No. 296 FEBRUARY 2011

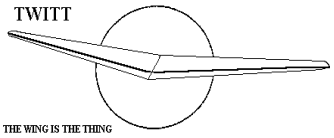
T.W.I.T.T. NEWSLETTER

The 2-meter wing makes a low pass. See article on Page 6. Photo by Steve Hunt.
Source: http://www.rcsoaringdigest.com/pdfs/RCSD-2010/RCSD-2010-12.pdf

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., **1102** means this is your last issue unless renewed.

Next TWITT meeting: Saturday, March 19, 2011, 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).

TABLE OF CONTENTS

PRESIDENT'S CORNER

In this issue I have included a memorial to Al Backstrom with the centerpiece being the recollections of Jim Marske on his experiences with Al. I have also extracted some historical information from a article Al wrote for Bunge Cord in 1981 that takes you through his early years. We will all miss Al but his legacy will continue as the younger generation take his plans and update them for modern materials and newer aero dynamics.

The second part of this issue is an article by Norm Masters on "Flaps for Swept Wings". This is very interesting and I hope that it might stir up some conversations between Norm and our members. This is one of the best ways to learn and expand your knowledge base. So don't let Norm get away with anything if you think there is a better solution or want clarification on a particular part. My thanks to Norm for taking his time to put this together with some really great illustrations. The cover photo and two on page 11 were authorized by Paul Westrup and are from his RC Soaring Digest article published in December 2010. You can use the web link on the cover to read his entire article.

I hope everyone has had a great start to the new year and that your building projects are reaching the final stages so you will be out flying in the coming months. Don't forget to take some pictures and send them in to share with out other members.

Andy

LETTERS TO THE EDITOR

January 4, 2011

Hi Bob. Do you happen to have worked on a Sparrow Hawk or any other small hawk? I'm looking for a small radio control model of a bird.

Thanks,

Bhargav Gajjar
<bhargav@MIT.EDU>

(ed. – Bob Hoey was included as an addressee but I haven't seen anything back from him on whether or not he has had any experience with smaller sized bird models.)

January 5, 2011

Hey Andy, thanks for the quick reply. I am a pilot and remote control pilot and have been fascinated by wings (flying or otherwise) most of my life. I saw your website during one of my ongoing research projects on flying wings. Recently my friend, Col. Mike Billlick (USAF Retired) and I built 2 Multiplex Xeno flying wings (RC aircraft) and added two interesting methods of propulsion....ducted fans. We just maidened the last one yesterday so I am getting together the videos, etc. We would be glad to share our experiences with the group. I am sure you guys will like it since it's pretty cool.

Here is a picture of the 2 wings we built. Also, here is the link for the video of our flying wing experimental project.

http://www.youtube.com/watch?v=i1qga4mje4s

Pilot/Builder: Gus Piangerelli
Pilot/Builder: Col. Mike Billick (USAF Retired)
Videographer: Bob Halvorsen

Let me know what you think.

Thanks,

Gus Piangerelli
<pablogus24@gmail.com>

(ed. – Gus is a new member and this is his response to my usual welcoming message that asking how he came across TWITT and what his interests are.)

January 5, 2011

Subject: OSHKOSH AIRSHOW 2010

To those of you who are not familiar with the Oshkosh, WI air show. This video only shows a small part of this world famous show. Planes, new and old, come from all over the world. If you look closely you can see the Japanese air team. They are to Japan what the Blue Angels are to the U.S.

Toward the end of the video you will see a replica of the French Aeronought who flew first across the English Channel. Please take the time to enjoy this video.

Charles Bixel
<cbixel@cox.net>

(ed. – Oshkosh is one of those air shows that everyone needs to attend at least once in their life time. Once I retire I am hoping to make the trek and enjoy the real thing.)

January 7, 2011

Dear Andy,

Did you have a good Christmas time? I hope, everything is fine with you.

For the start into the New Year I wish you and the TWITT community all the best.

With my best wishes to you all,

Reinhold Stadler

(ed. – This came in after I had already sent the January issue off to the printer, but it is the thought that counts. Our best wishes for a great new year to Reinhold.)

January 12, 2011

I am not sure who I should address this to, so I will introduce myself and hope this finds itself in the right hands.

My name is Sheona McDonald and I am a documentary filmmaker. For the last couple of years I have been working with a group in Toronto who have been building, and eventually flying, the "Snowbird" a human-powered ornithopter.

I am making a documentary called "When Dreams Take Flight" about why humans are compelled to fly like birds. It was Jim DeLaurier who first alerted me to the project.

I am finally in the process of actually putting the film together and have been doing more extensive research. I was reading about the work of Jim Theis and his Nighthawk. I was sad to learn that Mr. Theis passed away but his work seems very interesting and his desire to fly by flapping wings very in line with the project I'm doing. I understand he is survived by a son who also has a passion for flying. Further, I understand Mr. Theis documented his flights on video/film and I'm wondering about the possibility of talking to someone about seeing that footage or even using it as part of my documentary.

I thank you very much for your time and hope to hear back from you about how best to proceed.

Further, if there is anyone else who is passionate about human-powered flapping flight that you think it would be valuable to talk to or other such footage that could help me build a narrative about this interesting and compelling dream/desire I would greatly appreciate your input.

With Warmest Regards,

Sheona McDonald
<sheona@dimestore.org>

(ed. – I haven't had a chance to look through our records yet, but I don't think we have much more than what is already on the web site. If any of our members have more information they could pass along to Sheona, please include TWITT as an addressee so we can share with the other members.)

January 12, 2011

Hi Andy,

Thanks for the nice information about the BKB 1. I hope we did not break any Canadian Patents building a BKB. Wingspan is about 3,5m. Picture will follow also a small report about the Schapel.

Jörg Schaden
<joergschaden@googlemail.com>

(ed. – See the top of the next page for the picture of the partially completed model.)

January 16, 2011

Thanks for the info. I look forward to perusing the member's section.

I stumbled across your site as I was looking for more information on flying wings. I've always been interested in pushing the limits of low powered, man carrying airplanes. My biggest challenge has always

been structural weight. A flying wing eliminates most of that issue. Now I am looking for information on software that can assist with stability and performance calculations for full-scale designs.

Andy Kavie
<andy.kavie@comcast.net>

(ed. – Andy is another new member so if anyone out there has some ideas on software, please contact him and include TWITT so we can share.)

Jörg Schaden's BKB model.

January 21, 2011

Dear TWITT,

Someone emailed me regarding an ad you have for Mitchell Wing blueprints. My husband, Richard Avalon, passed away 2 years ago in March. I'm sorry I have not contacted you before this time. We were together for 32 years and the loss has been tremendous.

I had continued selling the plans at $140 for about 6 months after his passing until I realized he was selling them at a loss. In order to continue, I had to raise the prices to $250 for US and $280 for outside US. I put a link on my website

http://home.earthlink.net/~mitchellwing

for TWITT as well as the Yahoo Mitchell Wing and U-2 groups. I wanted to make sure that people purchasing the plans had information on building and flying the Mitchell Wings as well as the interesting information you publish.

If you are still going to keep the ad for the Mitchell Wing Plans can you please change the prices to those mentioned above.

Richard loved your publication and was especially proud of the fact that he won the award for your logo design. Richard's main passion in life was the Mitchell Wings and wingless aircraft, which is one of the reasons I continue to sell the blueprints. I enjoy seeing that same passion and enthusiasm in other new pilots.

Thanks so much for your support.

Best Regards,

Carol Avalon
<mitchellwing@earthlink.net>

(ed. – I have updated the information in the classified section of the newsletter to reflect the new pricing. There has been a lot of interest in the U-2 design so it is good news that she will be continuing to offer plans.)

(ed. – The message from Serge Krauss on the passing of Al Backstrom came in too late to put something together for the January issue. Since then I have received a series of messages from Jim Marske that says it all about Al's contributions to the flying wing community. I also received a copy of a Bungee Cord issue from his wife Marion where Al wrote sort of a short autobiography. If you would like to communicate with her she is still monitoring Al's e-mail address at: albackstrom@austin.rr.com.)

IN MEMORY OF AL BACKSTROM

Albert A. Backstrom, 83, of Austin, formerly of Dallas, died Wednesday, August 4, 2010. He is survived by his wife Marion. No services planned. Arrangements by Heart of Texas. (Published in "Austin American-Statesman" on August 10, 2010.)

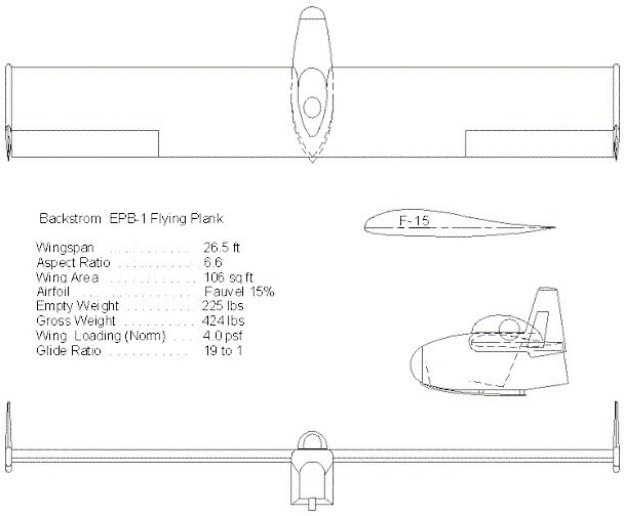
(ed. – This is the only obituary available from the Internet, but it is our understanding they he passed quietly at home with family near. Below is a combination of information from sources, including some historical information from Jim Marske and examples of Al's work on flying planks. My thanks to Marion Backstrom and Jim for providing this look back at Al's accomplishments and story.

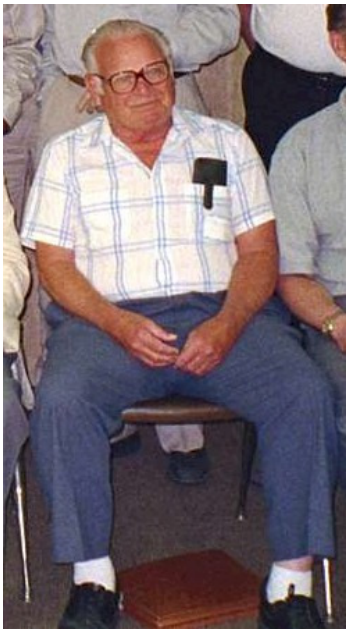
The photo to the right was taken in 1997 at the Harris Hill Flying Wing Symposium where he joined the likes of Dr. Paul MacCready, Dr. Karl Nickel, Paul Schweizer, Jack Lambie, Dezso George-Falvy, Jan Scott, Rudy Optiz, Bruce Carmichael, Jim Marske and Al Bowers.)

Jim Marske wrote:

I did not know of Al's passing till I saw a comment on the Nurflugel group a few days ago.

Al Backstrom is remembered primarily as the designer of the Flying Plank sailplane. Though the Plank was first flown in 1954 and did not achieve any fame, what makes this man and his aircraft so special? The Plank was not particularly a successful production aircraft as only a handful were ever built. The concept is not noted in the aerodynamic annuals nor is it a high performance racer. So what has Al's claim to fame?





Al dared to dream, to step out of the norm and create a new concept when all the experts said it would never fly. Besides that, the experts said, if it did fly it would be uncontrollable and tumble end over end.

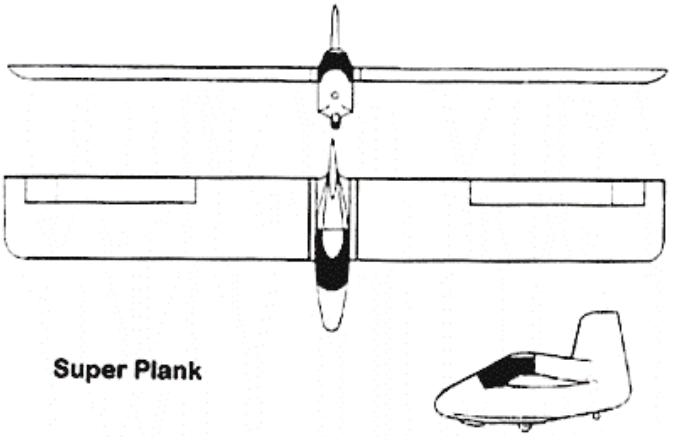
Despite all the prophets of doom, Al risked his life to prove that it would fly – and fly it did.

In an article Al once said that the Plank has aroused quite a bit of interest, both pro and con. People seem to be all for it or scared to death of it. The Plank went on to fly aerobatics at air shows which included loops, slow rolls, an inverted pass at minimum altitude with a push up to vertical followed by a split 's' maneuver before landing. Despite all this I have heard remarks from several well-known sailplane designers saying, "I've seen it fly, but still don't believe it". Another said, "First man to fly that thing dies". Alas, eventually Al's Plank faded into obscurity. Years later the pilot who flew the aerobatic routine stated, "But who knows, perhaps the Plank may once again emerge from out of the woodwork to become the center of attraction at a gathering. And maybe . . . just maybe, the murmur among the new generation of spectators will ask once more, "What is it? Is it a plane? Will it fly?

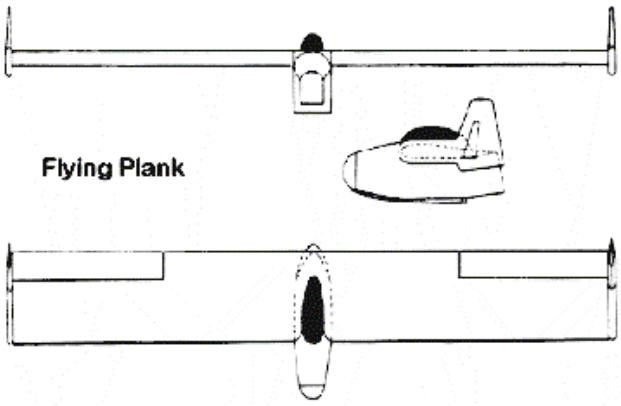
From a personal standpoint, Al's EPB-1 was an inspiration to me. I had been in the process of designing a variation of Fauvel's AV-36 glider when I saw several articles in Soaring concerning the building and test flying of the EPB-1. Al's design was simpler than the AV-36 and led me to writing Al a letter. Al was very helpful in providing advice during the design of my XM-1 Plank. I still have the original paper of the

airfoil ordinates he sent me for his Plank. His work laid down the foundation for me to build on.

Al sold drawings for the EPB-1A at the exorbitant price of $25.00. I do not know how many sets of drawings were sold but I think less than ten were built. Some of the later versions of the EPB-1 eliminated the tip fins and added a central fin and rudder on the aft fuselage.



The original prototype replaced the landing skid with a main wheel located directly under the aircraft's C.G. Mississippi State under Gus Raspet did a performance evaluation of the prototype and measured 19.8 to 1 at 60 mph. That's a very respectable L/D for such a low Aspect Ratio and short wingspan. Tuft studies uncovered severe airflow separation in the wing to fuselage juncture, both over the upper and lower surfaces. If this were corrected the L/D would have gone to 23.5 to 1 at 65 mph. The wing used a thinned down Fauvel airfoil (17% to 15%). Unfortunately, the maximum lift coefficient obtainable was only .83 when a 1.0 was expected. I found the same CL max with the same airfoil (14% version) on my XM-1.



Next I did a study using a modern stable low drag airfoil (MRL-35). The CL max is at 1.1 which drops the minimum flying speed from 43.5 to 37.7 mph at the same wing loading of 4 psf. Max L/D went to 26.4 to 1 at 73 mph. The minimum sink rate is fairly high on each of the versions mainly due to the low 6.6 Aspect Ratio and resulting high-induced drag.

After exchanging letters for a number of years I finally met Al Backstrom in person at a soaring symposium in Los Angeles in 1960. During the question and answer period I stood up and asked him if he had strong adverse yaw problems and why did he not run the elevons all the way to the tip on his Super Plank. I had been flying my Plank, model 'C', with a central fin and using wing tip drag rudders but the drag rudders were still not powerful enough to counter the adverse yaw. This was especially problematic on air tow in turbulent air. I was lucky if I could keep my glider aimed in the same direction as the tow plane. Al answered by saying that the adverse yaw was not objectionable and was easily countered by the central rudder. On the subject of not running the elevons all the way out to the tip he said, "The extreme tip in is wrapped up in the wingtip vortex so the outboard end of the elevon would be ineffective". Those words shut me up as I finally realized that my drag rudders were positioned right in the wingtip vortex. The following week I scabbed on 15" extended wingtips and flew it a few days later. The difference was astounding. No longer me, "The best thing I ever did was to help you get started in Flying Wings". Al not only got me started but saved the project when I thought I had reached a dead end. Funny how such little things can completely turn the results around. Thank you Al.

In later years Al was very active in small rubber band powered balsa models called the 'peanut class'. Several of these were of the Flying Plank type.

Attached are several photos Al sent me of a follow up design, the Super Plank (below) using a laminar Wortmann helicopter profile.

(ed. - The following are excerpts from a copy of Bunge Cord, Vol. 7 No. 2 Summer, 1981 provided by Marion Backstrom.)

"The seeds *(in aviation)* were planted but of course many other things are involved in growing up. The thing outside our control that affected all of us was WWII. I joined the Navy in February 1945, the day before I was 18 and eligible to be drafted. I was sent to San Diego for boot camp and then to North Island for duty.

In the fall of 1945, after the shooting part of WWII was over, I went to a general aviation show in San Diego. There were some interesting prototype airplanes but I was attracted by something else. Ray Parker and Bob Fronius had the AGCSC *(ed. – Associated Glider Clubs of Southern California)* TG-2 there to advertise their soon-to-open soaring school The following Saturday I became the first student. I was fortunate to have Johnny Robinson as my first instructor followed by Ray Parker and Wally Wiberg. I soloed in early '46, the weekend before being shipped out to the South Pacific for the rest of the year.

I got out of the Navy in Dec. '46 and started a rather uncommitted drifting period. I went to Northrop's engineering school in the latter half of 1947 and was able to watch the first flight and some later flights of the XB-49, jet flying wing bomber. This stimulated my interest in tailless airplane design but it didn't get past the modeling stage.

In mid '48 I moved to Dallas-Fort Worth, TX area and wound up working for Chance Vought. Vought had the XF7U-1 Cutlass, a tailless jet fighter flying at this time. Before I left Vought I had also worked on the prototype Regulus I tailless cruise type missile.

January of 1950 found me enrolling in the Aero - Engineering Department at Miss. State College. During the first few months I bugged the hell out of Gus Raspet, Ray Parker, Dick Johnson, etc. trying to help (probably mostly getting in the way) on the various private and school projects that were underway. It was great fun even if I had to work my tail off trying to catch up with what I had forgotten since I had been in school. During my junior and senior years I started seriously studying tailless airplanes and their design problems. This covered both research of the literature and model tests. From this study I came to the conclusion that the "plank" configuration would be the best to try.

After graduation in January 1953 I went to work for Aero Design at Oklahoma City. A lay off in September forced a move so I went back to work for Chance Vought. At this time I was making preliminary design doodles on plank type sailplanes.

The actual construction of the EPB-1 was started in late February of 1954 and it was ready for test flights in early June.

Pat Sherman asked me to take my vacation and crew for him at the Nationals in Elsinore, CA (1954). The opportunity to take a break from our routine was irresistible. While there I got to fly the Fauvel AV-36 built by Syd Hall, which I think was the only one built in this country.

The Plank was flown from early 1955 to the fall of 1956. During this time we continued to build up confidence in the ship and started to let other pilots fly it. When a reasonable account of time had been built up on the EPB-1, I drew up plans for a 1A version that tried to correct the mistakes in the prototype. There have been several sailplanes built from these drawings but I don't know how many. Many of these have borne only a vague similarity to the plans version, These drawings are now available from VSA.

In the fall of 1956 I returned to Miss. State to attend graduate school. I was working for Gus Raspet in the Aerophysics Department in addition to the school work. Unfortunately Gus and I disagreed about how to proceed (with modifications to the design). I wanted to add a central fin and conduct flight tests in the next couple of weeks. With this test data I could complete my thesis, which was all I needed to finish my M.S. Gus wanted to start a new research program to try and develop wing tips that could provide the directional stability. Given many years of perspective I guess we were both right and both wrong depending upon the point of view you take. Gus was the boss but I couldn't talk myself into doing it his way so I quit."

(ed. – This is where Al ends his story but we all know he was a continual influence in the world of flying wings until his passing.)

Flaps for Swept Wings

By Norm Masters

"It can't be done, it'll pitch uncontrollably"! So goes the conventional wisdom and once again the warning was repeated to Paul Westrup when he asked for advice with placing camber flaps on his 'wing. Of course high lift devices, both plain camber flaps and split flaps, have been part of the swept 'wing designer's bag of tricks from at least 1942. It's just not as easy to figure out where to put them as on conventional planes. In fact our problem, the balancing of pitching moments, is reduced almost to a triviality by the addition of a tail. Our problem is compounded by the fact that there doesn't

seem to be an exact mathematical solution to placing pitch neutral or self-trimming flaps on a swept wing although the approximate solution can be found in section 7.8 of “Tailless Aircraft in Theory and Practice”. This lack of precision scared me off, at first, but as I've gotten used to the fact that the span-wise position of the center of lift moves around with pitch changes, either commanded or as the result of a gust, I've relaxed my idea of how predictable the pitch reaction to flaps should be.

Okay so how can you find the flap size and location that will need minimal elevon trim at a given angle of attack? You could use software or you could find the last surviving brain cells that were conditioned by that high school geometry class and see if they still work.

There is actually quite a bit of free software that can do part or all of this job now. Since this article is about doing it old school I'll just list a few links and call this paragraph “done”.

Links:

Nurflügel 2.26: http://www.zanonia.de/ranis.php German interface but a French version may be available soon.

FLZ-vortex: http://www.flz-vortex.de/ German and English interface

XFLR5: http://sourceforge.net/projects/xflr5/ English interface.

Jean Claude Etiemble's MAC calculator for multi panel wings: http://scherrer.pagesperso-orange.fr/matthieu/english/mce.html English interface with metric or imperial versions. The span-wise position that this program shows looks like the average geometric chord but that's a good starting point.

A **discrete vortex Weissinger analysis**: http://www.rc-soar.com/tech/winganalysis.htm can help you understand how the center of lift moves around and the source of tip stall.

OK, now that that's out of the way, let me invite you back to the Stone Age. To a time when we solved these problems in spite of our lack of high-speed computers or even the theoretical knowledge needed to program them for this problem. (*Actually simple sweep theory was invented in 1935 by Adolf Busemann but it was largely ignored because he presented it as only applying to supersonic flight*)

The first thing you will need to know is the center of lift of the half span. As I mentioned earlier the center of lift moves with AoA and elevon deflection so this is going to have to be an estimate. Let's assume that the basic lift distribution is elliptical. This narrows our choices down to less than ½ of 1% of the semi-span and isn't a bad guess at the cruising lift distribution of a constant chord wing with washout. Fortunately for us the center of a quarter ellipse is always at 42.xx% on the long axis. Now we can draw Figure 1.

If the pitch axis *the transverse line that passes through the CG and intersects the quarter chord line at 42% of the half span* and the washout is right, you should be able to have an elliptical lift distribution *ESLD* without any control deflection but only at one

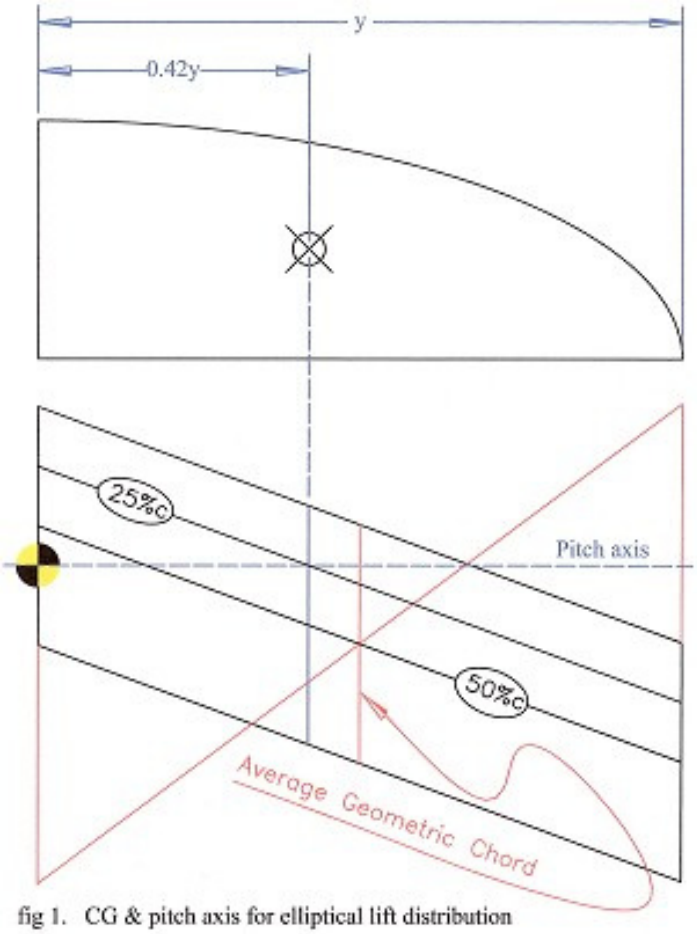


fig 1. CG & pitch axis for elliptical lift distribution

speed. Since this is what you want for best glide let's assume that this intersection marks the center of lift. This is quite some distance inboard of the average geometric chord and is related to why constant chord wings tend to be more controllable post stall than tapered wings. Any additional lift inboard of this point (42%y) will push the nose up but a camber increase will pitch the nose down so what we're trying to find is that point where the wing pitching moment is exactly opposite of the airfoil section pitching moment. This could be done mathematically but the solution would only be valid for one speed so we're just going to guess and shave one end off of the flap later if the trimmed speed isn't to our liking.

As the plane slows below this speed for the ESLD the center of lift moves inboard and the lift distribution becomes somewhat bell shaped. This bell shaped lift distribution *BSLD* develops because the elevons are reducing the camber, and therefore lift, of the outboard panel. The center of lift of this BSLD can be found with calculus but we'll just say that the maximum inboard limit is 30% of the half span. Now we have a fairly narrow zone in which to place the center of the flapped section.

Now for the guess that's at the heart of this technique. Pick a point on the 50% chord line within that zone. Let's call it point 'a'. That's it, the hard part is over, now all we have to do is pick one end of the flap. Since we're adding flaps to an already built 'wing we'll say the outboard end of the flap will butt up against the elevon and, because this is a constant chord wing, all we have to do is double the length of the chord line there to get point “b”. Now draw a line parallel to the trailing edge and offset by one chord length. The opposite end of the flap will be where a line drawn from point ***b*** through point ***a*** intersects with the offset trailing edge as illustrated in Figure 2.

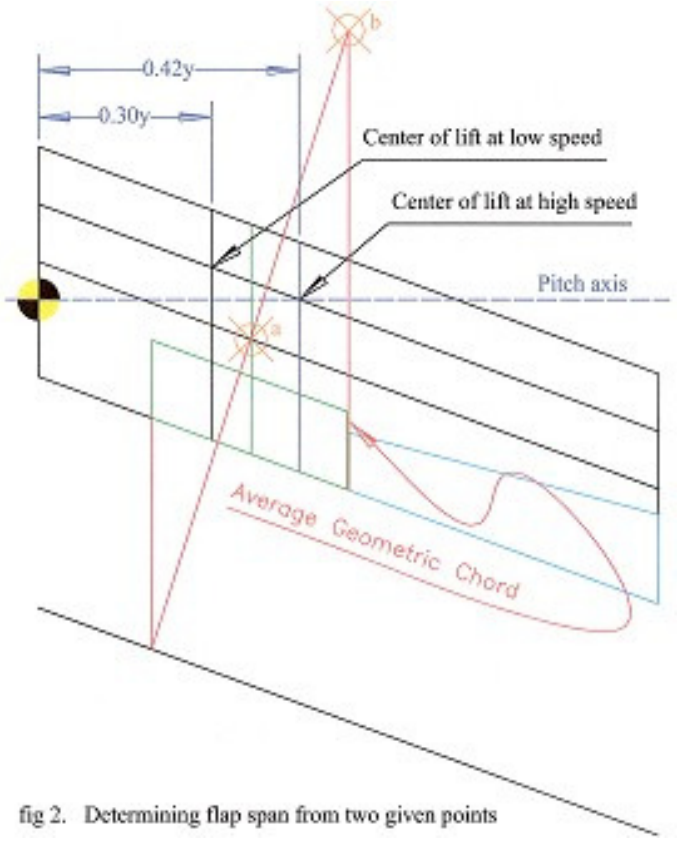


fig 2. Determining flap span from two given points

If we're willing to settle for a shorter span elevon we can have a longer flap as in Figure 3.

This method can also be applied to tapered 'wings *Fig 4*. Point ***b*** is now a variable instead of a fixed point and of course we can only know the chord of the wing at one end of the flap.

We should also consider the possibility that a tapered wing may not have an elliptical lift distribution. Specifically that a highly tapered wing cannot support an elliptical lift distribution because the tips will stall too easily so we must balance it for a bell shaped lift distribution. This narrows the range that we can place point '**a**' to between 30 and 35% of the half span.

To work the diagram in Figure 4 *(next page)* choose one end of the flap (it can be either end) and extend the wing chord at that location. Then draw a diagonal line through point '**a**' that intersects the

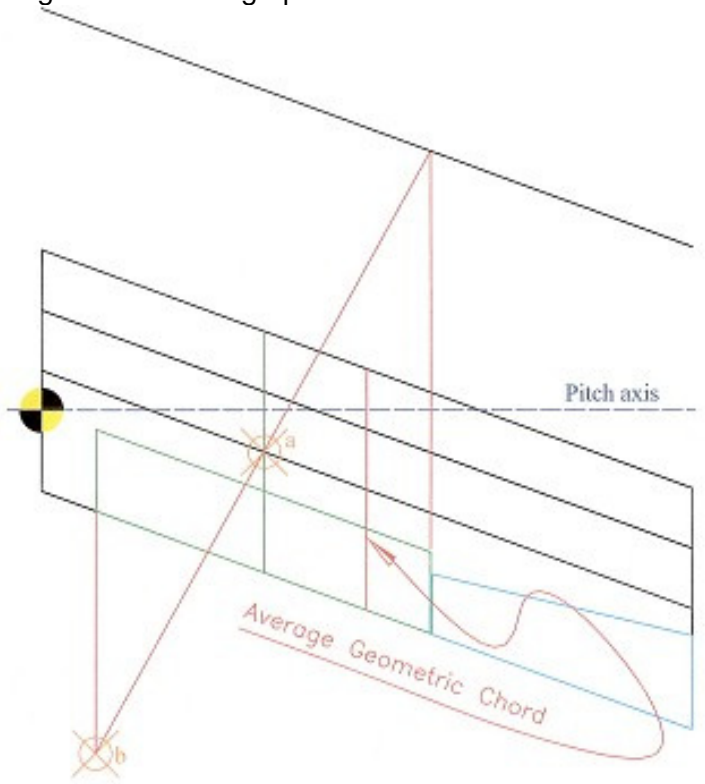


fig 3. Determining flap span from two given points

extended known chord. The length of the extension is a possible unknown chord so we copy that line over to a location near the wing root where its end points lie on the edge of the wing and the diagonal line. Then check that the distance from the wing edge to the diagonal is the same as the known chord. If it's not then we rotate the diagonal line and check again. On paper this can be pretty tedious but in CAD using <snap to nearest> can speed things up a lot by allowing you to set the moving line's extension once and then all you have to do is slide it back and forth along the wing's edge until you find the unknown chord. You still have to rotate the diagonal and measure manually though. The number of iterations depends on how good your first guess is.

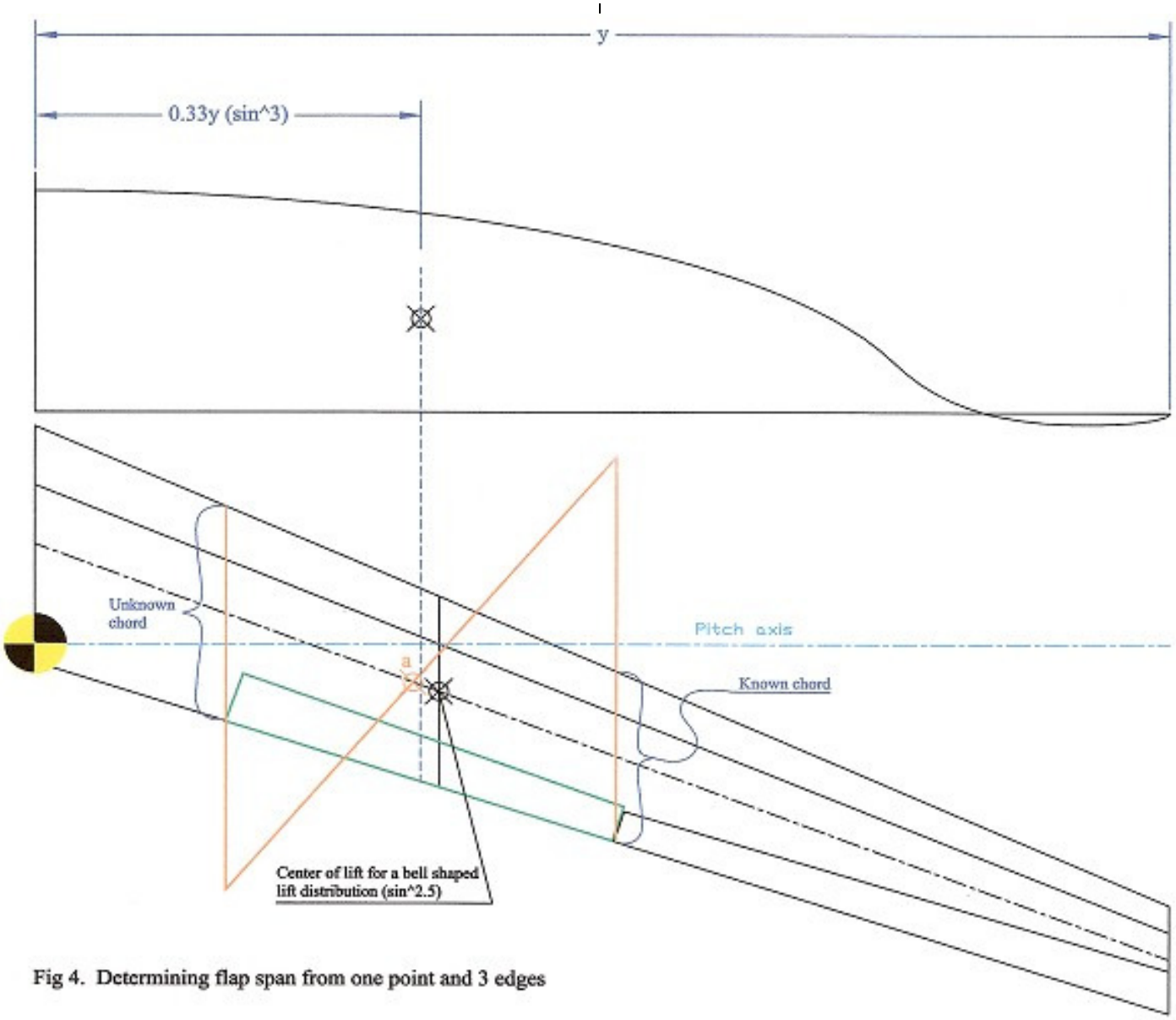


Fig 4. Determining flap span from one point and 3 edges

Now for the fine adjustment. If the plane pitches up when flaps are deployed cut some material off of the inboard end if it pitches down you can trim that moment out with the elevons.

(ed. – See the bottom of page 11 for a couple of pictures that accompanied the one on the cover.)

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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.

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

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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.

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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.

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Launching the 2-meter wing. Photo by Steve Hunt

2-meter wing overhead. Photo by Steve Hunt.