No. 219 SEPTEMBER 2004

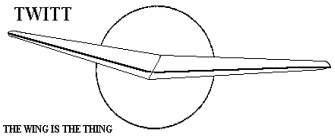
T.W.I.T.T. NEWSLETTER

Proud owner Bob Chase with his brand new Soaring Gull 2000 that was delivered to him during the 2004 SHA Western Workshop. He will be transferring it to Perris Valley Airport where he will really start learning how to fly it well. He was very excited since he has been waiting nearly a year for the plane.

T.W.I.T.T.
The Wing Is The Thing
P.O. Box 20430
El Cajon, CA 92021

The number after your name indicates the ending year and month of your current subscription, i.e., **0409** means this is your last issue unless renewed.

Next TWITT meeting: Saturday, September 18, 2004, beginning at 1:30 pm at hanger A-4, Gillespie Field, El Cajon, CA (first hanger row on Joe Crosson Drive - Southeast side of Gillespie).



THE WING IS THE THING (T.W.I.T.T.)

T.W.I.T.T. is a non-profit organization whose membership seeks to promote the research and development of flying wings and other tailless aircraft by providing a forum for the exchange of ideas and experiences on an international basis. T.W.I.T.T. is affiliated with The Hunsaker Foundation, which is dedicated to furthering education and research in a variety of disciplines.

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Meetings are held on the third Saturday of every other month (beginning with January), at 1:30 PM, at Hanger A-4, Gillespie Field, El Cajon, California (first row of hangers on the south end of Joe Crosson Drive (#1720), east side of Gillespie or Skid Row for those flying in).

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PRESIDENT'S CORNER

As with most years, there were a few of us TWITTers at the annual SHA Western Workshop held at the Mountain Valley Airport in Tehachapi, CA. Bruce Carmichael again put together an excellent program, ranging from Al Bowers talking about "Aero Gravity Assist" soaring that would accelerate a space vehicle to speeds in excess of Mach 48, to Taras Kiceniuk talking about how to predict dynamic soaring, to Bill Liscomb relating the history of hang gliding using Rogallo wings.

The usual group of hanggliders and ultralights were missing from the event this year, which comprised the flying wing segment. However, Norm Casteneto did bring his powered SWIFT in on Sunday and made several flights.

Richard Avalon was there and indicated his business in selling Mitchell B-10 and U-2 plans is continuing to grow. He will be in a position very soon to start shipping parts, like fittings, to builders and will eventually be offering kits (projected date unknown).

As you can see from the cover we are featuring Bob Chase with his new airplane, the Soaring Gull 2000 motorglider. This version has an extra 10' of wingspan over the standard version and looks like it could do some soaring in the right conditions. Bob has agreed to give us a preliminary pilot report on his first experiences with the plane in the next newsletter. I will also include a few more pictures I took of it sitting in Les King's hanger at Tehachapi the day before Bob ferried it to Perris Valley Airport, which will be his base of operation for a while.

So you can see what you missed by not taking a short vacation and attending the Western Workshop. One builder said he just found out about the workshop last year and has vowed never to miss another one. That says a lot about the type of programs Bruce has pulled together over the years.

Andy

SEPTEMBER 21, 2004 PROGRAM

I am sorry to say that we haven't been able to put together a program for the September meeting. I know this has become the norm rather than the exception, but there just isn't anyone left in the Southern California area that has something new to tell us about flying wings. We will continue to keep our ears open for any good prospects, but we can always use your help in finding people. Let us know if you do, and we will make the contact.

However, ***I am please to announce we have made contact with Dave Raspet***, Dr. August Raspet's son, who has agreed to do a November program on his father's work, including experiments with the Horten IV. Dave indicated he would have recovered more of his father's pictures by that time, so it should be a great program. **Mark November 20th as a must meeting.**

LETTERS TO THE EDITOR

(ed. – Last month I included a letter from Koen Van de Kerckhove talking about his proposal for the basic ultralight Motorglider. Since then he has provided more information through various channels, and Bob Hoey has provided a reply to Koen's inquiries relative to the bird like tip feather control system, and to Tony Neerings' winggrid questions. Our thanks to Bob for his insight and quick responses. Koen had also included the concept drawings on the following page. Also take a look at what he has on this at his website. http://users.skynet.be/nestofdragons/f_o_m_t_index.htm)

August 14, 2004

Koen:

Here are some off-the-top-of-the-head thoughts regarding your BULM Proposal.

(1) The wing aspect ratio looks to be about 3.7, which is low, but probably OK. The good news for a low-aspect-ratio flying wing is that the chord is fairly long which results in a longer moment arm for pitch stability and controllability. The bad news is that the angle of attack range is quite large and you will need a LOT of power to take off and climb. You will have to use a reflexed airfoil, and it appears from your drawings that you have done that.

(2) Don't expect anything dramatic by way of increased efficiency from the bird-feather wing tips. I don't think they are aerodynamically any more efficient than a normal tip. The trailing-edge-feather elevons that you show will produce a lot of adverse yaw. Since you show a rudder, you can link the two and probably create a reasonable turn capability, but I suspect you may have trouble if you also intend to use those surfaces for pitch control (tip stall, etc.). You might consider using the forward 2 or 3 feathers on a span-wise axis for roll control (as I have been doing on my bird models), and a separate, inboard trailing edge surface for pitch control. The advantage of using the forward feathers is that the neutral or zero setting for both feathers can be adjusted by rigging to eliminate any adverse yaw.

(3) It looks like your placement of the pilot is a little too far aft. I suspect that your cg will be behind the best starting location of about the1/4 chord. Even if the airplane can be balanced by the engine and fuel, your cg will vary greatly with the weight of the pilot. Try to put his belly button directly under the 1/4 chord.

(4) Regarding the rear tip feather never being stalled, I suspect that is not true. The flow over the rear feathers depends on what is happening on the forward feathers. There is no magic formula for determining the relative angle of incidence of the individual feathers as you progress aft. What is right for one condition may be very wrong for another condition (of course the birds can vary these individual angles at will!). What I am saying is that a stalled condition on any of the forward feathers (either from too much positive, OR NEGATIVE angle of attack) will mess up the flow over the top of that rear feather.

(5) The overall configuration has some merit, and would be worth building an R/C model to establish the best control system, airfoil, cg location, etc. You could also incorporate some of your hinging ideas to see how they work.

Good luck!!

Bob Hoey
bobh@antelecom.net

August 16, 2004

Hi Tony:

Andy at TWITT forwarded your message. It sounds like we have a lot in common, or at least are both pursuing the same interests. One of my personal failings is that I'd rather "do it myself" than do web research and find out what others have done. A couple of years ago I DID spend some time looking at the "winggrid" concept. I came away with SOME understanding, but an awful lot of puzzlement.

My initial model testing was aimed at flying without any vertical surfaces, as the birds do. I used drag flaps under each wing, or spoilers on the top of the wing, to initiate turns. Both worked OK, but the spoilers were more linear. My wing-tip ailerons did not evolve from the winggrid concept. I did several tests on bird models with different wing tip configurations and found very little difference. Some were worse than others, but none provided any magic improvement over a standard airplane-type rounded tip. I established a different notion about what's going on at a bird's wing tip. If you were to remove the six primary feathers from a bird's wing, leaving a squared-off tip, you would expect a strong tip vortex to form. That means that the air immediately outboard of the squared-off tip, (where the tip feathers would normally be) is in a strong up flow region as the air flows upward and back around the tip.

The tip feathers are merely blades stuck out into this up flow region, and the bird can adjust the local angle of attack of each blade to create additional lift (either up or down). This theory helps correlate the observation of fairly large negative angles of incidence for the forward tip feathers on a soaring bird, yet they are bent upward indicating that they are creating lift. The significance of all of this becomes more obvious when you analyze the effect for differential deflection of the tip feathers for roll control. The forward feather is creating a local lift force that is canted forward due to the local up flow. That's thrust!! Normally we consider that a down going aileron on the trailing edge of a wing will generate more drag and thus create adverse yaw, which slows the turn. For the forward tip feathers the effect will be to create proverse yaw, which will help the turn.

To test this theory I built a wingtip that had the 3 forward feathers mounted on a single spanwise axis. There was a change from adverse yaw to proverse yaw as the initial bias position of the ailerons was changed. The best bias position was with the forward feather at a whopping big -27 degrees of incidence relative to the chord of the rest of the wing. I built a model of this wing tip and ran it in the NASA DFRC water tunnel. These tests confirmed that the flow over the forward tip feather was smooth at -27 degrees, but would stall (on the bottom) at -35 degrees, and stall (on the top) at -22 degrees.

I will attach some photos of the tip aileron for my Turkey Vulture glider model. I am using the throttle control on the transmitter to adjust the bias position (both tip ailerons together), and the aileron control stick to deflect the ailerons differentially. There is a "sweet spot" for the bias that corresponds with the -27 degree front feather, that allows smooth, coordinated turns, with NO vertical tail.

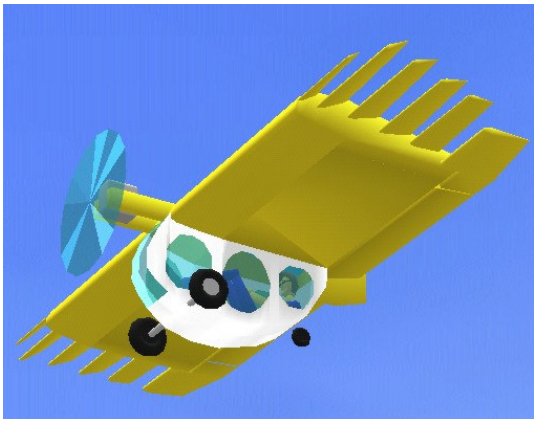
The feather airfoils are merely flat plates of 1/16th balsa, with rounded leading edges. The wing airfoil is a computer-generated airfoil, which produces a positive pitching moment of about .02. It has a lot of camber and therefore does not penetrate well. The intent for these bird glider models was to try to duplicate the soaring flight regime of birds, where fairly high camber and slow speeds are present. I'll attach an EXCEL spreadsheet that has the airfoil coordinates. I have read and understand the fly-by-wire pitch stabilization for the Albatross, but don't think that complexity is necessary for what I am trying to do.

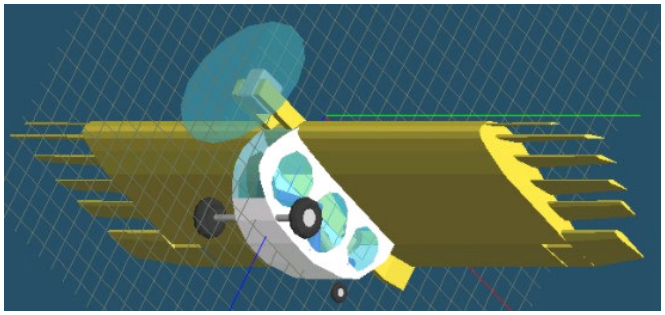
I recently did an experiment where I put three hinges on the wing - one at the centerline and one at each wrist joint, to try to adjust the wing sweep in flight. (Inboard panels rotate forward, outboard panels rotate aft.) My primary purpose was to shoot for a high-speed configuration that would be more like the birds use between thermals. The linkage got rather complex, but worked OK. Unfortunately, I used a different airfoil, which didn't have nearly enough reflex, and I misjudged the amount of tail deflection it would require for normal straight flight. (It requires full up elevator for both wing configurations). I will need to build another wing (ARGHHHH!) in order to continue the test. Notice that this triple hinge arrangement, if done properly, reduces the span, and also the area, but does not significantly alter the cg position. These birds are pretty smart! Incidentally, the feather angles on my more successful bird ailerons are roughly the same angle as the upper surface of the wing airfoil, not the camber line.

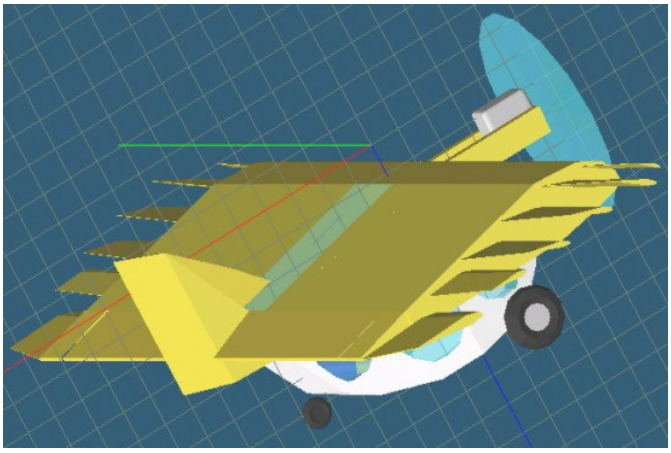
I did see some slight improvement in the glide angle when I added the wing tip ailerons to my Raven model.

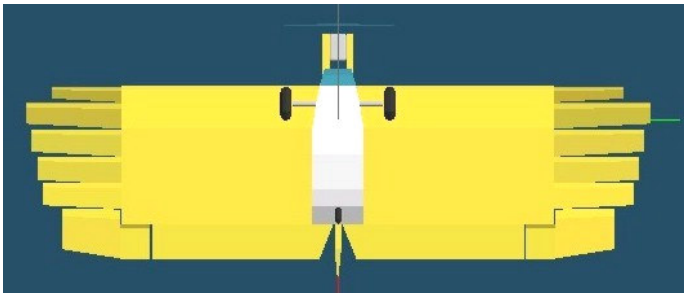
Stay in touch,

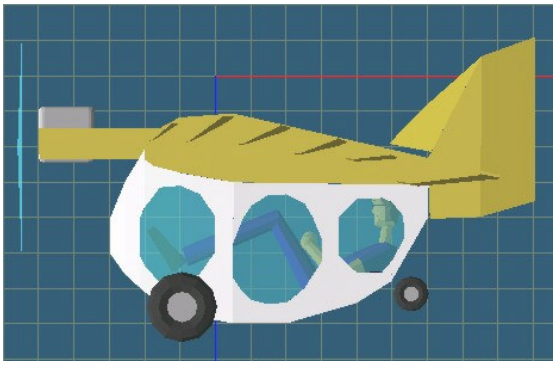
Bob Hoey

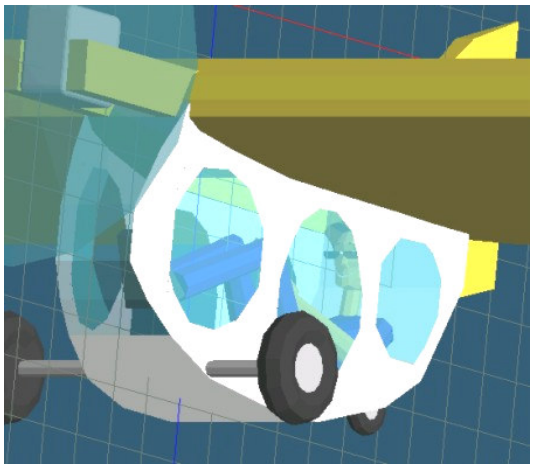


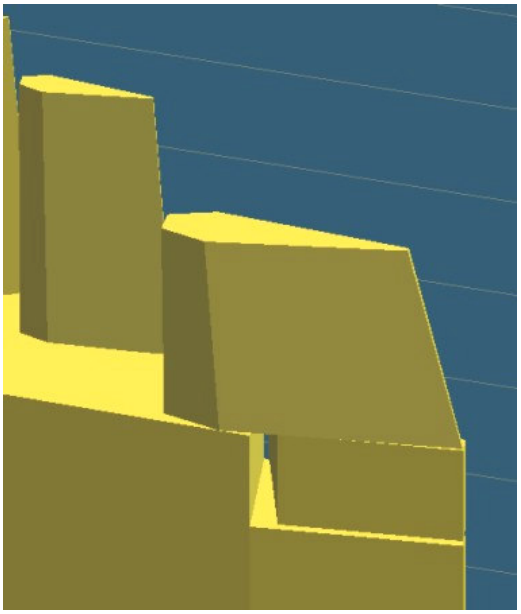


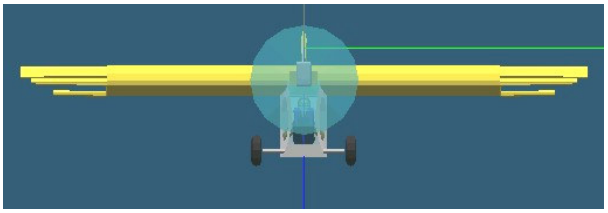












August 29, 2004

Which section for an 1876 Penaud Amphibian?

Hi,

I have been thinking about building an electric powered model of The Penaud & Gauchot Amphibian (1876). Images here...

http://www.ctie.monash.edu.au/hargrave/images/aeropenaud2_500.jpg
http://www.ctie.monash.edu.au/hargrave/images/aeropenaud1_500.jpg

I have lots of building and flying experience but I need some advice on a wing section. Could you recommend a section?

It needs to have a positive pitching moment because there is no sweep, and it needs to be quite thin or it won't look very scale.

The plan form is approximately elliptical but the aspect ratio is very low. I expect I will have to enlarge the control surfaces - the elevator looks too small.

Thanks

Colin Watters
colin.watters@pandora.be
http://users.pandora.be/colin.watters/index.htm

(Mr & Mrs C. Watters Tel: +32 11 593165
Hasseltse Dreef 136 Fax: +32 11 593267
3512 Stevoort
Belgium)

(ed. – I sent Bruce Carmichael Colin's request for information and he has sent him a section from Dr. Eppler's book that should work. Bruce commented that, "Penaud was an early tragic genius and his design made a lot of sense. Glad to hear that someone is going to try it in model scale."

If anyone has more specific information for the design, please let Colin and TWITT know about it.)

August 31, 2004

Hi:

Some years ago, I heard of your group. I flew a B-10 Mitchell wing for a while and then started building another. Then I switched to Kasperwings, hang gliders and sailplanes. All have been enjoyable.

Now, have just completed a Kolb Mk III and am waiting on the FAA go-ahead to fly legally. Do you have members in the Sacramento area or the Susanville, Calif. area? My hanger is located in Susanville. I am looking for a partner in my 80% complete Mitchell B-10 and a partner in my 95% complete Corbin Junior Ace with a Continental 85-12 engine.

What are your annual dues and do you meet as a group now and then?

Vic Gibson
APilot@webtv.net

(ed. – I wrote to Vic explaining I couldn't give him any names and addresses due to the privacy liabilities of releasing this sort of information to non-members. So if any of you are in his area and are interested in contacting him, drop him an e-mail. If you don't have that capability, let me know and I will forward your information to him.

And speaking of Mitchell wings, here is an ad that Norm Masters forwarded for anyone who might be interested.)

Mitchell Wing A10 project for sale

I have an A10 that is not getting finished while in my possession and needs to find a home. It is in SoCal, has a Zenoah engine, needs a new prop along with some minor fabricating work (rudder hinges and stabs). Email me at altpyper@sbcglobal.net if interested.

Jason
<flim_wing@yahoo.com>

September 1, 2004

Facet Opal question

Hi Mike and Rose Lee
(rmlee98@pathwaynet.com)

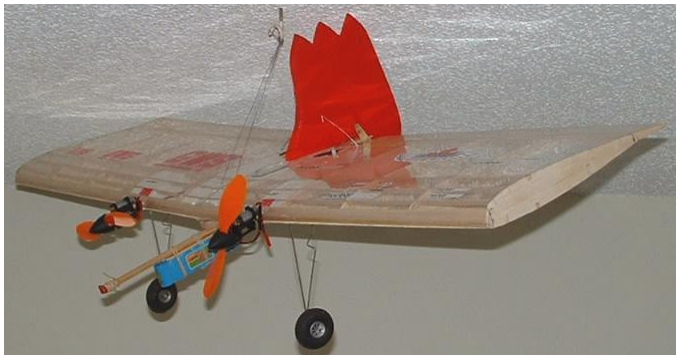
I know this is a long shot, but you asked a question in 2000 to TWITT readers if any plans were available for the FACET OPAL. I would like to know if you found any more information about this fascinating record breaking Australian design.

I am an aviation enthusiast, ultralight - and paraglider pilot and model airplane designer/ builder/pilot. I have built and flown a slightly modified (by me) version of Bill Evans's Zippity-do-da flying wing model airplane and the performance was amazing. It

is very stable in all axis. I took the wing and made a glider body for it and flew it on the slopes with great results. Recently I designed and built a twin engine electric flying wing using my own airfoil. It flies with the same stable characteristics I have come to expect from this type of aircraft.

The only design lead of the FACET OPAL I could find is the attached picture:

The model I designed, built and flew is the other photo attached.



I do not even know if this e-mail address is still working, but If so, I would really like to hear from you or from any one at TWITT that may have more info, pictures plans etc. of FACET OPAL.

Thanks

Josef Swart
<josefswart@shaw.ca>

(ed. – Here are a couple more pictures of the Facet Opal I had in my electronic files. Unfortunately, we still have not come across any useful information on this design, although there seems to be some general interest in it.)

(ed. – Although I had more letters than usual this month, I still needed to take some material from the Nurflugel bulletin board to share with you.)

Ho 229 drawings

From: David Lednicer <dave@amiwest.com>

For those interested in Ho 229 drawings, Arthur Bentley now has a web site up to sell his drawings. Go to:

http://www.albentley-drawings.com/

Found Very Old Flying Wing Patent (1926)

Just go see the patent 1,729,354 at:

http://patft.uspto.gov/netahtml/srchnum.htm

It is low aspect ratio having 3-axis steering. It is not powered: to be towed behind a airplane. Originally designed to be used as structure to place night advertisement!

Anyway, it looks like a nice low aspect ratio flying wing to me. Did this designer, Gordon E. Mounce, design any known flying wings?

Koen

PS. if you don't have the plug-in to view the images, go see HELP and you are guided to the site with the freeware plug-in.

Horten Ho 33 V2

From: Manfred Poznanski
<manfred.poznanski@t-online.de>

The Horten Ho 33 V2 is owned by the Glider-Museum Wasserkuppe, Germany. After missing the Center Section for some years it has now been found and is currently in the process of being restored. Due to no engine available and to fit better into the Glider-Museum, the V2 will be restored to represent the V1, which is originally flown as a glider. I have made a small video of the Center Section, the wings are currently stored inaccessible.

You can find my video here (4,2 MB):

http://www.avpics.de/lffamp/ho33v2.html

For Information of the Glider-Museum Wasserkuppe look here:

www.segelflugmuseum.de

Facet Airfoils

From: Koen Van de Kerckhove
<nestofdragons@hotmail.com>

Working on a idea. Need a facet like airfoil? Where can I find the coordinates of such airfoils?

From: Andre Martins
<almartins2000@yahoo.com.br>

Here goes a facet airfoil :-D

X	Y
0.000	1.000
0.500	0.100
0.000	0.000
0.500	-0.100
1.000	0.000

Just kidding... Well, I've never seen any coordinates for airfoils specifically designed to be faceted, i.e., to be polygons with a finite number of sides.

I think it might be difficult to find something, since most (public) airfoil design procedures and software (e.g. XFOIL) make the assumption of smooth airfoils.

From: Paul Siemons
<paul.siemons@pandora.be>

Here maybe?

http://users.aol.com/slicklynne/facet.htm

Groeten uit Wommelgem,

From: Koen Van de Kerckhove

Paul,

When looking at the Facetmobile, you see that the airfoil is not the same on two different places. In the center it has a single top point. Next to it there are two top points in the airfoil. Not only thickness does change, but also the places of the top points in the airfoil. Mr. Barnaby Wainfan sure made a remarkable design.

In his Frequently Asked Questions section on his site, you can read how he tested his models on air separation over the edges. Sure is an easy way to do it.

From: Carlo Godel
<regiaero@acsol.net>

In modeling we use facet airfoils because we can get away with it at the scales we are working in. Wainfan used these systems for his modeling for many years before he built the Facetmobile. The Facetmobile is the conclusion of many years of experimentation in what is basically a wingless design (a flying fuselage if you will), he started with a cone shape with the curve on the bottom and went through many varied and different configurations learning more and more about what was and was not possible.

I have been flying faceted airfoils for years and have no problems with them the problems with facets are at the other end of the sizes as they can and do produce large amounts of drag because of the eddies and back currents at the transition points.

Conclusion is that a model could be built with facet airfoils and it would perform as well as a model with a regular curved airfoil if the chord is kept at a minimum size (less than 5 inches) any larger and the induced drag becomes very high.

Barney's Facetmobile crashed because of a lack of power, Rotax advertises 50 HP and it produces far less than that in all of the sizes.

I concentrate on scale models and have very few photos of my other models, other people take pics but I

haven't had the time or inclination to do so. While Barney is very sharp, his wife is sharper and consistently beats him at his own game, a wonderful couple to know. As to why he does not offer this as an ultralight I do not know the circumstances of his reluctance I have not seen him or Lynne since I moved to Colorado six years ago.

From: Joachim Bergmeyer"
<jbergmeyer@t-online.de>

Koen wrote: I am really thinking more and more to get that model building up again. That will teach me a lot about my own ideas. But I am doubting between electric engines and fuel engines. Any advice?

Go electric. The recent developments regarding brushless outrunner motors and high-current lithium batteries let the fuel engines be just loud and slimy. In my opinion a drive system that just works reliably and quietly for a predetermined number of minutes is much better for experimenting with the airframe than an engine that refuses to run always at the wrong moment.

From: Don Stackhouse
<djaerotech@erinet.com>

There is a place in the world for both types. However, for simple, hassle-free flying, today's electrics probably have the advantage. In fact, for folks with a busy, unpredictable schedule, a "backyard" or "park flyer" model such as one of our "Roadkill Series" profile electrics is ideal. If I want to fly, I just go out in my back yard, turn on the transmitter and the airplane and fly. Even a simple little 2-cell 250 mah Lithium-polymer battery (about half an ounce of battery weight) in something like our Piper J-3 Cub or Curtiss-Wright "Junior" (both about 3 ounces total flying weight) is good for a little over half an hour of flying time. My Ryan ST with a 3-cell 700 mah Li-poly battery will go 48 minutes of pretty energetic aerobatics on one charge. Even the "gas hog" of the group, my Fokker Triplane, will do 15-18 minutes of wildly aerobatic flying on its 3-cell 250 mah battery.

Also, unlike the older nickel-cadmium and nickel-metal hydride technologies, the new Li-poly batteries will hold a charge literally for months. I can charge my batteries at my leisure after a flying session, and they will be all ready to go for the next flying session, even if it's weeks or months later.

Park Fliers such as our Cub or Junior also make excellent trainers. They are small and light enough that they survive crashes very well, and they are slow enough to give the beginner time to think, something that the more traditional larger and faster trainers are actually quite poor about. The other ones that seem to work well are some of the entry-level sailplanes, such as our 2-meter Chrysalis. Above all else a beginner needs time to think, and a slow model gives them that time.

These little park flyer models and their power systems are pretty simple. When you get into the bigger electrics it gets a little more complex. Nicads and NiMH batteries are heavy, but they do perform well at high currents. Li-poly batteries have much better energy density than the nickel-based cells, but they don't put out much amps per cell. If you're trying to power a large model, you're likely to end up with lots of Nicad or NiMH cells in series to get enough voltage, or a lot of Li-poly cells in series-parallel to get enough amps. Large, high-powered electrics can work very well, but they are not a good place to start.

For the larger models, internal combustion engines probably still have an advantage, although the electrics are rapidly catching up. I doubt that batteries will come close to the energy density of gasoline or methanol, at least not any time soon.

OTOH, if you want to build a multi-engined model, electrics are definitely the way to go. The problem of getting more than one glow-ignition engine to all run reliably at the same time for an entire flight has been the undoing of many models. Although electric motors are not immune to failure, the incidence of it is quite low. Our Roadkill Series Boeing B-17 starts all four engines just by opening the throttle.

The bottom line is that if you stay with the hobby, you will probably end up with both gas models and electrics sooner or later, and maybe some sailplanes as well. As far as where to start out, based on my own observations of what planes seem to have the best overall success rates with beginners, I'd suggest a small park flyer electric, such as a GWS Slow Stik or Tiger Moth, or our Roadkill Series Cub or Junior.

X-47B UCAV

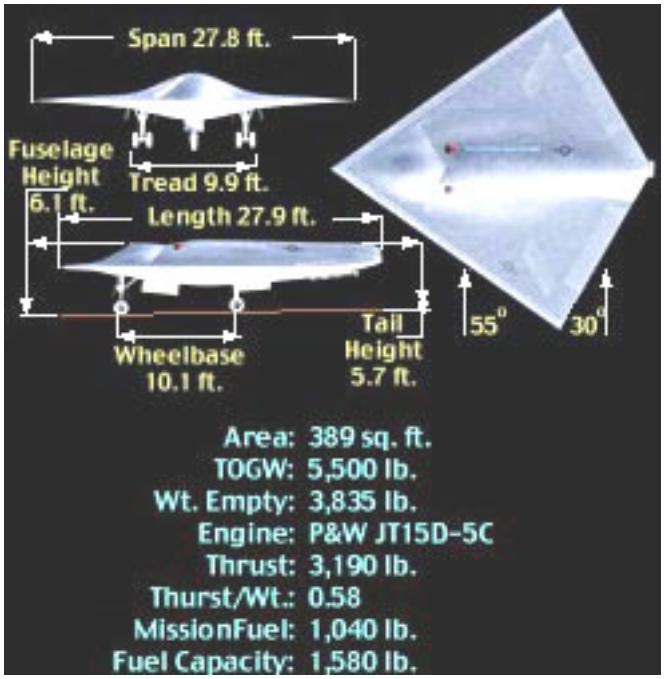
(ed. – The following was extracted from the web site referenced at the end of the article. I discovered I had never included any real information on this flying wing in the past, and it is now getting some new attention.)

It is tailless, shaped like a kite and designed to be stealthy, It's Northrop-Grumman's unmanned X-

47A Pegasus UCAV-N.

As of May 2003, DARPA had given Northrop-Grumman the green light to build 2 demonstration versions of the X-47B, which will demonstrate the technical and operational feasibility of using a UCAV to conduct U.S. Navy missions from an aircraft carrier.

Expected capabilities of the Pegasus include a combat radius of 1,300 nautical miles with a payload of 4,500 pounds, and the ability to loiter for two hours over a target up to 1,000 nautical miles away, an operational altitude of greater than 35,000 feet and a high subsonic speed.



ABOVE: This is the X-47A technology demonstrator, which is called Pegasus, a name that will not be carried over to the X-47B operational versions.

The X-47B is planned to be capable for three primary missions; surveillance/reconnaissance, suppression of enemy air defenses (SEAD) and strike and of course all the missions require stealth and consequent survivability.

Surveillance/reconnaissance: The X-47B will have passive and active sensor suites able to cover a large geographic area and have a long loiter time once over the target area.

Suppression of enemy air defense: The X-47B will be capable of defense stimulation, deception and neutralization as well as being remotely networked with theater and national sensor systems. Expect the plane

Pictures on this page are of the X-47A demonstrator.

to carry a complement of advanced SEAD ordinance and accurately target multiple enemies simultaneously.

Strike: The X-47 will be extremely survivable and will carry a complement of existing weapons, as well as a synthetic aperture radar and a state of the art electro-optical / infrared suite all the while being interoperable with current C4I systems.

Tests are currently on going at Naval Air Weapons Station, China Lake, California.

http://www.air-attack.com/page.php?pid=28

(ed. – This information was extracted from "Running Hot – Competition flares for a new category of survivable, high-altitude jet UAVs", David A. Fulghum, Aviation Week & Space Technology, August 2, 2004, The McGraw Hill Companies, pp. 50-52. The X-47 program is not part of this competition, which will develop a different type of UAV.)

General Atomics and Northrop-Grumman are now in a competition to develop a new class of Unmanned Aerial Vehicle (UAV) that is stealthy or can evade detection in a medium-threat environment. Each has a different approach to winning the final contract.

Northrop-Grumman is looking at what could become a family of UAVs in a potential market for 2,000 to 3,000 aircraft in a variety of sizes and capabilities. A key consideration will be international sales, since Northrop-Grumman will offer advanced, but exportable, technology, a stumbling block to selling the more advanced Global Hawk.

"There is market space in the mid-range," says Douglas L. Fronius, a key executive at Northrop-Grumman's UAV growth in recent years. "In my mind the story [of operational need] is simple, not complex. There's a market for the Chevy."

The Northrop-Grumman hunter-killer design hasn't been finalized, but a study of the options and recommendations will be presented to Northrop-Grumman's Integrated Systems chief at the beginning of August 2004. Company analysts believe, contrary to Pentagon claims, that a low initial purchase price is more important in the competition than projected lifetime operating costs. Northrop-Grumman is expected to come in with an inexpensive, high-performance aircraft that company officials think GA will have a tough time matching.

(ed. – This information was extracted from the San Diego Union Tribune, Bruce Bigelow, September 1, 2004, Business Section, Copley Press. I offer it for those of you who might remember the roll of Ryan Aeronautical in aviation history.)

Ryan flying high after lean years.

When Allegheny Teledyne sold the San Diego company to Northrop-Grumman for $140 million in 1999, Ryan closed its sprawling plant near Lindbergh Field and moved to what has become four office buildings in Rancho Bernardo just north of San Diego. They went from having roughly 350 employees, mainly in manufacturing, to over 2,000, 80% of which are software developers, communications engineers, and system integrators.

Ryan plans on hiring about 200 more employees in the coming year as work gears up on the X-47B, an unmanned combat aircraft that represents the Pentagon's next generation of war planes. It also means that Ryan is now competing more with technology companies like Qualcomm than with other aerospace manufacturers when it comes to recruiting employees.

Ryan was an apt choice for a competitor in the X-47B program because it had built jet-powered drones that flew more than 3,400 reconnaissance and electronic eavesdropping missions in Vietnam. The key breakthrough came in 1985 when Ryan landed a $164 million contract to build an unmanned jet capable of flying high altitude surveillance missions anywhere in the world. This aircraft become the Global Hawk, which has proved a valuable asset in the current war on terrorists.

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