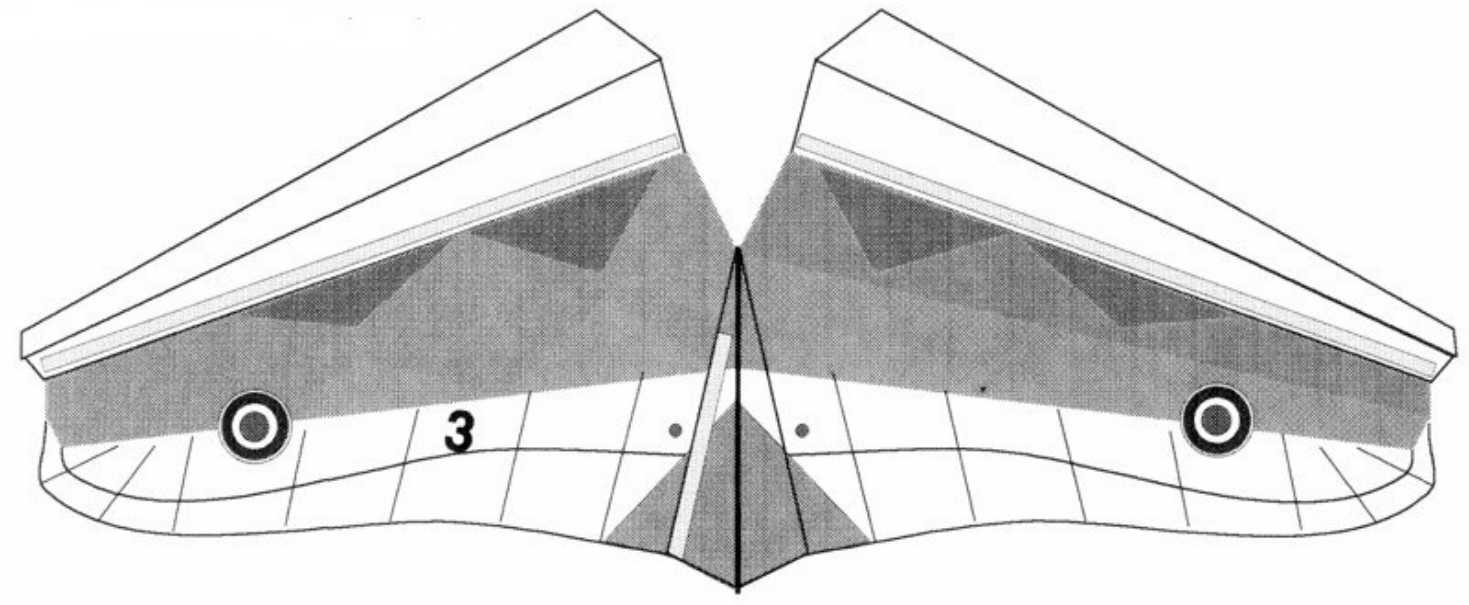
No. 209 NOVEMBER 2003

T.W.I.T.T. NEWSLETTER

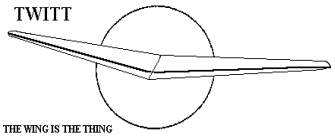


This is a sample of Pat Oliver's paper airplane collection that includes many flying wings. To see more and actually build some, join us at the meeting in November.

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., **0311** means this is your last issue unless renewed.

Next TWITT meeting: Saturday, November 15, 2003, 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:

President:	**Andy Kecskes**	**(619) 589-1898**
Secretary:	**Phillip Burgers**	**(619) 279-7901**
Treasurer:	**Bob Fronius**	**(619) 224-1497**
Editor:	**Andy Kecskes**	
Archivist:	**Gavin Slater**	

The **T.W.I.T.T.** office is located at:
Hanger A-4, Gillespie Field, El Cajon, California.
Mailing address: P.O. Box 20430
El Cajon, CA 92021

(619) 596-2518 (10am-5:30pm, PST)
(619) 224-1497 (after 7pm, PST)
E-Mail: twitt@pobox.com
Internet: http://www.twitt.org
Members only section: ID – **twittmbr**
Password – **member02**

Subscription Rates: $20 per year (US)
$30 per year (Foreign)

Information Packages: $3.00 ($4 foreign)
(includes one newsletter)

Single Issues of Newsletter: $1.50 each (US) PP
Multiple Back Issues of the newsletter:
$1.00 ea + bulk postage

Foreign mailings: $0.75 each plus postage

Wt/#Issues	FRG	AUSTRALIA	AFRICA
1oz/1	1.75	1.75	1.00
12oz/12	11.00	12.00	8.00
24oz/24	20.00	22.00	15.00
36oz/36	30.00	32.00	22.00
48oz/48	40.00	42.00	30.00
60oz/60	50.00	53.00	37.00

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

As the editor for Sailplane Builder, the Sailplane Homebuilders Association newsletter, I attended the Central Workshop in Moriarity, NM on October 10-11. It was much smaller than the Western Workshop, but those who did attend found it worthwhile in learning a little more about designing and building. Our host, George Applebay, did a demonstration on how to blow a canopy, which was very interesting. I will include a couple of pictures later in the newsletter so you can get an idea of how he does it. They are thinking about having next year's event in the Wichita, KS area so it may be more accessible for a larger number of people.

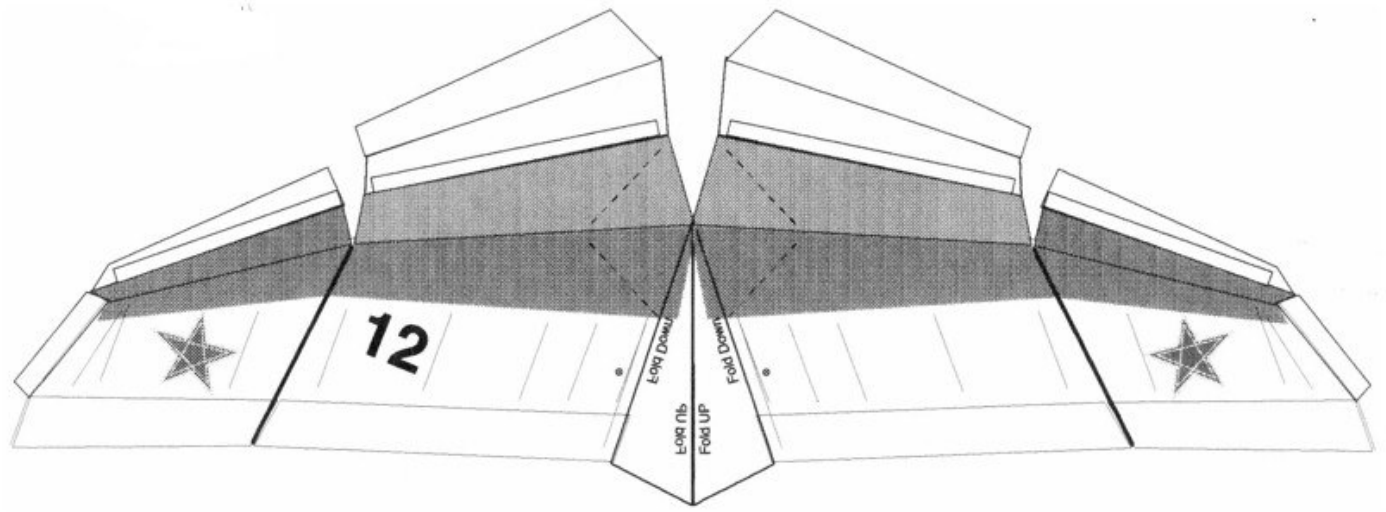
As a side note, we also attended the world famous Albuquerque balloon fiesta and had a great experience. If you have never been to this event, you have to do it just once in your lifetime. You stand in the middle of hundreds of hot air balloons all trying to get airborne at the same time. They don't quite make it, but they do all get launched within about one and a half hours. It is all very well orchestrated and I don't think I actually saw any balloon hit another one after launching. The special shaped balloons are a sight to see.

I think we are going to have a fun meeting this month. We have had speakers in the past say that sometimes the simple approach to making scale prototype models to test theories is the best. So come and see what you can do with Pat's paper models to improve them. If your idea doesn't work, just cut out another one and try a different approach. Maybe you will find the idea will work better with a different type of planform, and all it takes is a little cutting and gluing to prove your point. So come join us for some fun in experimenting with the theories of flight.

Andy

NOVEMBER 15, 2003 PROGRAM

Our program this month features out own ***Pat Oliver***, paper modeler extraordinaire, who is going to conduct a workshop on building, trimming and flying paper flying wings. Most of you have seen the various models in the hanger, like the Marske Pioneer and BKB-1, which are just a couple in Pat's extensive library of all types of paper models. You can see from the cover and this one below that they can be very simple, but he also has those that are more complicated like the N9M or BKB-1. You will have your pick of what to construct and Pat will assist you in getting it folded correctly. While we are cutting, folding, gluing and trimming our creations, Pat will also be leading a general discussion on the overall configuration of flying wings and what might be done to better optimize them.



For those of you who have not seen it before, I will also have the TV footage of Horten aircraft that came out of WW II. This was on the Discovery Channel a while back (rerun from earlier this year) and has some interesting animations of what the Horten Brothers were working toward at the cessation of hostilities. One of these is the idea of Germany dropping an atom bomb on New York City using the Horten flying wing.

So, **bring your sharpest pair of scissors** and come ready to be creative. We will provide the rest of the construction materials.

LETTERS TO THE EDITOR

October 8, 2003

Dear TWITT:

Coanda aircraft

I ran across a web site on the Russian Coanda plane: http://home.dmv.com/~tbastian/russ.htm It gives a small amount of information, but it is interesting.

Sincerely,

Pat Gates
patrickgates@moscow.com

(ed. – The picture on the next page is what Pat is talking about. I recall seeing it some years ago but didn't really consider it a flying wing, however, I guess because it doesn't have a real fuselage it qualifies as some form of tailless aircraft. I imagine the project is going the same way as the Ekranoplan that ended up under funded and rusting away in some hanger. It will be interesting to see what other oddities the Russians have been working on behind closed doors all these years. As more and more of it becomes unclassified, hopefully we will have a chance to see it come up on aviation web sites. If anyone has more information they think would be of interest, please let us know.)

From the TWITT Guest Book:

Having read several B-Squared books I have designed and built various 'wings. I have endeavored to steer clear of 'straight taper' design and have some successful ellipsoid swept wings with features such as ribs radial to the curved LE as opposed to parallel to the root and the use of full span carbon fibre tubing spars as well as spars laid up along pre-jigged ribs.

Pete White
peter2shaz@yahoo.com

(ed. – I wrote to Pete and he responded he would be glad to forward us some pictures and information when he returned home, probably sometime in early November.)

From Nurflugel:

Stateside this might be old hat but here in Britain 'The Nazi Plan To Bomb New York' hits our screens on Channel 4 at 20:00 UK time on Saturday, 18 October. One of three featured programs for the day in The Radio Times, the country's leading TV guide, the picture with it is of Reimar and Walter Horton looking down on a Horten II and III.

Recommended viewing - or not?

Chris Bryant
chris@palenquin.demon.co.uk

We recorded this last week but only got around to watching it the other night. It was interesting, and some of the projects described were worth further investigation, but I was immediately struck by a blatant mistake about the Ho.9 crash that killed Erwin Ziller.

According to the documentary, Ziller lost power on one engine and spun in because the Ho.9 didn't have a rudder and was therefore unable to fly in a straight line any more! The Horten brothers watched helplessly as the plane got lower and lower, finally smashing itself to pieces and bursting into flames on impact.

That is totally different from the story I was familiar with. First, the Ho.9 was perfectly controllable on one engine - it had already been demonstrated in front of Goering that way!

Ziller lost an engine in flight (and was having trouble with the throttle settings on the other engine) but he was an experienced pilot and should have been able to handle that. He came in too low, put the landing gear down too early (it was designed to be lowered only at the last minute), and hit a railway embankment (2-3 metres high) at the end of the runway. This tore off the gear and the plane skidded down the landing strip, then veered off to the left and collided with some trees. It burst into flame and Ziller was killed as a result.

The Hortens were actually away in Gottingen when the crash occurred, and learned of it via a telephone call. They certainly hadn't stood and watched the crash happen.

That's quite a different story to the one told on TV last week.

Some of this could be blamed on differing accounts from separate sources, but what I've just related above came directly from Monogram Close-Up #12 'Horten 229' written by David Myhra himself!

If he can't get his own story right, it does make me wonder about the other things he presented in that show.

Steve Kerry
steve_kerry_uk@yahoo.com

Hi every one,

I have watched the same documentary. I have studied the crash that killed Erwin Ziller. My conclusion is that there must have been some kind of engine stall that took Ziller of guard having no fly by wire he could not control the wing and crashed. I would also recommend that you read The Flying Wings of Northrop. They also had mysterious accidents.

Mauricio Schneegans
mauri1972@yahoo.com

Vmc problem as it appears to me. I do not think the 229 had sufficient yaw authority for flight outside some probably well defined parameters and lets not forget

that the early turbines were very slow to spool and not forgiving of operator or installation errors. Still a beautiful aircraft, what would it be like with a couple of CJ 610's, spectacular I think..

Albert Robinson
arobins1@midsouth.rr.com

Had a brief foray back into modeling, playing with the R/C stuff that had progressed several orders of magnitude beyond my single channel, tube, rubber escapement days. With full proportional multi channel, I delighted in modeling a few uncommon birds. Did a slope soaring U-2 that won a duration contest, and to really shake up the gang, a good flying B-47 glider. I built a Backstrom EPB-1 Plank as a kid with a single center fin and Lesher tips, and it flew fine. The model I built in '81 did not do as well, possibly due to scale effects, possibly due to bad trim and pilotage.

I always felt the Go229 was brute force while the Ho9 was elegance. I'm disappointed that the only flying models I've seen have been the Go, but model turbines and prop fans are probably in the same relative stage of technology as the full size axial turbines were back then, and modelers probably appreciate the extra engine size to play with.

I built a 7' Ho9 glider and had no problems with yaw control, unlike a Nimbus that I had, but on the second flight (my first at the controls), I got into a PIO cycle three times, the fourth fatal. Mostly trim and pilot, but someone else with more talent should try.

Cheers,

Bob Storck
bstorck@sprynet.com

(ed. – I thought this was an interesting thread concerning the presentation of Horten history by David Myhra. I am not sure if this is the same show I have on tape that will be shown at the November meeting. Does anyone else have an opinion on the subject? If so, drop us a line or put it out on the Nurflugel mailing *list and see what type of response you get.)*

More E-Mails

October 25, 2003

TWITT:

I am a student at the U of MN, and am working with some other classmates to design a solar powered plane, and I was hoping that you could help me! I would appreciate some advice on what kind of skin/wing covering material to use. I need the lightest strongest material available. I was thinking some kind of Mylar film would be good, but don't know which would be best. Also, how far apart could I space the ribs for a given covering material thickness? How much will the skin material deform for a given rib spacing distance, and is there an easy way (or hard way) to estimate the amount of skin deformation when flying? I need to place the ribs as far apart as possible to save on weight. Also, is there a good way to estimate the forces that will be acting on the ribs? How far apart do you think the ribs should be spaced? If you have any good ideas on this subject please let me know!

I would really appreciate your help with this!

Thanks,

Matt Grimm
supergrimm@hotmail.com

(ed. – I sent this one off to Bruce Carmichael, Paul MacCready and Al Bowers to see if they had some time to respond to Matt. If I hear anything back from them I will pass it along.)

October 30, 2003

TWITT:

I am curious if anyone is building a BKB-1. Since the best way to complete Stefan Brochocki's design goals would be to build one, test it and then make the appropriate modifications, one would hope there is one under construction somewhere under Brochocki's guidance.

If this is not the case, I have a hangar in Post Mills, Vermont, which is about a 3 hour drive south of Montreal, that could host a BKB-1 build and test program. I have all the tools and experience to build the BKB-1 out of whatever material Mr. Brochocki recommends. We have a gliding club on the field with very capable pilots and an L-19 tow plane.

I'd hate to see this remarkable design be relegated to a "curious footnote" in aviation history without being given the chance of being perfected and proven.

Please broach this subject with the Brochocki's...

Best regards,

Andy J. Gelston
ajg@ConceptsNrec.com

(ed. – I forward this message to Stefanie since she is in the best position to let Andy know if there is any possibility of putting such a project together. I am sure Stefan will be delighted that someone would like to build a BKB-1 and do additional tests to determine what could be improved. That is something he was never really able to completely finish before the original glider was taken to the US by Kasper.

Stefanie wrote back to say her father, brother and her were both delighted with the prospect of someone building a BKB-1. Andy also responded to my message indicating that he might pursue the project on his own, even it there isn't any other support, which is also good news.)

October 24, 2003

Dear TWITT:

I was browsing the web and came across yours. I have spent nine years developing a drive system that is a means to very, very, VERY simply allow an ornithopter invention to flap wings, spin wings continuously forward or backwards, (might be nice option for take-off's and landings) swing, flutter, fold back against fuselage during a flight like those wings on black birds, torque, and of course, accomplish the long sought after breast stroke action. This means it will also raise and lower selected artificial feathers etc. Most other ornithopter inventors are having a very difficult time with their actuators for wings.

I am using generated heat from my loss of energy that's created during an operation of hydraulics, pneumatics, drive shafts etc. whereof said frictional heat is routed in between a wing's membrane and there after allowed to permeate/escape out beneath the lower surface area of the wing/s. I theorize I will have an excessive amount of thermal lift! An immense powerful crossbow is used as a main power source. To restore any lost energy, one simply glides during a flight at various/regular intervals.

I believe I have a marketable ornithopter that uses a manual recumbent crank pedaling action. I desire to seek investors to do cad work, take over costs of my patent pending, and of course a working prototype. Would you know of anyone who might be interested?

Thanks for your time and I hope to hear back from you.

October 25, 2003

Regarding the above, I wanted to clarify to you that when I'd said, "I spent nine years developing this creation, I didn't mean I spent nine years solely on the ornithopter claims. I spent nine years developing this drive system and propulsion system for all types of vehicles. This drive/propulsion unit can be used on a flying wing, a dragon fly type aircraft, helicopters, all fix winged aircrafts etc. This includes a flying wing aircraft!

I am wondering if you and or your members would desire to open up an aerospace company? I own twenty years worth of major, desirous, economical, very unique and marketable inventions. Three of these inventions pertain to aircraft with a fourth being a spacecraft and propulsion system based on laws of physics. This spacecraft/propulsion system will revolutionize entire space industry forever more. No, I'm not being grandiose it is the LAWS OF PHYSICS!

Would you like to know how to drastically reduce drag on all types of vehicles from cars to trains, to ships, submarines, airplanes, jets etc?? It's so simple!!!

I am willing to go with a partnership to the ornithopter and no, you won't be able to circumvent as, I claim usage of one wing, one bow, one hydraulic unit and to protect myself even further, I claim no bow, no hydraulic pneumatic system, just my drive system and heat being produced thereof being pumped into my wing/s.

I'll disclose full details to you regarding this ornithopter. I have been showing anyone and everyone on the internet etc. You'll not be able to figure out the mechanics of this ornithopter as one has to rebuild a bicycle from ground up; even with this clue you'll not be able to figure things out.

Sincerely,

Dan E. Leffingwell
ledavian@yahoo.com

(ed. – At first I thought this was a humorous message from someone who ran across our website. However, after further correspondence, I have determined he is serious about trying to complete the patenting of this idea and marketing it. He has not sent any of the drawings or sketches of the basics of the design, given that we couldn't figure out how it worked even if we had it. I had asked him if his prototype was a flying

wing, which would seem to be the case based on the second message. I don't seriously think there is anyone in TWITT that would be interested in such a project, but it does have a certain charm about it.

In other parts of his messages he has expressed extreme frustration with big corporate America when it comes to looking at and trying new ideas, or trying to steal them from the inventor. So, if you are thinking about contacting him for more information, please keep in mind that he may be a unique individual that could be hard to deal with in the normal business sense.

November 3, 2003

I have been working on a control system for a flying plank primary glider and was wondering if anyone in the group has come across any good sites discussing side stick design or elevon mixer design.

I admire the side stick of the Archaeopteryx ultralight glider. I would appreciate any referral to instructive images of very compact and lightweight control stick implementations.

Alternatively, if you have ideas about very light control systems please do weigh in. No pun intended.

My Plank is high wing and uses horizontal drag rudders and elevons. A split flap vertical fin for approach control completes the system. This is the setup advocated by Al Backstrom in his September 2000 article for the Sailplane Homebuilders Newsletter.

Thus far, I remain unsatisfied with my control system routing and design and am seeking images for new inspiration.

Nicholas Cafarelli
nicke@yahoo.com

(ed. – This came in just before publication and I thought it would be interesting to everyone since it involves some of Al Backstrom's work. Al is still thinking of new ideas for tailless sailplanes and I hope to have something for the next newsletter based on his presentation at the SHA Central Workshop.

If anyone out there has a side stick scheme they would like to share, please send it to me and I will pass it along.)

LATCHING MECHANISMS

Irv Culver (July 11, 1988)

I have seen and heard of many canopy, door and hatch inadvertent openings in flight and there is always the same excuse: they didn't properly latch the thing. The fact remains that very little technical effort is given to the subject of latches compared to structures in airplane design, whereas the number of lives lost due to latch failure may be as high or higher than due to structural failure.

Of the many latching problems I have been involved in one stands out above all others. One day the door of my office banged open and Herman "Fish" Salmon barged in and said "Irv, let me tell you a story and see if you can figure it out. Here I am flying the F-104 on a cannon-firing test at about 35,000 ft. altitude. When I fired the cannon the cockpit went black, I couldn't see anything, and there was a heck of a big wind blowing. I thought 'If you can't see and you don't know what's going on you better get out' so I pulled the exit handle and went out. Doc Barron fed me sodium penithol (truth syrup) to see if I could remember anything more, but that is all I remember)"

I said, "Herman, you told the whole story just now to me! What more do you need to remember; there isn't anything more. The story goes like this: a gunnery test run at altitude, your pressure suit is turned on and is at cockpit pressure so you don't need the crotch straps tight to hold your helmet down (you never tighten those straps anyway.) Now you fire the cannon. The vibration from the cannon unlatches the lower escape hatch which blows off, allowing the wind to blow through the cockpit area ("big wind") and the reduced pressure in the cockpit causes your pressure suit to expand pushing your headgear up so that your eyeballs don't match the window that you are supposed to see out of ("can't see anything")

Herman said, "That explains it! Let's go tell the 104 project office! "The head project engineer said, "Irv, that's too simple. That latch has been tested to 5 times the load that was on it at the time of Fish's test flight." But I said, "I'm not talking about load or structural failure. I'm talking about vibration and friction!**"** "Oh go a way," was the reply. I told Fish to forget the whole thing - that the stupid will wake up eventually.

About a week later I got a call from the 104 project saying all is forgiven. Please come over; we have a problem. At the project office the irate head of the inspection department was telling the project office that they had better keep everybody away from the airplane on the line being tested for cockpit leakage. "This is the third time one of my inspectors has been sitting in the cockpit of a 104 on the line testing for leak-down time when someone comes along arid drives a rivet into the airplane and the lower hatch comes off, causing ear damage to my inspectors due to rapid decompression. You have got to stop riveting when we are testing!"

Generally when I was asked to investigate the failure of latching mechanisms I heard such statements

as 'Oh, it's friction locked or It's a positive lock.' The basic enemies of latching mechanisms are vibration and friction, coupled with a basic opening force from aerodynamic load and/or pressurization. Example: the aerodynamic load on a canopy can be as high as 1.5 q (below ambient) acting to open the canopy, and the internal pressure could be close to 1q (above ambient) if a big scoop is used to vent the cockpit on a hot day and the exit for the cockpit air is small. This results in 2.5q trying to open the canopy.

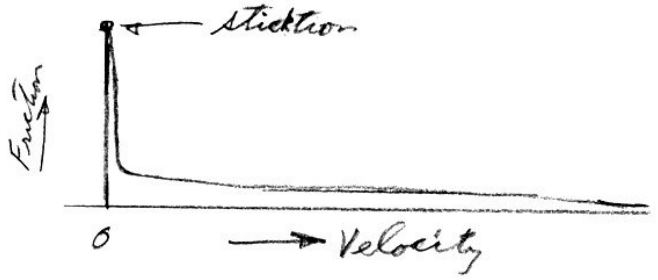
q at sea level is $\delta V^2/2$ = q sea level standard day δ = .002378 slugs per cubic ft.
q is in lbs. per sq. ft.

The above is neglecting mach number effects (compressibility) and slip stream effects.

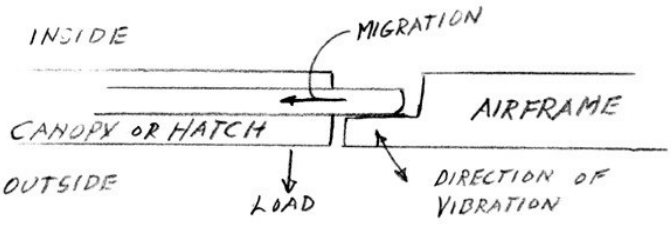
Or at sea level standard day q = (mph)x(mph)/391

Now we have a canopy trying to open itself and a latching mechanism trying to hold it closed. This means a steady force on the latching mechanism.

Now we introduce vibration and friction. Friction comes in two parts called friction and sticktion. At "0" interface velocity the sticktion coefficient is considerably higher than the sliding friction coefficient.

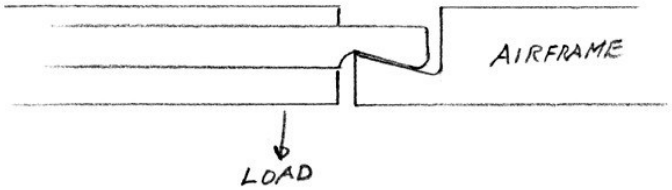


If we force vibrate the latch from one side at an angle to the interface the latch tends to crawl towards either the locked or the unlocked position depending on the angle of the vibration relative to the latch interface.

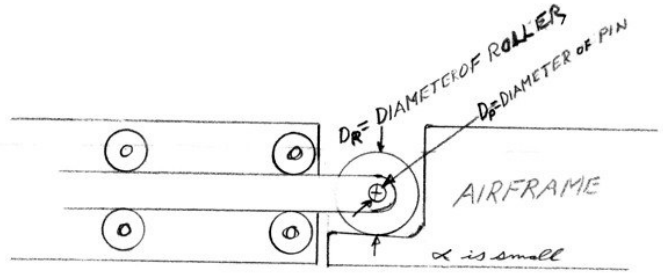


In slow motion, when the acceleration is inward the interface force is high and the sticktion is high, trying to drive the latch open; when the acceleration is outward the friction is lower and the interface force is lower so the latch tends to migrate towards the open position. This is the reason we have so many doors coming open, canopies coming off, hatches blown off, etc.

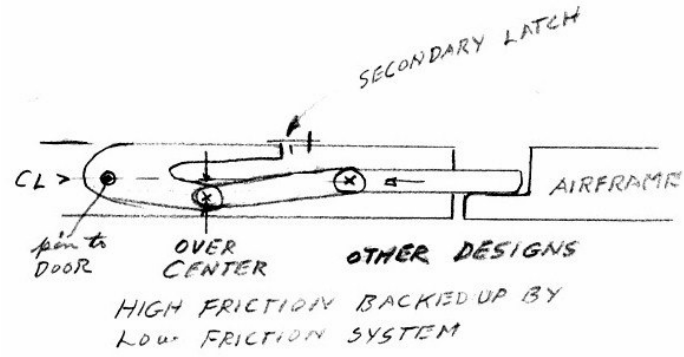
The cure is 1) reduce the friction, and 2) provide an over center effect so that the basic load tends to hold the latch closed. An example of 1) - the basic load tends to hold the latch in place, but has high friction.



The unfortunate thing about this design is that you find it difficult to open under loads and it requires that the canopy or door go considerably past flush during latching. The unfortunate thing about low friction latching systems is that they generally require more space.



MAX C_F = .3 APPROX. SO $\rightarrow$ $\alpha_R = .3 \times \frac{D_P}{D_R}$
$\alpha_R = \alpha$ IN RADIANS SO MUST MULTIPLY BY 57.3 TO GET THE ANGLE IN DEGREES
$\alpha_R \times 57.3 = \alpha_0$ or $\alpha_0 = .3 \times \frac{D_P}{D_R} \times 57.3$
C_F is the stiction coefficient



A common fault of design is not allowing for elastic deflection of the structure of the airframe and/or the deflection of the door or canopy.

Since friction is the enemy of latching mechanisms arid oil arid grease get on the upholstery and clothes, candle wax should be used for lubrication on latching mechanisms to reduce friction. It's not so dirty and oily.

Of course there is the more complex design approach than what has been discussed so far in this paper: the compound mechanism, where the primary latch is of the high friction type but is backed up by a low friction over-center system which can have a final detent on the handle.

There are many practical designs such as hooks and rollers where the mechanism reaches out and grabs the door or canopy and pulls it in place. Just remember that friction does not work in favor of keeping the mechanism locked. It can and does just the opposite at the most unexpected time.

POOR MAN'S BLOWN CANOPY

The one and only demonstration at the SHA Central Workshop in Moriarity, NM on October 10-11, 2003 was George Applebay blowing a typical canopy. This will attempt to explain the process as best as possible, relying on memory about all the things he explained as we went along. As you will see from the pictures, he doesn't use any sophisticated equipment and it is something the average homebuilder could put together if he was really serious about blowing his own canopies.

Here you see the lucite glass mounted on the forming board. It takes all those clamping pieces to properly secure the glass so the edge won't move during the expansion process. The area in the middle is where the air pressure fitting will be installed from the back side. Note the loop on the cable in the right foreground. It comes into play after flipping this whole piece over using the hoist.

By the time we got to the hanger George already had the Lucite glass bolted down onto the forming frame. This was obviously a very tedious task, but it is necessary to properly hold the glass in place as it heats up. In this instance he used a series of blocks bolted close together, but he had other forms laying around the shop that were a single piece with lots and lots of bolt holes. It probably doesn't matter which method you use since the flange that is created is eventually cut off.

Between the glass, bolts, blocks and backing plate this whole assembly is quite heavy. George uses a simple method for turning it over and placing it on top of the heat box. The crossbar hanging from the hoist had two sets of loops on each end cable. The longer loop allows enough clearance to turn the form plate over to put the glass side down. After setting it back down on the sawhorses, the shorter loop on the cable is attached to the crossbar and hoist used to raise the form plate to the height of the box. The box is then rolled under the plate and it's lowered into position.

Once the cables are released and the hoist moved out of the way, the form plate is attached to the top of the box with four wood screws, one in each corner. The pressure fitting had been added while the plate was down on the sawhorses, so all that was left was to place the three thermometers into their respective holes in the plate. He has two on one side of the box and one on the opposite side, which allows

Here's George explaining a little about the entire process of forming a new canopy. The hoist will raise the panel and allow it to be flipped over. The short loops noted in a previous picture will then allow the hoist to raise the panel up to the height of the heat box and put it in place. I am sure this saves a lot of back aches.

him to balance the temperature evenly within it by turning on and off the various 4,000 watt heaters in the bottom. As you can see from the picture he also has a diffuser plate in the bottom so the heat doesn't project directly on the glass and heat it up too fast. The desired temperature is between 320 and 325 degrees, at which point the glass should start sagging under its own weight.

This is the heating box that George built. It is fully mobile with steerable wheels at the right end. The window allows viewing the glass while it is heating up without letting the heat escape. The switches below the window control the heaters (simple on/off) mounted in the bottom. The whole unit is simple and very functional as you will see from the finished product.

With all ten heaters turned on we waited for the temperature to reach the right level. A temperature chart is maintained for each thermometer and readings taken every 5-minutes. The heaters are switched off if one section is heating up faster than the others and then turned back on as the temperature restabliizes.

Now you can see the panel flipped over and the short cable hooked up for the hoist to the top of the box. George is installing the air pressure fitting into the hole that will eventually blow the canopy and provide a source for the pressure gauge.

The pressure fitting on the top of the box also has a pressure differential sensor outlet. This is attached to a manometer so they can adjust the air pressure according to the inches of water they are pushing. Again, this is a simple device consisting of a clear plastic tube partially filled with water and run up and down a yardstick and hung vertically. As the air pressure is “very, very” slowly let into the area above the glass (George uses a finely geared regulator) he watches the differential in the water tube. I am not sure how many inches he uses, but I am imagine it depends on the size of the canopy, especially the height that needs to be achieved for a particular application.

This is a shot of the heat box's interior. On the bottom you can see the 4000 watt heaters underneath a diffuser panel. You can also see the fiberglass lining and a portion of the switching panel. I imagine that when all the heaters are operating the electric meter is spinning probably to the point of seeing the needles moving on the indicators.

The panel is now on top of the heat box. It is secured at the four corners with wood screws which is sufficient to seal it from loosing very much heat. You can see the three thermometers sticking out of the panel on the left and right of the box. He records temperatures every 5-minutes until reaching the desired level evenly distributed throughout the interior which is lined with fiberglass insulation.

The size of the canopy is monitored through the viewing window and the heat is adjusted as necessary to keep it expanding at a constant rate. Once the desired shape is achieved the heaters are turned off, the window opened and the box allowed to cool down naturally.

After the proper cool down, the canopy is removed from the frame (a lot of work to remove all those retaining bolts) and the flange cut off. I believe he uses a thin cutting wheel, like on a Dremel, but you should try some tests on junk pieces of glass to make sure you won’t crack it during the process.

Here is a shot of the almost finished canopy hanging from the form. Now you can see why all the clamps are necessary. Even in this state you can see the glass is very good optically, partially due to the glass quality and partly because of the very slow expansion that allows the glass to maintain a consistent thickness.

So, you can see with a little preparatory work (building the box, making the frame and acquiring the necessary instrumentation) you too can have that "perfect" canopy. And all without paying someone else $2,000 to $3,000 dollars for it. If you learn how to do it good enough, you could even do them for your friends and earn back what you paid for the equipment (I must be a dreamer to think that's even a possibility).

Here is the almost finished product. George has taken it out of the frame and trimmed off the flange. The canopy is flexible enough to reshape it to several different frames so it can be adapted to various sailplanes. You can get an idea just how clear and undistorted it is.

AVAILABLE PLANS & REFERENCE MATERIAL

Coming Soon: Tailless Aircraft Bibliography Edition 1-g

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

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

Prices: To Be Announced

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

Personal Aircraft Drag Reduction, 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
Add: $ 2.00 for foreign postage

VHS tape of July 15, 2000 presentation by Stefanie Brochocki on the design history of the BKB-1 (Brochocki,Kasper,Bodek) as related by her father Stefan. The second part of this program was conducted by Henry Jex on the design and flights of the radio controlled Quetzalcoatlus northropi (pterodactyl) used in the Smithsonian IMAX film. This was an Aerovironment project led by Dr. Paul MacCready.

Cost: $8.00 postage paid
Add: $2.00 for foreign postage

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.

Cost: $5.00 postage paid
Add: $1.50 for foreign postage

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
$15.00 foreign orders

NURFLUGEL

"Flying Wing"
by Dr. Reimar Horten & Peter Selinger

350 illustrations
German & English text
Limited number of the "flying wing bible" available
Cost: $49.00 plus $4 shipping and handling

SCOTT flycow@aol.com
12582 Luthern Church Road
Lovettsville, VA 20189 Sole U.S. Distributor

Tailless Aircraft in Theory and Practice

By Karl Nickel and Michael Wohlfahrt

498 pages, hardback, photos, charts, graphs, illus., references.

Nickel and Wohlfahrt are mathematicians at the University of Freiburg in Germany who have steeped themselves in aerodynamic theory and practice, creating this definitive work explaining the mysteries of tailless aircraft flight. For many years, Nickel was a close associate of the Horten brothers, renowned for their revolutionary tailless designs. The text has been translated from the German Schwanzlose Flugzeuge (1990, Birkhauser Verlag, Basel) by test pilot Captain Eric M. Brown, RN. Alive with enthusiasm and academic precision, this book will appeal to both amateurs and professional aerodynamicists.

Contents: Introduction; Aerodynamic Basic Principles; Stability; Control; Flight Characteristics; Design of Sweptback Flying Wings - Optimization, Fundamentals, and Special Problems; Hanggliders; Flying Models; Fables, Misjudgments and Prejudices, Fairy Tales and Myths, and; Discussion of Representative Tailless Aircraft.

Order #94-2(9991) (ISBN 1-56347-094-2) from:

AIAA 1-800-682-AIAA
1801 Alexander Bell Drive, Suite 500
Reston, WA 20191-4344 USA
Members: $59.95 Non-Members: $79.95

*Outside the US, Canada & South America, order from: Edward Arnold (Publishers), a division of Hodder Headline PLC, 338 Euston Road, London NW1 3 BH (ISBN 0 340 61402 1).

FLYING WING SALES

BLUEPRINTS – Available for the Mitchell Wing Model U-2 Superwing Experimental motor glider and the B-10 Ultralight motor glider. These two aircraft were designed by Don Mitchell and are considered by many to be the finest flying wing airplanes available. The complete drawings, which include instructions, constructions photos and a flight manual cost $140, postage paid. Add $15 for foreign shipping.

U.S. Pacific (650) 583-3665
892 Jenevein Avenue mitchellwing@earthlink.net
San Bruno, CA 94066 http://home.earthlink.net/~mitchellwing/

COMPANION AVIATION PUBLICATIONS

SAILPLANE HOMEBUILDERS ASSOCIATION

The purpose of SHA is to foster progress in sailplane design and construction which will produce the highest return in performance and safety for a given investment by the builder. They encourage innovation and builder coop-eration as a means of achieving their goal. Membership Dues: (payable in U.S. currency)

United States	$21 /yr	Canada	$26 /yr
So/Cntrl Amer.	$36 /yr	Europe	$41 /yr
Pacific Rim	$46 /yr	U.S. Students	$15 /yr

(includes 6 issues of SAILPLANE BUILDER)

Make checks payable to: Sailplane Homebuilders Association, & mail to Secretary-Treasurer, 21100 Angel Street, Tehachapi, CA 93561.