No. 226 APRIL 2005

T.W.I.T.T. NEWSLETTER


I couldn't resist this as I was searching the Internet. The B-58 Hustler meets the criteria for a flying wing since there are no tail surfaces. I don't know about you, but I would certainly not like being on the receiving end of this thing coming at me with a full armament load. Photos were found at:

http://www.globalsecurity.org/wmd/systems/b-58-pics.htm

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., **0504** means this is your last issue unless renewed.

Next TWITT meeting: Saturday, May 21, 2005, 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).

TWITT

THE WING IS THE THING

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) 589-1898
Secretary: Phillip Burgers (619) 279-7901
Treasurer: Bob Fronius (619) 224-1497
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) 596-2518 (10am-5:30pm, PST)
(619) 224-1497 (after 7pm, PST)
E-Mail: twitt@pobox.com
Internet: http://www.twitt.org
Members only section: ID –
Password –

Subscription Rates: $20 per year (US)
$30 per year (Foreign)

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 pub-lication or any portion thereof, provided credit is given to the author, publisher & TWITT. If an author disapproves of reproduction, so state in your article.

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

As you are probably all aware by now, the newsletter is a week late. It is the usual excuse of time just got away from me after the last meeting and I didn't get to work on until the week is should have been mailed.

I do need to thank Phil Barnes for providing an electronic copy of his presentation so I could use it to prepare a majority of the meeting recap without having to laboriously transcribe the audiotape. I did try to extract the added comments that came from the group asking questions during the talk to sort of personalize it a little more. Phil also sent along his choice of slides from the presentation to illustrate his points and I have included them in the appropriate spots. I apologize for any problems you might have reading through some of the formulas, but Microsoft Word doesn't handle these things very well sometimes.

There have been some interesting things going on around the BKB-1 and BEKAS sailplanes. We received an e-mail that a partially built BEKAS was being offered for sale from Leo Schober in Ontario Canada. Leo was in the process of moving from his house to a smaller apartment and didn't have room for the plane. He also had a set of plans available for the BEKAS. I put this out on Nurflugel as the quickest way to get the word to anyone who could take advantage of this, but I don't know if anything came of it, yet. Leo is a friend of Stefanie Brochocki and her dad Stefan. Leo was around when the BKB was being tested in Hawkesbury in the 60's.

We are also aware of a builder who is going to starting on a composite construction BKB-1 in the near future. He has been working with Stefanie on plans and other issues, and visiting with Stefan getting some tips on the sailplane. This should be something we need to keep an eye on in the coming months and keep you up-to-date on the progress.

Andy

MAY 21, 2005 PROGRAM

As of our publication date we didn't have a firm program lined up for May. We are hoping to keep the 2005 "streak" of having actual programs alive so will keep looking for a topic and speaker.

If you know of someone who could put on an aviation oriented program of about 45-60 minutes in length, please let me know by phone or e-mail with the contact information.

MARCH 19, 2005 MEETING RECAP

Andy welcomed everyone to the March 2005 meeting and quickly covered the usual housekeeping items for any new attendees. We were pleased to have Bob Hoey and his wife down from the high desert to take in the program featuring birds. As you will see later, he also brought along a new experimental model.

Bob Chase brought in a magazine with a two-page article on a proposed Boeing flying wing from the 1935 era. Unfortunately, I wasn't able to get a picture of the page and haven't been able to find it on the Internet. We also queried him on the location of the small flying wing he had seen off of I-15 several months ago. Andy will be going by the area in early May and is going to look into it again and possibly leave a note behind and see if the owner will contact him.

Andy then introduced Phil Barnes who would be giving us the presentation he made before the SAE recently on the methods an Albatross uses to dynamically soar over the oceans for long periods of time.

Before Phil got started Andy put forth the question on how had Phil been able to discern this information, since Andy had always been under the impression that the Albatross' migration habits were difficult to observe. Andy also went on to relate a couple of quick stories on his observations of the bird's behavior at Midway Island in the Pacific Ocean. He was impressed with their grace when slope soaring along the sand dunes of the island, but also amused by their antics in trying to takeoff and land. In reply Phil said that much of what he was presenting had been generated from scratch with some references to existing literature, and that he is presenting the information in a totally different way.

Phil opened with an overview of how he will explain how the Albatross remains aloft perpetually on fixed wings as long as the wind is up and, travels around the globe several times a year. This would be done with both math and science to explain the physical phenomenon of our natural world. This will also include the use of photography, paleontology, physics, engineering and even some poetry.

One of the objectives of the presentation was to increase our knowledge of what the Albatross can do and how it does it so we can take the actions necessary to preserve these natural treasures. The main technical message is that without flapping its wings the Albatross can sustain soaring flight in any net overall direction.

Sustain means it can do it perpetually, so once it is airborne and has achieved shoulder lock it can remain aloft as long as the wind is blowing. It can also point in any direction it wants to go whether it's upwind, downwind or crosswind through a series of intelligent maneuvers.

(ed. – Phil was very gracious in providing me with the notes that go with his PowerPoint presentation, which is going to make it much easier to relate it to you. So if this seems a little canned, that's because it is, however I have also included his comments to questions asked from the floor. Phil continued with:)

It is my pleasure to share with this interested audience recent discoveries explaining how the albatross uses its dynamic soaring technique to remain aloft on fixed wings as it travels around the globe. This presentation will draw from several disciplines to understand what the albatross does, and how it does it, so that we may perhaps take greater interest in halting its slide toward extinction.

Let's begin with an excerpt from "Part the First" of the famous poem by Samuel Taylor Coleridge….

And a good south wind sprung up behind;
And the Albatross did follow,
And every day, for food or play,
Came to the mariners' hollo!

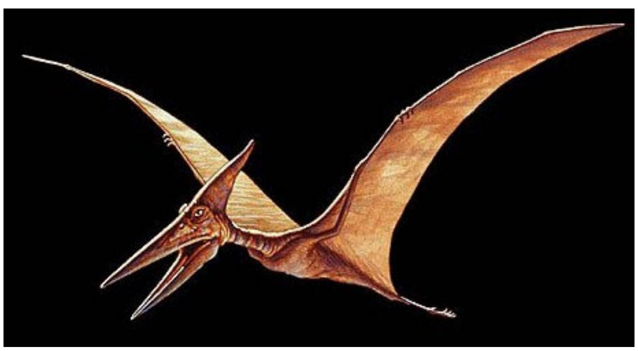
In "The Rhyme of the Ancient Mariner – Part the First," the sailor shot the albatross with his crossbow, believing the albatross responsible for the ice-cold storm. This was unfortunate for both because, as the story goes, the albatross was also "the bird that made the wind to blow." Consequently, the ship drifted into the doldrums, and the crew perished from thirst. Today we are still shooting the albatross, in a manner of speaking. Our crossbows are the long-line fishing fleet, or reams of floating plastic at sea. Many albatross species have lost half of their population within the last two human generations alone.

We'll begin by introducing the albatross, then model its geometry and aerodynamics, and explain the technique of dynamic soaring. Next we will derive the flight mechanics and then suggest a repertoire of maneuvers. We will then finish with real-time computer simulations, which show the albatross soaring on fixed wings over a wave-less sea. The latter condition simply means that waves are not required for dynamic soaring. Of course, the albatross takes advantage of wave lift when it is available. But the waves travel slower than the wind, and as we shall show, the albatross can make net downwind progress faster than the wind itself.

Evolution and Dynamic Soaring

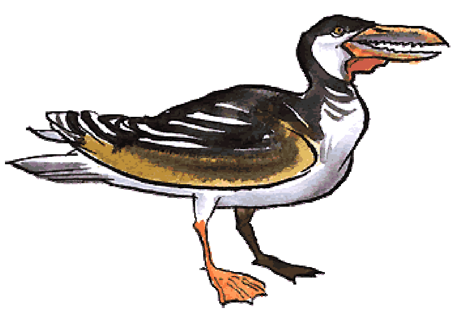
150 Million Yr.

Pteranodon



9-m wingspan
200-65 Million yr.
3.5-m span

Osteodontornis



6-m wingspan
55-5 million yr.

Before we get technical, let's start near the very beginning, specifically with Archaeopteryx, the feathered dinosaur, which lived 150 million years ago. By 100 million years ago, modern birds were well along their evolutionary path. An early albatross named Osteodontornis lived over the period between 55 and 5 million years ago. This enormous seabird had a wingspan up to 6-meters, or 20-ft. It was very much like the Albatross and also a sea bird and, fossils have been found all over the globe.

We may be surprised to learn that the ancestors of Osteodontornis, and perhaps Osteodontornis itself, shared the ocean skies with the Pteranodon flying reptile. Pteranodon was itself an expert at dynamic soaring. It was no fleeting evolutionary experiment, having lived as a species for 135 million years. Today, the Wandering Albatross is one of 13 albatross species, which grace our blue planet. Its 3.5-m wingspan is the largest of any living bird. The Wandering Albatross is the subject of our computer simulations.

Here's a view of our spaceship Earth (a shot of the globe from out in space was shown). The very thin line around the globe (as shown on the slide), a graphical artifact, closely represents the actual thickness of our atmosphere. In the center, we see Antarctica, a continent to which the albatross is intimately tied. The Antarctic land mass is depressed almost 1-km by the weight of 2-km of ice. This ice represents about 70% of the world's fresh water, and sea level would rise by 70-m were the ice to melt. Antarctica has numerous ice shelves (including Ross, Ronne, and Larson) and these extend out over the ocean, typically showing 50-m above water, while hiding 250-m below. These ice shelves are the source of tabular icebergs, which break away in lengths up to 300-km. Every southern winter, Antarctica is enveloped in darkness. During this time it doubles its apparent area by freezing and de-salinating the upper meter of the sea around it. This sea ice advances about 4-km/day. We mention Antarctica because the story of the Albatross is linked to the story of Antarctica.

Throughout the year, the Antarctic Circumpolar Current (ACC), sweeps around the continent, or its sea ice. In the Antarctic summer, the ACC looks something like this. Here, in the roaring forties and furious fifties southern latitudes, the ACC is accompanied by strong and consistent eastbound wind, and on occasion, the largest waves on the planet. The northern and southern fronts of the ACC are marked by sharp changes in water temperature, salinity, and concentrations of phytoplankton and zooplankton. The ACC also represents a huge thermal engine exchanging heat between the northern and southern oceans.

The wandering albatross rides the wind above the ACC. Feeding primarily on squid, the albatross uses its dynamic soaring technique to travel downwind, across the wind, and even upwind, as we shall show, essentially never flapping its wings except to takeoff after landing on the water. A tagged bird was found to have completed the circumnavigation in about 46-days.

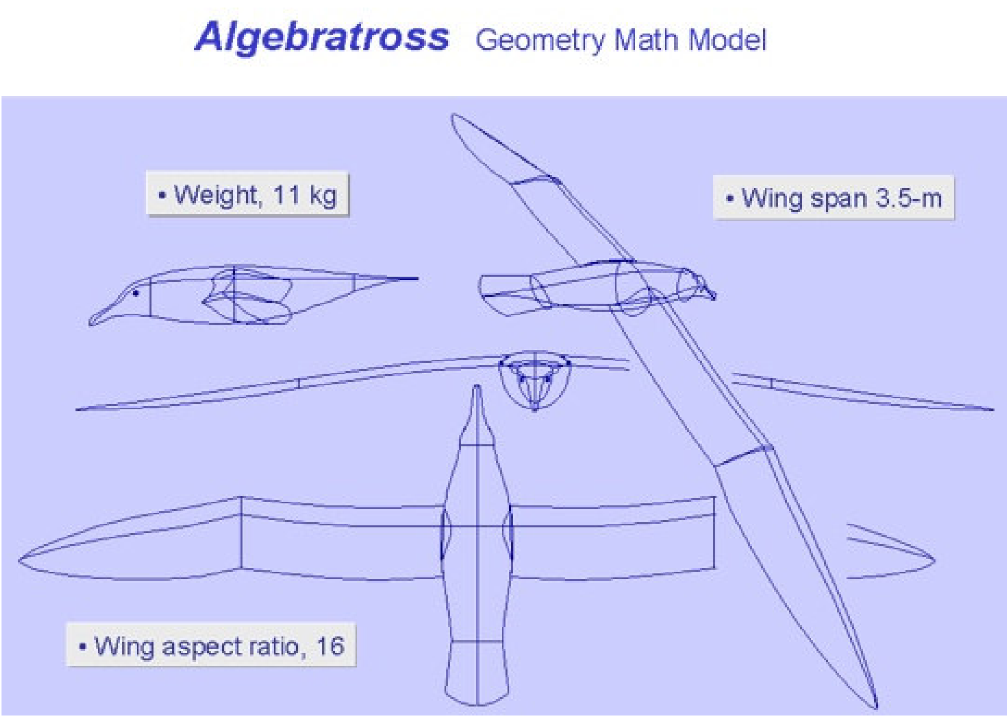
The albatross enjoys a shoulder lock (sort of like an iron cross you would do in gymnastics) so it can rest on its wings while soaring. It may travel 1000 km/day, perhaps circumnavigating the continent 6 times per year. It appears capable of sleeping on the wing. One such instance was observed when an albatross that was constantly circling a ship crashed into it as the ship made a turn away from the existing path.

Every other year after about age ten, the albatross navigates with pinpoint accuracy to the island where it was hatched and, with good fortune, greets its life-long mate to raise a single chick. After an initial period of full-time supervision by one parent, the chick is left alone and fed every 5 days as each parent returns separately from a 10-day excursion.

Modeling the Albatross

Algebratross Geometry Math Model

Meet "Algebratross," modeled with equations from beak to tail, and from wingtip to wingtip. Algebratross weighs 11 kg, or 24-lb. Its 3.5-m wing has an aspect ratio of 16. As we shall see, high aspect ratio is essential to reduce drag during high-g turns associated with dynamic soaring.



Estimated Drag Polar

Although we know very little about the wing twist and wing section under flight loads, we do know the body frontal area and wing aspect ratio, A.

Max L/D = 27
near CL ~ 0.8
Aspect ratio, A = 16
Drag Coefficient
$C_D \approx C_{Do} + C_L^2/3A$

These are sufficient for a reasonable estimate of the drag polar, which anchored to a "zero lift drag," adds a parabolic term representing the induced drag. The latter varies with the square of lift coefficient and inversely with the aspect ratio. The "3A" denominator is more accurate than the theoretical value of "pi A." The slope of the line crossing through the origin and tangent to the polar yields a maximum L/D near 27, not much below that of a high-performance sailplane. This means the albatross sinks only one meter when gliding over a distance of 27 meters. As we shall see in our simulations, the albatross will enjoy nearly constant, and near optimal, L/D throughout its dynamic soaring maneuvers. Although the albatross glides slightly steeper than a sailplane, only the albatross can land on a dime, fold its wings into a compact package, launch itself from the surface of the water, and closely follow the terrain with the pilot half asleep.

Understanding Dynamic soaring

Qualitative Analysis

- Study circular "zoom" maneuver in still air.
- Kinetic, potential, and total "specific" energy.
- Examine the wind profile & "wind gradient".
- "Turn off" the wind profile, gravity, and drag.
- Restore and assess each effect *separately.*

Quantitative Analysis (number crunching)

- Postulate & quantify "dynamic soaring force".
- Derive & apply the equations of motion.
- Math-model climb/dive/bank angle "schedules".
- Simulate (observe) the system response.

We will first take a "qualitative" look at dynamic soaring. To aid our understanding we will first study a circular zoom maneuver in still air and define the total specific energy. Then we will examine the wind profile out on the open sea. Next we will turn off the wind, gravity, and drag, restoring each step-by-step to isolate its effect on the total energy. This approach will allow us to understand qualitatively how the albatross gains energy with vertical motion in the wind profile.

We will then find ourselves at a crossroads where we will need to make computations for further understanding. Specifically, we need to assess whether the albatross can preserve energy overall in each zoom maneuver cycle. In so doing, we will quantify a dynamic soaring force vector, derive the equations of motion, schedule the climb and bank angles (or climb angle and turn radius), and then observe the response of airspeed, elevation, energy, and trajectory. The albatross is actually synthesizing thrust from the wind profile, which is no different then it having a small jet engine on its back.

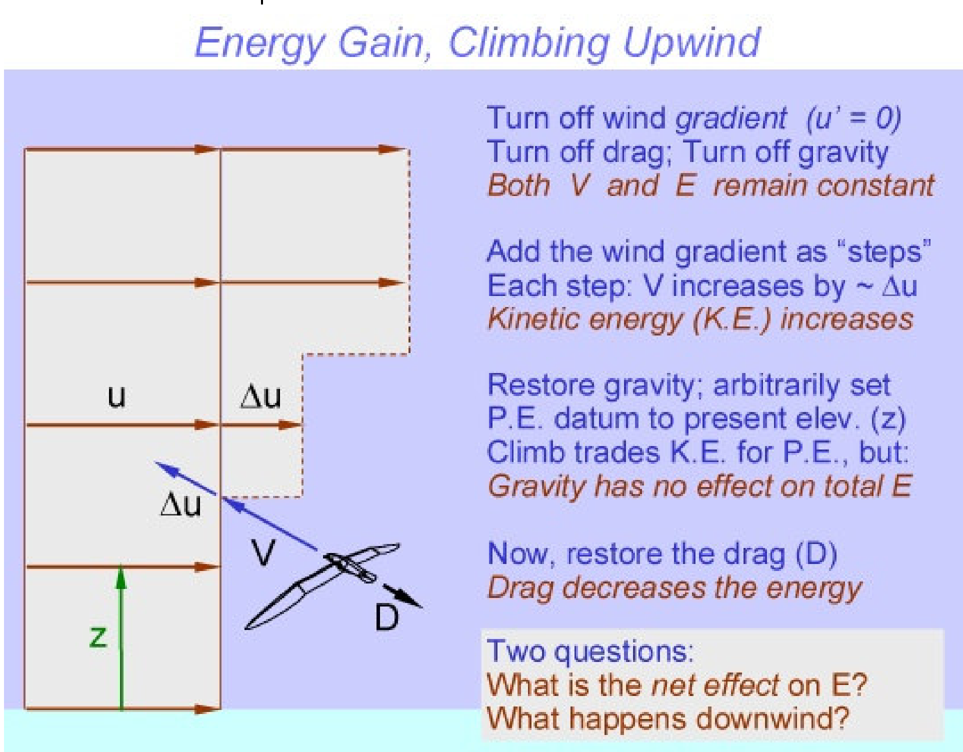
Circular Zoom in Still Air

Before we can understand dynamic soaring, we must first understand what is called a "zoom maneuver." Here, an airplane or bird executes a circular zoom maneuver in still air, constantly exchanging kinetic and potential energy. For this example, we could imagine that the albatross has this small jet engine backpack, where the engine thrust is constantly adjusted to match the drag. Alternatively, we can imagine that both thrust and drag are zero. Either way, total specific energy remains constant throughout this maneuver, which can thus continue indefinitely.

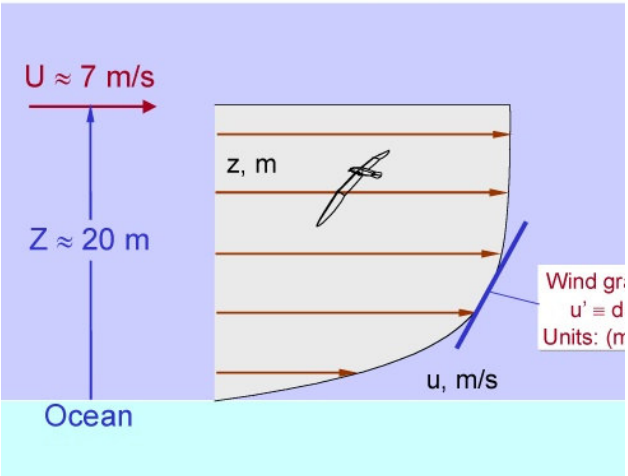
Define: V = *airspeed*, z = elevation
"Specific" kinetic + potential energy:
$E \equiv V^2/2 + gz$ = constant (here only)
K.E. P.E. (both per unit mass)

Wind Profile and Gradient

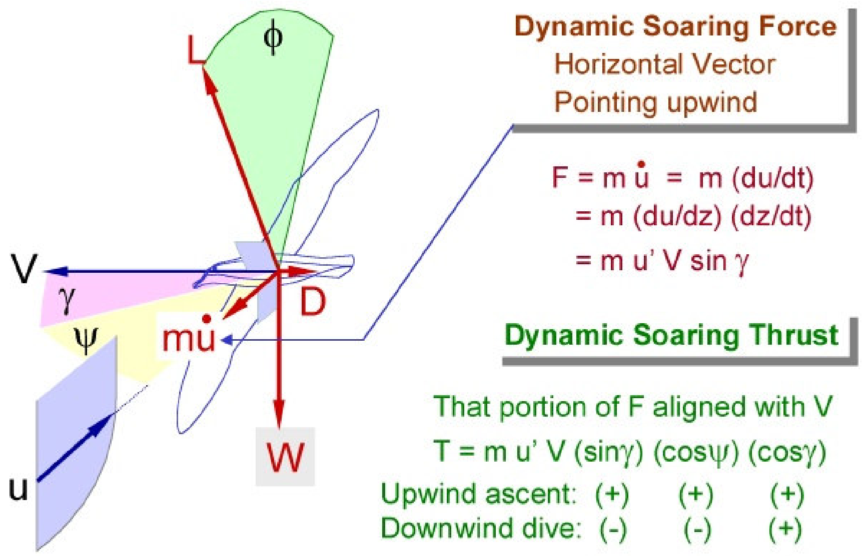
Out on the open ocean, the boundary layer, or wind profile, is about 20-m high. That's about 65-ft. A conservative wind speed at the top of the profile is 7 m/s, or 16 mph. As we will show, the albatross cycles vertically within this profile to restore the energy lost to drag.



Wind Profile and Gradient



Dynamic Soaring ~ Force Diagram



Energy Gain, Climbing Upwind

Energy Gain, Descending Downwind

Qualitative Vs. Quantitative Analysis: Number crunching is now required to track the energy for a complete cycle, including the energy lost during *crosswind* flight. The albatross encounters decreasing tailwind upon downwind descent through each wind profile "step". Same result as upwind ascent: Airspeed, V increases by ~ Δu *Kinetic energy (K.E.) increases.*

Flight Mechanics

Maneuver Angles ~ Initial Orientation

Before maneuvering, the albatross is assumed to be pointed directly upwind with wings level. At this point, heading, pitch, and roll angles are all zero.

Next the albatross yaws to the heading angle (psi). This motion takes place within a horizontal yaw circle. After the yaw, the wingtips form a pitch axis A-A

The albatross and airspeed vector together pitch up to the flight path angle, gamma. This motion takes place within a vertical pitch circle.

Finally, the albatross rolls about the airspeed vector by the angle (phi). This motion takes place within a roll circle, which is tilted at the angle (gamma).

Dynamic Soaring ~ Force Diagram

Now that the albatross has maneuvered into position, we show all the forces, including lift, weight, and drag. In particular note the dynamic soaring force of magnitude m du/dt. We postulate this force to be constrained to a horizontal plane and directed upwind (sign convention will soon follow). The component of this force which is aligned with the airspeed vector provides what we will call the dynamic soaring thrust. Noting that both (u') and (cos gamma) are always positive, a careful study of sign convention reveals that the dynamic soaring thrust is positive when the albatross ascends upwind, and also when the albatross descends downwind. This is consistent with our earlier "qualitative" study. Thus, the albatross must follow the "dynamic soaring rule" (climb when pointed upwind, and descend when pointed downwind) if it is to remain aloft on fixed wings.

Equations of Motion ~ Apply Newton's Laws

Now let's apply Newton's Law in three orthogonal directions to obtain the equations of motion. First we sum the forces aligned with the airspeed vector to obtain the acceleration dV/dt, tangential to the flight path.

Next we take all forces in a vertical plane normal to the airspeed vector to obtain the centripetal acceleration V gamma dot.

Likewise, but with a subtle difference, we project the airspeed onto the horizontal plane, obtaining V cos gamma. Then, summing all forces in a horizontal plane normal to this will yield the centripetal acceleration, which is proportional to the turn rate. Finally, we non-dimensionalize the equations in terms of the tangential and normal load factors, and the all-important lift-to-drag ratio, L/D.

Equations of Motion for Dynamic Soaring

We are now ready to summarize the equations, which describe dynamic soaring. Not looking at them too closely, let's just say that they represent the effects of wind gradient, tangential load factor, normal load factor, turn rate, lift coefficient, and drag-to-lift ratio. The computer cycles through these several times, every fraction of a second, to track the orientation of the albatross, and to track its 3-dimensional trajectory.

The one equation on which we [should] focus our attention shows the balance between dynamic soaring thrust and aerodynamic drag. First, note that the dynamic soaring thrust is proportional to both airspeed and wind gradient. Second, note that the drag penalty is made worse by the g-load factor, but this is mitigated if the albatross has a high L/D.

Thus, to enhance the dynamic soaring thrust and allow upwind penetration, nature has endowed the albatross with a high airspeed, V, in relation to the wind speed, U. And finally, to enhance L/D during high-g turns, nature has endowed the albatross with a high aspect ratio wing.

```
- Sum forces along the flight path
    tangential acceleration, dV/dt
- Forces in vertical plane normal to V
    centripetal acceleration, V dγ/dt
- Forces in horizontal plane normal to Vcosγ
    centripetal acceleration, Vcosγ dψ/dt
- Sum forces along the flight path
    tangential acceleration, dV/dt
Non-dimensionalize the equations using:
   - Tangential load factor, nt ≡ (1/g) dV/dt
+ sinγ
   - Normal load factor, nn ≡ L / W
   - Lift-to-Drag ratio, L / Dγ
```

Math Modeling Maneuver Angle Schedules

Everything about a dynamic soaring maneuver is periodic. Thus, the sine wave is our best mathematical friend in helping us to schedule the climb and bank angles. However, we need to distort the sine wave to simulate the flight of the albatross. Starting with a basic sine wave versus dimensionless time, we can apply a sin-squared adder to adjust the amplitudes. Also, by defining an auxiliary time, which adds a bump to the real time, we can accelerate or delay the halfway point. A further auxiliary time simulates a dwell at the beginning and end of the cycle. Resulting schedules for flight path and roll angles might look like this. Then given these schedules, tailored to follow the dynamic soaring rule, the laws of motion will reveal the response of the remaining maneuver parameters such as airspeed, elevation, specific energy, and trajectory.

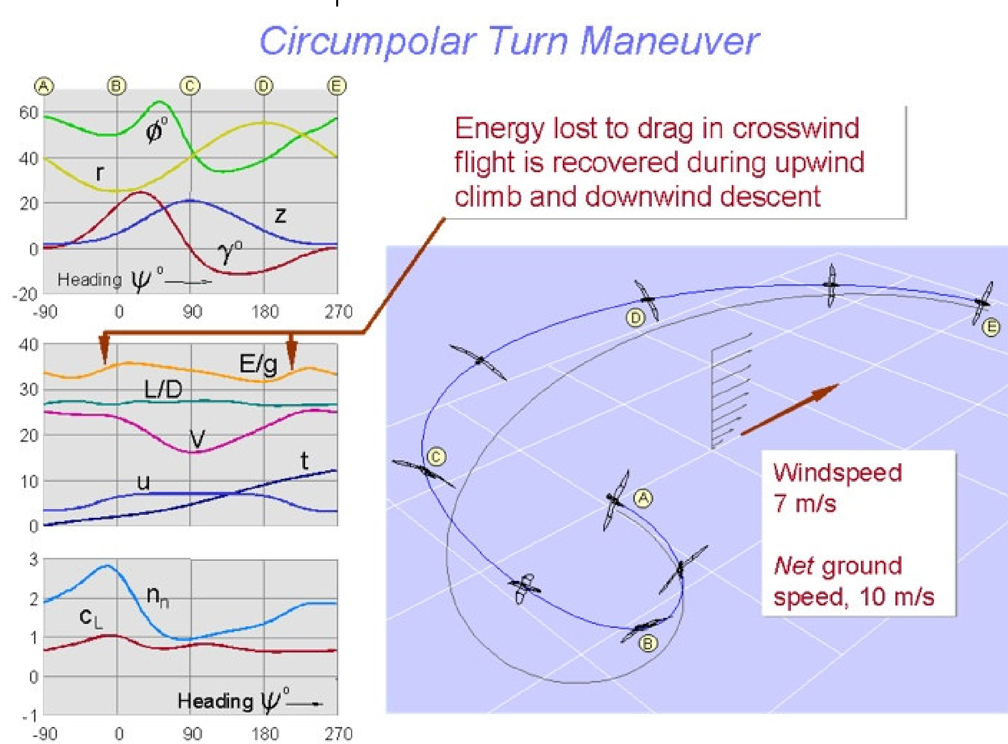
Maneuver Repertoire

Here we have imagined a family of maneuvers, each of which has been simulated on the computer and documented in the paper for those interested. For example, the albatross can hover, so to speak, without drifting overall downwind, with a circular or figure-8 ground track. It can travel overall directly across the wind, overall straight downwind, or overall directly upwind. As you see, the key word is "overall," because the albatross is obligated to execute upwind climbs and downwind dives as part of its overall net soaring motion.

In short, although the wind is blowing to the right for these examples, the direction the wind is blowing is of no consequence to an albatross as it soars on fixed wings from any point A to any point B. Our real-time simulations will focus on the maneuvers, which make either downwind or upwind overall progress.

Circular Zoom in Still Air ~ Study the Details

Before showing our real-time simulations, let's review in greater detail the circular zoom in still air, with drag turned off. In this example, the albatross flies with a fixed turn radius of 40-m. The bank angle varies as required to hold that radius. Following a flight path angle (gamma) schedule, the albatross climbs to an



elevation of 20-m and then returns to sea level. The cycle is repeated every 11-sec, and could continue indefinitely since there is no drag in this example.

Point (A) is at the bottom of the zoom and point (c) is at the top. The airspeed (V) reaches a minimum when the elevation (z) is a maximum. Notice that the energy (E) is constant throughout the maneuver for the stated assumptions.

Circumpolar Turn Maneuver

Now we'll restore both the wind and the drag, and also focus on the circumpolar turn maneuver, which the albatross makes rapid progress, overall, straight downwind. Instead of flying a fixed turn radius, we'll schedule the turn radius (r) with heading. As before, we will also schedule the flight path angle using a distorted sine wave. Most significantly, notice first that the energy lost to drag in crosswind flight is restored during the upwind climb and downwind descent, and second, that the energy is conserved at the end of the cycle.

Some interesting facts:

The albatross pulls almost 3-g in the upwind turn.

The L/D is largely constant and optimal throughout the maneuver.

The overall speed downwind is faster than the wind itself.

Upwind Snake Maneuver

Now we switch to the upwind-snake maneuver, whereby the albatross makes overall progress directly upwind. The maneuver is characterized by staying low to mitigate downwind drift, and by short-steep downwind descent alternating with long-shallow upwind ascent. Notice the math-modeled climb and bank schedules, carefully tailored to follow the dynamic soaring rule while attaining net upwind motion. The system response includes net upwind progress at 3.6 m/s against a 7 m/s headwind, all the while preserving energy overall after each zoom cycle.

Summary

An early albatross likely shared the ocean skies with the pteranodon. The albatross can dynamically soar overall downwind faster than the wind. With *dynamic soaring*, the albatross extracts thrust from the wind profile by ascending upwind and descending downwind. On fixed wings, the albatross can make net progress in any direction, including Upwind.

In summary, we have attempted to show what the albatross can do, and how it does it. By extracting thrust from the wind profile, the albatross can soar on fixed wings over a wave-less sea in any net direction, and can fly overall downwind faster than the wind itself.

Whereas the albatross has graced our blue planet for tens of millions of years, we "modern" humans have only been here about 0.1-million years, and our impact has been pronounced just within the last 0.001-million years.

We close with an excerpt from part 2 of Coleridge's poem, and then step back to take a global view on behalf of our albatross.

From ***The Rhyme of the Ancient Mariner*** ~ *Part the Second – Samuel Taylor Coleridge*

- *And the good south wind still blew behind;*
- *But no sweet bird did follow,*
- *Nor any day, for food or play,*
- *Came to the mariners' hollo!*

Let not the albatross vanish from the earth on our short watch.

Supporting Evidence

"Albatrosses are the unquestioned champions of gliding flight.… Given wind enough, they travel effortlessly in any direction, upwind as well as down, with hardly a wingstroke…. in irregular circles, figure eights, and letter S's…"
- Oliver L. Austin, Jr., *Birds of the World,* Golden Press, 1961, p. 32

After the paper was written, this book was found at a local library sale and purchased for $1.

About the Speaker

Phil Barnes has a Bachelor's Degree in Mechanical Engineering from the University of Arizona and a Master's Degree in Aerospace Engineering from Cal Poly Pomona. He has 25-years of experience in performance analysis and computer modeling of aerospace vehicles and subsystems at a major aerospace corporation. He has authored technical papers on aerodynamics, gears, and orbital mechanics. Drawing from his SAE technical paper of the same title, this presentation brings together Phil's knowledge of aerodynamics, flight mechanics, geometry math modeling, and computer graphics with a passion for soaring flight.

In keeping with the theme of the day, Bob Hoey brought along his latest model, a Frigate bird. He says they are still trying to work out the bugs, but it does fly.

He will be increasing the size of the tip ailerons to help with the handling characteristics. You can see from the picture he has already added extensions on the trailing edge, but it still needs more authority. Hopefully, we will hear more about it in the future.

Below is the real thing in flight.

LETTERS TO THE EDITOR

(ed. – This was forwarded by Norm Masters and is now a little dated, but I thought those of you involved in Mitchell projects would be interested. You might call the hospital before sending a card.)

March 15, 2005

Richard Avalon is in the hospital

Richard Avalon was involved with Don Mitchell way back when Mitchell Wing was just getting started in Porterville, CA. I believe he was Mitchell's main test pilot. Whatever his role then, when Don passed away he left the manufacturing rights to Richard. Richard's wife called me earlier today and said that Richard is in the Stanford University Medical Center awaiting a liver transplant. Apparently he's #1 on the list, so it sounds pretty serious. Cards can be sent to the:

Stanford University Medical Center
ATTN: Richard Avalon
300 Pasteur Drive
Stanford, CA 94305

The phone number for Guest Services is (650) 498-3333. Send Richard a card & let him know we're all hoping he's up and around soon.

Bob Chester
B-10 driver
U-2Wing@yahoogroups.com

March 18, 2005

Hi Andy,

E-mail address change, <cbixel@cox.net>

I am still getting occasional calls on the FLAT AIRFOIL/ BIXEL WIG, paper T.W.I.T.T. published years ago. Unfortunately, my e-mail address has since changed and needs updating. Hopefully, you can find the time to correct the problem.

Enjoy,

Chuck Bixel

(ed. – I have updated Chuck's address on the applicable page of the website so he will get any future messages. We are pleased that there are still people out there interested in the design concepts and want to talk about them with Chuck.)

March 20, 2005

Hi Phil,

First let me thank you for an excellent presentation at the TWITT meeting on 19 Mar. The theoretical and empirical work that you have done to validate the wind shear concept for sustained flight of the Albatross is outstanding. I agree with all of your work, and it is almost entirely consistent with my observations when cruising between New Zealand and Australia. I am attaching a copy of my observation notes, written at the time and unedited, which will probably parallel your observations.

I mentioned at the meeting that I think there is another source of lift that the birds are using when the wind is not blowing, but there are moderate swells present, (usually the case in the open sea).

I think they are using the vertical motion of the water, (and the air immediately above it) as a source of lift. I have characterized this assuming that the wave height varies as a sine wave with time. If we assume a 5 second period to the swell, and a wave height of + - 3 feet, the attached chart shows that the vertical velocity of the water is above 2 fps for a significant portion of each cycle. (From your data, I calculated that the bird will travel at about 55 fps at max L/D. For an L/D of 27, that results in a requirement for 2 fps of lift to sustain flight.)

I would be curious as to your thoughts on this theory. I would think it could be modeled in much the same manner as the wind shear.

Bob Hoey
<bobh@antelecom.net>

(ed. – If anyone has additional comments or observations they would like to present on this dynamic soaring concept, please forward them to me and I will see that are forwarded. We haven't seen Phil's response to Bob yet, but it should be interesting.)

March 23, 2005

Klingberg wing.

To: <Ramakers@cavemanrocketry.com>

I just found an old post from you about a Klingberg wing. Are you still looking for plans to the kits? I have two kits and I have the plans for both. One is a 6' version and the other is for a rocket powered 52" version.
I might be able to get you copies for them if your still looking.

Alan Shaffmaster
<Flying-Al@kc.rr.com>

To: <rcmodel@hotmail.com>

I just saw an old post about you getting some 12' foam Klingberg wings made. I am wondering how that worked out and where you got them made etc.

I have a couple of their kits and have been having fun with them but they are hard to find.

Thanks in advance.

Alan.

(ed. – These were a couple of messages sent to people who have asked us questions over the years and I have placed them on the website. I don't go back and delete them after any particular time period and, it is interesting that they are still being read and replied too. I hope the people make contact and help is provided even after long periods.)

AVAILABLE PLANS & REFERENCE MATERIAL

Coming Soon: Tailless Aircraft Bibliography
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

Personal Aircraft Drag Reduction, by Bruce Carmichael.

Soft cover, 81/2 by 11, 220 page, 195 illustrations, 230 references. Laminar flow history, detailed data and, drag minimization methods. Unique data on laminar bodies, wings, tails. Practical problems and solutions and, drag calculations for 100HP 300mph aircraft. 3d printing. $25 post paid.

Bruce Carmichael brucecar1@juno.com
34795 Camino Capistrano
Capistrano Beach, CA 92624 (949) 496-5191

VIDEOS AND AUDIO TAPES

VHS tape containing First Flights "Flying Wings," Discovery Channel's The Wing Will Fly, and ME-163, SWIFT flight footage, Paragliding, and other miscellaneous items (approximately 3½+ hours of material).
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
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 Paul MacCready's presentation on March 21,1998, covering his experiences with flying wings and how flying wings occur in nature. Tape includes Aerovironment's "Doing More With Much Less", and the presentations by Rudy Opitz, Dez George-Falvy and Jim Marske at the 1997 Flying Wing Symposiums at Harris Hill, plus some other miscellaneous "stuff".
Cost: $8.00 postage paid in US
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

NURFLUGEL

"Flying Wing"
by Dr. Reimar Horten & Peter Selinger

350 illustrations
German & English text
Limited number of the "flying wing bible" available
Cost: $49.00 plus $4 shipping and handling

SCOTT flycow@aol.com
12582 Luthern Church Road
Lovettsville, VA 20189 Sole U.S. Distributor

Tailless Aircraft in Theory and Practice

By Karl Nickel and Michael Wohlfahrt

498 pages, hardback, photos, charts, graphs, illus., references.

Nickel and Wohlfahrt are mathematicians at the University of Freiburg in Germany who have steeped themselves in aerodynamic theory and practice, creating this definitive work explaining the mysteries of tailless aircraft flight. For many years, Nickel was a close associate of the Horten brothers, renowned for their revolutionary tailless designs. The text has been translated from the German Schwanzlose Flugzeuge (1990, Birkhauser Verlag, Basel) by test pilot Captain Eric M. Brown, RN. Alive with enthusiasm and academic precision, this book will appeal to both amateurs and professional aerodynamicists.

Contents: Introduction; Aerodynamic Basic Principles; Stability; Control; Flight Characteristics; Design of Sweptback Flying Wings - Optimization, Fundamentals, and Special Problems; Hanggliders; Flying Models; Fables, Misjudgments and Prejudices, Fairy Tales and Myths, and; Discussion of Representative Tailless Aircraft.

Order #94-2(9991) (ISBN 1-56347-094-2) from:

AIAA 1-800-682-AIAA
1801 Alexander Bell Drive, Suite 500
Reston, WA 20191-4344 USA
Members: $59.95 Non-Members: $79.95

*Outside the US, Canada & South America, order from: Edward Arnold (Publishers), a division of Hodder Headline PLC, 338 Euston Road, London NW1 3 BH (ISBN 0 340 61402 1).

COMPANION AVIATION PUBLICATIONS

SAILPLANE HOMEBUILDERS ASSOCIATION

The purpose of SHA 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 coop-eration as a means of achieving their goal. Membership Dues: (payable in U.S. currency)

United States	$21 /yr	Canada	$26 /yr
So/Cntrl Amer.	$36 /yr	Europe	$41 /yr
Pacific Rim	$46 /yr	U.S. Students	$15 /yr

(includes 6 issues of SAILPLANE BUILDER)

Make checks payable to: Sailplane Homebuilders Association, & mail to Secretary-Treasurer, 21100 Angel Street, Tehachapi, CA 93561.