Radio Controlled Soaring Digest

June 2012 Vol. 29, No. 6

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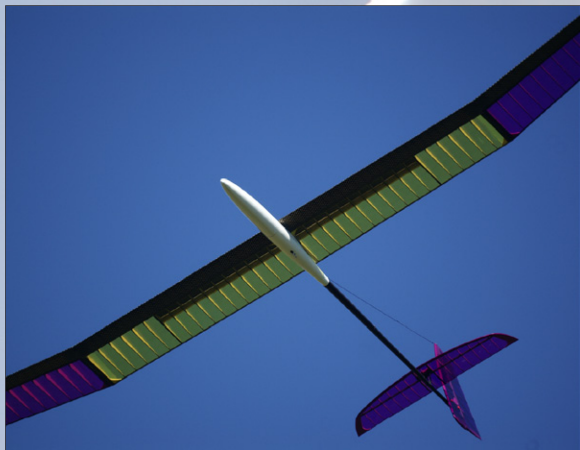

Front cover: Loren Steel's Super AVA (no longer in production, unfortunately) coasts overhead at 60 Acres South, Redmond, Washington. Photo by Bill Kuhlman
Konica Minolta Maxxum 7D, ISO 100, 1/400 sec., f8, 500 mm

Back cover: "Transparency," a photo by Bill Kuhlman.
Konica Minolta Maxxum 7D, ISO 100, 1/160 sec., f11, 30mm

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In the Air

There's an unusual mix of subjects in this issue of *RC Soaring Digest*. There's a contest report and a slope soaring diary of sorts, a bit of history, an exposé on a new side of the sport, and an article with a more technical bent. We hope you enjoy it.

And this brings up the continuing need for material for future issues. The broad range of material in recent issues should be an indication of the astoundingly large number of acceptable topics open to potential authors. Just about anything which deals with radio controlled soaring is fair game.

We are always on the lookout for articles dealing with design and construction, flying skills and flying fields, contest coverage, aerodynamics and structures, electronics and other technical and non-technical topics of interest to readers. Additionally, photos which can be used for the front cover and back cover are always appreciated.

RCSD does not accept advertising, nor does *RCSD* pay for articles or photos. *RCSD* does accept press releases for new items and does publish product reviews. If you are a manufacturer or a distributor and have an item you'd like to see promoted in *RCSD* we encourgae you to get in conact with us.

We're trying out some new fonts in this issue, hoping the text will be more readable when viewed on a computer monitor. Let us know what you think!

Time to build another sailplane!

High-Speed Robotic Albatross:

Unmanned Aerial Vehicle powered by dynamic soaring

Philip L. Richardson, prichardson@whoi.edu

Abstract

Wandering albatrosses exploit the vertical gradient of wind velocity (wind shear) above the ocean to gain energy for long distance dynamic soaring with a typical airspeed of 36 mph. In principle, albatrosses could soar much faster than this in sufficient wind, but the limited strength of their wings prevents a much faster airspeed. Recently, pilots of radio-controlled (RC) gliders have exploited the wind shear associated with winds blowing over mountain ridges to achieve very fast glider speeds, reaching a record of 498 mph in March 2012. A relatively simple two-layer model of dynamic soaring predicts maximum glider airspeed to be around 10 times the wind speed of the upper layer (assuming zero wind speed in the lower layer). This indicates that a glider could soar with an airspeed of around 200 mph in a wind speed of 20 mph, much faster than an albatross. It is proposed that recent high-performance RC gliders and their pilots' expertise could be used to develop a high-speed robotic albatross UAV (Unmanned Aerial Vehicle), which could soar over the ocean like an albatross, but much faster than the bird. This UAV could be used for various purposes such as surveillance, search and rescue, and environmental monitoring. A first step is for pilots of RC gliders to demonstrate high-speed dynamic soaring over the ocean in realistic winds and waves.

1. Introduction

Wandering albatrosses exploit the vertical gradient of wind velocity to fly long distances over the Southern Ocean without flapping their wings in what is called dynamic soaring. The birds' typical cruise velocity through the air is around 36 mph. Given sufficient wind speeds an albatross could use dynamic soaring to fly much faster than 36 mph, but high speeds can cause excessive forces on the bird's wings. The limited strength of the bird's wings prevents them from high-speed dynamic soaring.

Pilots of radio-controlled (RC) gliders exploit fast wind blowing over mountain ridges and use dynamic soaring to fly at very high speeds, reaching a record of 498 mph in March 2012. These high speeds require very strong high-performance gliders and accurate control by the pilots. Accelerations of the gliders reach around 100 times gravity (or more). The fast speeds and strong gliders suggest that the technology of these gliders and the experience of the pilots could be used to help develop a high-speed dynamic-soaring robotic albatross UAV (Unmanned Aerial Vehicle) for flight over the ocean. Such a UAV could be useful for various applications such as surveillance, search and rescue, and remote sampling of the marine boundary layer and ocean surface.

Recently, I developed a simple two-layer model of dynamic soaring to help understand how albatrosses use this technique to soar over ocean waves (Richardson, 2011). This model also provides insight into the characteristics of the much faster RC glider flight, which is more than ten times the typical albatross airspeed (Richardson, 2012). The model provides a framework for evaluating whether high-speed dynamic soaring could be exploited over the ocean.

The following describes the observed dynamic soaring of albatrosses and RC gliders and interprets their flight using the two-layer model. The possibility of high-speed dynamic soaring over ocean waves is discussed. It is concluded that a high-speed robotic albatross UAV is possible given sufficiently large wind and waves, but that this concept needs to be proved by having experienced pilots of RC gliders successfully fly them over the ocean using dynamic soaring.

< *Title page illustration: Conceptual illustration of a robotic albatross UAV soaring over the ocean. An image of a Kinetic 100 RC glider being flown by Spencer Lisenby at Weldon Hill California was superimposed on a photo of a black-browed albatross soaring over the Southern Ocean. Photos by Phil Richardson*

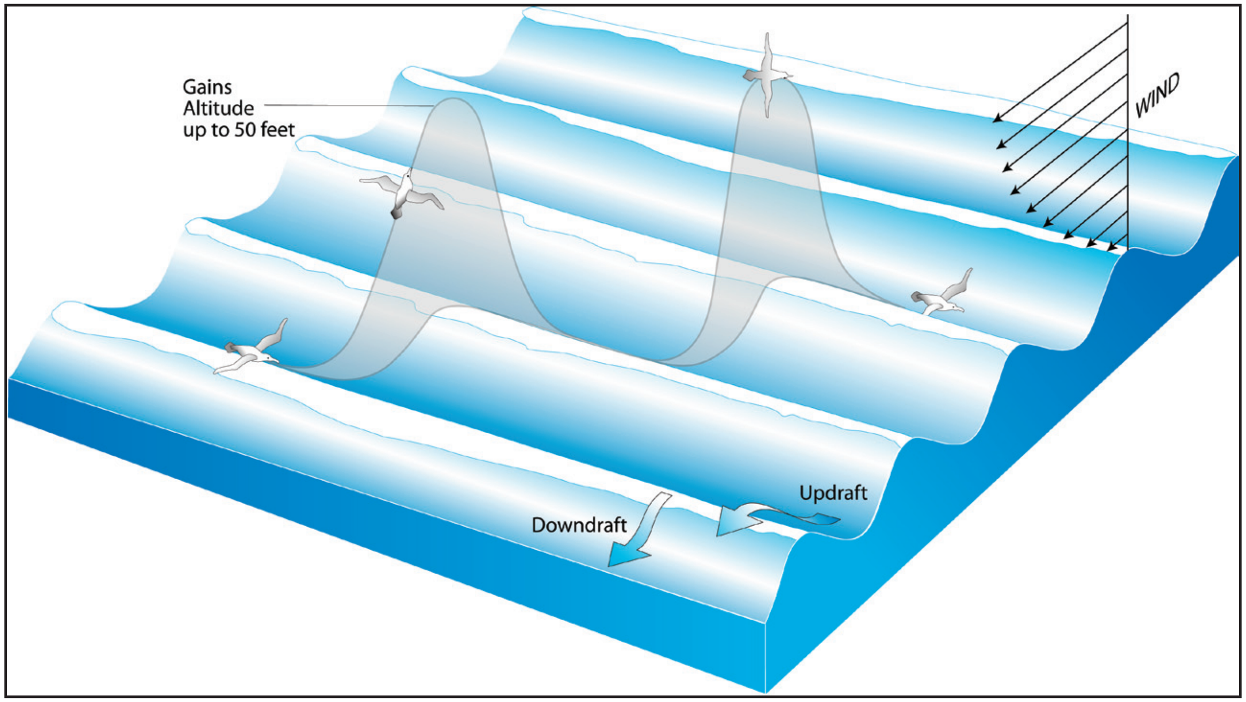


Figure 1. Schematic summary of the zigzag swooping flight pattern of an albatross soaring over waves as observed during a cruise to the South Atlantic. The swooping motion is shown relative to the waves, which are moving downwind. Each climb is upwind and each descent is downwind since the waves are going downwind, although the downwind component is difficult to show in the figure and looks almost parallel to the wave crest. The average direction of flight has an upwind component. The schematic waves are uniform for simplicity; real ocean waves are much more complicated. Regions of updraft and downdraft due to wind blowing over waves are indicated schematically. Simplified vectors of a typical average wind velocity profile over the ocean surface are indicated in the right part of the figure. Most of the vertical gradient of wind velocity (wind shear) is located in a thin boundary layer near the ocean surface. The wave phase speed was not subtracted from the wind speed in this diagram.

2. Albatross soaring over the ocean

I observed wandering albatrosses soaring during two cruises to the South Atlantic. The albatrosses flew in a characteristic and distinctive flight pattern consisting of a swooping motion where each swoop tended to be tightly coupled to a wave crest (Figure 1). Each swoop began with a fast flight parallel to and just above the windward side of a wave. This was followed a turn into the wind and a climb of around 30-50 feet, followed by a downwind descent towards another wave and a turn parallel to the wave. The typical time to complete a swoop was around 10 s. These observations are largely in accord with previous studies (Alerstam et al., 1993; Idrac, 1925, 1931; Pennycuick, 1982).

Figure 1 illustrates an albatross soaring in an upwind direction (as observed) as the bird flew parallel to the ship, which was steaming in a general upwind direction at 12 knots. Of course, albatrosses can soar in other directions too. The observed zigzag snaking flight pattern illustrates the way an albatross extracts energy from the wind using dynamic soaring and uses it to travel over the ocean. Albatrosses can also remain in a particular region by flying in circles or figure-eight patterns.

Dynamic soaring exploits the vertical gradient of wind velocity over ocean waves. The largest vertical gradient of wind velocity (largest wind shear) is located in a thin boundary layer located within several feet of the water surface. However, the structure of the wind field near the ocean surface is complicated by the presence of waves. Strong wind flowing over a sharp-crested and breaking wave separates from the wave crest forming an area of weaker wind or a lee eddy just downwind of the wave crest (Figure 2) as described by Pennycuick (2002) (see also Gent and Taylor, 1977; Hsu et al., 1981; Kawaii, 1982; Reul et al., 1999). Located above this region of weaker wind is a thin wind-shear region, a wind-shear boundary layer that separates from the upwind wave crest, and above that a layer of stronger wind and reduced wind shear. Pennycuick (2002) proposed that albatrosses take advantage of the strong wind shear located between these two layers downwind of sharp-crested waves in order to gain energy from the wind in what he calls "gust soaring," which is a special case of more general dynamic soaring. Pennycuick (2002) uses the term to mean the rapid increase of wind speed encountered by a bird as it climbs across the thin wind-shear layer located above a lee eddy.

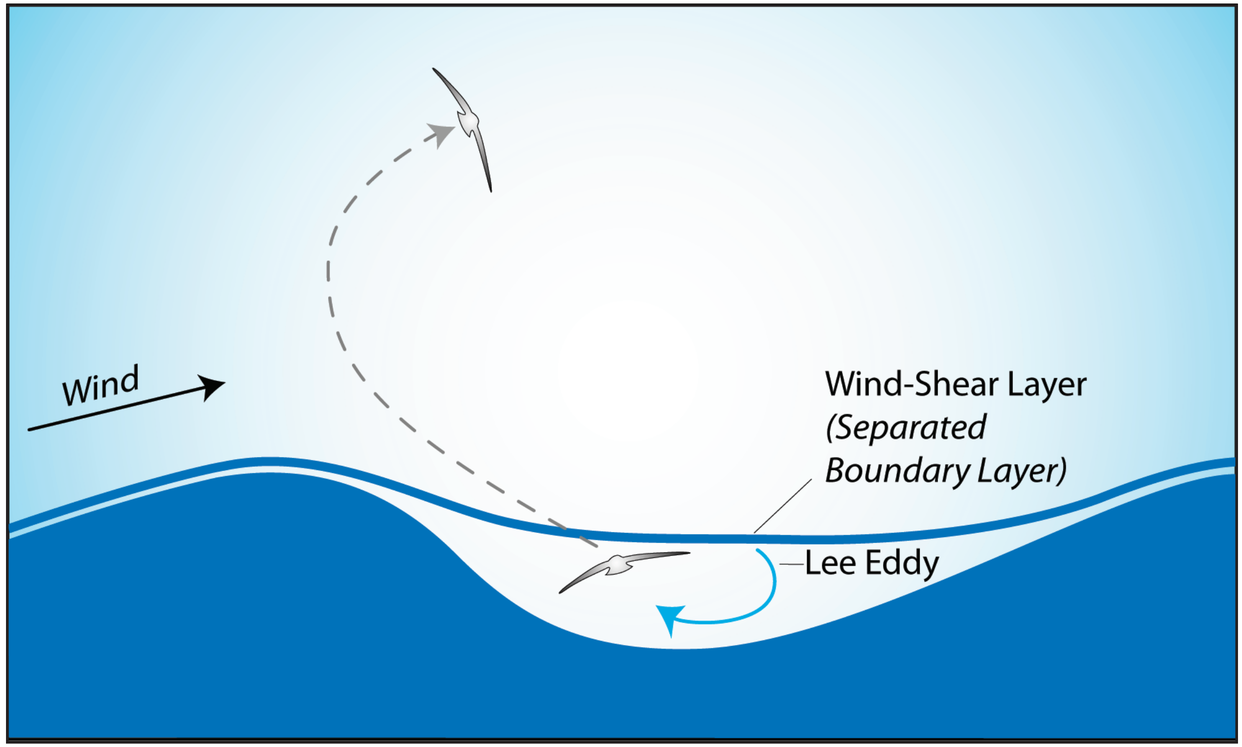


Figure 2. Schematic of an albatross "gust soaring" (after Pennycuick, 2002). Starting in a lee eddy (or separation bubble) located downwind of a sharp-crested wave a bird climbs up through a thin wind-shear layer (separated boundary layer) that has detached from the wave crest. On crossing the wind-shear layer, the bird's airspeed abruptly increases, and the bird experiences a "gust." The increase in airspeed can be used to climb up to heights of 30-50 feet by trading airspeed (kinetic energy) for height (potential energy). A lee eddy is a region of closed streamlines with clockwise circulation in this figure.

Gust soaring can be understood by using a two-layer approximation first described by Rayleigh (1883) in which a lower layer has zero wind speed and an upper layer has a uniform wind speed of 10 mph (for

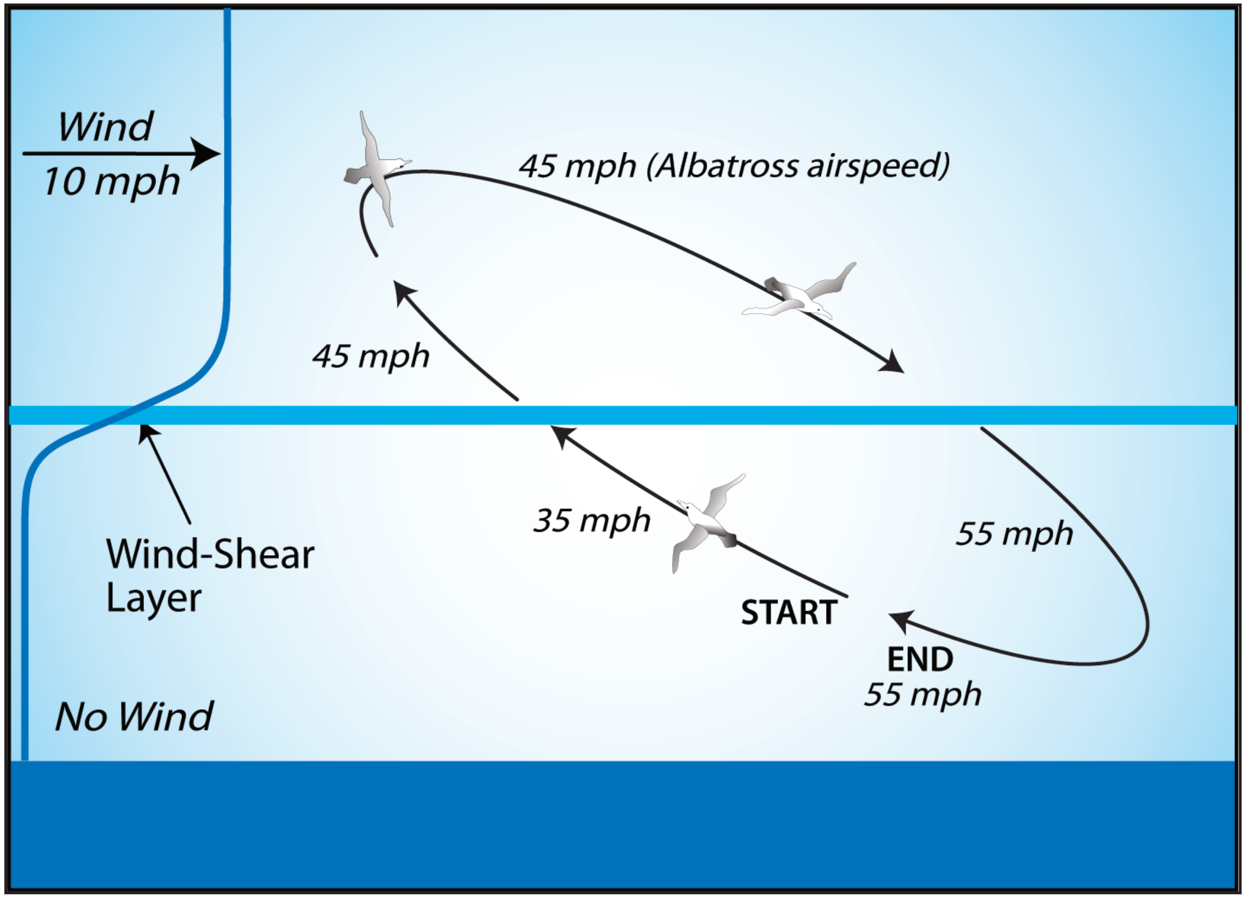


Figure 3. Idealized example of the airspeeds of a dragless albatross gust soaring through a thin wind-shear layer in which the wind increases from zero below the layer to 10 mph above. This example shows how an albatross could gust soar in the region downwind of a wave crest as indicated in Figure 2. Starting in the lower layer with an airspeed of 35 mph an albatross climbs upwind a short distance vertically across the wind-shear layer, which increases the airspeed to 45 mph. The bird then turns and flies downwind with the same airspeed of 45 mph. During the turn, the bird's ground speed increases to 55 mph in the downwind direction and consists of the 45 mph airspeed plus (tail) wind speed of 10 mph. The albatross descends downwind a short distance vertically across the wind-shear layer, which increases airspeed to 55 mph. The bird then turns upwind flying with an airspeed of 55 mph.

example) (Figure 3). A dragless albatross flying at a typical airspeed of 35 mph in an upwind direction in the lower layer pulls up a short distance into the upper layer encountering a 10 mph "gust," which increases the bird's airspeed to 45 mph and adds a pulse of kinetic energy. The bird then turns downwind to fly in the opposite direction and descends into the lower layer, which increases the bird's airspeed to 55 mph, adding another pulse of airspeed and kinetic energy. Thus, in one loop the bird's airspeed increases from 35 mph to 55 mph or two times the 10 mph wind speed of the upper layer. When the energy gained by crossing the wind-shear layer just balances the decrease of energy due to drag, the bird could continuously soar in energy-neutral flight.

The interaction between wind and waves is complicated and depends on the wind velocity and the wave phase velocity. In general the interaction results in a lee eddy or region of closed streamlines synchronous with the wave and located in its trough (Hristov, et al., 2003; Sullivan et al., 2000). A lee eddy can deflect the layer of fast wind away from the wave surface as shown schematically by Figure 2. The upwind part of a lee eddy contains a region of updraft caused partly by the upward orbital motion of the wave surface. This updraft can merge with an updraft due to the wind blowing over the windward wave slope, and the merged region of updraft can extend above a wave crest (Hristov, et al., 2003; Sullivan, et al., 2000, 2008). An albatross could use the updrafts over waves to gain altitude (potential energy) from the wind in addition to gaining airspeed (kinetic energy) from the wind-shear. This would be particularly useful for soaring in low wind speeds and large swell waves. Albatrosses probably use both wind shear and updrafts to gain kinetic energy, depending on the characteristics of the local wind and waves, but wind shear and dynamic soaring is thought to provide most of the energy for sustained soaring (Richardson, 2011).

The characteristics of the observed albatross flight were used to develop a simple model of dynamic soaring based on Rayleigh's (1883) concept of a bird soaring across a sharp wind-shear layer and on the aerodynamic equations of motion (Lissaman, 2005, 2007). The modeled flight pattern is referred to as the Rayleigh cycle since he was the first to describe the concept of dynamic soaring. The Rayleigh cycle, in which a bird circles across the boundary of two horizontal homogenous wind layers, is an efficient way to gain energy from a wind profile. The Rayleigh cycle predicts soaring airspeeds which agree well with more complex simulations of albatross flight (Lissaman, 2005; Richardson, 2011; Sachs, 2005).

Table 1. Minimum wind speed for dynamic soaring

	Wandering Albatross		Kinetic 100 Glider
Weight (pounds)	21		22.4
Wing Span (feet)	10		8.8
Maximum lift/drag	21.2		30
Cruise Speed (mph)	36		55
Loop Period (s)	Optimum: 7.2	Observed: 10	Optimum: 11.1
Minimum Wind Speed (mph)	7.5	7.9	8.1
Loop Diameter (feet)	121	167	286
Bank Angle (degrees)	54.7	45.7	54.7
Load Factor (g)	1.7	1.4	1.7

Minimum wind speed required for sustained dynamic soaring by a wandering albatross and a Kinetic 100 RC glider. The examples use the characteristics of a wandering albatross given by Pennycuick (2008) and a ballasted high-performance glider similar to a Kinetic 100, the present world speed record holder (http://www.dskinetic.com). Adding ballast (payload) to the 15 pound unballasted glider was assumed to maintain the same maximum lift/drag value and to increase the cruise airspeed, which corresponds to the maximum lift/drag value. Cruise speed is proportional to the square root of glider weight, and a 49% increase of glider weight increased cruise speed from 45 mph (unballasted glider) to 55 mph (ballasted glider). The minimum wind speed for energy-neutral dynamic soaring was calculated using the model Rayleigh cycle, the maximum lift/drag value for straight flight, the cruise airspeed, and the loop period. Loop diameter, bank angle and load factor were calculated using the loop period and cruise airspeed. Load factor is given in terms of the acceleration of gravity (g).

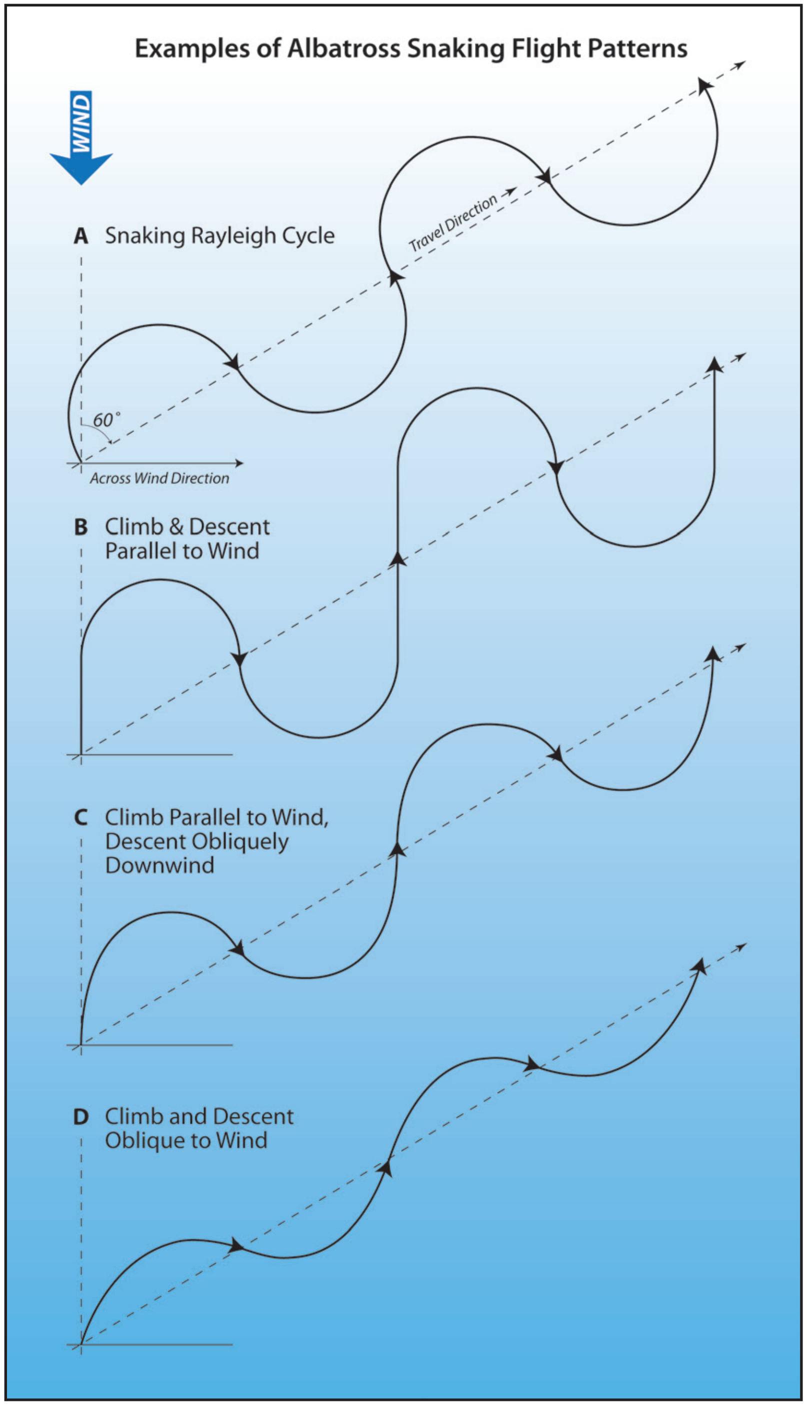


Figure 4. Plan view, showing examples of snaking (zigzag) flight at an angle of 60 degrees to the right of the wind similar to the flight shown in Figure 1. (A) Rayleigh snaking cycle created by linking together semi-circular pieces of the circular Rayleigh cycle to simulate the albatross zigzag flight pattern and average travel velocity. (B) Semi-circular snaking cycle modified to cross the wind-shear layer parallel to the wind direction for maximum energy gain. (C) Snaking cycle modified so that the upwind climb is parallel to the wind and the descent is obliquely downwind and parallel to wave crests; this pattern closely resembles my observations of albatross soaring and those of Idrac (1925, 1931). (D) Snaking cycle further smoothed so that the climb is obliquely upwind and the descent is mainly across-wind as observed by Idrac (1925, 1931). Flight patterns in panels C and D could be used to reduce energy gain in fast wind and large wind shear.

The essential assumptions are that an albatross soars in nearly-circular loops along a plane tilted upward into the wind and crossing the wind-shear layer with a small angle, so that vertical motions can be ignored. Vertical motions are ignored because no energy can be gained from them in a loop without wind. The sudden increase of airspeed (kinetic energy) caused by crossing the shear layer is assumed to balance the gradual loss of airspeed due to drag over half a loop, resulting in energy-neutral flight. Lift/drag values for the circular flight were modeled using the aerodynamic equations of motion for balanced circular flight (Lissaman, 2005, 2007; Torenbeek and Wittenberg, 2009) and a quadratic drag law, in which the drag coefficient is proportional to the lift coefficient squared. The derivations of the equations in the Rayleigh cycle model are given by Richardson (2011, 2012).

The Rayleigh cycle was used to estimate that a minimum wind speed of 7.5 mph is required for the sustained dynamic soaring of a wandering albatross. The minimum wind speed is a function of the loop period and albatross airspeed, and there is a minimum wind speed associated with an optimum loop period, which coincides with the minimum drag and energy loss in a loop. The absolute minimum wind speed occurs at an optimum loop period of 7.2 s and cruise airspeed of 36 mph (Table 1). The cruise airspeed is the airspeed at the maximum lift/drag value in straight flight. The 10 s observed typical loop period of a wandering albatross is somewhat larger than the optimum period and results in a slightly larger 7.9 mph minimum wind speed (Table 1). The larger 10 s loop period reduces the stall speed and load factor compared to values at the optimum loop period.

In low wind speeds some albatrosses and giant petrels are observed to alternate periods of flapping and gliding (flap-gliding) to assist dynamic soaring. When the wind completely dies, the birds often sit on the water surface. In calm conditions but with a large (~ 10 foot) swell running, albatrosses have been observed to soar without flap-gliding by using the updrafts over waves caused by the upward orbital motion of the wave surface (Alerstam et al., 1993; Froude, 1888; Pennycuick, 1982).

The travel velocity of a dynamic soaring albatross was modeled by dividing the Rayleigh cycle into semi-circular half loops and connecting a series of them together in a snaking flight pattern similar to that observed (Figure 4). The bird was assumed to quickly change banking directions during the upwind and downwind portions of its trajectory. The average travel velocity in flight perpendicular to the wind velocity was estimated to be 23 mph, based on the 36 mph cruise airspeed. The average travel velocity over the ground includes a downwind component due to leeway and is slower than 23 mph for a bird soaring upwind and faster when soaring downwind (Alerstam et al., 1993; Richardson, 2011; Wakefield et al., 2009). The simulations of albatross travel velocity using the Rayleigh cycle agree well with tracking measurements of real albatrosses soaring over the ocean.

3. Dynamic soaring of RC gliders

In April 2011, I watched pilots of radio-controlled (RC) gliders at Weldon Hill California use dynamic soaring to achieve glider speeds of up to 450 mph. The dynamic soaring at Weldon exploited the wind shear caused by fast wind blowing over a sharp-crested mountain ridge <http://www.rcspeeds.com>. Wind speed over Weldon Hill increased with height from near zero velocity at the ground level up to 50-70 mph as measured in gusts with an anemometer held overhead at a height of around 7 feet. The largest vertical gradient of wind velocity (largest wind shear) appeared to be located in a thin boundary layer located within several feet of the ridge crest. The fast wind blowing over the ridge formed an area of weaker wind or a lee eddy just downwind of the ridge crest and below the level of the crest. The wind-shear boundary layer was inferred to separate from the ridge crest, to extend nearly horizontally in a downwind direction, and to gradually thicken with distance downwind.

The RC gliders flew in approximately circular loops lying roughly along a plane that tilted upward toward the wind direction, starting from the region in the lee of the ridge, extending above the ridge crest, and crossing the wind-shear layer near the ridge crest. The gliders flew in fast steeply-banked loops with a loop period of around 3 seconds. The glider wings looked like they were nearly perpendicular to the tilted plane all the way around a loop, implying very large accelerations. An accelerometer in a Kinetic 100 glider recorded a maximum acceleration of 90 g, the accelerometer's upper limit (Chris Bosley, personal communication). Glider speeds of 300-450 mph were measured with radar guns. Maximum measured glider speeds are around 10 times the wind speed, although this seems to be more realistic at lower speeds (< 350 mph) than at higher speeds (> 350 mph) (S. Lisenby, personal communication). The RC gliders had ailerons and an elevator to control flight and a fin in place of a moveable rudder. The ailerons and flaps could be adjusted to improve lift/drag during fast flight. Flaps reduced the stall speed when landing.

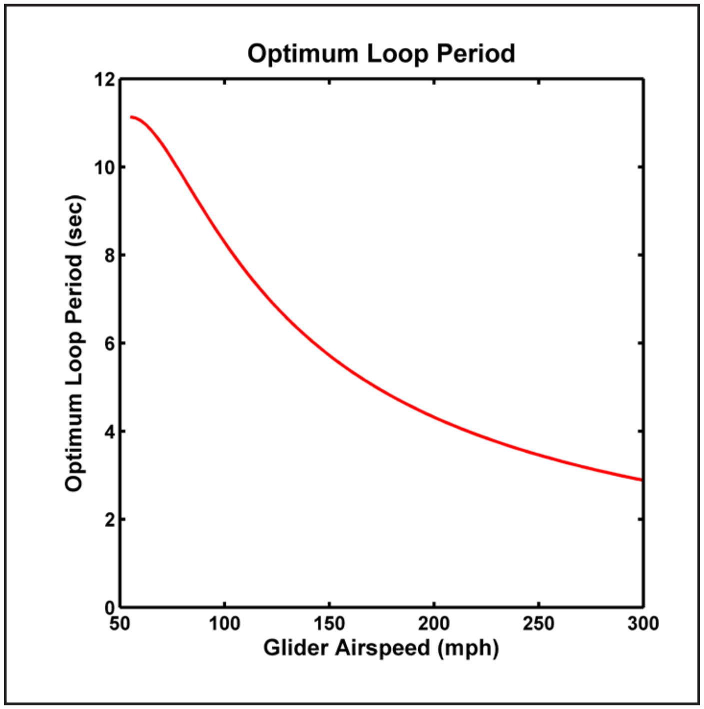
Maximum glider airspeeds in a Rayleigh cycle were calculated using optimum loop periods and also, for comparison, by using the relationship of glider speed equals 10 times wind speed (Figure 5). A typical high-performance RC glider like the present world speed record holder Kinetic 100 has a lift/drag value around 30, and the maximum possible dynamic soaring airspeed based on the Rayleigh cycle is around 9.5 times the wind speed of the upper layer. The model predicts that for wind speeds greater than around 10 mph the glider airspeed is proportional to values of maximum lift/drag and wind speed. This indicates that faster glider airspeeds could be achieved with gliders with larger values of maximum lift/drag. A key result is that over most of the range of wind speeds between around 10 mph and 30 mph (and higher) glider airspeed increases nearly linearly with wind speed from around 90 mph up to around 285 mph (Figure 5). This result appears to be in accord with the anecdotal observations of the very fast glider speeds as measured by radar guns.

The relationship between maximum glider airspeed and wind speed (Figure 5) is based on using the optimum loop period, which varies with glider speed as shown in Figure 6. As glider air speed and drag increase, the optimum loop period decreases to provide more frequent shear-layer crossings and to achieve energy-neutral flight. Optimum diameter, on the other hand, remains nearly constant at around 400 feet for airspeeds greater than around 120 mph (Figure 7). The typical period of fast glider loops at Weldon was around 3 s, although periods as small at 2 s are possible but difficult to fly in efficient dynamic soaring (C. Bosley and S. Lisenby, personal communications). The optimum loop period of 3 s occurs near an airspeed of 300 mph, suggesting that it is difficult to fly at optimum loop periods at glider speeds greater than around 300 mph (Figure 6). This suggests that higher wind speeds would be needed to achieve a particular airspeed than predicted by the curve in Figure 5 using the optimum loop period. Fast speeds and small loop periods cause large load factors ~ 30 g as shown in Figure 8.

The travel velocity of a dynamic soaring glider was modeled by dividing the Rayleigh cycle into semi-circular half loops and connecting a series of them together in a snaking flight pattern, similar to that of an albatross (Figure 4). The glider was assumed to quickly change banking directions during the upwind and downwind portions of its trajectory. The average travel velocity for flight perpendicular to the wind velocity was estimated to be around 6.1 times the wind speed (Figure 5). For example, a glider soaring in a wind of 20 knots (23 mph) from a favorable direction could fly with a travel velocity of 122 knots and

Figure 5. Maximum glider airspeed (red curve) calculated using a Rayleigh cycle and the optimum loop period, which coincides with the minimum energy loss in a loop and the maximum possible glider airspeed for a given wind speed. The value of maximum lift/drag in straight flight was assumed to equal 30 at the associated cruise airspeed of 55 mph (airspeed of minimum drag), values that are consistent with a Kinetic 100 RC glider with added ballast (payload) of around 50% of the unballasted glider weight. The blue straight line represents the relationship for which airspeed equals ten times the wind speed (V = 10 W) and assumes a maximum lift/drag value of 31.4. Travel speed (green curve) is the component of (average) travel velocity for flight perpendicular to the wind velocity, assuming a snaking flight pattern consisting of a series of semi-circular half loops (see Fig. 4).

Figure 6. Optimum loop periods corresponding to the minimum energy loss in a loop and the maximum possible glider airspeeds in a Rayleigh cycle. The value of maximum lift/drag in straight flight was assumed to equal 30 at a cruise airspeed of 55 mph. Note that optimum loop periods decrease to around 3 s at an airspeed of 300 mph.



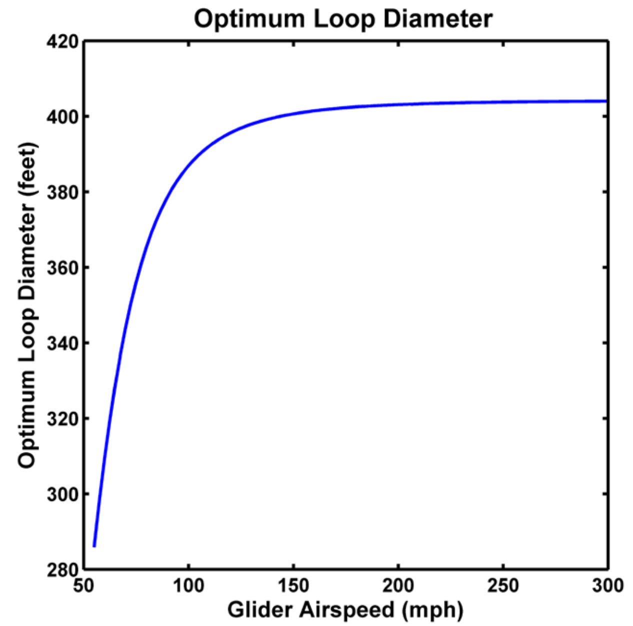


Figure 7. Optimum loop diameter corresponding to the optimum loop period and the associated maximum glider airspeed. Note that the loop diameter is approximately 400 feet for glider airspeeds greater than around 100 mph.

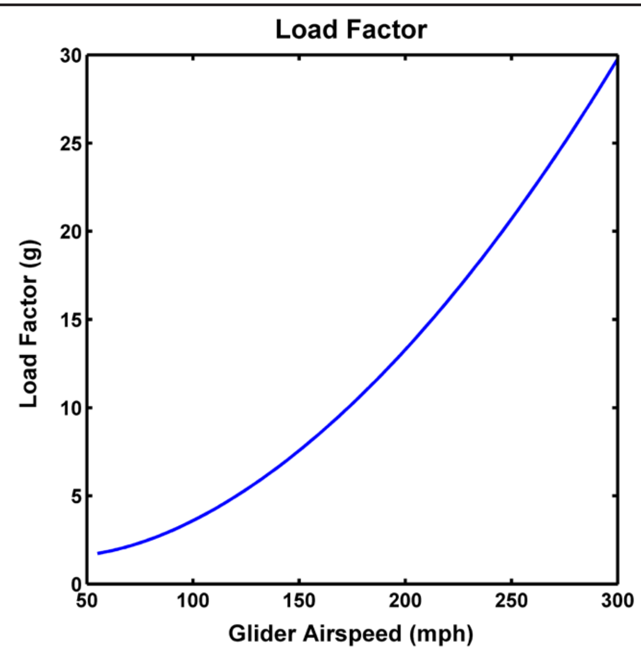


Figure 8. Load factor, which is the total acceleration of the glider in balanced circular flight, in terms of the acceleration of gravity (g). Load factor was calculated using the optimum loop period and glider airspeed. Note that values of load factor increase to around 30 times gravity at a glider airspeed of 300 mph. The corresponding bank angle is around 88 degrees.

cross the Atlantic in less than a day (from Woods Hole, MA to Brest, France, for example). Different travel velocities would be obtained in other directions relative to the wind, generally slower when headed into the wind and faster when headed downwind as was observed for albatrosses (see Deittert et al. 2009; Richardson 2011).

As in the case of an albatross, the Rayleigh cycle was used to estimate the minimum wind speed required for a high-performance glider to fly in energy-neutral dynamic soaring. Properties of a Kinetic 100 were used for the calculations, including an estimated maximum lift/drag value of 30 at a cruise speed of 55 mph (Table 1). The minimum wind speed is 8.1 mph at the glider airspeed of 55 mph, only slightly above the minimum wind speed (7.9 mph) for the wandering albatross. This airspeed of 55 mph corresponds to the glider's airspeed at the minimum sink rate in the loop, which is just above the stall speed. To help prevent a stall, the stall speed could be reduced by deploying flaps and also by increasing the loop period as in the case of a wandering albatross.

The 8 mph minimum wind speed for sustained dynamic soaring is small enough to suggest that it might not be fast enough to generate sufficiently large waves needed for gust soaring and that, therefore, gust soaring might not be an appropriate model for such low winds. However, in the presence of decreasing winds, which had generated large waves, or in the presence of large swell propagating into an area from elsewhere, the waves might be sufficiently large enough with the addition of local wind waves to generate lee eddies, which could be used for gust soaring. Clearly, it would be beneficial to fly a dynamic-soaring UAV in regions of substantial winds and waves such as the Southern Ocean, home of most species of albatrosses, and the northern parts of the Atlantic and Pacific Oceans, especially during the windier times of the year. In low wind speeds a UAV could adapt techniques learned from the flight of albatrosses and exploit both updrafts over waves and supplemental power. Supplemental power could also assist take-off and landing. Numerical modeling of dynamic soaring in low winds and waves might help develop a successful strategy for these conditions.

4. Could a robotic albatross UAV use dynamic soaring to fly at high-speeds over the ocean?

In the low-level part of a swoop, an albatross flies very close to the ocean surface in a wave trough, close enough so that the bird's wing tip often grazes the water surface. This allows the bird to descend across the thin wind-shear layer and enter the lee eddy located in the wave trough and then turn and climb up across the thin wind-shear layer again. Grazing the surface of the water with wing-tip feathers does not appear to be a problem for an albatross, but touching the wing of a glider in the water could cause a crash. To avoid a crash, a UAV must maintain a safe gliding distance above the ocean surface. However, to fully exploit gust soaring through the thin wind-shear layer over waves, a UAV must also be able to descend down below the wind-shear layer into a wave trough, and this could be compromised if the minimum safe flying distance above the ocean surface were greater than the wave height. Therefore, it is possible that increasing a UAV height above the ocean for safety could lead to a reduced amount of energy being gained from the available wind shear (compared to an albatross and Rayleigh cycle) and a slower maximum airspeed, especially with low-amplitude waves.

A related issue is that optimum loop diameter of the glider in fast flight is around 400 feet, much larger than the 167 feet of a wandering albatross flying at an airspeed of 36 mph and loop period of 10 s (Table 1). The larger loop diameter could make it difficult to fully exploit the wind shear for maximum airspeed, since only the lower part of the loop would cross the wind-shear layer and the crossing could significantly deviate from a direction parallel to the wind as modeled by the Rayleigh cycle. Therefore, there is a question about whether the larger glider loop diameter would affect the exploitation of wind shear over waves and possibly lead to smaller maximum airspeeds than values predicted by the Rayleigh cycle.

In the snaking travel mode the bank angle changes twice in each loop period, where loop period used here means the period of two semi-circular half loops. The loop period of a wandering albatross is around 10 s, much larger than the fast ~ 3 s RC glider loops at a speed of 300 mph. This raises a question about whether a fast glider in a snaking flight pattern over the ocean could quickly alternate steep bank angles to the right and left with a loop period as small as 3 s. Some rapid high-speed acrobatic maneuvers performed at Weldon suggest that this would not be a problem, but fast snaking flight over ocean waves by a UAV needs to be demonstrated.

In order to explore these possible limitations to fast dynamic soaring over the ocean, it would be beneficial to have experienced pilots of RC gliders take high-performance (waterproof) gliders to sea and experiment with field trials in order to measure how fast dynamic soaring could be accomplished in realistic winds and waves. An RC glider flown from the shoreline or from a ship would probably have to be confined to mainly short segments of snaking flight, to keep the glider in sight. In order to measure travel speed and further evaluate fast snaking flight, a car driving along the shore or possibly a helicopter might be used to track a fast glider. Perhaps a Coast Guard ship or helicopter could be made available, since a successful fast UAV glider could aid Coast Guard surveillance and search and rescue operations. In such demonstration flights it would be helpful to have instruments to measure high-resolution positions, orientations, velocities and accelerations over the ocean and through the air, as well as record detailed information about the wind and waves.

Deittert et al. (2009) discussed model simulations, which provide another evaluation of a UAV soaring flight over the ocean. They numerically modeled dynamic soaring over a flat ocean surface (no waves) using an exponential wind profile. Most (~ 65%) of the increase of wind speed above the (flat) ocean in their modeled 66-foot wind layer occurs in the first 3 feet, and thus most of the increase of wind speed of the wind profile was missed by their UAV because of its banked wings and the clearance to the water surface. Moderate glider speeds of 22-63 mph were obtained for a direction perpendicular to the wind direction in wind speeds of 18-45 mph (specified at a height of 66 feet). Their ratios of UAV travel speed to wind speed are around 1.6 as compared to 6.1 using the same wind speeds in the Rayleigh cycle as described above. Thus, gust soaring, which exploits the large wind shear located just downwind of ocean wave crests (and mountain ridges), is a more efficient way to obtain energy from the wind and to fly approximately four times faster than speeds achieved by using an exponential wind profile over a flat ocean. Simulations like those described by Deittert et al. could be made more relevant to soaring over the real ocean by incorporating the dynamic soaring of a UAV into models that resolve wind-wave interactions and features like lee eddies and detached shear layers, which albatrosses use for gust soaring. It seems probable that, when these features are incorporated into a simulation, a model UAV would fly closer to the speeds found using the Rayleigh cycle. Such simulations could also reveal information about optimal flight characteristics over waves. On the other hand, the slower travel speeds found by Deittert et al. could be more realistic in practice if UAV gust soaring turns out to be less efficient than predicted by the Rayleigh cycle.

5. Summary and conclusions

Fast dynamic soaring as demonstrated by RC gliders at Weldon CA was modeled in order to investigate the flight parameters that permit such fast flight and to evaluate whether dynamic soaring could be exploited by a robotic albatross UAV for fast flight over the ocean. A two-dimensional model (Rayleigh cycle) was developed of dynamic gust soaring along a plane that intersects a wind-shear layer. The model wind-shear layer is caused by a layer of uniform wind overlying a layer of zero wind, which was assumed to exist below and downwind of ocean wave crests and mountain ridge crests. The Rayleigh cycle was used to calculate the characteristics of energy-neutral dynamic soaring.

The maximum possible airspeed in the Rayleigh cycle coincides with the minimum energy loss in a loop and an optimum loop period. The optimum loop period was used to calculate the maximum glider speed as a function of wind speed. For wind speeds > 10 mph and a typical glider maximum lift/drag value of around 30, the maximum glider airspeed was found to equal around 9.5 times the wind speed in the upper layer. Both the fast measured RC glider speeds at Weldon and the results of the model Rayleigh cycle indicate how effective gust soaring through a wind-shear layer can be for extracting energy and using it to fly at exceptionally fast speeds. Maximum (average) travel velocity perpendicular to the wind velocity using the Rayleigh cycle in a snaking flight pattern similar to that of an albatross was found to be around 6.1 times the wind speed.

Could dynamic soaring be used by a UAV for high-speed flight over the ocean? As long as sufficiently fast winds and large waves generate lee eddies and the strong shear layers located above them, then in principle dynamic gust soaring could be used for high-speed flight. This assumes a snaking flight pattern similar to that of an albatross. However, for safety, a UAV needs to maintain a larger clearance above the water surface than does an albatross, which suggests that field experiments need to be performed to investigate how well a UAV can fully exploit the wind-shear layer above wave troughs to fly at fast speeds. In addition there are questions about how the larger optimum diameter and smaller optimum loop period of fast flight in the Rayleigh cycle could affect fast flight in practice. Test flying RC gliders at sea in various wind and wave conditions would be a good way to assess fast dynamic soaring over the ocean, especially the snaking travel mode of flight.

To further investigate the dynamic soaring of gliders over the ocean, it would be helpful to add instruments to measure high-resolution positions, orientations, velocities and accelerations over the ground and through the air, as well as information about the structure of the wind interacting with waves. Numerical modeling could be used to investigate high-speed dynamic gust soaring over ocean waves and help refine high-performance glider design and optimum flight patterns. A robotic albatross UAV would require the ability to measure and respond to the topography of the ocean surface (waves crests and troughs), the adjacent wind field, and obstructions like ships. Back-up power would be needed to help launch and recover a UAV and for low wind conditions, when dynamic soaring plus wave-slope soaring could be insufficient for energy-neutral soaring. Given sufficient wind, energy from dynamic soaring could be used to provide power for an autopilot, instrumentation, navigation, communication and an auxiliary motor. This would result in a somewhat slower UAV compared to the maximum speed possible but would be acceptable for many applications.

Acknowledgements.

I profited from discussions with Peter Lissaman about the aerodynamics of gliding flight and the model Rayleigh cycle. Chris Bosley and Spencer Lisenby invited me to see fast dynamic soaring at Weldon Hill CA and explained and discussed RC glider dynamic soaring techniques. Don Herzog flew me down to Bakersfield in his high-performance Trinidad airplane at 200 mph (much slower than the RC gliders) and joined in the trip up to Weldon. Paul Oberlander helped draft some of the figures.

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E-FLAPS

Eco-Friendly Little AirPlane Society

Our First ALES Contest

Larry Dunn, ledunn@centurytel.net
Photos by Larry Dunn and Fred Rutan

Our E-FLAPS (Port Orchard, Washington) club held our first ALES contest today under some very challenging wind conditions but I think it was a success. On the plus side, it was a gloriously sunny and mild day.

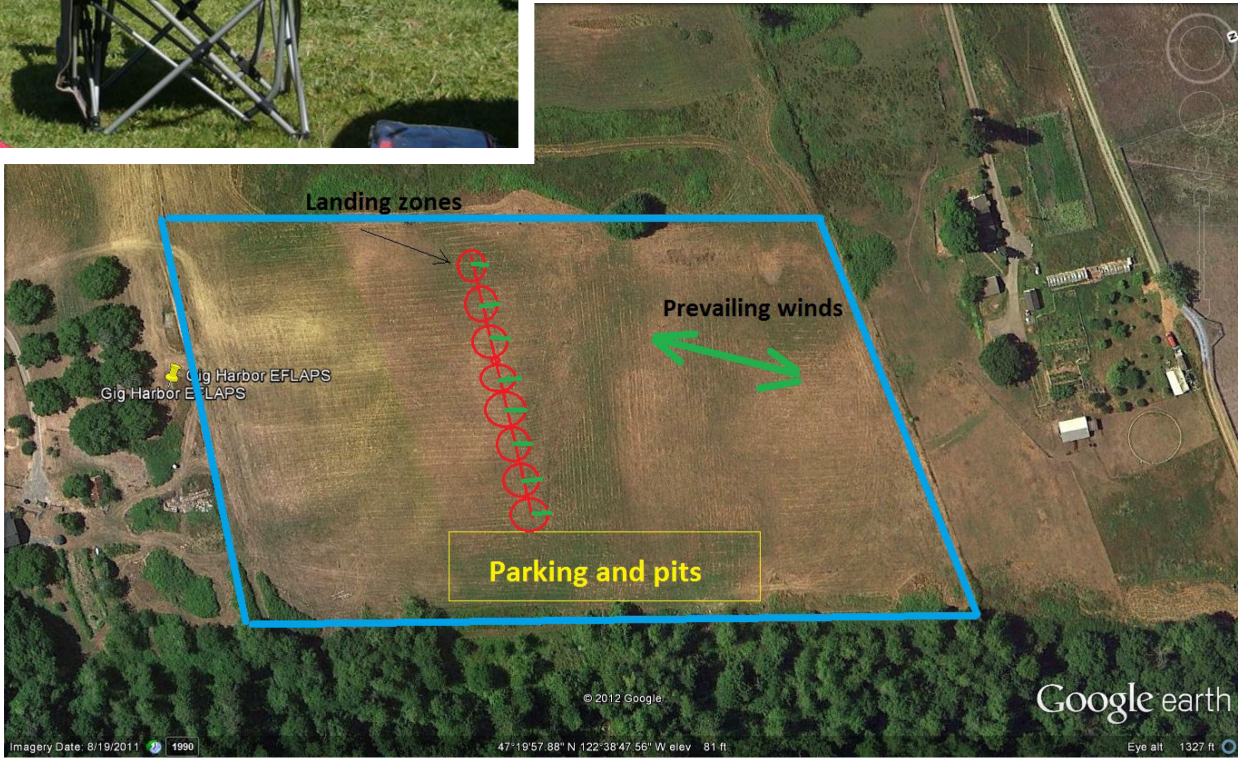
We had 12 pilots starting out flying everything from bone stock Radians to an Ava and two Bird of Times, my Mirage and several other built-up models.

Congratulations to James Henderson on the first place win flying a Radian!! Yes, the Radian beat out an Ava, two Bird of Times, my Mirage and several other built up models. Way to go, James!! Don't let anyone tell you Radians are at a severe disadvantage in windy conditions, either. It was blowing 12 to 15 mph most of the day with gusts to 21 and the Radian still placed first. Actually, I guess we have to give pilot James Henderson a little bit of the credit

As I said, the winds were a real challenge today and unfortunately we had some casualties along the way. The wind caught my Mirage and flipped it, damaging one wing tip badly and we had two or three other planes with significant damage. But - no one landed in any of the cow patties!

Thanks to everyone who attended and to my fellow club mates for their invaluable help.

We will do this again!


Landing zones
Prevailing winds
Gig Harbor EFLAPS
Gig Harbor EFLAPS
Parking and pits
© 2012 Google
Google earth
Imagery Date: 8/19/2011
1990
47°19'57.88" N 122°38'47.56" W elev 81 ft
Eye alt 1327 ft


RADIAN

35 YEARS OF Winglets

Chuck Anderson, chucka371@yahoo.com

Figure 2. Spica wings

I have resumed flying a model that uses the winglets I flew on my 2-meter model from 1979 through 1998. It occurred to me that my experiences in designing and flying winglets might be of interest to some modelers. This summary will also include the article I wrote for the May 1980 Model Aviation. That issue is available on the AMA web site

I learned about Whitcomb Winglets in 1977 while working on a research proposal. The project was never funded but the NASA reports I reviewed got me to thinking about using winglets on models so I decided to see if I could detect any effects on model airplanes. I really enjoy experimenting with my sailplanes and this looked like it might be fun without costing too much.

I needed a low aspect ratio wing that generated strong tip vortices to make it easier to measure winglet effects so I adapted my 1978 sailplane. The Spica is basically a cleaned up Paragon build around a fiberglass fuselage from my 1976 F3B model. It had plug-in outer panels to allow it to be flown as a 100 inch span standard class model or a 115-inch span unlimited class model. Removing the outboard wing

‹ *Figure 1. Spica 1979*

panels gave me a 78-inch span wing with an aspect ratio of 7.8.

The winglets were designed from criteria in NASA TN D8260 but with the winglet tip chord increased to avoid unnecessarily low Reynolds numbers. The root chord was 7 inches, tip chord 4 inches, height was 10 inches, and leading edge sweep was 30 degrees. Selection of an airfoil for the winglets was difficult because the tip chord was only 4 inches which put it below the critical Reynolds number for most popular sailplane airfoils at normal flying speeds. In 1979, there was very little low Reynolds Number airfoil data and only free flight model used airfoils flying in that Reynolds number range. The airfoil finally selected was a Go 796 thinned to 10% thickness with turbulator spars to promote early boundary layer transition.

A few flights with and without the winglets confirmed that the winglets were improving the performance but how much? I needed a simple and cheap way to determine the optimum winglet angle and measure its performance. Today, there are several telemetry systems available that would make it easy to evaluate performance but there were none in 1979. Absolute values of sink rate and airspeed need not be measured if the only requirement is to compare the effects of small changes to a model. Flight time from a fixed altitude can be substituted for sink rate, and the airspeed in steady flight is approximately constant for a fixed stabilizer angle. Comparing flight time from a fixed altitude versus stabilizer angle can provide a way to evaluate the effects of small variations to a model. Therefore, all that was required to evaluate the winglets was a stopwatch, still air, and a lot of time. If done with a good telemetry system, it would be possible to determine winglet settings for higher speed in addition to the speed for minimum sink rate.

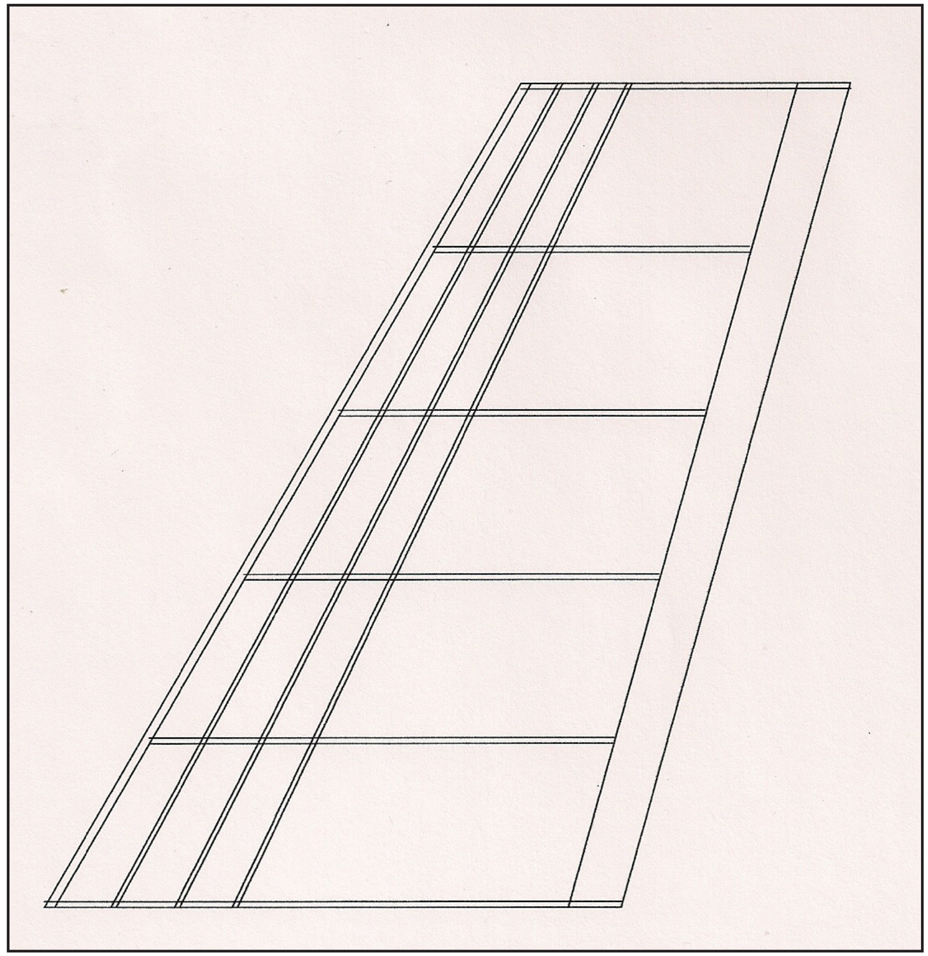


Figure 3. Winglet

All performance evaluation flights were made during the last hour before sunset with surface winds less than 5 mph. The stabilizer was set to a trim angle before launch and left there for the entire flight. All launches were made using the same winch with the turnaround pulley 250 meters from the winch. Each launch was flown as identically as possible and the flight aborted if any deviation from a normal launch was observed. The model was floated off the towline and flown in 500 foot diameter circles using only rudder trim. The flight was aborted if it became necessary to use rudder or elevator after tow release. The major problem with this method is that the data has a lot of scatter no matter how much care is taken to fly each flight in the same way so many flights must be flown for each winglet angle and stabilizer setting to get a good average.

Over 150 flights were made with various winglet angles to establish a data base. Another 50 flights were made under the same controlled conditions to obtain comparison data with the 78-inch wing without winglets and with the 100-inch wing. Polars were obtained for five winglet angles as well as for the model without winglets and for the Standard Class Spica. The maximum endurance obtained from the polars was plotted against winglet toe out angle to determine the best winglet angle for minimum sink rate. Longest flight times were obtained with winglet toe out angle of 3.5 degrees. The data can be found in the May 1980 Model Aviation article Winglets, Are They Worth It.

When I started back in 1979, I only wanted to know if winglets were of any value for model sailplanes. When I had enough data to show that the winglets were working, I ask Bill Winter if he was interested in an article on winglets for Model Aviation. When Bill asked for an article, I found myself committed to finishing the test program. When I looked at the data I had acquired, I realized that I needed a lot more flights to get a good average flight time for winglet angles between 2.5 and 4 degrees so I spent the rest of the summer filling in the data for those angles. I drove passed the model field on the way home from work every day and it soon became a relief when conditions were not suitable for testing. After three months, the testing was no longer fun but a job.

While the winglet investigation was far from complete, enough data were obtained to show that winglets can provide a significant improvement in sailplane performance for low aspect ratio wings; however the winglet toe out angle must be adjusted for optimum performance at a given airspeed. The winglets produce a wing rock when flying at low speed near thermals. It’s almost as if the model is waving and saying, “Here it is.” The rudder is very effective in inducing roll at normal flying speeds but is less effective at high speeds where the wing is operating at lower lift coefficients. The winglet model is very stable but is difficult to trim for a tight, hands off circle.

While adding winglets to the low aspect ratio wing gave about a 15% improvement in still air duration, there ain’t no such thing as a free lunch and improvements in one area must usually be paid for with penalties in other areas. Some of the penalties of large winglets are:

1. Winglets require more trimming and adjusting.

2. Winglets make the model more sensitive to wind gusts when landing.

3. Winglets have a narrow speed range and add drag if flown outside that speed range.

4. The winglets must be removable for transportation.

Figure 4. Carl Goldberg examining winglet

5. Winglets are more susceptible to hanger rash.

6. The winglet model is difficult to trim for a tight thermal circle.

While the winglets worked as expected, it is easier to just increase the wing span and avoid the sensitivity to wind and airspeed unless the rules limit wing span. For unlimited class models, winglets are not necessary or worth the effort if improved performance is the goal.

The Winglet Spica was not designed to the 2-meter class rules but when the wing span with winglets turned out to be slightly less than 2-meters, it became my 2-meter contest model. I flew the Spica in 2-meter and Standard class at the AMA Nats and LSF tournaments from 1979 through 1998. I even flew it in 2-meter, Standard, and Unlimited at the 1983 Nats at Springfield, MA using all three outer wing panels. The original Winglet Spica flew its last contest at the 1998 Nats and was retired after 20 years of contests.

At the 1982 Nats, I had just finished flying in 2-meter and was changing to the 100-inch wing for standard Class the next day when Carl Goldberg stopped by to discuss the winglets I had been flying all day. I put the winglets back on and spent a very enjoyable few minutes discussing winglet aerodynamics.

Job conflicts prevented me from entering the Nats from 1984 through 1990. In 1991, I was able to resume flying at the Nats whenever it was flown at Vincennes Indiana or Muncie Indiana. I started flying in the Visalia Fall Soaring Festival in 1993. The Spica could be packed in an archery bow case and carried on the airlines as luggage at no extra charge so I always carried it as a backup for my Unlimited sailplane but only had to use it one time.

The Winglet Spica's last contest win was in 1996 when I flew it in unlimited class after damaging my unlimited model. The Winglet Spica won because of unusual weather conditions that day. It was a clear day with no wind and small weak thermals. I never got higher than initial launch altitude and floated around working very small weak thermals. The Winglet Spica talks to me a lot. It signals lift by rocking the wings when flying near the edge of a thermal. Trouble is it often lies in turbulence. There was no wind that day so I was able to find and work a lot of thermals that were too small and weak for most unlimited models. This was my third LSF Level V win.

In July 1997, vision problems forced me to give up contest flying with small sailplanes; however I did enter 2-meter at the 1998 Nats just to complete 20 years of competition before retiring the Winglet Spica. It is now hanging from my shop ceiling.

Even though I had stopped flying 2-meter contests, I did not give up considering winglets for other applications. I really liked the way my winglet model responded to rudder as compared to the way the same model responded to rudder with the 100-inch wing. It was also more stable on tow and climbed as if on rails. In 2001, I designed a high performance RES model with a

Figure 5. Spica Visalia 1997

Figure 6. '79 and '09 Winglet Spicas

140 inch span to accommodate my reduced vision. The performance lived up to spec but the handling qualities did not meet my requirements. When modifications to dihedral and fin/rudder area failed to give the control I wanted, I considered adding winglets to give increased control power. The final increase in fin and rudder area gave the desired control response so the winglet option was never tried. It would have been an interesting experiment.

In 2009, my club scheduled a club 2-meter contest. I though about taking the Winglet Spica out of retirement for the contest but instead build a new set of wings with winglets for a later version of the Spica.

The new wing has a Bubble Dancer type carbon fiber spar and a Drela AG35 airfoil. I considered using a good hand-launched glider airfoil for the winglet but finally decided that I didn't want to go through another test program so I just copied the original winglets. The new Winglet Spica has the same good flying qualities as the original so it has now become my fun-fly model for light winds.

If the span is limited by rules, then winglets allow a much larger wing to be used. A wide chord, low aspect ratio wing with properly designed winglets flies at a much more efficient Reynolds number without excessive induced drag. The larger wing combined with the winglets make the model much easier to see. This has become more important as I get older. One final advantage of large winglets is that I never fly the wrong model when circling in a thermal with other models. The Winglet Spica is fun to fly as long as I don't have to chase thermals too far away.

When I designed the original Spica winglets, there was very little reliable information about airfoils in the winglet Reynolds number range. Today, there are good airfoil design programs and wind tunnel data as well as the work done for hand launch gliders. If I were to start over, I would use one of the modern hand launch airfoils on the winglets. There is also much more information about winglets on the internet. "Wingtip Devices" on Wikipedia is a good source of general information on winglets and other wing tip devices to reduce drag but doesn't have much technical information about the design of winglets. It also discusses other non-planar wing concepts, some of which I have used on most of my sailplanes since 1973.

Figure 7. Current Winglet Spica

Meter Beaters

Jim Spell, hazpro@live.com

With the advent of inexpensive high quality electrical components, i.e., Made in China… high powered electric flight is now available to everyone. Because of this "warehouse pricing," pilots are able to add affordable power plants to dusty old workshop planes and be in the air for less than $60.00. These economical excursions into electric flight have become affectionately known as "Meter Beaters."

Made popular in the West, Meter Beaters are fast becoming the "WOW" at RC airfields. Bob Buske, one of the founding fathers of the MB philosophy, enjoys landing his ancient Global "Easy Answer" (two meter glider) just above stall speed and dropping it at his feet... this after buzzing the field inverted. Imagine a polyhedral wing doing a low flyby at your field!

Forgoing such concepts as "scale-like appearance" and "beautifully finished," the Meter Beater pilot prefers flight and formula to "finely detailed." Meter beaters or MB's for short, are built fast and functional. The main idea is to apply motor, speed control and battery in proper combination so as not to tear the multicolored stick built wings off a 20 year old fuselage preferring to fly it right up to the performance edge. For the MB pilot it is not about power but about speed and balance, both on and off the flight line. The mission of an MB pilot is to quickly assemble an aerodynamic if somewhat funky model and install massive Volts of LiPo power into a brushless motor designed to deliver enormous amounts of Watts at the prop. Then go out and have yourself a hoot and a ball…duct tape, toothpicks and "superglue" notwithstanding.

Fly the P-51 or Stinson Staggerwing on the Forth of July because Meter Beaters are for flying everyday… all day. As the Meter Beater Motto so aptly expresses, "A beautiful flight with an ugly plane is still a beautiful flight."

Granted it is extremely difficult for a master builder to wrap his or her thumbs around the idea of a high flying, high performance airplane, kit bashed from an old hanger carcass, but that is exactly what you have to do in order to enter the world of Meter Beaters.

Utilizing all of your experience with incidence angles, CG positioning, servo placement and stress points, you forget about the tape repairs and spilled glue from years past and you resurrect that old remembrance all the way up to flying status.

And it doesn't have to be that two meter glider way in the back of the shop. Any plane can be modified to withstand the rigors of modern electric flight, given the correct power package… an old gasser whose motor didn't survive that nose first landing… a sloper that you never quite had time for. And if it breaks, you stick another together over the week and you are flying again by Saturday, and probably with the same power plant as last week.

A Meter Beater - Bob Buske's 25 year old Gentle Lady ready for some fun flying. >

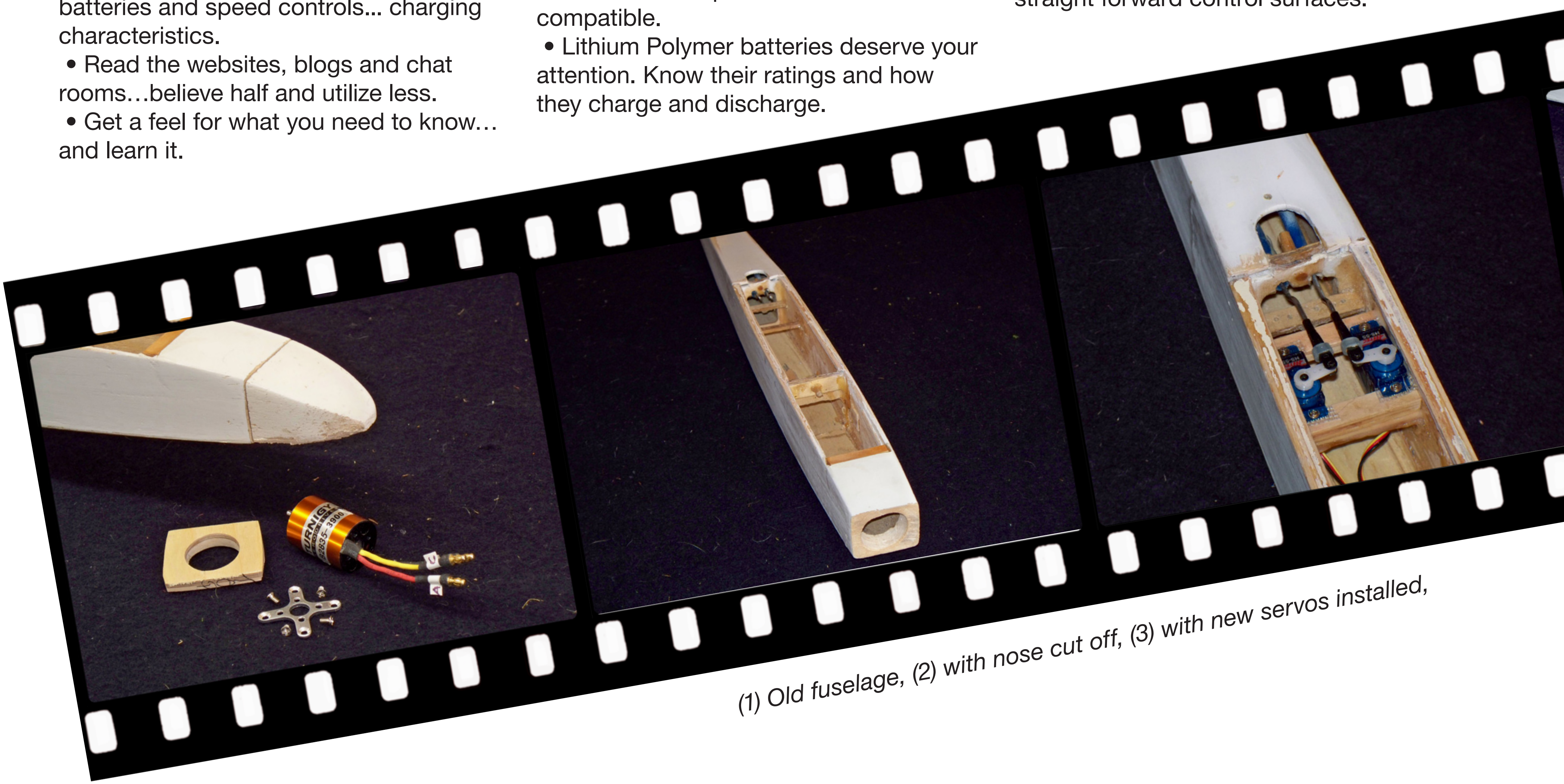
The object of a Meter Beater is to fly frequently and for fun…and if you happen to learn about Volts, Watts, Amps and the like, so much the better.

Meter Beater Basics

- Learn about power systems... how they work and how they work together.
- Study types of motors, size of batteries and speed controls... charging characteristics.
- Read the websites, blogs and chat rooms…believe half and utilize less.
- Get a feel for what you need to know… and learn it.
- Buy a Wattmeter and learn how to use it. Understanding a Wattmeter means you are beginning to “get it”… study electricity.
- Respect the “power” of these new electrical components… 14.8 Volts is a lot of “punch” as is 300 Watts at the prop.
- Electrical components MUST BE compatible.
- Lithium Polymer batteries deserve your attention. Know their ratings and how they charge and discharge.

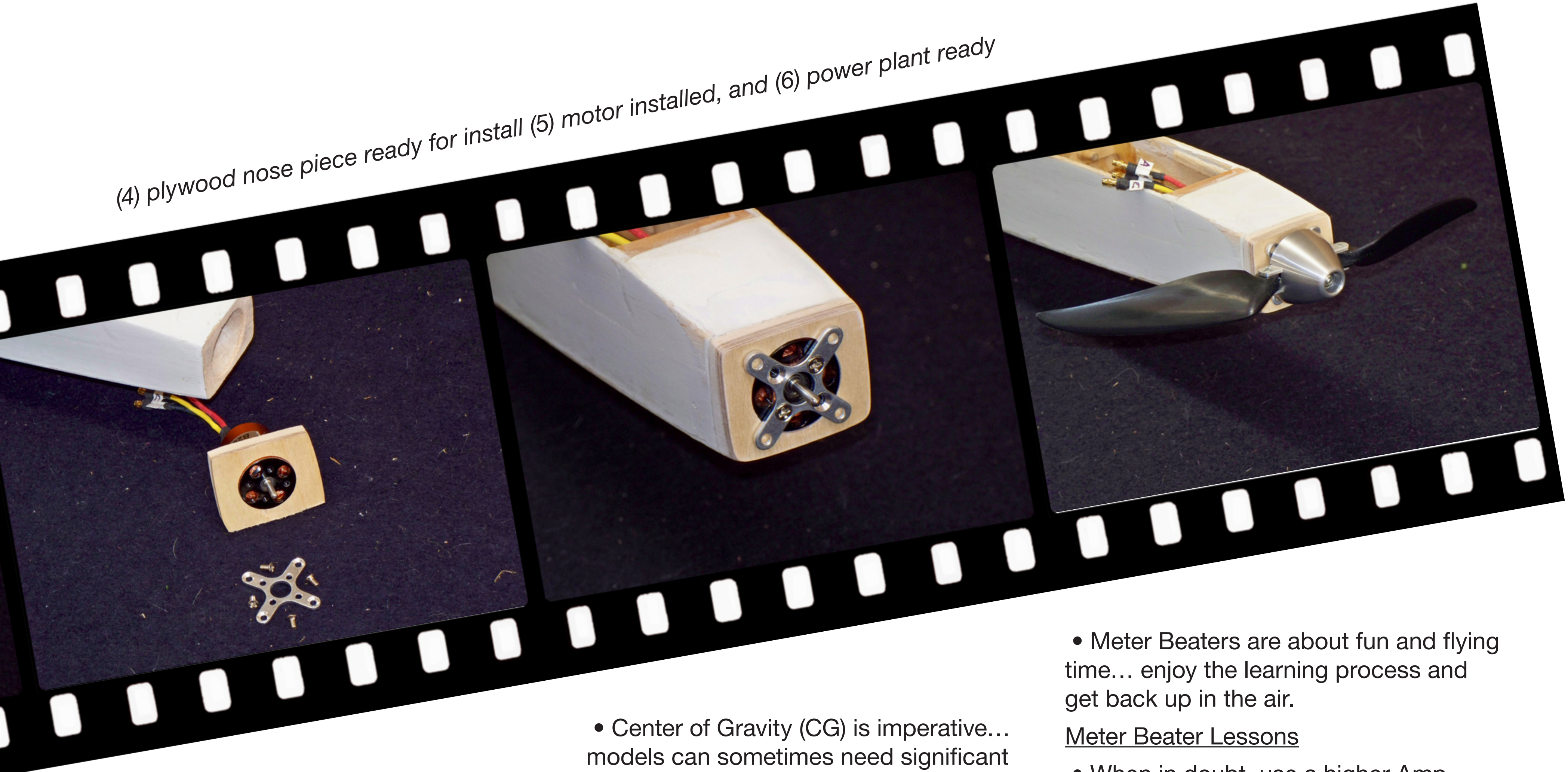
Meter Beater Plane Selection

- Let go of the guilt… spend time making your MB aerodynamically engineered not cosmetically correct.
- Develop a complete plan… know how much power your plane needs and use it.
- Minimal or reasonable repairs first… straight forward control surfaces.



(1) Old fuselage, (2) with nose cut off, (3) with new servos installed,

(4) plywood nose piece ready for install (5) motor installed, and (6) power plant ready



• Insure room for modifications… new servos, power systems, modern radio components.
• Confirm angles of incidence… especially with different wing designs.
• Ensure proper throws for the power you are utilizing… apply dual rates and use them first.

• Center of Gravity (CG) is imperative… models can sometimes need significant nose OR tail weight.

<u>Meter Beater Etiquette at the Flying Field</u>

• Think outside the museum… be prepared to fix or modify anything. Share your stuff with others…after seeing your MB; folks will assume you can repair anything.
• Tolerate the teasing before you fly… and the attention after.

• Meter Beaters are about fun and flying time… enjoy the learning process and get back up in the air.

<u>Meter Beater Lessons</u>

• When in doubt, use a higher Amp rated speed control.
• Start with smaller props and work up… check for heat and noise.
• Stay behind the prop just like the gassers… folding props cut just as deep.
• Mount the motor secure and strong… use a breakable lockset fluid for ALL screws

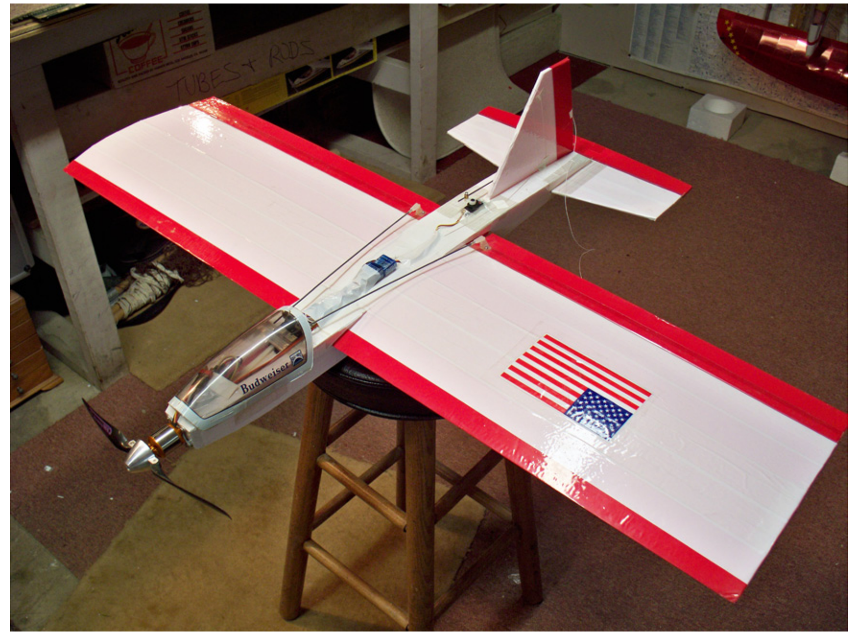
- Beef up firewalls and mounting assemblies… use NO plastic.
- Use cutoff switches whenever possible.
- Yes, 100 Watts per pound is more than enough power.

Alright, let’s be perfectly honest. Meter Beaters are not a new idea, but rather an old solution. As traditional (translation: “old”) modelers we are all familiar with the miscalculations and design flaws that send us back into the workshop to salvage and repair our beautiful builds. We spend hours bringing our “baby” back up to “field form” as well as flying status… sanding patches and matching Monokote. And there is great satisfaction if not pride in this. In fact, most of us remember when a skilled model builder was as respected at the local flying field as a great pilot and brilliant repairs were met with awe. But with the advent of ARF’s and yes, those “overseas knockoffs,” anyone can fly anything once and the thought of replacement is easier to comprehend than repair.

Meter Beaters are simply airplanes flown by pilots whose desire to fly has overcome all obstacles except maybe their wallet. These are the folks who cannot bear to put a splintered and tangled mess into the trash but would rather dispatch them to a distant corner of the shop to be buried forever.

Now we have a name and an excuse to bring them back from our model graveyard and to fly again and again without apology. Not that we ever needed it, but it helps. Learning to take a step back from that “perfect plane” and engage in straightforward aerodynamic engineering is a huge step in anyone’s modeling career. And it is one that must be taken if you are to improve as a pilot. Period.

Interestingly enough, almost every Meter Beater pilot has one or more magnificent and meticulously hand-crafted airplanes in their workshop. They fly them often and with the poise and precision that comes with hours of practice. Practice hours that come worry free because of these wonderful and slightly irreverent “aeroforms” known as “Meter Beaters.”



A Meter Beater can also be a converted slope ’ship.

Bob Buske hands his Meter Beater over to the author

CEWAMS

Chris Erikson's Wild Arsed Mountain Slopers

Saddle Mountain Slopener, April 2012

Philip Randolph, amphioxus.philip@gmail.com

In which: A moderate amount of flying toys. Michael Zanol takes the pulse of a dead coyote. A charge by a demented shopping cart, and operator. Lesser beings not present prove to be omnipresent or archetypical: Mr. Zanol's scientific invention. Philip proves himself wrong and thereby achieves greater olfactory understanding of nomadic third world poverty. A tornado tragically offers reprieve. Chris replies to Philip but thinks he is replying to his sweetheart, and thus sends Philip a love note, excised from this article for his delicate privacy, and that of his sweetheart. Not mentioned again. (Too bad for you.) Plus: Many bad puns of questionable taste. (Well, of unquestionably poor taste. Some redacted for delicate viewer's comfort.) What guys talk about, when unmoderated by the civilized half of the species. A bit of slope opera. Not in which, on the trip, I only blabbed a little about Frederick William Lanchester's phenomenal, 1894, wave theory of lift. See last month's *RCSD*. Look at the pictures—they tell most. It's a wild, fresh take on aerodynamics. There. PSA over. Or SSA. (Self-Serving Announcement.)

Getting there is half the, well, not quite, but...

The attendance was whittling down. Erik Utter wouldn't blow off his corporate obligations for lower purposes. Bill Henley let us know that a friend on a trip to California had his house here in Seattle burglarized, so he had to clean it up. (Quote #1, slightly adulterated, from an earlier email: "As he will not be attending, Mr. Henley will not be exuding Argon and Xenon in our presence. (No Bill gasses.)) Sanders was building shelves in his expanded garage for toy airplanes. (Evidently it's more important to store them than to fly them.) Dave Carey was on a scientific trip to Argentina. Ryan wasn't eager to have the border guards do another investigative search and interrogation, in order to cross down from British Columbia.

So Friday night, it was to be Chris Erikson (intrepid slope explorer and flounder of the non-organization, Chris Erikson's Wild Arsed Mountain Slopers), Mike Zanol (intrepid camper and hiker), and me.

Saturday we were expecting Stephen Allmaras, perhaps a couple guys we hadn't met, Steve and Dave, and Damian Monda.

Friday afternoon: I load up half my S-10 pickup with six-inch beach logs, the other half with camp gear and toy planes.

Destination: Saddle Mountain, central Washington, ten miles south of Vantage. Saddle runs East from the Columbia river for 25 miles, and West from the Columbia river for a few more. It's a ridge. The Columbia River won, having been their first, and thus exerting dominance, but the gap was one of the choke points for the ice age floods that ripped the Columbia River gorge. The Columbia hadn't always won. It got pushed around by uplifting Cascades and lava flows. But then it got older, and this ridge folded up, but not so fast that the river couldn't cut its course through it. By now it is so peaceful, having been tamed by fish-killing dams, that as I dropped down toward the Vantage bridge it just made me feel good. Gorgeous country.

But back a couple hours earlier, in Cle-Elum: I'm poking along the gastro-intestinal aids isle in the local Safeway when suddenly this big guy with a short black beard and angry eyes in an old army jacket is charging his full shopping cart down the isle, straight at me. Running. I was scratching my head trying to remember if one of my arch-enemies got out on parole. Well, I didn't have

Title page photo: Stephen Allmaras at Sentinel, with Lumberjack.

Philip's truck half full of wood. Mike Zanol and half of dog.

Fire and Tikis, Damian and Mike .

to scratch long. I don't have any arch-enemies. That I am aware of. It's Damian. Quotes: "I was running my cart straight at you, and I could tell you didn't recognize me at first, and you didn't even change expression." "Yeah, but I was faking it. I was saying, 'Well, this is kind of freaky.'" Later: "I thought you weren't going to make it till tomorrow?" "I have work obligations. I brought my computer."

A couple hours later, sixish, we pull into a camp spot in the middle of basalt cliffs. Michael Zanol is there, with a big pile of cherry wood. Damian sets up his black "POW MIA We Have Not Forgotten You" flag, and six Tiki Torches. He unloads a huge crate of firewood from his ForeRunner that he traded Cokes to some factory workers for. He hauls out a car battery, a couple fair sized speakers, a Zune MP3 player, cranks the tunes. It's loud enough so that it reminds me of that time in Southeast Alaska, by a little island near Craig, when we anchored a couple salmon seiners full of twelve guys near a big sailboat and proceeded to crank tunes. A while after I got out my old cornet and blew till my lips were flubber, the sailboat up-anchored and set off to find more peaceful climes. Well, here we didn't scare anyone off, that we know of.

Friday evening quote: "Where are all the refrigerators and washing machines full of bullet holes?" Someone has cleaned up our camping hole-in-the-wall. The only trash left are small chunks of an old

Pete and Weasel Evo. 30mph winds.

toilet, evidently used for target practice. And empty .22 casings. Well, Chris's deathmobile, while not having actual bullet holes, is not a bad substitute for a dead refrigerator. It's a 1975 Datsun 510 wagon, with over 200,000 miles on it, yellowish tan mixed with navy blue replacement fenders, and six headlights in the grille. We build a big fire with my beach logs and Michael's cherry, crank the tunes, and look at the sky.

Scents: Michael picks a big bunch of sage. We all take turns burying our faces in it. Olfactory heaven.

Sky: Venus is huge. Jupiter is down toward the horizon, opposite Mars. After Jupiter sets, Saturn rises. Chris says, "How they're spread out makes the ecliptic plane very visible." He always says stuff like that.

Damian and Chris, over beers, have a long and detailed discussion of their favorite characters in Northern Exposure, and a couple other old TV dramas. Michael has set up the Tiki Torches, to lead up a sandy path, for some inscrutable purpose. But after a while they blow out. Or Damian collects them.

Marvin, not here and omnipresent: Michael is an eloquent espouser of liberal issues, hence his big arguments with Chris. But in science, well, this night he is as possessed by the spirit of Marvin, who didn't make it, but whose science is, well, amusing. More later. He goes on about a technological application he thought up. “Why can’t we use solar cells to make the current to electrically separate the hydrogen and oxygen from sludge, and then recombine them to make clean water. The world has a shortage of clean water.” Oh, yeah, Michael has brought two dogs.

Late at night: Clean water my arse. Philip: “Michael, your dogs are marking their territory right next to my truck, and my toy airplanes.” (Well, that’s not quite what happened, but this is a family eRag.)

Michael: “They’re ten feet away.” Heck. I could grab its collar and my truck and have bent elbows.

Chris calms things down, by kicking sand over it all.

Michael: “It didn’t get your toy airplanes. See?” He bends down toward where Damian has piled the Tiki Torches. Blotto to the point where he thinks a Tiki Torch is a toy airplane. What if he tried to fly one? Oh, well, they aren’t lit. The price of gud times. Clean water. Solar cells. But I had noticed that the clean desert smell of sage had been somewhat eclipsed.

Saturday. Weather: Beautiful. Warm. Windy.

Leaving our campsite bright and early Saturday morning at the crack of 11:00 AM, Philip takes a picture of Michael Zanol taking the pulse of the dead coyote. (Not included here, but available upon request through the editors.) Maybe should have got the whole group on that, with a few planes. Or hauled it along, to hoist on Damian’s POW MIA flagpole, as a sort of a mascot, or a wind gage.

Stephen Allmaras meets us at the taco stand in Mattawa.

Previous readers, you will remember ‘attitude girl,’ the glowering matron of three Mattawa businesses in one building — the auto parts store, the liquor store, and the espresso bar. Gawd she was fun. It was worth getting coffee or hooch just to see all that attitude. Damian claims I made her smile once. Well, the espresso bar and the liquor store are boarded up. Should have checked the auto parts store. It was always like, ‘Scary Movie II.’

We munch. Michael orders a tongue burrito, and I order lengua (tongue) tacos. Michael always used to order sesas, brains, before the mad-cow scare. Now they don’t serve sesos. Too bad. He’s a lawyer. He needs all the brains he can get.

BTW, grumble girl once sort of half explained that Mattawa is the Mexican’s town, and we should go to Desert Aire, down by the river. Now, just a bit closer to the highway, there are a few real Gringo looking businesses, including a nice, big, Red Apple Market. I go across the street to a little Mexican grocery store, for water and ice. I also get a mango and a few ‘guyabas.’ The woman behind the counter explains she likes them. They turn out to be a sort of small fig, with white innards. I stick the rinds on Chris’s deathmobile, for enhancement. And it’s up to Sentinel. Well, all but Damian. He drives off in search of Wi-Fi signal, ’cuz he’s supposed to round up a team by Monday, for some project in Wichita.

On the gravel road up to Sentinel, we meet Pete, who we barely missed at the taco stand. New blood.

Sentinel, the knob at the west end of Saddle Mountain, 1400' above a bend in the Columbia River, below to the West. Wind rips out of the northwest. We drive a couple miles east to see if a steep north face works. It’s that one where Damian found the kid who flew over the edge on his motorcycle, and, amazingly, was okay. Too much sheer to even try. Back to Sentinel.

My wind gage mostly reads between 25 and 35 at the lip, occasionally down to 17 or up to 40, mph. Stephen Allmaras gets in the air first, with his Super Scooter. Steve gets the award for the most stick time. He also flies a Boomerang and a Lumberjack. Chris puts up his Sheetrock. Damian flies a 4' Mountain-Gote-cut chevron, and later his Great Jones, that he designed, cut, and built, all by himself. Delta wing with a fuse and tail. I fly a Half-Pipe and a Sonic, a Chevron that preceded Bowman’s Hobbies JW, with the same airfoil. Unfortunately, it has a radio glitch. Michael, well, we haven’t ever been able to get him to grab one of our sticks. He normally flies a Guinness, 163mm, 305cc.

Pete has a Weasel Evo. He's a bit light on experience, so Chris helps him fly it. He does okay. Unfortunately, Chris likes to fly a properly balanced wing. In this wind, a newer flyer would have done better with the CG a bit more forward, gaining stability. The price of forward CG is having to set more up elevator for level flight. That makes more drag at low speeds, but in this wind it would be invisible. It looks to me like it's still flying at the edge of twitchiness.

Towards 6:00 PM, Stephen says, "Hay, Philip, want to try some DS?" Okay, I always write 'Hay' instead of 'Hey.' It's that stuff horses eat. So Steve tries some DS with his Super Scooter. It's tough. He catches it just right, once. One loop. I try a bunch of times with the Half-Pipe. I got it used. The guy who built it reinforced the middle with glass-reinforced tape, running fore and aft. It has taken some impacts. Now, tape should be spanwise, near the trailing edge, because on a nose bonker, the wingtips want to spread forward, which they have. Near the left wing root the tape has split along the fore-aft lines of glass fiber, top and bottom, and all the way through. The whole left wing pivots around the joiner. But it's a friction fit, so I shove it back into alignment, and try some DS. I'm not good at DS, in spite of those *RCSD* articles I wrote. Many tosses. Many crashes. The guys back at the trucks hear me yell, "Yes!" for the one circle in which I do it right. And it's off to Cow Corner, minus our newest addition, who heads back to Seattle.

Cow Corner, where Michael again plays Marvin, and so does Philip

What we call Cow Corner is fifteen or twenty miles east of Sentinel, on the same Saddle Mountain Ridge. I should have taken a photo in the early morning light, of the little valley we camp in. Gorgeous. Old yellow grass stalks above newer green. The mustard flowers aren't out yet, but soon they'll cover this hillside.

< *(Fore to far) Chris, Stephen, Pete. View south across Columbia River.*

Super Scooter, with which Stephen took the most airtime.

Michael opens the tailgate of his white Blazer. He holds up the remains of a jug of Dry Fly vodka. It's out of a little designer distillery up Spokane way. "It must have busted when I went over a bump." Everyone is disappointed. Michael is noted for bringing upscale hootch. There is a bit in the bottom of the bottle. I suggest straining it to get rid of glass shards. Michael upends the bottom of the bottle, and drinks it off. Philip: "Well, the glass shards in your crop will help you grind up worms."

Cows. They have been here. Philip gets Chris's shovel, and spends a half-hour removing the big, mostly dry things. Damian and Michael retrieve rocks to rebuild the fire circle, and get the remaining wood from the trucks. And then! Philip gets a brilliant idea, which ultimately will help him commune with the costs of third-world nomadic poverty. Off in Mongolia and in the Sahara, nomads burn camel dung! Philip shovels four or five tire-flattened, quite dry cow Frisbees into the firepit. Mike Zanol seems to think this makes sense. Damian doesn't object. Chris does. A couple times. The second time he makes an iPhone vid.

Chris: "That stuff is going to stink. Whose truck is downwind?"

Philip: "Well, Damian's."

Chris: "Who else?"

Philip: "Steve."

Chris: "Who else?"

Philip: "Let me think a minute. Oh! Fortunately: You!"

Chris stomps off. Returns, as Michael lights the fire, and adds 1x4s from Damian's wood box.

Philip, almost instantly, as he grabs the shovel: "You were right, Chris." Philip uses the shovel to remove Michael's 1x4s, and picks up a burning, 14" cow Frisbee. He takes it thirty feet up the road, leaves it in a tire track. Returns.

Philip: "This stuff stinks to high heaven."

Michael. "It's just grass." Michael has put his 1x4s back on top of the burning cow manure. Philip removes them with the shovel and deports another smoking Frisbee.

Michael: "I haven't gotten a whiff of it yet." He puts his 1x4s back on.

Repeats three more times.

The cow manure, up in the road and on a bare spot beside it, continues to burn for half-an-hour. Yep, burns gud.

Now, the technically interesting thing here is the contrast between two neo-Marvin scientists, in how rapidly they give up their hypotheses in the face of conflicting evidence. To (lack of) wit: "It's just grass." And "This stuff stinks. You were right, Chris."

Chris's comment: "If it's just grass, why don't you lie down in it?"

Chris' 6' Sheetrock, looking west across the Columbia River.

Cuz it's on fire, nitwit? (Things we wish we had said, at the time.)

So we cook steaks and frankfurters and sausages that Damian calls, well, skip that. All on the tailgate of Damian's 4Runner.

What guys talk about

It gets cold, and clear. Venus, Mars, and Saturn are again in the same elliptic. (No disorbits.) Fire blazes. Lots, lots of wood. Beers. Chris has some <$10 tequilla that is surprisingly smooth. And he has some corn whiskey moonshine in a mason jar. Me, I take it a bit easy, which means sips. Also, I got St. Pauli Girl (lightweight) Beer,

Cow Corner looking south. Deathmobile is third. Dog is not dead.

so I wouldn't get too looped. See how pious I are?

Piety, as in religion: Philip, to Damian: "Is it the violin, or the player." Damian is Catholic. It will be tomorrow when I explain that I am complimenting him.

Michael, looking thoughtful: "It's both."

Marvin, here again: Remember that stuff from an earlier slop report, about Marvin trying to convince Steve and me, "Doesn't ice melt just a little, when it breaks?" Well, Steve and I are both here, so Marvin's spirit, having possessed Michael Zanol, resurges with his innovation, of getting hydrogen and oxygen from sludge, by electrolysis, powered by solar cells, and then recombined into water. "The world is running out of clean water."

"Yeah, but you don't want it clean anyway. You want it as a component of beer."

Philip: "You could mount the solar cell on your motorcycle and use its electricity to separate the hydrogen and oxygen from your beer, and then burn them, powering your motorcycle, and collect clean water from the exhaust pipe."

He and Stephen actually have a fairly long discussion, in which Stephen actually answers him with some seriousness. Oh well. Stephen explains

Damian's Great Jones, home wire cut.

that the most efficient method of producing clean water is with osmosis.

Then Michael somehow starts talking about how Dachshunds originally were tough dogs, till the breeders started making them smaller, and with shorter and shorter legs.

Philip: “Maybe they’ll breed the legs right off them, so they’ll be like snakes.”

Chris: “Oh yuck.”

Further description is redacted, as this is a family eZine.

Sunday morning

Chris: “Zanol and I stayed up till 2:30, arguing about whether corporations are really people. I finally got him to where he told me to shut up and said, ‘Let’s change the subject.’”

Michael: “Corporations aren’t really people, because you can’t put them in jail.”

Okay, here as an outsider, I’m actually not sure which of them was arguing which side. Maybe it was Chris who said, “You can’t put a corporation in jail.” See? Maybe both of them were arguing the same position.

I tried to throw Chris a bone. I figured since he doesn’t like governmental regulation, I could get him to agree with: “Sure you can put a corporation in jail. A corporation’s jail is regulations.” Chris argues back. Oh, well. I doubt if I could get him to agree with himself.

Damian explains, “On Friday, my boss’s boss, who is a VP, told him to get eighteen persons to Witchita by Monday. My boss said, ‘Damian’s on it.’ I did it. Rounded them up. Only as of this morning it’s all on hold. A major tornado hit the plant. All employees are told not to show up.”

Philip, to Damian: “When I asked if it were the violin or the player, I was complimenting you. You play your religion well. Maybe I should have asked, is it the sheet music, or the instrument?”

Chris: “Maybe Google will come up with an app that translates Philip.” Variations follow, by most.

Dave’s E-Cub.

Marvin, again, as Philip washes his hands under Chris's five gallon jug:

Chris: "I only have about three gallons left." He's pretending that he's worried about water.

Philip: "Is your water broken?"

Philip, trying to be Marvin: "When an ice queen's water breaks, does she melt, just a little?"

Breakfast. Damian makes fried vegetables. I fry another steak. Chris makes hot doggies.

Nerd talk: Damian starts talking about a college course he took involving convoluted forms of Taylor and Loren series expans of functions. "The guy started virtually every lecture with a recap of the fundamental theorem of calculus. That's basically that the indefinite integration can be reversed by differentiation, which guarantees antiderivatives of continuous functions. Or roughly vice-versa."

Stephen responds. Stephen has a Ph.D., so whatever he said is even less intelligible, and the back and forth looks like what a tennis match would look like to a visiting Martian. But they have a good time, proving once again that beer is a gateway drug to mathematics, or that the antiderivative of mathematics is beer. Even though Stephen doesn't drink beer. Especially with breakfast.

Damian throws the rocks from the fire circle up the bank. It is CEWAMS standard operating what we do sometimes to leave few traces, here. He shovels dusty dirt over the black of ashes and burnt out coals. He salvages a few cow pie Frisbees, places them where the fire was.

And we're off to the flying site by Wahatis peak.

Robot flying time

Where the wind is okay, if a bit light, and later sporadic. Again, Stephen gets the most flying time. My Half-Pipe is a bit heavy for the light wind. I fly the Sonic a few times. But its radio glitches are even worse. That makes flying interesting. At one

Chris points to his downed plane. The telephoto shot hides fact that the plane is far, far down, hundreds of yards. But earlier he went further down. Chris wins the walk of shame non-contest.

point a glitch rolls the thing 360°. I do get to fly Damian's Javelin, 60", standard planform, EPP wings, standard tail on a boom. The CG is initially a bit aft, so we bend a 1/4" rod of lead around its nose. Flies great. Reminds me of mine, which is too busted up to haul.

Damian spends a fair amount of time in his truck, on his computer and cell phone, poking at the post-tornado fallout and chaos from his Wichita project.

Another new addition, Ducati Dave, shows up, with his girlfriend Holly. Chris met him when he saw Dave's fancy glider up above the highway down in the Gorge, a bit upstream from The Dalles. They looked for us last night. Drove all over the place, and spent the night in Quincy. Drove past us this morning, ending up in Mattawa. Chris watches for them on the highway below, with his 8x24 binoculars. Holly is standing up through the sun roof, to be recognizable. Chris gets on the cell phone and guides them in.

Looking West past Wahatis peak. Later Chris would fly a glider far along the basalt layers of the bowl, and back, in very light air.

Ground Squirrel. Michael's hand

Dave and Michael and Damian are all gathered around something at the edge of the lip. "It's a critter." I walk over. It's a tiny ground squirrel, curled in a small depression. Trying to make its living, out here in a land of snakes, hawks, and toy airplane guys with oversized boots. Michael pets it with one finger (maybe he was taking its pulse) and then builds a shelter over it, from us, with a few rocks. He temporarily removes the rocks to show Holly.

The wind has died. Dave flies an electric Piper Cub around. He flies a couple fancier gliders, but I don't see that.

I take a nap, slightly interrupted by Michael's booming voice, "Oh, you really are taking a nap!" Gawrd.

I get up. Chris is giving a homebuilt 60" delta hard tosses, letting it float in the minimal ridge lift around the bowl to the north, just above a layer of basalt flow, turning for the long drift back, and then sometimes doing a downwind catch. Michael Zanol once stops it from slamming into the trucks.

Late in the afternoon, Stephen and I leave at about the same times. Damian, Chris, and Michael stick around. Chris says that as the evening came on, the wind picked up and steadied, and they had great flying. In great weather. The best spring weather in recent years, for a CEWAMS Saddle Slopener.

Damian flies Javelin near Wahatis Peak. Chris reclines.

Damian's Bowman's Hobbies Javelin knock off. He bought one, and then wire-cut two more. 60" EPP.