No. 141 MARCH 1998

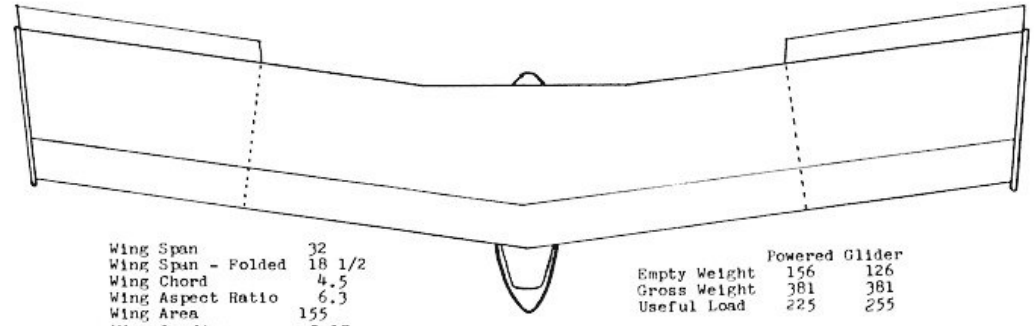
T.W.I.T.T. NEWSLETTER

FOOT LAUNCHED AIR CYCLE
- Specifications -

COPIES OF THIS PAGE MAY BE USED TO TRY COLOR SCHEMES.

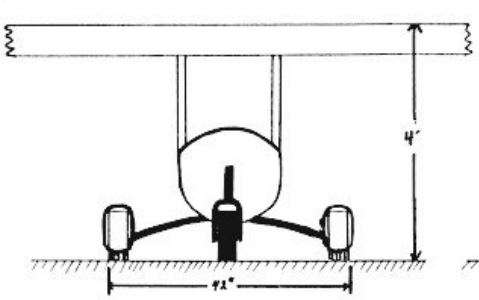
3-View and specifications for the Foot Launched Air Cycle designed by Ken Striplin. It was produced in various kit forms for awhile, but is no longer available. See the detailed account of this design beginning on page 4, inside.

Material contributed by:
Kevin Renshaw

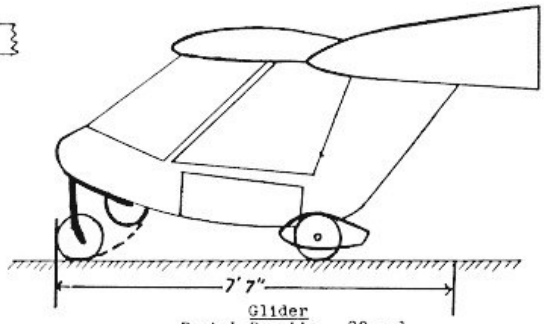


Wing Span	32
Wing Span - Folded	18 1/2
Wing Chord	4.5
Wing Aspect Ratio	6.3
Wing Area	155
Wing Loading	2.17

	Powered	Glider
Empty Weight	156	126
Gross Weight	381	381
Useful Load	225	255



Velocity Never Exceeds	80 MPH
Velocity Max Power	60 MPH
Velocity Cruise Power	55 MPH
Velocity Stall	16 MPH
Velocity Landing	18 MPH



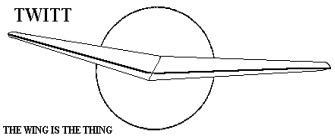
Glider

Best L-D ratio	20 - 1
Best L-D speed	36 MPH
Minimum sink	150 FPM
Minimum sink speed	32 MPH

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., **9803** means this is your last issue unless renewed.

Next TWITT meeting: Saturday, March 21, 1998, 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
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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, east side of Gillespie).

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PRESIDENT'S CORNER

Depending on where you live, the winter should just about be over. For those of us under the influence of El Nino I'm not sure we really had a true winter this year, although it sure has been a lot of weather. I will keep my fingers crossed that March 21 dawns bright, dry and warm so we can all enjoy a really good meeting with Paul MacCready. Make sure to mark your calendar and leave home a little earlier than normal to allow time for the inevitable traffic jam.

I have let the people on the Nurflugel mailing list know about our speaker, so I am hoping for a really good turnout. Don't forget to bring a friend if you think he/she would enjoy a program that includes something then can relate to in nature that corresponds to your interest in flying wings.

If you have a library of aviation & flying wing related material in your hobby room how about going through it and seeing if there is anything that might be of interest to the membership. We can thank Kevin Renshaw for sharing some of his house cleaning efforts this month and perhaps there are others out there that need to go through the same process to keep their significant other happy. We could sure use the information for future newsletters.

I hope you enjoy the picture of the Pathfinder from the NASA website. It you haven't explored this wonderful resource, make it a point to get to your local library and sign-on to the web and browse around for a while. There is something there for everyone. You can find it at: www.drfc.nasa.gov. I think you will find it was well worth port of your Saturday or Sunday relaxing time.

Again, remember to kick the tires and light the fire in your favorite motorized steed on March 21st and hi-tail it down to the hanger for a really super meeting.

Andy

MARCH 21, 1998 PROGRAM

We are extremely pleased to announce your speaker for March will be **Dr. Paul MacCready**, a world-renowned authority in atmospheric science and pioneer of efficient vehicles. He will be talking about Flying Wing Technology - We Learn About This From Nature and will include a slide presentation of naturally occurring flying wings along with a short video. We also belief he will be talking a little bit about the Pathfinder project that was developed by his company AeroVironment.

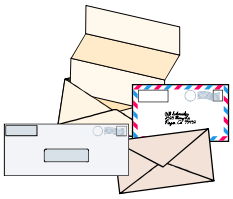
For those not familiar with Pathfinder, it is a solar airplane developed for NASA as a technology demonstration platform testing the viability of solar powered aircraft for high-altitude, long-endurance flight. Pathfinder has flown over 71,000 feet already, breaking several world records. AeroVironment is designing two similar but larger solar airplanes. Centurion will fly at over 100,000 feet and a quarter-scale model is already undergoing flight testing. Helios is intended to be a long-endurance platform that can operate world-wide as a low-cost satellite substitute for many applications.

AeroVironment was created in 1971 to help meet environmental and energy needs for now and the future and its customers include federal, state, regional and foreign governments and agencies, Fortune 500 companies, and small manufacturers.

AeroVironment provides highly efficient systems in the areas of electric vehicles, distributed energy supply, unmanned air vehicles and environmental measurement. It supplies automated test equipment and energy management systems for electric vehicles, is developing low-cost battery electric powertrains, hybrid electric powertrains and demonstration hybrid electric and battery electric cars, motorcycles and bicycles.

Without a doubt, this is a MUST event for your March calendar. I know most of our Southern California members have not heard this presentation or had an opportunity to ask questions about Pathfinder and the follow-on flying wing based programs by AeroVironment. So, now is your chance to do both all at one time in one place.

Dryden Flight Research Center EC95 43261-2 9/11/95 10:15 a.m
Pathfinder in flight above Edwards, CA: On way to setting new solar-powered altitude record. Photo by T. Landis



LETTERS TO THE EDITOR

2/12/98

TWITT:

I was cleaning out a file cabinet and found the enclosed material on the Striplin "Foot Launched Air Cycle" (FLAC) from the late 1970's. Ken Striplin designed it as a powered ultralight and was selling kits with preformed fiberglass leading edges and fiberglass pod. Unfortunately his son Paul was killed in a crash and the company went away shortly after.

Based on that book *(referring to Myhra's book - see book review later in this issue)* and other references, I don't think the aircraft shown in issue #140 is a Horten. The planform is distinctly un-Horten and the presence of the fuselage would have interferred with Reimar Horten's theory of flow distribution across the

center of the wing. It may be a copy or modification of one of Lippisch's designs.

Keven Renshaw
Fort Worth, TX

(ed. - Thanks for the material on FLAC. I had plenty of room this month so have included it in its entirety for the membership to review. I seem to recall we had a member working on a similar looking desgign a few years back, but it wasn't meant to be foot launched.

I took your book review material and included it in the "Book Review" section covering Myhra's book. A little difference in opinions on the book, but overall I have been seeing more positive comments than negative about it.

Thanks for the comments on the unknown design in last month's issue. Hopefully, we will get some other input, especially from some of our Horten experts in Germany.

Keep cleaning out those file cabinets and see what else you can come up with!!!)

BOOK REVIEW

The Horten Brothers and Their All-Wing Aircraft
By David Myhra
As reviewed by: Raul Blacksten

If you love to just sit and look at pictures, then you are gonna love this book. If you want to know about the Horten brothers, you will learn something from this book. If you love to read a well written and engrossing book, well maybe you should look somewhere else.

One important thing that Myhra did not have when he wrote this book was a good editor. Poor grammer jumps off the page and, poor paragraph construction often made me wonder what Myhra was trying to say. There are a lot of rambling paragraphs and the book itself seem to ramble.

Myhra does seem to have done his research, no matter what I think of his style and, there is a lot of information here although not all of it is relevant.

One thing which does shine in this book is that there are a lot of marvelous pictures. Probably, if you put them all together, something like 200 pages of this 320 page book would be pictures. Some pictures are used more than once in the book and there does appear to be some mis-identifications on the aircraft.

Thirty-three of the last 42 pages are the Appendices. Here Myhra has provided us with the "Complete Horten Aircraft Line." This is a chronological listing of 61 designs. There is also a list of 44 work numbers for gliders built during 1933-44. If you like 3-views, there are 59 of them.

On the whole, if you are looking for a great, or even good book, this may not be it. Nevertheless, if you are interested in a book with a lot of Horten information and a lot of pictures, then this one just might fit your bill.

Finally, I would like to say that the preceeding review is the personal opinion of this reviewer alone and does not necessarily reflect the opinion of TWITT.

The following was included in a recent letter from Kevin Renshaw.

"I picked up a copy of David Myhra's book on the Horten Brothers and I highly recommend it to all TWITTs. It is extremely well researched and excrutiatingly thorough. It not only has many, many photos of every Horten design, but is also a detailed narrative that describes what the Hortens went through to design, build and fly their aircraft. It gives an interesting account of what is was like to be involved in aviation during the time when the Third Reich was coming to power in Germany. An excellent book, even though it is expensive."

(ed. - There have been other comments within the tailless community concerning this book that compliment it for the amount of Horten material, some of which they had not seen in the past, especially the large number of pictures. They also comment that even with some shortcomings, this is at least a English text book of the Horten brothers with information not seen in the Nickel/Wohlfarht book. If you are a true afficianado, then you will probably buy this book no matter what anyone has to say about it, but it seems the general concensus is that it is worth the price, especially if you take advantage of the reduced price through Doug Bullard.)

The book is available through:

Schiffer Military/Aviation History, Atglen, PA
ISBN: 0-7643-0441-0.
Price: $60, plus shipping and handling.

Or it can also be ordered from:

Douglas Bullard
14525 SW Forest Drive
Beaverton, OR 97007
Price: $51 including shipping and handling

FOOT LAUNCHED AIR CYCLE (FLAC)

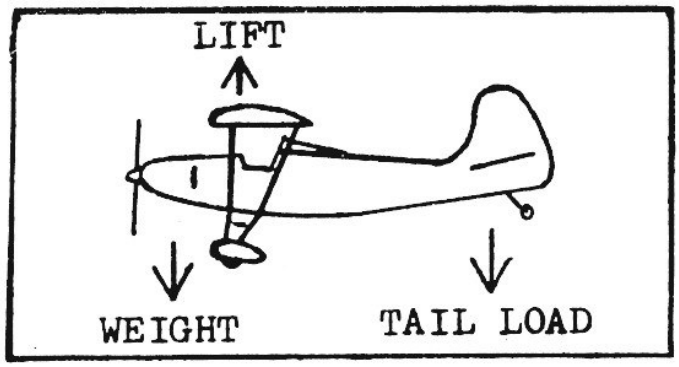
By Ken Striplin

(Material provided by Keven Renshaw)

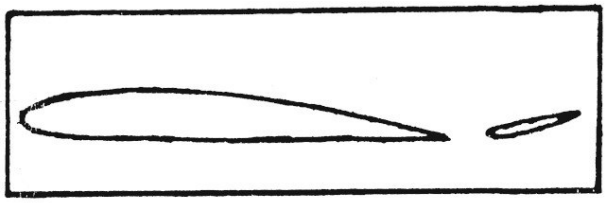
(Note: This appears to be promotional piece for the FLAC which is no longer available in the kit form described here. This material is presented in its original form so you can get an idea of what a kit manufacturer went through to get an aircraft to the public.)

FLYING WING STABILITY

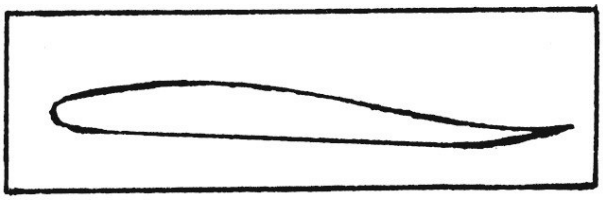
Although many types and designs of flying wings have been flying for years, there are still people who do not believe or cannot understand how and why a wing flies. The flying wing flies for exactly the same reasons that the tailed aircraft flies. To see this, just look at an ordinary aircraft. The center of gravity is normally forward of the center of lift. This produces a downward pitching moment that must be balanced by a down force (upward pitching moment) at the end of the tail. Now let's try moving the center of gravity closer to the center of lift. If we move the CG half way to the center of lift, it follows that we can move the tail half way (assuming the same size tail) and still balance. If we move things just a little closer together, we can combine the wing and tail into what is called a reflexed airfoil. The reflexed airfoil is stable and has less drag than the original wing and tail combined. It has less drag because the tail is "hiding" behind the wing. It's also simpler to build (and lighter) than the original wing and tail. What have we lost? Most importantly, we have lost that long boom that used to hold up the tail. We have lost its weight, its drag, and eliminated the time required to build it. Have we lost anything else? Yes. The CG range for a tailed aircraft is about 10% of its length. That's quite a bit. The CG range for a fling wing is about 10% of its length. That's not much. We can recover part of that lost CG range by giving the wings a slightly swept back planform.



CONVENTIONAL AIRCRAFT



WING WITH ELEVATOR



REFLEXED AIRFOIL

STATIC STABILITY

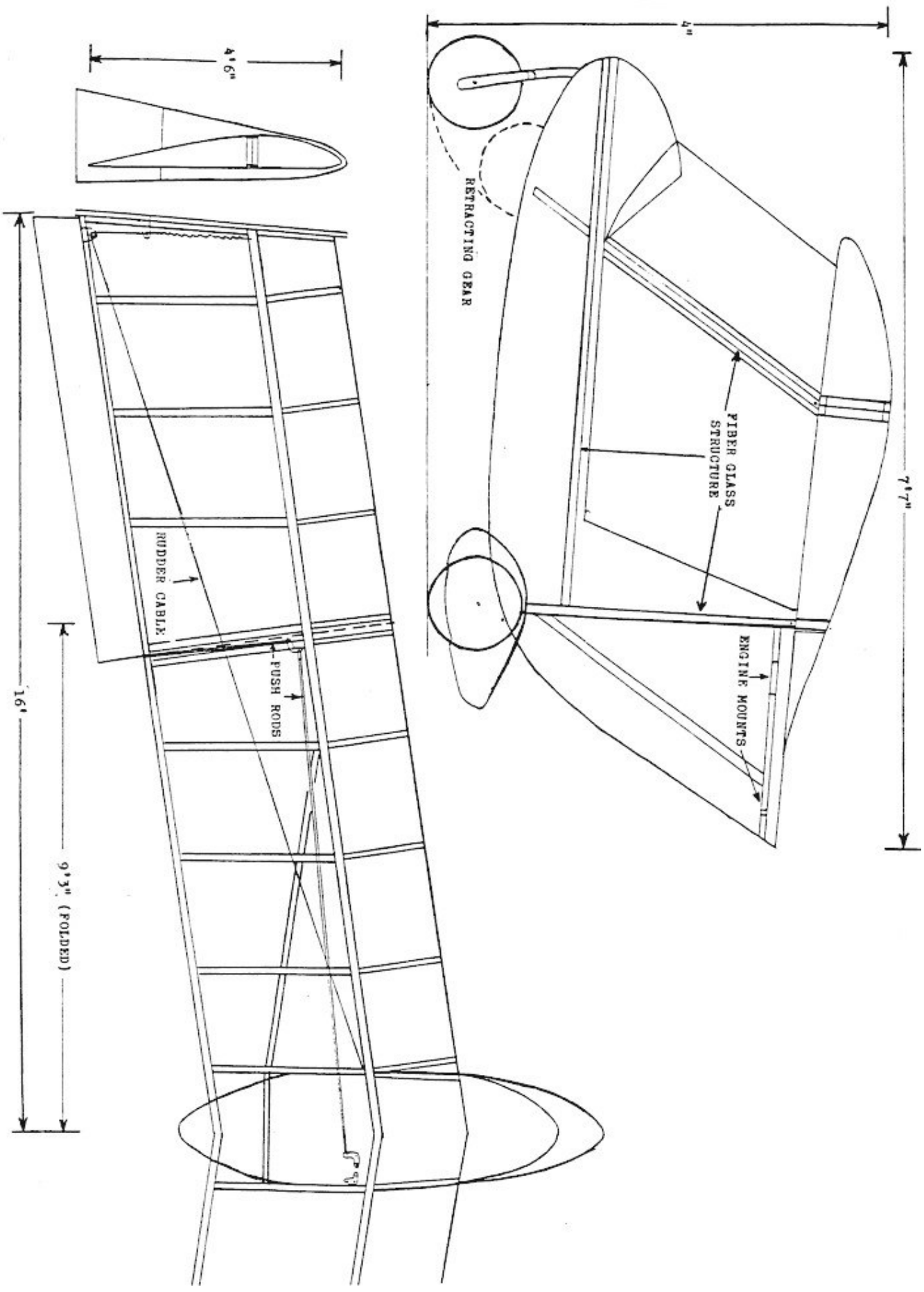
A conventional aircraft has static stability because of the down load on the tail which is balanced by the forward CG. If the aircraft pitches down (due to gust, for instance), the airspeed will increase. The down load will increase, causing the nose to pitch up. If the increase in airspeed caused a pitch down, the aircraft would be statically unstable (not to mention dangerous).

The FLAC is statically stable for the same reason as a conventional aircraft. The reflex produces a pitch up moment that is a function of airspeed. The higher the airspeed, the more the wing tends to pitch up.

DYNAMIC STABILITY

An aircraft that has static stability but poor dynamic stability will tend to oscillate in pitch. It will dive, pick up speed, climb, lose speed, then dive again. This oscillation has a long period and is called a phugoid oscillation. Dynamic stability is much too complex a subject to go into here, but because of a combination of factors, flying wings tend to be much more dynamically stable than tailed aircraft. Since this seems to surprise a lot of people, we will point out one of the reasons.

A conventional aircraft has a large moment of inertia in pitch. In returning to level flight after some


4'6"
RETRACTING GEAR
FIBER GLASS STRUCTURE
ENGINE MOUNTS
RUDDER CABLE
PUSH RODS
16'
9'3" (FOLDED)

disturbance, it tends to swing past level. A flying wing like the FLAC has all its mass close to the CG. I has a low pitch moment of inertia, so it tends to return to level flight and stay there.

Most conventional aircraft will start a phugoid oscillation if you just take your hands off the stick. This has never been observed in the FLAC. This natural stability makes the FLAC a real joy to fly.

STALL STABILITY

Can you stall a FLAC? Yes! You can stall almost any aircraft if you try hard enough. (We won't talk about balloons, and parachutes don't count.) An aircraft can be stalled if you dive to pick up speed, then put it into a steep climb until it stops. The nose just has to drop. The FLAC can also be stalled at forward CG (pilot sitting forward in the seat). I has a very gentle straight ahead stall with quick recovery and no tendency to drop a wing. At aft CG (pilot sitting up straight), the FLAC will not stall. If you put the stick all the way back and hold it, the FLAC will simply mush under full control.

TUMBLING

The FLAC will not tumble. The only way to make a flying wing tumble is to force the CG aft of the center of pressure. There is no practicaly way to do this on the FLAC.

SPINS

The FLAC will not spin. Spins are usually the result of stalling a wing tip. The FLAC has elevons which provide an effective wash out in the up range. This prevents the tips from stalling first.

ELEVONS

The elevons provide both pitch and roll control via a side mounted stick. Control is precise without being over sensitive. When used for roll control the elevons have a differential action which eliminates adverse yaw. Used for pitch, they change the shape of the airfoil. This changes the stable angle of attack of the wing. The wing moves to that angle of attack and stays there.

TIP PLATES AND RUDDERS

The tip plates and rudders provide a variety of functions. (On the FLAC everything serves at least two purposes. If it doesn't do at least two jobs, we get rid of it.) The tip plates and rudders act as a flow fence to reduce the tip vortex and increase the effective span. They have a five degree toe-in that increases the drag on the leading wing tip if the FLAC is not flying straight. This eliminates the tendency to "Dutch roll" that is common in conventional aircraft.

The rudders are controlled by rudder pedals and can, of course, be used for yaw control. In fact, FLAC is so stable that you can use the rudders by themselves to make relatively flat turns. This is nice for staying in the core of a thermal.

As if all the above weren't enough, the rudders can both be extended as drag brakes for glide patch control. This is important on a low drag machine like the FLAC because it allows you to land where you want to rather than a mile or two further on.

LIFT DISTRIBUTION

The lift distribution on a conventional wing is high in the center, but goes to zero at the wing tip. Tip plates on the FLAC reduce the spanwise flow and provide a more even lift distribution. This is equivalent to having a higher aspect ratio and reduces the induced drag. During high G pull-up the outer panels are unloaded by the elevons so the stress on the wing is reduced.

CONVENTIONAL WING

ELEVATORS UP

WITH END PLATES

POD STRUCTURE

Tough is the only word that adequately describes the structure of the FLAC. The FLAC was test flown from rough dirt fields by a 19 year old student pilot. Between the field and the pilot it was a good test.

We found a few (actually very few) items that needed improving and improved them. Minor changes were made to the landing gear attach points and the wing attach points. Both of these get a lot of compression loading during a hard landing. (The aircraft was designed so it would fly safely; now it was being modified so it could be crashed without damage!) Interestingly, despite the rough field and hard landings, the pilot never received any injuries. The pod offers a great deal of protection to the pilot. It consists of a tough molded fiberglass shell with the equivalent of an aluminum tube frame built right in. The frame is constructed of high strength, uni-directional fiberglass impregnated with the same aircraft grade epoxy used for the pod. The uni-directional fiberglass is layed up on foam framing that is glued inside the premolded pod skin. This premolded skin is the main reason that plans are not sold separately. The "outside in" construction technique drastically reduces the time and labor required to build an aircraft. Sanding, filling and painting even a small aircraft requires a surprising amount of time. The molded skin also gives the designer better control over the final thickness of the part. He does not have to add extra layers of glass cloth so the builder can sand it off! Not only does this improve the uniformity, it reduces the total weight

WING STRUCTURE

The main spar is an "I" beam structure consisting of aircraft spruce cap strips with a fiberglass web. The leading edge is a very smooth preformed fiberglass skin. This smooth "D" cell keeps the airflow laminar back to the spar (which is about all you can expect) and provides for the torque loads on the wing. The leading edge is very light and will not warp like plywood. The ribs are foam with a fiberglass web and cap strip. From the spar back, the wing is covered with light weight, zero porosity, rip-stop dacron fabric that does not need dope. The trailing edge is a wood strip.

The wing can be folded for highway travel and with the wing folded, the FLAC can be stored in the garage above your car.

WING MOUNTING

The wing is attached to the pod with four bolts. Fiberglass does not take well to having bolts holes drilled in it, so we designed the FLAC with the bolt holes built in. When the pod is built, we reinforce the pod sides and uprights with high strength uni-directional glass tape. The tape makes a "U" at the top of the pod. Buried in this "U" is a light weight metal tube or fitting that the wing attach bolts go through. This keeps the glass in tension for maximum strength, and the metal tube avoids any abrasion of the glass fibers. The result is a very strong, reliable fitting. The attachment points on the wing are held in place by uni-directional tape that wraps around the fitting and the spar.

LANDING GEAR

The main landing gear bow is a high strength uni-directional fiberglass laminate that comes pre-formed with the kit. It weighs only two pounds and provides a measure of safety not found in most hang gliders. It has enough flexibility to give a smooth even ride and provide for hard landings. The steerable nose gear is also pre-formed. It weighs one and half pounds. In the extended position it holds the FLAC in its take-off attitude. For take-off you do not rotate; just wait until the FLAC is ready to fly. The nose gear retracts for reduced drag in flight and for proper balance on the ground without the pilot. Its primary purpose, however, is to provide a safe way to land in gusty wing conditions. Landing with the nose gear up provides an immediate negative angle of attack. Yes, the nose gear will roll in the up position. This reduces the landing roll and prevents ballooning.

BUILDING YOUR FLAC

Our motto at S.A.C. is "We make it fun and simple." In order to give you a great, functional and inexpensive flying machine, we have made use of the latest building techniques so we can produce the FLAC with very low man hour requirements, which lowers component cost. This low cost is passed on to you whether you buy the economy kit or the fast flight kit. We realize that a majority of FLACs will be built by first time builders, therefore, special care was used in writing the construction manual. Every effort is made to give you the know-how to build a safe, beautiful machine you will be proud to fly.

To achieve simplicity of construction, the FLAC is designed so that no welding or machining is required. All parts can be made and assembled with ordinary hand and small power tools. With our selection of kits you can pick the kit which best matches your skill level.

Elaborate jigs and fixtures are not required. However, a sturdy and properly sized work table is needed. To make a level, well balanced table, two sheets of 4' by 8' by ¾ particle board are used. This information is in the construction manual.

LEGAL REQUIREMENTS

The S.A.C. - FLAC is a basic foot-launched hang glider or a powered hang glider, by definition.

At the present time FAA does not require a pilot's license or an aircraft license to operate and fly, but FAA does require adherance to FAR 91-B operating rules. *(ed. - This material is old, so if you were to build something like this make sure to check with the FAA about pilot and aircraft licensing requirements.)* S.A.C. strongly recommends that you as an operator obtain a solo student certificate and pass the written FAA test as a minimum for your own safety. We earnestly plead that regardless of your experience that you always operate and fly in a sane manner and observe the written rules of flight in addition to the common sense rules. Your freedom to fly depends on everyone's coorperation.

LIMITS

The FLAC is designed to meet utility category limits listed in the FARs. It is not rated for acrobatic maneuvers as it is intended to be a fun glider. Because of the light wing loading, it should never be flown in heavy wind conditions.

FLYING WINGS DELIVER THE GOODS

The Winter 1997 issue of *The Mobile* WARRIOR published by the US Army Soldier System Command contained a couple of interesting uses for flying wings. The pictures on this page represent the use of a paraglider and a modern rigid wing hangglider wing for the delivery of combat supplies to forward operating areas.

This is a four year research initiative to explore technologies that are expected to contribute substantially more accurate cargo high altitude air delivery capabilities for DOD. Investments in these research areas was determined by the team to have the most potential for improving high altitude airdrop with ballistic or semi-ballistic airdrop systems.

The research teams consists of members from government, private companies and universities for across the country. The demonstration will most likely consist of a 2200 pound Container Delivery System (CDS) that is dropped from approximately 25,000 feet and impact a selected target within 50 meters. These efforts will be exploring both the inexpensive ballistic CDS capabilities available (short of no parachute) and very low cost semi-ballistic systems.

One key to meeting the goals is “smart” aerial delivery of supplies, equipment and munitions. Remote sensors and munitions can be placed by autonomous, high glide aerial delivery systems to provide information and a response capability to the movements of opposing forces without risk to personnel.

High glide wing technology will significantly enhance the delivery capability through substantially higher glide ratios than are possible with ram air parachutes. Such a system must be deployable from all conventional delivery platforms (C-130, C-17, etc.), operate at night or under adverse weather conditions, allow for a “drop and forget” capability, and be able to deliver to multiple drop sites from a single release point.

In addition to a natural high glide (6:1 or better) performance, the system must have an optional glide augmentation system which provides offset ranges of up to 300 km. These features will greatly reduce aircraft vulnerability to hostile fire and reduce the threat of detection of the delivered payload and drop zone, allowing a just-in-time re-supply for rapidly moving troops.

Flight tests have successfully demonstrated gravity extraction from a C-130, automatic wing deployment, transition to glide, autonomous gliding flight of up to 15 miles to a GPS waypoint and automatic landing within 50 meters of the target. Besides the flying wing models, there is also a conventional configuration version being considered for longer flights and power augmentation.