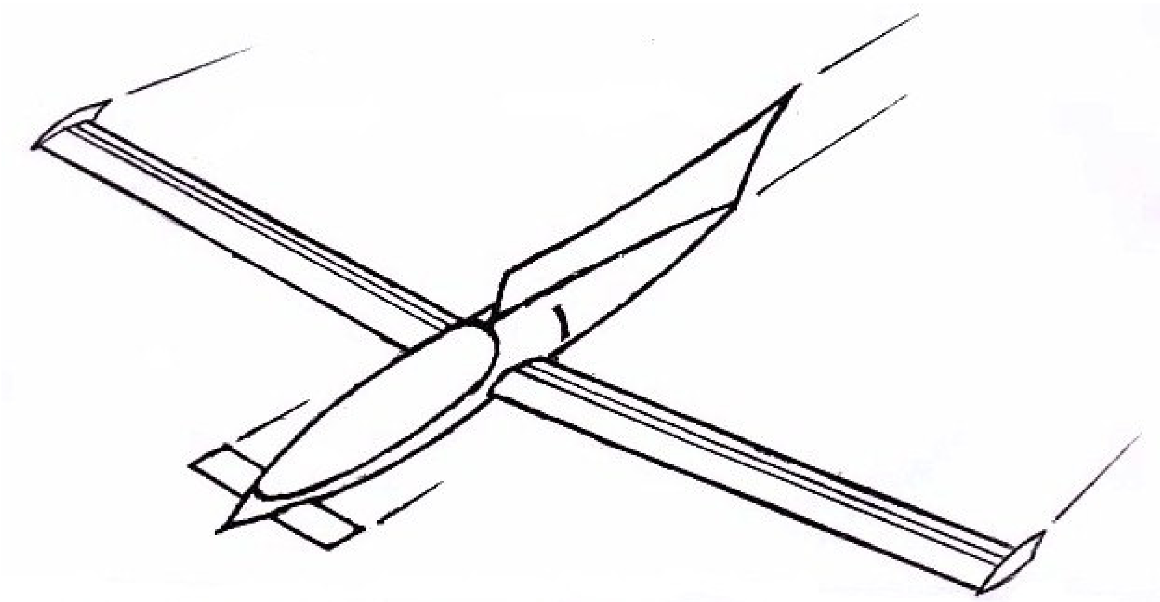
No. 229 JULY 2005

T.W.I.T.T. NEWSLETTER



This was sent to us by Jean Vladimir Teremetz with no explanation in English of its origin or name. I tried some French to English translation of the information included on the pages, but it was less than satisfactory. If someone would like to translate an offer us more information I will be glad to forward the file.

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., **0507** means this is your last issue unless renewed.

Next TWITT meeting: Saturday, July 16, 2005, 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.

T.W.I.T.T. Officers:

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Editor: Andy Kecskes
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Wt/#Issues	FRG	AUSTRALIA	AFRICA
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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

It is hard to believe we are now 19 years old, since our real anniversary is in June but we celebrate in July since that is the first meeting after the event. We are much larger than that initial group of 11 enthusiasts that got it off the ground in 1986, but smaller than at our hay-day in the 1990s. Right now we have stabilized at about 85 members who continue to renew each year. We will have to plan something special for the 20th anniversary next year and perhaps some of our more distant members could plan far enough in advance to take a vacation and come to El Cajon for it.

As usual, I have been remiss in not getting to the website as I should. My professional life has gotten more complicated than I had anticipated with several extra curricular activities that are taking more time to get straightened out. I now monitor and maintain a total of three websites and am the president of one group for the next couple of years. That one was supposed to be easy until the treasurer and communications board members resigned right after I took over. Obviously, life got a lot more complicated in a big hurry.

For those of you interested in building aircraft, don't forget that the ESA (Experimental Soaring Association – old SHA) will be sponsoring the annual Western Workshop over the Labor Day weekend at the Mountain View glider port outside Tehachapi, CA. Bruce Carmichael is putting together his usual fine array of speakers on a variety of subjects related to sailplane construction and design. There is a good full-service campground at the airport and several good motels in town that are just a short drive away. You can see more at www.esoaring.com and find the numbers for making an event registration. See you there.

Andy

JULY 16, 2005 PROGRAM

I am sorry to report that we weren't able to pull a program together for the July meeting.

However, don't forget it is our 19th Anniversary meeting and we would sure like to see everyone come by and help us celebrate another year of promoting flying wings to the world of aviation. We will have plenty of ice cream and cake, along with cold drinks.

We will have a selection of various flying wing videos you can watch at your leisure or fast forward through them looking for the bits and pieces that interest you most.

So mark you calendar for July 16th and come enjoy a day with the TWITT group. Sometimes these types of gatherings take on a life of their own and actually come out just as good as if we did have a planned program. See you there.

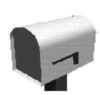
(ed. – Since this is an anniversary month, I thought I would include some of the entries from the *TWITT Newsletter* *No. 1, June 1986 minutes written by Richard Miller. Since Richard wrote it in his typical somewhat theatrical manner, I am only including stuff that relates to the technical aspects of what they thought TWITT should be doing.*

The original members at that meeting included: Bob Fronius, Ed Lockhart (deceased), Richard Miller (deceased), Pat Oliver, Floyd Fronius, Bruce Carmichael, Hernan Posnansky, Harald Buettner, Marc de Piolenc, Ralph Wilcox and Don Webb.)

". . .Bruce went to the board. In response to his request for a set of performance figures to being with he gets, from Bob Fronius an L/D of 40, which is not a surprise, and a minimum sink rate of 1.1 ft./sec., which raises some eyebrows. A general discuss of parameters, proportions and dimensions follows. Hernan talks about performance, working down from a section L/D of 200 to a real-world figure of, perhaps 50. This with a span of 18-10 meters. There follows a discussion of the pilot position, the prone and the supine, the advantages and disadvantages of each. After Bruce sat down, Hernan spoke about the active control system which, it is hoped, will solve otherwise insolvable problems of stability and control. He said he is in favor of using existing airframes, such as "the White Knight" for testing such a system than a brand new, expensive prototype. The point is made that a glider equipped with such a system must be able to function in a fail-safe, stable mode.

"It had grown late. Bob asked Bruce to give a summary. Bruce did so. He said that we had discussed various aspects of high performance flying wing and that the discussion had pointed up the nature of the difficulties to be overcome in undertaking to design and build one. He said that we had gotten off the subject, into the area of wing-tip design, but the he trusted Bob to get us back on the track. Bob finished with a summary of his own, as statement of what he and Hernan hope to do. He said that he wanted a commitment to the ideal and, within a month or two, to the first steps in construction. He said that he thought it might be possible to get outside financing but that he preferred that the project be financed by the participants. Work space, he said, is required. He welcomes any contributions and expresses his thanks to those who attended the meeting. There are reciprocal thanks to Bob for brining us together. End of meeting."

(ed. – For those of you who aren't familiar with this early history, the object of the group was to build a flying wing prototype with an electro-hydraulic control system that would allow flying at the edges of instability. There were a set of wing molds made using Diamant wings as the plug, but a set were never constructed and there was no fuselage ever built. There was a lot of discussions on configurations and airfoil selections, but it eventually turned out that you can't design this type of aircraft through committee decisions. So due to lack of a design commitment, no funds for materials and workspace, the project never materialized. It was at that point TWITT evolved into a research and education organization to help promote the development of flying wing aircraft by others.)



LETTERS TO THE EDITOR

May 30, 2005

TWITT Membership:

I am interested in joining. Do you take PayPal for payment?

Building a very modified Mitchell U-2

Leon McAtee
<leon@cstreetshop.com>

(ed. – I included this since I wrote back to Leon explaining we don't take PayPal or credit card payments due to our small size and very limited budget that can't absorb the transaction fees. Just a reminder that we can only take cash, checks or money orders payable in US currency.)

June 13, 2005

E-Mail Address:

Just got my email working last week so here is the address, albackstrom@austin.rr.com

Al Backstrom

(ed. – This came in early enough for the ESA/SHA newsletter, so now everyone has both of Al's new addresses.)

June 14, 2005

Control Sizing For Tailless Aircraft

A good reference for checking the control size is listed below.

NACA TN 1674 "Estimation of the Effectiveness of Flap Type Controls on Sweptback Wings" by Lowry and Scheitner, 1948.

It can be downloaded from on of the following sites. I have not used the first site for a few months so I can't guarantee that it hasn't been changed.

http://naca.larc.nasa.gov (this has NACA reports from 1917 to 1958)

http://ntrs.nasa.gov (I believe this will bring up most of the government funded aerospace reports, NASA, NACA, LaRC,....)

TN 1674 coupled with an aerodynamic center calculated as shown in "Theory of Wing Sections" by Abbott and von Doenhoff (fig.15 pg.21) and your desired center of gravity position will allow you to calculate a control deflection necessary to maintain a given angle of attack (or coefficient of lift).

TN 1674 does not give a calculation of control surface area required for stability since stability is a result of aerodynamic twist and center of gravity position, not control surface area. The tail volume calculation you mentioned is used to roughly size horizontal tail area (not control surface area, except for stabilators) and is an experience-based method of satisfying stability on airplanes with conventional tails. Abbott and Von Doenhoff contains figures and equations for determining the required wing twist to satisfy stability on a wing alone.

I have been through this for the X-4 using NACA flight test data (found by searching the websites listed above) and the method appears to be pretty good at predicting control surface deflection to maintain a given angle of attack (or coefficient of lift).

Have fun,

James McLellan
<jwmcl@att.net>

(ed. – This was in response to the letter by Zarir Pastakia and James included Zarir in his reply. I appreciate Jim taking the time to provide such a thorough answer and getting Zarir moving in the right direction.)

June 12, 2005

Aircraft Query:

I recently read an article about an NP-100A Albatross, 1975 Japanese ducted fan motor glider powered by a Kawasaki three cylinder motorcycle engine. However I cannot find any reference to the aircraft anywhere. Can you help me at least find a picture or some technical data on the aircraft?

Regards

Michael Swan
<fsrkuwait@hotmail.com>

(ed. – He's right about it being hard to find information. I tried four different search engines and could only come up with pincher pliers and batteries. Does anyone have some information that would help?)

June 17, 2005

Howard Hughes and Kaiser

(ed. – This was a question posted on the Nurflugel bulletin board – "I wondered what did Hughes feel about the flying wing design? Any famous or not-so-famous incidents?" The response follows.)

If I recall correctly, the Hughes "Spruce Goose" flying boat was designed to carry troops and war materials across the Atlantic. Interestingly, another competing?) response to the same problem was the well publicized "Kaiser Tailless" design from H.J. Kaiser of automotive fame (remember the 'Henry J'?). A 1/17-scale model of this huge, multi-engined, straight-winged tailless design was wind tunnel tested by NACA in the 1940's. It was the subject of tech reports, and its configuration was also tested with other unconventional designs in the spin tunnel. Articles of the time sometimes referred to it or showed its layout. I'd guess that Hughes considered the flying wing for his long-range design, but chose differently.

Serge Krauss
<skrauss@ameritech.net>

(ed. – You can read the scale-model report at: http://naca.larc.nasa.gov/reports/1946/naca-wr-l-531/ I searched the web but couldn't find a picture of the model or a conceptual drawing of the aircraft. Does anyone have a link to one or one in a book they could copy and send us?)

June 28, 2005

Membership:

Hello, my name is Troy Eastin. I am currently working as an aerospace structural engineer and am interested in learning more about the design and development of blended wing body aircraft. Please contact me with more information regarding meetings, events, membership, etc.

Warm Regards,

Troy Eastin
2225 Hillslake Drive
El Cajon, CA. 92020
619-922-1271
<jeastin@cox.net>

(ed – I responded to Troy referring him to the BWB portion of our website just in case he hadn't seen it yet. I also invited him to join us at the July meeting especially since he lives close by. Hopefully we will see him and he can get some of his questions answered or at least pointed in the right direction.)

(ed. – The following items were extracted from the Nurflugel bulletin board that showed up during the past month. I haven't edited much of this so there may be some odd spelling errors or phrases.)

June 26, 2005

PITCH UP (OR DOWN)

Chris Bryant wrote:
<chris@palenquin.demon.co.uk>

I have been looking through my library for a beginner's description of the causes and cures for this phenomenon and I have not found one. Can anyone point me at some useful texts?

It seems to me that at certain parts of the performance envelope an aircraft can develop a pitching moment that its controls cannot develop enough power to stop and/or that the rate at which AoA changes for a given control input goes exponential and is too quick for the pilot to counter in time. Of course, this condition would be dependent on many factors ‹ planform, wing sections, control systems and their effectiveness at various AoA, center of gravity position and the cures would be equally varied including redesign, increased control power, limiting AoA or get a computer to fly it for you (F117A)! Am I on the right lines? It seems to be associated with swept wing designs but not straight ones.

Bruno De Michelis wrote:
<msmprod@optushome.com.au>

The phenomenon you are mentioning is present on any aircraft with any wing planform, but in some cases is less felt than in others. In ground effect, for example, plain rectangular wings resent from it much more than swept wings, because of the changed dynamic situation (addition of center of height and center of pitch plus noticeable movement of the center of pressure). Possibly, the reverse delta is the one that resents the least from this happening, but within certain speed limits.

Pure flying wings present a constant, even if not pronounced, phugoid oscillation produced by the reflexed profile. In normal flight (at altitude) aircrafts that present this kind of deficiency are usually suffering from poor design as far as the wing / tail proportional area is concerned, or by an incorrect AoA setting (decalage) between main wing and tail plane.

The only craft that seem not to be affected are flexi-wing (hang gliders, motorized or not) because of their extremely mild semi-stall characteristics and their dampening capability.

Matthieu Scherrer wrote:
<matthieu.scherrer@free.fr>

I know 2 kinds of pitch silly phenomenon on swept wing, and particularly FW

- Classical pitch up:

The tip stall first, and due to lever arm of the swept wing, the stall part is behind the CG : the loss of lift creates a pitch up. This is a high AoA matter, at least for subsonic flow. This is quite well known even on classical airplane.

- Quick pitch oscillation:

The FW seems to flight on "corrugated iron". Causes are complex as far as I know:

+ Aerodynamic cause might be oscillating laminar bubble.

+ From a handling point of view, it sometimes happened that rigid aircraft short period (and not phugoid) and structural torsion modes might be coupled, then causing the phenomenon to damp slowly. This means natural movement of the aircraft and wing torsion movement are happy together, and vibrate in phase. Pilot may worsen the thing (PIO).

This happened to SB 13. I experienced it on a model...

Other may exist as well!

Nick Sturm wrote:
<grindelsturm@yahoo.com>

To throw in my two cents here:

I guess you would also have to mention high speed tuck where whether through aerodynamic or structural reasons the elevator becomes unresponsive.

Reference the P-38 for aerodynamic reasons, I think it had problems because in a dive it would go transonic.

A swept wing might tuck because it did not have the torsional stiffness required and loses its twist.

I think some (early?) hang gliders would tuck because the batons would bend under flight loads and the airfoil would loose its shape.

Speaking of: I had my first tandem hang glider flight Saturday. I don't know if I'm hooked or not, weight shift will take some getting used to. Fun though. next week, if everything goes alright...hill training.

Bob Storck wrote:
<bstorck@sprynet.com>

Testing indicated that this was the same shock wave propagated on the horizontal stab. When it moved just forward of the elevator hinge line, the controls lost effectiveness. They came up with "dive flaps," hydraulically actuated spoiler type devices, located on the lower wing surface between pod and nacelle. When actuated, it would slow the craft down enough to regain control effectiveness.

A small addenda. When this was developed, they rushed enough kits through to handle all ETO aircraft and packed them in a transport aircraft. In a rare situation, that airplane was intercepted and shot down by a FW200.

Chris Bryant wrote:

Fellow Nurflugelers, I knew I could rely on you. Thank you very much for your contributions.

It would seem that the main cause under 1) of Matthieu Scherrer's description would be caused by a large movement of the center of pressure. This is also the presumed cause in Nick Sturm's point:

And the need for a stronger elevator response is movement of the center of pressure?

These two cases are the form of pitch up I was referring to.

Matthieu's second point has been called alpha pecking and is usually sufficiently damped (given that the structure is reasonably flutter proof) not to be too much of a nuisance. Just uncomfortable. Apparently, the B2 stealth and the SB-13 suffer from it in turbulent conditions. I have had several of my model designs do it, but they are all of high aspect ratio and inherently less torsionally stiff than lower aspect ratio designs, so this may be a contributory cause.

By the way, Concorde operated at high AoA’s at take off and landing. How close was it to pitching up? Does anyone know? Or was the design not prone to it?

Bruno De Michelis wrote:

In the region of 27-28 degrees. typical of delta.

Serge Krauss wrote:
<skrauss@ameritech.net>

Another perspective? My apologies if this approach has been implied or discussed before or is too elementary a model. FWIW, for all-wing types without "fly by wire", the wing itself must have a positive pitching moment that is then balanced by placing the center of mass at an appropriate static margin ahead of the aerodynamic center of the wing. Control surfaces have an inherently shorter moment arm to work with, and they can easily compromise the lifting function of the wing.

The positive pitching moment to achieve static stability is aerodynamically achieved through reflex or twist and thus (even without a c.p. movement) would vary with the square of the speed, becoming excessive at high speeds. It requires regulation by deflection of short-coupled control surfaces. Some finesse and subtlety of design are required to achieve efficiency, while avoiding creation of a one-speed aircraft that would pitch up at higher speeds. Dragging a tail far behind the wing makes it easier to control this tendency with tail drag and small moveable surfaces operating on a long arm. This can cover up a wide variety of design sins.

As I said, FWIW.

Chris Bryant wrote:

Thanks for this, Serge. Sums up the problem pretty well.

Further, it also happens at much lower speeds when the AoA gets too large. I seem to remember that aircraft like F-86s ‹ and other early swept-wing aircraft could pitch up at take-off if the pilot got too enthusiastic with his pull up. Similarly, Concorde got frisky at greater AoA's than 27 to 28 degrees (thank you Bruno De Michelis for that information).

Your point about a shorter moment arm for the pitch controls on a flying wing is one of the reasons why I posed this question in the first place. Not having a tail on a suitably long fuselage reduces the damping of the whole aircraft in pitch and makes it much more difficult to balance out all the pitching forces acting on it across the performance envelope. You have not got so much control and trimming forces to play with. And if you have, then you have probably compromised other aspects of the design. Adding in reflex to keep the pitching moment under control can make it better.

Overall, designing a good flying wing is a bit trickier than designing a good conventional one!

Bruno De Michelis wrote:

My pleasure. At present I am dealing with the same situation in testing my latest WIG model. It reaches its top speed (81.4 km/h, 48% above take off speed, not just a "sweet spot") and then, if one tries to increase it by means of a very small amount of down elevator, phugoid motion comes in. Every craft has its limits.

I recently found that plane (untwisted) reverse delta wings, using instead a slightly reflexed profile (NACA 23112-75, Marske's "Monarch" and similars) work much better and are more stable, both at take off and at speed, than the classic Lippisch 7 degrees at root and 0 at tips. With the latter, top speed equals 10-15% more than take off speed (sweet spot) and also take off speed is very high and fairly critical. I made two models of the famous ESKA-1, following the exact instructions of the chief designer Grunin (I translated from Cyrillic the full text regarding the Eska and published it on the WIG group) and both of them were very difficult to control and quite mediocre. A model of the X-113 flew better, but still with a "sweet spot" as speed.

Chris Bryant wrote:

Very interesting, Bruno, what size are your models?

The WIG case is very different to the free air one, of course. Exceeding the limits is much more important as the surface is so close! Am I right in thinking that one of the big Russian WIG prototypes made a medium-sized hole in the Black Sea for similar reasons trying to fly outside the sweet zone?

Bruno De Michelis wrote:

Not that I know, Chris. The KM had accidents but not of that kind. My models vary in size from tiny 6" gliders to two meters R/C models. Lately I am working on a 1/10th linear model, electrically powered, of the twin seater I will build.

Bob Storck wrote:

I found a remarkably detailed Naval Air Intelligence report on WIG in the files of the Naval Institute in Annapolis, obviously used by Tom Clancy in at least one of his books. Apparently they were very unforgiving of sea state, and had pitching problems that did many of them in . . . not just one. There was a pretty good TV documentary, focusing on the primary Russian designer, and the program was focused on how development fell into Russian politics and funding issues.

June 24, 2005

Doug Holverson wrote:
<dholverson@cox.net>

Am working on the latest Golden Hawk prototype (4/3 scale Silver Hawk II) and getting a little frustrated.

First flight on a B6-2 sort of Red Baroned when the shock cord got wrapped around the stubby little boom. The glider still kept fairly horizontal and tried to get its nose up and glide despite having the pop-pod dragging it down. Make me think that flying wings get a bad rep for not being stable.

Second flight of the Golden Hawk shredded on a C6-3. My main frustration with these 'Hawk gliders is that they don't upscale well. I'm guessing that the tip rudders add a lot of bad drag and inertia loading and possibly tip flutter out there. Anybody else have any insights?
http://elwood.longlines.com/~holvrson/splinter.jpg

1/8" thick balsa, ~450mm span.

Don Stackhouse wrote:
<djaerotech@erinet.com>

Flutter and structural divergence are both possibilities.

A big factor in flutter is the torsional stiffness of the wing. You might try a trick we use on our "Roadkill Series" models to improve the stiffness of your wing. Instead of making each wing panel from a single sheet of wood, split it down the 50% chord location (in other words, a front half and a back half of about equal chords). Make the grain of the front half parallel to the leading edge, and the grain of the rear half parallel to the trailing edge. This creates a sort of "A" frame effect that significantly improves the torsional stiffness.

Other big factors in flutter are the chordwise locations of the panel's C/G and "shear center". Both are important, although the panel's C/G location is probably the most important.

Imagine holding the root of the panel rigid, then applying a pure twisting (no up, down, forwards or backwards bending) to the tip of the panel. The leading edge will flex one way, the trailing edge will flex in the opposite direction, and some point in the middle will be stationary, the "axis" about which the rest of the panel is twisting. This axis is the shear center. On a flat, uniform, rectangular cross-section slab of wood the shear center will be at the 50% chord location.

To combat flutter, you need to get both the panel's C/G and its shear center to coincide with its aerodynamic center, in other words at 25% of the chord aft of the leading edge. One way to do this is to make the forward 20-25% of the panel out of something stiffer than the rest of the panel. With the older style wooden blades for model helicopter rotors, they typically make the forward portion out of maple and the aft portion out of pine, or even balsa. On both model and full-scale rotor blades it's also common to add weights to the leading edge to get the blade's C/G forward, in addition to the added inertia to help store energy for the landing flare during autorotations. Lead is commonly used on model helicopter blades, and on full scale I've even seen cases of a tungsten bar built into the leading edge of the blade. A Bell Jet Ranger has 25 pounds of lead in the tip of each blade, and I can assure you that it's located as close to the leading edge as possible.

Control surface flutter on airplanes is a similar problem, and similar solutions apply. Mass balancing is frequently the solution there as well. If the hinge line is aft of the leading edge (such as the rudder on a DC-3), the mass balance can be inside the leading edge of the control surface itself. If not, then the mass balance may be inside of an aerodynamic counterbalance or strut that sticks forward from the tip (very common on light aircraft elevators and ailerons), or even a simple weight mounted on a forward-angled strut, such as above and below the elevator on a P-38.

It's possible to add a strut sticking forwards from the tip of your wing, with a lead weight on the end. However, safety aspects of the possibility of that snagging on everything in sight (including people) is a potential problem.

One alternative would be to get some of the lead foil tape they use as a sensor strip for windows in burglar alarm systems. It's thin, adhesive-backed lead foil typically about 1/2" wide. They use a strip of it around the perimeters of windows, so that if a burglar breaks the glass, the lead foil tape is broken, electrically triggering the alarm. Radio Shack used to sell it for their do-it-yourself home alarm systems, although with all the paranoia about lead these days I don't know if they still carry it. Carve your wing panel to shape, making the leading edge cross-section shape a little thinner than the final airfoil shape. Next, apply one or more (as required) strips of this tape along the leading edge, half above and half below, sort of like a de-ice boot, until the panel balances at the 25% chord location. If you're worried about the possible lead exposure, paint over the tape with a tough paint, or cover it with a slightly wider strip of thin plastic tape.

Don continues with:

Doug Holverson asks, with regard to the "A" frame effect I described form using tapered fore and aft portions in a wing panel to improve torsional stiffness:

Doug asked: I'm wondering if you could do the split down the MAC.

I presume you mean splitting it along the line of aerodynamic centers at the 25% chord locations along the wing?

If you were making the forward section out of something very hard and stiff, like maple or perhaps pine, and the aft section out of balsa, that could be made to work. However, if the front and aft sections were out of similar materials, it could start acting structurally like a forward-swept wing, twisting as it bent under load. Properly done on your swept-back planforms, this could cancel out the natural washout effect due to bending in these planforms, but it could get tricky. You might want to make some test samples, put some long chordwise sticks at the root and tip for reference, then experiment with what happens to twist when you do a static load test.

AVAILABLE PLANS & REFERENCE MATERIAL

Coming Soon: <u>Tailless Aircraft Bibliography</u>
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

Serge Krauss, Jr. skrauss@earthlink.net
3114 Edgehill Road
Cleveland Hts., OH 44118 (216) 321-5743

<u>Personal Aircraft Drag Reduction,</u> by Bruce Carmichael.

Soft cover, 81/2 by 11, 220 page, 195 illustrations, 230 references. Laminar flow history, detailed data and, drag minimization methods. Unique data on laminar bodies, wings, tails. Practical problems and solutions and, drag calculations for 100HP 300mph aircraft. 3d printing. $25 post paid.

Bruce Carmichael brucecar1@juno.com
34795 Camino Capistrano
Capistrano Beach, CA 92624 (949) 496-5191

VIDEOS AND AUDIO TAPES

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
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VHS tape of July 15, 2000 presentation by Stefanie Brochocki on the design history of the BKB-1 (<u>B</u>rochocki,<u>K</u>asper,<u>B</u>odek) 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.
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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".
Cost: $8.00 postage paid in US
Add: $2.00 for foreign postage

VHS of Robert Hoey's presentation on November 20, 1999, covering his group's experimentation with radio controlled bird models being used to explore the control and performance parameters of birds. Tape comes with a complete set of the overhead slides used in the presentation.
Cost : $10.00 postage paid in US
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The three drag polars (clean, take-off, and landing) are shown in Fig. 9.

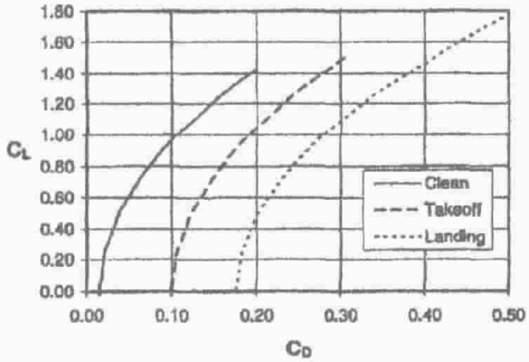

Fig. 9. BV-208.P3 Drag Polars

Drag Reduction

A comparison in values of C_{D_o} with two other military aircraft, the P-51 Mustang and ME-163, both designed in the same era as the BV-208.P3 is shown in Fig. 9. The values of parasite drag coefficient for the two comparison aircraft are taken from Hoerner[19].

It can be seen from Fig. 10 that the BV-208.P3 has a much lower zero lift drag coefficient than that of the P-51, which is a conventional configuration. Its drag coefficient is only slight greater than that of the semi-tailless ME-163, yet the ME-163 had no engine-air or cooling intakes (it was rocket powered), possessed a small vertical tail and was, overall, an extremely clean configuration. Thus, the BV-208.P3 configuration clearly demonstrates its claims of reduced drag.

Powerplant - The BV-208.P3 made use of the Daimler Benz DB 603 L reciprocating engine. The limited data available did not provide the variation in power available with altitude or define the critical altitude for the engine. To overcome these difficulties and to provide a reasonable approximation to the performance of the engine, critical altitude variations were approximated by utilizing data from a comparable engine of the time period. The engine selected was the Packard-Merlin (Rolls-Royce) which was at a similar stage of development at that time.

Propeller - The available propeller data provided was limited to the number of blades and the propeller diameter. The geometric data was obtained for a Hamilton Standard propeller as used on the P-51 and incorporated into a modified blade-element/ momentum/vortex propeller model which included compressibility effects.[20]

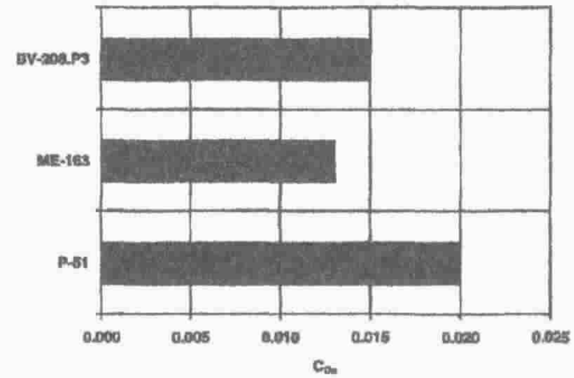

Fig. 10. Parasite Drag comparison between P-51, ME-163, and BV-208.P3

PERFORMANCE RESULTS

Takeoff and Landing

Since one of the performance parameters available from the German literature[14] was the take-off distance, a significant effort was expended to determine the projected take-off distance. Two separate analysis methods were used. First a classical analytic method[20] and, second, a semi-empirical method from Ref. 18. The comparative values for take-off distance are shown in Fig. 11. Although no landing data was given, landing distance was calculated to be 550 m.

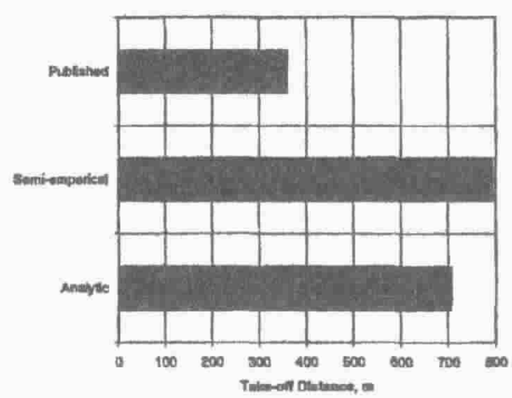

Fig. 11. Take-off distance

Maneuver and Maximum Speed

Maneuver envelopes were calculated for both 1g and 2g sustained capabilities (Fig. 12). The 1g case is the steady level flight envelope of the aircraft. A significant amount of pertinent performance information can be observed by an examination of this curve. The left hand portion up to the inflection point at the maximum altitude is the stall speed of the aircraft as a function of altitude. The inflection point defines the absolute ceiling at which $V_{stall} = V_{max}$ (because the maximum power available is equal to the minimum power required). From the inflection point on the right hand side, descending in altitude, is the maximum velocity of the aircraft as a function of altitude. Within this envelope the aircraft can maintain a steady, trimmed 1g condition.

The 2g envelope is the region where the aircraft can operate while sustaining a 2g steady, trimmed flight condition. This corresponds to a sustained 2g turning capability and is representative of the maneuver potential of the aircraft. In Fig. 12, the two symbols represent the published values of the maximum speed for two altitudes. The predicted values of maximum speed are both within 5.5% of the published values for those same altitudes. This would indicate a high degree of confidence in the methodology and the drag polar.

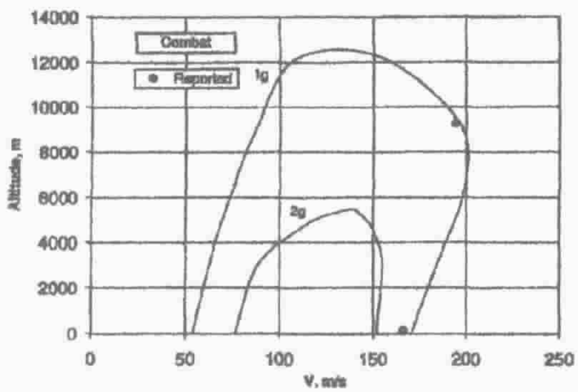

Fig. 12. Maneuver Envelope

CONCLUSIONS

The feasibility of the "scissor-tail" semi-tailless aircraft configuration has been examined and the original claims by the designers evaluated.

1. The claims of reduced drag are accurate. The BV-208's coefficient of drag is much lower than a conventional aircraft configuration.
2. Several performance points were matched, indicating a high degree of confidence in the analysis methods.
3. For the "scissor-tail" configuration, the empennage effectiveness is increased, but not to the extent previously claimed. The expected increase in dynamic pressure ratio did not occur due to the small size of the near vortex flow field.
4. A methodology has been developed for the analysis of similar configurations in the future.

Based on the above, the "scissor-tail" configuration is a viable candidate for a general-aviation aircraft configuration.

RECOMMENDATIONS AND FUTURE WORK

A dynamic analysis should be performed to include the coupled surface analysis and to evaluate flying qualities to obtain a level 1 configuration. The designers also claimed a number of structural advantages that were not evaluated in this paper. A detailed structural analysis will need to be completed to evaluate these claims.

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