No. 184 OCTOBER 2001

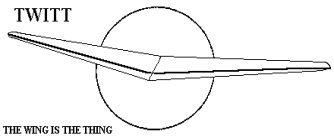
T.W.I.T.T. NEWSLETTER

Thomas Bircher (at the controls) and friend getting ready for a flight of the LEA 23. This version features a pusher propeller, but based on recent questions it appears they may be headed for a jet powered version in the future. (ed. We hope to have more on this next month.)

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., **0110** means this is your last issue unless renewed.

Next TWITT meeting: Saturday, November 18, 2001, 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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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).

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PRESIDENT'S CORNER

A few months back we announced that Mike Brown was going to do a series of construction articles while building a Mitchell B-10. As you saw in the newsletter he got a good start with several episodes on building the ribs. I am also sure you have noticed there have been no new additions to the series.

Mike just recently informed me that he will be unable to continue with this project. His personal commitments to business and family have taken precedence at this time and he regrets having to withdraw from his promise to put the series together. While I am disappointed in the outcome, I do fully understand that circumstances can change over time and get in the way of the best-laid plans. On the other hand, it also points out that this has turned into a real life project as many a homebuilder can attest. How many times have you started a long-term project and at some point had to put it aside for extended periods to take care of other high-priority things in your "real" world. I wish Mike good luck and hope that he can come back to this sometime in the future.

Another month of a shortage of letters from our members. Come-on guys, I know you are doing things with flying wings but just not telling us about them. We really need your cards and letters to keep this thing going and be of value to all the members. If your thinking about a new project and have questions, this is the forum for getting answers. If you are stuck on something right now, let others help you through the tuff spot.

We are going to have a visit from Thomas Bircher in the middle of this month. His team Switzerland is working on the LEA 23 project and I hope to have some updated information for the next newsletter.

Andy

NOVEMER 18, 2001 PROGRAM

As of our publication date, we have been unable to put together a final announcement of what the program will be for November. We actually have a couple of prospects, but they were not able to give us a positive confirmation by the time we had to get this month's newsletter out to you. So check back here next month or check out the website from time to time, since we will post a notice there just as soon as we lock in the program.

SEPTEMBER 15, 2001 MEETING RECAP

There is not much to tell you about the September meeting since there was no formal program. We were unable to find a suitable program between the newsletter publication and meeting, so we basically just had a visiting and viewing session for a couple of hours.

As noted in the non-program announcement, Andy showed the video of a recent PBS television program on the achievements of Paul MacCready for the 5-6 members and non-members gathered in the hanger. Most had not seen it, so watched intently at the many unique projects that have filled Paul MacCready's life since he was a small boy. It is interesting to note that his inventiveness carried over to his children as we watched Tyler MacCready teach narrator Alan Alda to make Tyler's Walk Around glider fly in front of him. There is a rumor that these light, foam gliders will eventually be available in stores for both children and adults to play with.

Although we lost a couple of people, a few were still there to watch the Greenwood, New Hampshire 2000 Fly-In that concentrated mainly on a Mitchell B-10 powered trike and, a Kasper powered ultralight do takeoffs and landings. Greenwood is an interesting little strip sort of hollowed out of the trees and with an elevated takeoff area and a wall of trees at the departure end. The fly-in looked like it was well attended with a lot of different types of ultralights.

So, that's about it for this meeting. Everyone enjoyed the variety of donuts and left with a few more calories than they probably wanted.

JULY 21, 2001 MEETING RECAP

(ed. – This is the last part to Stefanie Brochocki's presentation on the BKB-1 flying wing glider. I hope you have enjoyed her comments on the history and background of the unusual sailplane. I have also included some of the exhibits for the previous section that weren't available at publication time. I have been continually amazed at the amount of interest this aircraft generates even after all these years.)

THE BKB AND THE VORTEX LIFT CONTOVERSY

(The following text refers to the performance of Stefan Brochocki's BKB-1 tailless glider sometimes referred to as the BKB-1a. Originally black & white, it was later painted red & white. It is often confused with the Bekas, Witold Kasper's longer wingspan version of the BKB which was painted in a similar red & white scheme. The performance of the two gliders was not comparable, the Bekas having considerable stability problems. Subsequent powered aircraft by Kasper did not fly successfully, although various literature erroneously attributes BKB-like capabilities to them. - Stefanie)

It 's claimed by some that the BKB glider utilized vortices on the upper surface of its wing to produce enough lift to allow it to descend slowly, in complete control, and near-vertically to the ground. Could it really do this, and was vortex lift a factor? I think I may have a small piece of the puzzle, though there are more to be discovered.

It's very likely a vortex was involved as a component of a dynamic stall, but the BKB was not the first to demonstrate it. Norm Masters sent me a story entitled "The First Superstall" which describes a similar incident with another aircraft, the Airspeed Queen Wasp, in 1937:

"Two prototypes were built in 1937, and the first of them, K8887, had a singularly remarkable quality. Airspeed's test pilot, George Errington, took its designer, Hessell Tiltman, on a flight one day to show him. "I would like you to look over the side," he said. "We are at 2,000 feet, heading into the wind over the leeward side of the field. I shall now close the throttle and pull the stick back until the angle of incidence is on the other side of the stall." Tiltman watched the airspeed indicator drop to 45 mph, then gradually to zero. The attitude of the airplane was normal, but they were losing height rapidly. Errington had full control all the time — he could even rock the wings with the ailerons. At the end of the near-vertical descent, he had to apply full throttle to reach the field, just skimming a hedge. Errington was probably the first test pilot to encounter a stabilized superstall. The angle of attack must have been close to 80 degrees. The funny thing is that none of the other Queen Wasps built could do this trick, and nobody knows why. (Don Middleton: Test Pilots)" (Check http://www.aerofiles.com/liteside.html for this story and "Who Needs a Helicopter?"#1 and 2, similar incidents.)

Dez George-Falvy told me he noted a similar effect when he test flew the BKB. He also believed vortex lift was involved, with the lift lasting perhaps 15 sec. Earlier on, he had told Jim Davis that it was not a new experience for him. Years ago in Hungary, Dez's flying instructor had taught him to use this technique to get momentary lift when pulling quickly into a high angle of attack. Seems you can do it with many aircraft; it's just easier with a tailless, but it doesn't last any longer. This effect is known as dynamic or superstall and occurs when the pilot pulls quickly into a very high angle of attack so that he passes far beyond the normal stall angle. Control can be maintained, and a large vortex is formed over the wing, giving temporary but substantial lift. *(By the way, Dez also tumbled the BKB, backwards only. He said it was "easy".)*

ABOVE: This is what should have been included in last month's newsletter as Fig. 5, but the picture wouldn't convert for publication. It also works this month in looking at some of tuft movement during the vortex lift testing.

Norm Masters *(Check out Norm's website on Vortex Lift,* http://www.gj.net/~nmasters/*)* maintains that pilots are so conditioned to avoid a stall that the whole area of post-stall behavior of aircraft has been largely ignored. Witold Kasper was one of the first to explore this phenomenon as a pilot. Unfortunately the BKB did not have the instrumentation which would have allowed crucial data-gathering on its behavior, so his claims of very low-speed descent could not be substantiated.

Steve Grossruck, one of the developers of the Kasperwing Ultralight experienced a similar situation while flying his craft. He confirmed what George-Falvy had said earlier about this transitory effect of high lift as the angle of attack was increased. He added that the high lift was followed by a brief period of instability before the ultralight continued its slow descent. Al Bowers explained it something like this: During the period of instability, the start-up vortex is still operating but it is separating from the wing at this point. It doesn't necessarily separate from both wings at the same time. If one can't pass quickly enough through this uncontrolled stall interval to controlled stall, the classic stall/spin mode takes over. No way out for a glider. According to George-Falvy, the whole sequence lasted 50 - 60 sec. of which 10 -15 sec. was in the high lift mode.

The BKB and the Ultralights could pass very nicely through this interval. The BKB's slightly swept and twisted wing had an elliptical lift distribution which meant stall would occur at different parts of the wing at different times and perhaps this was of significance in this event. I can't speak for the Ultralight, though their pilots say the sweep (13^{O} in the BKB) is important. One even ventured to say that the phenomenon seems to favor a four-foot chord.

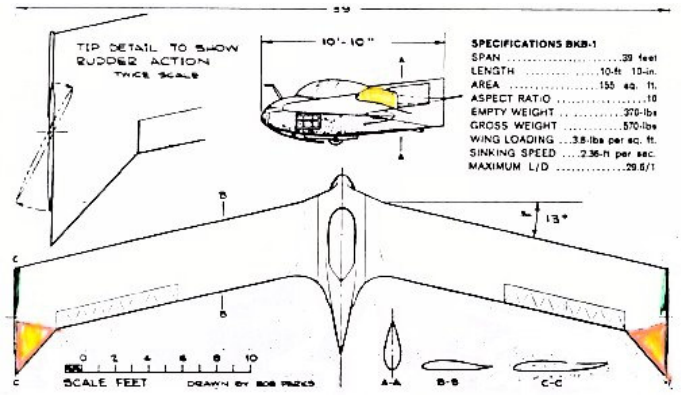
Various pilots estimated that the rate of descent for the K-wing hang-glider was about 800 fpm and the ultralight about 1000 fpm. Kasper's claim of a 200-fpm sink rate for the BKB in steep descent seems quite optimistic. George-Falvy estimated it to be around 600 fpm. But though the actual rate of sink is in doubt, George-Falvy, Grossruck, Higgins, and various other pilots, all maintain that this aircraft ***was*** capable of unusually slow, controlled flight at high angles of attack.

What happens after the start-up vortex separates? Kasper and some of his associates believed in the existence of a continuous vortex which allowed a very slow descent. Films exist of tuft behavior showing the reverse airflow on the BKB wing. Some claim this is proof of the continuous (or bound) vortex. Without seeing these films it's impossible to comment on the duration of the effect, its continuity, or at what stage in the sequence of events it is occurring. One enthusiast who saw such a film said that the reverse flow only lasted about 10 sec, and that it was necessary to keep changing the angle of attack in order to maintain the reversal.

Harry Higgins (formerly Chief of Stability and Control at Boeing) provided a first-hand description of the tuft behavior in a letter to P.G. Saffman at the California Institute of Technology in June of 1978:

"I flew the BKB on four occasions and I witnessed some of Witold's tuft experiments from another glider flying in close formation. As far as I am concerned the tufts revealed a classical case of separated flow. The BKB had an unusual capability of stabilized flight at very high angles of attack. (Descent rates I observed during these conditions were conventional and similar to those of the Schweizer 1-26 I was flying).

At high angles of attack the tufts on a large area of the wing upper surface lay forward as an average but also moved in a slow random fashion, obviously responding to stalled, separated flow of low dynamic pressure. None of the tuft characteristics were in the least unusual or remarkable. To infer that the tufts revealed the presence of a steady vortex is in my opinion completely erroneous. I would expect a steady vortex scrubbing the wing upper surface to generate surface velocities at least as great as free stream. The tufts I witnessed on the BKB at high angles of attack indicated a low energy, meandering flow, reversed in direction from the free stream only as a time average."



ABOVE: This is an illustration of the tip changes made by Kasper which seemed to have a positive affect on handling. They include the extended trailing edge "spikes" and more area in front of the rudder hinge point.

It is not clear what allowed the BKB, the Kasperwing Ultralight, or for that matter, the Queen Wasp, to descend so steeply in full control. It may be possible that a continuous or bound vortex exists, but the experts maintain it would be much weaker than the original starting vortex in the lift it provides. Many do not believe another vortex is formed or involved after the separation of the initial one. The *amount of control still available and the stability* are what seem to make these aircraft unusual. Vortex theories alone don't seem to account for the glider's control capabilities at high angles of attack, so it's important to keep an open mind until we know for certain what's happening.

Wind tunnel tests at the University of Washington do not substantiate claims of high lift. Saab-Scania's efforts to maintain a steady lift-producing vortex were unsuccessful without blowing. NASA Langley's 1973 wind tunnel tests on the BKB wing do not appear to be well documented. With all of these tests, it would be interesting to discover if the angle of attack had been increased quickly or gradually. The effect of each might be quite different. And, one witness to the strange performance of the BKB speculated that it might be the shape of the nose that contributed to the flow over the wing. Tunnel tests have not incorporated a fuselage.

The phenomenon of vortex lift in the BKB should be explored further, but not just by more wind tunnel tests. No one will ever be convinced by their results alone, no matter how definitive. The BKB needs to be built again and subjected to a complete, engineered, testing program just as George-Falvy recommended in the early seventies. I could say we have come full circle. We are back almost to where Stefan, Fred Bodek, and their team of test pilots were in 1960, when they saw the need for Dr. Raspet's team at MSU to take over the testing of this unusual glider. Who knows how its performance would have improved had it been "Raspetized".

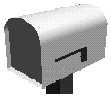
It seems to me that in all of the controversy and fuss over vortex lift, and the amazing feats the BKB was reputed to demonstrate, some important things have been forgotten. The BKB achieved, maybe surpassed the expectations of its creator, Stefan Brochocki. He set out to create a simple, well-performing glider that was easy and economical to build; one whose characteristics and handling could rival that of the expensive, complex, and sophisticated Horten IV. And he succeeded!

ABOVE: Horten IV being prepared for flight, location unknown.

Perhaps we have lost sight of that fact. Stefan designed for great stability, not for tumbling, vortex lift, or the other peculiar attributes of the BKB. This glider was intended to be a good soaring machine within the reach of most enthusiasts. That vision was lost (temporarily, I hope) in a legacy of bad publicity and controversy. We will never know what could have been learned without rebuilding the original BKB and then exploring all its possibilities through thorough testing and further development. My family and Fred Bodek sincerely hope that day will come, and that the BKB will be remembered for what it truly accomplished.

Stefan Brochocki has written some of his thoughts towards the possibility of reconstructing the BKB. I'd be pleased to forward a copy to interested parties. Contact me at <sbrochocki@yahoo.com>.

I am grateful to Bernard Dobrovolskis for hours of fine work in editing and enhancing the film "BKB", and to everyone who has assisted me. Big thanks always to Andy Kecskes. What would we do without him!



LETTERS TO THE EDITOR

(ed. – The following are pieces from the Nurflugel mailing list group. Since we didn't have any member letters and, these seemed like subjects of general interest, I am substituting them as I have in the past.)

September 16, 2001
From: Doug Holverson <dholvrsn@netins.net>

Subject: Klingberg Questions

Last spring I built a sin^3 wash out rig to build a Klingberg Sport Wing. I have then had cold feet about building the thing this way because I couldn't get the ribs and TE to line up with the blue print pasted on the rig's base.

Any advice on building it this way or should I play it safe and build it on an original style jig?

DGH

September 23, 2001
From: Norman Masters <philadelphus@reanet.net>

Subject: Re: Klingberg Wing

>Toni Bäuerle wrote: *(ed. – in response to my providing the mailing list with the cited link.)*
> Link doesn't work.

I think Mike graduated last year. When I heard he was graduating I expected the university to remove his student home page, so I saved some stuff from it, but the link to his flying wing page is still working (at least it worked when I tried it this morning). Try again, if it doesn't work for you I can forward the coordinates for the jig and some pictures.
http://pr.erau.edu/~allenm/wing.html

October 1, 2001
From: Doug Holverson <dholvrsn@netins.net>

Subject: Re: Klingberg Wing

That is what got me into this mess. His is the regular wing and mine is the Sport Wing. Nothing lines up on the templates and I'm getting cold feet and about ready to assemble the Klingberg with linear washout. Since it is an irreplaceable last of it's breed, I really don't what to mess anything up, but I would also like to make it special (Horten washout) if possible.

DGH

September 17, 2001
From: veeduber@pacbell.net

Subject: Homebuilt (ie, Full Scale) Info Needed

Dear Group,

I could use some help on MAC determination of an airframe similar to the PUL-10; 24' span, 35 degree sweep, 72" root (Horton IIIc - modified), 18" tip (NACA 0015). +3 degree at the root, -7 at the tip. Aluminum & welded steel tube, 650 pound empty weight. Modified VW powerplant producing approximately 420 pounds of static thrust (2:1 PSRU).

If this is a models-only group, please excuse the intrusion.

-R.S.Hoover

September 17, 2001
From: "Jon Darby" <jdarby@lplizard.com>

Subject: Re: Homebuilt (ie, Full Scale) Info Needed

Wow, is this the famous Bob Hoover of VW Type II fame? If so, you were indeed an inspiration for my philosophical and mathematical education on VW maintenance over the past 5 or so years with my stable of vintage Volkswagens thus paying for a significant chunk of my college education by freelance VW work. Who knew you were also a nurflugel fanatic? If I remember correctly, it would be pretty historically accurate to include a VW powerplant in a German nurflugel-inspired design (I remember picking up from the Myrha book that the powered H II powerplant was a VW block). I wish you luck in your project!

Sincere appreciation,
Jon Darby

September 18, 2001
From: Norman Masters <philadelphus@reanet.net>

Subject: Re: Homebuilt (ie, Full Scale) Info Needed

Look at this link:
http://www.eaa62.org/technotes/cg.htm It has a drawing showing the graphical method to locate MAC on a single taper wing half way down the page.

September 18 2001
From: Carlo Godel <regiaero@gj.net>

Subject: Re: Homebuilt (ie, Full Scale) Info Needed

The graphic method works very well as long as there is little to no washout at the tips of the wings. If washout is used on a swept wing (not unusual) the CG and MAC will diverge from that shown. All aircraft tailed, canards and otherwise the CG falls at around 20% of the MAC of all surfaces but the washout will modify it to a certain extent. Rule of thumb, For each 3 degrees of washout move CG forward 1% of MAC.

Carlo

September 18, 2001
From: Norman Masters <philadelphus@reanet.net>

Subject: Re: Homebuilt (ie, Full Scale) Info Needed

Yes the position of the neutral point depends on overall geometry but that's not what Mr. Hoover asked. He simply asked how to determine the mean aerodynamic chord. Since MAC is that line which divides the wing into 2 equal area panels one need only consider the plan form. And, considering that he included the other geometric information and the weight in his question, I'm assuming

that he or one of his collaborators knows how to calculate the neutral point and static margin.

September 24, 2001
From: "Jan Evert Leeuw" <jan.evert.leeuw@adv.demon.nl>

Subject: Schafer Flying Wing

Dear nurflugelfriends,

In July I saw on German television "Sat 1" a program about a new German "Nurflugel" flying wing. It was built by Ulrich Schafer and has the German registration D-MUIS, and, it did fly!

In the program it was told that there was a site "nurflugel.de" where to find more information but, unfortunately, it is recently closed. I was to late. Does someone know this aircraft, know more about it and can you help me to contact this Ulrich?

Thank you,

Jan Evert Leeuw

September 25, 2001
From: Serge Krauss <SKrauss@Earthlink.net>

Subject: Schafer Flying Wing

Jan-

Ulrich Schafer's Nurflugel (D-MUIS) is called the "Projekt 'A' Aachen" and was built between 1987 and 1994, first flyiing in January of 1995. It is a Horten inspired motor glider, Ulrich Schafer having spent 4 weeks with Reimar Horten in Argentina in 1987, when a preliminary 12-m UL was designed or constructed (?). The "Projekt Aachen" is a swept, low-wing pusher spanning 13.2m. It is powered by a 600cc 2-cyl. Goebler-Hirth engine of 26 hp. and has a maximum speed of 110-120 km/hr and a claimed glide ratio of 26.

Here is a short list of magazine articles featuring this aircraft (all courtesy of Philippe Vigneron):

1) "Nurflugel Projekt Aachen", Modellflug International, 4/96, pp.40-45 (5 photos, 5-V scale drawings plus fuselage and wing details, spec table).

2) Schafer, Ulrich; "Abenteur Nurflugel"; Modellflug International; 4/96; pp. 52-55 (dev. history; 3 photos)

3) Ewald, J.; "Nurflugel Projekt Aachen - Fast Echt Horten"; Modellflug International; 5/96; pp.64-67 (flight report; 4 photos).

4) Ewald, J.; "Hortens Legitimer Nachfolger"; Flieger Magazine; cover; 7/96, pp.12-16 (9 photos, spec table).

The last information I had (early 1999, I think) indicated that kits were available from a company called Christiani Wassertechnik, Heinrich Heini Str. 15, D-52249 Eschweiler, Germany. Phone: 02403/53047, FAX 02403/51468. 'hope these are not too out of date.

I will look in my current bibliography files to see if there are more listings or information. All of this is in the 6th Edition, dated 1/99.

As always, I would appreciate any updates of newer bibliographical information for my work. Thanks.

Serge Krauss

(ed. – As a refresher, we published a letter from Terry Baxter in the April issue of the newsletter where he included the sketch below. Here is what Terry said and below that is the "real" thing he was talking about.)

Terry Baxter begins by talking about many large scale models that have been successfully flown and asking the question why some of these have not been turned into homebuilt ultralight kits. He said, "Another was Teledyne 262 of about 7' wing span using a rotoduct. I could not find any details of this model but it was all fiberglass. This would suit a belt reduction, flat 4-cylinder Subaru."

(ed. -Baxter suggested a side-by-side seating arrangement in this interpretive drawing.)

Terry Baxter
c/o Darwin Butterfly Sanctuary
79 Mueller Road, MALAK
Darwin, Northern Territory
AUSTRALIA 0812

THE MINI-DRONES

Wagner, William, and William P. Sloan, FIREFLIES AND OTHER UAVs (Unmanned Aerial Vehicles), Aerofax, Inc.,

Arlington, TX, USA, 1992, pp. 135-136 (ISBN 0-942548-54-X (Softcover), 0-942548-55-8 (Hardcover))

Although unmanned aerial vehicles had grown to large physical dimensions (81-foot wingspan of Compass Cope, for example), the whole idea grew out of small radio-controlled model airplanes. Film star Reginald Denny, a model plane hobbyist of the 1930s, was one of the mini-RPVs midwives.

Flying a model plane above the battle field, or at see over-the-horizon, to see what the enemy was up to was an idea whose time had come.

Over the years, this led to many studies and development of a wide variety of airframe and engine mini-drone configurations for Army, Navy, Marine Corps and Air Force missions.

MODEL 262 "MANTA RAY"

An early Navy effort was the STAR project, a mini-RPV demonstration program, supported by the Defense Advanced Research Projects Agency (DARPA).

Preceding award of a Ship Tactical Airborne RPV contract, Teledyne Ryan had flown experimental models RPV-004 and –007 as half-scale delta-wing testbeds. Using rotorduct propulsion, these drones flew conventional takeoff and landings during demonstration flights.

The final configuration which evolved from earlier half-scale tests, was Model 262 'Manta Ray', of which three evaluation units were built.

Dave Gosselt

Above: Ship Tactical Airborne RPV, known as 'STAR' by the Navy and 'Manta Ray' by TRA, displays the sleek delta-shaped design which minimizes radar detection. Photo at right shows automatic net recovery 'landing.'

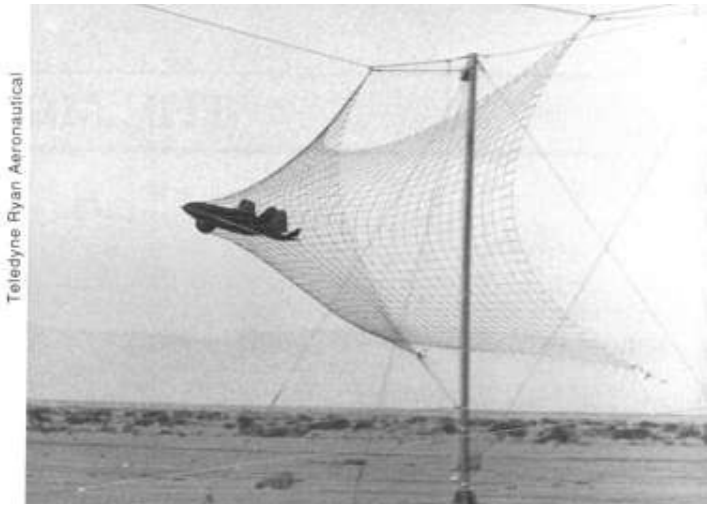
With 7½-foot wing span and 25 hp piston engine driving the ducted propeller, the 160-pound delta-wing drone was easily transported by two men.

Bud Wolford

Above: Composite materials, delta-wing design and a rotorduct propulsion system were key features of the Model 262 "Manta Ray" mini-drone.

Constructed of fiberglass, and with virtually no straight lines or flat surfaces, the mini-drone had inherently low radar cross-section shaping and low infrared signatures, assuring maximum survivability in hostile environments.

Designed for shipboard launch, the 262 utilized an All American, Inc., compressed-air rail-type launcher and was flown into a raised webbing for recovery.



Teledyne Ryan Aeronautical

A Poise optical tracker looking through the webbing provided automatic uplink commands to steer the air vehicle into the net. Unlike the hobbyist who has to wield a net to catch a butterfly, the Manta Ray had to be convinced it should fly *into* the retrieval web.

With six consecutive successful shore-based test flights, ending in net 'landings' at the Naval Parachute Test Range, the system proved the potential for operation aboard ship.

Other versions of the Manta Ray could, of course, be configured with conventional landing gear for takeoffs and landings.

This flight test program was successfully completed in 1976 at the El Centro, California parachute test facility.

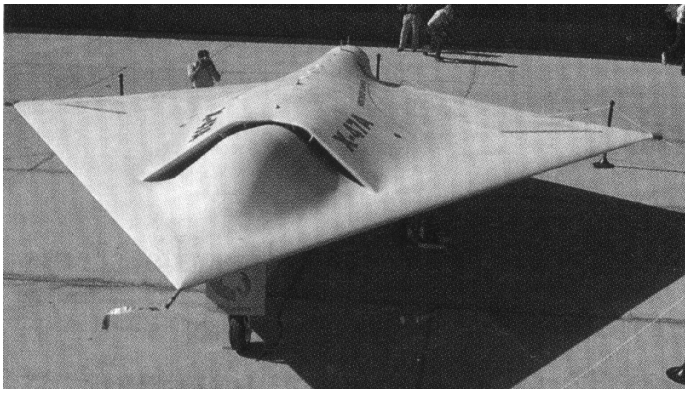
(ed. - Two recent articles in Aviation Week & Space Technology magazine are of interest to those of you who like what is happening in the future of flying wing technology. I will recap them here.)

August 6, 2001 issue, page 41:

"Pegasus To Test Navel UCAV Concept"

Northrop Grumman has decided to proceed with a demonstrator version of the X-47A, a carrier based unmanned combat air vehicle (UCAV). They are working in concert with DARPA and the Navy and expect it to begin test flights by the end of the year. The composite airframe was built by Scaled Composites at Mojave Airport. After initial systems checks at the Northrop Grumman plant in El Segundo, flight testing will be conducted at the Naval Air Warfare Center at China Lake.

This kite-shaped drone has a 27.8-ft. wing span and is 27.9-ft. long with a 55 degree leading edge sweep and 30 degree trailing edge sweep, with 389 sq.ft. of area. It will be powered by a Pratt & Whitney Canada JT15D-5C turbofan with 3,190 lbf. The control surfaces include two elevons on the trailing edge and four inlaid drag rudders at mid-chord inboard of the tips, a pair on the bottom and a pair on the top. The aircraft is slightly unstable.



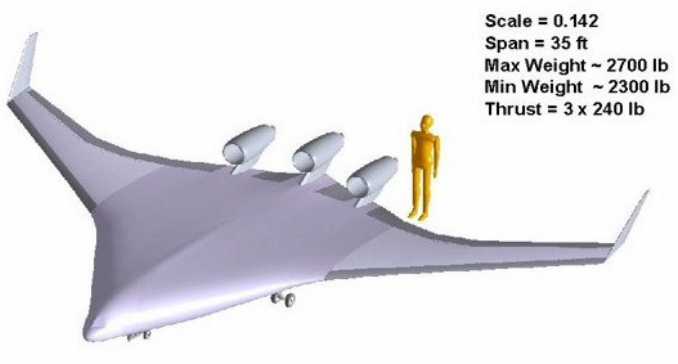
(Photo by: Michael A Dornheim/Los Angeles)

The demonstrator looks like a stealth, however, it does not have some of the stealth features that would be included in a production model.

August 13, 2001 issue, page 27:

"Boeing Takes Over FCS Work From NASA Dryden"

Boeing is taking over design development of the flight control system for NASA's proposed BWB low-speed-vehicle, now that Dryden Flight Research has withdrawn from the program. Depending on the continuation of funding and personnel, Boeing is planning on trying to meet the original 2005 wind tunnel testing program at Langley.



(NASA concept image.)

The plan calls for Dryden to then take over a six month ground test and then proceed with a 40 flight test schedule. This is all dependent on funding and personnel being available from the Dryden side.

Boeing is attempting to keep the program running since it is interested in a full-scale BWB that would carry 468 passengers, 8,500 nautical miles at speeds up to Mach 0.85.