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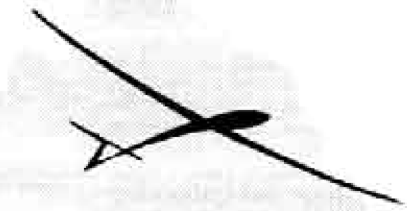
R/C Soaring Digest

A publication for the R/C sailplane enthusiast!



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R/C Soaring Digest (RCSD) is a reader-written monthly publication for the R/C sailplane enthusiast and has been published since January, 1984. It is dedicated to sharing technical and educational information. All material submitted must be exclusive and original and not infringe upon the copyrights of others. It is the policy of *RCSD* to provide accurate information. Please let us know of any error that significantly affects the meaning of a story. Because we encourage new ideas, the content of all articles, model designs, press & news releases, etc. are the opinion of the author and may not necessarily reflect those of *RCSD*. We encourage anyone who wishes to obtain additional information to contact the author. *RCSD* was founded by Jim Gray, lecturer and technical consultant. He can be reached at: 210 East Chateau Circle, Payson, AZ 85541; (602) 474-5015.

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The Soaring Site

Who Is ZIKA?

A few weeks ago one of our readers, Jack Zika, sent in some of his brother's artwork to share with other fellow enthusiasts. The first cartoon appeared in the June issue and was done by Gene Zika of Arvada, Colorado. Gene says, "I first became interested in the art of cartooning as a result of a boring desk job. I soon enrolled in the Leo Stoutsenberger school of cartooning and drew all of my cartoons by hand with a brush. It was just in the last year that I started to draw my cartoons using a Macintosh® IIsi computer and the Adobe Illustrator® and Quark Express® software programs. My interest in drawing "soaring" or "glider" cartoons was a direct result of my brother Jack's interest in soaring and his membership in the "Rocky Mountain Soaring Association" club of the greater Denver metro area." So, thanks to both Jack and Gene, we hope you enjoy Gene's cartoon work as much as we do.

An Invitation from Canada

Should any of you find yourself in Canada in August an invitation is being extended by Etienne Dorig to join them at one of their contest events. He says, "Our two day soaring contest will be held the 15th-16th of August in Montreal, Quebec. The contact is myself, Etienne Dorig, and I can be reached on (514) 465-1113. Usually, we have people coming from New York, Vermont, and Ontario. So, if any of you are travelling close to our area during this period, you will be welcome. I hope this summer will be hot because we are just starting to fly again. (The winter was long.) Imagine how you are lucky to fly nearly all year." Etienne's new address is 381 Joseph-Huet, Boucherville, PQ, J4B 2C5, Canada.

A Volunteer

We received the following letter from Dale Willoughby who was in Paris at the time. He says, "Thanks for a copy of the *R/C Soaring Digest* which arrived the day before I left Colorado on my long-planned round-the-world flight to mark my 75th birthday. So far, I have been to Bangkok, Bombay and now, Paris.

"On the 14th, I will board the Concorde (speedbird) enroute to New York and, at 0805, pop the cork. At that point in time, I will have been on the Earth a total of one trillion, seven hundred seventeen billion, two hundred thousand seconds (1,717,200,000)!

"While in Paris, I visited FAI and gathered material for an article on FAI F3B - Class 33 - speed in a straight line. You should be aware that I wrote the rules for both Class 33 and Class 34. As well as for all classes in flatland speed, and was the first secretary for League of Silent Flight. And, during my more active day, was the first to attain Level IV. Then, I sold out to Windspiel Models and founded Model Helicopter; and later, Model Plan Service and Scale Model Research. Just recently, I returned from Guam where I operated a hobby shop and worked as an investigative reporter for the Guam Tribune. Almost back to square one, I completed a Bird of Time and flew it at Travis AFB and helped V.P. District 10, Reggie Keyawa start up an AMA club on base.

"My interest in R/C soaring speed began before I wrote the rules while I published "The Zephyr" in 1965-1966. The next year, I set a world's record - 47 mph - in F3B Class 33, and two years later set a second of 86 mph. One downwind pass clocked by the Norwegian Aero Club at 101 mph in the same area as the next winter olympics will be held.

"While the original rules prescribed a 25 - 50 - 25 meter course layout, it is now a 50 - 100 - 50 meter run, still below 20 meters entry from both directions, and landing within 30 minutes from launch. Werner Sitar closed out the old course with an amazing 390.8 km/hr - 242.08 mph!!

"There has only been one record using the new course - that of Klaus Kowalski of Germany - 237.20 km/hr in July, 1991. That is just over 147 mph. One way over the course in 2.47 seconds downwind with an upwind leg clocked at 3.82 seconds. Run that up your flag pole and see who salutes it.

"I have had some serious thought regarding asking AMA to buy and furnish state of the art electronic timing devices and schedule FAI F3B-33 world record trials, late this fall. With that in mind, I would welcome suitable soaring sites - slope - for such a venue from your readers. While I would volunteer as the event director (CD), I would welcome help from all those interested in speed flying to attend, compete and assist. First choice of a locale would be in the S.F., Santa Clara, Fremont area, where winter winds are fairly constant and reliable. I would not rule out Washington state area or even San Diego's Torrey Pines Park. Send your comments to: Dale Willoughby, Captain USMC Retired, 26278 Woodard Ave KVE, Moffat, CO 81143-9701." ■

On Not Being Strictly Neutral

..by Martin Simons
13 Loch Street, Stepney
South Australia 5069

Part I

I have followed with interest the three part article by Frank Deis in *Radio Control Soaring Digest* Vol 9, Feb, March & April 1992, about centre of gravity, elevator trim and decalage.

A few points arise. First let me emphasise a point Frank himself makes. The advice he gives about trimming produces the kind of handling that he prefers. I am sure he will agree that what suits him will not necessarily suit everyone and he does not recommended it for beginners.

I doubt whether it should be recommended to anyone at all, but personal preferences will be the final arbiter.

I shall avoid technical quibbles and go at once to the central matter of the dive test.

It is correct that moving the centre of gravity back or forward as described by Frank, will produce the various responses shown in his diagram (Figure 4, p 21, March *RCSD*). In this sense, the dive test 'works'.

Tuck under

Another flight path, the full-blown 'tuck under', should be added. I have done this (Figure 1). In a tuck under, after initiating a dive, when the pilot moves the control stick back, the model does not pull out but continues to dive more steeply and with **elevator fully up**, hits the ground at high velocity.

It is possible sometimes for a quick thinking pilot to save a model in a tuck under by moving the stick forward instead of back. The aircraft will probably bunt through the vertical into an inverted position. It may then be half rolled or outside looped to normal flight. It might break up in the air before this.

A contributory cause of tucking under is flexibility of the structure of the model; tail and rear fuselage bending and wings twisting. This may be why we see more of these disasters with older style, lightly built models. But having the c.g. too far aft can cause tuck under on almost any model.

So there is one good reason to treat the dive test with great caution.

Neutral stability

Consider now Frank's Falcon 880 which, his diagram shows, has been adjusted until it exhibits neutral stability.

The example which he labels 'just right', is also neutrally stable but dynamically unstable. With control stick central it continues diving, like the Falcon, with no sign of pulling out (neutral stability). In addition it tends to oscillate, nose up a little, nose down a little, around the average diving angle (dynamic instability). This is more typical in fact, than the Falcon's steady dive without any variations.

Neutral stability is not an outcome of the particular geometry of the Falcon. I have been flying a Falcon 880 all this (Australian) summer. I set up my Falcon with the c.g. about 35% of the mean wing chord, so that when I do the dive test, it pulls itself out of the dive. Frank would regard this as having the c.g. too far forward for his preference. It is the c.g. position, not the design layout or aerofoil section that is significant here.

Any model sailplane at all can be brought to neutral stability by suitably aft positioning of the balance point. And any model sailplane, by moving the c.g. forward, can be brought away from neutral into positive stability. It is a matter of choice.

But what exactly is neutral stability and what are the consequences of trimming a model so?

In a simple account, we ignore such factors as density altitude, Reynolds number variations and even structural flexibility (though we have already seen this does become important in steep, fast dives). We shall also, for the moment, neglect the unstable dynamic oscillations that usually accompany neutral stability, and consider only the simple case of Frank's Falcon 880 and any other sailplane which, by successive backward movements of the c.g., produces this effect of continuing to dive 'hands off'. What we cannot neglect are airspeed variations resulting from the dive and the response of the aircraft to elevator control movements.

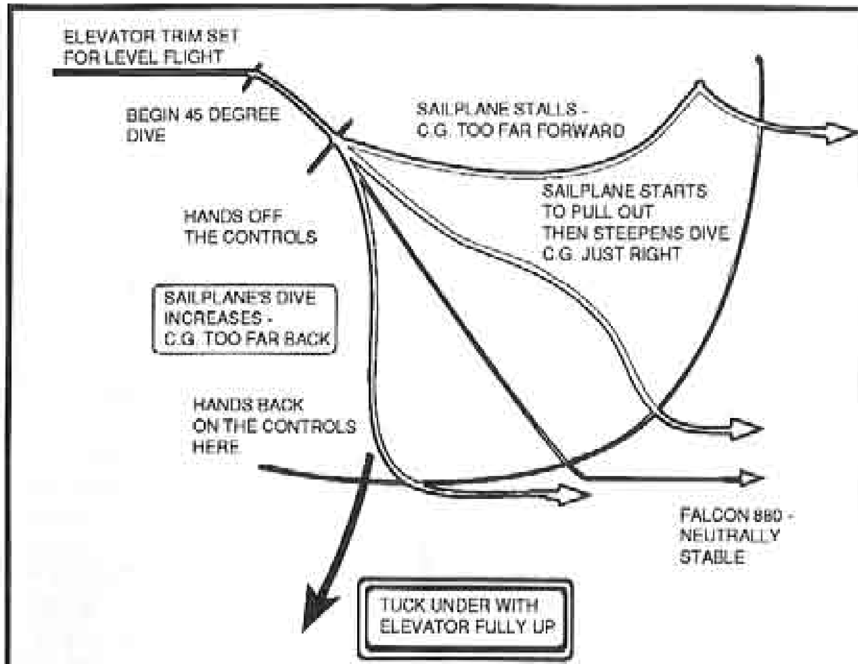


FIGURE 1 (MODIFIED FROM FRANK DEIS) WHAT TO LOOK FOR IN THE DIVE TEST

Let us run through the dive test procedure. The sailplane comes off the launch at some good height, and is first positioned, as Frank suggests, so that it is flying straight and level, **control stick central**. Now we begin the test; the elevator is used to pitch the model to about 45 degrees dive, then the pilot takes hands off. **The stick goes back to the central position** under the influence of the centring springs. If the model is truly neutrally stable it continues to dive and will dive all the way to the ground unless we intervene. This is what Frank aims for.

We have here a model which, before the dive, was flying **straight and level with the control stick central**. It is now **diving with the stick central**.

So we grab the stick, pull out, and get the model down safely. Our model has "passed the dive test". We think a little. Let's do it again.

Launch, settle down, **stick central, straight and level.** This time try a very slow speed, just short of the stall. Nose up a little. Hands off. **Stick central, slow nose up flight** continues until we intervene.

Ho hum! Again.

Launch, settle down, **stick central, straight and level.** This time try a very gentle dive, say 10 degrees. Hands off. **Stick central, dive at 10 degrees** continues until we intervene.

Well, that's interesting. Another dive test.

Launch, settle down, **stick central, straight and level.** Dive this time to a moderate angle, say 20 degrees. Hands off. **Stick central, dive at 20 degrees** continues until we intervene.

Let's be brave now!

Launch, settle down, **stick central, straight and level.** Dive this time to a steeper angle, say 60 degrees. Hands off. **Stick central, dive at 60 degrees** continues until we intervene.

Wow! Try again.

Launch, settle down, **stick central, straight and level**. Dive but this time to a fully vertical position, 90 degrees! Hands off. **Stick central, vertical dive** until we intervene, a bit quickly this time.

Let us make a little table.

Results of several dive tests

Stick Position	Model Attitude	Airspeed
Central	Min. speed	Very low
Central	Straight & level	Low
Central	10 ° dive	Faster
Central	20 ° dive	Faster still
Central	45 ° dive	Very fast
Central	60 ° dive	Very fast indeed
Central	Vertical dive	Dangerously fast

So now we have a model which will fly slowly, straight and level, or in a gentle dive, or in a moderate dive, or in a steep dive, or in a vertical dive, all **with stick central.**

Now, having set your model up to behave in this way, because that is your preference, turn to Frank's diagram showing the control stick and the slide switch that works the trim potentiometer on the transmitter (Figure 2).

We are now, following Frank's suggestions, going to mark our transmitter with the various desired trim positions for different flight speeds. So out comes the dymo tape and we print a little sign saying 'Minimum speed'. We consult the table above and find this label should go at the trim central, stick central, position and we stick it in place. Now we make a label reading 'Minimum sink'. The table instructs us to put this.....at the trim central, stick central position. So it goes over the top of the first one. Now the labels for Maximum L/D trim.... Maximum speed....Steep dive.....Vertical dive...! Can something be wrong here? All the trim labels go in the same place.

Well, if you don't like it after all, maybe you should not obey the dictates of the dive test! If you do, following the rules strictly, you might as well fix your trim slider in the central position and forget it.

That is exactly what neutral stability means. Indeed, it is part of the definition of "stick fixed neutral stability", as you will find it in practical test flying reports, that the aircraft will take up any flight speed, with the stick in one fixed position. (Strictly, it need not be central, but we have set up our model that way, so it is in our case.)

This behaviour is a **necessary consequence of having a neutrally stable aircraft**. Straight and level, dive, vertical dive, shallow dive, stick in one position. The centre of gravity of the aircraft is located at the so called "stick fixed neutral point".

It is, as mentioned briefly above, usually associated with some dynamic instability - a tendency for the aircraft to oscillate on either side of the flight path.

In the dive test it is the pilot who sets up the initial attitude. But in flight, the air itself will contain gusts which, whether the pilot wants it or not, will pitch the model sometimes nose up, sometimes nose down. With genuine neutral stability and central stick, the model will take up any position whatever and stay there, until the pilot intervenes, just as we had to intervene in order to prevent crashing in the dive test. You will find in practice, if you fly a model with this set up, that it

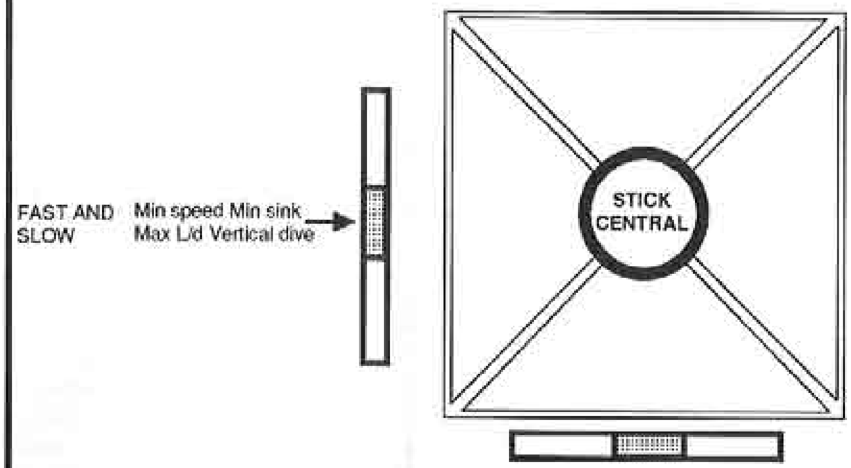


FIGURE 2 TRYING TO LOCATE THE KEY TRIM SETTINGS ON THE ELEVATOR TRIM LEVER WITH NEUTRAL STABILITY

will wander about, nose up, nose down, responding in random fashion to every slight irregularity in the air. To maintain it on a steady flight path, such as a nice, even circling in a turbulent thermal, or on a steady heading in rough slope lift, the pilot will constantly have to be correcting it. It will never settle down of its own accord.

If you like it that way, that is what you can get by moving the c.g. aft.

Elevator sensitivity

When the model has been made neutrally stable, the elevator does still work in the normal sense, that is, a forward stick movement produces a nose down pitch and back stick, nose up.

There is a little more to it. Anyone who has gone through the dive test procedure in gradual stages, will have noticed that each backward move of the c.g. produces an increase in the sensitivity of the elevator.

Take the model with c.g. at 35% of the mean chord, like my own Falcon 880. It will not dive unless I instruct it to. When I want it to dive, I move the stick by an amount proportional to the steepness of dive that I require. For a gentle dive, the stick goes forward a little way, for a steep dive, it goes further forward, for a vertical dive, it goes further and so on. For a bunt in aerobatics, it goes more forward still. I can feel exactly where the stick is at any moment and the elevator position is where I want it. The model responds positively and in a fully controlled fashion.

(If I wish a dive to continue, of course I have to hold the elevator down because if I do not, the model will begin to pull out of the dive before I wish it to do so. I command it to dive, it dives. If I withdraw my command by releasing the stick, it comes out of the dive. Trim labels on my transmitter, if I bothered to stick any on, would be well spaced out, which reflects my preference. But that is not my immediate point.)

If I move the c.g. aft a little on my Falcon, the first thing I notice is that to get the model into a steep dive, I do not have to move the elevator so far. The model enters the dive with a small stick movement. The elevator is more sensitive, a smaller movement produces a larger effect. All the control movements shrink in proportion. There is less difference in feel on the transmitter stick, between the control positions required for a steep dive and a bunt, for instance.

(And also the trim labels begin to bunch up closer.)

If the c.g. goes further aft again, the elevator becomes distinctly touchy - a little tremble of the thumb, pitches the model rather sharply. To make the model obey me now, I really have to be very, very careful. The difference between flying straight and level and going into a vertical dive, at the control stick, is a matter of only a finger width of movement.

(The trim labels bunch even closer.)

Finally, if I approach neutral stability, the elevator becomes so twitchy that I can barely manage the model all. A momentary lapse of concentration finds the model pitching wildly, nose up, nose down, even inverting itself. Maybe that is because my reflexes are not as fast as they used to be.... How fast are yours? How quick is the beginning pilot? How easy is it to control a neutrally stable Falcon 880 when it is circling in a thermal half a mile away at 1500 feet?

(Now the trim labels are all in the same place.)

Probably it is already apparent, without my spelling it out, that if the c.g. is moved just a little further aft than the stick fixed neutral stability point, it is possible to reach a c.g. position where, to change the attitude of the sailplane in flight, requires **no elevator movement at all!**

It will now change its attitude in flight to any extreme position without the pilot touching the stick. This very dangerous c.g. position is called the **stick fixed manoeuvre point** and is to be avoided. Keep the c.g. forward to keep control.

If your c.g. should ever go beyond the manoeuvre point (it can happen if your trim ballast, insecurely fastened, jumps out of the model while in flight), the elevator controls become reversed - nose down requiring up elevator, and vice versa.

I grant that anyone who flies aerobatics a good deal and who has quick reflexes, may prefer to have a sensitive elevator, and for this reason may prefer to have the c.g. further aft than the pilot who is chiefly interested in soaring. This is obviously a matter of preference and choice. One may have several different models trimmed in different ways, for different purposes.

But even an aerobatic model needs some reserve of stability. Otherwise it becomes extremely difficult to fly a tidy aerobatic pattern because the neutrally stable or unstable model tends to wander off line constantly. Returning the elevator to central, as in the dive test, does not produce a proportional nose up response, the pilot can never know, from the feel of the stick, just what attitude the model will take up.

There are, of course, ways of increasing elevator sensitivity which do not involve moving the c.g. back. One could increase the elevator throw, or increase the tail aspect ratio, or use faster servos and so on.

But what about drag?

Frank Deis's articles include quite a lot about trimming for maximum performance by reducing drag. The dive test evidently is expected to help in these respects.

Let's look at this. By moving the centre of gravity without changing anything else about the model, it is clear we are not altering the drag of the wing, fuselage, fin and rudder, or anything except the horizontal tail. But it is true that if the tail is required, at any time during flight, to generate some upward or downward forces, it will create more drag than when it is at its aerodynamic zero angle of attack.

The drag of any surface like a wing or tail, is made up of two parts, the profile drag and the tip vortex induced drag.

Tail profile drag

Profile drag of a symmetrical tail surface is least when the angle of attack is zero. It increases very little on either side of zero if the angle is not too great. One way of expressing this is to say there is a low drag range, or low drag bucket, extending for several degrees on either side of zero for a symmetrical section. Only if the tail is being made to work at some angle, negative or positive, outside the low drag range, will the profile drag begin to rise substantially.

In practice tails do not work at large angles of attack even in fairly extreme situations. Changing the c.g. position within reasonable limits is not likely to affect tail profile drag measurably, in either sense, increasing or decreasing it. This applies to all moving tailplanes.

If, by means of an elevator, the camber of the section is changed, the low drag range of the profile does not suddenly vanish. What happens is that the angle of attack for minimal profile drag moves with the elevator. If the elevator goes down (increasing the camber), the centre of the drag bucket moves to a positive angle of attack. (This is why we use cambered wings - a cambered wing has its least profile drag at a lifting angle of attack, not at aerodynamic zero. See the wind tunnel tests.) Vice versa, if the elevator moves up (negative camber), the low drag bucket moves to a negative angle of attack.

The angular position of a hinged elevator therefore does change the tail profile drag situation, but it is not likely to be a major factor. If a cambered section (e.g., a tail with an elevator deflected) is made to work 'upside down' at an angle of attack far out on the wrong side of its drag bucket, the profile drag will increase quite sharply. This turns out to be a valid reason for preferring all moving tails to fixed tails with hinged elevators. But the difference is still small except in very extreme cases where, for some reason, huge elevator deflections are needed to trim a model.

Tail vortex drag

Vortex induced drag will appear if the tail unit is required to operate at any aerodynamic angle of attack, negative or positive. There will be a difference in air pressure between the upper and lower surfaces, and the air near the tips will tend to flow round from the high pressure side to the low pressure side, creating tip vortices. It does not matter which way round the flow is. A tail which is being made to 'lift' downwards, at a negative angle of attack, will have tip vortices just as when it is lifting upwards. The vortices will create drag.

Not very much, however. As mentioned already, tails are not normally required to operate at large angles of attack. The lift they produce (up or down) is never going to be very great. Hence the pressure differences creating the tip vortices on a tail, will never be very powerful and the drag they create will not be large.

The tail's share of total drag

Summing up so far, if we now consider the total sailplane, the main source of drag is always the wing which in every situation is responsible for much more than half the total drag. At low flight speeds, when a sailplane is trimmed for minimum sink, the drag of the rest of the sailplane, compared with the wing, is almost negligible. The tailplane drag is a very small percentage of the total in this situation. There is very little scope for saving drag here.

At high speeds, the wing is still by far the largest drag item. The tailplane's share of the drag does increase, sometimes to as much as 10 or 12% of the total, maybe even 15%. If we can reduce this, we shall make some improvement to the high speed gliding performance of a sailplane.

It is very obvious that by moving the

c.g. of a model without changing any other feature, we cannot possibly be reducing the tail drag to zero. All we can possibly hope for, at the very best, is a small saving in both tail profile drag and tail vortex drag. We should be doing very well indeed if we saved, by this means, 1 or 2% of the total sailplane drag at high gliding speeds.

Even so, if we can save drag, we should try to do so on principle, even if in practice we cannot tell any difference!

So let's see.

The dive test again

Go back to the dive test, with the neutrally stable model, and consider what forces are operating.

Here (Figure 3) is our model diving at 45 degrees. It is at high airspeed. The wing is operating at a low angle of attack. It is in a steady dive, not pitching nose up or down.

The weight force is acting vertically downwards, as usual, and, since the model is neutrally stable, the point of action of this force, the centre of gravity, is at the 'stick fixed neutral point'.

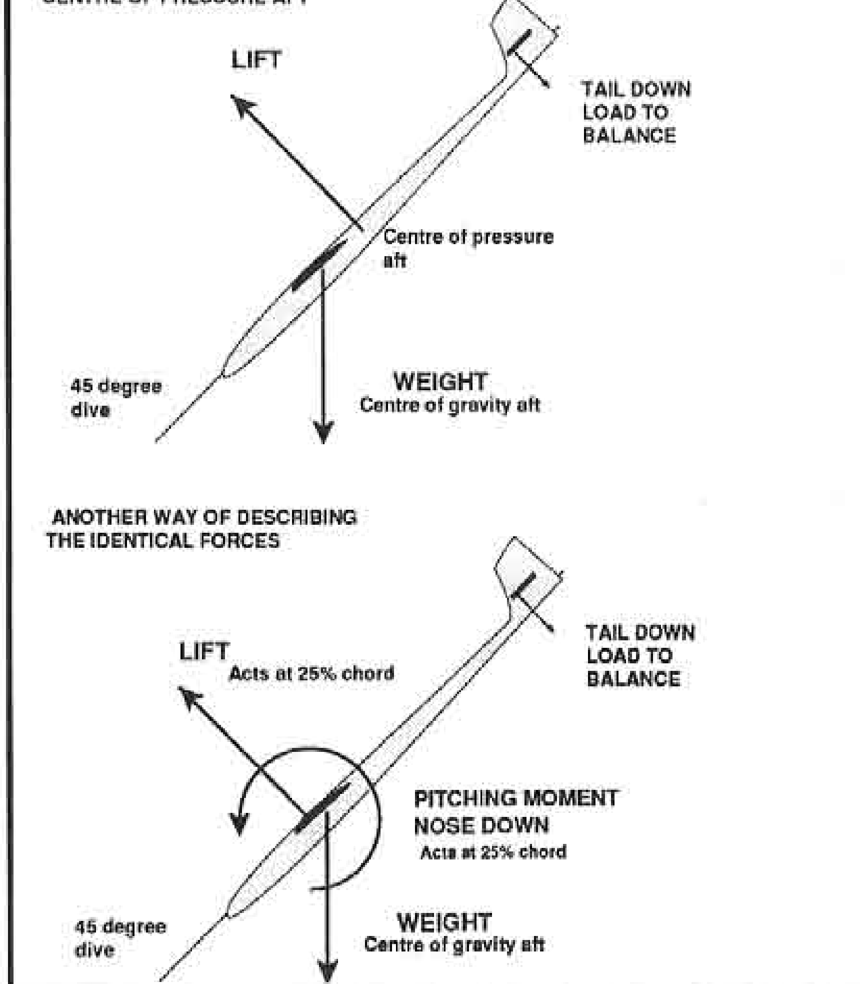


FIGURE 3 TAIL LOAD TO BALANCE MODEL IN DIVE WITH CENTRE OF PRESSURE AFT

The other large force is the wing lift, which acts in direction at right angles to the line of flight. But what is the point of action of the lift?

We know, from actual wind tunnel tests and practical flying experience, that when a cambered wing is moved to a low angle of attack, the apparent centre of action of the lift force moves aft. The smaller the angle of attack, the further back the point of action moves and **there is no aft limit to this.** Vice versa, as the angle of attack increases, the point of action appears to move forward. There is a forward limit because the wing eventually stalls.

This apparent moving point of action is termed the centre of pressure. In a 45 degree dive, a section like the Selig 3021 on a Falcon 880, has its centre of pressure well back, probably at about 120% of the wing mean chord. That is, behind the wing.

The centre of pressure can and does often move **behind the trailing edge of the wing.** This strikes most people as very odd. But the movement of the point of action of the lift force is only an apparent movement which, in the early days of aviation, was used to explain the things that actually happened in flight. The theory of centres of pressure leads to the strange result that the point of action of the lift, is, in a dive, located somewhere behind the wing that is producing the lift. (At even higher airspeeds and smaller angles of attack, the wing c.p. may appear to have moved behind the tailplane. In a truly vertical dive it is at infinity, whatever wing section is used.)

In more modern times, the old centre of pressure theory has been largely replaced by recognition that the real forces actually operating in practice on an unstalled wing, are the lift, which acts at a fixed aerodynamic centre, and a pitching force or pitching moment, also acting at the aerodynamic centre. The aerodynamic centre where these two forces operate, is invariably close to the 25% chord position. It does not move about. With a cambered wing section like the S 3021, the pitching moment is nose down at all angles of attack. (A method of calculating the approximate pitching moment for the Selig 3021 or any other section, is given in Soartech 8, from which Frank Deis took his wind tunnel test information. It was not measured in the tests.)

The two methods of describing the forces, old fashioned centre of pressure movement, or aerodynamic centre with pitching moment, are alternative ways of describing exactly the same facts, so it does not really matter which is used provided they are not confused, and provided the realities of the forces are recognised.

Tail drag in the dive

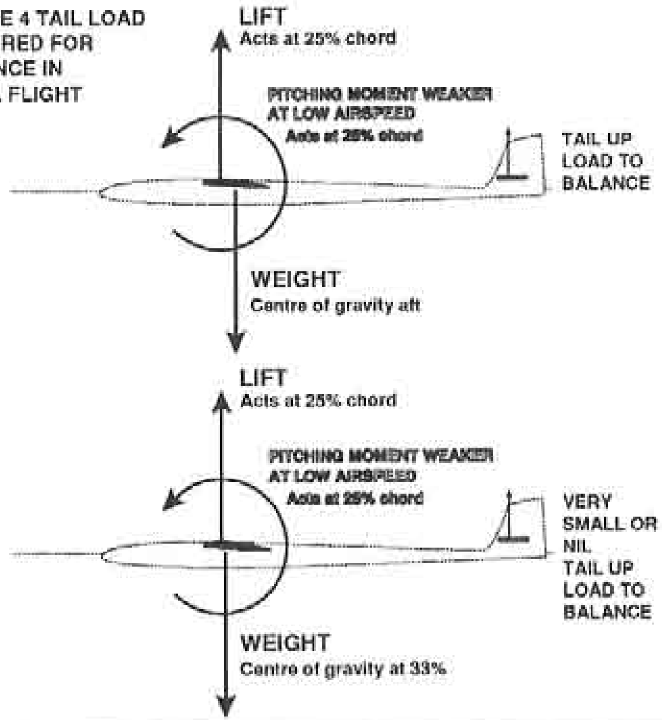
In the present case, what we have is, the weight force at the c.g. with a nose down pitching force ahead of this tending to push the model into a steeper dive.

But we have arranged the model, with tail rigging angles and 'decalage' or 'longitudinal dihedral' to use Frank's terms, so that it remains in the dive at constant angle (unless disturbed by air turbulence). Obviously, in this situation, **the tail must provide a balancing force to prevent the further nose down pitch.**

It is evident that moving the c.g. aft to produce neutral stability, has not, after all, given us a tailplane that, in the 45 degree dive, is at its minimum drag angle of attack. On the contrary, the tail in this situation must produce a downward force to achieve balance. There will be some tail vortex drag as well as the inescapable profile drag.

It is important to recognise that this tail down force **must** be present even though the control stick is central. Without it, the model will tuck under.

FIGURE 4 TAIL LOAD REQUIRED FOR BALANCE IN LEVEL FLIGHT



We may now project the argument to the other situations considered in the previous discussion. As the angle of attack is increased, the old theoretical centre of pressure may be imagined as moving forward. What actually happens is that the nose down pitching force becomes less, because the airspeed is reduced. The lift force, acting ahead of the centre of gravity, does not diminish. (For purists, the wing pitching moment coefficient remains unchanged, but the wing lift coefficient increases. The relative magnitudes of the aerodynamic forces themselves depend on this and the airspeed.)

When the neutrally stable model approaches minimum speed in level flight, the combined effect of the wing lift and the pitching moment is a nose up tendency. The tail now has to provide a corrective or balancing upward lift force to keep the nose down. (Figure 4) This causes it to produce more drag than it would at its zero angle of attack.

Again, the tail **must** produce this force or the model will pitch up violently and stall. But the stick remains central because of the neutral stability.

Somewhere between the diving situation with tail download, and the slow flying situation with tail up load, there is **one position and one flight speed only**, where the tail must produce no balancing force. It will then be at its minimum drag angle of attack. There is no way it can be made to operate at this minimum drag angle at any other airspeeds or flying attitudes.

All this happens to the tail without alteration to the trim, because in all flight attitudes, the stick fixed neutrally stable aircraft has its stick central.

Tail drag with c.g. forward

All this applies in much the same fashion to a model with c.g. forward.

In the 45 degree dive, the pitching moment is just as strong. (The c.p. is just as far aft.) The model thus requires a down force from the tail to balance. Since the c.g. is forward the tail has a slightly longer lever arm to work with but the nose up effect of the lift is on a correspondingly slightly shorter arm. The result in terms of tail lift force is not very different from the neutral stability case.

(Note, although the stick is now held forward to maintain the diving attitude, the direction of force on the tail is nevertheless down. This is a necessary result of having a stable sailplane.)

In the slow, minimum speed straight and level trim situation, with the c.g. forward, the pitching moment is reduced as because this depends on airspeed. The lift is the same, the weight is the same, but the nose up moment of the lift just ahead of the c.g., more or less balances out the nose down pitching force. The outcome is, probably, with c.g. at 35%, a very nearly perfect balance. The tail then has to supply a very small, or perhaps zero balancing lift force. It is at its minimum drag angle or very close to it.

However, at this flight attitude the airspeed is low, so the tail drag, as mentioned above, is only a very small proportion of the total. So although a tiny bit of drag may be saved, it is of negligible importance.

The best answer of all?

It is very common in full scale aviation practice, to put the c.g. even further forward than I have it on my Falcon 880, to about 25% mean chord. It then coincides as nearly as possible with the wing aerodynamic centre. The points of action of the lift and the weight forces are coincident as nearly as possible. (Often there is some vertical displacement, the aerodynamic centre of the wing may be above the c.g. or below it by some small amount.) All the tail now has to do is to balance out the nose down pitching force, all the time, in every flight situation there will be a down load on the tail.

Having the c.g. at 25% makes for a very safe degree of automatic stability and a noticeable reduction in elevator sensitivity. It also means that there is no speed, and no trim, at which the tail is producing zero lift. The tailplane has to provide a downward lift force always and therefore generates a very little extra vortex drag.

But there is a much more important consideration. It is argued above that by moving the centre of gravity about without altering anything else, any saving in tail drag will be very small indeed and hardly noticeable in practice. There is, nevertheless, a way of saving tail drag which can make a difference. That is, **reducing the size of the horizontal tail.** If, for example, the tail which is producing as much as 12% of the total drag of a model (which it might, at high flight speeds), could be cut down to half its area, we would very nearly halve its drag. That would be worthwhile.

However, reducing the tail area is not something to be done carelessly. It will have an immediate effect on stability. By doing this, we might even produce, from an initially stable sailplane, one which is only neutrally stable. To prevent this we must move the centre of gravity forward, perhaps to 25% mean wing chord. By so doing, it is true, we will compel the tail to provide some small down force at all flight speeds. That cannot be escaped. But we shall have less tail drag in total because of the considerable reduction in tail area.

So a small tail, with a forward c.g., is, in the end, the best answer of all. It gives a model which responds accurately to control movements in aerobatics, and at all other times is pleasant to fly and not too twitchy. And it has a little less drag too. The only disadvantage is that such a model may be somewhat too docile for the aerobatic expert.

So what is your preference? ■

Teaching Yourself to Slope Soar

...by Yule "Buster" Upgood

(This article was originally published in the Madison Area Radio Control Society (MARCS) *Sparks*.. It is a true story about one person's learning experiences. Buster can be contacted by writing to Yule "Buster" Upgood, C/O Richard Moran, 2535 Kendall Avenue, Madison, Wisconsin 53705.)

My appetite for slope soaring was whetted by a magazine article describing sailplanes averaging better than 60 mph around 8 laps of a pylon course. My provisions came from a Tower Hobbies catalog. I'd flown commercial jetliners (coach), and had mastered the Microsoft Flight Simulator's sailplane program (from the Control Tower perspective). I didn't anticipate many problems.

The first step of teaching yourself to "Slope" is to choose and build an appropriate aircraft. I chose the Bob Martin Coyote as my first radio controlled model. I figured the 72" wingspan should provide performance similar to Two Meter Thermal ships (experienced guys, laugh here), and the "unbreakable durelene fuselage" sounded good. I expected to "dork" a few landings.

I overcame adversities: there is NO WAY you can install the elevator push rod, tail and elevator or install the wing the way Bob Martin wrote in the instruction manual. Aside from this, I can't say enough good about the Coyote.

The second step is to "trim out" the model with a few hand-tosses. Instead, I screwed a hook into the Coyote, and stretched a brand new hi-start across the University of Wisconsin soccer fields. I held my transmitter, new model, 300 yards of taut rubber tubing and nylon string, facing a fresh breeze; pondering what was about to happen. In fact, I pondered long enough that a fellow slope soaring pilot wandered by. "Wow! Another Coyote! How did you install the elevator push rod?" I knew this was a Coyote owner. "I've never seen one launched off a hi-start... you must be GOOD." I was not about to admit that I was a Master of Microsoft Flight Simulator. DOUBT was entering my mind.

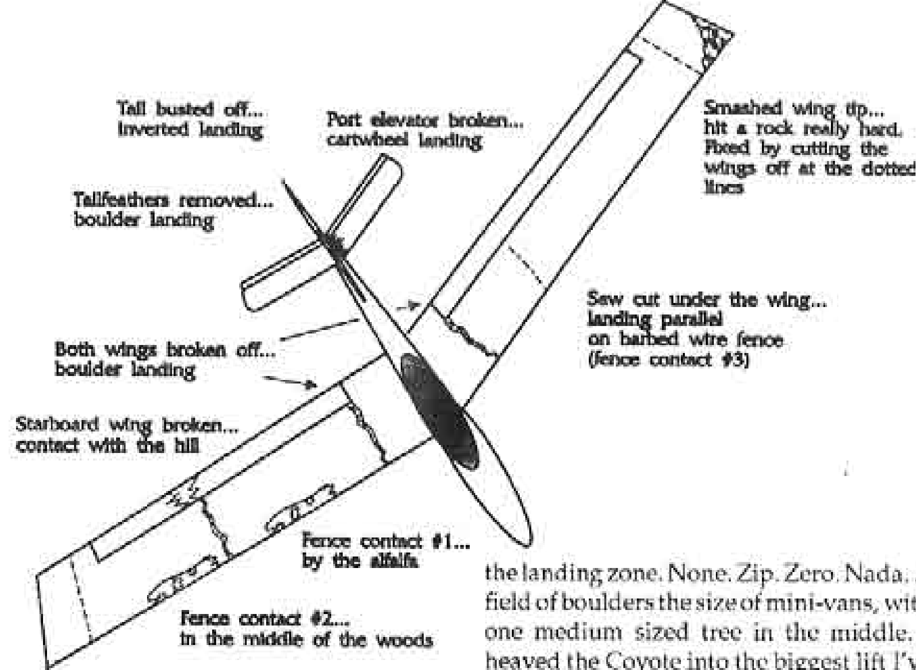
We stood talking, I continued to Ponder and Doubt. Just then, Darryl Lonowski (President of the Madison Area Radio Control Society) wandered by. (This is a true story.) Darryl, having Experience, recognized (from visual cues) that I didn't know what I was doing. Darryl offered help. His first hand toss revealed reversed ailerons... oops.

Pretty soon, we were ready to shoot the Coyote up the Hi-start. Darryl gave his Standard Warning: "I know what I'm doing, but while teaching you, there is a remote chance that I might smash your plane to dust." OK.

The third step in teaching yourself to fly is to get some instruction. Under Darryl's control, the Coyote thundered into the sky off the hi-start. After several seconds of adjusting the trim, he handed me the transmitter. "Here, you take it." This was the moment I had been waiting for. "Ok... Uh... Uh...Uh...TAKE IT BACK! TAKE IT BACK!" Are details necessary? Darryl could fly the Coyote fine, and the plane looked great in the air. I began to suspect that perhaps I had bitten off a bit much to chew. We flew perhaps half a dozen high start launches, and I gradually got up to perhaps 20 seconds of stick time before Darryl would save me from myself. We all had some fun that day; on reflection, this was a rare flying session in that my plane came home in one piece.

The fourth step is to practice. Part A: back to the flight simulator. Microsoft Flight Simulator lets you construct software models to "fly". I found that a 600 pound jet with 35' wingspan (0 dihedral) and 20,000 pounds of thrust behaves about like an aileron slope plane.

Part B: real life. I have found plenty of bad hills for slope soaring. I've discovered that Bad Hills and/or bad conditions plus



Zero skill equals "dorked" airplane. I busted the tail off. I found that only "hot melt" glue will stick to an "unbreakable durelene fuselage". I busted the right wing clean in half. I learned to collect even the smallest splinters of wood and foam; the repair of what looks hopeless is pretty simple. I started getting more and more stick time, and considered my new hobby "fixing RC gliders".

I joined the MARCS, and found out about "Cedar Hills". This alone was worth the membership fee. Excellent Hill plus Faint skill equals Lots of stick time plus "dorked" airplane. Now I was hitting trees, corn fields, and barbed-wire fences instead of just Earth. Things were heating up! My flights were getting to be consistently longer than 15 minutes and occasionally well over an hour. I was looping, rolling, and flying with confidence.

My last slope soaring flight of 1991 was at the peak of the South Face of Devil's Lake State Park, a pleasant mile hike. I found a 30 foot diameter rock outcropping, three sides surrounded by trees; the fourth side is the edge of the world. My face and hair whipped upward and back by a cold, 20-30 mph wind from the north. I surveyed the landing zone. None. Zip. Zero. Nada. A field of boulders the size of mini-vans, with one medium sized tree in the middle. I heaved the Coyote into the biggest lift I've yet to experience, fearlessly. After all, there was a TREE down there; I had experience landing in trees.

This was thrilling flight. "Blue Angles afterburner" lift extended as far out as I could see the big Coyote, and astounding turbulence resulted in 50 foot drops, at random. Four Turkey buzzards wandered by. We all had some fun until I looped behind them and got a Top-Gun "radar lock" on them. They didn't like that, so went home. A Red Tail hawk soared high above... he was no lumbering Turkey buzzard, and never let me get behind him. After 30 minutes, I had to land. I was shaking from excitement, tension, and cold. I had to pee real bad, too.

I spent five minutes attempting vainly to land in the tree, before I realized how lucky I had been all year. When a low and slow opportunity appeared, I opted to nose my battered Coyote into a soft boulder, about the size of a VW bug. Not bad results... Two busted wings, the tail and elevator both popped off the fuselage. Nothing I hadn't fixed before. I'm going to testify: the Coyote is mighty tough overall, and the fuselage is really "unbreakable"; I gave it my best shot. ■

on the Wing

B²

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Jerry Blumenthal's "Rattler" & A Small In-The-Wing Mixer

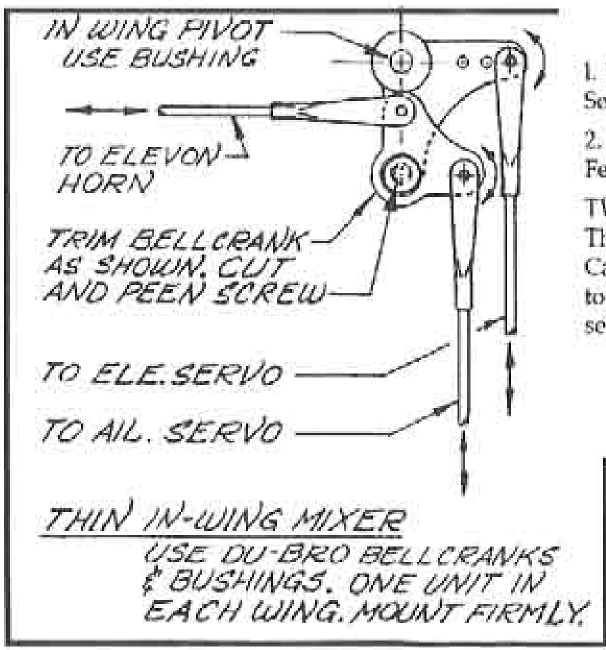
Jerry Blumenthal, a member of TWITT (The Wing Is The Thing), came up with novel methods of attaining pitch and yaw stability in his newest full sized design[1], and then fabricated an elevon mixer capable of fitting in spaces not large enough for a servo[2].

Conventional plank designs utilize a reflexed airfoil which has two inherent disadvantages - high drag and compromised lift capability. The new design, which Jerry has named "Rattler", is a single place sailplane of modified plank design which utilizes an airfoil with no reflex, and incorporates wing twist to achieve pitch stability! A look at the 3-view shows how this is possible. The CG is located ahead of the main portion of the wing, so the wing twist can apply the required stabilizing download. Jerry maintains the 4° twist creates less drag and allows the wing to produce more lift in comparison to established plank planform.

The "Rattler" is also unique in its lack of vertical surface for yaw control. The canopy fairing and wing dihedral provide sufficient lateral area behind the CG.

A side benefit of the "Rattler" planform is its simple straight spar.

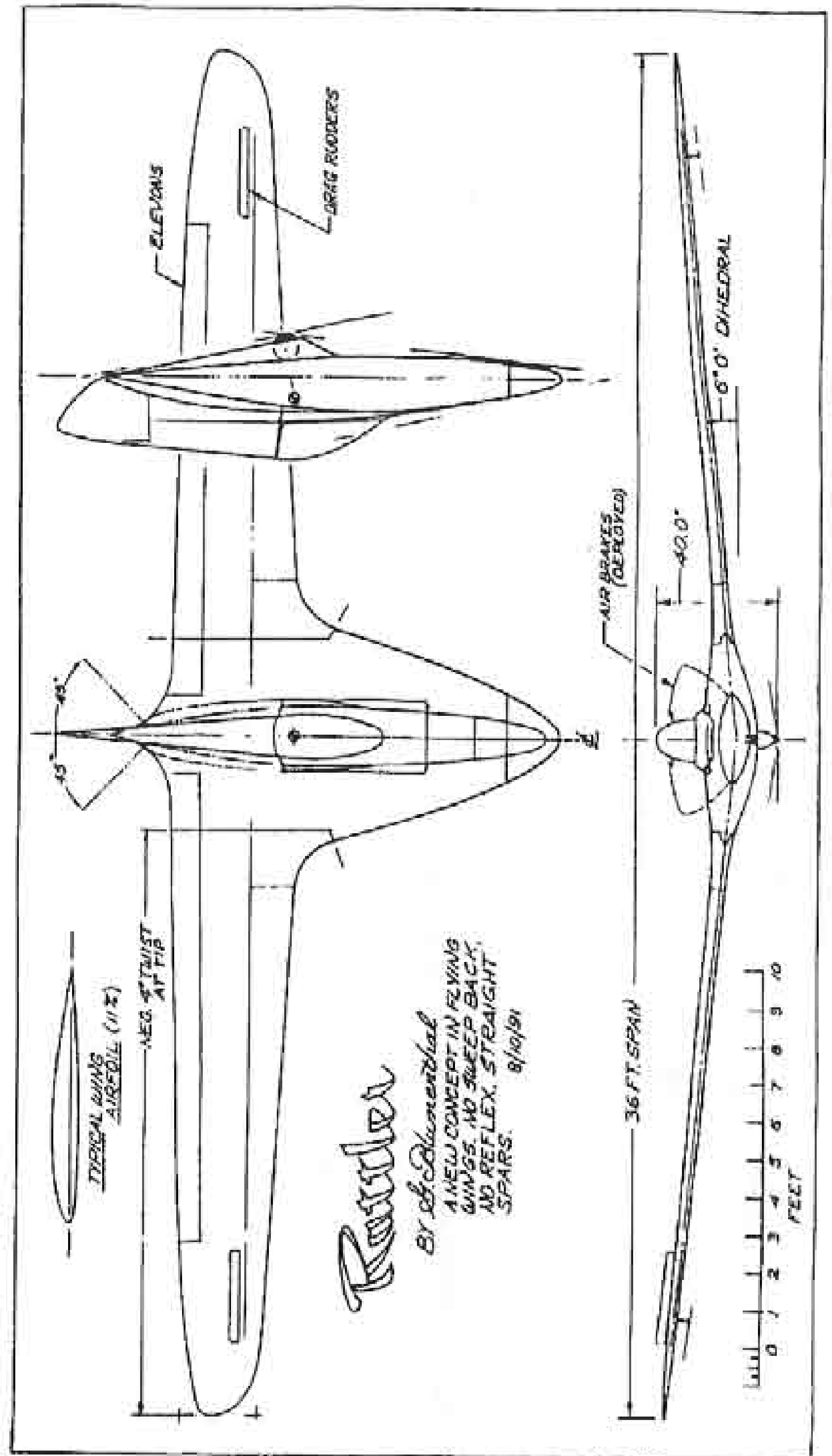
In an effort to prove the design before construction of a full-sized version, Jerry is building a scale model. Needing a mechanical mixer which would fit within the wing very close to the elevon, he came up with a nifty assembly. While we would prefer a mechanical arrangement where both servos pull the elevon up, there is little doubt Jerry's mechanism is both efficient and compact.



1. TWITT's Newsletter #63, September 1991.

2. TWITT's Newsletter #68, February 1992.

TWITT (The Wing Is The Thing), P.O. Box 20430, El Cajon, CA 92021. Refer also to the Special Interest Group section of this issue. ■



Scale Realism: (One Click Too Far...)

...by Mark Foster
South Pasadena, California

Well, it finally happened. I think I've lost control of the hobby, and probably my mind, too. After several years of flying RC scale sailplanes, I had convinced myself that the little plastic cloth creature sitting under the canopy was just that — a little plastic cloth creature... You know... it's just another part of the overall inanimate object that I control with the latest high tech radio paraphernalia...

Then, "Old Ned Foster" came to town. Proclaiming to be my long lost uncle... several times removed, of course. He convinced me and most of the others that they were not lifeless figures (pilots) like we had assumed. He was actually a **seasoned** "Old Timer" with **pro** flying skills. He boasted, "There's two things I know — corn and sailplanes — and that ASW-24 sittin' there ain't no popcorn. It looks mighty sweet to me." Yea, you know pilots are pretty colorful characters — rugged individualists and all that sort of manly stuff... Old Ned was no exception...

It was a clear, windy day in March that I decided to launch my new 4.3m, ASW-24. The wind was blowing from the south at about 12 mph. Unfortunately, at the San Diego Torrey Pines site, the wind was misdirected. So, my flying buddy, that was with me, suggested an inland slope. Old Ned (Who had been chosen by all the other pilot dummies — I mean figures.) said, "It doesn't matter to me what slope you pick — I'll fly off an ant hill, need be..."

So, we loaded up the Saburu and went looking for a flyable slope... Yes, about six miles inland we found a large indention in the earth that had 200 foot sides and meandered back into a valley for several miles... It looked flyable from many directions. As we were setting up the sailplanes for the slope, I noticed a peculiar difference between my buddy's flight preparation and mine; Old Ned was in and out of my model telling me to tape this and tighten that. At my buddy's plane, things were quite silent; everything was tightened, plugged in and range checked with the pilot sitting comfortably in the DG-300 cockpit. His head didn't move — not even a last minute nod of approval as he was being chucked off into the uncertainty of new untested slope lift...

After a thirty plus minute flight by the DG-300, I decided that it was the moment of truth for Old Ned and the ASW-24.

Everything appeared normal on the launch — Wait a minute!! Did the old geezer stroke out on the stick? Or, what? It took full up-trim and back stick to make the plane fly level — and it was hot at that... I was beginning to think I should have trusted Old Ned with the winter harvest instead of my new model. OK! Let's land the thing, Ned. Things were looking pretty good on the approach. If you can say good is downwind, glide over rocks into a small grassy area in front of a cement ditch... As fate would have it, only one spoiler popped open. Since the sailplane was so close to the ground, the nose followed the dropped wing, striking the ground causing the tail boom to experience a splitting jolt.

As I slowly walked over to the crash site, I heard grumbling coming from out the fuselage. Who Else? Old Ned was brushing grass and leafs from his person. Between the expletives I could hear him say, "I forgot more than he'll ever know 'bout flyin'." You know, you can look pretty darn ridiculous arguing with a 1/3 scale pilot **dummy**, so I tried to keep the verbal exchange to a bare minimum.

Well, I need some help with this. Or, maybe, I just need help.

Should I give the old guy another try? *(With a properly balanced sailplane?)* Gee, that little guy can write, too.

Better yet, I should send Goober back to the farm.

Hey, I got it! Is anyone looking for a pilot for their next scale project?.... ■

Winch Line ...by Gordon Jones

Gordon Jones, 214 Sunflower Drive, Garland, Texas 75041; (214) 840-8116

Energy Conservation

Henry Bostick drives a SAAB four door sedan. Two meter one piece wings are not exactly easy to carry in a four door sedan. Henry got tired of the wing beating him to death and not being able to see the road during his trips to the flying field. Henry did something about it! Henry built the "Mother of all trailers" to carry his planes and the winch.

Henry started looking for a trailer to haul his air force around about a year ago, and he found a nice sized sturdy trailer to do the job. He then preceded to get carried away. (Henry does that a lot.) First, he fitted the trailer with two storage containers that would hold enough planes to fly at any contest. The larger of the two was mounted directly on the trailer and the second, a fiberglass container, was mounted on the top of the metal container. This was great; he had enough room to carry all his planes at one time.

Then the fun began; since he had all this room left on the trailer why not put it to good use. Henry added a cooler on the front to hold his liquid refreshment on ice. Still having room to spare and not wanting to use space in his SAAB for anything but passengers, he added the PVC tubes that he carried his tent and poles with to the sides of the trailer so they would be out of the way. Hey, this thing was really starting to look pretty neat. As you can see in the pictures it is a fancy devil.

The only thing that Henry could think of to add to this rapidly growing project was to have the winch and retriever mounted on the trailer so he would not have to carry the launch equipment all over the place when setting up to fly. (Henry is into energy conversation; especially Henry's!) This was accomplished by having a rack made at the local welding shop to hold the batteries and back to the trailer shop to find a box to hold all the assorted equipment that goes with a winch. This was the best idea of the lot! With the winch and retriever set-up he could pull onto the flying field and be set up to fly in a matter of minutes. This has especially worked well during contests when a winch or retriever would fail; Henry could just pull his trailer up on line and have things ready to go in about five minutes.

After using this trailer for about a year and seeing how well this set-up worked the club decided to adopt the idea and put the two contest winches and retrievers on trailers as well. This was accomplished on a somewhat smaller scale than the "Lexus" model that Henry had built. The club purchased two small utility trailers and used a wood floor with 2 x 12 frames on which to mount the winches, retrievers and batteries. In addition, a plastic box was mounted on each trailer to carry the assorted winch equipment and to permanently mount the chargers so they would be accessible as well. As you can see from the pictures it came out to be quite compact and makes a lot more sense than carrying the equipment all over the place at the field and spending time on assembly.

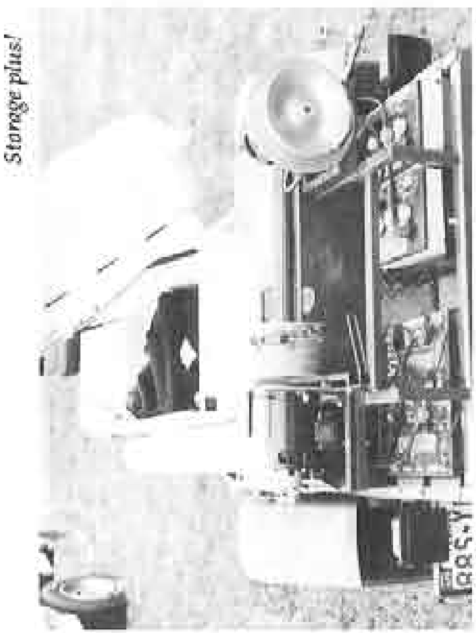
The total set-up takes about as long as it takes the individual to run the turn-around to the end of the line and pound it into the ground. The batteries are already hooked up, and with laying out the foot pedal the dirty deed is done in considerably less time now. In addition to the ease of set up, one trailer has the winch and retriever mounted forward to allow a trailer hitch to be installed on the rear of the trailer so that they can be hauled in tandem to the contests. This works great folks and is something to consider if you are tired of setting up winches and retrievers.

Oh by the way, Henry still carries his two meter wing in the SAAB! ■

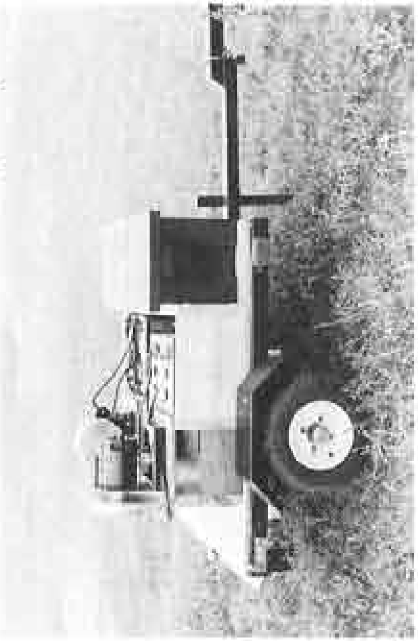
Henry's "Lexus" model.

The cooler on the front is nice; but where is the TV?

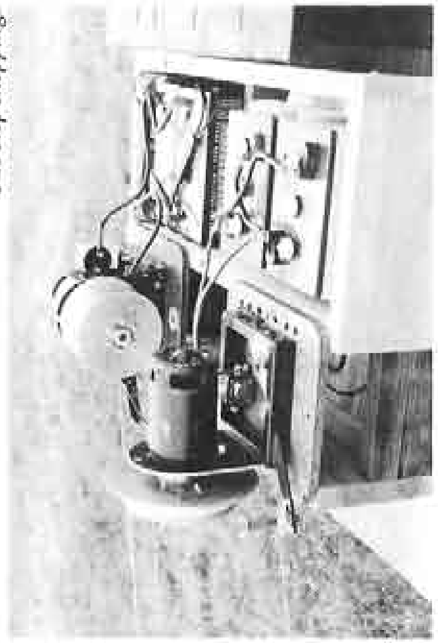
Simple Assembly.



Storage plus!



Simple but effective.

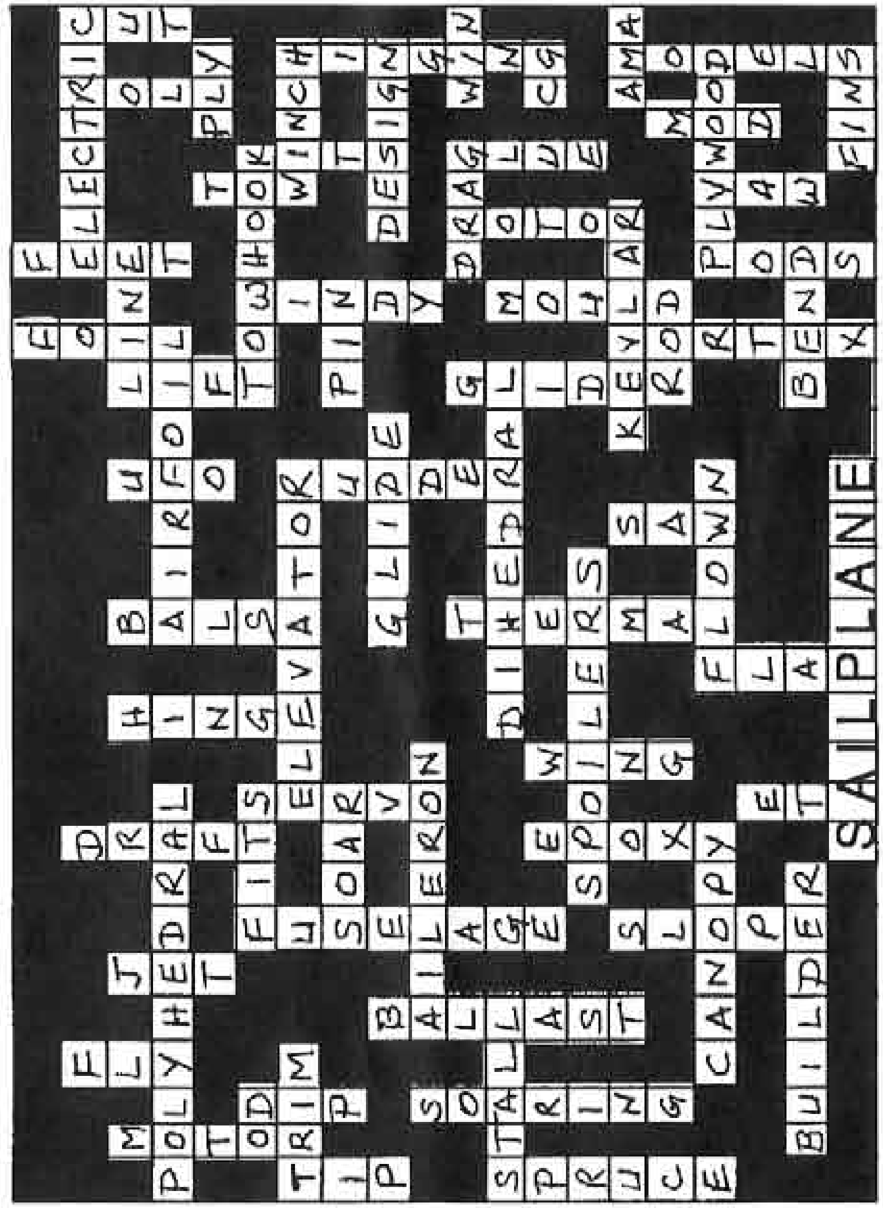


One stop shopping.

Answers To The Sailplane Puzzle

(June Issue)

We received a FAX from John Berry of Australia with the correct answers to the puzzle. (There are two words that can go in one of two places.) Thanks, John!



Dynamic Soaring

...by Graham Woods

19 Mimms Hall Road, Potters Bar, Hertfordshire, EN6 3BZ England

The title of this article may puzzle many fliers who may never have come across the term before. I must admit that it is rather an esoteric subject; I have come across only scant reference to it in my own reading. Nevertheless, I wanted to know a little more and went about finding out something of the subject.

Dynamic Soaring is concerned with extracting energy from the wind itself, or rather the differences in windspeeds at different heights above the surface of the sea or land.

I'm not just talking about slope lift which one might call **'Static Soaring'**; just converting slope lift into flying speed. Nor am I talking about **'Thermal Soaring'** sic; Flying in rising, cooling air, but actually taking energy from the system, making use of the wind gradient.

F3F STYLE...

It was F3F flying which first brought me to thinking about dynamic soaring as a fact rather than some fanciful notion of perpetual motion.

I wondered why, nowadays, the almost universally accepted **'Danish Style'** turn in F3F seemed to give better 1 km. times than the standard pylon turn favoured by pylon racers.

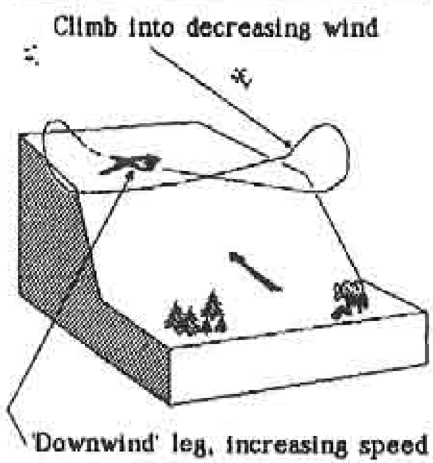
At first thought I believed it was simply that the *old* pylon races were over much longer courses of up to 250+ metres long and that straight line speed and a high wing loading were the all important aspects of the race with turns only of secondary importance.

But the shortening of the course down to 100 metres meant that the model had hardly exited one turn when it was required to do another and so the straight line speed had less influence on the result than the actual turns themselves.

Even so, a pylon turn should still have been good enough to compare favourably with one of the Danish style turns which I considered a fashionable fad. I thought that its use was due to the lower roll-rate of the Danes' wing twist 'Typhun" designs. That was until I considered the **'new'** turn was perhaps using the wind itself advantageously. They had, after all, been flying this format for more than a decade and would surely have learned the best flight path to follow.

A closer look at such an F3F flight path shows that at the initiation of the turn, one pulls in a little 'up elevator', climbing into wind *(through the wind gradient)* at the same time as rolling into the turn. From the highest point of the turn the model then descends effectively 'downwind' towards the slope, picking up airspeed. This is much the same way in which the great seabirds soar seemingly effortlessly over great distances, except they do it over the sea.

DANISH STYLE F3F TURN



TELL IT TO THE BIRDS...

Intrigue, and a little research led me to the leading expert on bird flight, Prof. C.J. Pennycuick[1] of the University of Miami, and his bird study in the southern oceans. From his paper, I found he and some others had written quite a few words and not a little mathematical explanation on the soaring of large seabirds. The earliest reference to Dynamic Soaring is that by ***Lord Rayleigh***[2] in a letter to **'Nature'** in **1883**. He suggested that a bird would be able to gain energy from the wind by gliding through ***'planes of separation'*** (what we call the wind gradient nowadays) leeward, turning and climbing through such planes windward.

Since that time, various scholars have interested themselves in the flight of seabirds, albatrosses and petrels in particular, and the way in which they manage to soar, spending a great deal of their life on the wing.

As a matter of interest to us soarers, the largest of these birds, the wandering albatross, has an **average** span of about 3m (male birds being larger up to around 3.5m, females somewhat smaller), an average weight of over 8 kg and as much as 10 kg. An adapted part of the bird's chest *(pectoral)* muscle in the form of a sheet of tendon enables the bird to effectively ***'lock'*** its wings in the gliding position, thus saving energy.

Such a bird would have a wing loading of something like 140 $g.dm^{-2}$ and aspect ratio of 15:1. Flight characteristics might be of the order of: a minimum sink speed of just under 12 $m.sec^{-1}$, minimum sink rate of just under 0.6 $m.sec^{-1}$ and a best glide ratio of more than 23:1 at 15.7 m/sec. Figures consistent with a **very** heavily ballasted F3B model! And so to the wind...

THE LOG WIND PROFILE...

That does sound fancy, doesn't it? This is the reason that Dynamic Soaring can take place.

From terra firma the wind increases in strength with increasing height up to around 500 metres or so when it attains the so called Geostrophic windspeed. This first few hundred metres of the atmosphere *(where we spend most of our lives and do all our flying)* is often called the **Friction Layer or Surface Boundary Layer.** Moving air is slowed by friction with the surface of the Earth; local turbulence caused by vegetation and surface features and thermal activity, create this boundary layer.

Now, as the name suggests, log wind profile has something to do with logarithms and for those of you who worry about the maths of it all, as I do sometimes, here is a little piece to ponder. If you don't care for maths, then skip the following and just grasp the idea that the wind changes with height and have a look at an imaginary example and the graphs plotted from it.

BACK TO SCHOOL...

Since the windspeed varies inversely with height, the log wind formula comes from the integration of the term 1/z: Where w is the wind gradient, V is the windspeed, u, a friction velocity associated with the prevailing conditions, z is height, and k is a constant of the order of 0.4. Integration gives equation 2, and it follows that the difference in windspeed for two heights, z_2 & z_1 would be as given by equation 3.

$$W = \frac{dV}{dz} = \frac{u_*1}{k\,z} \qquad 1.$$

$$V = \frac{u_*}{k}\log_e z + C \qquad 2.$$

$$V_2 - V_1 = \frac{u_*}{k}\left[\log_e z_2 - \log_e z_1\right] \qquad 3.$$

MAKING UP SOME NUMBERS...

From observations that have been made, it appears that at 10 metres above the surface (where *surface wind* is generally measured) the wind speed is around 40% of the Geostrophic windspeed. So if, for example, we choose a geostrophic windspeed of 12.5 $m.sec^{-1}$ at, say, 600 m, then at 10 m it would be around 5 $m.sec^{-1}$ and from these imaginary figures we can work the factor u, and then a whole load of numbers to plot on graphs and then have a look at them.

z	2	10	20	50	100	200	300	400	500	600
V	2.05	5	6.27	7.95	9.22	10.49	11.23	11.76	12.17	12.5
$\ln_z$	.693	2.30	3.00	3.91	4.61	5.30	5.70	5.99	6.21	6.40

VARIATION OF WIND WITH HEIGHT...

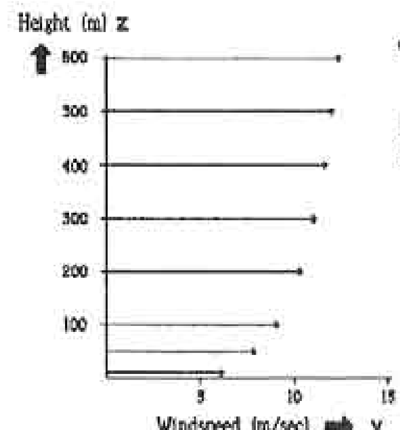
The first graph shows the variation of wind with height and is a curve and, as I have drawn it, it is a good way of visualising the pattern of wind distribution with height.

From the second graph we can see that the straight line crosses the height axis at a point below 0, z_0, where the windspeed is zero; this value is called the ***'aerodynamic roughness length'*** and depends on the type of surface (i.e., long grass, trees, sand, water, etc.), and it is value which determines the amount of turbulence and, therefore, the profile of the wind. (This number, z_0, is often added to the log wind equation 4.)

In our example, the value for z_0 is 0.65 by calculation. This value is consistent with the fact that z_0 is around 1/10th of the height of the vegetation above the ground. So, 6.5m would be a good figure for hedgerows and trees. Actual measured values are <0.1m for long grass and <0.01m for mown grass and snow and <0.001m for sand. It's not the height but the variation in height which determines z_0.

Two conclusions can be made from the equation. The higher the variation in height of surface features the greater the wind gradient. [For example, the air across a large airfield would have less of a change of wind strength with height

Variation of Windspeed with Height

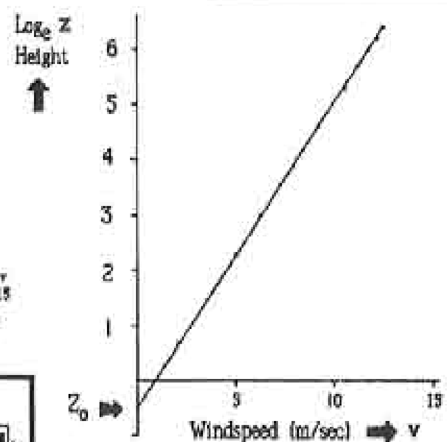


Graph 1.

$$4. \quad V_2 - V_1 = \frac{u}{k}\left[\log_e \frac{z_2}{z_o} - \log_e \frac{z_1}{z_o}\right]$$

Graph 2.

Variation of Windspeed with Log_e of Height



z_0 -aerodynamic roughness length

(wind gradient) than air coming over a varied landscape of isolated trees and hedgerows.]

The other conclusion to draw is that a greater wind velocity will produce a greater wind gradient.

THE EKMAN SPIRAL...

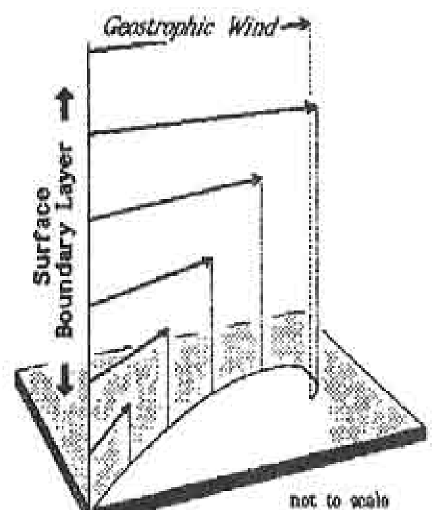
Graph 2 shows how the wind varies in strength according to its height above the surface of the Earth and the surface roughness value. We can now turn to the direction of the wind itself at the surface even though it has no direct relevance to Dynamic Soaring. The geostrophic wind is that wind which blows above the surface boundary layer and is largely unaffected by the surface features. In the boundary layer, as we have seen, the wind is affected by turbulence but there is not only a change in windspeed with height, but also a change in direction.

The reason for this change in wind direction with height can be easily understood by imagining that the spinning Earth drags with it the air that is closest to its surface and, naturally enough, this frictional drag reduces as you move further away from the surface up to the level of the *'free atmosphere'* and the Geostrophic wind. This drag is dependent on the roughness of the surface, wind speed and thermal activity.

The frictional drag produces an increasing deflection in angle from the geostrophic level at the surface. (See diagram.) It averages around 10-20° over the sea and 25-35° over land, but never reaches the theoretical value of 45°.

The best way to visualise the effect is by looking at the theoretical classic, the ***'Ekman spiral'***. Actual measurements do not follow an exponential spiral curve exactly, but do approximate it.

THE EKMAN SPIRAL



WIND ON THE SLOPE...

Quite a bit has been written on wind and slopes in the past, but there is one thing worth a mention here: wind speed on the slope.

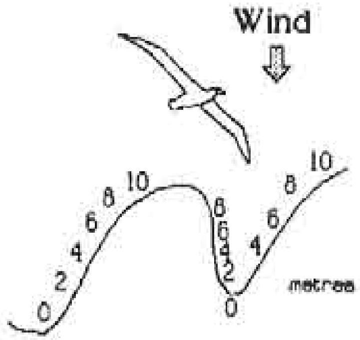
From what I have written one would think that since the wind is least closest to the ground, then the wind on the edge of a slope should also be low. This is patently not the case; in fact, the wind is stronger on the apex of a hill than the overall windspeed of the airflow.

To understand the reason, we must consider the air flowing over a hill almost as a fluid, that is to say, incompressible.

Air is a gas and can be compressed, but over a hill it does behave rather like a fluid and like the airflow over an airfoil section; the airflow is constricted and the air has to flow faster over the apex (with consequent increases in pressure, temperature, density) than the 'free' air. This is called the ***Venturi Effect***. I have no figures for it, but it's worth bearing in mind as we try to understand the behaviour of the air in front of, and over, slopes. It means that we can readily fly from an area of high windspeed to an area of low windspeed with ease remembering that we don't always have to fly in front of the slope.

DYNAMICS...

My introduction started with slope fly-



ing where Dynamic Soaring is not necessary since there is slope and thermal lift nearly always available. Bird flight over the sea uses these forms of lift to a varying extent; thermals being non-existent in heavy weather over the oceans but slope lift from the waves is used by birds. It obviously plays a part, but the lift from ocean swell cannot really explain how birds make headway against a strong wind without significant flapping input. A look at a typical flight path of an albatross shows that it flies downwind then turns into wind and downwind and so on in a series of climbs and dives. The best way to consider the flight is to look separately at the *into wind* and *downwind* legs.

A MODEL...

To start, we need a model and, erring on the conservative side, I have chosen my slope soarer which has a more or less symmetrical section. From the polar, figure 1, the model at 2 kg. has a stall speed of around 10 m/sec, a best sink rate of 0.65 m/sec and a best L/D of around 20 flying at just over 14 m/sec. I have a range of figures for drag, lift, and speed, etc. which I can use later on but, first, a closer look at the wind gradient w.

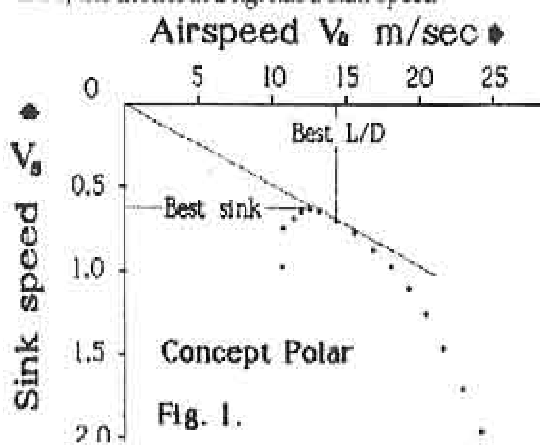


Fig. 1.

SATISFYING...

To satisfy the condition that we are extracting energy from the wind (i.e., Dynamic Soaring), we have to climb into wind and gain airspeed at the same time (the model effectively accelerating with respect to the wind). In other words, overcome drag, increase airspeed and gain height.

We know that if we climb, we will lose airspeed and gain height, but for every metre we climb the windspeed increases, and therefore our airspeed will increase at the rate of w, the wind gradient. Choosing particular flying speeds for my glider, we can have a look at what happens to see if Dynamic Soaring is taking place.

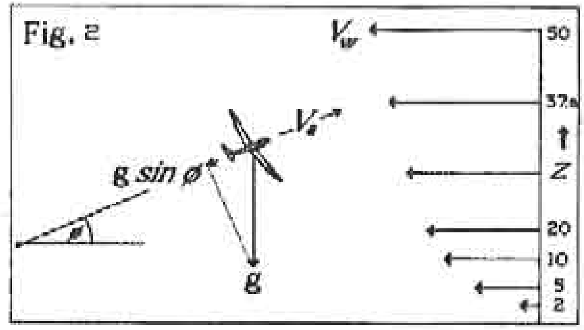
AERODYNAMICS...

There has always been some doubt about the possibility of Dynamic Soaring, but it seems to have been accepted by most who have looked at it. From Rayleigh's time the maths have become more detailed, from simple trigonometry to computer simulations. We can start with Prof. Pennycuick's easier interpretation below, but if you're into aerodynamics, it leaves a lot to be desired. He naturally enough takes all his figures from bird data but, since gliders *could* be considered as a species of bird, we can apply the same reasoning as he does.

A SIMPLE MODEL...

Invoking the idea of a *dragless* model, we can first look at an into wind climb.

Looking at figure 2, we can see that such a glider, climbing at some positive angle Ø, loses airspeed V_a at the rate of g sin



Ø (i.e., gravity), but at the same time its effective airspeed is increasing at the rate of $wV_a \sin Ø$ as a result of climbing into a stronger wind (i.e., climbing through the wind gradient).

For the model to maintain its airspeed, it is evident that $g \sin Ø = wV_a \sin Ø$ or:

$$6. \quad w = \frac{g}{V_a}$$

If we make $w > g/V_a$, we are satisfying the condition that the model is increasing its airspeed (i.e., accelerating) and climbing at the same time and, therefore, extracting energy or Dynamic Soaring.

Using the above relationship for my model flying at 14 and 21 m/sec (w>9.8/14 & w>9.8/21), I would have to have a wind gradient of more than 0.7 and 0.5.

Looking at graph 3, these values are available up to heights around 5 metres, so on this basis, my *dragless glider* would be able to extract some energy from the wind.

WHAT DRAG???

Unless we include some figure for drag, all that I have just written doesn't account for very much since the formula takes absolutely no account of the model's characteristics, whether it be a draggy biplane or sleek F3B model, so we ***must*** include some term for drag. The easiest way is to add Walkden's[4] value for drag to our equation g/L/D as in equation 7.

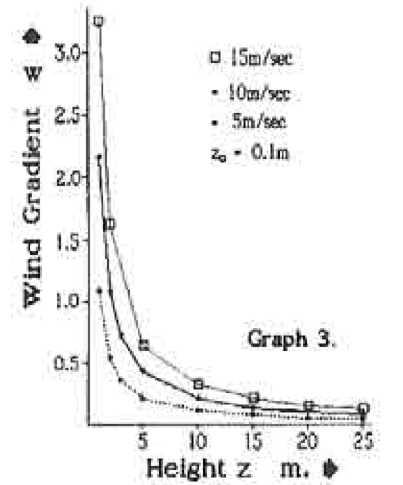
The additional term increases the re-

WIND GRADIENT

On an earlier page, we looked at the Log Wind Profile and saw how the wind changes with height; this *wind gradient* can be determined by doing some maths (partial differentiation) with equation 4. From equation 5 we can work out some numbers for the wind gradient (the change in speed per metre of height) at different windspeeds.

$$5. \quad w = \frac{V_2}{z\,[\log_e z_2 - \log_e z_0]}$$

I have plotted three curves for values of the wind gradient w, for three windspeeds (V_2): 5, 10, 15 m/sec. (at 10 m, z_2). Except that in this case, flying on the flat field, I have chosen a more realistic value for z_0 (0.1). Graph 3 shows, as one would expect, that stronger wind gives higher ranges of values for w, and that a value of more than 1.0 is only available up to around 5 metres, or the wind must be strong.



7.

$$wV_a \sin\phi - g\sin\phi - \left(\frac{g}{L/D}\right) > 0$$

quired wind gradient, complicates our simple relationship and introduces another variable, the angle of climb Ø. We can insert values for Ø, but as we shall see later, there is an optimum climb angle which appears to be around 20°. Reworking 7, we find now that a minimum wind gradient of 0.8 (0.7) and 0.56 (0.5) are required. So, even taking into account some amount of drag, Dynamic Soaring still seems possible using this model.

Pennycuick, for this in his maths, now rearranges this equation (9) and argues that the L/D ratio is multiplied by some positive number given by 1+wVa/g. Even a small value here of wind gradient (0.1) gives a substantial increase (14%) in glide angle *at the same flying speed*. Alternatively, instead of a shallow dive to maintain airspeed, a large increase in airspeed can be gained by a steeper, 40 - 60°, downwind dive, so there is a gain here, also.

9.

$$\operatorname{cosec}\phi = \frac{L}{D}\left[1 + \frac{wV_a}{g}\right]$$

DOWNWIND FLIGHT...

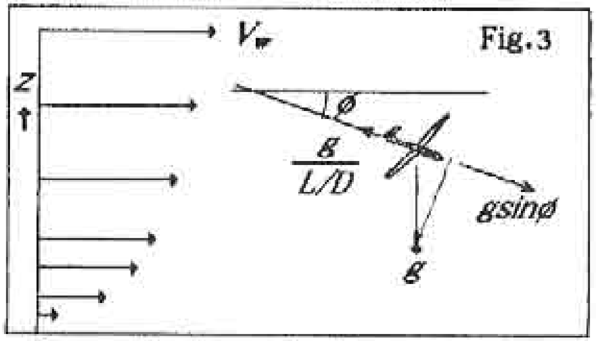


Fig.3

To conclude, using this simple model, it appears that some small benefit *may* be obtained into wind within a couple of metres of the ground flying into wind and more, after a climb, flying downwind. The conditions required are a high value of wind gradient (i.e., a strong wind and high value of aerodynamic roughness - discussed earlier) and a fast flying model (i.e., high wing loading rather than down elevator).

The model has to be ballasted bearing in mind that doubling its weight increases flying speed by √2 or 41%. (In my case, a 4 kg model would take me over the FAI limit, if flying in competition.)

If we consider that equation 7 is *nearer* to what is actually happening, we can now turn our attention to the downwind glide in Figure 3 where the same forces are at work.

Our model continues to increase its airspeed at the rate of $wV_a \sin Ø$ by virtue of the wind gradient. Its drag, g/L/D, still opposes its flight but, now diving, it gains airspeed at the rate g sin Ø. The only thing to change is the sign on the g sin Ø term, since we are now flying with the wind. From equation 7 we now have:

8.

$$wV_a \sin\phi + g\sin\phi - \frac{g}{L/D} > 0$$

A COMPUTER MODEL...

As I mentioned earlier, attempts to prove Dynamic Soaring have varied from simple maths, like the above, to computer simulations. Wood [3], in fact, has done such a thing and here's some of his thinking.

The term for the drag, g/L/D, although an approximation, doesn't quite tally with Wood's drag equation for a bird. (See panel.)

DRAG after Milne-Thompson (1966)

$$d = aV^2 + \frac{b\,l^2}{V^2}$$

where, $a = \frac{\rho\, s\, C_{do}}{2\,m\,g}$ $\qquad b = \frac{2\,k\,m\,g}{\rho\, s\, \pi\, A}$

$$l = \frac{V_a \sin^2\phi\; dV_w/dz}{g} + \cos\phi + \frac{V_a\,(d\phi/dt)}{g}$$

ρ is air density (1.22)
s is wing area (m)
m is mass (kg)
C_{do} is a coefficient for zero lift
g is accln. gravity (9.81m/sec)
k is span factor >1 (1.1)
A is aspect ratio
Ø is climb angle

The first term describes the drag of the body and skin friction of the wing; the second term describes the drag due to the tip vortices of the wing and neglects any drag for a tailplane.

Wood, after some difficult calculus, comes up with a flight equation which defines the rate of change of airspeed with time (acceleration) as:

10.

$$dV_a/dt = V_a \sin\phi\cos\phi\,(dV_w/dz) - g\sin\phi - \left[g\,a\,V_a^2 + \frac{g\,b\,l^2}{V_a^2}\right]$$

with a sign change on the wind gradient (dV/dz) for downwind flight.

To see if there is any possibility of increasing airspeed and climbing at the same time [our conditions for dynamic soaring (i.e., extracting energy)], we can plot the change in airspeed acceleration (dV/dt) in the above equation against a range of values of Ø for climbing. As before, we assume a constant value for w, the wind gradient. (Also, a fixed rate for dØ/dt = 0.)

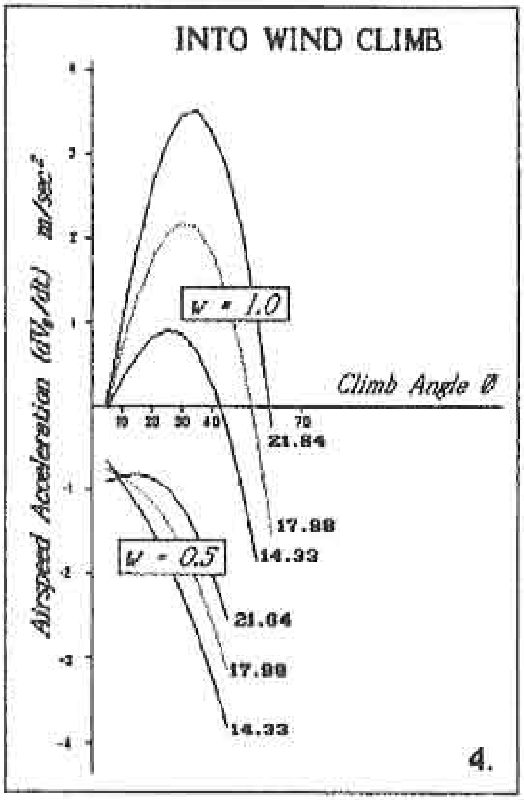
Here, I have again chosen two values for w (0.5 & 1.0) and used three flying speeds [14.33, 17.98 & 21.64 m/sec (without ballast)] on the flat part of the model's polar.

Graph 4 (top of next page) is probably a better proof that energy is extracted from the wind in the upwind climb. It shows that the highest accelerations are obtained flying at the highest airspeeds in the strongest wind gradients, as you would expect. It also shows that there are values for airspeed and wind gradient which fail to become positive (i.e., no energy is being extracted and, therefore, no Dynamic Soaring).

The corresponding graph, 5, for downwind flight, shows impossible decelerations which can only mean, in real terms, very rapid speed increases in a dive or, as we saw from Pennycuick's analysis, easily maintained flying speed in a long, shallow downwind glide for all wind gradients and airspeeds.

The fact that the graphs have peaks indicates that there **is** an optimum angle for climbing into wind, which I mentioned earlier.

Wood goes further and introduces the concept of 'energy height', using the kinetic/potential energy formula $1/2\,mv^2 = mgh$ to relate height and acceleration. He does some more calculus and comes



up with the term g sin Ø and then plots dV/dt/gsinØ against climb angle to find optimum climb angle.

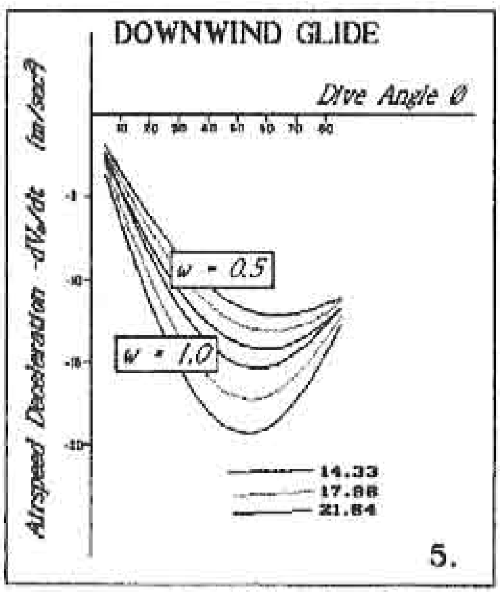
Surprisingly, most values peak at around 5° either side of 20° showing that there is almost an optimum angle to climb irrespective of airspeed or wind gradient.

At this point, I leave Wood's analysis. He did, however, run a computer program for an albatross and concluded that it was certainly possible in one cycle of climbing into wind and gliding downwind the bird could not only fly without flapping, but actually make progress upwind. His step-by-step integration program took into account the fact that the wind gradient varies with height (which I haven't done here), varied the values of acceleration and climb angle. He also varied the coefficient of lift and took the two turns (at height of climb and bottom of dive) into account. Even so, his program fell short of the real flight trajectory being only in two dimensions and not three.

Nevertheless, in one of his simulations of a theoretical gliding albatross, the flight path showed that a bird starting at 20 m/sec at one metre height climbed to a height of some 16m, turned downwind in a dive to one metre height reaching a maximum speed of 28 m/sec and turned back into wind, and that by the time its speed had returned to 20 m/sec at one metre, it had made a net progress against the wind of 48m over a period of time of 22 sec. He noted that a tight downwind turn would have had a deleterious effect on the overall gain windward.

CONCLUSION

Well, this article has turned out a little longer than I had at first expected. Such a subject, being of no practical use to full-size aircraft, has received little attention. As I explained at the very beginning, it was just curiosity that set me on the trail of Dynamic Soaring and I hope I have gone some way in pointing to it as a fact rather than a fiction. All the evidence I have used has come from bird



observations and it spans 100 years; it may be suspect. That's for you to decide.

I'm still not entirely happy about drag; some aspects of the total drag of a model are really quite small and the graphs I have plotted neglect any tailplane drag. Values I have used came out in the range from 0.4 to 1.2 for my model. It is interesting to note that increasing the weight of a model has a significant effect on the amount of drag, doubling the weight in the term, a/V^2 (see box), halves the drag value, but then flying faster increases drag. Increasing the aspect ratio also reduces one aspect of the drag.

I suppose the reason that this type of soaring hasn't turned up before is that on the slope it is not necessary and on the flat field, thermal soarers, being mostly lightly loaded, don't care for the wind and don't fly unless they have to.

So, what does it mean for soarers, today? There may be one or two of you who might care to actually try to do some Dynamic Soaring for the sake of trying it, but most will want to know what it offers them. I could suggest that you fly in the lee of a line of hedge or other obstruction (cars and buildings). Here the air will be moving more slowly than in the open and use may be made of the gradient by climbing above and diving below a hedgerow. Flying close to such obstacles (apart from hitting them) does have drawbacks since there will be more turbulence, but then a high wing loading and fast speed may take care of that.

For thermal soarers, it may provide a means of stretching out that last few seconds on the landing approach in competition. But flying so close to the ground at high speed may make the landing area more dangerous than it already is.

For those flying F3B, it may be an added technique for the same reason, but may also help in the last laps of distance. Instead of just flying to and fro, maybe the last turns should climb at 20° into wind and, perhaps, a steeper glide along the course, downwind, always turning into the wind. Not forgetting the change in wind direction from launch height (230+m) down to the ground.

Electric fliers may benefit more easily since their models are nearly always heavily loaded with batteries of cells and, as we have seen, a high wing loading is one of the criteria for dynamic soaring; perhaps they too will benefit more easily when close to the ground.

On the slope, the situation is a lot more complicated since we already have variations in slope lift with respect to position on the slope and now we see that varying windspeed around the slope also has an impact on the available energy. Wind gradient here may be even greater than on the flat because the hill may have in front some considerable variation in vegetation and the apex of the hill exaggerates the windspeed variations.

I believe the F3F flight path I started with makes use of Dynamic Soaring and the reason why, in very light conditions, some faster flying slope soarers may out perform thermal floaters and gulls. I shall continue to search for evidence of the existence of Dynamic soaring in my own flying as an adjunct to thermal and slope lift. I suspect you may be watching out for it, as well...

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World Postal Soaring Announcement

(This announcement was sent in by Morten Munkesoe (Chairman), S.M.S.K (Sealand's Model Soaring Club, Denmark), Valmuebakken 22, DK-2625 Vallensbaek, Denmark.)

The Danish 2M class can this year celebrate its 10 year anniversary. In connection with this event, we would like to invite interested soarer pilots to a World Postal Contest on September 27, 1992.

The Danish 2M class was originally designed as an alternative (amputated) to the F3B class, as the F3B itself had become too advanced for many of us.

The rules have been gradually developed during the past ten years and, judging by the number of participants in the competitions, the support and enthusiasm for this 2M class is still increasing.

Today, 10 contests are normally arranged each year with great success; so the 2M class is here to stay - no doubt about that!

One category of the 2M is the annual Danish Postal Contest, which this year hopefully will have around 50 pilots, if the weather permits flying.

Now, as we are to celebrate the 10 year anniversary of the 2M class, we would like pilots all around the world to compete with us in our first, International Postal Soaring Contest. You will hereby have the opportunity to become world champion with a $30 airplane; but remember you will get lots of competition from experienced 2M pilots in Denmark.

The following procedure is used for the World Postal Contest:

- On September 27, 1992, the actual contest is carried out on your own airfield.
- The specific rules are mentioned below, and should not lead to misunderstandings.
- 2 rounds are to be flown. (If time allows more than 2 rounds, only the 2 best rounds count in the contest.)
- After that, the final results are sent to the contact person: Steen Hoej Rasmussen, Tjoernehusene 20, DK-2600 Glostrup, Denmark.
- Deadline for the results is October 26, 1992.

The results will be evaluated soon after the deadline, and the results will be announced in this magazine as soon as possible. The winner will be contacted directly.

Brief Class Characteristics

The Danish 2M class is mainly designed for standard 2M soarer planes available on the market. Ailerons are permitted, but only two servos are allowed. 1/3 of total maximum score can be achieved by landing accuracy.

The 2M contests are held in proper weather conditions and will normally be cancelled, if the wind velocity exceeds 8 m/s. This only to indicate the kind of soarers the Danish 2M class is designed for.

Hints

The favourite models this year will, depending on the weather, probably be (all with polydihedral):

Olympic
Gentle Lady (Goldberg)
Spirit (Great Planes)
Blue Phoenix (Modell Produkter)
Drifter II (Dynaflite)
Riser (Sig)
Metric (Topflite)
Wanderer (Dynaflite)

Typical battle weight: 750 grams
Typical area of wings: 40 dm^2

We wish you a pleasant flight! (...and thank you for flying the 2M class.) ■

2M Rules

1. The Model Sailplane

Maximum wingspan of the model is not to exceed 2 mtrs. projected. The maximum number of servos is 2, used according to the pilot's wishes. It is not allowed to receive signals from the model. The model must comply with FAI rules.

2. Start

The start takes place by means of one of the lines (bungees), installed by the officials of the event. Line specifications: maximum 30 mtrs. of rubber (bungee), 120 mtrs. regular line + parachute and 30 cms. of leader. Maximum pull on the line is not to exceed 6 kgs. Start attempt: The pilot has 2 minutes to start, from the moment the model is ready to be launched. Re-start is granted in case of line defects, or if officials judge the start attempt to have been disturbed by crossing lines or other models.

3. Flying

Each round should have 5 starts or less, if so decided by the officials of the event because of the weather or the duration of the event. The sequence of the 5 starts per round is: 3, 4, 5, 6, 7 minutes. Each second equals 1 point. When the maximum time for each start is reached, 1 point is deducted per second of excess time. More than 60 seconds of excess time will cause the start to be forfeited, and no points will be awarded.

4. Landing

Landing must take place on a strip 25 mtrs. long, and points are given according to the following table:

0 - 50 cms	=	150 points
51 - 100 cms	=	135 points
101 - 150 cms	=	120 points
151 - 200 cms	=	105 points
201 - 250 cms	=	90 points
251 - 300 cms	=	75 points
301 - 350 cms	=	60 points
351 - 400 cms	=	45 points
401 - 450 cms	=	30 points
451 - 500 cms	=	15 points

The distance is measured from the nose of the model to the middle of the strip. More models may land at the same strip at the same time. The landing is forfeited and awarded no points if:

A. The model lands on its back, stands in the ground (spear landing), or if the pilot moves the model before measuring has taken place.
B. The model loses any parts from the moment of start and until the model lies still on the ground.
C. The model touches persons or objects, which may have affected the landing.

The start is also forfeited if the model lands outside the appointed flying field.

5. Time Keeping

The time keeping starts upon release from the start line, and stops upon the model's first contact with the ground. Time is measured in full seconds; no fractions are used.

6. General Conditions

Participants must be a member of the national model flying organization. The model airplane must be marked with the participant's membership number on the right wing. The model may only be replaced with another if the model with which the participant started the contest is unable to fly.

The contest is called off in case of wind velocity constantly exceeding 8 mtrs. per second.

Protests may be filed against a fee of DKR 50,00. Protests must be in writing, and submitted to the officials of the event no later than 30 minutes after the event is officially closed, but before the prize giving. The fee will be paid back only if the protest is sustained.

Protests, the actual running of the event, security and the settling of conflicts are the sole responsibility of the officials of the event. ■

Please feel free to reproduce the letter, & rules. A full-size 8 1/2 X 11 score sheet is available. Please send a LSASE for a copy. The next issue will contain a reduced version. ED ■

Lift Off!

...by Ed Slegers
Route 15, Wharton, New Jersey 07885

Electric Breeze

"The Electric Breeze (52" span) is Douglas Aircraft Models first electric release. It is a 7 cell, .05-.075 design which evolved from Douglas' Silhouette and Quicksilver, which are aerobatic slope glider kits. These are airplanes which fly well and do a wide range of aerobatics without a motor! At Douglas Aircraft Models we believe that glider technology holds the key to the success of the aerobatic electrics of the future. Hence, the Breeze utilizes the exact wing and tail as does the Quicksilver slope glider. The wing is the key. The release of Michael Selig's SD 6060 airfoil, a wind tunnel demonstrated improvement of the slope soarer's favorite to date, the Eppler 374, has given us a wing which will fly fast right side up or inverted, and will still carry weight, well. Add electric power, and WOW! With 7 cells, a good ferrite motor, and a good prop, you can have tons of fun doing all kinds of aerobatics including outside loops. Add a hot cobalt motor and performance is truly amazing! The Breeze can be flown well with 2 ch aileron/elevator control or add rudder and speed control for all out 4 ch fun! Removable landing gear allow the option of flying without wheels if your landing area permits. Not for the beginner, the Breeze is an exciting experience for the intermediate and advanced pilot alike."

The above is a quote from the press release for the Douglas Aircraft Electric Breeze and really tells it like it is.

Here on the east coast, we do not have many slope sites. I wanted to try a high performance, slope type plane, but without a slope close by I decided to try an electric powered slope plane. I've built and flown both the Quicksilver and Silhouette from Douglas Aircraft and, being very happy with both quality and performance, it seemed that the Electric Breeze was the way to go.

The Electric Breeze uses the same wing and tail as the Quicksilver, but more importantly has the same fine quality. The kit is first class with excellent foam cores, very good wood and hardware, good plans and an excellent construction manual. The plans have coordinates (letters along one edge and numbers along the other). The instruction manual keeps referring to these coordinates. This makes looking up the construction steps very easy, much like locating a town on a road map.

Because the instruction manual and plans are so good, I won't go into a step by step construction article. A few notes might help, though. First, build light, light, light. All efforts should be made to keep the Electric Breeze as light as possible for the best performance. One place to save weight is to be very careful on the amount of epoxy used to sheet the wing. Another is to use a lot of sandpaper. Don't be afraid to use your sanding block. Another is to use the lightest radio gear you can get. Unless you have to, I would not recommend using the optional landing gear. The list could go on and on, but the point here is to build light.

A change to the instruction is in step 7. Doug is correct. The thin Sullivan cable is too fragile. Make sure to replace it with the 1/16 Sullivan cable. Also, instead of closing the wing faring over the servo, make an access door that can be screwed down. This could be removed in case servo maintenance is necessary.

As Doug of Douglas Aircraft says, this is not a beginner's plane, but is for the intermediate or advanced pilot. Doug is correct. The Breeze is a very fast and responsive plane. Although I haven't tried it, I think for a novice that it could be tamed down by putting in a little dihedral and using the new Astro FAI .035 on 6 cells. For my plane, I found the best results by using the FAI .05 on a 7 cell 900 ma pack and an 8 X 5 prop and a Flightec SEC II speed controller with the BEC.

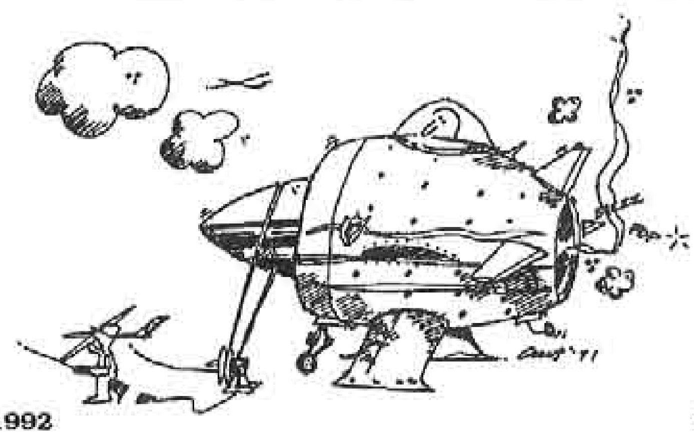
If you want a very high performance and very aerobatic plane, I would highly recommend the Breeze. Great quality, instructions and super performance at a very reasonable price; the Electric Breeze is hard to beat!

Douglas Aircraft wants to know where their customers first heard about their products. If you should get in touch with Douglas Aircraft, be sure to let them know you read about the Electric Breeze in *RCSD*.

Good Flying!

Douglas Aircraft Model Aviation, P.O. Box 92472, Long Beach, CA 90809; (213) 498-1737

Flightec, 21 Juniper Way, Hamilton, NJ 08619; (609) 584-9409 ■



Curt Nehring
San Dimas, California

R/C Soaring Resources

Do you hold seminars and workshops? Would you like to be included as a contact to answer questions on soaring sites or contests in your area? If so, please contact *RCSD*. Our address and telephone numbers are on page 1.

Seminars & Workshops

Free instruction for beginners on construction and flight techniques. Friday & week-ends (Excluding contest days) Bob Pairman, 3274 Kathleen St., San Jose, California, 95124; (408) 377-2115

Free instruction for beginners on construction and flight techniques. Sunday - Thursday. Bob Welch, 1247B Manet Drive, Sunnyvale, California 94087; (408) 749-1279

Fall & Winter 1 day seminars on composite construction techniques. Free with purchase of Weston Aerodesign plan set ($35.00) or kit. Frank Weston, 944 Placid Ct., Arnold, Maryland 21012; (301) 757-5199

Reference Material

Madison Area Radio Control Society (M.A.R.C.S.) *National Sailplane Symposium Proceedings*, 2 day conference, on the subject and direction of soaring. 1983 for $9.00, 1984 for $9.00, 1985 for $11.00, 1986 for $10.00, 1987 for $10.00, 1988 for $11.00, 1989 for $12.00. Delivery in U.S.A.is $3.00 per copy. Outside U.S.A. is $6.00 per copy. Set of 8 sent UPS in U.S.A. for $75.00. Walt Seaborg, 1517 Forest Glen Road, Oregon, WI. 53575

BBS

BBS: Slope Tech, Southern California; (310) 866-0924, 8-N-1

BBS: South Bay Soaring Society, Northern California; (408) 281-4895, 8-N-1

Reference listings of *RCSD* articles & advertisers from January, 1984. Database files from a free 24 hour a day BBS. 8-N-1

Bear's Cave, (414) 727-1605, Neenah, Wisconsin, U.S.A., System Operator: Andrew Meyer

Reference listing is updated by Lee Murray. If unable to access BBS, disks may be obtained from Lee. Disks: $10 in IBM PC/PS-2 (Text or MS-Works Database), MacIntosh (Test File), Apple II (Appleworks 2.0) formats.

Lee Murray, 1300 Bay Ridge Road, Appleton, Wisconsin, 54915 U.S.A.; (414) 731-4848

Contacts & Special Interest Groups

California - California Slope Racers, John Dvorak, 1638 Farringdon Court, San Jose, California 95127 U.S.A., (408) 259-4205.

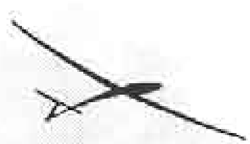
California - Northern California Soaring League, Mike Clancy (President), 2018 El Dorado Ct., Novato, California 94947 U.S.A., (415) 897-2917

Canada - Southern Ontario Glider Group, "Wings" Program, dedicated instructors, Fred Freeman (416) 627-9090 or David Woodhouse (519) 821-4346

Texas - Texas Soaring Conference (Texas, Oklahoma, New Mexico, Louisiana, Arkansas), Gordon Jones (Contact), 214 Sunflower Drive, Garland, Texas 75041 U.S.A., (214) 840-8116.

Maryland - Baltimore Area Soaring Society, Steve Pasierb (President), 21 Redare Court, Baltimore, Maryland 21234 U.S.A., (410) 661-6641

Washington - Seattle Area Soaring Society, Waid Reynolds (Editor), 12448 83rd Avenue South, Seattle, Washington 98178 U.S.A., (206) 772-0291.



F3B/USA

The Newsletter for the Multi-Task Soaring Enthusiast

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(303) 688-9572**

LSF

The League of Silent Flight (LSF) is an international fraternity of RC Soaring pilots who have earned the right to become members by achieving specific goals in soaring flight. There are no dues. Once you qualify for membership you are in for life.

The LSF program consists of five "Achievement Levels". These levels contain specific soaring tasks to be completed prior to advancement to the next level.

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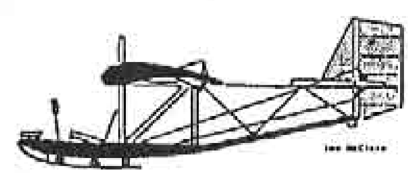
ForInformation,Contact:
NSSSecretary/Treasurer
RobertMassmann
282JodieLane
Wilmington,OH45177
(513)382-4612

T.W.I.T.T.

(The Wing Is The Thing)

T.W.I.T.T. is an organization of engineers, scientists, pilots, sailplane enthusiasts, model builders and many other persons having an interest in flying wing/tailless aircraft technology. Write to T.W.I.T.T., P.O. Box 20430, El Cajon, CA 92021 to find out how you can participate.

Send SASE for membership application and flyer: "What is T.W.I.T.T." or, send $2.00 for full information package including one back issue of our newsletter, postpaid. Full membership is $15.00 per year and includes twelve issues of the newsletter. Back issues of newsletter are $.75 each, postpaid.



The Vintage Sailplane Association

VSA is a very dedicated group of soaring enthusiasts who are keeping our gliding history and heritage alive by building, restoring and flying military and civilian gliders from the past, some more than fifty years old. Several vintage glider meets are held each year. Members include modellers, pilot veterans, aviation historians and other aviation enthusiasts from all continents of the world. VSA publishes the quarterly magazine BUNGEE CORD. Sample issue $1.-. Membership $10.- per year. For more information write:

**Vintage Sailplane Association
Route 1, Box 239
Lovettsville, VA 22080**

NEW PRODUCTS

The information in this column has been derived from manufacturers press releases or other material submitted by a manufacturer about their product. The appearance of any product in this column does not constitute an endorsement of the product by the *R/C Soaring Digest*.

Alcyone 2M, Culpepper Models

...from Northeast Sailplane Products

(Wingspan: 78.75", Wing area: 609 sq. in., Weight: 35 oz., Wing loading: 8.5 oz/sq. ft., Airfoil: SD7032/SD7037, Skill level: Int/Int)

Northeast Sailplane Products is pleased to introduce the Alcyone 2M, an innovative design from Leroy Satterlee. The Alcyone 2M was designed for the pilot looking to expand his horizons beyond the beginner sailplane. Its handling characteristics will not intimidate the intermediate pilot but at the same time its performance will satisfy expert pilots, as well.

Maybe you love the Alcyone as much as we do and have dreamed of finding a two meter sailplane with the performance and handling of the Alcyone. Perhaps you need a sailplane that can step you up from the two meter gasbags into high performance but won't strain your pocketbook or your flying skills. The solution in both cases is the Alcyone 2M.

The Alcyone 2M has a one-piece foam wing with a simple yet very strong spar reinforced with carbon fiber. This system minimizes the weight and maximizes the strength of the wing. The fuselage is constructed of plywood, balsa and spruce and has minimal frontal area without sacrificing ease of radio installation. The stabilator and rudder use a simplified pull/pull cable system for lighter weight and accuracy. The flying stab uses the SD8020 airfoil in a foam and balsa construction. A built-wing 2M version will be available later in the year.

Like its bigger brother, the Alcyone 2M features ailerons and coupled rudder, elevator and flaps. It's a three-servo operation without a need for a computer radio. For the ultimate in handling at a sacrifice in wing loading, wing servos can be used. We recommend using smaller servos (minis, not micros) to minimize weight.

The Alcyone 2M features the same configuration and airfoil combination with similar handling and performance as the Alcyone but in a smaller package. The wing loading is reasonably low for a two meter design, which contributes to its outstanding sink rate performance. The modified Schuemann planform, SD7032/SD7037 airfoil combination and turned up tiplets give easy and quick response, stability in thermals, and a surprisingly flat glide.

Using the SD7032 at the root and tapering to a SD7037 (the tiplets are pure SD7037) seems to give the Alcyone 2M the best of both airfoils. This combination will float in light lift, climb very fast in thermals and is extremely resistant to tip stalls. The thicker root section concentrates strength where it's needed. The transitioning airfoil controls spanwise flow and results in a greatly enhanced speed range.

The long tail moment of the Alcyone 2M results in smooth pitch response reminiscent of much larger sailplanes. Roll response is quick and agile with no bad habits. The Alcyone's large flaps and its slow speed capabilities make spot landings a snap. If you can't win in your local contest with this baby, give it up! CUPALC03 Culpepper Models Alcyone 2M is $99.95. Available from Northeast Sailplane Products, 16 Kirby Lane, Williston, Vermont 05495; (802) 658-9482. ■

Release of Molded Wings

...from Greco Technologies

Greco Technologies in its continuing effort to improve its product is now introducing the Modi 900 in a molded version. The Modi previously has been made using a vacuum bagging process. Greco has always been interested in offering the Modi in a molded version and has been working on the project for some time now. The main advantage of molded wings is greater control over quality. Each wing is exactly the same shape and size as the mold. With vacuum bagging techniques it is difficult to be as accurate. However, Greco was disappointed the extra flashing that was left over with standard methods of molding. This extra flashing runs around the entire outside of the wing and is extremely difficult to cut away accurately. Greco did not want to produce a molded wing with flashing. A special technique was used to eliminate the flashing around the outside. The resulting wing leaves very little finishing work to be done and is extremely accurate.

For those not yet familiar with Greco, they are developing a new line of radio controlled airplane kits. This engineering and technical consulting firm based in Pasadena, California is using its expertise to create a new line of planes. Greco's staff includes aerospace engineers who are sailplane enthusiasts. This allows them insight into both the technical aspects of aerodynamics, the latest developments in composite material and insight to the wants and needs of the hobbyist. The first plane in the series was the vacuum bagged Modi 900. They have since introduced the Thermal Modi, a wood laminated sailplane, and will be bringing out a hand-launch plane in the summer.

The Molded Modi is an open-class competition sailplane. It has a 50 inch fiberglass and Kevlar fuselage. The two strips of Kevlar in the boom run from the middle of the fin all the way past the wing saddles. Running this much Kevlar adds strength and helps to reduce stress fractures. The molded wings are laminated with fiberglass and high compression polyurethane foam. The molding process produces a wing that has an outside finish that is similar to a fiberglass fuselage. The structural spar is considered by some to be overkill. It runs almost the entire length of the wing. It is made of a high compression polyurethane foam, carbon fiber laminates and wrapped in fiberglass.

The wing joiner rod is a 14 mil. carbon fiber rod that fits into a carbon fiber receiver tube in the core of the wing. Aluminum shaft hinges with Teflon inserts for the flaps and ailerons are included and installed. This type of hinge design withstands much more pressure than the standard method of tape and mylar. The control horns are made out of 1/16" aluminum to reduce play in the control surfaces. The bellcrank is also constructed out of 1/16" machined aluminum with a percussion bearing to prevent slop in the stabilator and allow for the most fluid movement possible.

The Molded Modi comes near ready to fly. All that is left to install is the radio equipment, servos, and linkage. Other vital statistics of the Modi 900 include: Span: 116 in. wing, 50 in. fuse; Wing Area: 949.21 sq. in.; Aspect ratio: 13.1:1; Airfoils: RG15 wing, S8020 stabilizer. For more information contact Greco Technologies at: P.O. Box 10, South Pasadena, California, 91031; or call: 1-800-34-GRECO. ■

Transmitter Trays, Etc.

...from Mid-Columbia R/C

Mid-Columbia is pleased to announce that we have many new accessories including transmitter trays, aluminum transmitter cases, and 21st Century Film in flourescent colors. For more information, please call: Mid-Columbia R/C (509) 627-5224 or write to: Rt. 4, Box 9544, W. Richland, WA 99352. ■

Your Very Own Weather Reports

In Orange County, California

...by George Siposs
Costa Mesa, California

How many times have you gone out to your favorite flying spot, especially slope, only to find that the wind is from the wrong direction, too strong or non-existent? There is a way to prevent needless trips.

The Orange County Tower, at the airport, has a continuous reporting service on the telephone. You can listen to it and tell whether conditions are right. But, first, a refresher in wind reporting terminology.

North, East, South and West are the principal directions of the compass. They cover a complete circle which, by convention, is divided into 360 parts or degrees. North is "0" degrees, or 360; East is 90 degrees; South is 180, and West is 270. (If you pictured a gigantic clock laid out of the Earth's surface, you could substitute 12 o'clock for North, 3 o'clock for East, and so on.) Wind direction is reported as the direction FROM which the wind is blowing. An Eastern wind means that it is blowing from the direction of Saddleback mountain or 90 degrees.

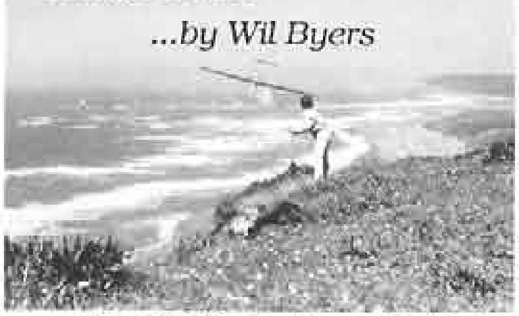
Now, before you go flying, call 546-2279. (Works only in 714 area code. Check your own airport for their number.) You'll hear a man or woman rushing through a garbled message that only pilots understand. But, if you listen carefully, you can glean information relating to the wind.

You'll hear all kinds of cryptic words like Zulu, Tango, Dew Point and, then, if you listen carefully, you hear something like, "Wind, two-five-zero at nine." This means that the wind is blowing from a direction of 250 degrees (almost west) at nine miles an hour. Let the message run through several times; it repeats about every 45 seconds and there is no charge for the service.

At the field, check the wind direction and strength. When you get home after flying, call 546-2279 again and check to see if the wind has changed. Compare your measurements with the report, as the wind could have changed while you were out there. Now, you can correlate them for future reference. If you have a compass, take it out to the slope and check the most favorable wind direction as well as the maximum deviation that you could still live with. A simple phone call... And, you save a lot of grief. ■

Ridge Writer

...by Wil Byers



RT. 4 Box 9544, W. Richland, Washington 99352; (509) 627-5224 (7:00 PM - 10:00 PM weekdays, after 9:00 AM weekends)

Special News Flash

Northwest Slope Soaring Research Associates Inc. (NSSRA) has compiled some astonishing technical soaring data. NSSRA a recently established private non-profit corporation developed to find the ultimate answers to R/C soaring is finally releasing their special findings. And, this affiliation of technical wizards has amassed a huge volume of somewhat tainted, as well as biased, empirical and analytical data. Data that evaluates the design parameters associated with high performance scale R/C soaring machines. Careful analysis of the data presented in this dissertation is imperative to the continued technological progress of R/C soaring. Any lack of attention to details presented herein may result in an immediate deterioration of the stated goals of the R/C soaring movement and thereby lead to its ultimate ruination.

You will be interested to know that the NSSRA research project dates back some five years to 1987 when a select fraternity of soaring aficionados were creatively funded via NSSRA methods. The purpose for their study was to develop a core theory for enhanced performance of scale R/C soaring machines as compared to non-scale replicas of model soaring aircraft. After exhaustive research and huge expenditures of time and money, this body of intellect has reluctantly disclosed their findings. Findings that both verify and substantiate continued research in this area, even in the face of spousal opposition. Opposition that often threatens and impedes major technological breakthroughs. As well, it is opposition that threatens to remove funding from this ongoing search for optimized model efficiency and for higher Reynolds numbers.

You may be interested to know that this team is composed of some of the best scientific names in model soaring today, with researchers like Bill Liscomb, Gene Cope, Peter Bechtel, Ed Mason, Ray Franz, Gary Brokaw, Eric Eiche, and other brilliantly enlightened individuals. These are individual contributors dedicated to the project and its generation of data that guarantees pleasurable diversion.

When posed the question, "Why do scale R/C soaring machines possess a performance advantage?" our team of internationally renowned researchers moved quickly into action. Their first milestone within the constraints of the project was to obtain funding via the "Honey Do" process. They then promptly requisitioned and procured the necessary laboratory and test equipment. They requisitioned such items as a 1/5 scale ASW-17, a 1/4 scale ASW-20, a 1/4 scale Salto, a 1/3 scale LS-3, a 1/4 scale Kestral 17, a 1/4 scale Jantar I, a 1/3 scale Austria Elephant, a 1/4 scale Fafnir, a 1/4 scale ASW-22, and other suitable test devices.

Upon receipt of the experimental equipment many high level management meetings were held to provide appropriate and necessary spousal justification. After management was assured and confident that all the research was obligatory to a profitable marital federation, the measurement and test equipment (M&TE) was assembled and rapidly entered into test environments. The results of these test are, to say the least, vindication for requisition. They are also certification of further sanctioning and requisitioning which will further this body of knowledge.

To clearly understand the full significance of the data to follow, one must have some rudimentary knowledge of conversion between U.S. standards of weights and measures and the metric system. Here in the U.S. we long ago decided wisely to separate ourselves completely from European domination. In the process we made only one fatal error. That error being the adoption of our weights and measures system. We unfortunately opted to use the well known system of feet and inches, which have fractional measure broken into units of 2, 4, 8, 16, 32 and so on. Additionally, we for some unexplainable reason decided to use pounds and ounces, too. But, intelligently the rest of world standardized on a system of metric measure. In the metric system of measures lengths are gauged in meters. Also, in this metric system mass is measured in kilograms. Both metric units are divided into units of 10, which simplifies fractionalization somewhat. Therefore, if one is to analyze design data pertinent to sailplanes utilizing both systems, one must have a methodology to convert between both systems.

As a prelude to the presentation to the design data findings this paper will provide a simple fundamental table of weights and measures. (See Table.)

Linear Measure

10 hectometer	= 1 kilometer	= 3,280.8 feet	
10 decimeters	= 1 meter	= 39.37 inches	
10 centimeters	= 1 decimeter	= 3.937 inches	
10 millimeters	= 1 centimeter	= .3937 inch	
1 millimeter	= .03937 inch		

Square Measure

100 square decimeters	= 1 square meter	= 1,549.9 square inches
100 square centimeters	= 1 square decimeter	= 15.499 square inches
100 square millimeters	= 1 square centimeter	= .15499 square inch
1 square millimeter	= .00155 square inch	
1 square foot	= 144 square inches	= 9.2909 square decimeters
1 square inch	= 6.452 square centimeters	

Weights

10 hectograms	= 1 kilogram	= 2.2046 pounds
10 decagrams	= 1 hectogram	= 3.5274 ounces
10 grams	= 1 decagram	= 0.3527 ounce
453.5924 grams	= 16 ounces	= 1 pound
28.3495 grams	= 16 drams	= 1 ounce
1.722 grams	= 1 dram	= 27.34 grains

Many if not most of the high aspect ratio experimental devices flown by the research team were imported from Europe and, therefore, have design data generated in the metric system. As a consequence, a simple conversion methodology was developed to allow the team to analyze this data in either of the two measurement formats.

The following is a formula for conversion from oz/ft^2 to gm/dec^2. Or in long hand, ounces per square foot to grams per square decimeter.

$Gm/Dec2 = ((1\ dec^2 \div 1\ ft^2) \times (gm/oz \times oz/ft^2))$ As an example: $(((1\ dec^2=15.499) \div (1\ ft^2=144)=.1076) \times (((gm/oz = 28.3495\ grams) \times (12\ oz/ft$ wing loading$) = 340.1940)) = 36.6157\ gm/dec^2$.

For the inversion relationship of the above formula, or converting from grams per square decimeter to ounces per square foot, the team utilized the following formula:

$Oz/Ft^2 = ((1\ ft^2 \div 1\ dec^2) \times (gm/dec^2 \div gm/oz))$, i.e., $(((1\ ft^2 = 144$ square inches$) \div (1\ dec^2 = 15.499$ inches$) = 9.2909)) \times (((\text{wing loading in } gm/dec^2 = 36.6157) \div (gm/oz$ of 28.3495 grams$) = 1.2916)) = 12\ oz/ft^2$.

The team's dissertation will continue next month. It will then compare specific design parameters such as aspect ratio, wing loading, span, directional stability coefficient, mean aerodynamic chord, wing dihedral, and other parameters pertinent to maximized performance, L/D, and any technique appropriate to advocate the advancement of scale R/C soaring. ■

"The Scale Fun Fly in Eastern Washington was wonderful, even with minimal/no wind. Sunday was a great thermal day with no wind at all, so many went down to West Richland's soccer field and did some flat land flying. Eric Eiche had a beautiful Fafnir at the slope, and Gary Brokaw and a huge twin tailed Austria at both sites. He made an awe inspiring thermal flight at the soccer field with it. John Raley, who contributed the article on foam fuselages for scale 'ships to *RCSD*, had his PWS-101 at the flying site, as well. Very nicely done, and complete with 3-D instruments on the panel. One of the exciting highlights of the event was watching Wil Byers put up his Jantar on the winch. This was his first ROG winch launch! Bill Liscomb coached him well, however, and the launch was flawless. The landing was picture-perfect, too." B^2 ■

1ST Annual IMA Mini-F3J Contest Results

...by Scott Smith
Irvine, California

The first annual Irvine Model Aviation (IMA) Mini-F3J/Hand Launch Contest was held on May 3, 1992, at the IMA field in Irvine, California. This contest was announced in the February 1992 issue of *RCSD* for March 15; unfortunately the site permission process was not completed until April.

The contest was conducted according to the rules in the *RCSD* article. 9 pilots competed; 8 in the 60" open class and 2 in the "novice" 2-meter class. The 60" class was divided into two groups and, for reasons that will be explained later, the two groups kept the same contestants for all three rounds.

Contest Results

Marv Wager and Armand Weese, who custom-built a beautiful entry specific for the contest, each won in their groups. Bob Reynolds and Bill West both came in second. Ian Douglas, who was plagued with incredibly bad luck, came in third, as did Dr. Norman Thompson. Wayne Walker and Brian Curry, who lost a round due to a crash, came in fourth.

In the two-meter contest, Don Edberg showed what could be accomplished with a "heavy" Oly 650 with almost perfect 10 and 5 minute scores, while "Dr. Norm" had a most-respectable second place showing.

The Towline

The gliders were launched using a "mini-F3J" towline. The towline consisted of a 5 foot length of 2-meter upstart rubber connected to a plastic 2-liter soft drink bottle that doubled as a spool and a handle for the runner. The other end was connected through a ring to 70 feet of braided surveyor line to a hook which was connected to the tow hook on the glider. Also, a foot from the glider ring, a plastic cup was attached to act as a parachute. A total of six towlines were fabricated for the contest.

Launching

Each pilot was assisted by a timer and a runner. The pilot or runner initially held the glider while the runner held the 2-liter bottle by its neck with the line slightly taut. At the "go" signal, the most successful scenarios had the runner simply start running. The pilot or timer would release the glider at a 45° angle or steeper when the line pull felt between 5 and 10 pounds. The gliders launched steeply and would fly directly overhead within a few seconds. At that time, the runner simply stopped and the glider, flying ahead, would simply drop the line. With 75 feet of line and rubber held 6 feet high, launches of 80-85 feet were routine. Successful teams had the runner and launcher/timer immediately reposition the towline to be ready for the next launch.

With a little practice (and planes that were sturdy), zoom launches were accomplished that appeared to routinely get an additional 10-15 feet of altitude.

Impressions

Everyone was successful finding thermals from the low (85-100 feet) launches. Of course, thermal conditions were good as they often are this time of year with the marine layer "burning off". Everyone, including those with persistent launch problems, was impressed with the launching technique; several felt that this format was what they were really looking for in a hand-launch contest. Everyone also liked the involvement of several people to keep one plane up; contestants "borrowed" pilots from the other group, and it was decided that they wanted to keep the "teams" together. This was the reason that the two groups did not compete against each other.

Problems

The biggest problem was drops off the line when the launcher released the glider. Some planes almost never dropped; others almost always did drop. The cause was isolated to a single issue: if the CG was too far forward, the plane would catapult in front of the line and the line would fall off. The CG must be moved back much farther than normal for winch launching; some pilots have the hook moved behind the CG. The rear CG placement of the towhook was especially important when wind was nonexistent; otherwise the runner has to run pretty fast to get a reluctant sailplane into the air. Correct placement of the towhook made launching easy, even in dead air.

The second most common cause of line drop was the launcher holding the plane too level. The planes launched consistently (if the towhook location was correct) if the plane was held 45° or more when released.

The combination of changing wind direction and beginner inexperience almost damaged some sailplanes, though more planes were damaged in landings than in launches. Practicing launching in light consistent wind until one has the hang of it is recommended.

Observations

After the contest, the participants discussed what worked and what didn't. All of them enjoyed the contest and would like to see more events like this one put on. The following are the detailed observations:

The overall lengths of the string and the rubber are about right. The rubber is made from a 5 foot length of small surgical rubber tubing; the line is 71 feet of braided surveyor line. Previous attempts with twisted line would tangle disastrously.

The only improvement would be to use a fluorescent kite tail instead of the plastic cup for a parachute. The cups would crack; then the line would inadvertently loop around it. Sometimes the loop went unnoticed and would snap loose during launch and drop the hook thereby aborting the launch.

To prevent tangling in the field, contestants learned to simply drag one end of the line. Winding the line on the bottle worked well; just making loops to wind it sometimes resulted in mild tangles. All six launchers were intact at the end of contest.

Some runners would not stop after the plane was at altitude. In a couple of cases they succeeded in pulling the towhook off. (Junior-high kids have amazing speed, endurance, and persistence even when everyone is shouting "STOP!".)

A minimum of three people were needed for each sailplane: the pilot (who launches the sailplane), the timer, and the runner. Some participants said that another person to move the launch end of the line while the runner moved the "running" end of the line was invaluable for setting up for the next launch in the shortest amount of time.

The only difference between the 60" and 2-meter airplanes in launching ease was that the sensitivity was more critical for towhook placement on the 60" gliders. Everyone agreed that this is an ideal contest format for 2-meter airplanes. Everyone also thoroughly enjoyed the simultaneous launching that is the trademark of "hand launch" contests.

Zooming was possible if the plane was sturdy enough. Don Edberg showed us how by getting 20-30 foot zooms on his 4 pound Oly 650 with a fleet-footed (and brave!) junior runner. He was brave because the rubber could snap back quite aggressively on line release from the airplane. There was some controversy over whether or not zooming should be allowed, since some argued that the purpose of the format is to have everyone launch at the same altitude.

A poll was taken for how many times

the contestants would like to see such a "mini-F3J" contest conducted. Those who have an active contest agenda tended to indicate two times per year; those who were primarily casual flyers and slope flyers tended to say 4 times per year. Suggested times were May, fall, and early spring. What was encouraging was that everyone liked the format and wanted to see it repeated (even those who had trouble). The idea of having a round in which everyone launched at the same time and the last one down (within the 10 minute round) winning was agreed to be an interesting feature of future contests.

How to build a tow line:

Materials:

5 feet of 2-meter grade upstart rubber tubing

71 feet of braided HIGHLY VISIBLE (fluorescent yellow) line

2 key rings

1 empty recyclable 2-liter plastic bottle

Instructions:

Tie one end of the rubber to the neck of the bottle. (I use a slip knot; others might find a more permanent knot.)

Tie the other end to one of the rings.

Tie one end of the line to the ring connected to the rubber.

14 inches from the other end of the line, connect the "kite tail". The kite tail is to help identify when the line releases from the plane and to find it on the ground. It should be something that does NOT tangle in the weeds or the line.

Finally, tie the other end to the other ring. ■

Schedule of Special Events

Date	Event	Location	Contact
July 4	Fun Fly 4th Annual	Long Beach, CA	Bob Reynolds (310) 866-2104
July 18-19	CSS Mid-Summer Contests	Cincinnati, OH	Chuck Lohre (513) 731-3429
July 18-25	LSF R/C Soaring National Championships	Vincennes, IN	Mike Stump (616) 775-7445
July 25/26	World Inter-Glide 92	Fairlop, London	Les Sparkes 81-505-0191
July 25-26	Western U.S. R/C Soaring Championships	North of Galt, CA	Ronald Lenci (209) 838-3869 or 838-1276
Aug. 1-2	18th Annual 2m/Standard/Open	Coteau Station, Quebec	Bill Pettigrew
Aug. 15-16	Contest Soaring	Montreal, Quebec	Etienne Dorig (514) 465-1113
Aug. 22	MASS Soaring Unlimited	Memphis, TN	Bob Sowder (901) 757-5536
Sept. 27	World Postal 2m (July, 1992 Issue - invitation)	Everywhere	Steen Hoej Rasmussen Denmark
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Aileron Differential

...by E. H. Jentsch

2887 Glenora Lane, Rockville, MD 20850
(301) 279-7611

So, Bunky, you're building your very first aileron ship and you're wondering about something you overheard at the flying field last weekend — the aileron differential. What is it? How much does it cost? Where do you buy one? Where does it go? Do you even need one?

Let me try to help. First, it isn't THE aileron differential, it's simply aileron differential. Nothing like the thing on your car. It's simply a term to describe the difference between an aileron's upward movement and its downward movement. On a glider, in particular, the upward movement should be greater than the downward movement, typically by at least a factor of two. Why? Because it takes more force to push a wing down than up.

Ah, I can see by your expression that a light just went on. Of course. Without this difference in movement the roll axis of the plane might not be through the fuselage. So, when you applied the ailerons the plane would bob up like a cork, which might cause people to question your flying skills.

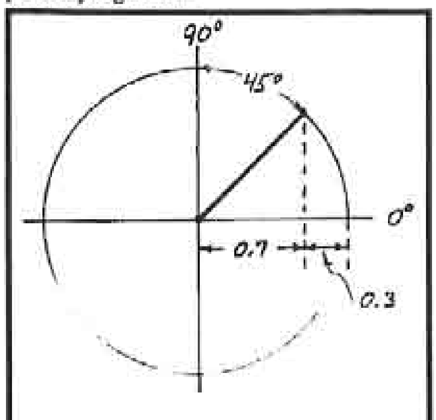

FIGURE 1

Cost? There's a good-news, bad-news answer to that. The bad news is that if you're a perfectionist it will cost a computer radio. But I can tell from looking at your plane that cheap carries more weight than perfection with you. For cheap, there's good news - geometry is all you need, and that costs nothing. Why does anyone bother with computer radios then? Because you get what you pay for. With geometry, fortunately, you get more than nothing, but not everything.

A servo, as you know, is a rotary device. In model airplane controls, the servo's rotary motion is translated into linear motion by a pushrod. By taking advantage of that translation, rotary motion to linear motion, we can achieve differential control movement.

Look at Figure 1, Bunky. When a linkage, like a servo arm, rotates from 90 to 45 degrees, it covers over 70% of the distance along the zero axis. The remaining 30% takes an equal amount of rotation. That's where differential comes from.

Another light has gone on, I see. You're thinking that all you have to do is set the neutral point of your aileron servos so the arms point 45 degrees forward. Then, when the servo arm rotates forward it pulls the pushrod, moving the aileron down, less than half the distance as when it rotates back, moving the aileron up. Put an aileron on each servo, facing away from each other, set each to 45 degrees and, voila, better than 2-to-1 differential. Sorry, Bunky, it's not quite that simple.

You're not convinced. Well a dash of trigonometry should cool your ardor somewhat. Here's an equation that can be used to calculate differential control movement in a standard airplane setup (Figure 2): Differential =

$$\frac{C - \arccos(\cos A - \cos[A+B] + \cos C)}{\arccos(\cos C - \cos[B-A] + \cos A) - C}$$

Pretty fancy, isn't it? I almost hesitate to mention that it works for only a limited set of conditions. But, it's good enough for the conditions we're working with.

Remember from Miss Myers' class (I agree, she herself was a work of geometry), that the value of the cosine of an angle varies from 1 to 0 as the angle varies from zero to 90 degrees. And, this variation is non-linear. That's why the differential exists, and that's why your simple-minded approach isn't quite right.

Although it doesn't exactly pop out at you, the smaller 'B' (the angle the servo arm moves) is, the less differential there is. Another thing that doesn't quite pop out but, it's there, is that the smaller 'A' is, the greater the differential for a given angle of servo arm movement provided, naturally, that you don't make 'A' so small that the servo arm can rotate through the zero degree line.

Yes. I see it. The effective angle of the control horn is also involved in determining the differential. But for the most part, there isn't much you can gain from this, since you don't have a lot of latitude in positioning an aileron control horn. No. You're right. Every little bit could help. But, don't get too creative here. If you make angle 'C' small enough, the mechanism would bind. My preference is to ignore this factor, but it's your choice.

You know, you really are catching on to this stuff pretty fast for an engineer, Bunky. But you haven't noticed what's missing from the equation. Sorry. I judged in haste. You were ahead of me after all. Yes, the servo arm and control horn lengths are glaringly absent. Obviously they aren't a factor in determining the differential inherent in the mechanism.

Why the puzzled, "I don't swallow that one" expression? Ah yes, now I see the source of confusion. If you set the pushrod for maximum control surface movement you only get the full effect of differential when the aileron is at a big angle. Change the pushrod to minimize control surface movement, and the full effect shows up at smaller angles. Very astute observation. And a useful one too. But before we get to it, let's go back to the point we were on.

The difficulty you're having is understandable, since we didn't get into how the equation was derived. In our equation, differential is a ratio of two angles. And because it's a ratio, the servo arm and control horn lengths cancelled out of the equation early in its derivation, leaving only the three angles, A, B, and C as the variables that determine differential. Makes things much simpler.

But what you've pointed out is something we can take advantage of. If you set the pushrods for smaller absolute aileron movement, you get better differential at smaller angles of aileron movement. Good for those of us who fly

FIGURE 2

thermal ships; not so good for stunt pilots.

So much for basics. Let's now take a look at the derivative of the differential with respect to... Come on, Bunky! You don't need that disgusted expression to tell me you're only interested in some quick rules of thumb so you can finish this plane and get it in the air... (some people are destined to keep their feet in the mud)... OK, if you insist, here's how to maximize aileron differential :

- Find out (measure it if need be) the maximum angle of rotation for your aileron servos. E.g., my Futaba S133's will rotate +/- 25 degrees from neutral, not counting trim, and +/- 30 degrees with trim. I used 30 degrees.
- Set the servo arms at this angle from the zero degree line, which is the line between the aileron hinge and the pivot point of the servo arm. If the aileron servo arms exit the wing lower surface, the arms should point forward. If the servo arms exit the wing top surface, point them rearward.
- To gain a tad more differential: with bottom exiting servos, position the control horn as far back as sensible from the aileron hinge line; with top exiting servos, do the opposite.
- Use trial and error (non-catastrophic, hopefully) to arrive at the settings for the pushrods. Connecting the pushrod close to the pivot point at the servo end and far from the aileron hinge at the control horn end improves differential for small control surface movements. But at the expense of maximum control surface movement. This is a trade-off you have to make to suit your needs.

One more thing, Bunky, before we leave for the flying site. If you're wondering why your last plane, a not-so-lucky but-Gentle Lady, never turned as well to the left as it did to the right, it's probably because you inadvertently introduced differential rudder movement at either the servo end or, more likely, at the control horn end. It's too bad that gap in the tree line wasn't to the right. ■

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