

# T.W.I.T.T. NEWSLETTER

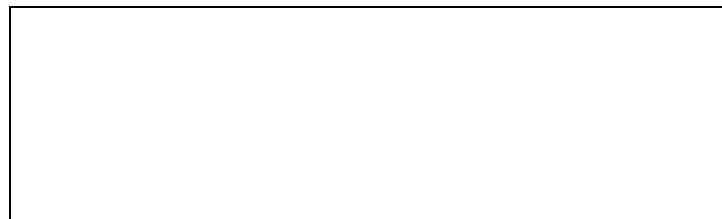


ZupAir Z1 - High Performance Flying Wing. ZupAir produces one of the nicest flying wings we have seen. The Z1 offers outstanding glide ratio, sink rate, energy retention and handling. The high performance is achieved through careful optimization of sweep, taper, airfoil shape, and twist. Source:

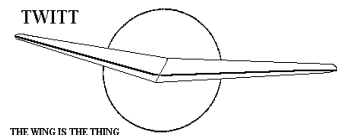
<https://alofthobbies.com/zupair-z1-high-performance-flying-wing.html>

## 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., **1903** 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

**E-Mail:** [twitt@pobox.com](mailto: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

**PERMISSION IS GRANTED to reproduce this publication or any portion thereof, provided credit is given to the author, publisher & TWITT. If an author disapproves of reproduction, so state in your article.**

Gatherings are held on the third Saturday of every odd numbered month, 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 ..... 1**  
**Al Bowers on Induced Drag ..... 2**  
**Available Plans/Reference Material..... 7**

**PRESIDENT'S CORNER**



In going through some of the materials I brought with me to Texas I ran across the slides for a presentation by Al Bowers on minimum induced drag. I think this is from a talk he did at the 2011 ESA Western Workshop but for which I don't have a narrative. I have included the first 10 slides doubling up on each page of the newsletter.

I am going to do some more research to see if it is available but in the mean time the slides contain enough information to give you an idea of his theories. If I don't find anything then I will put the next 10 slides in the April issue, then any remaining ones in the May issue.

If you have an questions on this subject or would like to add your opinion(s) you can send them to me and I will see if I can get Al to address them. I don't know if he is still at NASA or retired but I will find out.

Hope your flying season is getting off to a good start. We have lost some weekends to storms and high winds but hopefully it will improve in the coming months.

# On the Minimum Induced Drag of Wings -or- Thinking Outside the Box

Albion H. Bowers  
NASA Dryden Flight Research Center

04 Sep 11

## The Boxes In Our Minds

- Assumptions
- Ideas and Concepts

# Introduction

---

- The History of Spanload  
Development of the Optimum Spanload
- Performance, Structure, & Control
- Propellers
- Concluding Remarks

## Birds

---

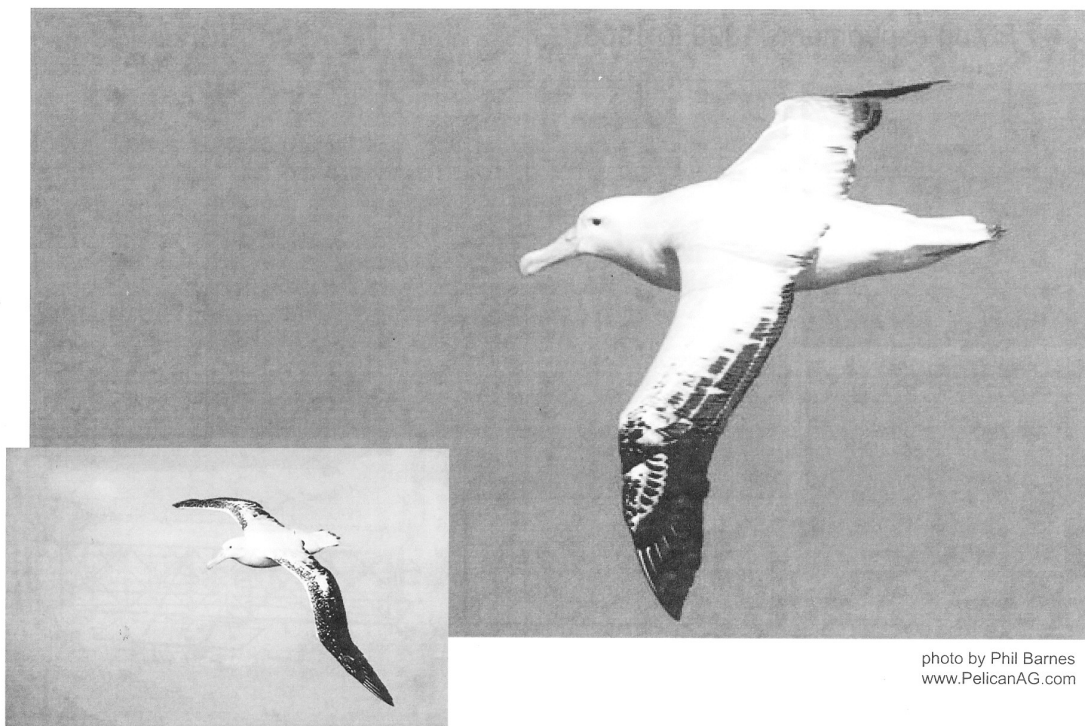
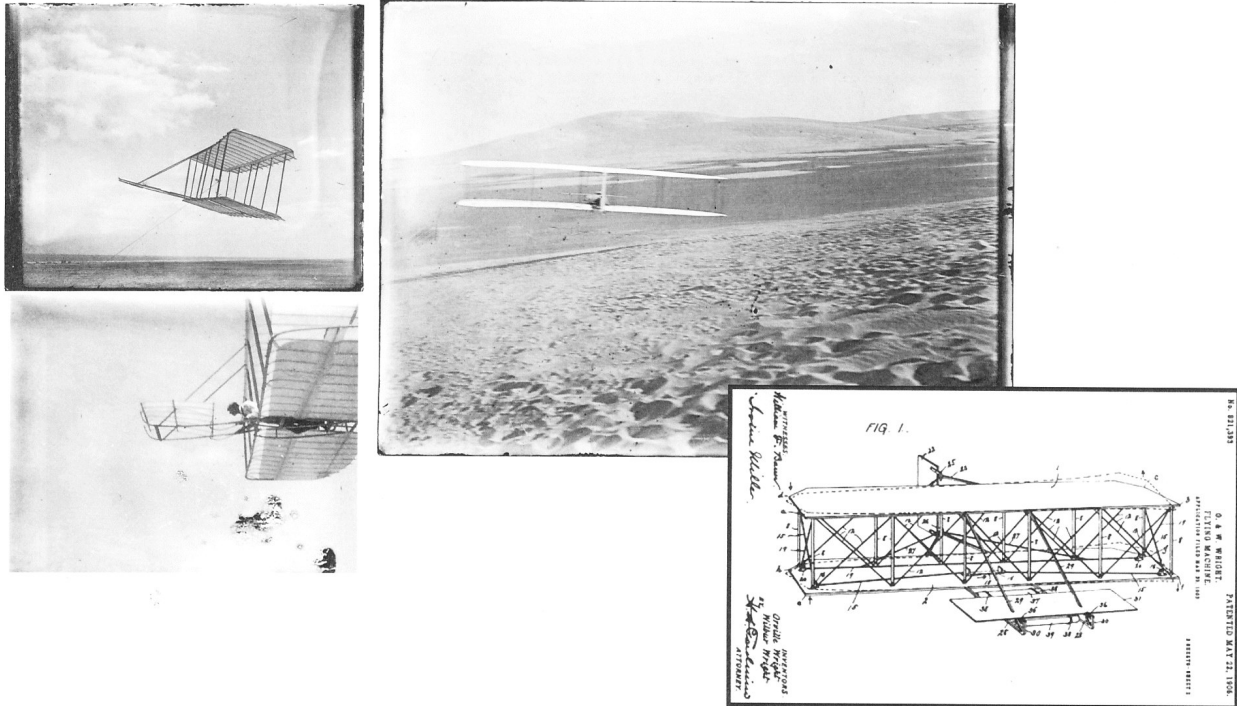


photo by Phil Barnes  
[www.PelicanAG.com](http://www.PelicanAG.com)

## Wilbur & Orville Wright

- Flying experiments 1899 to 1905



## Spanload Development

- Ludwig Prandtl
  - Development of the boundary layer concept (1903)
  - Developed the “lifting line” theory
  - Developed the concept of induced drag
  - Calculated the spanload for minimum induced drag (1908?)
  - Published in open literature (1920)
- Albert Betz
  - Published calculation of induced drag
  - Published optimum spanload for minimum induced drag (1914)
  - Credited all to Prandtl (circa 1908)

## Spanload Development (continued)

---

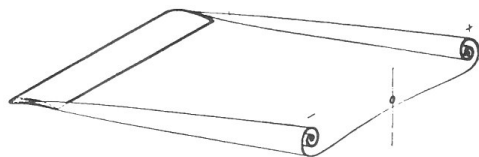
- Max Munk  
General solution to multiple airfoils  
Referred to as the “stagger biplane theorem” (1920)  
Munk worked for NACA Langley from 1920 through 1926
- Prandtl (again!)  
“The Minimum Induced Drag of Wings” (1932)  
Introduction of new constraint to spanload  
Considers the bending moment as well as the lift and induced drag

## Practical Spanload Developments

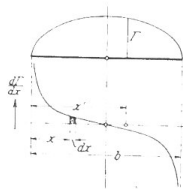
---

- Reimar Horten (1945)  
Use of Prandtl’s latest spanload work in sailplanes & aircraft  
Discovery of induced thrust at wingtips  
Discovery of flight mechanics implications  
Use of the term “bell shaped” spanload
- Robert T Jones  
Spanload for minimum induced drag and wing root bending moment  
Application of wing root bending moment is less general than Prandtl’s  
No prior knowledge of Prandtl’s work, entirely independent (1950)
- Armin Klein & Sathy Viswanathan  
Minimum induced drag for given structural weight (1975)  
Includes bending moment  
Includes shear

# Prandtl Lifting Line Theory

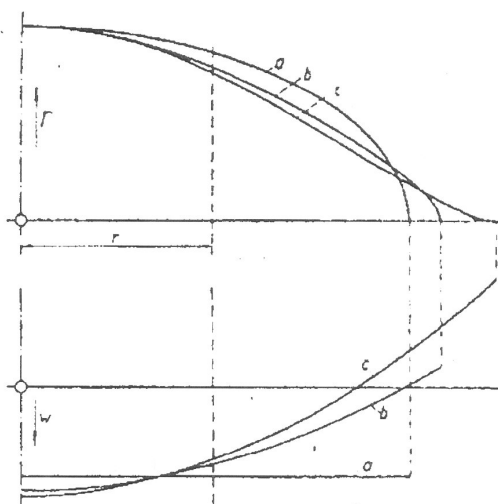


- Prandtl's "vortex ribbons"



- Elliptical spanload (1914)
- "the downwash produced by the longitudinal vortices must be uniform at all points on the aerofoils in order that there may be a minimum of drag for a given total lift."  $y = c$

## Minimum Induced Drag & Bending Moment



- Prandtl (1932)  
 Constrain minimum induced drag  
 Constrain bending moment  
 22% increase in span with 11% decrease in induced drag

**AVAILABLE PLANS &  
REFERENCE MATERIAL**



**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** 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.

Cost: \$8.00 postage paid  
Add: \$2.00 for foreign postage

**An** Overview of Composite Design Properties, by Alex Kozloff, as presented at the TWITT Meeting 3/19/94. Includes pamphlet of charts and graphs on composite characteristics, and audio cassette tape of Alex's presentation explaining the material.

Cost: \$5.00 postage paid  
Add: \$1.50 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.