

T.W.I.T.T. NEWSLETTER



This is a shot from the Mississippi State archival photos we got as part of Dave Raspet's talk earlier this year. This is a different configuration than that used by the Germans, which is what Bob Fronius was trying to duplicate with his trailer and scale model of the Horten IV.

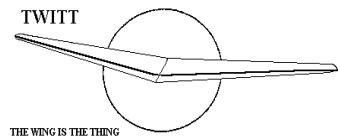
T.W.I.T.T.

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., 0508 means this is your last issue unless renewed.

Next TWITT meeting: Saturday, September 17, 2005, beginning at 1:30 pm at hanger A-4, Gillespie Field, El Cajon, CA (first hanger row on Joe Crosson Drive - Southeast side of Gillespie).



**THE WING IS
THE THING
(T.W.I.T.T.)**

T.W.I.T.T. is a non-profit organization whose membership seeks to promote the research and development of flying wings and other tailless aircraft by providing a forum for the exchange of ideas and experiences on an international basis. T.W.I.T.T. is affiliated with The Hunsaker Foundation, which is dedicated to furthering education and research in a variety of disciplines.

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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

While the turnout at the last meeting wasn't what Doug and I had hoped for to celebrate both Bob Fronius' 90th birthday and TWITT's 19th Anniversary, those that showed up all had a good time. Apparently there was a fly-in in northern California on the same weekend and this took many of the skid row residents away from the party. Next time we will have to check the aviation events calendar and see what we are up against.

You may notice a little difference in the appearance of the newsletter this month. I converted it into an Adobe Acrobat file before sending it to the printer. This usually results in the margins becoming a little wider, but I hope by having the text print size a little larger that the readability remains the same. This also means I can send the file to the printer without worrying about it changing size and shape because of differences in software program settings.

In line with this, I will also start converting the archived newsletters into the PDF format and replace the MS Word versions on the website. This will ensure that when you download them so you can view the pictures in color the format will be stable and not dependent on what printer settings you have on your computer. I have done a couple of test runs on the conversion and they seem to look okay, so I hope everyone likes the capability better than in the past.

I have managed to do this without buying any new software. For those of you who, like me, don't know of this free software, you can download several different versions from <http://www.software995.com/> If you don't want to pay the pop-up removal fee, you just need to endure a little extra time to close the windows to proceed with the conversion.



**AUGUST 17, 2005
PROGRAM**

We haven't been able to find a viable program for the September meeting. Part of this is due to the ESA/SHA Western Workshop in Tehachapi earlier in the month and that takes a lot of speakers who can't afford to be away for two weekends. But if anyone has a contact that could do a program related to aviation and/or flying wings, please let me know as soon as possible so I can see what can be arranged.

**JULY 16, 2005
MEETING RECAP**

We were happy to see our regulars and some faces we hadn't seen in a while turn out for the 19th Anniversary party and Bob Fronius' pseudo 90th birthday party. There was plenty of cake and ice cream to go around and you will see from the pictures there was a lot of hanger flying going on. Although I had brought along a couple of videos, no one was really interested in sitting down and staring at a TV screen when there were better things to do and talk about.

Since there was no real meeting there is nothing to write about so I thought I would include some of the pictures I took.



Doug Fronius & Gavin Slater wishing Bob a happy birthday and encouraging him to blow out the candles.



Above: Dominick Viellard and Floyd Fronius enjoying a moment of conversation, probably about music and musically instruments rather than things related to flying.



Above: Bill Otto and Bruce Carmichael having just finished a conversation with June Wiberg in the background.



Above: Jorge Padilla, Ralph Wilcox and Steve Kecskes talk about things of the past as these old-timers got together.



Above: Russ Clemens, Bob and Floyd Fronius enjoying some of the cake and ice cream while talking about mutual interest in gliders and airplanes.



Above: Steve Kecskes (age 96) and Bob (age 90) are among the last of the early San Diego aviation pioneers. They were instrumental in developing and flying from the famed Torrey Pines Glider port and were key members of the Associated Glider Club of Southern California for many years.



Above: Dominick and Pat Oliver sharing a moment at the party. They also share a hanger down the row where Dom keeps his Citabria and Pat his glider that is undergoing a restoration.



Above: And last, but not least, is a shot of Bob's cake, which was way fancier than the bland looking all white frosted cake we had brought in for the TWITT anniversary.



LETTERS TO THE EDITOR

July 13, 2005

Here are my dues for the next 12 months. I'm glad to see that you've had some membership inquiries. Hopefully, they will both join. We could sure use some new blood. Not that there's any lack of talent in the current membership but much of what's there has already been documented in the newsletter.

Speaking of past newsletters. Is there an index of TWITT articles and, if there is, how much should I send to get a copy? If the newsletter has not been indexed I would volunteer for that job but it's kind of a long trip and it might take a while. I'll try to make it out there for the 20th anniversary but, with my life, planning ahead is a pretty iffy proposition. I almost made it this month but got diverted to Seattle, so instead of having cake and ice cream with you guys I'll look up Bill and Bunny Kuhlman and see the new exhibits at the Boeing museum.

Norm Masters

(ed. – Thanks for the renewal. Hopefully, we will continue to retain the current members, but the total has been dwindling over the past months.

As to your offer to prepare an index of the newsletter article, we would be very pleased to have to

take it on. Just as a warning on the project, we have had volunteers in the past take this on, but unfortunately nothing ever came out that we could use. It apparently was much more daunting than they anticipated. I have tried starting it several times with not much to show for it either.

If you still want to take this on, you could use the issues you have received and start working backwards until you run out of issues. We could then send you the ones you are missing so the project could continue. Your "payment" for doing all this work would be a complete library of issues to fill in the ones you are currently missing.

So, let me know if you want to do this and I can send you the Excel spreadsheet I used to get it started some time ago. You can then continue with it or convert it into a database and do it that way.)

July 21, 2005

I am interested in aircraft designed by Vincent Burnelli, specifically, the CBY. I've been pursuing this interest for about 5 years now. I've visited the New England Air Museum twice in that time, and viewed the CBY blueprints that they have. I have accumulated an information file of about an inch thick of downloaded articles, information, photos, etc...

I'm interested in airfoils of the CBY, those in the wing, tail, and flying fuselage. ANY information as to structure, innovations, etc.... would be greatly welcomed.

Is there anyone in your group versed in the CBY?

I have an e-mail correspondence active with Chalmers Goodlin, one of the few pilots to fly a CBY.

Any information or contacts you'd be willing to share would be appreciated.

(Must I join your group-a requirement I'd gladly meet-to get this service from you?)

John Schmidt
1942 Kenwood Drive East
St. Paul, Minnesota 55117
651 776 1717
<jeschmidt@hotmail.com>

(ed. – I sent him the following, to which he replied:

Were you aware of this address and phone number for the Burnelli Aircraft Company? Maybe they have what you are looking for.

<http://www.burnelli.com/>
The Burnelli Company

7620 Red River Road
 West Palm Beach, Florida 33411
 Tel: 516-683-1690
 Fax: 516-683-1584
 E-mail may be goodlink@adelphia.net

"Yes, I'm aware of the Burnelli Company. Slick Goodlin, president, is the last remaining Burnelli advocate. He's had time at the controls of a CBY. He thinks the government was/is out to 'get' Burnelli, and there is some sort of conspiracy against the CBY.

At Oshkosh, I talked with a guy from Udvar-Hazy. He's leading me down another path toward more Burnelli information.

The only real solution is to get hands on plans, and build one. This could challenge even the strongest budget. "

John

(ed. – Again, if anyone in our group has more information that would help John in his quest, please let all of us know. I told him he didn't need to join, but if we can be of assistance I am sure he would become a member and share any of the information he has that would be of interest.)

August 5, 2005

I am a private pilot that has a great interest in flying wings and I would like to find out the current status of the Davis Wing. Can you let me in your club?

Tim MacEwan
 <tmacewan@telus.net>
 (250)992-7748

(ed. – I wrote back to Tim to let him know how to go about joining TWITT. I also told him we really didn't know much more about the Davis Wing than what was already on the web site. So if anyone has had a recent contact with Davis and knows if there will be kits or plans available in the near future, please let us know.)

(ed. – These also came in asking about the Davis Wing, so there is obviously some interest in the design.)

July 18, 2005

I am curious as to the status of the Davis Wing project. Have you heard anything other than what's listed on your site? Has it been abandoned? Any info would be greatly appreciated.

Thank You

Wayne Matter
matter@mhccable.com

From Nurflugel:

I found an article on the Davis Flying Wing in a Jan 1987 Popular Mechanics magazine the other day. I would like to know much more about this aircraft. Also found the info on the twitt.org site. Can anyone tell me if plans are available for this aircraft and if anyone plans to carry on this homebuilt design? I'm trying to locate the find the referenced articles in Sport Pilot April and October 1990. Any help would be very much appreciate.

Jim Pruitt
 <jpruitt63@juno.com>

Which elicited this reply:

The Davis wing is almost a scale copy of an N9M, using a single engine with a span of about 40'. Davis flew the prototype quite a bit, logged a lot of miles, and planned to build a multi-seat version called the Gemini. He wasn't offering plans, just kits...but the project never got to the "kits for sale" stage. Davis was seriously injured in a takeoff accident when the propeller's belt drive failed. I talked to him on the phone back about 1995, and he was interested in selling the whole project at that time.

Brian Eckels
 <sixbender@net-venture.com>

(ed. – The following was extracted from the Nurflugel bulletin board.)

Some time ago Al Backstrom wrote an article entitled "A Flying Plank Sailplane For Today".

I have been working along the lines he suggested and thought I would throw out to the group my design decisions as fuel for discussion.

Empty weight: 155 pounds or less.
 Span 23.5 feet.
 Chord 3.5 feet.
 Area 82.5 square feet.
 Spar shear web height 5 inches.
 No struts.
 Open fuselage for crow hopping.
 Fully enclosed fuselage for full flight testing.

My calculations indicate approximately 75 feet of 0.20 x 0.092 graphite pultrusion will suffice for main spar caps.

I have budgeted 80 pounds for the fuselage and 75 pounds for the wing. I believe the wing might come out lighter.

I will use elevons, a split central rudder (instead of spoilers), and horizontal drag rudders (projecting up from the top of the wing).

I have a thick skin and look forward to frankly stated opinions.

I have purposely compromised stall for overall size.

I continue to seek out elevon mixer mechanisms - should anyone have links, I would love to see them.

Fly right.

Nicholas Cafarelli
<nicke@yahoo.com>

Dave Swanson replied:
<DavidRSw@bdumail.com>
Glendale, CA

I am not so sure that I would call a 23.5' span aircraft a sailplane. Doubling that would seem more like it.

That size of pultrusion looks awfully familiar... ;-)
Marske, right?

Great choice!! $0.20 \times 0.092 = 0.0184$ sq. inches

By running your figures through my stress calculations spreadsheet, assuming a 60 mph at max lift (say 1.8 Cl) would be an 7.13 G loading. This would be 2173.6 lbs. of total wing lift and 65,891.73 inch pounds of Root Bending Moment. Using the Marske ultimate for the pultrusion, it looks like you need a minimum of 0.058 sq. inches for each cap strip at the root or 3.15 rods upper and lower. At 25% of span out from the root, the sq. in. area drops to .036 sq. in. or 1.956 (~ 2) rods. At half span, it looks like you'd only need one rod at .018 sq. in. for 16, 473 inch pounds of Bending Moment. Cut that in half by the 65% of span and then none by ~85% of span.

The loads are zero at the tip, so just let the skin and shear web carry the loads.

I haven't taken the time to total it all up, so you'll get to do that. You'll use more rod if you use a lower Ultimate than I did. Just make sure that you design the spar to prevent the buckling that can occur at these high loads. Most like to lay the rods side by side, but that isn't as resistant to buckling as a square shape.

Me too, especially if you use good composite construction. My 40' span 156 sq. ft. area tapered wing will be just around 80 lbs. and a 10 G load limit.

Nicholas replies:

I guess that's why the EPB came to be called the Plank. :)

Actually, I have a vague memory of Derek Piggot writing about gliders versus sailplanes. I think he may have claimed that anything that can soar might just be a sailplane. Maybe not.

Of course, my modest plan is no world-beater. Anything above 17 to 1 will satisfy me. I believe it will fare somewhat better.

I am compromising performance for economy and ease of construction and hopefully speedy construction. Extra tows and out landing might make the compromises false economy.

Doing things slightly differently than the norm might prove instructive. So I hope. Instead of removing wing halves from the fuselage I will remove the nose of the fuselage for transport and storage. Fauvel's AV-36 also had a removable nose. I will remove a longer section. I am also considering removable wing tips. Fastener weight penalties should be small compared to forked central spar attachment.

The goal is to car top the wing by inverting the aircraft. A transport fairing will send air around the fuselage since during transport air will travel from one wingtip to the other.

I have also designed a drive under setup as follows: In the same way that a pickup truck backs up to a camper which is jacked up, I will drive under a frame which will attach to my car's bumpers. I could extend this idea and build a box to completely contain the glider.

Given the short span and small fuselage this looks workable.

You might be thinking - what about the fin and rudder? These will also be demountable.

I fully realize that there are shortcomings to these ideas. I still think it is worth doing and look forward to the continuing adventure.

msmprod@optushome.com.au wrote:

And do not forget

http://users.skynet.be/nestofdragons/weird_06.htm

That is DEFINITELY a beautiful sailplane.



Pelican

Bob Storck replies:
<bstorck@sprynet.com>

About 1961 I built an EPB-1 that I called a "C" although someone else built another using that designation later. I really made the pod swoopy with balsa tacked on to smooth lines, and a T-34 rear canopy to make nice curve over cockpit. Did away with tip fins, using upswept Horner tips with input from Dr. Leshner. Had faired in center rudder ala original Gee Bee w/o the extra little hump. Split the rudder for glide control, mash both pedals to go down (springs on split rudder bar, detent to positively lock halves back together, and magnets on TE.) Backstrom mixer worked fine, used more up than down aileron to help yaw, had flush spoilers on top 1/3 of aileron near tips activated with last half of rudder. Per Bruce Carmichael's suggestion, the rudder was 1/4" thicker than lead in fuselage/fin, and had great authority.

Had a dolly for t/o but most time flew off grass, and just did without, especially as it was easy to tip up on nose and inspect skid wear. Had bridle going into holes behind pilot, loops to center release pin. Got idea from Ray Parker's Tiny Mite. IMHO, I consider anyone who hopes to use feet for landing gear in anything but a parachute has no respect for God's gift of lower extremities. In my sixties, I am paying a high price for football, skiing, plane crash and motorcycle bumps and bruises that seemed so minor at the time.

For trailering, had 16" long two-wheel trolley, and removed rudder only for travel (actually it wound up 8'2" but I trailered an LK with almost 10' Stab and never got measured). Had long center pivot bolt w/locking nut fixed - auto control hookup - 2 minutes and no fuss. Rudder stored in cockpit. 40' wing overlapped the car trunk, which was elegant, but had to unhook the trailer to open most trunks. Mounted a red flag on the left (rear most) unsupported wing tip, and it was over 4' from the ground, but that still was surprisingly close on some uneven ground.

Didn't get it fully trimmed out before selling it, but I'd put it against any 1-26 in glide, and nothing would climb with it. Just put it in center of a thermal, pull the stick into your gut, and pivot on a wing tip. No twist, but

just mushed out of stall, even in turns. If I had to do it over, I'd taper the wing ala Fauvel or Marske.

Jim Marske wrote in response to the following that was related to the above discussion:
<marske@marion.net>

"Static stability and control authority are linearly proportional to both tail area and tail moment arm. However, although dynamic stability is linear with tail area, it's proportional to the SQUARE of the tail moment arm. Note, this is why getting decent dynamic stability is such a challenge for many flying wings, with their inherently short effective tail moment arms.

Don Stackhouse
djaerotech@erinet.com"

Ok guys, I have made at least a 1,000 flights in flying wings and I have ground looped only once.

That's because I landed too close to the edge of the runway and shortly after touchdown a wingtip went down into the tall grass. Before I knew it I was turned around backwards and finished the roll out watching where I had been. It stopped in a matter of 30 feet and no damage was done. This was in my 12 meter XM-1 Plank. The glider had no tendency to ground loop. The main wheel was located just behind the aft cg.

My Pioneer 2 design has a similar main gear location just behind the cg. I have seen only one ground loop in this type aircraft. It had just landed and was half way through the rollout when a wingtip touched the tall grass just enough to start a yaw. The nose pitched down just enough for the nosewheel to contact the sod runway. With the nosewheel well ahead of the cg a ground loop was underway. Again no damage except for an embarrassed pilot. I might add that the large nosewheel protruded well below the fuselage.

I remember well the ground looper AV-36. Jack Lambie said if you had the slightest yaw at touchdown you would ground loop. Here there was no landing wheel, just a skid. When the skid contacted the ground the friction would cause the nose to pitch down putting a major portion of the aircraft's load on the forward end of the skid. Add a bit of yaw and unstable situation exists resulting in a ground loop.

As far as a narrow wheel spacing goes you can't get it any closer than a sailplane which has only one main wheel. The only sailplanes I know of to ground loop are those with the main wheel located well ahead of the aircraft's cg. I guess that covers a lot of modern sailplanes. And often times their precious long tail booms break off.

Another factor not mentioned about bouncing on a wheel. As a young man I restored a J-3 Piper Cub and flew it a lot. I noticed that the wheels could stand a bit more pressure so I pumped them up. On landing it became the bounciest plane in the air. The slightest bump on the sod runway would pitch me back into the air. I had to make 3 circuits with umpteen bounces before I could finally keep it on the ground. Needless to say I immediately let the excess air out of the main tires.

Bob Storck replied:
<bstorck@sprynet.com>

On my EPB-1C plank, I also used a skid, but had it with most curve in front, flattening toward the rear. (used neoprene balls to provide shock absorbing -- pretty naive, I know, but then I was 16 and knew everything) It tracked well on takeoff and landing. and presented no problem. Anxious to protect the center rudder, the rear end of the skid stuck down 3-4" from the bottom of the pod.

He let me fly the Fauvel once at Elsinore, and 1) the dolly was ridiculous, 2) he told me it would ground loop, and it did (it landed so slow that it had almost stopped before it started), 3) directional control was miserable at low speeds. It seemed to have a heavy left wing, and when I slowed down checking it out at altitude, I could not keep it from dropping - - not a stall/spin entry, more of a wing down mush.

(ed. – This last piece ended the thread and the group moved on to other protracted discussions like:)

Nick Sturm wrote:
<grindelsturm@yahoo.com>

Subject: Heinkel He P.1078B and others

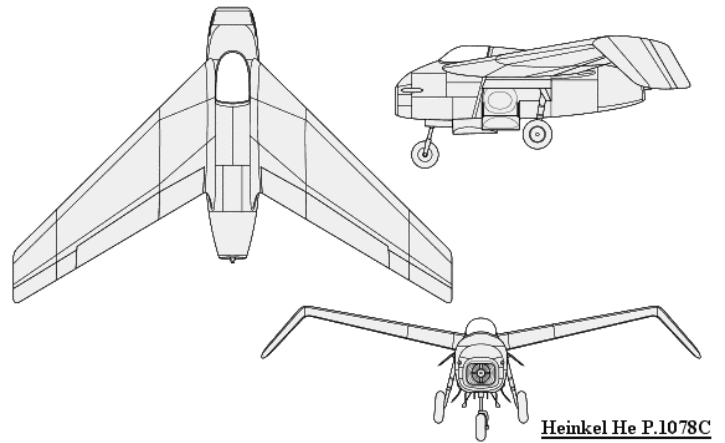
<http://www.luft46.com/heinkel/hep1078c.html>

Can anyone comment on the cranked down wing tips of this plane? I can see the advantages of increased directional stability and adverse yaw cancellation, but also acknowledge the problems of ground clearance and maybe some structural difficulties. My thoughts recently on swept flying wings have run along a similar vein...with, perhaps, a very mild gull wing with the outer portion of the wing being cranked down.

I seem to remember early Northrop designs having these and some other concepts. But they seem to disappear in later craft. Does anyone have a good reason why this is so? What would you expect crank

do to the span wise flow? How about on a bell shaped lift distribution at the zero lift point?

Also, do any of you have experience with Fun3D? I am trying it to see if I can teach myself to do some useful CFD but I expect it to be a hard uphill battle. I understand that VLM is only useful for wings with only small amounts of span wise flow. I would think this is probably not a good assumption for a swept flying wing.



Bob Storck replied:
<bstorck@sprynet.com>

The Northrop N1-M was a remarkable and flexible test bed, with outer wing panels able to be changed in anhedral/dihedral over a range of something like 20 degrees. It was the subject of very exacting flight tests, and this data spawned the whole series of remarkable Northrop flying wings.

Doug Holverson replied:
<dholverson@cox.net>

They're diffuser tips, which is like having decalaged stabilizer and rudder combos mounted on the wing tips.

Also a very easy way for a hobbyist to carve their own little wings, like the old Estes Nighthawk.

Norman Masters replies:
<nmasters@acsol.net>

We have discussed this topic before. I see that you, Nick, participated in some of these threads so you are already aware of those but newer members may not be. It appears that the break lines of the He-1078's tips are parallel to the longitudinal axis so purists would argue that they are not diffuser tips but the effective AoA changes with elevon setting so I wouldn't quibble about that.

Another variation that looks very interesting is the "scissor-tail" which shifts the cranked down wing tips aft to get them into the area where the vortices are more developed. It looks like tip tanks with very large downward angled fins. Just as the Heinkel 1078C the BV-208 was a paper airplane but the scissor-tail concept was actually tested on the Skoda-Kauba SL-6. shown on this page:

<http://www.luft46.com/bv/bvp208.html>

B&V produced several other designs with scissor-tails so go up one directory after looking at that one. I think the BV P.215 is particularly interesting:

<http://www.luft46.com/bv/bvp215.html>

In 1995 B. J. Tipton, at Oklahoma University, did his masters thesis on a plane with a scissor-tail. Over the last few months TWITT has published AIAA paper 96-0408 "The Aerodynamics and Performance Analysis of a Semi-Tailless Aircraft Configuration" which Tipton co wrote with D. E. Smith and B. R. Mullins. It basically says that Blohm und Vos were onto something good here i.e. the scissor-tail reduces drag and is a good control surface.

Here's a little blurb about Paul MacCready's foray into scissor-tail aerodynamics:

<http://www.twitt.org/maccready.htm>

It's all about energy recovery and redirection. Tilt that resultant vector as far forward as possible!

Which reminds me of some other things. Al Bowers has suggested that a good way to conceptualize a wing with \sin^n twist, ala Horten, is to think of the tips as horizontal winglets as described here:

<http://groups.yahoo.com/group/nurflugel/message/998>

If you keep cranking that winglet down it turn's into a diffuser. Then if you follow Martin Hepperle's advice

and move it down stream it starts to look like a scissor-tail.

Martin Hepperle's site uses frames so if you want to see his winglet page go to
<<http://www.mh-aerotoools.de/airfoils/index.htm>>

then pick "Aerodynamics" from the menu on the left. Then "A Close Look at Winglets" from the table of contents at the top of the frame.

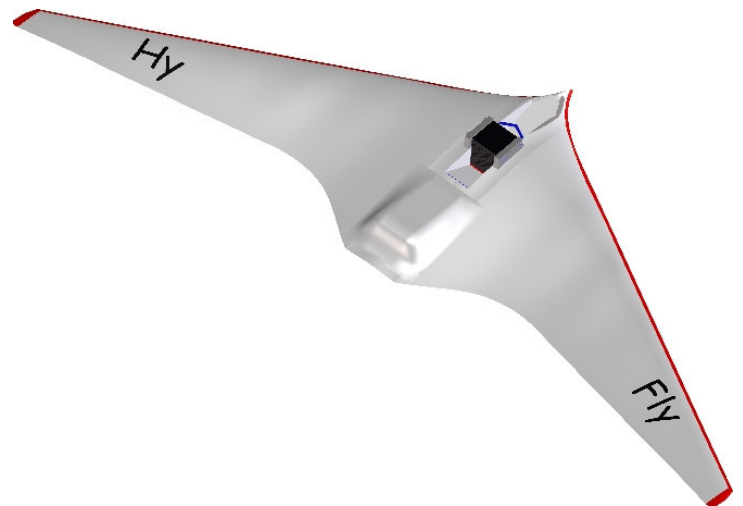
How's that for a tangled web

Manfred Poznanski wrote on a new topic:
<manfred.poznanski@t-online.de>

There is a high school project already on the way to get a model aircraft flying, powered only by fuel cells. The model used for this experiments is based on a nurflugel similar to the Horten design. German readers will find more information on the following site (an English version will be available soon).

<http://www.hy-fly.de>

On this site you can find a link to videos showing the first three flights of this model but powered by conventional batteries to check the general flying characteristics and made some adjustments. The first flight using fuel cell power took place on 09. July 2005.



Greg wrote on a new subject:
evolbaby@aol.com

Is The Space Shuttle Obsolete? What's Next?

This space shuttle drama is too much. Since there are so many experts on this list regarding space flight, is the shuttle obsolete? Due to retire? What's going to replace it?

I for one think the public is unaware of the marvels being done with space flight and especially the unmanned probes and rovers.

Yet a reusable delivery vehicle should always be there. Actually we should have a fleet of them. Money is no object.

So what's the next step? Were any brilliant plans pushed aside by bureaucrats and naysayers?

Any geniuses of today not being listened to?

Albion Bowers replied:
<al.bowers@drc.nasa.gov>

That's a media problem, not a technical one. I suspect the problems were always there, it's just the heightened level of attention after Columbia is making everyone aware of the difficulties that were always there. Rather than the foam strike being a fluke, it was probably the case that foam has ALWAYS been shedding, and Columbia was just the fluke to have the strike.

Yes, shuttle is old. And there is TREMENDOUS risk with all endeavors of this sort. It floors me when I hear pundits speak of safety when it comes to shuttle. It's about the same level of risk as a cat shot off a carrier; but given the complexity of the systems and the level of potential energy, it's astounding the risk is that low.

Shuttle will be retired in 2010. It's replacement will be Crew Exploration Vehicle (the entire system is called Constellation) in 2014. I expect both those dates to slip. And to fill the gap, the current plan is to buy launches from others (Russia? China? ESA?).

Well, it IS a huge problem with respect to money. Government policy is dictated by money. Congress allocates dollars to where they want work to be done (pretty simple actually) through passage of budgets (which are law). And the current level of funding for NASA is about 30% of what it was in 1967-1969 (the peak of Apollo). It would appear that Congress does not want a program as vigorous as the Moon landings were at this time.

The bigger problem was that the operations costs of shuttle were so high that replacement vehicles, which were planned and worked on at low levels, were killed off. The money simply was not there. Any of

the vehicles worked on could have been made to work technically, but the political will was not there (still really isn't). X-33 was workable 9though not without flaws). Ditto X-38 (the first space vehicle was built, and is in storage at Johnson Space Center).

Lots of them. Personally, I'd go for Constellation right now. The whole team needs to go fast, finish ISS with 19 shuttle missions, pass ISS off to industry, and concentrate on Constellation...

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