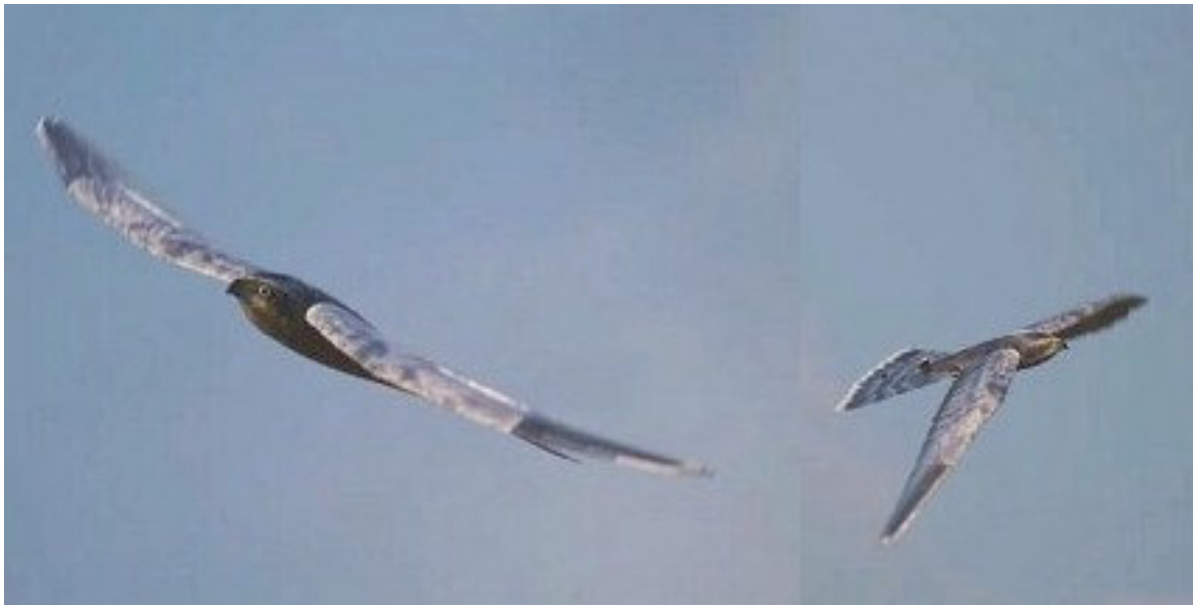
No. 266 AUGUST 2008

T.W.I.T.T. NEWSLETTER

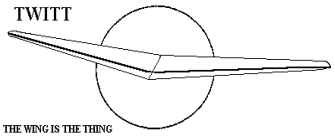


Is this a real bird in flight or is it a radio-controlled model? See the Letters to the Editor section for a little more on what this is along with another look alike. In making your decision be sure to note the position of the wings in each image (hint left is flat, right is anhedral).

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., **0808** means this is your last issue unless renewed.

Next TWITT meeting: Saturday, September 20, 2008, 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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Members only section: ID – **twitt2008**
Password – **08member08**

Subscription Rates: $20 per year (US)
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Information Packages: $3.00 ($4 foreign)
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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

I would like to thank those who came to the July meeting to hear Dr. Scott Jenkins talk about underwater flying wings. I have tried to include the more pertinent parts of his presentation in the recap and include as many pictures from his PowerPoint file so you get a good idea of the sophistication of this project.

For those of you who haven't been members for a long time, I will be doing some further updating of the on-line versions of the newsletters sometime in late August. I am just about done with my conference planning and execution so will have the time for a change. The quality of these older issues isn't as good since I have to scan black and white printing masters and pictures that were originally half-toned for the printing methods of the time.

If you would like hardcopies of any of these, we have a great many in our files and can provide them at the rates shown in the left column of this page.

Based on the photos from the cover and in the Letters section, I am just amazed at the level of sophistication model builders are achieving in replicating the look of actual birds.

For those of you in the western US, don't forget that the Labor Day weekend is time for the Experimental Soaring Association (ESA) Western Workshop at Mountain Valley Airport (L94) in Tehachapi, CA. This year features a number of presentations on alternate launch and soaring with electric power. Speakers include Al Bowers, Tyler MacCready, Taras Kiceniuk, Phil Barnes, Bob Hoey and, Scott Jenkins. This is an excellent way to spend a long weekend learn a lot and renew friendships.

I apologize for this issue getting out late, but I had too many projects all due at the same time and others were more time sensitive than the newsletter.

Andy

SEPTEMBER 20, 2008 PROGRAM

At the time I had to go to press with this late newsletter I did not have a program confirmed for September. We do have a possibility depending on whether there are no other conflicts with the speaker's schedule.

Please keep tabs on the web site to see if there is a program announcement after you receive this issue. I will also post a short note that there won't be a meeting if that becomes the case.

JULY 19, 2008 MEETING RECAP

Andy opened the meeting by thanking everyone for coming out considering the infrequent occurrence of them lately. He then introduced Dr. Scott Jenkins who would be telling us about how he got involved in the underwater flying wing project and the development of this fascinating application of a flying wing.

Scott started with a brief self-introduction on how he got involved with the project. He has been flying sailplanes since 1978 and has also done R/C glider at the famous Torrey Pines glider port. He started at Scripps Institution of Oceanography when he was 16 years old while going to high school and has been there since earning his PhD in Physical Oceanography. Soaring has been a relaxing pastime while still being close to the main core of what he does at work. He is a hydro dynamist of the near shore ocean. He spends a lot of time building computer models of near shore currents that effect things like beach erosion.

About the time he was experimenting with long distance downwind wave soaring the Navy became interested in underwater gliders following suggestions from Henry Stammel, a famous oceanographer. He came up with the way large ocean current occur and developed formulas for them. Based on how his basic sounding buoys that would simply float along with the current he was studying, he came up with the idea of putting wings on them so they could directed to specific spots.

In the early 1990's the Navy contracted with Scripps, the University of Washington and Web Research to come up with a working design of an underwater glider. It took seven years before the team was actually able to control them enough to fly from Point A to Point B. They would fly a dolphin glide path as they varied their buoyancy between negative and positive. In a negative state the vehicle glides to the bottom and upon changing to a positive buoyancy it glides back to the surface where it can transmit the collected data via satellite.

These early gliders looked very much like a cruise missile with a cylindrical body and short wings. They operated at glide angles of about 20 degrees so had an L/D of less than 3. With these results the researchers declared they had developed gliders.

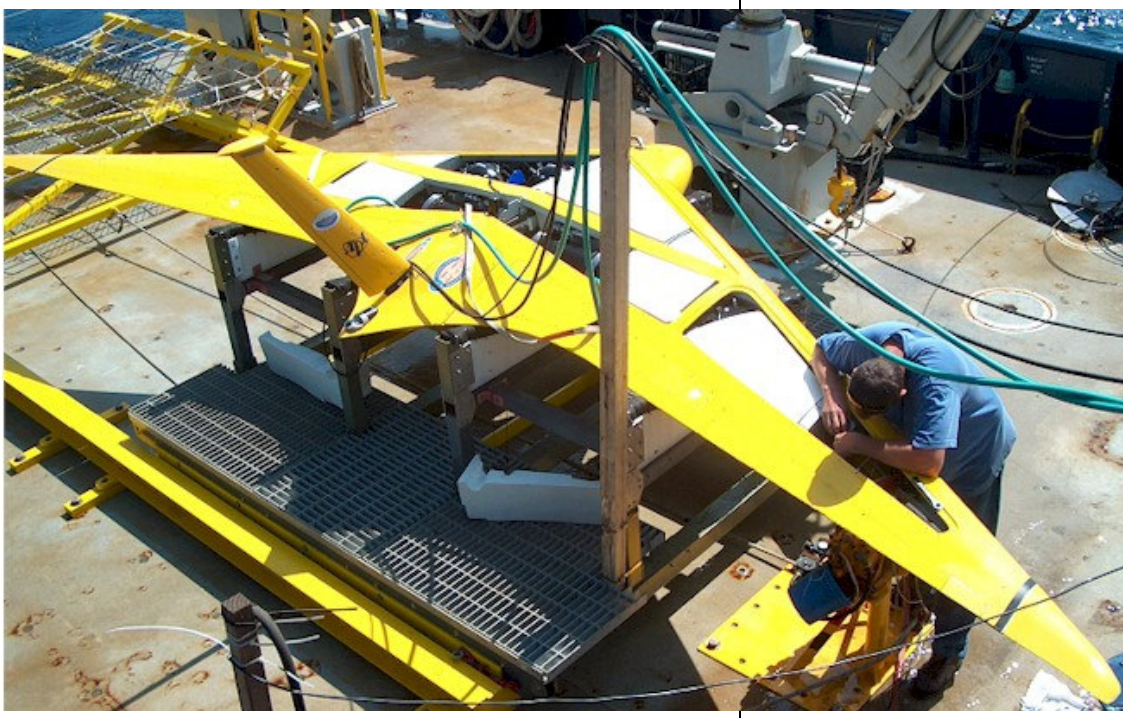
ABOVE: Stingray version of the underwater glider. Note the use winglets and the smaller size of the nose cone when compared to the subsequent XRay glider.

Scott made a comment at one of the site reviews that they weren't really gliding but simply bobbing. With that comment he became a member of the peer review teams on all the papers that were being submitted by the researchers.

He wrote some critical reviews noting they had basically ignored over 80-years of soaring science and literature. After pointing out many of report errors the Navy asked Scott to perform systems study of all the work done on underwater gliders to merge it with existing soaring technology.

What he found was that these vehicles are more like gliding blimps than a traditional sailplane. Since they use buoyancy engines a large volume wing is necessary to get the engine inside. His study found that to maximize L/D the leading factor is wing area to total wetted area. The shapes that can maximize that ratio are the most efficient shapes for underwater gliders and that led them to the obvious solution of a flying wing.

In 2004 they produced the first prototype called Stingray that had a 20' wingspan. They attached a plumb weight to take the positively buoyant wing down to 500' and then let it go so it could glide to the surface. With full instrumentation they had lots of data to analyze to prove their basic thesis that the fling wing could get very high L/Ds and reasonably high glide speeds, which underwater meant a couple of knots. This was a substantial increase from earlier models that were getting less than half a knot in glide speeds. The Stingray achieved an L/D of at least 17 and they eventually reached glide speeds of 5 knots by changing the buoyancy factors.



ABOVE: The current XRay version sitting on the mother ship launch pad. Note the lack of winglets, addition of the communications vertical that can partially fold down for transport and, the larger nose cone area.

In 2005 they received funding for development of a fully autonomous underwater flying wing glider. This would be one with all the systems and electronics to be able to do the flight from Point A to B and transmit the accumulated data back to the team.

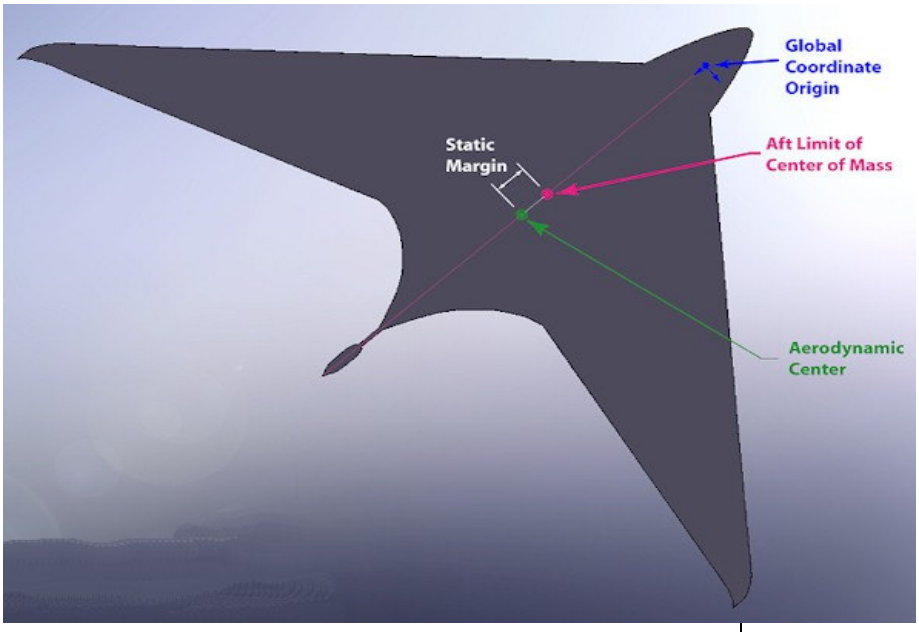
With the basics laid out, Scott moved into his PowerPoint slides to show us more but XRay. From the first slide you could tell the lineage of the 2004 Stingray version being that of the Horten Ho II from 1935 and the Northrop N-1M of 1940. The XRay next stage version then takes on the characteristics of a blended wing body with some remaining Horten at the center section trailing edge.

Another consideration that fit the blended wing body configuration was the structural strength needed when trying to lift the vehicle out of the water. To create the buoyancy engine the airframe is flooded with water and even though some of it has been evacuated for positive buoyancy it can still weigh nearly 2,000 pounds when trying to lift it onto a heaving boat deck. The large structural depth of a blended wing produces the necessary bending strength to carry high static loads.

It is built using vinyl ester resin with e-glass and traditional I-beam spars with carbon fiber caps with an e-glass shear web. The spars are laid out in sort of an A-frame with one spar running behind the leading edge and a rear spar further aft that links the front spars.

The basic airframe weighs about 1,400 pounds, which means it would just sink to the bottom without some type of floatation. So a lot of the volume (about 10%) is taken up with foam that creates a neutral buoyancy condition when in the water.

The sizing of the glider was based on the launch ships deck area for handling it. Based on the theories of John McMasters paper of the 1970's, they would have liked to make it bigger since this would have produced higher L/D values, but they had to settle for the 20' span in order to get it off and on the ship. As you can see from the picture the glider sits on a mobile dolly that is pushed off the back of the ship which is moving forward at about a knot. The glider then simply floats off the dolly to begin its scheduled journey.



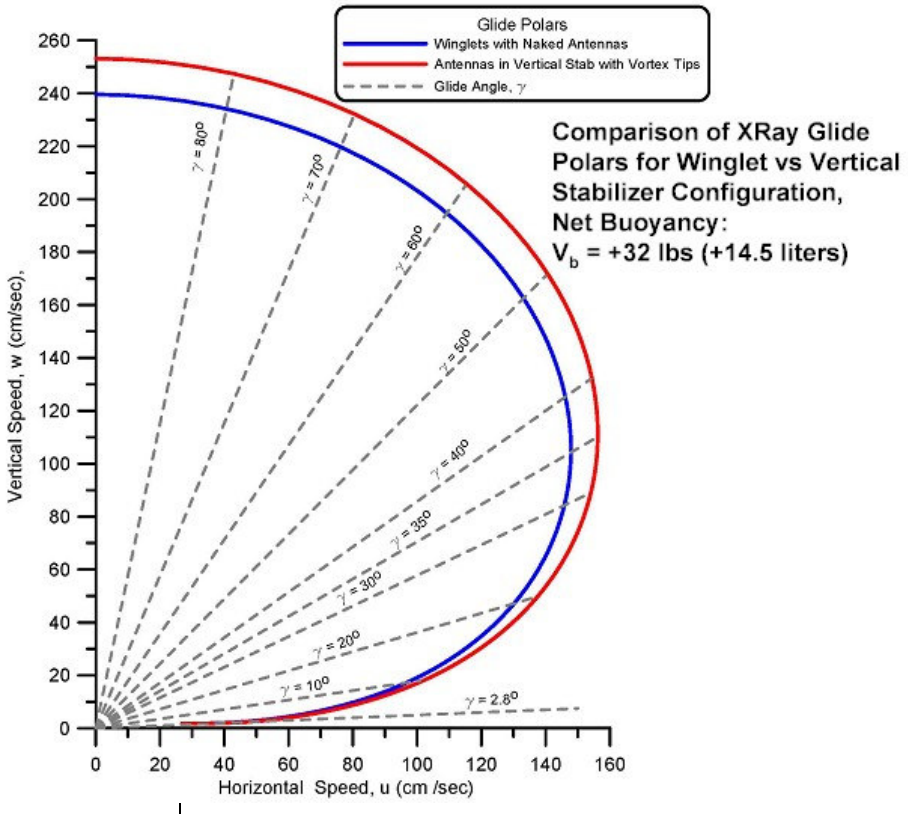
Scott's next slide shows the arrangement of all the equipment inside the wing structure. He explained how the buoyancy engine works by pumping water into holding tanks for the descent and then blowing it out at the bottom apex of the dive to make it positive for the ascent. They use tanks with internal bladders that allow them to store air backpressure and water is forced into them. When it is time for the ascent this backpressure acts like an accumulator to push with several hundred PSI to conserve pumping power and battery life. This is all done with gear pumps that work bi-directionally with high pressures, which are also used for small maneuvering jets.

Mass shifting is used for controlling pitch and roll just like a hangglider. For pitch there is a small weight that moves fore and aft on a set of rails using a screw drive. Roll is done by transferring oil from one wing to the other that takes about 30-seconds, so there is a fairly long lag in the actuation. They are now looking at putting ailerons on future models to assist with roll, but not eliminating the oil transfer system.

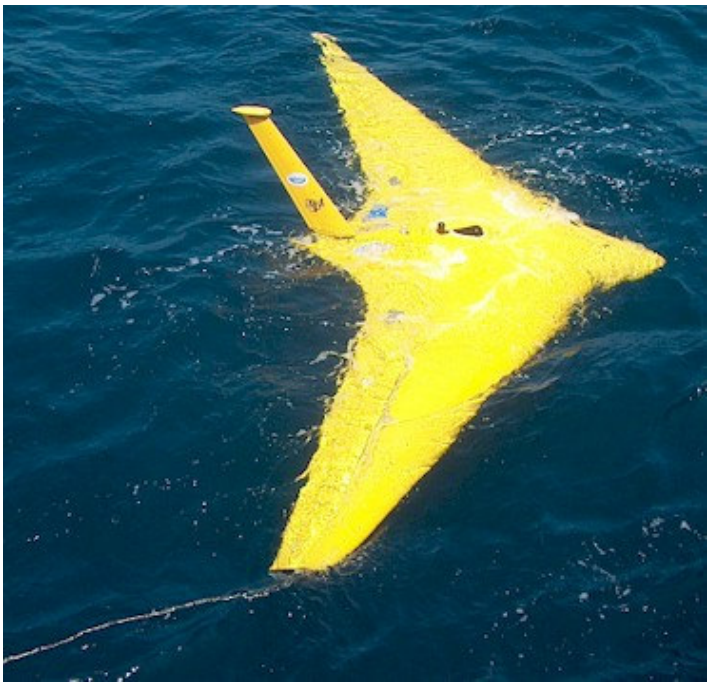
One of the latest changes is installation of a high aspect ratio vertical stabilizer not for control but for use as an antenna mast. This allows for better communication links when the vehicle is on the surface. The new vertical surface eliminated the need to the winglets so they went to a more Horner type of wing tips. The picture also shows that the right tip has been jettisoned and a catch line spooled out from inside the wing. This allows the crew to hook the line with a hook and bring the vehicle into position for returning it to the deck.

Scott spent a little time going through some of the CFD modeling they are currently doing to come up with the next generation of vehicle. One thing that Scott wanted to find out more on was the reasons for some pitch oscillations in certain sections of the dive profile. In the glider they found the static margin was not correct and that it appeared they had a tail-heavy bird that needed some corrections. They installed some additional lead weight in the large nose cone section by taking out the sensor equipment and also added foam to offset the mass to create neutral buoyancy.

He then explained a little about the drag polar for this glider, which looks very different than what most glider pilots are used to. The lower portion of the curve looks somewhat like a normal polar, but the upper portion is something a normal aircraft could not do without breaking the wings off. The underwater glider goes into absolute nose down vertical flight so the polar wraps around on itself. As the steepness of the



dive increases the curve starts to wrap around itself as the ground speed decreases back to zero.



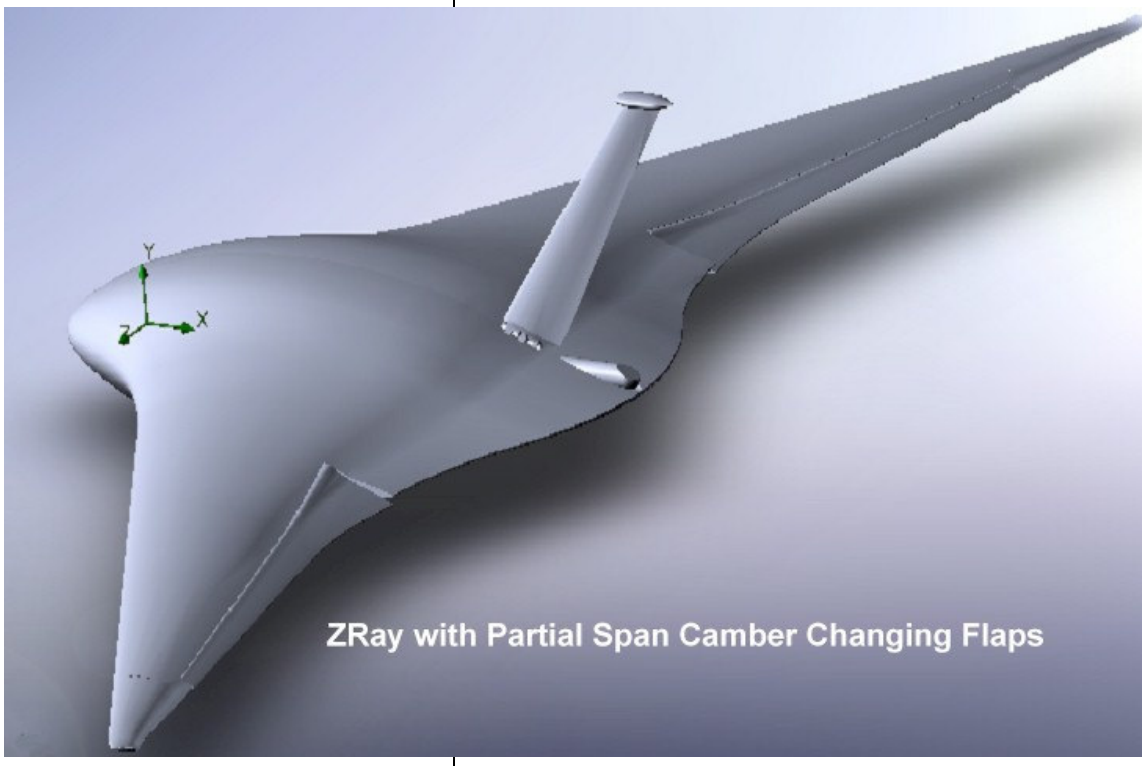
ABOVE: XRay on the surface with the right tip deployed to extend the retrieval line.

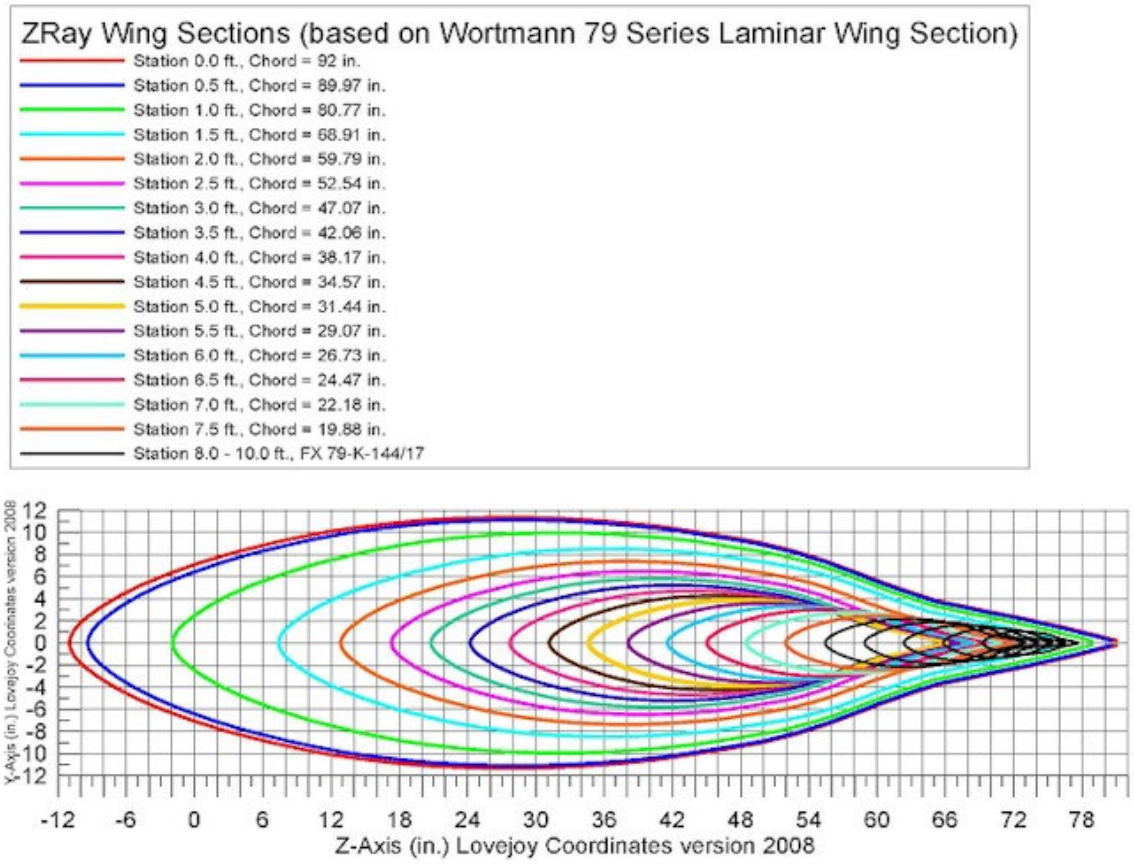
One thing that Scott discovered as he worked with different angles on the glider polar was that regardless of the gliders shape the maximum cross country speed is always achieved at 35 degrees. This is a nose down angle not normally done in a airborne glider due to it being extreme with the glider exceeding redline before reaching the equilibrium speed

There was a general discussion of the “autopilot” system used for the flight profiles. The computer is programmed with the desired pitch and roll parameters for the flight to achieve the best L/D. It much simpler than those used in airborne UAVs, but the demands are also much simpler. After flying the profile, the glider returns to the surface, uploads the data it has gathered to the mother ship, updates its position and then resumes the profile. Due to the low water current movements at the depths being flown, there is very little deviation to profile and the periodic updates help to reduce the deviations as the profiles continues.

A question was asked about the wing’s sweep angle. Scott indicated it was 30 degrees and then commented that he thought Northrop and Horten were on the same track. If you look at the basic question of static margin in a flying wing, it comes down to two things, aerodynamic center and center of volume. Tracking center of volume is good substitute for the center of mass. So if you want to design for a specific static margin you will be working in a very small part of the parameter space when you look at how center of volume and aerodynamic center change with taper ratio and sweep back angle. This will give you points

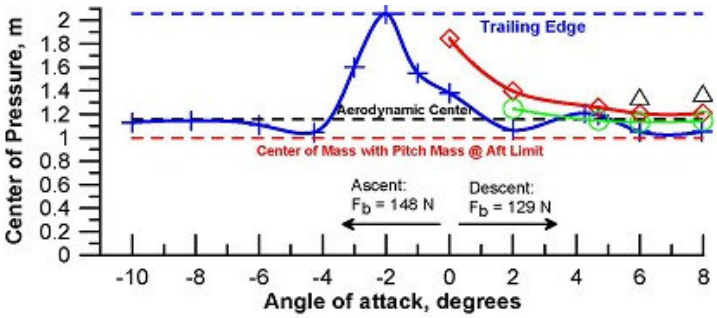
RIGHT: Computer ZRay image showing the increase in center section depth, smoothing of the trailing edge and the addition of ailerons that terminate before reaching the tip.





that are very similar to the Horten and Northrop wings.

Scott moved on to talk about the addition of ailerons to the next prototype. These will give a 4-to-one advantage over the current method of moving fluids from side-to-side. These will also give instantaneous roll versus the very slow roll rate of the current system. They will retain the current system for use during very slow and drifting fight when the ailerons would not be as effective.



ABOVE: A comparison graph of the actual XRay as shown by the line with plus signs and theoretical results on the ZRay with the two different flap configurations. The XRay dips on either side of the vertical line segment represented the lack of desired static margin discussed in the recap.

The question was asked if they are experiencing adverse yaw. Scott responded that they definitely have it since everything they do is a slipping turn. But he also noted there are no style points underwater so they are not worrying about correcting this aspect of performance. The rates of turn are so low, like a 180-degree turn in a half-mile of ocean it really doesn't matter. A follow-up question related to using roll tips, however, due to the amount of shipboard dings the glider receives this is not a good option. The current tips are held on by high-tension cables and sit in ball socket. This allows them to get moved around during launch and then return to the desired position. The new ailerons will stop somewhat inboard of the tips for this very reason. You can also see in the accompanying picture that the tips can then be jettisoned and pull out a retrieval rope. They then throw a hook out and pull the glider into position on the launch/recovery net to bring it back onboard.

The next generation under development is called ZRay. It has a larger internal volume that that the equipment can be better placed for removal to do maintenance and testing while not in the glider. It will have camber changing flaps on a Wortmann 79 series airfoil. One version has them as partial span flaperons and the other as a dual set. They have also gotten rid of the sharp edges that have a tendency to get caught in the launch netting.

You can see the progression of the airfoil series in the accompanying image. One of the nice things about this series is that apparently you can thicken it as much as you want and you still get the same recovery bucket. The span will be 22 feet (vs 20) with an aspect ratio of 8.7. They have also improved the static margin and he feels this is partly due to the Wortmann airfoil with its maximum thickness further aft. They are estimating that the new max L/D will be

36 using the camber changing flap configuration, but if they get 30 they will be happy. If they go with the simple flap configuration they are estimating an L/D in the high 20s.

Scott finished up his program with a short explanation of how these gliders will be used in the future, but due to the sensitive nature of some of the information we won't recount it here.

LETTERS TO THE EDITOR

July 7, 2008

My name is Ben Jansson, a retired aeronautical engineer. I live in Sweden. (Used to work at Northrop California back in the sixties.)

I have a dream!!!! A small swept flying sailplane with flaps!

Span: 8 meters
Sweep: 15 deg (at 1/4 chord line)
Taper ratio: .4
Wing area: 5 sqm
Aspect ratio: 12
Best glide ratio: 29 @ 60 mph

50% chord 3-parted flaps along the span, with 10% alleviating trim tabs on the inner two to eliminate the pitching moment of the flaps. The outer section=20% chord for ailerons. Winglets with outgoing deflections for rudders.

Anyone interested to develop the idea?

Ben
hinna43@3mail.se

(ed. – As I have noted in the past, there always seems to be more interest in developing and/or building flying wing aircraft in the European area than here in the US. At least Richard Avalon seem to be selling plans for the Mitchell designs as he notes in another letter below. Hopefully some of those plans will result in flyable aircraft in the next several years.)

July 9, 2008

Perhaps you were thinking of the glider on page 5 of the June 2006 TWITT newsletter (#240). The claim on the plans is 2.minutes 28.sec duration.

I've attached a similar plan from a 1954 model magazine.

Have fun,

James McLellan
<jwmcl@qwest.net>

That is it!

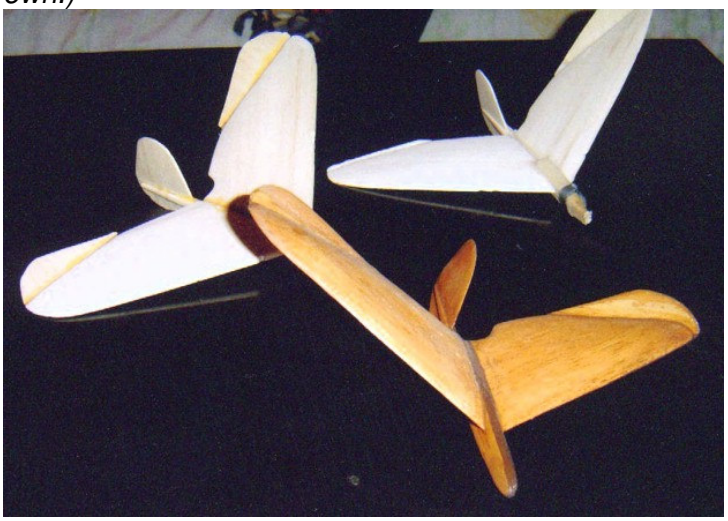
Thanks,

Strange when I looked at the plans for the Slinger that Robert Sisson placed on the Nurflugel web site I did not recognize it. However, the fact that you pointed out that it was also in the TWITT newsletter and going back and looking at those pictures did the trick.

So now we need to think about how we can make it even better perhaps even achieve the 2 minute + time as originally claimed.

Warren

(ed. – Here is one of the pictures from the June 2006 issue as a reminder of what these look like. Page 5 contained the drawing you could use to make your own.)



July 15, 2008

I am moving form Round Rock, TX to near Houston, TX and want to update my address so that I can continue receiving the TWITT newsletter.

My NEW address is:
Warren Bean
4022 Cypress Lake Dr
Spring, TX 77388

My personal email is: warren.bean@gmail.com

If you don't mind I would like to look at some old issues of the newsletter but do not currently have the sign-in info with me. (Old copies of the newsletter are in boxes and in storage until the end of the month.) so could you email me the user name and password once you verify my membership? Please send it to my personal email address.

Thanks,

Warren Bean

(ed. - I included this so others can correspond with Warren and as a reminder that there a newsletter dating back to January 1996 in the members only section of the website. The ID and password are included in the masthead at the beginning of each newsletter in case you forget it.)

July 20, 2008

Fairly easy drive home. Well worth the effort, thou. Great presentation!

I am attaching photos from Robert Musters, (Netherlands). He had some videos of his bird in flight, but recently removed them from the website. Very impressive electric-powered ornithopter!!

I'll also include an article about another fan-jet-powered Hawk model (not an ornithopter) used in Italy to keep the birds away from the airports.

Bob Hoey
<bobh@antelecom.net>

Robotic hawk UAV unveiled.
&&&&&&Flight Global (2/25) reported, "Bird Raptor has unveiled in Rome its Falco Robot (robotic hawk) gregarious bird removal system (GBRS) unmanned air vehicle (UAV)." The Falco Robot, which has been in development for 11 years, "is designed to eliminate the need to train real birds of prey to discourage the presence of birds at airports." The UAV "is a life-size copy of a female goshawk, with a 1.6m wingspan and 1kg weight, built using composite materials and powered by a small brushless electric motor driving a ducted fan installed into the 'body.' Powered flight lasts only a short time,...after which the air intake and exhaust are closed." Then, "[t]he Falco Robot...flies like a goshawk, exploiting thermal updrafts." Flight Global noted that, in a recent test of the UAV's capabilities, "the Falco Robot kept all birds away from" runways at Italy's Rome Fiumicino airport "for an entire day after a single mission lasting only 35 seconds."

ABOVE: Robotic Hawk UAV

ABOVE: Robert Musters' ornithoper in flight.

July 24, 2008

(ed. – I wrote to Richard since his newsletter came back indicating a bad address. This was his reply, and I have updated his information in the classifieds section if you ever need it again.)

Sorry about the address mix-up. My correct address is: 8104 S. Cherry Ave., Fresno, CA 93745-9448. Web site is still: mitchellwing@earthlink.net and this may change in the future. My phone is: 559-834-9107

I receive several E mail inquires on the B-10 and the U-2 and am delivering 3 to 4 set of plans per month. I'm surprised with this interest, if I was able to supply parts and airplanes and advertised a little, I'm

sure I would be swamped with orders. But who knows, I'll take that ride when I find that lift.

BTW don't you think it's time to turn the flying wing on the logo back around so it's pointed correctly. *(ed. – For those of you who don't know the story, Richard won the logo contest years ago, but we decided the wing needed to have a top perspective vs. his bottom view.)*

Big thanks for all of your support over the years

Richard Avalon

Mitchell U-2 Threads: (most recent)

July 6, 2008

Anyone interested in a set of A-10 wings, landing gear, two place steering yoke located in Ohio for $700? It lacks the "trike" though. It has a yoke built for a two-seater and some cables and the landing gear. The wings are complete though with tip rudders and balanced ailerons.

Daniel Moadus
<Dmoadusjr@neo.rr.com>

July 25, 2008

U2 for sale on Barnstormers.com right now.....if anyone is interested...

<jyeagly@yahoo.com>

August 6, 2008

Mitchell wing B-10 for sale, located in the San Francisco Bay Area. I bought this last fall intending to fly it, my situation has changed dramatically since and as a result she must go.

Good fabric
Cuyuna 215
Ground Handling Dolly for getting on and off trailer
Pictures on request

Price $2250.00

I'm not happy about this but she must go to a good home.

Dennis Mingear
<dennismingear@yahoo.com>

Nurflugel Threads: (most recent)

Horten II S

July 21, 2008

I read in different books that there are some parts of a Horten II S, built 1935, stored in Krakow. Does anybody have some information what kind of parts are there stored. I think that this Horten has flown in Bonn-Hangelar

Jörg Schaden
<joergschaden@googlemail.com>

All these reports are completely wrong. The wing pair stored at Krakow Aviation Museum is a remain from a swept flying wing, that's true, but a strutted one! The Horten brothers never had built a strutted flying wing. But unfortunately it's unknown from which type. Neither the nose angle, nor the main spar sweep angle nor the other dimensions fit a known (published) European flying wing design. So it's to hope that one-day a more experienced specialist of flying wing history will be able to detect the real origin of this wing pair. I forgot to mention that these wings in Poland are tapered.

Peter Selinger
<Peter.F.Selinger@jocki.org>

You've posed an interesting challenge for us to figure out. I thought perhaps it was a Lippisch design, but the taper would have given that away.

I find it interesting that the great and esteemed Peter F Selinger would turn to us to solve a sailplane history problem, which he cannot solve! We should all give up hope if Peter cannot solve it... :-)

A very interesting problem for us!

Al Bowers
<Albion.H.Bowers@nasa.gov>

Dear Al,

That's much to much honour for me. Additionally I've been not alone to solve the mystery.

We believed to had it solved, but also the Gotha planes designed pre-war by Dr. August Kupper had different sweep angles of nose and main spar. Generally these two wings would fit into the general layout of Kupper's strutted high wing tailless planes for

Gotha, but not in detail, so we ceased all efforts. The strut fittings go downwards, so it must be a high or shoulder wing design, originally. But if no mystery, no challenge and boring times only.

Peter

July 22, 2008

Cool Flying Wing Patent Links

I was checking out a patent online....and as I'm prone to do, I got distracted by airplanes.

http://patft.uspto.gov/netahtml/PTO/search-bool.html

I stumbled across 5,082,204 which is pretty cool and then found 2,406,506 2,412,646 and 2,650,780 which are all Northrop patents for his flying wing.

One cool thing is that if you find an airplane that you think has a cool shape, you can look at all of the patents that it references and many of them also have cool shapes. It is amazing the variety of airplane shapes that people conceived of back in the 1930s, just proving again that it is very hard to come up with a new concept in aviation. Many of the concepts haven't been developed adequately, but it is hard to develop anything truly new. I see many of Burt Rutan's ideas spread amongst these 40-80 year old patents.

Dennis Olcott
<dennisolcott@hotmail.com>

July 23, 2008

Ho XVI Colibri

Hello one of the members of the IG built a 1:3 Ho XVI Colibri with a wingspan aof 4 meters. Pictures are here : http://www.ig-horten.de//html/colibri

Regards

Jörg Schaden
<joergschaden@googlemail.com>

Thank you for the nice pictures of the model.

But please take into account that never has existed a Horten plane Ho XVI.

The Horten brothers named their planes with the capital H only.

Only the RLM issued type designations received the two character kind of shortened name, as the 'Ho' 229 for the original H IX.

Peter F. Selinger
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August 6, 2008

Italian Flying Wing

I bought the book Alianti Italiani about the Italian Sailplanes from 1923 till 2000. I found in the book another very Interesting Flying Wing it is from B. Posniak it is a Muscle powered Flying Wing from 1936. Picture --> http://www.ig-horten.de/italy.jpg

Has anybody more information?

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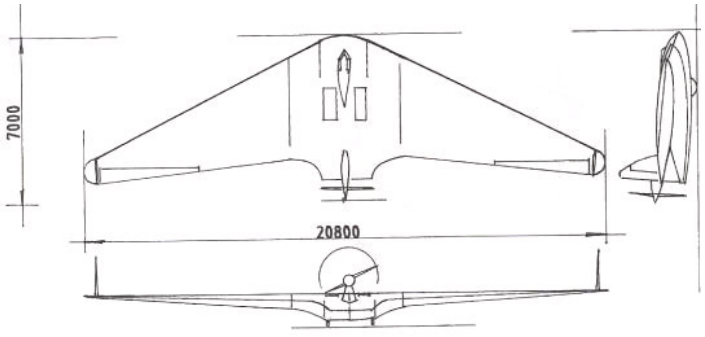

AVAILABLE PLANS & REFERENCE MATERIAL

Coming Soon: Tailless Aircraft Bibliography Edition 1-g

Edition 1-f, which is sold out, contained over 5600 annotated tailless aircraft and related listings: reports, papers, books, articles, patents, etc. of 1867 - present, listed chronologically and supported by introductory material, 3 Appendices, and other helpful information. Historical overview. Information on
sources, location and acquisition of material. Alphabetical listing of 370 creators of tailless and related aircraft, including dates and configurations. More. Only a limited number printed. Not cross referenced: 342 pages. It was spiral bound in plain black vinyl. By far the largest ever of its kind - a unique source of hardcore information.

But don't despair, Edition 1-g is in the works and will be bigger and better than ever. It will also include a very extensive listing of the relevant U.S. patents, which may be the most comprehensive one ever put together. A publication date has not been set yet, so check back here once in a while.

Prices: To Be Announced

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VIDEOS AND AUDIO TAPES

(ed. – These videos are also now available on DVD, at the buyer's choice.)

VHS tape containing First Flights "Flying Wings," Discovery Channel's The Wing Will Fly, and ME-163, SWIFT flight footage, Paragliding, and other miscellaneous items (approximately 3½+ hours of material).
Cost: $8.00 postage paid
Add: $2.00 for foreign postage

VHS tape of Al Bowers' September 19, 1998 presentation on "The Horten H X Series: Ultra Light Flying Wing Sailplanes." The package includes Al's 20 pages of slides so you won't have to squint at the TV screen trying to read what he is explaining. This was an excellent presentation covering Horten history and an analysis of bell and elliptical lift distributions.
Cost: $10.00 postage paid
Add: $ 2.00 for foreign postage

VHS tape of July 15, 2000 presentation by Stefanie Brochocki on the design history of the BKB-1 (Brochocki,Kasper,Bodek) as related by her father Stefan. The second part of this program was conducted by Henry Jex on the design and flights of the radio controlled Quetzalcoatlus northropi (pterodactyl) used in the Smithsonian IMAX film. This was an Aerovironment project led by Dr. Paul MacCready.
Cost: $8.00 postage paid
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An Overview of Composite Design Properties, by Alex Kozloff, as presented at the TWITT Meeting 3/19/94. Includes pamphlet of charts and graphs on composite characteristics, and audio cassette tape of Alex's presentation explaining the material.
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VHS of Paul MacCready's presentation on March 21,1998, covering his experiences with flying wings and how flying wings occur in nature. Tape includes Aerovironment's "Doing More With Much Less", and the presentations by Rudy Opitz, Dez George-Falvy and Jim Marske at the 1997 Flying Wing Symposiums at Harris Hill, plus some other miscellaneous "stuff".
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