No. 282 DECEMBER 2009

T.W.I.T.T. NEWSLETTER

Boeing Bird of Prey technology demonstrator pioneered advances in low observable features, tailless aircraft design and rapid prototyping. Test pilot Rudy Haug flew the Bird of Prey for the first time on September 11, 1996 and only 38 missions were flown between 1996 and 1999. It is now on display at the US Air Force National Museum at Wright-Patterson AFB. Source: http://www.military-heat.com/tag/stealth/

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., **0912** means this is your last issue unless renewed.

Next TWITT meeting: Saturday, January 16, 2009, 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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Wt/#Issues	FRG	AUSTRALIA	AFRICA
1oz/1	1.75	1.75	1.00
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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).

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PRESIDENT'S CORNER

One holiday dinner down and one more to go before we close out another year of TWITT Newsletter issues. This year now seems like it has gone by very quickly with so much activity at work and at the hanger working on a Cessna 180. I don't see anything slowing down in 2010 so I will have to keep on my toes not to forget producing an issue.

We did reach a milestone with all the back issues now on the Internet. I hope you have taken advantage of this and gone through the issues published before you joined. There is a lot of interesting things in all those issues and it seems like there was actually more activity related to flying wing development than found now. However, you will see a couple of people who are part of the Nurflugel group are trying to work on new projects. I have included them since they should act as a catalyst in generating new thoughts on both models and full sized aircraft. There are a lot of good building hints and techniques that might allow you to do some experimentation during the winter months and be ready for test flying when the snow clears.

Although not a flying wing I have purchased Schweizer 1-26 #026 and will start a full restoration of it very soon. My father and I restored it from a complete wreck and flew it for a number of years before I went into the military and he finally sold it. Fortunately this time around it won't require making everything straight again, but just refurbishing it to as close as new as I can get and then covering it all with Dacron.

HAPPY HOLIDAYS TO EVERYONE

Andy

LETTERS TO THE EDITOR

November 28, 2009

Hi Andy... Thanks for all your work in putting out all those newsletters and monthly meetings. I have been a TWITT member for many years and have always wanted to own a real live flying wing. Just before Thanksgiving I bought a Marske Pioneer 2B glider that has almost 600 hours on it. It is a long road I have started down first importing it from Canada and complying with the Transport Canada and FAA requirements. Then there is the small matter that it is in Toronto, Ontario and I live in Scottsdale, Arizona, 2215 miles according to AAA. I know there are some things that the seller has told me that need to be done, like recovering the rudder and finish painting the fuselage as well as re-installing the instruments. I am sure there are many other small things I will have to do as well. I will send you updates on the project and some pictures of the progress. Maybe down the road after it flys I could bring it to a TWITT meeting so everyone can check it out. It turns out Jim Marske's daughter lives a couple of miles from me and Jim visits her several times a year so maybe I can get him over to look at it and offer some suggestions.

Happy holidays

Curtis Clark
Scottsdale, Arizona
azskybum@aol.com

(ed. – I wrote back with a congratulation on his purchase and told him we looked forward to seeing some pictures as he move along with the project.)

(ed. – There weren't any other new messages or letters in the past month to include in this section. However, we did find another reference to Kronfeld in answer to the search by Raul Blacksten. It was in the March-April 1948 issue of Soaring *magazine and included the picture shown below. This was all forwarded to Raul, who had already run across it in his research. For those of you who aren't sailplane historians, that is a WW II Pratt-Read in the background. I am not sure, but there may be only one or two of these in flying condition anymore.)*

Emil Lehecka
The late Robert Kronfeld enjoying American hospitality during his visit to the U. S.

Let's Take A Fresh Look At Ultra Light Airplanes

By Al Backstrom

(ed. – There was no date on this article but based on the description of materials and the relation to Al's other designs it is fairly old. However, it does describe concepts that are still valid today, especially with some of the new, lighter construction materials and more powerful engines.)

In watching EAA action from almost the beginning, it seems that we have come just past a half cycle. Most early homebuilts were adaptations of the simple light plane designs of the twenties and thirties modified for a 65 horsepower engine. From this we have evolved to sophisticated airplanes that rival the complexity of current production aircraft of the same weight. I would not argue that these are not good airplanes, but some of us in EAA should look into the possibilities of really flyable ultra light airplanes. These airplane designs should be based on currently available materials and equipment and not another rehash of what has been done in the past. I do not mean to detract from any of the excellent efforts in this line, such as the PL-4, but I feel that these are only a good start in the right direction.

I think we have a need for airplanes that can be built for a nominal cost and that con be operated economically. At best our airplanes of today can be described in one word – expensive. We should also be thinking of the future airplane and operating costs. With our current energy shortage, taxes and inflation it is not unreasonable to expect that we may be paying a dollar a gallon for aviation fuel before long. For the same reasons we cannot expect the cost of buying or building an airplane of current design to do anything but go up.

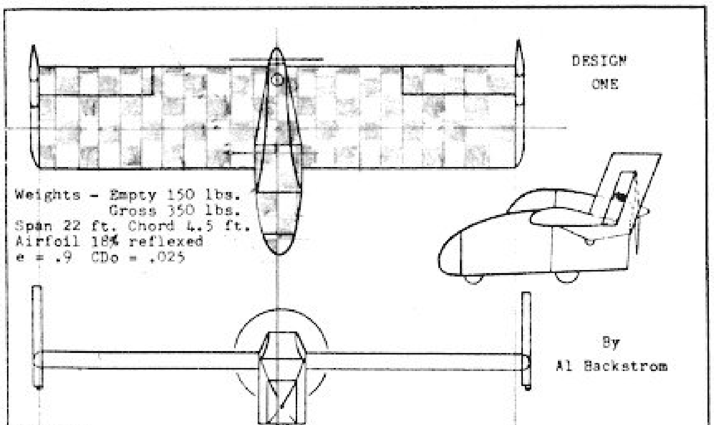


Figure 1

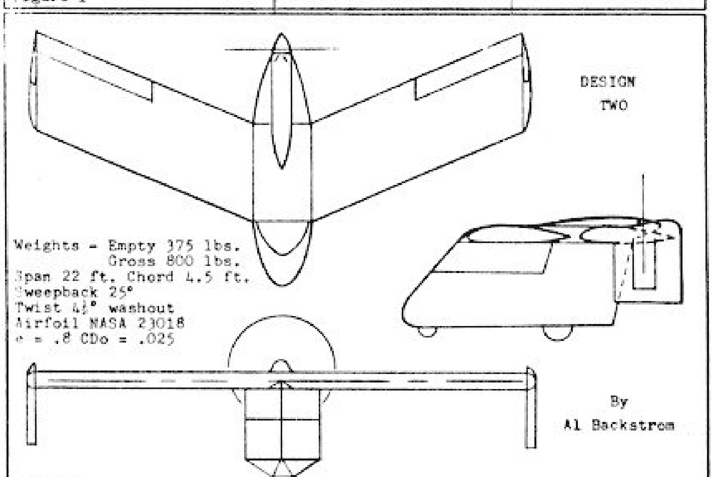


Figure 2

To achieve an airplane that is low in cost and operating expense it is necessary to look at a finesse approach rather than the brute force method often used in the past. Airplanes built on this approach must have:

1. Minimum weight – all materials for construction are basically purchased on a dollars per pound basis.
2. Low aerodynamic drag – except that unnecessary weight should not be sacrificed to reduce drag.

The end result of these two difficult objectives will be airplanes that will fly well on minimum power.

Let's see how we might obtain these objectives with items that are available today. In trying to obtain a low weight it must be remembered that any unnecessary weight added has a magnifying effect on the final gross weight of the airplane. The largest single item in the empty weight of a small airplane is the engine. Low powered and low weight aircraft engines are not available. Automotive engine conversions are excessively heavy for the power, except possible the VW. Fortunately, there are available some two cycle air-cooled engines built for go carts and snowmobiles that offer good power to weight ratios. These engines do have high specific fuel consumptions when compared to a good four-cycle engine, but their low weight should allow a smaller lighter airframe so that the end product would favor these engines. Hopefully, the Wankels for snowmobiles may offer a better compromise in a few years.

A lightweight airframe must be built from high quality materials. For our purposes this means aircraft structural materials. These are not cheap so let's look at how to minimize the quantity of material. This can be done by making parts serve more than one function where this is possible. All unnecessary parts must be eliminated. You might look at it by thinking "If it ain't there, I don't have to build it, it has no weight and no drag". The readily available lightweight construction materials today are aluminum sheet, steel tubing and Dacron fabric. A steel tube fuselage of minimum tube size and a few fairing strips covered with Dacron fabric is very light. Sheet metal wings and tail surfaces can be kept light by using fabric covering where strength is not required. Wing spar weight can be kept low by nesting bent angles for spar caps. The angle sections can be nested for the required root strength and individual angles cut off outboard as the wing bening load reduces.

Well, we have some sketchy ideas on keeping the airplane weight down but we still have the drag problem. It will be of little use to build a light airframe and then use all the power available trying to drag it up to flying speed. Put your helmet and goggles back in the closet, and forget the wind whistling in the struts and wires. Drag items such as these can't be tolerated in an airplane that is to fly well on low power. What we can look at since we won't be Mach critical is thick cantilever surfaces. We can also resume the approach of leaving off what we can fly without and making parts serve more than one function.

These rudimentary thoughts mean nothing unless they can be expanded to buildable airplanes. To illustrate what might be done I have made two design studies. The airplanes both rely heavily on my sailplane experience and a mild conviction not to get too confused by previous ultra light designs. Let's call them simply Design 1 (single place) and Design 2 (two place). The aerodynamic configuration of Design 1 is from my Plank sailplanes. The engine is the McCullouch 101A with installation details similar to Mr. Hovey's Whing Ding. Just to keep things even on the borrowed ideas, Design 2 uses the aerodynamic configuration developed by Mr. Waterman on his Aerobile and the engine installation is based on one I am designing for a single place Plank using the Kiekhaefer Aeromarine 440.

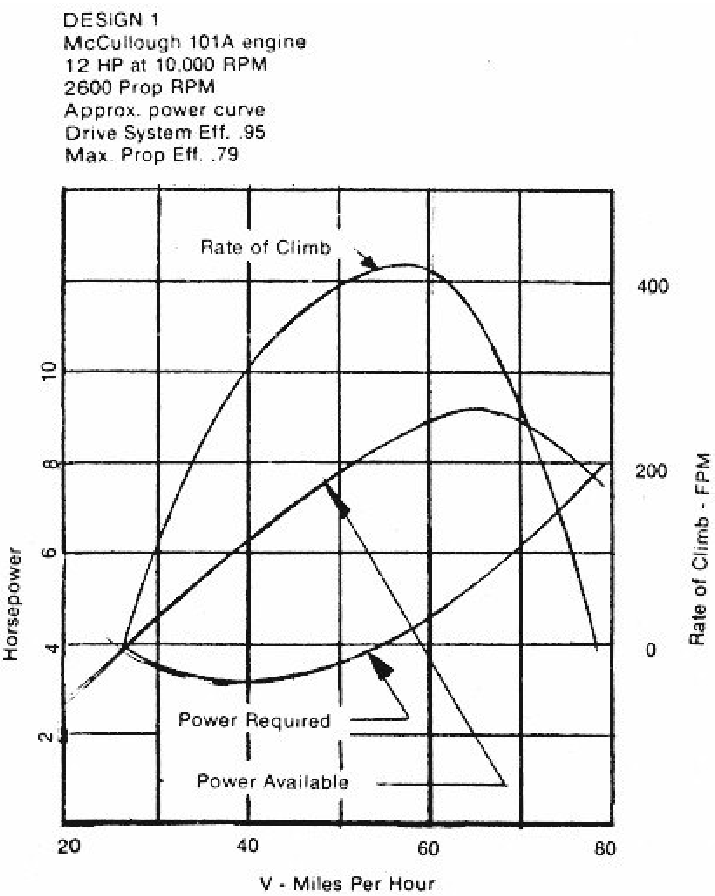


Figure 3

The structure of both designs is intended to be mixed, as discussed earlier, with steel tubing pods, sheet metal wings and fins. Bonding and riveting of the sheet metal would be used. The landing gear is the permanently retracted sailplane type with a steerable nose gear. I have flown this arrangement on the Nelson Hummingbird powered sailplane and it works very well once you get accustomed to taxiing with a wing down. The ground handling is like a tricycle gear. The wheels and tires would be industrial units with an external band brake on the main wheel.

The control system uses elevons for pitch and roll control. Directional control is provided by drag rudders on the tip fins. The tip fins should provide some end plate effect for increasing the effective aspect ratio in addition to being required for stability.

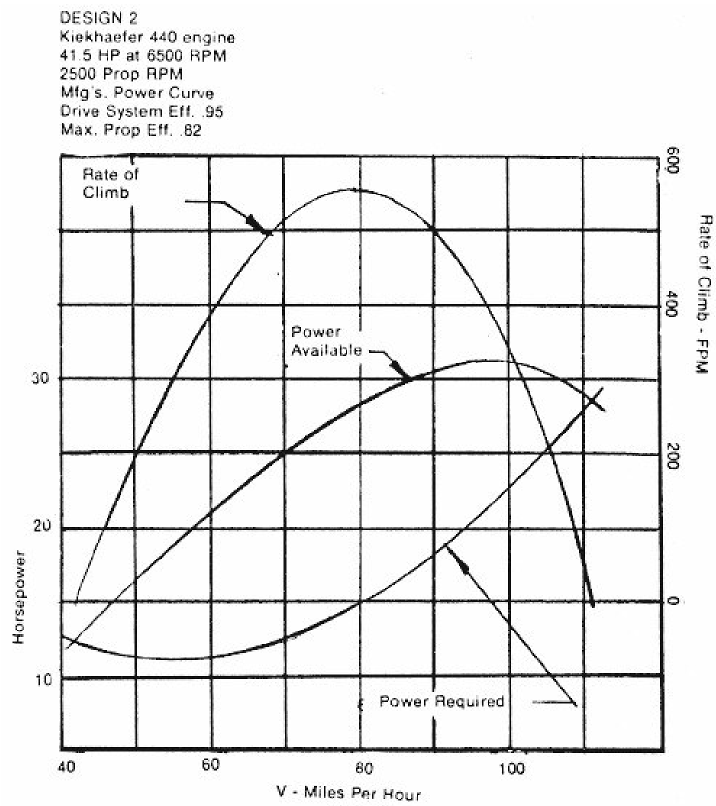


Figure 4

Both designs are intended for sailplane type disassembly so that they can be stored at home in the garage when not being flown. Naturally the designs are compromises. The constant section wings give a weight and drag penalty but they are easier to build. The abrupt corners on the pods are not the lowest drag shape but they will be light and relatively easy to build. The single cylinder engine on Design 1 was left exposed for cooling and simplicity. Since the Kiekhaefer 440 has an integral cooling fan, a buried installation was used on Design 2. The two design studies wound up the same size because Design 1 has only 12 horsepower and almost a 30-1 power to weight ratio. Design 2 has a 20-1 power to weight ratio so a higher wing loading could be used.

The designs and performance information are shown in Figures 1 through 4. Performance calculations were made using simplified methods so they can be considered to have an accuracy of plus 0 and minus 10%. The power available curves were based on the efficiency obtainable from a conventional fixed pitch wood propeller.

Even taking 10% off the performance shown it appears that really flyable low cost airplanes can be built. Those of us in EAA who are experimental or development minded should try the ultra light approach.

(ed. - Fred Blanton sent this information in a couple of months ago and I kind of overlooked it until doing some office cleaning the other day. The first picture is obviously a very much modified U2 when compared to the standard U2 in the other pictures.)

Lightsport Aircraft Pilot is a directory of aircraft that generally fit into what are described as ultralight aircraft, advanced ultralight aircraft, light sport aircraft, experimental light sport aircraft, experimental aircraft, amateur built aircraft, ELSA or homebuilt aircraft in the United States and Canada. These include weight shift aircraft, more commonly known as trikes, powered parachutes, and powered para-gliders.

http://www.ultralightflyer.com/mitchell_wing_U2_ultralight/index.html

The Mitchell Wing U2 is a single place part 103 legal ultralight in the United States. It is a flying wing using any Rotax 277, single cylinder 28 hp Rotax engine in a pusher configuration. The aircraft is constructed of wood and fabric. While it features three axis control, it uses wingtip rudders and ailerons for steering in the air. Pitch and roll is controlled by half span elevons. It has a double surfaced cantilevered wing.

It uses a tricycle landing gear, with a steerable nose wheel.

Mitchell Wing U2 flying wing specifications.

Engine	Rotax 277 20 hp
Length	8'6"
Height	6'2"
Wing Span	34'4"
Range	151 miles
Empty Weight	250 pounds
Gross Weight	550 pounds
Cruise Speed	55 mph
Stall speed	25 mph
Climb Rate	650 ft./m

NURFLUGEL BULLETIN BOARD THREADS

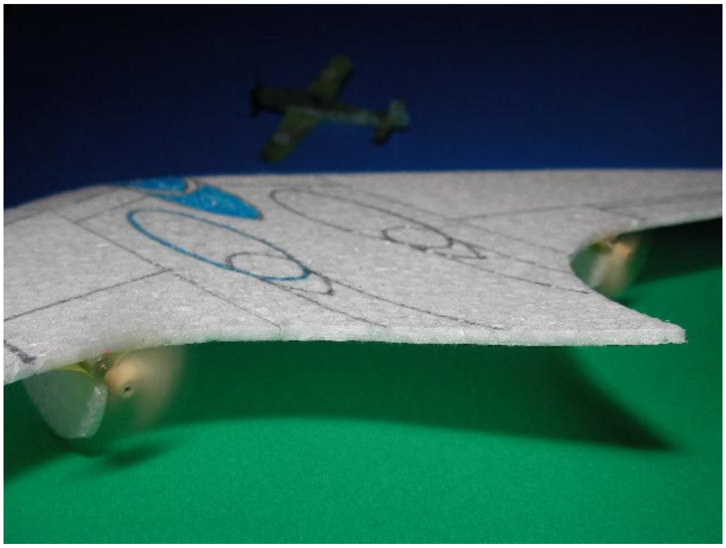
The Nyaruten V

http://www.youtube.com/watch?v=12VzGjp5XhY&feature=related
http://trhk.exblog.jp/5063723/

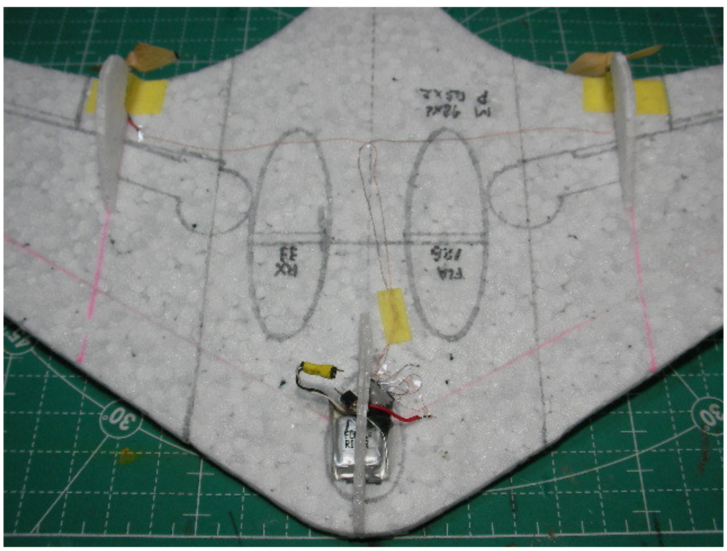
Stop drawing - Start flying! :-)

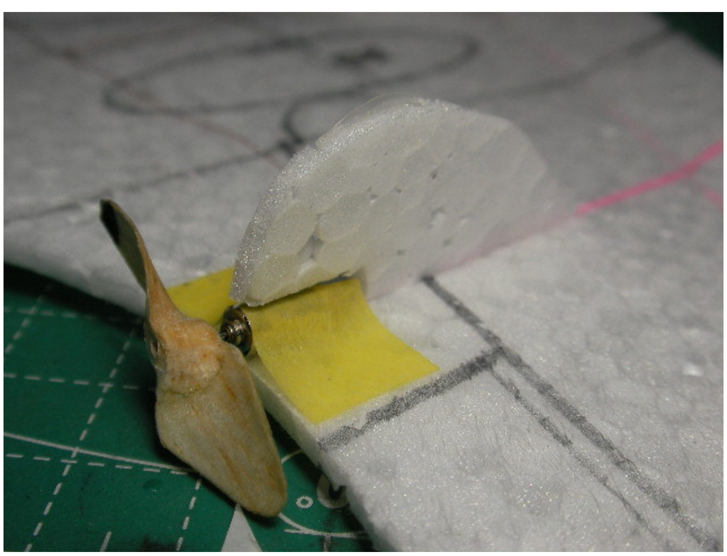
<mrk@karenfuxia.com>

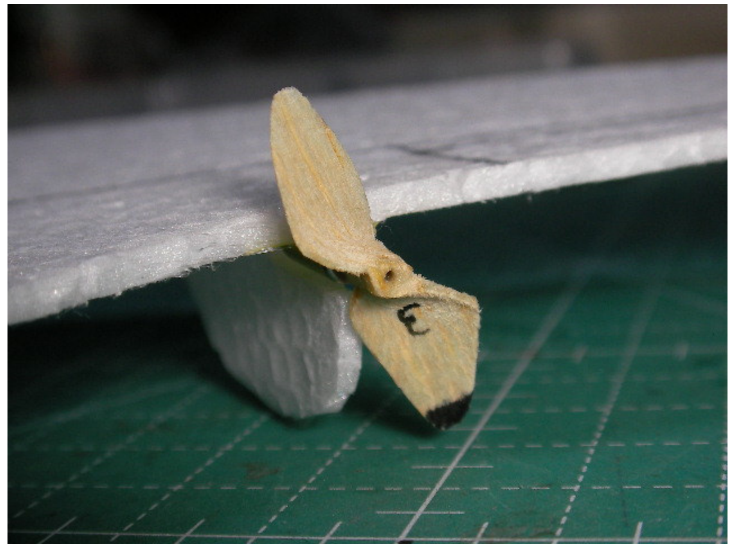
(ed. – See some of the images from the second link on the next page.)



It may be hard to tell but the propellers are spinning in this shot.







Hello Ho-229 researchers,

By chance I read some of your discussion on the Ho 229 drawing sets. I did not follow the whole discussion, so maybe some of the info is well known. Sorry for this.

As I did some research years ago on this airplane I worked through these sets. Most of the drawings represent the "Göttinger Ausführung" (V3 to V5), mainly for the V3. As the prototypes were under construction some of the drawings were obsolete as changes were introduced. Some of the drawings were made to document changes. If you look into the center section you can identify some of the changes. The V3-design was partly based on the V2-layout, which can be seen in the structure of the lower center shell. The drawings show two different layouts for the control system, as I understood the outer wings in the Smithsonian represent the second, simplified system.

There are also some drawings of the V6 single-seater mockup and concept at Gotha (in drawing group 00).

There are a few concept overviews that give some insight into the design evolution.

If I remember right, the two reels contain about 2000 drawings (at least the drawing list is about 130 pages), covering about 90% of the Ho 229 V3 (to V5).

Information missing is mainly from parts delivered by suppliers, so I guess it's the set from Gotha. Numbering system used is typical German wartime, with better structure then, for example, the Me 163 drawing set.

There is another set of wing-drawings existing in Berlin, for which I had paid the microfilming to save this information for future research. There are some differences in detail drawings, which I think are due to independent design evolution at the different partners. This set is the outer wings only, so these may come from one of the external woodwork companies dedicated to serial fabrication.

With these infos it should be possible to rebuild or restore this airplane, if doing proper research first and recreate the missing drawings from the original built parts, as landing gear, engine covers. However, I am not sure if the steel grades still exist, required for the tubular frame parts (I remember that for a H IV project surviving wartime tubes were collected to have this high grade material available).

Interesting are the different versions of hydraulic systems and electrical wiring systems (including wiring for BMW-engines), as it was not easy to identify what was really built into the prototypes. Interesting was also the parachute system, which was planned as tactical brake, not for landing purposes. Seems there was an issue with decelerating this wing. No proof for the tank-wing (integral fuel tank) is known to me, however, some of the concept drawings could be interpreted that way. Also available are some drawings for ground handling equipment, as the entry ladder. This ladder still exists.

The V3 shows no radio equipment, but there are clear indications of the planned equipment. No hard points for payload was possible on the "Göttinger Ausführung", so these were aerodynamic test pieces. The V6 was the first to be equipped with payload / armament / operational equipment, according to the drawings. A comparison of drawing and checking dates verified that these work was dome under high pressure, full week. Some of the people incorporated could be identified with the signatures. The drawings were matched to the design calculations surviving, so there could be some correlation established and some info completed.

I hope, this info helps your research. I still have my archive stored away as no time yet to resume research (so please don't be embarrassed that I can not follow this discussion, I only have time to read the mailing list from time to time, being a silent flying wing fan). I used my info for the cutaway you may find on Doug's Nurflugel-page. A revised version was started, but is not yet finished. Work for some other day...
Good luck.

Greetings to all who still remember me.

Kind regards,

Reinhold Stadler
<mw40200@mucweb.de>

Hello Reinhold,

It is good to see you are still following this group.

So you confirm, that there are only two reels in Munich, thank you. I have not seen the wing drawings in Berlin. Do you have an idea where these drawings came from? Probably from Hartwig at Sonneberg?

I have not yet understood what drawing groups 00 and 000 mean. Why did they change the numbering system? There are also V 2 and V 3 - 5 drawings in group 00, and V 3 - V 5 drawings in group 000. It is really difficult to relate these drawings because the "Baugruppe" (assembly group number) is missing for these drawings. It appears that also all the part lists are missing, which would be needed to allocate these drawings.

For a complete reconstruction it would be helpful to compare the drawings with the existing V 3. So I hope that lots of photos will be taken during the restoration process.

Maik Swoboda
<ErzwoD2@hotmail.com>

Hi Gang,

My name is Bengt Jansson, a retired aeronautical engineer, with a dream of a small, but potent, flying wing glider.

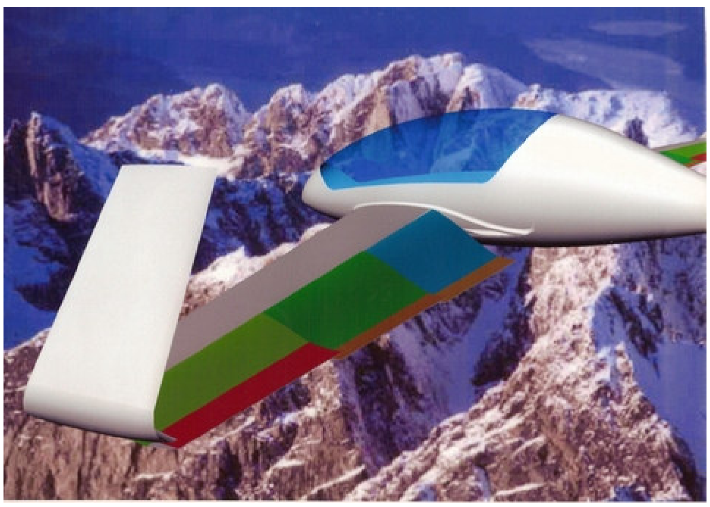
Span 8 m
L/D 30 at 40 m/s
Stall 20 m/s
W/S 27-35 kg/sq-m.

This dream has been me for over 40 years. My bones are getting to weary to complete this project by my self, but I want to forward my ideas. Please look at my photos, and mail me for further info. There are 4 pics of my dream (early version) in the photo section. I shall send more detailed geometrical data shortly, with explanation of my ideas how to interconnect flaps with Cm-alleviating trim tabs.

Bengt Jansson
<bengtjansson30@yahoo.com>

(ed. – See two of the concept images of Ben's design on the next page.)

This is the clean configuration.



This is the 16 degrees of flap configuration.

Hello Ben

More or less (much less than more, but nonetheless) we (you and me) hit on the same thing. Your photos did not make it through the list, I suggest you post them online somewhere so we can see them as for the stall speed, I suggest you lower your specs to 18 m/s so you make it ULM (microlight) and have no fuss with authorities. This means increasing your Clmax of roughly 20-25% the value you have now (it's a lot I know) maintaining same wing area. I guess you have a full up weight of 80(pilot) +5(parachute)+35(whole structure)=120 kg (you say "potent" so I guess it is full carbon thing and not a tube and sail thing); with your wing loading you should be around 4.5-3.5 m2 wing area; with your stated span (for which I like the challenge) this means an AR of about 14-18, very good; and a Clmax (for 18 m/s) of 1.45-1.9, can be done (there is space for increasing full up weight on the lower wing loading specs, or adding a small motor for autonomous take off, but CG can be tricky if it is in pusher config, anyhow I would not consider a tractor arrangement as a flying wing with a tractor prop is like wearing your underpants above your pants :-)

As for sweep, I'd try to trade some sweep for performance, as with a good deal of sweep (20?) you can start to hit with good flaps without worrying much on the trim (moreover, with that AR, Cm from flaps is relatively low given the small chord, mac is about 0.56-0.43). I would not worry much about flutter given the relative "shape stiffness" you can get with the above numbers

Concerning my post, there were some imperfection on the Clmax computation (in excess :-)!!! this never happens)...other excess will be present in the .doc :-) Hope this will stimulate some more numbers to come from others.

<mrk@karenfuxia.com>

Hello Specialists,

What have I to do to modify a thermal airfoil to get a positive pitching moment that then can be used for a flying plank?

Wingspan ~260cm (~100") or a bit less.
Root chord ~30cm (~11,8") (because of the Re number)
Tip chord ~20cm (~7.9")
Weight < 1600g (< 56oz) - I am not the best lightweight builder ;-)
Wing Loading < 25 g/sqdm

Goal: to get a plank (not swept) for very light conditions (thermal and slope). Good penetration is not in the foreground. Can profili2 professional support this?

Thanks for your help!

Kind regards,

Tom
<sky_surfer_fra@yahoo.com>

Tom,

One problem with any technical discussion, as this thread has already demonstrated, is that if you ask a dozen experts the same question, you will get a dozen answers. If they're really good experts, you will get two-dozen answers.

That said, since I've been making my living for quite a few years now designing and manufacturing R/C sailplanes in about the same size and airspeed range that you are addressing, I might be qualified to add my $.02 worth.

First of all, it's very possible to get excellent performance at very low Reynolds numbers, well below 60K to 100K. However, you cannot get there by scaling down technology (particularly airfoils) developed for higher Re's. Designing good airfoils for low RE's is almost as much an art as a science, and it can definitely be more challenging than developing an equally good airfoil for higher Re's. All of the software available has limitations, and your experience with interpreting the results counts for at least as much as the accuracy of the program itself.

At the Re's you will be dealing with, 10% to 12% thickness is WAAYYYY too thick. At these Re's, excessive thickness not only increases drag, it also reduces Clmax. At these Re's the flow tends to be laminar (in fact even if you turbulate it, the flow may revert to laminar), and this means that the ability of the flow on the aft portions of the airfoil to tolerate adverse pressure gradients is seriously limited. If you use up all your adverse pressure gradient "budget" on just negotiating your way around a too-thick airfoil, there won't be much left to make lift from. The result can be an airfoil that has either separation on top, separation on the bottom, or both, and possibly at all angles of attack in extreme cases.

You should be looking for something with about 6.5 to 8% thickness 9% at the very most, modest camber, high point well forward, maybe around 22-25%, and relatively flat (maybe even very faintly concave) on both the top and bottom surfaces on about the aft 30% or so. With a reflexed airfoil this will be especially tricky on the aft lower surface in particular. However, a too-steep contour anywhere on the aft top or bottom surface can cause separation. Starting the reflexed portion fairly far forward ad then keeping it more gradual will help.

The good news is that the features listed above will also help keep pitching moments low.

Control surfaces should be as wide-chord as possible. The ideal place for a hinge line will be about where you would normally put a turbulator. The further aft on the airfoil you get, the less ability it has to tolerate discontinuities (such as hinge lines) and sudden camber changes (such as deflected control surfaces). A well-forward hinge line gets the hinge line discontinuity out of the way at a location where the flow still has enough energy left to deal with it, and it also minimizes the angular deflection needed to accomplish a given % change in camber and effective incidence.

If your goal is maximizing low speed performance, then weight is your enemy. A thinner airfoil also helps minimize the weight of a foam core.

You were not terribly specific about launch methods. If your "thermal soaring" missions use an electric motor or even a Hi-start for launching, then the demands on the wing spar will be relatively modest. OTOH, if you plan on winch launching, the possible line tensions will set the requirements for your spar, and a significant part of your airframe weight.

That said, with the right materials and techniques, the weight can still be quite low. Our Spectre 120 had a ten foot span, a very high aspect ratio (not quite 20:1) and correspondingly narrow root chord, a thin airfoil section, and yet the wing could routinely handle line tensions in excess of 300 pounds. The plane's typical flying weight was only 45 ounces. Our two-meter composite sailplanes were as light as 25-27 ounces flying weight but designed (and static tested) for well in excess of 200 lbs line tension (note, realistically a 2-meter can't generate enough airspeed with the added drag of a towline to generate 300 lbs of line tension), again with thin airfoils.

Generally it takes unidirectional carbon fiber used in just the right amounts in just the right places to give those sorts of results, but obviously it can and has been done. It is possible to do with wood as well, but the job is quite a bit more challenging.

However, if you're willing to forego winch launching, or at least commit to using a very light foot on the winch pedal, it dramatically reduces the demands on your spar.

In any case, there's some good info on the Charles River website on some of Mark Drela's studies on very strong and lightweight spar designs.

As far as the rest of the wing structural design, it mostly comes down to getting adequate surface durability. If you don't plan to land in severe landing zones such as rocky areas or corn stubble, it doesn't take very much. 1/32" balsa is usually adequate, and don't bother with elaborate joining techniques between the balsa sheets.

Just tape them together along the seams on what will be the outer surface, squeegee the inside surface with laminating epoxy. The wood should be just damp with epoxy, not "wet", and certainly not "coated". It takes amazingly little epoxy to get a good bond if you have enough pressure when you then vacuum-bag the skins to the foam core of the wing. Use a layer of waxed paper over the outside of the skin, and a layer of paper towel over that to soak up any excess epoxy that squeezes out. Enough epoxy will wick up between the seams between the balsa sheets to bond the individual sheets to each other without worrying about joining them together as a separate operation.

You can do even better if you can find some Mylar sheet about .014" thick. Cut out layers that match the wing plan form minus about 1/8" to 1/4" at the leading edge, wax the Mylars, use a straight trailing edge and tape the Mylars together on their outside along the trailing edge with electrical tape. Open them out on a flat surface with the inside surfaces up, then lay up fiberglass (no balsa) wing skins. Other than possible local reinforcements, a single layer of 1 ounce/yard fiberglass on a +/- 45 degree orientation is more than sufficient for most 2-meter airplanes. Once again, if you get a good vacuum and plenty of squeeze, it takes very little epoxy to make a good bond. If you need carbon spars, lay them up on the inside of the glass skins before vacuum-bagging them to the cores.

There is no need to fill the pores of the foam core, there isn't enough resin present to soak in very far to begin with. By all means, apply the resin to the skins, not the cores. The cores will soak up resin like a sponge, requiring far more resin and weight than if the resin is only applied to the skins.

There are a lot of other details involved in successfully skinning foam cores. If you've never done this before, find someone in your local club or through your local hobby shop who can help you, or else plan on maybe having to make a couple attempts before you make one you're happy with.

As an alternative, don't discount good, old-fashioned built-up balsa structures. Properly done, these are weight-competitive with skinned foam-core wings, and easy to build and maintain. Our Chrysalis 2-meter sailplanes in the pure sailplane version use thin airfoils, have enough strength for judicious winch launching (although we recommend adding some thin carbon fiber to the inboard panel spar caps if you plan to winch launch frequently), and built-up wooden structures. Flying weights in the area of 24-27 ounces are typical.

The wing weight alone is around 11 ounces, even with concessions to make it more foolproof for beginning builders, and its area of a little over 5 square feet. The old-fashioned methods still work fine today, and with modern laser-cutting methods some new things are possible. There are a number of shops that can do custom laser cutting for you for a reasonable price, and even the old method of just cutting the parts out by hand is certainly still an option.

Don Stackhouse
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Hi Tom

Try posting your query on the xfoil yahoogroups, great R/C people there. To have positive pitching moment, just add reflex ;-(. Stability and CLmax is another issue though, but I think you know.
As per my knowledge, if your thermal airfoil is highly cambered you will have a really hard time for a (performance) flying plank :-)
Better try to lower your wing loading and use a less cambered foil, or peek into flying plank airfoils straight away. The Martin Hepperle website has quite a few just in case, some theory on flying wing (also sweptback) on his site.
http://www.mh-aerotools.de/airfoils/nf_1.htm
http://www.mh-aerotools.de/airfoils/flywing1.htm

<mrk@karenfuxia.com>

Hi Tom,

I have juggled a few positive Cm model airfoils. It seems hard to get good performance at Reynolds numbers below 80-100 000, at least at fairly high CL. A tip chord of at least 20 cm is OK at W/S> 20 g/dm2. If you try to go lighter, the drag and L/D drops off drastically, and you might end up with a higher sink rate!

I am a fan of aerodynamic winglets. If placed behind the neutral point, they provide lateral stability and increased aspect ratio, which decrease drag at high CL. The WL:s do not have a reflexed mean line and should be calculated for Rmin down to 30 000.

Can you handle .dat-files? I can send my airfoils, wing and WL, to you. Please respond to my home mail: hinna43@3mail.se.
Of course, I will also make them "public " to the group.

Ben
<bengtjansson30@yahoo.com>

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

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