No. 283 JANUARY 2010

T.W.I.T.T. NEWSLETTER

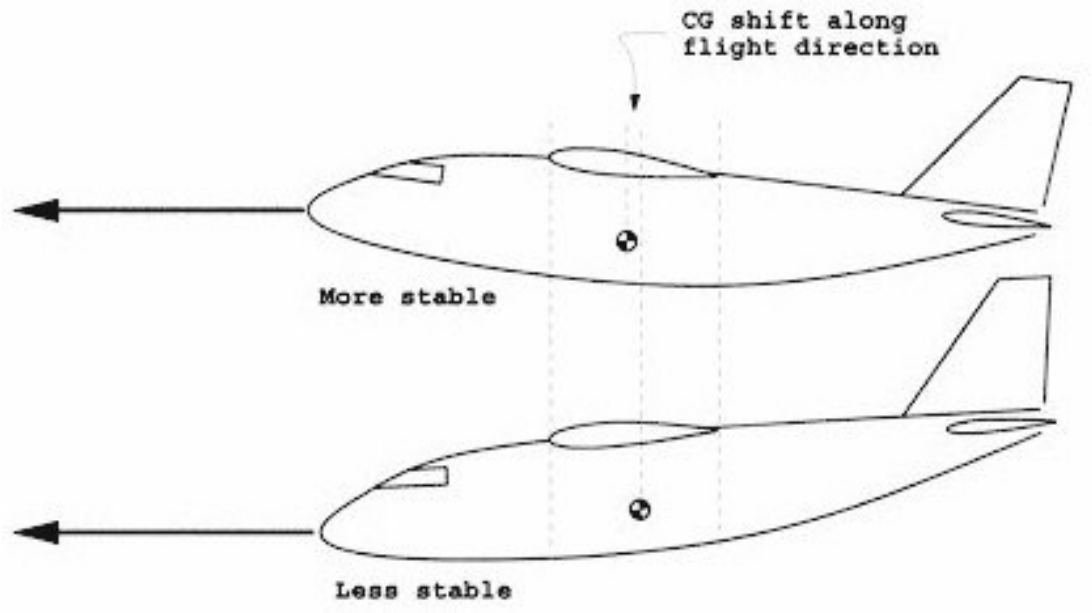
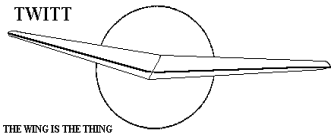


Illustration prepared by Prof. Mark Drela to explain CG locations as part of his reply to a question on the Nurflugel site. You can see more on his response on page 9.

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., **1001** means this is your last issue unless renewed.

Next TWITT meeting: Saturday, January 16, 2010, 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

I hope everyone had a happy and safe new year's celebration and are looking forward to working on your projects in 2010. I have gotten started on my 1-26 restoration and we did a trial fit of the wings this weekend to make sure the new carry-through plates would line up correctly. We only had to make a couple of adjustments to the drag spar fittings for everything to come together and fit properly, so it was a good day.

At the time of publishing I was not sure if I had all the renewals due to a problem at the post office box. It should be resolved in the next couple of days and then I will know if I missed anyone's renewal and accidently removed you from the mailing list. Not to worry, everyone will get the issues they are due but they may arrive a little later than normal.

As usual, January is the first meeting of each new year, but we don't have a program for you. I haven't received any suggestions from the more local membership that would be able to attend and I haven't run across any topics or speakers that would draw a crowd sufficient to justify putting something together. So if you can think of anything that would be a great draw and make it worth the speakers while to come talk to us, please let me know.

You can also help with the newsletter by submitting information on your projects by letter or e-mail. Pictures are always great and everyone loves to see them. So please take a few minutes and put something together to share with the members. I know and I would appreciated it.

HAPPY NEW YEAR

Andy

THERE IS NO SCHEDULED PROGRAM FOR THE JANUARY MEETING

Although there is no formal program scheduled for the first meeting of 2010, you are more than welcome to come down to the hanger and visit with others. Since there is a new restoration project going on with a Schweizer 1-26A, you might be able to lend a hand with one of the tasks.

LETTERS TO THE EDITOR

December 22, 2009

Do you know the video of Scott Winton´s Facet Opal?
Great Video, I wonder where it has been hiding all these years? A good thing for the TWITT Newsletter.

http://www.youtube.com/watch?v=h2wrSa8mCcI

Al Backstrom
<albackstrom@austin.rr.com>

(ed.- We have never seen this video before and it is excellent so if you don't have an Internet connection try to get to one and take a look. I didn't realize how small the Facet Opal was until seeing a person actually standing next to it. A must see. Thanks for the link Al. Included in the message where Al got the link was this shot. It is not a flying wing, but interesting anyway.)

December 22, 2009

Please note the new address. I do hope that this will be my address for many years. That is I do not want to be moving every year as it seem I have in the recent past. Let me know if there are other TWITT members in the Dallas area.

Thanks,

Warren Bean
1704 Bardfield Ave.
Garland, TX 75041
<warren.bean@gmail.com>

(ed. – We received this note with Warren's renewal for another year. I have passed his request along to those members I know live in the general area, but if you are passing through the Dallas area and would like to stop and chat with a fellow TWITTer (flying wing person not Internet chatter), drop Warren a line and see what can be arranged.)

December 24, 2009

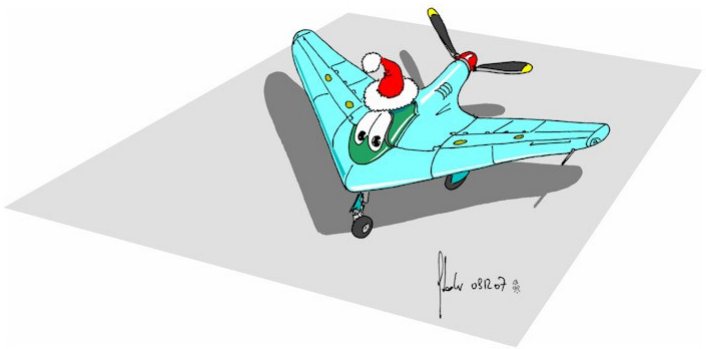
Hello Andy!

I wish you and the flying wing community a Merry Christmas and a good start into 2010.

Kind regards,

Reinhold Stadler
<mw40200@mucweb.de>

(ed. – This obviously came in after the December issue was already in the mail, but here is Reinhold's holiday card for all of us.)



January 3, 2010

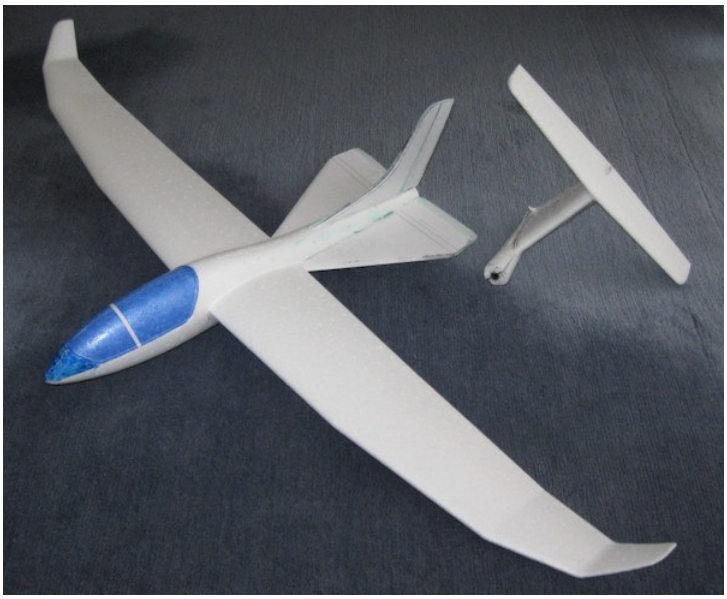
Hello friends,

With great pleasure I read the article ´bird oriented design concept´ by Mr. Syd Hall. He is a genius man! Perhaps you can give him my greetings and show him the picture attached. My project is similar and a model flies fantastic.

Thanks

Arno Hoffmann
<arno_hoffmann@t-online.de>

(ed. – Here is the picture included with Arno's message to Syd.)



(ed. – The following information was passed along by the late Richard Avalon some time ago and I was finally able to find it on the Internet to avoid having to hand type in the report. This was found at: http://www.roswellfiles.com/FOIA/FlyingWing.htm*. This document was released under the Freedom of Information Act and the original format was retained as much as possible.)*

As a result of Gen. Twining's Letter, Lt Col Walker, at the Air Material Command, asked his operatives in the field to discretely track down the Horton brothers and ascertain whether their radical "Flying Wing" designs- developed during WWII- might be responsible for the rash of Flying Saucer sightings in 1947. This is the report from the Berlin office.

SECRET

HEADQUARTERS BERLIN COMMAND
OFFICE OF MILITARY GOVERNMENT FOR GERMANY (US)
BERLIN, GERMANY

S-2 Branch
APO 742, US ARMY
16 December 47

Subject: Horton Brothers (Flying Saucers)

To: Deputy Director of Intelligence
European Command, Frankfurt
APO 757, US Army

(SOURCE: A-2)

1. The Horten brothers, Reimer and Walter, are residing in Goettingen at present. However, both of them are travelling a great deal throughout the Bi-Zone. Walter at present is travelling in Bavaria in search of a suitable place of employment. It is believed that he may have contacted USAFE Head- quarters in Wiesbaden for possible evacuation to the United States under "Paper Clip". Reimer is presently studying advanced mathematics at the university of Bonn, and is about to obtain his doctor's degree. It is believed that when his studies are completed he intends to accept a teaching position at the Institute for Technology (Techniscbe Hochechule) in Braunshweig sometime in February or March 1948.

2. Both brothers are exceedingly peculiar and can be easily classified as eccentric and individualistic. Especially is this so of Reimer. He is the one who developed the theory of the flying wing and subse- quently of all the models and aircrafts built by the brothers. Walter, on the other hand is the engineer who tried to put into practice the several somewhat fantastic ideas of his brother. The clash of person- alities resulted in a continuous quarrel and friction between the two brothers. Reimer was always developing new ideas, which would increase the speed of the aircraft or improve its maneuverability; Walter on the other hand was tearing down the fantastic ideas of his brother by practical calculations and considerations.

3. The two men worked together up to and including the "Horten VIII" a flying wing intended to be a fighter plane powered with two Hirt engines (HM-60-R) with a performance of approximately 650 horsepower each.

After the "Horten VIII" was finished, one of the usual and frequent quarrels separated the two brothers temporarily. Walter went to work alone on the "Horten IX", which is a fighter plane of the flying wing design, with practically no changes from the model VIII except for the engines. Walter substituted the Hirt engines with BMW Jets of the type TL-004. The plane was made completely of plywood and was furnished with a Messerschmidt ME-109 Landing gear.

The model of this aircraft (Horten IX) was tested extensively in the supersonic wind tunnel (Mach No. 1.0) of the aero-dynamic testing institute (Aerodynamische Versuchsanstalt), located in Goettingen. The tests were conducted in the late summer of 1944 under the personal supervision of Professor Betz, chief of the institute. Betz at that time was approximately sixty years old and next to Prandtl (then seventy-eight years old), was considered to be the best man on aerodynamics in Germany. Betz's attitude toward the flying wing is very conservative to say the least. Basically he is against the design of any flying wing. According to the official reports about the tests, air disturbances were created on the wing tips, resulting in air vacuums, which in turn would prevent the steering mechanism from functioning properly. This seems logical as, of course, neither the ailerons nor the rudders could properly accomplish their function in a partial vacuum created by air disturbances and whirls.

In spite of that, two Horten IX's were built and tried out by a test pilot, Eugen (now living in Goettingen) at Rechlin in the fall of 1944. One of the two planes, piloted by another test pilot, developed trouble with one of the jet engines while the pilot was trying to ascertain the maximum rate of climb. The right jet stopped suddenly, causing the aircraft to go into an immediate spin and subsequent crash in which the pilot was killed. Eugen, however, was more fortunate in putting the other ship through all the necessary paces without the least trouble. He maintains that the maximum speed attained was around 950 km per hour, and that there were no steering difficulties whatsoever, and that the danger of both head and tail spins was no greater that any other conventional aircraft.

After extensive tests, the Horten IX was accepted by the German Air Force as represented by Goering, who ordered immediate mass production. The first order went to Gothaer Waggon Fabrik, located in Gotha (Thuringia) in January 1945. Goering requested that ten planes be built immediately and that the entire factory was to concentrate and be converted to the production of the Horten IX. The firm in question received all the plans and designs of the ship. In spite of this explicit order, production of the Horten IX was never started. The technical manager of the firm, Berthold, immediately upon receipt of the plans, submitted a number of suggestions to improve the aircraft. It is believed that his intention was to eliminate the Horten brothers as inventors and to modify the ship to such an extent that it would be more his brainchild than anybody else's. Numerous letters were exchanged from High Command of the German Air Force and Dr. Berthold, which finally were interrupted by the armistice in May 1945. When US troops occupied the town of Gotha, the designs of the Horten IX were kept in hiding and not handed over to American Military authorities. The original designs in possession of the Horten brothers were hidden in a salt mine in Salzdettfurt, but the model tested by Eugen was destroyed in April 1945. The original designs were recovered from Salzdettfurt by British authorities in the summer of 1945.

The Horten brothers, together with Dr. Betz, Eugen and Dr. Stueper (the test pilot of the aerodynamic institute in Goettingen), were invited to go to England in the late summer of 1945 where they remained for approximately ninety days. They were interrogated and questioned about their ideas and were given several problems to work on. However Reimer was very unwilling to cooperate to any extent whatsoever, unless an immediate contract was offered to him and his brother. Walter, on the other hand, not being a theoretician, was unable to comply and Reimer was sufficiently stubborn not to move a finger. Upon their return to Goettingen Walter remained in contact with British authorities and was actually paid a salary by the British between October 1945 and April 1946, as the British contemplated but never did offer him employment. Walter subsequently had a final argument with his brother and the two decided to part. Reimer then went to the university of Bonn to obtain his degree, and Walter organized an engineering office in Goettingen which served as a cover firm to keep him out of trouble with the labor authorities. Walter married Fraulien von der Groeben, an extremely intelligent woman, former chief secretary to Air Force General Udet.

In the spring of 1947 Walter Horten heard about the flying wing design in the United States by Northrop and decided to write Northrop for employment. He was answered in the summer of 1947 by a letter in which Northrop pointed out that he, himself, could not do anything to get him over to the States, but that he would welcome it very much if he could come to the

United States and take up employment with the firm. He recommended that Walter should get in touch with USAFE Headquarters in Wiesbaden in order to obtain necessary clearance.

4. As can be seen from the above, most of the Hortens' work took place in Western Germany. According to our source, neither of the brothers ever had any contact with any representative of the Soviet Air Force or any other foreign power. In spite of the fact that Reimer is rather disgusted with the British for not offering him a contract, it is believed very unlikely that he has approached the Soviet authorities in order to sell out to them. The only possible link between the Horten brothers and the Soviet authorities is the fact that a complete set of plans and designs were hidden at the Gothaer Waggon Fabrik and the knowledge of this is known by Dr. Berthold and a number of other engineers. It is possible and likely that either Berthold or any of the others having knowledge of the Horten IX would have sold out to the Soviet authorities for one of a number of reasons. However, this will be checked upon in the future, and it is hoped that contact with the Gothaer Waggon Fabrik can be established.

5. As far as the "flying saucer" is concerned, a number of people were contacted in order to verify whether or not any such design at any time was contemplated or existed in the files of any German air research institute. The people contacted included the following:

Walter Horten

Fraulien von der Groeben, former Secretary to Air Force General Udet

Guenter Heinrich, former office for research of the High Command of the Air Force in Berlin

Professor Betz, former chief of Aerodynamic Institute in Goettingen

Eugen, former test pilot

All the above mentioned people contacted independently and at different times are very insistent on the fact that to their knowledge and belief no such design ever existed nor was projected by any of the German air research institutions. While they agree that such a design would be highly practical and desirable, they do not know anything about its possible realization now or in the past.

[signed]

HARRY H. PRETTY
Lt Col GSC S2
Telephone BERLIN 44715
Copy furnished: Director of Intelligence, OMGUS

SECRET

Nurflugel Bulletin Board Threads

I made the same post on xfoilgroups and wanted to share with you too

This made me bow in awe
http://www.youtube.com/watch?v=LLk3fPeQuD8

mrk@karenfuxia.com

Sorry boys, may be I'm a bit more dumb than usual -What is this guy trying to demonstrate? I also watched 2 other of his videos but neither shed any light...

Doug Russell-White
dear_w2002@yahoo.com

Hi Doug

The guy is half way an artist, these guys are involved in conceptual work, acts, esthetic (visit the blog linked)...what I think goes on his mind (but never push that too much!) is that he put the essential elements of flight in place: the wind (fans), the object (paper aircraft) and the space (between the fans). then comes "a gesture" which is, an expression of will, the artist touch "I put the object in the conceptual/real space" and, with minimum possible intervention, I have a maximum effect (this is somehow an "abstract" score that is usually important to achieve, both in this sort of conceptual art and in real engineering stuff).

The paper aircraft is flying, but it stays fixed in space, held there by a "flow trap" that the guy managed to set with those fans (supposedly the back fan is spinning at a lower speed than the front one, judging by the button he press, and this has to be critical :-)... just that trap is a piece of artwork that a lot of aerodynamicists will appreciate

One can also read -I'm pushing this too much maybe :-) – an esthetic loneliness of this paper aircraft, could be a modern "Don Quixote" automa, an idealist object

that flies and flies because that is its "leitmotif" (reason of existence), but it is just flying in a wind trap put in place by windmills (like the original Don Quixote) and eventually is kicked out by the trap, falls and dies.... ok I'm tragic here :-)))))))))))

But you can see whatever you like on it, those things are made also for making people think :-) sort of action poetry :-))))))

mrk

Gee... I just thought it was a neat little open section wind tunnel.

BTW here's some color footage of some flights of the N1-M:
<http://www.youtube.com/watch?v=KjKASCLsBW8>

Norm Masters
nmasters@acsol.net

I found this while looking for info on the Tileston Drake.
http://www.1000aircraftphotos.com/AmateurBuilt/3873.htm

Bill Higdon
willard561@aol.com

I wonder how stable it is.

Doug Halverson
dholverson@cox.net

(ed. – It is called the Sheen Flying Wing and I sent the following to the group: "Interesting in that these look similar to pictures taken by Bob Chase, one of our members, at about the same time at Jean when he spied it while on one of his many trips. He made inquiries of the airport folks but no one had any information on who it belonged to, whether it had flown, etc. I happen to go by Jean sometime later and it was no longer there, but again couldn't find anyone who had any information. I included them in our February 2005 issue to see if anyone else might know about it, but again there were no responses with information.")

Sky_surfer asked about airfoil for a flying wing "floater". A file is uploaded, showing a possible configuration. b=2.6m, S=60 sq-dm, W=1600 g.

I do love to "design" flying wing airfoils and have run some low Re-numbers (40 000 - 200 000), positive Cm airfoils through ProfiliPro, XLRF5, Design foil and Javafoil. There are quite a few discrepancies in Cl/alfa, Cm/Cl and Cl/Cd from the various programs! And, they all (except for Javafoil) use Xfoil!

In an attempt to straighten the results somewhat, I forced transition on the upper surface to turbulent at 10% cord. Even then, the output varied quite a bit.

Also, when using different NCrit (Profili Pro and XFLR5), the results scattered.

Any good ideas how to proceed?

For a flying wing (especially a "plank" it is of vital importance to get reasonable Cm/Cl, Cm/alfa values. Is NCrit=13 (sailplane) relevant for model airfoils at Re< 200 000?

MANY more questions to come!

Regards

Ben Jansson
bengtjansson30@yahoo.com

Ben, what do you call a positive Cm? A stable one or unstable one? The reason for which I am asking is that according to different countries the definition changes. Generally, a medium-thickness profile with an "S" shaped camber line should be good for your application. See also
http://www.mh-aerotools.de/airfoils/index.htm

Cheers from Bruno

msmprod@optusnet.com.au

I notice that in flying wings I design that have a "bat tail" that the CG is approximately 2 cm to 2.5 cm forward of the CG predicted by the online CG calculators. I am not compensating for the bat tail when I use the calculators. Even when I attempt to lengthen the root airfoil to compensate for the bat tail, the result is never the CG found in test flights.

I am curious what affect the bat tail is having on the CG. Any ideas?

Best regards,

Jeff
jeffimel@hotmail.com

Obviously a lifting effect. It tends to improve the lift distribution over the center of the wing and also to reduce drag. To fly straight and level the CG will have to be shifted a little forward of its theoretical position.

Cheers from Bruno

Jeff,

What airfoil(s) are you using? Are you imparting any twist into the center section of the wing?

The incorporation of a bat tail _should_ put the CG further back than the placement for a trapezoidal wing. But the CG placement is going to depend upon the aerodynamic wing twist, where more twist demands a further forward CG location.

Bill & Bunny Kuhlman
bsquared@themacisp.net

Hi Bruno and group,

With a "positive" Cm airfoil, I of course mean a ¨n S-shaped mean line, stable around 25% c. I´m a little confused about static margins for RC flying wings. It was my belief that 6-8% of MAC was necessary. Lately I have read of static margins as low as 3.5%! How about short period oscillations? (PIO only occurs from non-ideal human pilots.)

I upload a file of one of my airfoil polars. Turbulators seem to be necessary only at Re <80 000.

Ben

From a control theory point of view: Shouldn't oscillation frequency rise (and oscillations become stronger) with higher static margins? A plane with very low static margin would not oscillate at all (but of course, need a lot of attention at the stick).

Regards,

Jochen
jbergmeyer@t-online.de

Ben,

The more positive the pitching moment, the more forward the CG must be (larger static margin). Also keep in mind that because the reflex creates a down force, the CL max will be reduced as the section reflex is made greater.

The evolution of "plank" airfoils has been toward reducing the reflex and thus lowering the positive pitching moment and reducing the static margin - higher CLmax and lower CD means greater efficiency.

On our models, we've recently been using a section designed by Barnaby Wainfan - the BW050209. See <http://www.b2streamlines.com/BW050209.pdf > and <http://www.b2streamlines.com/BW050209plots.pdf >.

This section has a very low pitching moment, and we've been able to bring the static margin down to significantly less than 2.5%. Phugoid oscillations are not in evidence and these 'ships are able to fly hands-off for long periods.

Bill & Bunny Kuhlman
bsquared@themacisp.net

Jochen, that is an extremely useful observation. I have flown several plank designs. The Marske XM-1 used a Fauvel airfoil with a large static margin and the Pioneer series had much lower static margins. The lower static margin Pioneer I & II had much less tendency to oscillate in pitch than the XM-1 - and were much easier to fly.

My take is that once you select a plank design you have very low level of pitch damping - something you cannot change. What you can change is the pitching moment by the selection of airfoil section.

If the airfoil has a large restoring moment, (large static stability margin like the Fauvel which I'll call positive Cm) with the CG well forward, any change in angle of

attack will be met with a strong restoring force which due to the lack of damping, will overshoot the trimmed AOA and result in pitch oscillations around .5 Hz.

There will be two pitch oscillation modes. The longer period is the Phugoid of around 17 seconds per oscillation. It's the .5Hz oscillation that is affected by the CM and pitch damping. The Phugoid is damped by total drag and is not part of this thread.

Reducing the Cm toward zero reduces the restoring force until the very small damping capacity can deal with it.

However, I disagree that low pitching moment results in a difficult to fly aircraft. I've flown several different gliders with essentially zero pitch stability and found no difficulty whatsoever in controlling them. The glider simply tends to continue to do whatever it was doing when you released the control stick.

Bill Daniels
BILDAN@COMCAST.NET

Hey Bill:

2.5%, Really, best numbers I have seen tossed around is 5%. I have been using primarily MH series, like the MH45 and MH64 (slightly negative) on a slightly swept plank . On this last go really working on getting the CG back (adding Grains of Shot to the tail) and then measuring as carefully as possible to see how I did, about 8% is it for me. Now this is a 60" Foamie so I am sure it is loosing just on covering but I try to keep the covering in good condition.

At this point, in light to medium slope lift I must have a Launch preset of 1 mm up trim or even with a good toss and angled with some up it will it the ground in front me before I get my thumb on the stick. :-) But, as soon as she gets out flying 30-40 or 50 feet out and up to speed I can switch out of Launch into cruise and she holds level just fine. No bad habits and in Cruise mode and increased speed from a dive or mild DS, she doesn't pitch back up or require any re- trimming for speed. I have yet to make a template to see just where she is in Section though appears to be right there as neutral.

The Launch preset of 1 mm up is also rather nice as a lazy Thermal Mode rather than just using my thumb, kinda fun.

BW050209 is this on the Alula? If so, I got a chance to toss one around as a DLG a few weeks ago. For it's size and no peg to toss it, it performs very well, caught a few thermals with it.

I am not searching on airfoils for a Light Weight Floater, I am looking at a 3 meter Slope racer Plank I want to build. Knowing too much which means way too little causes me problems with deciding on what to use. :-)

Dan
danfield@roadrunner.com

Dan,

What B^2 aren't telling you is that after thousands of hours, they can handle low static margin aircraft too. One of the consequences of models is the non-scale excess damping. This causes the short-period to disappear and the only mode left is the phugoid. If you're a good enough pilot, you can take this out with pilot technique. Ergo: the plane flies really well with exactly the correct nuance in pilot technique. For lesser mortals (like ME!!!) we "jerk" around the sky like drunks...

Al Bowers
Albion.H.Bowers@nasa.gov

I may have lost track of where I am in this thread. When I first flew the Marske XM-1 plank, I think I spent most of the flight either in a vicious, high amplitude .5Hz PIO or flying sideways. By the second or third flight, I figured out I had to stop over-controlling in pitch and lead turns with full tip drag rudder and then to mix in just enough aileron (elevon actually) to keep the yaw string centered. IIRC, the CG on the constant chord wing was at about 19% MAC.

The first flight in the Pioneer 1 with only about 1% as much pitching moment was uneventful. The pitch control and damping seemed perfect. It was also at about 19% MAC.

As far as flight experience, I think Jim had all of 40 hours in a Schweizers and Piper J3 Cub when he test flew the XM-1. I think I had about 150 hours in gliders and a 7AC Champ. I had about 500 hours in gliders when I test flew the Pioneer 1.

To me, it seems clear that you don't want large static stability margins in plank-type aircraft - you just don't have enough damping to deal with it. Lower static stability makes it much easier to fly. I realize this will seem counter-intuitive.

Bill Daniels

Bill,

I was talking about models and their flight characteristics (all phugoid and no short period). I've yet to hear of a full-scale sailplane plank that didn't have some LCO (not PIO) pitch oscillations. Einar Envoldsen used to tell me stories about flying Al Backstrom's planks for him. It would make sense to reduce the static margin, and reduce the control power, this would reduce the short period and give manageable control power, but again, you end up with a very restricted CG envelope, another common complaint about flying wing aircraft.

Of course Einar's stories could be like the stories from Karl Nickel about flying Reimar's wings and their adverse yaw problems too...

Al

You're right about the restricted CG envelope Al. That works with a glider since it isn't carrying cargo or burning off fuel so the CG stays where it was at takeoff. A powered airplane would need some sort of CG shifting system to keep it trimmed.

Jim used a neat trick by placing the main wheel at 19% MAC. If ballasted so that it just barely rested on its nose skid, the plank's CG was perfect.

I just got an e-mail from Jim Marske correcting me on the XM-1's CG location. He says it flew best at 23% MAC and now I seem to remember the P1 also was about 23%.

That was a long time ago.

Bill Daniels

Maybe you can find some interesting thoughts here, one of Matthieu Scherrer personal papers

http://pagesperso-orange.fr/scherrer/matthieu/aero/papers/extended_stability_%20theory_for_models.pdf

mrk

That's a pretty good overview of the stability issues on low-Re sailplanes. It does get rather involved but for good reason --- it's a rather complex topic. There are however a few take-away messages that can be distilled out:

1) In the presence of viscous effects, which become especially pronounced at low Re, the airfoil's Aerodynamic Center (AC) is _not_ at the quarter chord. The rigorous definition is:

x_AC = 0.25 - (dCm/dalpha)/(dCl/dalpha)

For thin inviscid airfoils Cm is constant and hence dCm/dalpha = 0, which gives x_AC = 0.25 as expected. But if Cm varies then x_AC is not 0.25, but can be quite different. And in fact x_AC will vary quite a bit with alpha or Cl. Scherrer quotes x_AC values between 0.20 and 0.35 (!).

2) The real measure of plank stability is not positive Cm about the quarter chord, but positive Cm about the x_AC. If you know x_AC from above, then this modified Cm can be computed:

Cm_AC = Cm + (x_AC-0.25)*Cl

So this is the number that needs to be positive, not the usual Cm.

3) Scherrer also points out that static margin is not really a constant for any given airplane and CG location, but varies with alpha or CL. So the glider in his example can be stable at low speeds (higher CL's), but can become unstable and tuck in at a sufficiently high speed (low CL).

This varying static margin can be due to viscous effects on the airfoil as discussed above. But it turns out that it can also be caused by having the CG well above or below the wing's area centroid, whether due to a low wing or a high wing configuration, or just from dihedral. High-wing airplanes, or airplanes with lots of dihedral like rudder/elevator RC gliders, have a reduction in static margin with increasing speed due to an effective aft movement of the CG relative to the wing as alpha decreases. The effect is sketched here:http://web.mit.edu/drela/Public/acgshift2.pdf Low wing airplanes are just the opposite.

So to get back to the topic, it's clear that even the stability of a simple plank is not so simple after all.

Mark Drela
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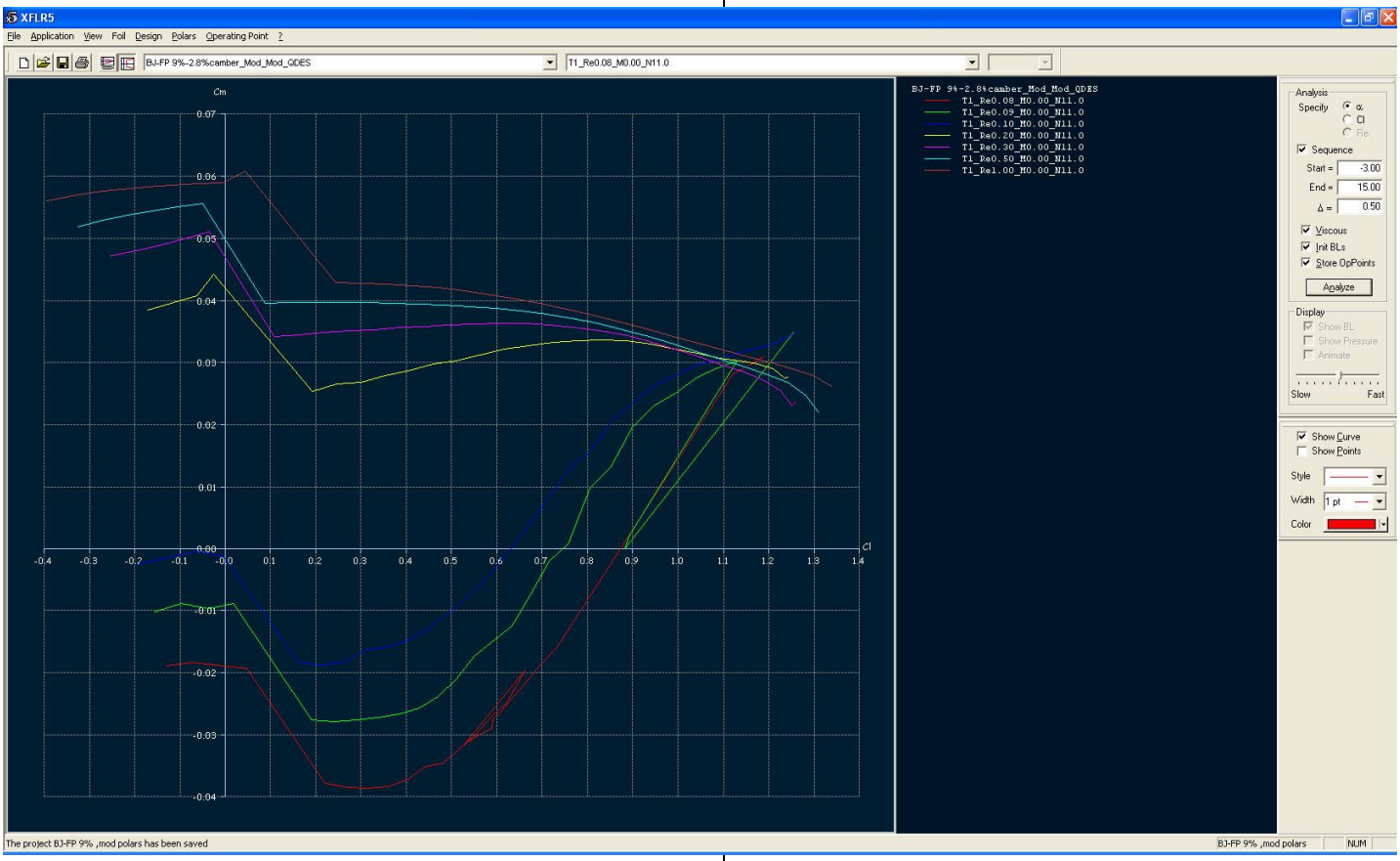
Hi Mark and Group. I upload a picture from XFLR5 showing a typical example how ac-position varies with Re-number. Even at "above critical" Re > 100 000 there is a marked shift in the ac position. Reading reports saying that a plane is flown at a specific cg-position doesn't tell the whole story. Stability margin comparing to what?

Keep the replies coming!

I am just as confused, but hopefully on a slightly higher level!

Ben



I recall a conversation with an aero engineer, whose name I will omit, about plank-type flying wings.

He said that if the elevator was deflected down it would negate the reflex in the airfoil and the glider would "go unstable" and nose over in an outside loop! We locked gaze for a few moments then he said, "OK, I get it - if you hold down elevator, you WANT to do an outside loop."

That's the key. The pitching moment varies with Reynolds number, speed and elevator position but the pilot just does whatever he has to achieve the maneuver desired. The amount of elevator needed will vary but, as long as there is enough elevator authority available, he's happy. A good parallel is the old-school control-line flying wing combat models with symmetrical airfoils.

The real issue is with "stick free" stability where you want the aircraft to remain in more or less the same attitude as when the stick was released. Surprisingly, counter-intuitively, a highly stable glider has more trouble with this than one with near neutral stability if there's any turbulence. A stable glider will chase every bump with pitch excursions - a neutrally stable glider will just ignore bumps.

Sailplanes are rarely in "cruise mode" where you want the glider to fly for extended periods hands-off. Most of the time you are aggressively maneuvering where high levels of pitch stability is a hindrance. There's more than a little similarity with fighters.

Bill Daniels

The short refutation is that the FW elevator deflection will change Cm, but not dCm/dalpha, so the stability is unaffected by elevator deflection (assuming small viscous effects, etc).

The consequence is that the still-stable airplane will try to hold a roughly constant nonzero pitch rate that's commanded by the elevator deflection. IF the airplane went unstable, then the pitch rate would not stay roughly constant, but would increase exponentially. So the outside loop would become a rapidly-tightening outside spiral, until the wing either stalls or breaks.

The real issue is with "stick free" stability where you want the aircraft to remain in more or less the same attitude as when > the stick was released.

This just requires that the free-stick elevator NOT be allowed to float and deflect in response to AoA changes, however that is achieved mechanically or aerodynamically.

This is only a concern for conventional aircraft or swept FW's with outboard elevators. For canards, and for swept FW with an inboard elevator, the stick-free elevator float will increase pitch stability.

Mark Drela

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