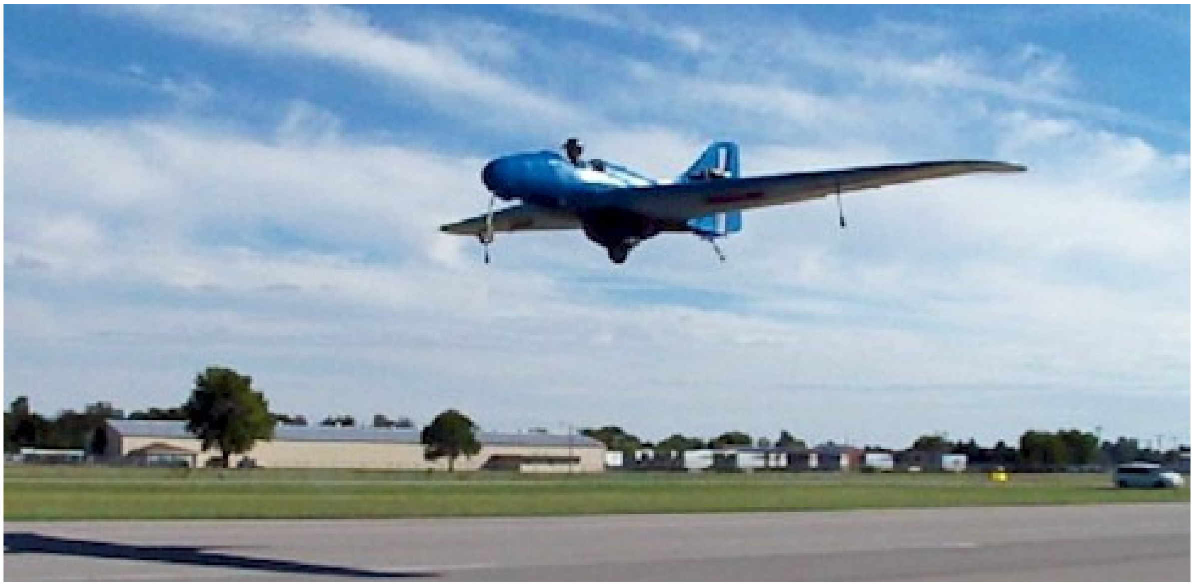
No. 369 APRIL 2017

T.W.I.T.T. NEWSLETTER



Robert Hoppe's H1 flying wing during an early test flight in September 2016. See more about this homebuilt starting on page 3,

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., **1704** means this is your last issue unless renewed.

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

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

T.W.I.T.T. Officers:

President: Andy Kecskes **(619) 980-9831**
Treasurer:
Editor: Andy Kecskes
Archivist: Gavin Slater

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

(619) 447-0460 (Evenings – Pacific Time)
E-Mail: twitt@pobox.com
Internet: http://www.twitt.org
Members only section: ID – **20issues10**
Password – **twittmbr**

Subscription Rates: $20 per year (US)
$30 per year (Foreign)
$23 per year US electronic
$33 per year foreign electronic

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

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

Foreign mailings: $0.75 each plus postage

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

Meetings are held on the third Saturday of every other month (beginning with January), at 1:30 PM, at Hanger A-4, Gillespie Field, El Cajon, California (first row of hangers on the south end of Joe Crosson Drive (#1720), east side of Gillespie or Skid Row for those flying in).

TABLE OF CONTENTS

PRESIDENT'S CORNER

My thanks to Robert Hoppe for contributing an article on his H1 homebuilt flying wing starting on page 3. It is really a two part story with the first part coming this month along with a little bit of the second part that will be published next month. This month goes through his long-term dedication to this project and all the problems he had to resolve to reach the current configuration. He also has provided some comments on lessons learned and some of the solutions which will be continued in May. I think you will find it all informational if you are thinking about doing your own design.

We also had a Nurflugel note come in with a link to a site featuring what could become the first flying wing to soar the atmosphere of Mars. Al Bowers brought a prototype to the ESA Western workshop in 2015 and explained how it would work and how it was designed to fit within the constraints of the delivery vehicle. Weight and space were both problems that needed to be overcome in order to win the competition for space on the mission so miniaturization was the name of the game. It always amazes me how far we have come with modern electronics to fit so many functions into such a small space and have it all work as advertised.

I hope everyone is having a great year so far. I finally got to do a little proficiency flying to get ready to fly my ship in the coming weeks.

Andy

LETTERS TO THE EDITOR

(ed - This is a continuation of last month's Nurflugel thread on Prandtl's formula.)

Most of us are aware of the Range Equation. Pretty simple really:

Range = efficiency(propulsion) * efficiency (aerodynamics) * ln (TOGW / LWT)

Many are aware its called the Breguet Range Equation. Textbooks and papers that talk about the range equation usually say something to the effect of "is generally credited to" or "is referred to."

I have NEVER seen the reference for the original derivation of the Breguet Range Equation.

Until today.

Our librarians were able to sleuth out the original paper. Indeed it is solely authored by Louis Breguet, and his name is at the end. And the equation is in the paper.

BRÉGUET, LOUIS. L'aviation d'hier et de demain. L'Aérophile, 29» année, Nos. 17-18 (1«>--15sept. 1921), Paris, pp. 265-272.
Reviewed in: Aéronautique, 3« année, No. 31 (déc. 1921), Paris, p. 524.

Why is the range equation such a big deal to me? Its very simple really. The Range Equation shows the relationship between aerodynamic efficiency for a given mass. That is, for that specified mass, what is the maximum aerodynamic efficiency that is possible? The answer to that question is Prandtl 1933…

My French is pretty bad. But I think the title is "Aviation Endurance and the Range."

Al
--
Albion H Bowers albion.h.bowers@nasa.gov
Chief Scientist
NASA Neil A. Armstrong Flight Research Center
w: 661.276.3716 c: 661.209.0304
"soar with eagles…"

No, Al. The title is "Yesterday's and tomorrow's aviation". The Range Equation shows the relationship between aerodynamic efficiency AND a given mass.

Cheers from Bruno De Michellis

Al,

You may have overlooked the careful derivation of the Bréguet equation found in von Mises "Theory of Flight". In my well-thumbed copy (Dover Edition) it is on page 463, and there is a further note on the equation with the L'Aerophile reference of 1921 on page 619.

Sergio Montes

Here is a link for anyone interested in Breguet´s article
http://gallica.bnf.fr/ark:/12148/bpt6k6554814t/f271.item.r=Breguet

Alejandro Irausquin

(ed. – Also selected text from a link provided through Nurflugel. Al Bowers talked about this at a Western Workshop in 2015, if I recall correctly))

This is a joint effort by NASA flight test staff and young interns. The effort involved no government funding to initiate, and is a proof of 70 year old concepts relating to efficient flight and stability. The Mars vehicle will be housed in something like a 6" x 6" cube, occupying otherwise unused spacecraft space. The flying wing is designed to be rolled up from the tips, and jettisoned on descent at around 100,000 ft. above Mars. It will gather data on the long glide until landing ... and maybe after.

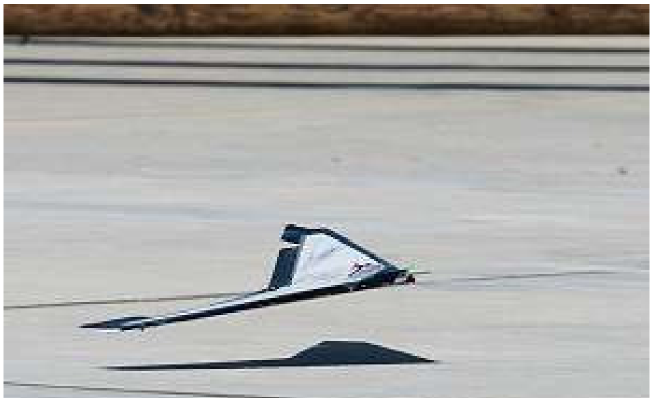
http://www.marsdaily.com/reports/Potential_Mars_Airplane_Resumes_Flight_999.html

Bob Storck

"Potential Mars Airplane Resumes Flight

by Staff Writers
Edwards AFB CA (SPX) Mar 31, 2017

Flight tests have resumed on subscale aircraft that could one day observe the Martian atmosphere and a variant that will improve collection of Earth's weather data.



The Prandtl-M completes a successful research flight. Image courtesy NASA and Lauren Hughes.

Work on the shape of the aircraft and the systems it will need to fly autonomously and collect data are ongoing for the Preliminary Research Aerodynamic Design to Land on Mars, or Prandtl-M aircraft. Student interns with support from staff members at NASA Armstrong Flight Research Center in California are advancing the project.

The March flights included two slightly different Prandtl-M aerodynamic models that were air launched from a remotely piloted Carbon Cub. The research validated the airframe that will be the basis for a potential Mars aircraft and the Weather Hazard Alert and Awareness Technology Radiation Radiosonde (WHAATRR) Glider on Earth.

In addition to confirming the aircraft's shape, the first flight data was collected on the Prandtl-M flight. Al Bowers, NASA Armstrong chief scientist and Prandtl-M project manager, said systems that will fly on the aircraft during the balloon air launch, such as the guidance controller, have already been tested in an altitude chamber at Armstrong up to 126,000 feet altitude."

(ed. – This is Part 1 of Bob Hoppe's article on his original design flying wing. He also sent along a number of pictures that I will incorporate into the story throughout both parts.)

THE HOPPE H1

October 2016 Status

This is one of those airplane projects that you hear about from time to time that has become a lifetime project. I certainly never thought when I built the first model of this plane in 1968 that it would be 2016 before I flew it enough to really call it a success. 48 years is a long time to be working on one airplane, but I guess persistence is really what counts in this game. I have never written anything about my plane, which I call simply Hoppe H1, because I felt that I had nothing worthwhile to say until I had flown it and proven it to be a success, now that I have I would like to write a description of my experience which might be of help to someone else who is interested in designing and building their own flying wing.

Ironically, considering how long it has taken and where I have ended up, when I sat down to start designing this plane, I actually had a very clear idea of what I wanted to achieve. I wanted the smallest glider I could make that would be efficient enough to soar. I wanted to fly from the prone position. It had to be a flying wing.

The good news is that I achieved all of these goals when I finished it for the first time. The bad news is that for a variety of reasons, I couldn't leave well enough alone and my various changes occupied the next 42 years. Between 1968 and 1971, I built 4 balsa and tissue flying models to prove my design was stable then in 1971, started building the full size plane finishing it in 1974, as a prone position flying wing glider *(below)*.

The center section structure was 4130 welded steel tubing covered with plywood, fiberglass, and fabric, with a bubble canopy I blow molded myself from a flat sheet of Plexiglas. The wings were all wood with a solid Douglas fir spar, ribs cut out of ¼ inch AA marine plywood, the wing covered back to the spar with 3/32 inch mahogany plywood to make a D cell and the rear fabric covered.

In the spring of 1974 I assembled it at the airport in Boulder Colorado, did a weight and balance, and found the CG to be at 25% and commenced flight-testing.

Like most builders, I had spent most of my time and money building, not flying, only had about 20 hours of flying time, had just got my glider license, was not qualified to test fly this thing, and so persuaded my flight instructor to test fly it for me. I towed him up and down the runway a number of times over a two-week period, early in the morning until he was satisfied it was OK then he took a high tow to 15,000 ft., (10,000 agl) and was in the air for about an hour. When he landed he shook my hand and said I had a fine glider here and since I could fly a Schweizer 1-26 I wouldn't have any trouble with this glider.

I was very happy to hear this and thought my troubles were behind me until I lay down in the cockpit and tried to fly it. I simply couldn't do anything with it, on my first tow down the runway, I immediately ran off the runway into the dirt and knocked a hole in the wing. The elevators had no feel to them at all (it was like moving a hydraulic lever), the ailerons created large adverse yaw, the rudder was nonexistent below 40 mph, and this was in addition to the 'thrill' of being towed down an asphalt runway at 40 mph while laying on my stomach with my head about 2 feet off the ground. I wanted to fly like a bird, but this was ridiculous.

I persevered through most of the summer and finally felt I was ready to take an aero tow. At 1000 ft. he started a turn and I began a PIO so I released, flew back and made an uneventful landing. I couldn't know it at the time but it would be 42 years before I flew it that high again.

I was actually within an inch of having a completely successful glider. In hindsight I can say that at this point I should have put it away in a hanger and gone out and got 200 or 300 hours of flying time, then came back and flew it. The only thing I really needed to do was to move the CG forward about 2 or 3 inches and it would have been fine.

Instead of fixing myself (more flying time), however, I decided to fix the glider by changing its configuration. This was a big mistake because it meant abandoning my original concept and wandering off into the wilderness. My problem now, and for the next 40 some years, was what to do with this thing. Once I abandoned my original concept, I simply didn't know what to do with it. This was always a part time project and I moved around quite a bit so it would sit somewhere in a garage or hanger for several years while I was off in another state working. Then I would go get it, set up a shop, work on it some more, then leave it behind while I went off somewhere else for awhile.

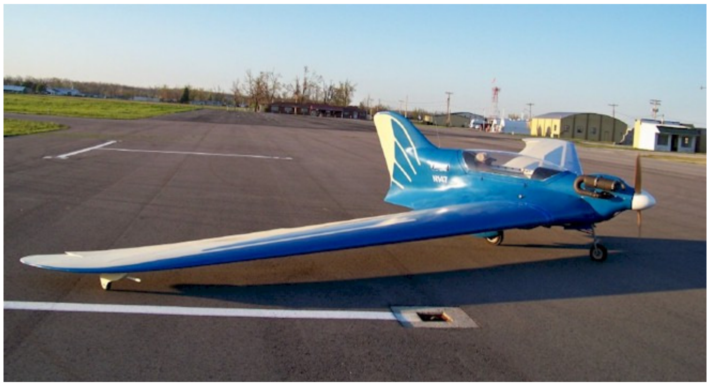
I was very uncomfortable with the prone position, ripped the top off the fuselage, turned the cockpit around so I could sit upright in it, and so began a series of interminable changes most of which were a waste of time.

--------- Fast forward to 1989. I decided to buy and install a small engine and make a powered glider out of it and so bought a Rotax 377 2 cycle 2 cyl. 35 hp. engine. My reasoning was that this would enable me to run the plane up and down the runway as many times as I needed to get familiar with it and not have to commit myself to flight until good and ready, and in the end, it worked out exactly this way but it would take another 27 years to get there.

The problem here was that I was sitting in the middle of the wing on the CG and so my weight did not help balance the engine. If I put it in the nose it was nose heavy, and if I put it in the rear it would be tail heavy. I really wanted to put it in the tail but the figures just did not add up, to balance it I would have to put a 2nd engine in the nose which would add too much weight. Never the less, twice over a period of years, flying in the face of common sense, I welded up motor mounts and had a two part shaft drive made up and mounted the engine in the rear only to tear it all out and start over.

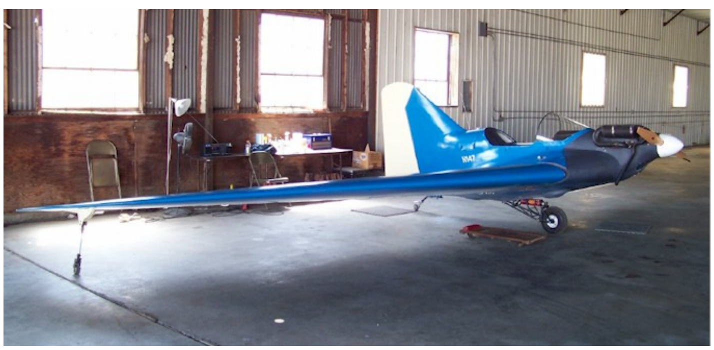
I finally made up motor mounts and mounted it in the nose and made a nice cowl around it and a steerable retractable nose wheel and a very slick sailplane canopy and a nice fin on the rear (but no rudder) knowing it would probably be too nose heavy to fly but at least it might not kill me which it would if it was tail heavy.

I assembled it at Dexter airport (30 mi. west from home) in April of 2009. This would be the first time I tried to fly it since my last attempt at aero tow in April 1977 and the first time under power. Things did not go well, the CG was at 13.5% and a series of large bounces ended with the landing gear busted off and the prop shattered. After repairs, I took it to Cape Girardeau airport (30 mi. north of home) in August and did some more taxi tests then quit for the year.



April 2009 configuration.

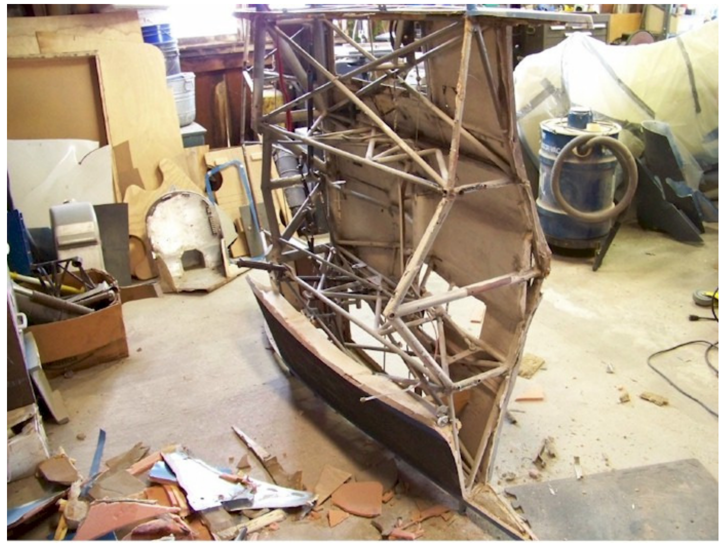
For the 2010 season, I simply took it out to our local airport, which has a 5000 ft. runway to try it again. After a series of taxi tests and some fiddling, I tried another attempt to get it airborne in October. CG was still too far forward and it wouldn't climb out of ground effect and another series of large bounces resulted in the landing gear busted off again and another $300.00 prop shattered, tubing bent and fiberglass destroyed.



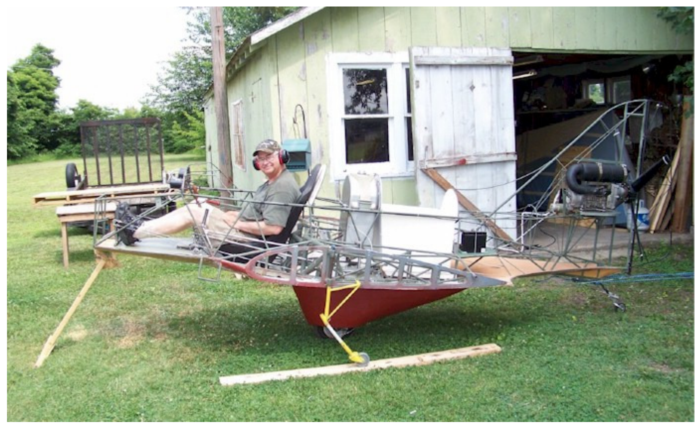
September 2010 Configuration.

I understood now that something drastic would have to be done to reconfigure it again, or I would just have to cut it up and throw it away and forget it which is what everyone was telling me to do anyway.

Being somewhat stubborn, however, I elected to spend the next 5 years reconfiguring it. I moved the cockpit forward of the main spar carry through, rebuilt all of the controls and put the engine in the extreme rear and mounted a rudder behind the propeller in the prop blast. The engine weighed about half as much as I did and was about twice as far to the rear so on paper it looked like a good fit. I knew absolutely that I wanted the CG to be at 20% this time around and I

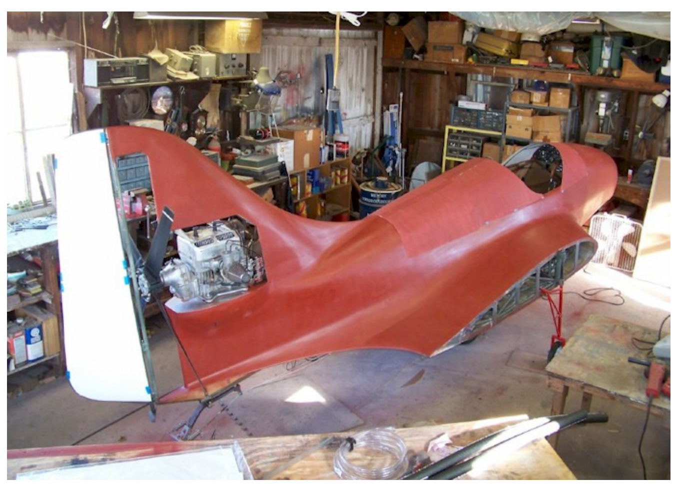


April 2012 rebuild progress.



July 2014 progress.

had a 3.0 inch range to hit and, glory be, when I did the weight and balance at the airport in may of 2015 I had hit it dead on.



November 2014.

I then did a series of taxi tests and found the landing gear to be a complete failure. The main wheel was too far forward of the CG (it was a tail dragger at this time) and I couldn't raise the tail even an 50 mph, so back into the shop for 2 months to rebuild the landing gear and move the wheel 12 inches to the rear (2 inches behind the CG) and put a steerable fixed nose gear on it, then back to the airport for more taxi tests.

Now I could raise the nose wheel at 35 mph but the outrigger wheels were too far out on the wing and kept falling off the taxiway. After 4 days of taxi tests and while taxiing back for another run the main tire blew out and while turning off the taxiway the right outrigger wheel was ripped off in the rough. I felt this was enough for the season and quit for the year. The repairs were simple and I moved the outrigger wheels to a position half way out on the wing and replaced the tire and tube on main and nose gear and was good to go again.

2016 was the year of the airplane. In June I took the plane back to the airport and began another series of taxi tests. This time everything was right. The controls, instruments, engine and landing gear all worked perfectly. I was not in a hurry and spent a full 8 hours in about 10 days making high-speed runs down the runway going faster and feeling out the controls and seeing how the plane responded. The advantage of the bicycle landing gear was that I could lift the nose wheel and balance on the main wheel and essentially fly with one foot on the ground. After 8 hours of this there was nothing left to do but keep the throttle forward and let it fly which it did beautifully on the third of August.

I climbed slowly to 1000 feet and circled the airport for a half hour, throttled back and landed smoothly with no problems at all. It was very solid and stable in the air and turned and maneuvered with ease. I went on to fly it 20 more times for a total of 23 hours before cold weather shut me down.

There is, of course, more to be done. I need trim flaps on the wing and a servo tab on the rudder and springs on the nose gear and probably will put the canopy back on it for the 3rd time, but all things considered, after all of this time and effort, I couldn't be more pleased with how everything has worked out.

If you are going to design one of the things, here are some of the most important parameters you will have to struggle with and my solutions to them.

- Airfoil Sections.
- Sweepback.
- Washout.
- Control System.
- Center of Gravity.
- Landing Gear.
- Pilot Position.

AIRFOIL SECTIONS:

There seems at first glance to be an unlimited number of airfoil sections available to the designer, but for flying wings we can eliminate most of them right off. Conventional sections are unstable, and are the 1st to go. Flying wings need sections that have positive pitch or neutral pitch at least, (this is not an absolute, nothing ever is, but it is a conservative approach). Northrop, for instance, used symmetrical sections on his flying wings. In my case, after reading all I had on sections, I knew that I wanted a positive pitch section with mild reflex for the root section with at least 15% thickness, and a thin symmetrical section at the tip. The tip section was pretty straight forward, I had coordinates for a number of symmetrical sections and picked out the NACA 0009 for the tip and placed it as the last rib before the start of the curve of the tip.

The Root section was more of a problem because I did not have coordinates for a 15% reflexed section. I did have coordinates for the old M6 section, however, which is a positive pitch section, around since the 1920's, with just the characteristics I was looking for except it was too thin being only about 12% thick, and I also had coordinates for a 15% symmetrical section. I knew that NACA had made families of airfoil sections using the same mean camber line with different thickness forms bent around them and figured if it worked for NACA it should work for me too. I therefore drew out the M6 section full size (72 inch chord for my wing), located the mean camber line, threw away the outside of the M6 and bent the 15% symmetrical section around the M6 mean camber line and I had my airfoil. I obviously have no data for this section, but I am assuming it has the same general characteristics as the M6 it is derived from (a bold and possibly incorrect assumption).

SWEEPBACK:

Sweepback is determined by where you want the CG to be, you increase the sweepback until the center of lift is located behind the CG and you have the nose heavy condition necessary for stability. I found in my models that the natural tendency for a flying wing is to be tail heavy and I wanted to use my weight to compensate for this. I was laying on my stomach in the prone position and my CG was at my hips so I added enough sweepback to get the center of lift about 6 inches behind my hips; this worked out to be 19 degrees on the quarter chord. This would have worked out all right except my assumptions about CG were off a bit.

WASHOUT:

The wingtips are acting as the horizontal stabilizer on a flying wing and are set at a negative angle in order to hold the center of the wing at a positive angle of attack and produce lift. Just how much negative angle to use is the 64-dollar question. The best book on design of flying wings that I have seen is "Tailless Aircraft in Theory and Practice" by Karl Nickel and Michael Wohlfahrt.

If you are interested in designing a flying wing you need this book since these guy really know what they are talking about and approach the subject both from the theoretical and the practical side and will keep you straight. They give formulas for calculating the washout based on the lift distribution of the wing. Unfortunately this book was not around when I was designing mine so I just had to ad lib it and picked 5 degrees as a reasonable number. This is 5 degrees from the zero lift line of the airfoil and in the case of the M6 this is minus 2 degrees so in my case it works out to be 3 degrees from the horizontal reference line of the section.

AVAILABLE PLANS & REFERENCE MATERIAL

Coming Soon: <u>Tailless Aircraft Bibliography</u>
Edition 1-g

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

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

Prices: To Be Announced

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

VIDEOS AND AUDIO TAPES

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

VHS tape of Al Bowers' September 19, 1998 presentation on "The Horten H X Series: Ultra Light Flying Wing Sailplanes." The package includes Al's 20 pages of slides so you won't have to squint at the TV screen trying to read what he is explaining. This was an excellent presentation covering Horten history and an analysis of bell and elliptical lift distributions.

Cost: $10.00 postage paid
Add: $ 2.00 for foreign postage

VHS of Robert Hoey's presentation on November 20, 1999, covering his group's experimentation with radio controlled bird models being used to explore the control and performance parameters of birds. Tape comes with a complete set of the overhead slides used in the presentation.

Cost : $10.00 postage paid in US
$15.00 foreign orders

FLYING WING SALES

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

U.S. Pacific (559) 834-9107
8104 S. Cherry Avenue mitchellwing@earthlink.net
San Bruno, CA 93725 http://home.earthlink.net/~mitchellwing/

COMPANION AVIATION PUBLICATIONS

EXPERIMENTAL SOARING ASSOCIATION

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

United States	$20 /yr
Canada (Air Mail)	$25 /yr
All Other Countries (Air Mail)	$35 /yr
Electronic	$10 /yr
U.S. Students	Free if full time student as defined by SSA)

Make checks payable to: Experimental Soaring Association, & mail to Murry Rozansky, Treasurer, 23165 Smith Road, Chatsworth, CA 91311.