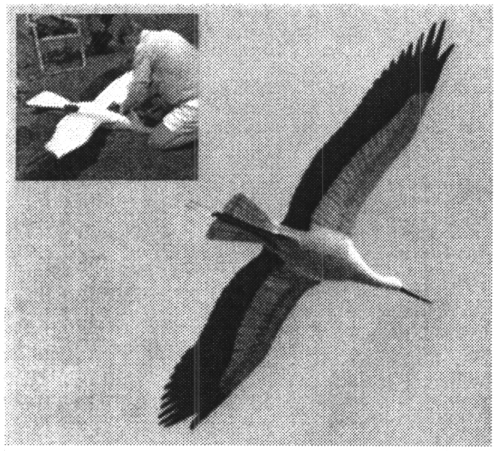
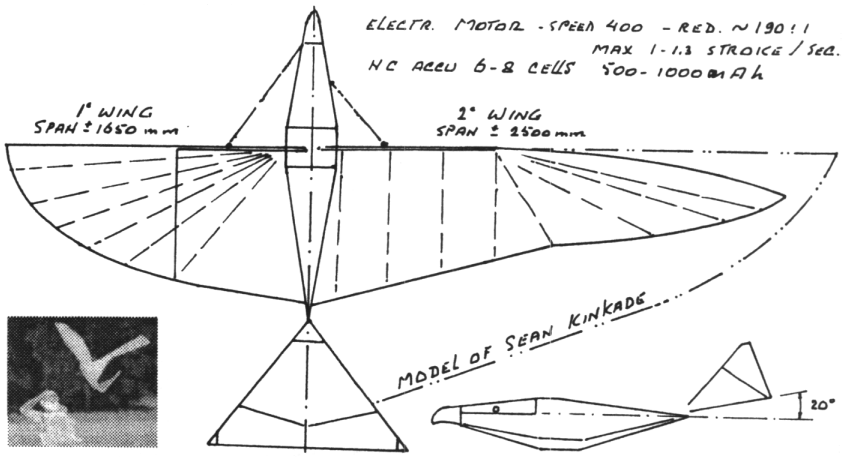
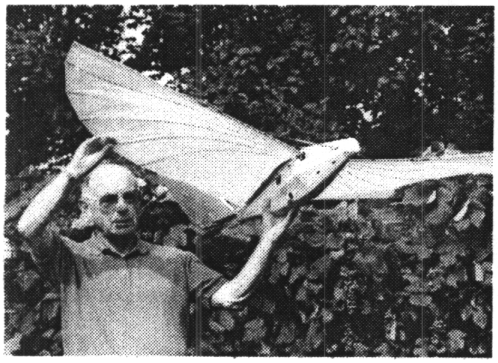
Inter-Ex 1998

Fred Ludwig was back at Inter-Ex this year. However, he left his electric RC ornithopter at home in favor of a beautiful RC stork. The stork is powered by a pusher prop which, when folded, resembles feet. You may remember Bob Hoey's similar bird models. Also at the experimental model aviation meet was Theo Gordijn with an electric ornithopter. His model hasn't made level flight yet, but it won the FMT Award, which is the highest award given at Inter-Ex. The 1120 gram ornithopter has a 165 cm wingspan and is powered by a Speed 400 motor on 8 cells, geared 190 to 1. Gordijn, eager to share his love of flight as he battles against cancer, has generously distributed these photos and drawings of his model. This year Inter-Ex will be held at Nederweert, Netherlands on 14 & 15 August.







Lachesis Project

by Phil Jones

The ornithopter I've been working on for the last two years is still under construction. The Lachesis, as I call it, is to have radio control and fully articulated wings. It turned out that the gearing system I had designed for it did not work. It was meant to be my 10th grade 4-H project. It still won the Ohio State Fair simply because of what it was. The first comment from the judge was "This is a *what*?!"

It then sat in pieces on the hobby desk for a year and a half before I decided to try a new technology. I began looking into shape memory alloys, also called muscle wires. When cool, they can be stretched up to five percent, and when electrically powered they shrink back to their original length. I was planning to use ten meters of wire to flap the wings. The wires would contract to produce the downstroke, while rubber bands would power the upstroke. I also built a pair of fully articulated wings that can move forward, tilt the leading edge up, and fold the remainder of the wing to reduce drag, while still allowing a suitable wing for gliding.

I just found out the sad truth this morning that the muscle wire has a horrible amount of electrical resistance. It requires 27 volts to power *one* meter, so there is no way to power ten. I'm looking at getting an electric airplane motor. If I can manage to find a gearbox that can take this down to 60 RPM, I should have better results. I want to enter the Westinghouse science competition to earn money for college.

Engineer continues quest for flapping wing

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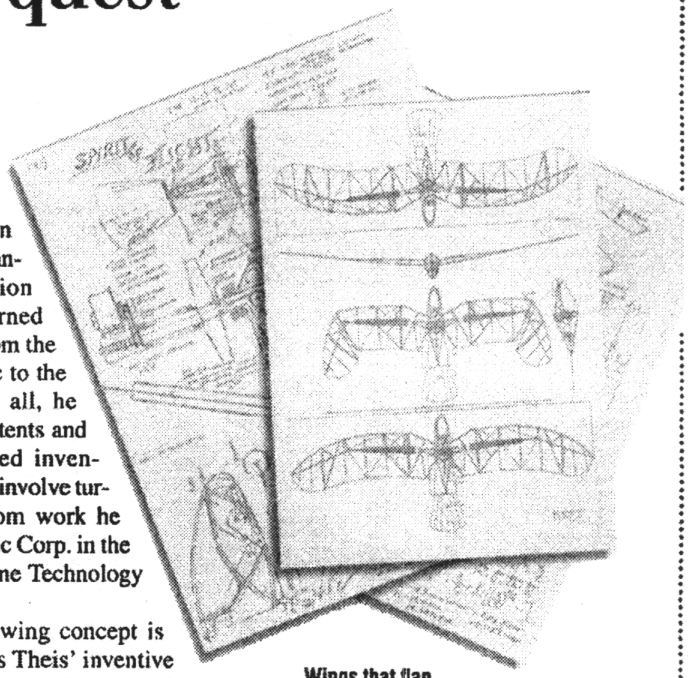
Charles J. Murray, Senior Regional Editor

Cannon Falls, MN—In his daydreams, Jim Theis sees small personal aircraft that can dip, turn, and hover like dragonflies. He envisions teen-agers soaring across town, dropping in on friends. And he foresees the day when soldiers will fly bird-like aircraft across enemy lines, swooping in on their targets as they do their reconnaissance.

Theis knows that his vision won't take shape soon. But he can't help working on it. Surrounded by fluid dynamics textbooks and reams of spreadsheets that contain 4,000 rows of propulsion calculations, Theis continues investigating his dream: the creation of a flapping-wing aircraft.

He's been at it for more than 20 years now. In the more than two intervening decades, he has taken time off to start his own company, New Product Design Inc., which he runs with his brother, Charley, who is the company president. Working in a converted barn in the tiny town of Cannon Falls (population 3,232), he has churned out ideas ranging from the theoretically esoteric to the purely practical. In all, he has more than 20 patents and countless unpatented inventions. Many of those involve turbines, stemming from work he did for the Hollymatic Corp. in the 1970s and Air Turbine Technology in the '80s.



Wings that flap.

But the flapping-wing concept is still the one that stirs Theis' inventive passions. He knows that its chances of near-term commercial success are slim, but that doesn't stop him. "Don't think I don't know what it sounds like when I talk about flapping-wing aircraft," Theis says."People think it's a waste of time. But I would ask you to think about what it would be like if we could use aircraft locally. I can foresee a time in the future when people will climb into their 'flappers,' punch a button, and a pair of wings will pop out."

That Theis can work on such experimental concepts is amazing in itself. Nineteen years ago, while flying an ultralight of his own design, Theis's aircraft clipped the edge of a steel tower and crashed 35 ft to the ground, breaking his back. He's still in a wheelchair.

In typical Theis fashion, however, his spirit was unbroken. His physical confinement gave him the opportunity to design better wheelchairs. In the past decade, he has designed steerable wheelchairs, hand-crank wheelchairs, and wheelchairs that fold up. His hand-crank chair is currently licensed to Ultimate Support Systems (Fort Collins, CO). The chair's hand crank is said to help eliminate serious hand, shoulder, and elbow injuries that often plague those in wheelchairs.

In addition to his work in flapping wing aircraft, inventor Jim Theis has developed a steerable, hand-crank wheelchair.

Whether or not the flapping wing enjoys similar commercial success isn't an issue for Theis. "You have to have faith in the process," he says. And because he has a rare abundance of faith, he continues his work, which is sponsored mostly by his wife, Linda. He has already laid out the design of a 420--lb piloted prototype with a 45-ft wingspan and a 15 hp motor. He plans plans to fly the prototype before the year 2000.

This year, he will again give a forum presentation at the world-renowned Experimental Aircraft Association Fly-In Convention in Oshkosh, WI, in August. The forum, he says, may not lead to the near-term development of a product, but it will add to the foundation of knowledge that's being built."The Wright brothers did all their work because they were driven by curiosity," Theis concludes. "When you invent, the passion has to be there. You can't pay for that kind of emotion." dn

Member Directory Survey

If you wish to be included in the OS Member Directory, please complete this survey and mail it to Tony Baker, 2646 East 5 Place, Tulsa OK 74104 USA, or complete the survey online at www.catskill.net/evolution/flight/osform.html.

Name:
Address:

Country:
Phone (day):
Phone (evening):
E mail:
Accomplishments:

Current interests or projects:

Publications. Please list books or articles you have written, or that have been written about your work, with page numbers and issue dates.

Plans and info. Please describe any plans, data, photos, etc. that you are willing to give or sell to other members.

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