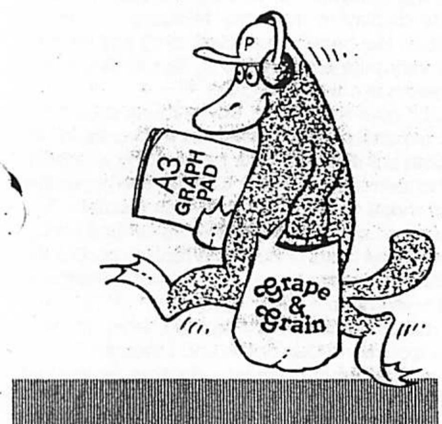
TAIL FEATHERS

Polar Exploration, or how about 100 to 1?

For nearly 30 seasons, after the low, pale sun passes the winter solstice (December 21 to the unwashed), one of my most consistent pleasures has been to sit back in an armchair with a ream of graphpaper, a glass of Taylor's vintage port by



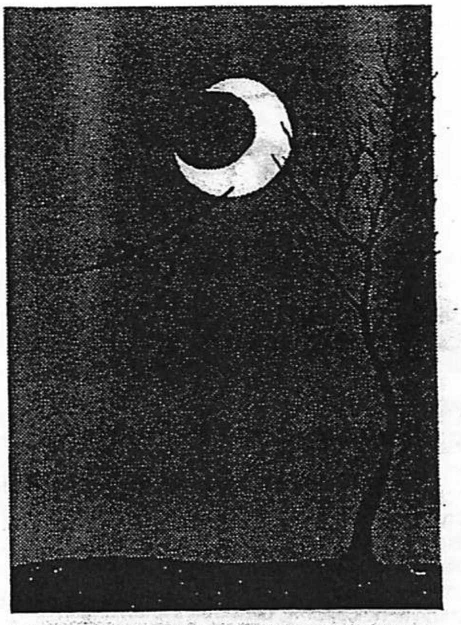
Platypus with his graphpaper and port.

my elbow, converting those start lift/drag diagrams into summer daydreams: *"now, assuming the lift distribution is as per Admiral Goodhart's Ostiv (1965) paper, and working on a wing-loading of 7.6lbs/sqft, I should climb at 2.6kt and achieve a ground speed to Sutton Bank of 73km/h, so I shan't make it home before 1855. Hm, let's try it without water" (take another swig of port as if to emphasise the point, and starts on a virgin page of graphpaper . . .)*

This used to take days and days. As a way of numbing the brain it beats watching TV, that's for sure.

However, carefully tempering theory with practice, I also made a point of analysing the speeds of the finishers in National Championships. Oh dear me; I found in the 1960s that the achieved cross-country speeds bore little relation to the theory. Generally the pilots were getting round slower than I calculated they should. Why?

Well, there are a mass of possible reasons, one of which is that the manufacturers in those days were lying in their teeth when they published their polar curves. Nowadays it does not pay to overdo this: the pilot of a spuriously-rated glider will get a pasting in a handicapped contest – *ie* any Regionals – and will not thank the manufacturers for idle boasts about performance.



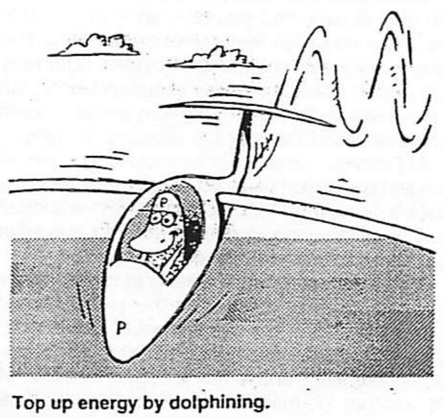
Generally the pilots were getting round slower.

However, even after allowing for this only a few pilots delivered what the theory said they should. Having to take a few weak thermals in order to cross a difficult patch has a devastating effect on groundspeed, especially on a windward leg. Deviations from track to get a useful thermal also erode the achieved speed.

Having to waste time sampling mediocre thermals before finding a good one is another penalty of lower-performance gliders. Finally there is sink between thermals, which may cover a larger area than lift between thermals, on the assumption that what goes up in the thermals has got to come down somewhere. All this conspires to push your actual achievement below the theoretical level.

Nowadays it's very different. People are covering the ground at speeds well in excess of theoretical levels, especially in the superships. For example in theory you need an average rate of climb of at least 6kt in a Nimbus 3 or ASW-22 to achieve 110km/h over the ground, but such speeds have been achieved with thermals of about 4kt or less.

The reason is simple. The theory assumes height is gained solely by circling, and that there



Top up energy by dolphining.

is neither lift nor sink between thermals. We have known that not to be so for 50 years or more, but only recently does it begin to make a really big difference. The theory also assumes all thermals are the same, whereas we know there are good, bad and indifferent thermals, from which the pilot with the flattest polar is able to make the most ruthless choice, discarding all but the best and treating the weaker ones as an opportunity to top up energy by dolphining. However it is the distribution of lift and sink between climbs that is the key, or so I guess.

With the purpose of seeing how much difference this can make I modelled a very simple dolphin-flight. I have decided to update my armchairing by computerising the graphpaper – and cutting down on the port, incidentally.

In this little exercise (sums tucked away at the bottom of the page, to spare those readers whose orbs look like sheep's eyeballs in aspic the moment a row of figures appears on the page) I imagined two gliders, a modern supership and a golden oldie, to be traversing first an area of 2kt sink*, then an area of 2kt lift, each zone being a kilometre wide. (Sorry about the melange of metric and imperial measures: it isn't my fault that we mix them all up in this country.) The object is compare the height loss in each case with that achieved in still air, and to compare the gain from dolphining that their respective pilots enjoy. Each glider is assumed to be attempting to maximise its glide angle, and to be capable of dolphining instantaneously from high to low speed – which is impossible, but never mind.

BENEFITS OF DOLPHIN FLIGHT FOR MODERN GLIDERS
1950s and 1980s Open Class Gliders compared

Glider A (Supership)
Max Glide 58

	Dolphin flight sink	lift	still air
Ambient lift/sink ft/min	−200	200	0
Distance km	1.00	1.00	2.00
Speed to fly km/h	140	74	100
Duration min	0.43	0.81	1.20
Ambient gain/loss ft	−86	162	0
Glider sink/rate ft/min	−160	−98	−95
Glider gain/loss ft	−69	−79	−114
Total gain/loss ft	−154	83	−114

Dolphining net loss ft −72
Effective L/D 92

Glider B (Golden Oldie)
Max Glide 32

	Dolphin flight sink	lift	still air
Ambient lift/sink ft/min	−200	200	0
Distance km	1.00	1.00	2.00
Speed to fly km/h	100	70	74
Duration min	0.60	0.86	1.62
Ambient gain/loss ft	−120	171	0
Glider sink/rate ft/min	−220	−127	−127
Glider gain/loss ft	−132	−109	−206
Total gain/loss ft	−252	63	−206

Dolphining net loss ft −189
Effective L/D 35

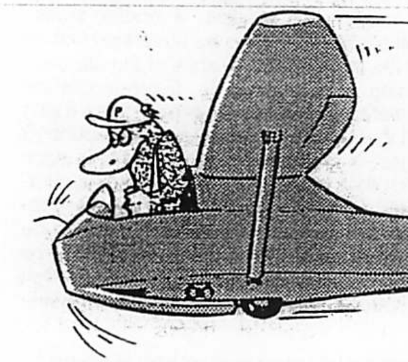
Still air advantage Supership vs Golden Oldie 81%
Dolphining advantage Supership vs Golden Oldie 166%

**Remember, this is the speed of ascent/descent of the air, not the glider: your achieved rate of climb if you circled in the lift portions would only be 100 to 150ft/min. The BST (British Standard Thermal, which is the basis of our handicapping system) is assumed to take you up at around 240ft/min.*

Double your L/D!!

What emerges is that by accurate dolphining the supership loses only 72ft, whereas if it had flown at a constant Max glide speed of 100km/h, or 54kt, it would have lost 114ft (exactly the same as it would have lost in still air, since it would have spent the same amount of time in the rising air as it did in the sinking air; the two cancel out.)

Obviously to lose only 72ft instead of 114ft over a given distance is the same as increasing your glider angle by 114/72 or a factor of 1:58. You are now getting a respectable 92:1, which is satisfactory to all but the greediest of armchair pundits. All right, if you are really greedy look at ambient sink and lift of 250ft/min. The supership's effective glide angle improves to 126, more than double the still air Max glide.



Very limited speed range.

However, even without doing any further calculations you can immediately conclude that a glider with a very limited speed range will *not* enjoy that increase of its glide ratio: even if it had 58:1 at 100km/h, but was stuck at that speed, there would be no increment whatever, since dolphining would not occur.

> ***"An unfair advantage in still air becomes positively grotesque if vertical air movements are considered."***

Glider B, (excellent value for money on the second-hand market, I hasten to put in, to avoid a flood of indignant letters) is, say, a Skylark 3, delivering a glide ratio of 32. However, because of its much narrower speed range, its passage through the same sink and lift, dolphining to the best of its pilot's ability, only reduces the height loss from 206 to 189ft. This represents an improvement in effective glide ratio of only 9% to 35:1. So the supership, which started out with a glide ratio a mere 81% better, ends up with advantage of 166%. An unfair advantage in still air becomes positively grotesque if vertical air movements are considered. And it becomes more monstrous if the vertical air movements are

There ain't no justice.

increased: if they are 250ft/min the supership's advantage becomes 238%. The impossibility of dolphining instantaneously from one speed to another may reduce this gap a bit, but there is no doubt the modern glider benefits to an extent for which handicapping, based on the assumption of still air between thermals, does not compensate.

To him that hath shall be given, but from him that hath not shall be taken away even that which he hath. Which, being translated, means: there ain't no justice. Here endeth the lesson.

SOMETHING SPECIAL

Brennig describes the most enjoyable flight in his life

It's nice to do a long flight or break a record, but so much single-minded dedication is required to the task at hand that you can't soak up much of the pleasure which the environment offers. It is nice to think that the most enjoyable flight may not involve much in the way of achievement, but rather the satisfaction of a mystery solved and an appreciation of the magical qualities of flight.

At Fuentemilanos on November 2 a cu nim of modest proportions was advancing slowly on the airfield from the west, so we all got launched before it, planning to do a flight before it arrived or get back after it had passed through.

There was no trouble getting to cloudbase at 12000ft when a voice over the radio said all English speaking pilots to stay within the range of the airfield. I thought, this is plainly discriminating against us Brits, and to hell with that, so I shot off to Villatoro 50 miles to the SW. This leg was under an enormous cloud street, but hardly any of it worked and fitfully at that, but on the return leg, which was more westerly as Fuentemilanos was now under the storm, there was a solid 10kt lift all the way while I was still climbing at 140kt (=170kts true airspeed).

Swinging round to the west of the airfield I now started to think how I was going to get back in, and my initial plan was to go north to Segovia which would give a nice departure fix so I could be sure to get back to the field, even though there was poor visibility from heavy rain. But in this area there was an abundant area of weak lift, so I continued to circle in large, wide turns and after a while went towards the mountains just ahead of the front. A little beyond them I found 10kt lift to 16500ft ahead of the cloud and considered breaking through Madrid TMA to Quatros Vientos giving flight safety as my explanation, but I opened brakes and descended to cloudbase at 12000ft where there was just enough visibility to get an idea of how to fly home. As I flew under the cloud at first there was lightning to the left, then lightning to the right, which reassured me. Then a whole display in front like festoons of virginia creeper. Not being accompanied by any sound it was very pleasant to look at, like finding a lion behaving like a gentle cat.

Back over the airfield the sky was cool, clear and expansive. I did a few wide circuits in the smooth still air and landed. Everyone was fresh and cheerful as the cool air after the oppresive heat made them feel more comfortable. The squall had blown all the furniture around on the terrace and there had been a rush to secure the gliders and cover the canopies, but no damage had been done.

I remember in 1936, aged ten, when my parents took me to Dunstable and I thought "That's for me". My most fantastic dreams were more than realised.

I did not need a hot ship, hardly any skill was required. The sky just buried me in its magical riches as I drifted gently, dream-like through the rain washed air.

BRENNIG JAMES

* * *

Would anyone else like to tell us about their most enjoyable flight in not more than 750 words? We would very much like to hear from readers and will print their accounts in future issues. Ed

VICKY'S POEM

After John Williamson gave nine year-old Vicky North an 11000ft flight in the Twin Astir at Feshiebridge she was so impressed she went away and wrote this poem.

When you're in a glider
you feel as free as a bird.
Sometimes like a parrot
which is absurd.
Sometimes like an owl
which is very wise.
But mostly like an
eagle soaring in the skies.

John says he isn't sure whether the parrot was him! Vicky's parents fly at HusBos.

EFFICIENT CROSS-COUNTRY FLYING

Flying efficiently may make the difference between safely reaching the next available landing area or not, never mind achieving that elusive 1000 K triangle or winning a contest day!

Overview

Speed-to-Fly for Glide Distance

MacReady Speed-to-Fly for Cruise

Some Problems

SO! What's the Solution?

The glider pilot may select the glide speed anywhere within the aircraft's permissible speed range. Depending on the situation, the pilot will choose the speed based on one of two objectives: first, achieving the maximum glide distance over the surface, and second, achieving the maximum cruise speed.

Speed-to-Fly for Glide Distance

Calm Wind

In calm wind, a speed ring setting of zero will result in the greatest possible glide distance. Without a speed ring, use your best glide speed...5-10 knots faster in sinking air and 0-5 knots slower in sink-delayed air. Perhaps best to drop water ballast because, while glide angle and glide distance remain the same, the lighter wing loading best glide speed will be slower (requiring decisions to be made at a slower rate) and the glider will remain aloft longer (allowing more time to search for lift and delayed sink).

Headwind

In headwinds, a speed ring setting of greater than zero will result in a greater glide distance than zero setting. Use a very moderate increased setting: less than 15 MPH headwind, "don't worry about it" *CDH*, 15 mph headwind = + 50 FPM setting, 25 MPH headwind = + 100 FPM setting. Without a speed ring, use your best glide speed plus half the estimated wind speed. Best to retain water ballast because the higher speed for a given sink rate is favorable in the headwind.

Tailwind

Perhaps best to use best glide speed or zero setting because the increased sink penalty is small but you'll travel through much more air and increase chances of finding lift and delayed sink. Best to drop ballast so as to maximize the time the tailwind pushes the glider along.

MacCready Speed-to-Fly for Cruise

Set the speed ring to the expected actual rate-of-climb of the next thermal. Of course, this is impossible to do so use an expected actual rate-of-climb for the current time of day.

Leave the thermal just before it weakens to below the actual rate-of-climb. In other words, leave your current thermal just before you're climbing at a worse rate than you will be climbing in your next thermal.

Fly the indicated speed-to-fly -- faster in sink and slower in lift.

Some Problems†

Airfoil Design

Modern gliders are designed, tested, and re-designed for optimal performance in wind tunnels at 1G...so zoomies and pushovers may reduce the efficiency of the airfoil more than the gain achieved by following MacCready Speed-to-Fly theory. Modern gliders are efficient in the pullup, less so in the pushover.

Lift Strengths vary with Altitude

Oftentimes, thermal lift strength increases with altitude, especially towards cloud base where the thermal tends to coalesce, being pulled from above and pushed from below. Also, thermals are much easier to core near cloudbase than below, because visual indicators allow the pilot to be more efficient.

Distance Flown

The straightest distance between two points is a straight line so zoomies and pushovers are increasing your actual distance traveled. Assume a 4000' straight glide vs. a 500' zoomie and pushover: you'd travel an extra 125'. Do this about 20 times and you've traveled an extra mile (one minute @ 60 MPH).

Energy Change = Drag

Greater periodicity of speed variations when flying true MacCready Speed-to-Fly tend to result in net increase to sum of induced drag. Changing kinetic energy to potential energy creates drag.

Collision Avoidance: See and Avoid

Both the zoomie and the pushover enter airspace you're unable to clear: into the zoomie you're unable to see above and behind and into the pushover you're unable to see below and forward.

Watching your variometer, speed-to-fly ring, and air speed indicator preclude your watching for traffic (and other important cross-country indicators). Flight computers help...audio variometers help.

Increase to Decision-Making Load

MacCready Speed-to-Fly theory requires attention to one detail which necessarily detracts from attention to other, perhaps more important, cross-county soaring details like navigation, route selection, lift detection, cloud whisps detection, spotting thermaling gliders or birds, etc.

Increase in Time Spent Low

More time spent low, being forced to monitor landout potential, with higher levels of attendant stress and diversion of attention to finding lift. In fact, flying slower might enable the pilot to fly airport to airport, thus eliminating off-field landings entirely.

Instrument Lag, Situation Recognition Lag, and Pilot Response Lag

It takes a moment for your variometer to register lift, then it takes a moment for the pilot to recognize the variometer movement, then it takes a moment to react and start the zoomie.... You may actually be flying quickly through lift and slowing down in the sink!

Vertical motion (rising or sinking) will not change airspeed; however, horizontal motion (shear) will increase or decrease airspeed

Density Altitude

12,000' @ MC=0 yields TAS 90 MPH.

From *Cross-Country Soaring* by Reichmann:

> "At very high altitudes both the air pressure and the air density are less. In order to generate the same aerodynamic forces, the sailplane must fly faster - and, of course, sink faster as well. The coordinates of each point on the polar are changed in the ratio of standard air density to actual air density or similar (but reversed) to the effect of a change in gross weight. It should be noted, in the interest of completeness, that the airspeed indicator is subject to the same changes. Thus, one is flying aerodynamically correctly at high altitudes if one continues to use the airspeed indicator as at lower altitudes. One should be aware, however, that one is actually flying more rapidly than the indicated value suggests."

However, note that as true airspeed increases, indicated airspeed for redline decreases....

Compensation Problems

If your variometer system is poorly compensated or not compensated, you can forget MacCready Speed-to-Fly theory!

Physiological Problems

Cruising slower is MUCH easier on your body, unless you're carrying water. Also, it's easier to feel the next thermal and react in an appropriate fashion, at slower speeds. Also, pulling excessive Gs makes your heart pump harder and your kidneys filter more blood so you have to pee more often.

Comparative Advantages

The penalty for flying faster than MacCready Speed-to-Fly or flying fast through lift and slow through sink is very much greater than the penalty for flying slower than MacCready Speed-to-Fly.

Reduced Search Area

Flying slower than MacCready Speed-to-Fly reduces the speed at which decisions must be made and increases your search area and time for sources of delayed sink or lift.

Fatigue

Flying fast (and performing zoomies and pushovers) is very fatiguing. Fatigue reduces your decision-making ability, which will reduce your cross-country performance. Ballast helps.

† Partially adapted from a lecture by Karl Striedieck.

SO! What's the Solution?

Set Your Speed-to-Fly Ring at 1/3 to 1/2 Your Average Rate-of-Climb

Recognize that MacCready Speed-to-Fly theory requires you to adjust your speed according to the expected *actual rate-of-climb* for the *next* thermal. This total includes the time to establish the thermal, the time to center the thermal, the time to climb the thermal, and the time to decide to leave the thermal as it decreases in strength.

Too conservative or aggressive a speed ring setting does result in comparative flight time increase; however, *the percent increase is small...a 25% error in speed ring setting equates to only a 1% flight time increase*! Keeping a speed ring setting of zero where the actual rate-of-climb is 300 FPM equates to a 30% flight time increase!!

Flying the high side of the speed ring greatly increases the chances of screwing up because the rate at which decisions are made also increases.... Flying the low side of the speed ring keeps you higher from thermal to thermal and the decisions come much more slowly....

Don't Chase the Speed Ring...

build up to it....

Recognize the Need to Shift Gears

Recognize that MacCready Speed-to-Fly theory requires you to adjust your speed according to the expected actual rate-of-climb for the *next thermal*.

Check your course way before you get to the top of the thermal, 500' below cloudbase. Account for compass indications during acceleration and deceleration on east or west headings.

Go Slower through Lift and Faster Through Sink

(But beware the zoomies and pushovers.)

Fly Faster than Your Best Glide Speed

The (vertical) penalty for flying 10-15 knots faster than your best glide speed is far exceeded by the speed advantage.

The Seat of Your Pants (at slower speeds, anyway) is as Good or Better than Your Variometer

Proper Compensation

Resist the Temptation to Turn

Remember the entry penalty...it is costly (time-wise) to stop, enter, and center a thermal. Given the average rate-of-climb, pick thermals with above average rates-of-climb and pass through (but slow down while in) thermals with less than average rates-of-climb.

Leave the thermal when it has dwindled to 75-80% of the actual rate-of-climb.

Wind

Cruise slower through strong tailwinds and faster through headwind.

Make Course Corrections Early

Follow the high ground. Get high and stay high. The mountain slopes are more perpendicular to the sun; therefore, heat more rapidy. Course deviations of 10 degrees or less are negligible. Deviate farther for weather or landout concerns. Deviate farther in weak lift conditions, less in strong lift conditions.

Reduce In-Flight Tasks to Aviation, Navigation, Communication

Prepare sectionals with:

- ✓ final glide circles to home airport and in-route airports
- ✓ intended route of flight (note actual route and wind direction each 15 minutes)
- ✓ a workable in-flight folding routine
- ✓ pre-flight familiarity (frequencies, airspace, airports, terrain)

Get High and Stay High!

Especially at the end of the thermal day for a long final glide.

TOTAL ENERGY COMPENSATION

by Rudolph Brozel

Reprinted from ***Soaring Pilot Magazine***

Rudolf Brozel is the designer and manufacturer of ILEC variometer systems and total energy probes. These instruments and probes are the result of extensive testing over several years. His total energy probes are now used by more than 1200 pilots around the world. The ILEC variometer is the variometer of choice many of the top European pilots and has recently been introduced to the United States. The competition version was used by the pilots who finished first and third at the Standard Class Nationals in Uvalde Texas this year. Simpler, less expensive, version is available for low performance sailplanes and club ships.

The following article is a summary of conclusions drawn from theoretical workover several years, including wind tunnel experiments and in-flight measurements. This research helps to explain the differences which exist between the real response of a total energy variometer and what a soaring pilot would prefer, or the ideal behavior. This article will help glider pilots better understand the response of the variometer, and also to aid in improving an existing system. It is suggested that you will understand the semi-technical information better after you read the article the second or third time.

THE INFLUENCE OF ACCELERATION ON THE SINK RATE OF A SAILPLANE AND ON THE INDICATION OF THE VARIOMETER.

Astute pilots may have noticed when they perform a normal pull-up maneuver as they might to enter a thermal, the TE (total energy) variometer first indicates a down reading, whereas the non-compensated variometer would rapidly go to the positive stop.

One would expect the TE variometer to not move at all. Many pilots interpret this phenomenon as an error of the TE compensation device and proceed to install further devices, or to begin shortening or lengthening tubes and/or tubing in an attempt to trim the system to remove this initial down indication.

On the contrary, if your variometer does not show this initial down indication, your total energy compensation is not working properly!

When you perform a pull-up maneuver, the lift of the wing must carry the weight of the glider, as during an un-accelerated, steady speed glide, but also must induce the additional force to accelerate the glider upward. The lift becomes n x w where n is the load factor and w is the weight of the glider. This increased lift also causes increased drag. The additional drag consumes additional energy. The increased energy loss rate can only be fed from the glider's potential energy stored which causes the glider to sink faster, or climb slower than it would have without the acceleration. A total energy variometer must register this additional energy loss, therefore the down reading.

A TE variometer doesn't indicate vertical speed, but the rate of change oft glider's total energy per unit of weight, therefore it's name. It measures the variation of the glider's total energy, which is the sum of potential energy (proportional to altitude) and kinetic energy (proportional to the square of velocity). Its indication can only be regarded as being equal to true vertical speed in the case where kinetic energy does not change, in other words: where the absolute value of velocity (airspeed)remains constant. Contrary to that, a non-compensated vario will measure the rate of change of potential energy alone, which means the

How Do We Achieve High Cruising Speeds?

If we plan to not only complete the task as planned, but do so at the highest possible cruise speed, it becomes a problem of cruise optimization. To calculate this requires us to juggle a number of factors which can be mathematically expressed with greater or lesser degrees of accuracy and whose relationships to one another must be properly weighed if we are to achieve decent results in flight. The values which must be considered include *climb* rate, which depends on the weather, the type of sailplane, and the pilot; the *glide* between thermals; and the *final glide* to the finish of the task.

WHICH IS MORE IMPORTANT, CLIMB OR GLIDE?

In order to point out the importance of both climbing and gliding, and their relationship to one another with regard to the overall cruise speed, let us examine a simplified example of a situation which occurs very often in real life.

We will assume that there are weak thermals every 5 mi (8 km) in which our sailplane (an ASW 15 flying at 5.75 psf) can climb 200 fpm (1 m/s). However, somewhat farther away — about 23 miles (37 km) — we see a truly splendid cloud below which we'll be able to climb at 600 fpm (3 m/s). The air between the clouds is calm. We start out from cloudbase at around 5000 feet (1500 m) and try to decide on an appropriate speed ring or speed-to-fly indicator setting. Now, before reading further, make your own decision on what *you* would do!

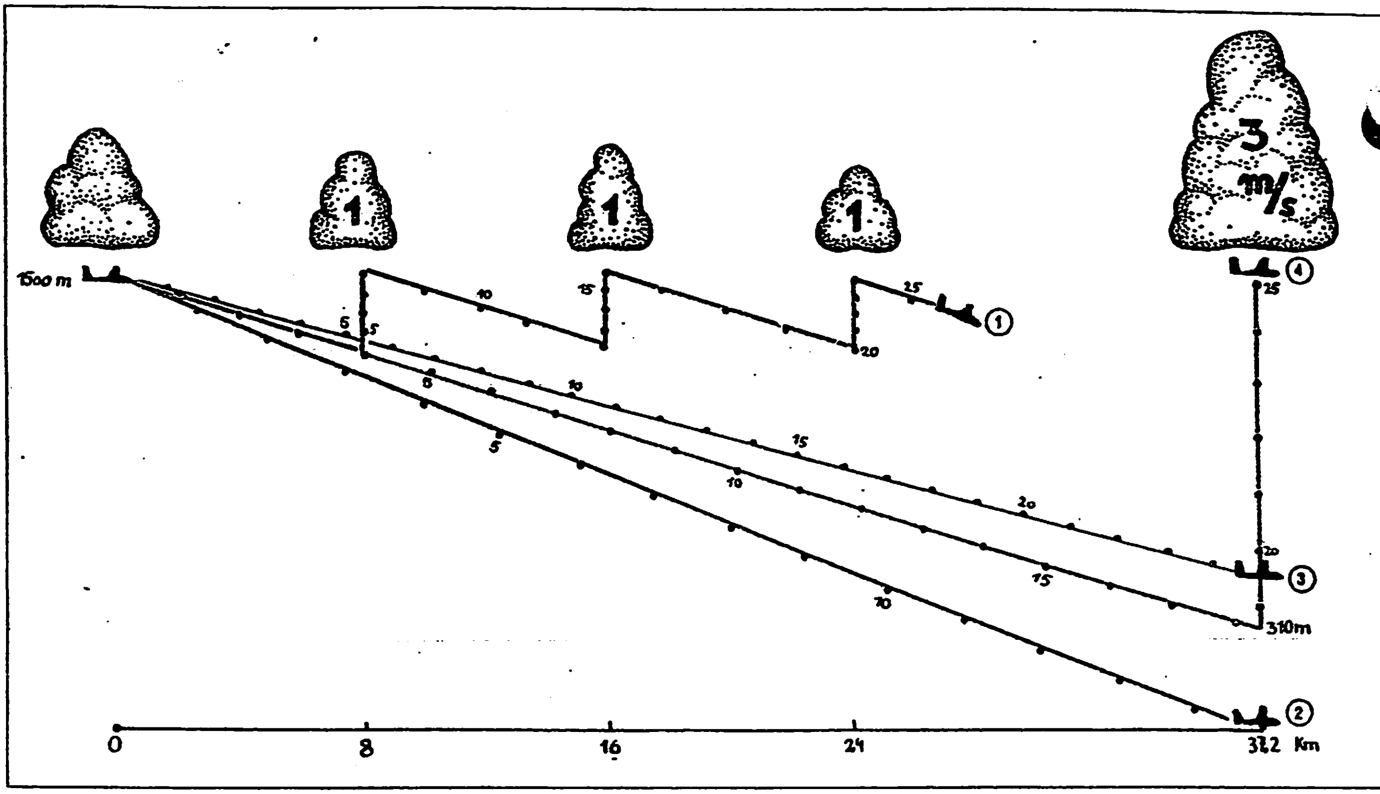
In our example, we will look at the different results obtained by four different pilots.

Pilot (1):
— has decided to fly as "correctly" as possible. He sets his speed ring at 200 fpm, flies to the next cloud, circles back up to 5000 feet, flies on to the next cloud at the same setting, circles, and so forth. When he reaches 5000 feet under the third small cloud he sets his ring at 600 fpm and heads for the big one.

His technique is that of a conscientious "classic speed-to-fly" pilot.

Pilot (2):
—has decided that the 200-fpm lift isn't worth trifling with, and tries to get right under the big cloud. He sets his speed ring at 600 fpm and roars off.

Pilot (3):
—he, too, doesn't want to trifle with the weaker lift, and wants to head straight for the big cloud. However, he's the cautious type: he sets his speed ring for zero and heads off at his best-L/D speed.



For highest average speed it is most important to reduce time spent climbing.

Pilot (4):
—has the same ideas as pilots (2) and (3), but feels that a ring setting of 600 fpm is too risky, since the high speed will reduce his glide distance too much. On the other hand, the setting of zero is too conservative and too slow. He estimates his altitude and the distance to the good cloud in comparison with his glide capabilities and decides that a ring setting of 200 fpm will get him there at adequate altitude even if he doesn't circle in lift. He sets his ring and flies straight to the strong thermal, like pilots (1), (2), and (3).

Which pilot makes the best speed? The envelope, please . . .

Pilot (1) — who is convinced that he is doing everything correctly — is still some 6 miles short of the big cloud after 25 minutes, at an altitude of 2100 feet. His overall speed will end up around 42 1/2 mph.

Pilot (2) has really missed the boat. True, he can make it as far as the big cloud, and gets there in only 15 minutes, but arrives there at ground level and has to land right under it. If only he'd run into 600-fpm lift along the way — then his average would have been 58 1/2 mph — but as it is, he is on the ground — although it must be admitted that he is ahead of the others !

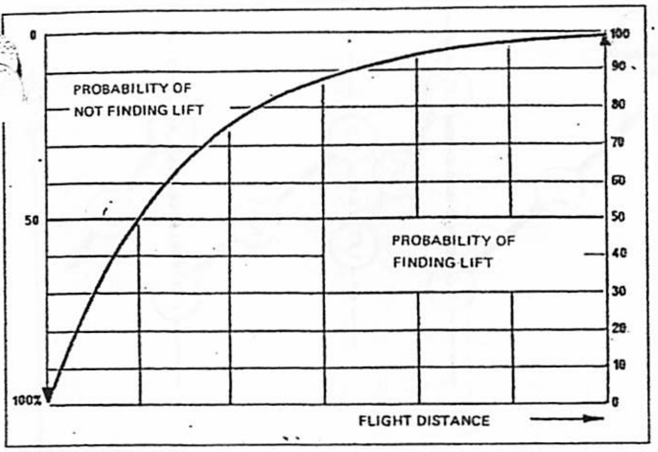
Pilot (3) arrives under the good cloud at an altitude of 1700 feet after 24.7 minutes. After a further 5 1/2 minutes he'll be back at altitude for an average of 45 1/2 mph.

Pilot (4) arrives under the big cloud at a bit over 1000 feet after 18.6 minutes. His calculation has been successful; he has sufficient altitude to get into the 600-fpm lift. At the end of 25 minutes he is back at cloudbase altitude. Pilot (3), 3000 feet lower, is just entering the thermal; both of them can look straight down and observe pilot (2) standing in a field next to his sailplane and shaking his fist. Pilot (1) is not only some 600 feet lower, but so far back (around 6 miles) that pilots (3) and (4) can't see him at all.

The illustration shows the situation at the end of 25.2 minutes. The dots and numbers along the various flight paths represent minutes; the differences are striking!

What appears particularly surprising in this example is that our star pilot (4) does not owe his good fortune to a speed ring setting based on his earlier average climb; on the contrary, it would appear that the choice of 200 fpm was an arbitrary one, yet he left the competition far behind!

Only thus was it possible for him to cover the desired distance as rapidly as possible while still maintaining an adequate margin of safety. He did not need to work the weak lift that he encountered, he flew on. The hoped-for strong lift was more important to him than a speed ring which reflected the expected climb rate accurately. In this case, his cruise speed was affected by a factor which is simply ignored by many pilots in their optimizations, or even intentionally disregarded in order to simplify calculation: probability.



PROBABILITY

The greater our radius of action, the greater our (weather-dependent) chance of encountering a thermal of given strength.

Let us assume that a sailplane with a 20:1 glide ratio flies off a mile of altitude, covering 20 miles of distance, and the weather is such that there is a 50% chance of hitting a good thermal in this distance.

If it flies twice as far — either by starting from 10,000 feet or by having a glide ratio of 40:1— the same 50% probability holds for the additional 20 miles. For the entire distance of 40 miles, the probability has increased — but not to 100%, which would require an infinitely long flight.

Of course, this asymptotic curve is valid only if the weather conditions along the distance flown remain the same. Even so, we can see clearly that relatively slim chances become even slimmer with alarming rapidity if too high a ring setting further reduces glide distance. (This is the altar on which pilot (2) was sacrificed in the earlier example.)

On the other hand, if our chances are good to begin with — say 90% — the distance increase achieved by slightly lower ring settings will not increase them much further. (Pilot (3) lost too much time by flying slowly, but hardly gained any additional safety compared to pilot (4).)

INITIAL AND FINAL RATE OF CLIMB

Thermals (and other sources of lift) often yield varying rates of climb at different altitudes. Optimization calculations usually are based on an average rate of climb arrived at by dividing the altitude gained by the time not spent cruising straight ahead on course (including searching for lift, centering, climbing, and leaving the thermal). This is actually an inaccurate procedure; Rene Comte has refined it.

A pilot who flies (cruises) rapidly not only arrives the next thermal at a low altitude, but often encounters an initial climb rate that will differ from that encountered by a slower pilot who enters the thermal at a higher altitude. Once he has worked himself up to the altitude at which the slower pilot entered the thermal their further climbs are identical.

Consequently, to optimize cruising speed — which will directly influence the altitude at which we enter our next thermal — we must base our calculations on our expected *initial* climb rate; by the same token, when we leave a thermal we should use our *final* climb rate as a basis for how high to climb and for setting the speed ring.

Here are two examples that may make this more evident:

1) Let us assume that the climb-rates achieved in a "blue thermal" decrease from 600 fpm through 400 fpm to a final 200 fpm as altitude increases. If the next thermal were to deliver a steady climb of 400 fpm it would be senseless to depart the first one when it had decreased to 500 fpm, since we would not be able to regain altitude as easily in the next thermal. It becomes obvious that the time to leave the thermal is when its climb rate has decreased to 400 fpm; in other words, when the final climb exactly equals the initial climb of the next thermal.

2) We fly from a constant 400-fpm thermal to one whose climb rate increases from 200 to 400 and ultimately to 600 fpm (this actually is the case quite frequently at lower altitudes). If we leave the first thermal too soon, we're forced to spend a long time scratching around at 200 fpm, because we entered the next thermal at too low an altitude. On the other hand, if we wait too long we'll reach the new thermal at too high an altitude to take advantage of most of its 500- and 600-fpm lift. Thus, we see that ideally the initial climb rate of the new thermal should be the same as the final climb rate in the thermal just left.

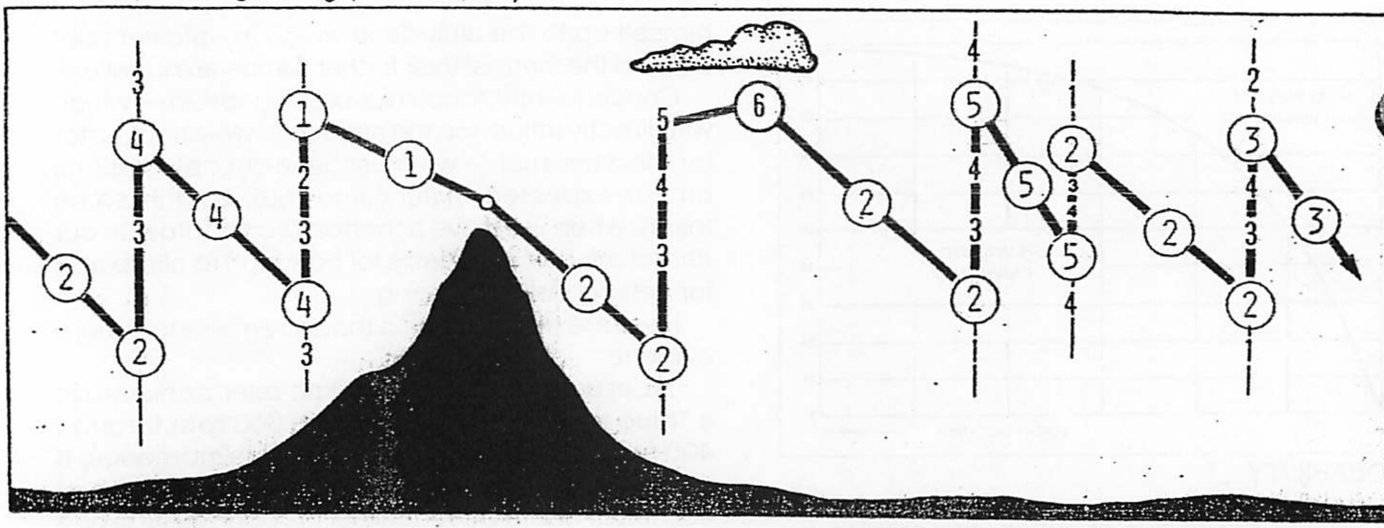
Both examples illustrate the need to climb to an altitude in which the final climb rate is equal to the initial climb rate of the next thermal. The appropriate speed-ring setting for the glide between thermals is thus the final climb rate (which equals the initial climb rate in the next thermal).

SPEED-TO-FLY RULE

One should fly so as to maintain the equation: FINAL CLIMB = INITIAL CLIMB. The altitude to which one must climb in a particular thermal is thus a definite value determined by rate of climb *and* the distance to the next thermal. If it is impossible to conform to this rule (due to high terrain, low cloud base, etc.) the ring must only be set according to the final (or, as the case may be, initial) climb rate.

The illustration shows how such a flight is carried out. The vertical lines represent thermals, with indicated rates of climb. The circled numbers indicate initial and final rates of climb, and hence also speed ring settings for each glide. The change in rate of climb with altitude has been intentionally exaggerated for clarity.

Optimum speed ring setting (René Comte)



Of course, if we ask ourselves exactly *how* we can conform exactly to the above rule, we'll find that it's impossible. Using earlier theories, it was already hard enough to set the speed ring exactly for our average climb; this new theory makes the situation even worse! The distance to the next thermal, the exact altitude at which we'll reach it, its initial climb rate — these cannot be estimated closely enough. Even so, we should try to gain altitude in the best possible lift — that is, based on the tendency that final lift should equal initial lift. As the lift in which we're climbing starts to taper off, we should ask ourselves if we are likely to do better in the next thermal, and depart at once if we are. This is the way to increase cruise speed, even if the actual speed-to-fly rule represents an unreachable ideal.

There are other factors which also influence our answer to the question of "to circle or not to circle."

On days of heavy wind shear the wind distribution at different altitudes plays a very definite role. It is sometimes possible to remain at favorable altitudes so that we can benefit from a tailwind; however, the wind shear levels themselves are usually unfavorable, since the thermals are usually "torn up" at those altitudes.

In general it is not worthwhile to work too many thermals if one is already at or near maximum altitude (cloudbase or the altitude at which climb rate decreases markedly) since one always loses some definite time while centering. Altitude should not be regained in too many small increments, but rather in fewer large ones.

A pilot who could actually always make the right decisions would probably make good average speeds from 10 to 20% faster than those of the task winners of a world championships!

Since we cannot conform exactly to the speed-to fly rule, we must consider which "errors" can be allowed because they do not cause too drastic a speed reduction, and which are simply too "costly."

The first example, with four pilots and thermals of varying strength, has showed us that climb-rate can play an extremely important role. What about gliding speed (or, as the case may be, the setting of our speed ring or speed-to-fly indicator)?

SPEED LOSSES FROM INCORRECT SPEED RING SETTINGS

The second part of this book will present a method for graphic construction of speed loss for erroneous ring settings. E. Kauer has done further research on this subject and has prepared computer printouts for speed losses in both the Standard Cirrus and Nimbus II. Both sailplanes show essentially the same data, despite the variation in their performance; the illustration shows the (calculated) flight-time increase for the Standard Cirrus against ring-setting error in per cent.

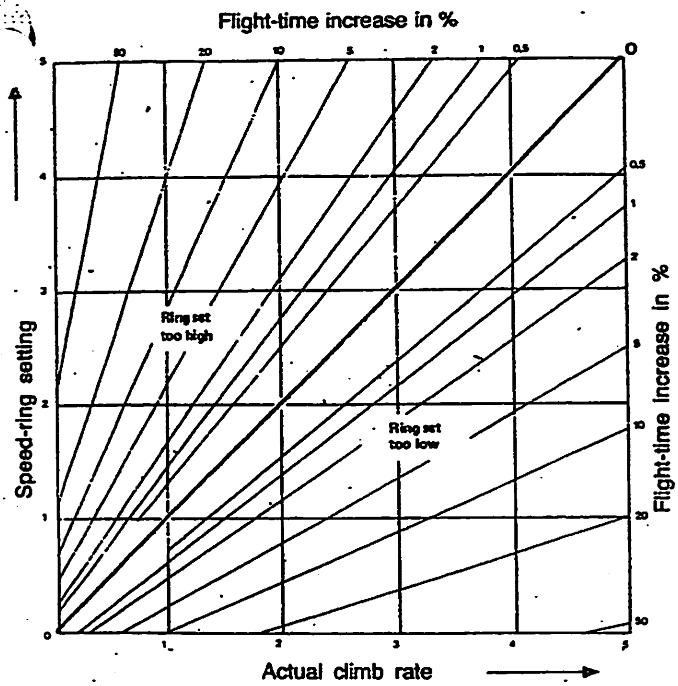
The red line in the diagram shows the ideal condition — that is, no error — in which actual achieved climb and the ring setting are identical. Above the line we find the losses for a too-high setting, below it for too low. We can see that a setting 25% in error still results in an approximate speed loss of less than one per cent!

It is also evident that leaving the ring at zero as climb rate increases leads very rapidly to large speed losses.

This graph is very reassuring; even if we set the ring at 400 fpm for an actual 800 fpm climb the actual speed loss will only be around five per cent. This might be fatal in a contest, but normally our errors of estimation are not quite so gross. Remember, a 25% error only causes about 1% speed loss! If this is the case, we really can dispense with fancy electronic rate-of-climb integrators and the like — since they indicate average climb they do not conform to the speed-to-fly rule in any case. We can simply make a rough estimate, as accuracy is not necessary.

Kauer summed this up in a pointed, but very apposite, comment in his article, *MacCready Flight*

Flight-time increase due to incorrect speed-ring setting (Standard Cirrus)



Without Illusions: "The secret of using the MacCready principle does not lie primarily in the exactitude of its use, but rather in the adherence to the rule of not using lift below the speed-ring setting except when absolutely necessary."

Nevertheless, the speed-to-fly variometer or MacCready ring remain very important devices for glide optimization; their settings, however, can be more or less freely chosen depending on the circumstances.

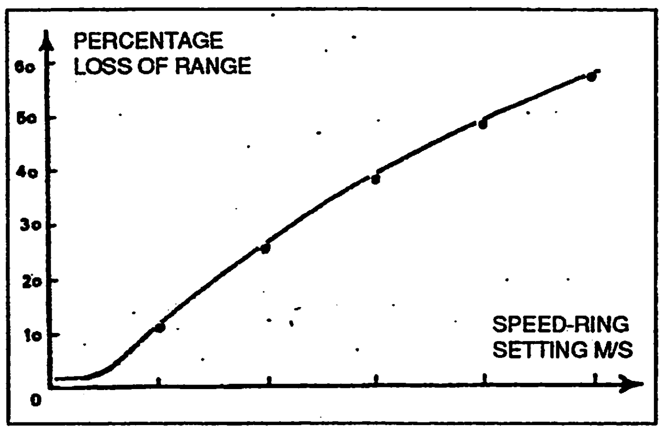
Another technique, used by four-time World Champion Ingo Renner, is to use a table of interthermal speeds based on climb rate and no vertical air movement between thermals. He flies these speeds with only slight variations depending on air movement; his success indicates that this is possible without prohibitive losses.

For example, if we see a tremendous Cumulus congestus building on course ahead, we could expect either 800-fpm lift... or rain and heavy sink. If we conservatively set our speed ring for 200-fpm lift, the worst that can happen is a 14% speed loss — and that only for a short distance. On the other hand, if the lift really fails to materialize we will still have enough altitude to get to the next thermal. In a ten-minute glide we would lose around 90 seconds if the huge cloud failed to produce any lift. Pity, though, the "brave" pilot who sets his speed ring for 800 fpm only to find rain and sink; due to his large altitude loss, he will be forced to land.

We can see from the graph that the zero setting causes larger losses if the lift is strong. This highly "economic" setting should be used only as a last resort.

In this context, it might be of interest to see how much range is lost when the speed ring is set to greater than zero. The following graph illustrates the loss of range at various speed-ring settings.

The graph shows that at ring settings of less than 100 fpm, the deterioration in range from the maximum possible is almost negligible. Thereafter, however, it rises very rapidly, touching 60% at 1000 fpm. If you are unsure whether you can reach the next area of lift, and range is therefore a vital consideration, it is sufficient to reduce the speed-ring setting to 100 fpm, thereby retaining virtually your maximum possible range. Should it then transpire that you have been unduly pessimistic, and can forge ahead freely, you will have sacrificed less speed in the cruise than you would have done with a highly unfavorable speed-ring setting of zero.



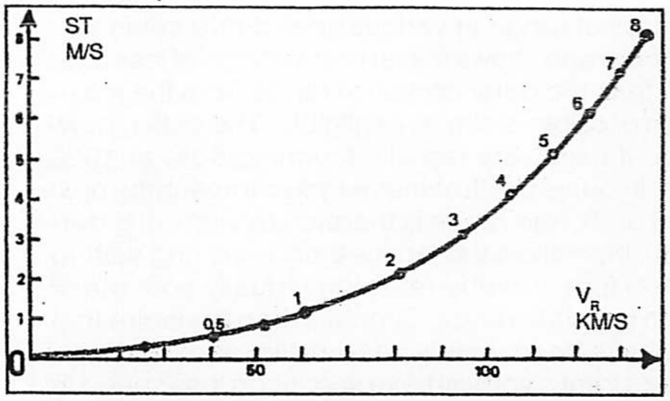
LOSS OF RANGE OF A STANDARD CLASS SAILPLANE AS SPEED-RING SETTING INCREASES.

Otherwise, the speed-ring setting becomes a matter of tactics, and should be chosen to allow us to reach the strongest possible lift with an adequate margin of safety. This can allow our flights to become more interesting and exciting than some of the "average-climb" enthusiasts of past years could have dreamed. If the weather is fairly constant and we are in no danger of landing out we can strive for the closest possible approximation to the speed-to-fly rule so as to squeeze the last few available percentage points of speed from the conditions at hand.

Contest flights, on the other hand, are not won because the pilot always set his speed ring with mathematical precision. The climb is the determining factor. The faster pilot is the one who climbs in only the best thermals and does not waste time in others, spends less time searching for lift, centers it better when he finds it, and whose course deviations make the best possible use of any available streets of lift.

A graph may help make this clearer. It shows the average speeds that can be achieved given various rates of climb, using standard cross-country soaring technique (i.e. circling in lift, then cruising wings-level).

The graph illustrates the enormous influence of climb rate on average speed. Particularly when the lift is weak, small differences in rates of climb can



AVERAGE SPEEDS ACHIEVABLE AT VARIOUS CLIMB RATES (ORTHODOX CROSS-COUNTRY TECHNIQUE, STANDARD CLASS GLIDER.)

lead to very big changes in average speed achieved. Good thermaling technique and concentration while working thermals are therefore vitally important, especially when the lift is weak.

DOLPHIN STYLE FLIGHT

As we fly through areas of rising or descending air while gliding, our speed ring or speed-to-fly indicator commands various changes in airspeed. Often these airspeed changes, whether to speed up or slow down, are quite abrupt. In the air this appears similar to the swimming and leaping movements of a dolphin.

If the flight path is cleverly chosen to run along areas of lift such as slopes, cloud or thermal streets, etc., it may be possible to fly considerable distances without circling and without losing altitude — perhaps even climbing. This has led to sensational reports of flights with very high average speeds, especially in the last few years.

In the meantime the world record for speed around a 300-km triangle has risen to 105 mph (Jean-Paul Castel, France), that for the 100-km triangle has reached 121 mph (Ingo Renner, Australia), and Hans Werner Grosse made a spectacular free-distance flight of 907 miles. The "magic word" that's being whispered throughout the soaring world is "dolphin flying."

According to the usual method of calculating cruise speeds based on the sailplane's polar, such speeds would require lift that would strain the limits of our credulity — even with today's high-performing sailplanes; but let's have the pilots speak for themselves.

Hans-Werner Grosse describes the beginning of his 514-mile triangle flight on May 16, 1973. "Takeoff at 8:45 a.m. (!), release at 3300 feet. Cloudbase initially at around 1500 feet, rising rapidly to 2100 feet. The low cloudbase brings with it thermals spaced so closely that I almost never have to circle and can fly straight ahead with airspeed variations. Thus, I am able to attain a cruise speed of 56 mph despite lift of less than 200 fpm . . ."
—We can see, then, that even weak lift can lead to high cruise speeds if other conditions are appropriate.

Grosse has not been the only one to prove that high cruise speeds are possible even in less-than-ideal conditions. Contest results of recent years show speeds that would have been considered impossible just a few years ago, especially when one considers that many contest tasks are flown on days of rather poor weather. To some extent, of course, this is due to the improvements in sailplanes — but by no means entirely! Although the steep upward trend of sailplane performance in recent years should not be underestimated, a larger influence on the enormous performance increases we have seen must be credited to the continued development of flying tactics, and especially the development of dolphin flight. The most spectacular successes are almost invariably due to this method; if we ask the pilots of these flights, though, what "recipe" they've used, when they circle and when they don't, we get widely differing answers. In fact, some of the top flyers actually contradict one another.

It is far from simple to express the theory for dolphin flight as unequivocally as various researchers — primarily Karl Nickel and Paul MacCready — have done for the "classic" cross-country flight based on circling in areas of lift. Since not only the strength of up- or downdrafts must be considered, but their horizontal extent as well, additional elements of complexity are introduced.

Various meteorological models can offer some aid in a mathematical approach, and four such models will be presented in the second part of this book. While the results of each are only exact for that particular model, in combination they provide adequate data for entirely usable conclusions. Interestingly enough, the "classic" (i.e. MacCready and others) speed-to-fly theory fits in as a special case for this new, expanded speed-to-fly theory, if one assumes that no distance is covered during a climb. We can then reasonably define dolphin flight as the straight portion of a flight based on speed-to-fly theories; thus, the straight portions of even a "classic" flight are, in fact, dolphin flights. (This will be covered more exactly in the second part of this book.)

Before we start examining the rules for dolphin flight one point should be made perfectly clear: what's really important is the ability and talent of the pilot to make small course deviations into areas of the best possible net "profit" of up- and downdrafts. Thus, and only thus, can we explain Grosse's cruise speed of 56 mph in lift of less than 200 fpm.

DOLPHIN-FLIGHT RULES

1) The speed ring or speed-to-fly indicator should generally be set at the *circling* climb rate encountered in strong lift.

2) In case flight along the (suspected) lift street results in loss of altitude, occasional circles in the

best possible lift are required.

3) If we threaten to exceed the maximum altitude (cloudbase) the ring setting must be increased to obtain an overall level flight path.

4) If a climb, rather than level flight, is desired, points (1) through (3) are just as valid; however, (2) and (3) now govern the flight path to achieve the desired climb rather than level flight.

5) Dolphin flight should not be "forced" by a lower speed-ring setting. If the weather is appropriate, it will happen by itself—especially if the thermals are close together, as is often the case if the convective layer is not too high or under cloud or thermal streets. In other words particularly strong thermals are not necessarily favorable to dolphin flight, since they are usually too far apart.

6) If the weather is favorable for dolphin flight, high wing loadings are recommended (ballast). (See also "Flight Along a Thermal Street," page 22.)

SPEED-TO-FLY CONTROL TECHNIQUES

If the air is either rising or sinking uniformly over wide areas, a fairly gentle form of dolphin flight can be adopted in which airspeed is held constant for quite lengthy periods of time, interrupted just occasionally by relatively short intervals of changing airspeed. In cases like this, the intervals of airspeed variation are inconsequential and may be ignored in speed-to-fly calculations. The dolphin-flight rules, based on a steady-state consideration of the speed-to-fly problem, are sufficiently precise for such cases.

However, when the pattern of vertical movements in the air changes rapidly within a small area, these transitional phases take on an important role. When airspeed changes, the g-load ceases to be equal to 1; that is, the aircraft's aerodynamic lift has to carry a load which for a pull-out is greater, and for a push-over smaller, than the total weight of the aircraft in steady, straight flight. The speed polar, which gives height loss, and therefore also energy loss in steady, straight flight, and which lies at the root of the steady-state version of the speed-to-fly problem, also ceases to be valid. There are also other significant influencing factors. As explained on page 112, calculations show that a glider can make particularly effective use of lift and sink if the g-loading is increased in rising air (to more than 1 g) and decreased (to below 1 g) in sinking air.

How may these complex forces now be combined to best effect with the steady-state theory (speed-to-fly rule, dolphin-flight rule)?

Because there are so many possible combinations of meteorological variables, no simple solutions are likely to emerge from a study of the non-steady state. We shall have to be satisfied with making assumptions about various possible meteorological circumstances and working out for each the various phases of an ideal flight pattern. This is a very time-consuming procedure (even using computers) and it also has the disadvantage that the realism of the calculations will vary, depending on the assumptions chosen; it is no easy task to draw conclusions out of each set of results, in the form of guidelines to pilots, which might prove applicable in real life (see also page 112). However, since control inputs in transitional phases constitute an important part of speed-to-fly piloting technique, a cautious attempt will be made to do just this.

TENTATIVE STATEMENTS ABOUT CONTROL INPUTS IN TRANSITIONAL PHASES

1. Quite apart from being impossible to achieve in practice, it is not only unnecessary but positively disadvantageous to attempt during transitional phases of flight to maintain "speed-to-fly," as dictated by the speed-ring or cruise-control variometer.

2. If the elevator is held in a constant position, changes automatically occur in airspeed and g-load as the aircraft flies into lift or sink. These result in a flight-pattern which comes very close to the theoretical optimum. Note: holding the elevator steady does not mean that the airspeed will remain constant!

3. Starting from the norm of a steady elevator position, as per paragraph 2, slight improvements can be obtained by easing back in lift and easing gently forward in sink. To be more precise: control inputs should ensure that g-load (and airspeed) increase and decrease in phase with the strength of lift and sink. Seat-of-pants tip: try to reinforce the impact of gusts.

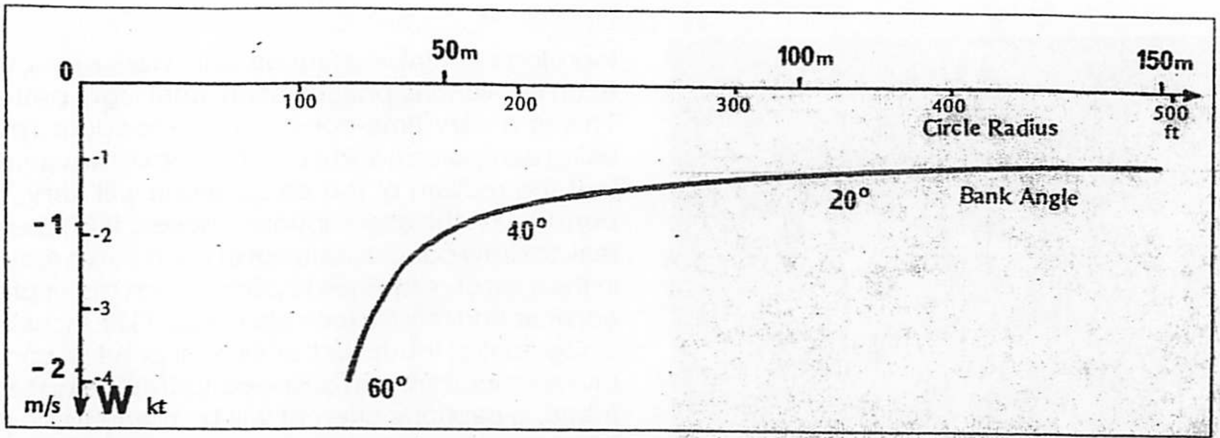
4. It may sometimes happen that a pilot who is trying to fly in accordance with steady-state speed-to-fly theory may completely fail to implement the dictates of his speed ring but nevertheless achieve quite respectable results, simply because he unintentionally reacts with a certain time-lag.

The time-lags mentioned in the last paragraph should not be too long. A significant phase-shift occurs anyway, without any action on the part of the pilot, for three reasons:

- the lag in variometer indications
- the pilot's reaction time
- the inertia of the sailplane

THE LAG IN VARIOMETER INDICATION

The lag in variometer indication depends on the type of instrument used. Commonly-used vane-type variometers (e.g. Winter, PZL) are already considerably faster than the older rate-of-climb indicators, while the newer taut-band instruments and electronic units are faster yet. Even so, it's doubtful if the extra expense of especially fast in-



Circling polar ASW 15 5.75 psf - optimum circle

struments is worthwhile if they prove too "nervous" for the pilot's taste and end up being damped by restrictors in their connections or electronic damping. Even an ideally fast — i.e. instantaneous — variometer, however, would have a certain lag displaying vertical air motions, since for example, a climb cannot be displayed until the sailplane's sink has been halted and it has already started to climb. However, for this to occur it must first be accelerated (up or down). Ideally, we should base our flying on these accelerations — that is, on "seat-of-the-pants" feel, using our compensated total energy variometer or speed-to-fly indicator as a check for the size of our (acceleration-based) speed change. If we keep an eye on the *trend* of its needle, rather than its instantaneous position, we can determine if the climb or sink becomes stronger or weaker, and thus if we're still approaching its maximum or have already passed it.

THE PILOT'S REACTION TIME

The pilot's reaction time depends, of course, largely on his own bodily tendencies and condition; one can improve it if one is well rested, well fed (but not bloated with hard-to-digest food), in short in that condition of physical and mental well-being that leads to both enjoyment of and concentration on the task at hand. Enjoying one's flight improves one's attention and reduces the reaction time; we should cultivate our sense for acceleration. Of course, it is difficult to differentiate between those accelerations caused by air motions and those we've caused ourselves by control movements; the only way is to practice and refine one's "feel" if we don't want our speed corrections to lag too far behind. We can train our ear to react quickly to the tone of an audio variometer — or better yet, an audio speed-to-fly variometer — so as to avoid the need for constant scrutiny of the instrument panel.

THE INERTIA OF THE SAILPLANE

The inertia of the sailplane cannot, of course, be overcome, but will cause less delay the more abrupt and rapid our control movements are. Unfortunately, rough or abrupt control use can lead to aerodynamic losses which vary with airspeed as well as with the g-load we apply. At higher speeds, it's not wrong to pull as much as 2 or 2 1/2 g, since the increase in lift occurs at entirely favorable values of C_L, and at rather low angles of favorable values of attack. Only at low airspeeds do we encounter significant losses from g-loads, a fact which we can verify by observing our total-energy variometer. Thus, we can pull harder at higher speeds.

"Pushing over" for higher speed is a different situation. The airfoils of a sailplane are generally inefficient for flight at less than one g; if we force the situation by too much forward pressure the angle of attack is far from favorable. If we go so far as to induce negative g-loads, so that charts, cameras, and anything else loose in the cockpit fly against the canopy (it is astonishing how much dirt, grass seeds, etc. can collect in the "bilges"' of even the best-kept sailplanes), we have reached an extremely inefficient condition: we are forcing a wing designed to produce lift to produce sink instead, with a marked drag increase. Thus, we should always temper our forward stick movements to the point that there is always perceptible pressure from the seat.

Generally, our pitch corrections should be more abrupt the stronger the changes in vertical air motion are over a given distance. Put more simply, in smooth weather fly smoothly, in rough weather fly roughly.

WATER BALLAST

"CLASSIC" FLIGHT

Any increase in wing loading decreases the circling performance of any sailplane. Circles can be flown in various fashions: a given diameter can be maintained at low speed and gentle bank angle, or at higher speed and steeper banks. When circling, we tend to "juggle" airspeed and bank angle by feel to obtain the lowest possible sink rate for a given diameter. In other words: there is an optimum airspeed and bank angle for any circle diameter.

To characterize the circling performance of a sailplane one can examine a special circling polar. The illustration shows how the sink rate of the sailplane — in this case an ASW 15 flying at 5.75 psf — increases as the circle's radius decreases (assuming that the optimum speed and bank angle are flown at all times). If one increases the wing loading to 6.5 psf, the sink rate for a circle of about 450 foot radius increases only about 0.3 fps, but for a circle of 150 foot radius the sink rate would increase by about 1.5 fps. The changes in performance for straight flight are similar; performance will be poorer at speeds less than best glide speed and better at higher speeds. If one expected to be forced to use only narrow thermals, dropping all the ballast would be the proper course of action in order to climb better, even at the cost of some high-speed performance. If the lift is weak, our speed-to-fly indicator won't command high inter-thermal speeds in any case, so we might as well get rid of whatever weight we can so as to reduce the time spent gaining altitude. After all, we have seen earlier that good climb rates are the most important requirement for high cruise speeds. The luxury of a high wing loading is only worthwhile when the penalty one must pay in climb remains a relatively small one. On the other hand, if one's climbing in a gaggle a small climb advantage is hardly a telling point, since the necessity for avoidance maneuvers while outclimbing other sailplanes will cost the pilot a large part of his advantage. The advantages of heavier wing loading are evident in glides without a similar disadvantage.

IN DOLPHIN FLIGHT

In dolphin flight on the other hand, the situation is different, as there is no need to circle. Since the increase in sink rate is much smaller for straight flight than for circles, a higher wing loading can be used to its fullest advantage. If longer stretches of dolphin flight are expected it is advantageous to carry ballast.

STARTING

Starting in contests with full water ballast is always a good idea. If the run through the start gate is made at high speed, heavier sailplanes will gain more height than light ones in the subsequent pullup; if thermals don't look good, the ballast can always be dumped on the way to the first one. One usually arrives at the first thermal at a higher altitude if one uses this system than if one had decided from the outset not to use ballast. If we are actually circling, of course, we must not drop any water if we can expect other competitors to enter the thermal below us, let alone if any are already in it. To wash someone out of the air like that is very unfair, especially if he is already fighting to stay airborne. Anyone who still has water aboard in such a situation must not have been paying attention to the situation earlier, and doesn't have the right to correct his mistake at the cost of another pilot's chances.

WATER BALLAST RULES

— High wing loading is advantageous for fast flight and is worthwhile if:
  — the thermals are large
  — the thermals are strong
  — cloud or thermal streets suitable for dolphin flight exist or are expected.
— Since heavier sailplanes pay a climb penalty, ballast should be dumped if:
  — thermals are small
  — thermals are weak
— Contest sailplanes should carry ballast on takeoff, if for no other reason than the speed advantage in the start gate.
— Never dump water on other sailplanes while circling.

THE FINAL GLIDE

It is always interesting for the spectator at smaller contests to observe how some pilots dive on the finish from a great height, whistle across the airfield on the deck at redline speed, and then make a breathtaking pullup to another great height. While this may well look very impressive, such a display — in addition to being dangerous to other pilots who may be finishing at the same time — serves to inform the initiated that this pilot calculated his final glide incorrectly — if, indeed, he calculated it at all. After all, the altitude for this airshow had to be gained back on course somewhere, and that costs time. Calculation of the final glide is an essential part of every speed flight and often makes a difference of five to ten minutes — sometimes, in fact, it makes the difference between making it home or landing out.

The speed-to-fly rules still hold true for final glides, of course; they are flown with the speed ring set for the final climb in the last thermal. This is a value which we know quite exactly, and, in combination with the wind, it gives us a definite glide angle over the ground, which in turn is used with the distance from the goal to determine the altitude at which the final glide will commence. Our capability for estimating distances cannot meet the demands of a final glide; this is why it must be calculated.

The entire final glide procedure is roughly as follows: still far from the goal, we try to decide approximately where we may be able to begin a final glide, based on our (thermally limited) operating altitude. At some point before reaching the final glide starting point we may obtain the winds aloft by calling FSS. If the wind information we receive corresponds more or less with that on our knee board, we can use the head or tailwind component we noted earlier. If not, this component must be calculated or estimated anew.

As our continued flight brings us to a thermal that appears to be good enough to make the climb to final glide altitude worthwhile, we calculate: starting with our climb rate and wind component, we find the optimal altitude for our distance from the finish. Our initial calculation will be based on an arrival at the finish line at zero altitude; that is, with no reserve. If the weather ahead looks good, and if our last climb was 600 fpm or better, we'll leave it at that, since the basic calculation leaves some margin; this is particularly true if we're flying at a higher wing loading than that used as a basis for the calibration of our final glide calculator. If the rate of climb has been less than about 300 fpm, we should add around 300 feet for safety; this should be sufficient unless things look uncertain up ahead (danger of rain, downslope winds, sink streets between invisible thermal streets, uncertain winds aloft information, etc.) in which case we add even more safety reserve.

This corrected altitude is now the goal for our final climb. If the lift increases as we climb higher, we recalculate and climb even higher for a faster final glide. If it decreases, on the other hand, we calculate a slower final glide with a lower departure altitude. If we can't make it to departure altitude at all (cloudbase) or if the thermal weakens to the point where it's no longer worthwhile, we proceed on course to find a new "final thermal" which will require another calculation of the glide.

After leaving the last thermal we'll check our position and altitude from time to time and compare them with what our calculator tells us is necessary. If we're consistently too high we set our speed ring for a higher speed, which we arrive at — again — by recalculating our glide from our present position. If we are too low, we set the ring for a lower speed by the same method. We should arrive at the airport at normal airspeeds and around 350 feet of altitude, plenty for a good landing pattern — as long as the landing area itself isn't too far from the finish gate.

A further point: sometimes at contests one can see absolutely catastrophic landing patterns, patterns that wouldn't be flown by the rankest beginner, flown by normally excellent pilots. It's as though the stress and strain of competition had drained them completely and they just shut off their minds after crossing the finish — after all, nothing left to do but land at the home airport . . .

It is this effect that caused, for example, three out of four of the German team at the 1974 World Championships at Waikerie to make immaculate belly landings — and we were joined in this exercise by a veritable United Nations of the greatest names in soaring. At least not all the sailplanes were damaged. Rather, we must force ourselves, if necessary several miles before finishing, to plan our landing and to make a regular before-landing check. The earliest that we can "shut down" is after our ship has been pulled clear of the active runway.

SPEEDIER THAN MACCREADY

Paul MacCready is a World Gliding Champion and a renowned engineer. His speed to fly theory revolutionized cross country soaring technique. Today's sailplanes are acheiving average speeds greater than the theorectical speeds he predicted, simply by flying slower. At reduced MacCready settings you will increase average speed as well as minimize the risk of landout. Why?

1. Slower cruise speed results in fewer climbs needed and more time between climbs. The increased range at slower speeds allows more selectivity in thermal choice. Time spent in low altitude, high stress situations is minimized resulting in better pilot judgement. This is especially important in the West due to the poor landing options.

Perhaps Paul was comfortable at 1000' AGL flying 70 knots in a wooden glider looking for his next thermal, but the rest of us fly smarter with a little more breathing room.

2. You will have a better feel for thermal strength when entering at slower speed. Seat of the pants and instruments will give a more reliable indication of core location, width, and rate of climb. Minimize the number of "foolers" that you turn in.

3. Off-field landings can be eliminated if cloudbase is adequate. Airport to airport flying can be acheived by adjusting Mc settings to effect the necessary range.

4. Larger speed variations between cruise and climb caused by high Mc settings result in greater energy losses. Also, the higher the Mc, the greater the actual distance flown. Paul proved that both these factors are negligible, but I believe they have some effect. An added benefit of slower flight is increased safety due to lower energy pull-ups and lower closing speed in a head on situation.

5. Lift strengths vary with altitude- often stronger near cloudbase. It's easier to find the core when closer to the cloud (smaller search radius.)

6. Experience has shown that final glides are more efficient using low Mc settings, and leaving the last thermal below the necessary altitude. The altitude deficit will be made up by staying with cloudstreets and avoiding sink areas.

7. The human nature factor. At the end of the day we all talk about that 10 knot thermal. The truth is those boomers probably average one half of what we see on the vario, after factoring in searching, centering, and exiting time.

RULE OF THUMB: SET MC TO 1/4 OF TYPICAL THERMAL

RICK WALTERS 6/20/96

The Price You Pay for McCready Speeds

Wil Schuemann

Ed Byars: We have all been looking forward to this next one. A lot of things have been said about McCready speeds, Dolphin flying and all kinds of good things like that. Wil has actually made a quantitative analysis of this and now he is going to tell us the price we pay for not flying McCready speeds -- maybe it is a high price, maybe it is a low price; I can't wait to hear. Wil Schuemann.

Wil Schuemann: Since Paul McCready worked out his little computer a ways back a lot has been said about it. The part I'm interested in is not so much the specific figures or curves or in trying to convince you what to do in any particular glider, but in trying to give you a general flavor. The calculations that go into the kind of curves that I am generating are fairly simple but very laborious if you don't happen to have a computer around. They are also the kind of things you can do without equations by just thinking it through in your head. A second thing is that there are a lot of options with regard to McCready speeds. There are a lot of different ways to manage this sort of thing. I think it is going to come through that I don't believe in it very much before we are all done. I have done a lot of calculations in a theoretical way to justify this belief. The calculations were done after I had made up my mind what was the best way to fly. I think you will find that most of the best pilots tend to fly this way anyway. The curves are about a fixed glider and a fixed condition. I am not the least bit interested in the details of the thermal, but will talk about curves, you are really doing a parametric analysis. All parametric analysis means is that you consider a number of things that are related, such as the glider polar, the thermal strength and the inter-thermal sink. The thermal strength is the motion of the air in the thermal -- not the climb rate of the glider. The inter-thermal sink is the motion of the air between thermals, not the vertical motion of the glider. The inter-thermal speed is the speed you fly your glider. The average speed is the speed achieved over any length that you fly, including the time it takes to climb back to altitude. All of these are related to a theoretical sense by equations. If you want to display the results, you have to set some of them equal to constants and let others vary. Then you can plot things on graphs.

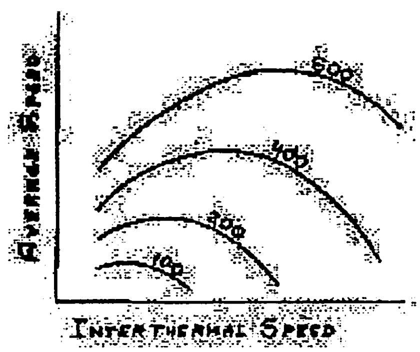


Figure 1

Figure 1 is the kind of curve Dick Johnson presented yesterday. It is by far the most familiar kind. You hold sink and the sailplane polar constant and then plot the average speed achieved for a course against the inter-thermal speed. This is the speed to fly and for different thermal strengths you can find the relationship. If for instance you are achieving 100 ft./per minute climb in thermals you pick the point at the top of the 100 ft. curve, and below it you read the inter-thermal speed to fly. If you are achieving 200 ft./per minute you read the 200 ft. curve the same way, etc. I am sure you are all familiar with this type of curve.

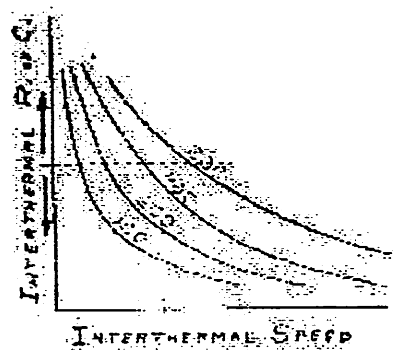


Figure 2

Figure 2 is a graph that usually isn't shown but is the basis from which the McCready speed ring is built. You plot the sink or climb, or the rising and falling of air between thermals on one axis, and your inter-thermal speed on the other. The curves are for different amounts of lift. You can see that if you pick values from this curve you can plot what your inter-thermal speed should be as a function of the rising and falling of the air between thermals. That's where McCready speed curves come from.

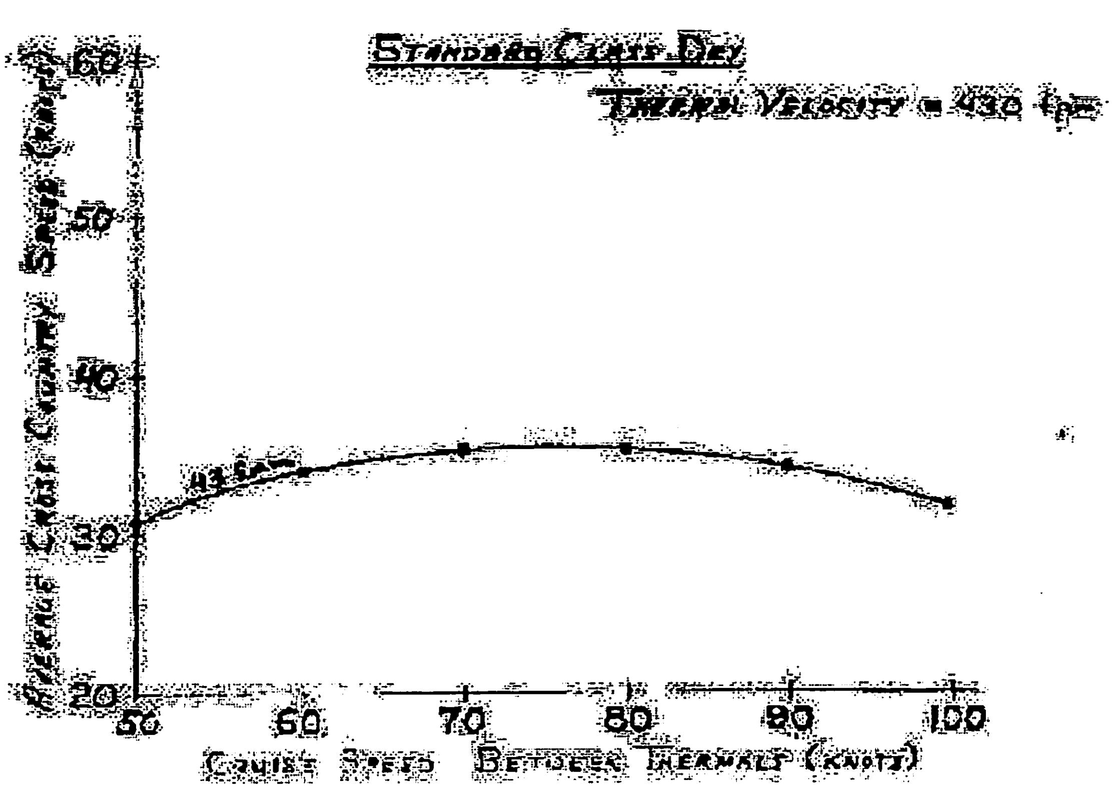


Figure 3

I am not going to talk about either of these curves. Rather I am going to do something a little different. In Figure 3 the thermal velocity is fixed. It's 430 feet per minute. This means that in a standard class ship without water you are going to be achieving roughly 300 feet per minute R/C, this is a typical eastern U.S. condition. In Figure 3 as in Dick Johnson's curve, the average cross country speed in knots is plotted against the cruise speed between the thermals. I have drawn a curve for a specific rate of sink of air between the thermals. If you are flying through average sink of 43 feet per minute (that's air motion) then clearly the optimum speed to fly is 75 knots. But you don't lose much by flying 70 and you don't lose much by flying 80. You can fly 65 and hardly argue about the difference, so it is a very broad function. And so there must be other reasons for choosing the exact speed to fly. Suppose you want to choose whether to fly 65 or 75. In one case, obviously you are going to make a little more speed. But suppose you want to drop back to 65, are you going to actually have more range or are you going to have less range? Because you are going to fly slower in sink are you really sure whether you are going to have more range or less range? If you are going to have more range, it is clearly to your benefit to slow up depending upon future conditions, of course.

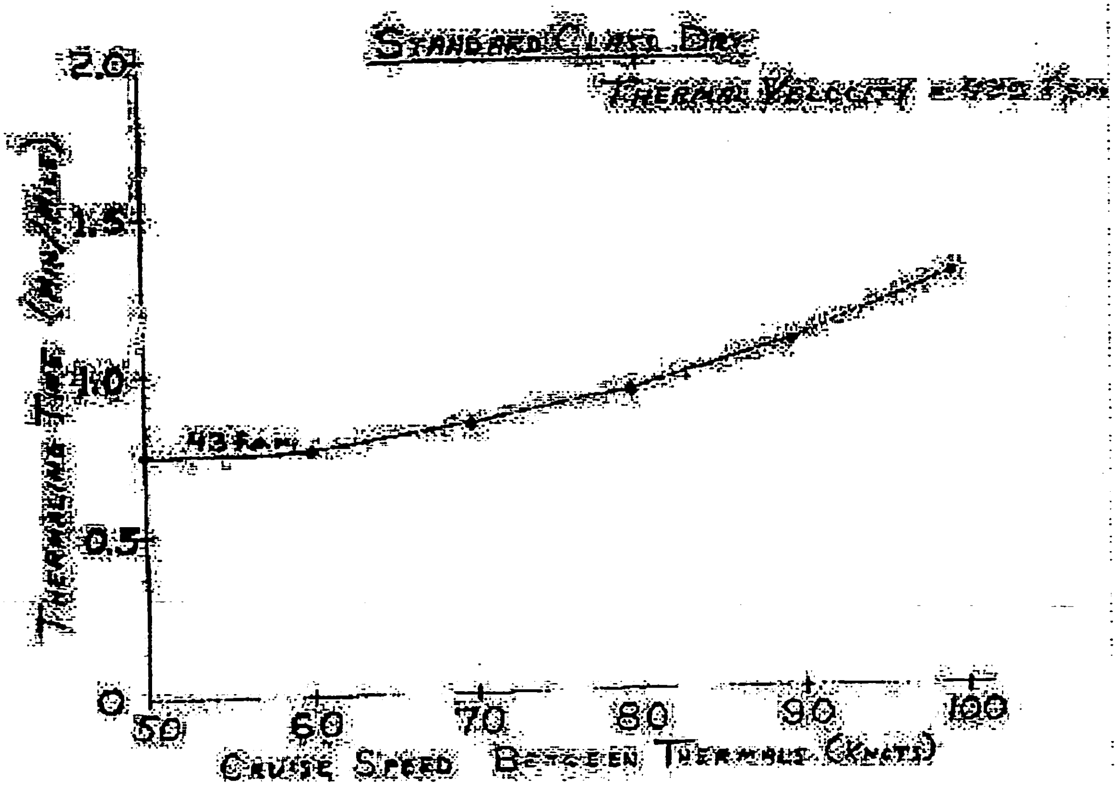


Figure 4

In answer to this question we go to Figure 4. The thing on the border is a kind of a cute unit but very useful. Thermalling time in minutes per mile is very interesting because it takes into account a ship that's dry or wet or open or whatever. It gives you a real idea of how many minutes a ship is going to have to thermal to finish a cross country task. It's really a measure of how much risk you are taking on a cross country flight. The more thermal minutes in a given flight means the more thermals you have to find. Minimizing thermalling time in minutes per mile is the name of the game. The horizontal axis is your cruise speed. I have plotted the same amount of sink as in Figure 3 so you can see the faster you fly the more miles per minute it takes in thermalling time to regain your altitude. We said the optimum speed was 75 knots. This turns out to be .9 minutes per mile thermalling time. If you slow up to 65 you are achieving essentially the same speed but you're down to .8 minutes per mile. You lose a small fraction in speed but in terms of your thermalling requirements you save 12%. That, for my way of flying, is a good bargain.

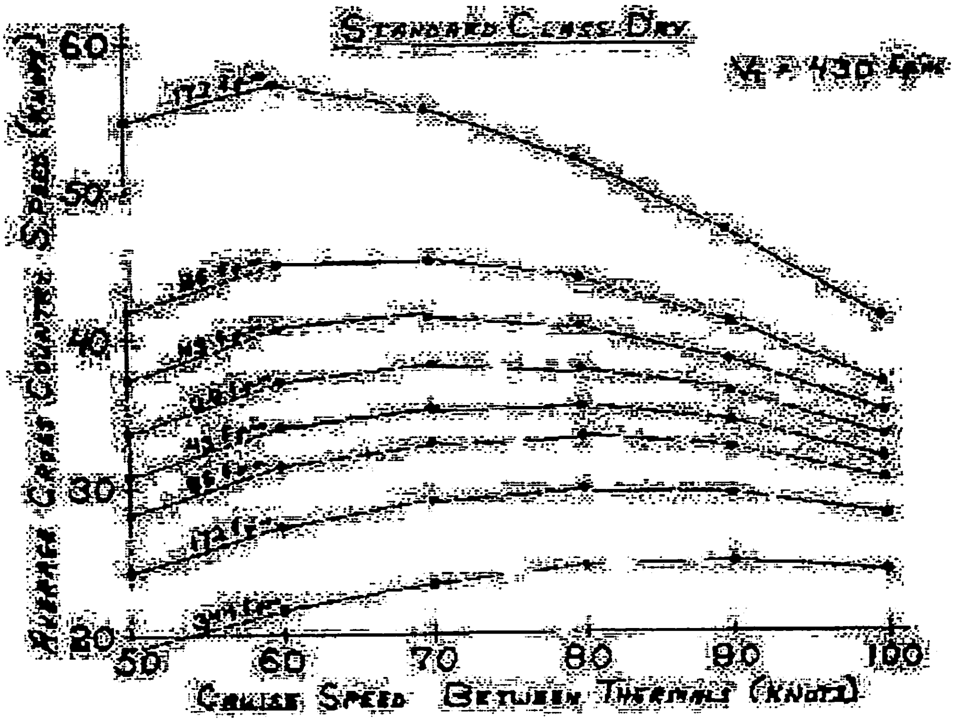


Figure 5

Now I have expanded on these curves so don't get overwhelmed by Figure 5. It is the same curve presented before, it shows your average cross country speed against your cruise speeds between thermals. Only this time I have shown it as a function of different rates of climb and rates of sink between thermals. (A) is the curve we had before at 43 feet per minute and the optimum speed to fly is about 75 knots. I'm arguing that maybe a speed of 65 is a pretty good choice. If you are flying through still air, (B) is 0.0 feet per minute. Your optimum speed drops to about 70 and you can probably do well at around 60 to 65. If you continue to fly into lift, 86 feet per minute (C) is coming up on zero sink on your variometer.

If you can get 172 feet per minute (D) which is essentially half of the thermal strength, you can slow up to 60 knots and achieve an average cross country speed of 57 knots when you are only flying 60 knots -- that's very nice. Going the other way, you get into a sink al; 86 (E) and 172 (F) feet per minute, the curve starts to shift to the right. If you have 172 feet per minute sink you have to add 172 to your glider polar and that looks pretty grim, over 300 feet per minute total sink. The optimum speed moves up to 80 knots or more but still you have latitude to play with. The question now becomes more interesting at 344 feet per minute down, you have to go to 90 knots to get the optimum cross country speed. Now, you say, "I am going to slow up to 80 or to 76 and sacrifice some of my achieved speed in order to increase my range." In that kind of sink I am not sure you increase your range. If you fly the McCready curve for this condition and you get into real heavy sink, it will lead you up to 90 knots and some people argue that that's the way to fly. But what Dick Johnson was arguing for yesterday was to shift down to some percent of that speed and fly a new curve. There is a third alternative. Let's suppose for this same condition that you are flying along as you fly most of the time when you are not in a panic but just trying to achieve the best flight you can for the day. I am going to argue that flying 75 knots almost all the time is a pretty good choice. If you fly through essentially still air in moderate sink at 75 knots you are going to achieve about the best speed that you can. When you fly into sink you will not lose very much in the way of achieved cross country speed. Seventy-five knots is just not very much different from optimum -- a fraction of a mile per hour in achieved cross country speed. If you have a moderate amount of lift between thermals, 75 knots still is not a bad choice. If you get some real lift, that's going to show positive, you can just slow up a little bit. I don't believe in slowing up very much. I am offering this alternative, fly 75 knots all the time, unless you hit a thermal, and then slow up to 65 knots.

Question: What ship is this for?

Answer: All the standard class ship curves are identical.

Question: How did you get away with not computing for the wind factor?

Answer: This is assuming still air. If you want to add headwinds and tailwinds you have more graphs and that's getting away from the point I am trying to make. I am trying to use these curves as a means of developing a philosophy. I find they show a trend or an apparent optimum way to do things.

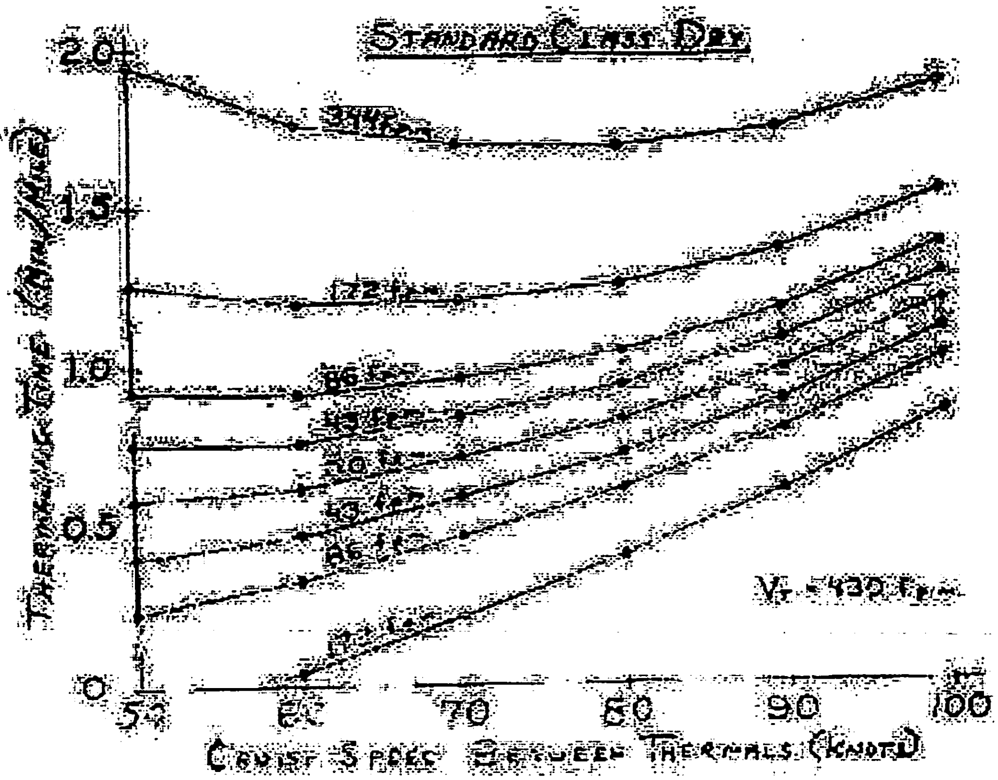


Figure 6

Figure 6 is an expanded curve to answer some of these questions. This shows your thermalling time in minutes per mile against cruise speed. As noted before flying at 65 instead of 75 saves you a lot of thermalling time. As you fly into more sink, your thermalling time increases just as you would expect it to. At 172 feet per minute sink between thermals you begin to pay a penalty for flying too slow. It is interesting to notice that when you get into heavy sink there is a minimum in the required number of thermal minutes per mile at about 75 knots. This means you are going to maximize your range if you fly 75 knots in heavy sink. That's quite contradictory to the McCready curve. Most people push it up to 90 knots when they get into heavy sink. They are actually getting into the part of the curve where they are losing a little range and are decreasing their time in the air by 25 to 30%. Then they haven't got that extra time to think. One of the observations that comes out of this is that when you get into heavy sink fly at 75 knots and start thinking. You have more time to do it. You are going to go farther and have more options. 75 knots is true of all sailplanes under all conditions. It is just something that comes about because the polar curves [go] down so quickly in that speed range. 75 knots is your maximum range speed any time in heavy sink. On the other end of the spectrum when you start to get lift between thermals the thermal requirements naturally go down. If you can maintain a level of lift calling for a speed of 58 knots you can complete the whole course without circling.

AVERAGE SPEED	37.9	38.0	+0.25%
THERMALLING TIME	0.96	1.01	+5.0%

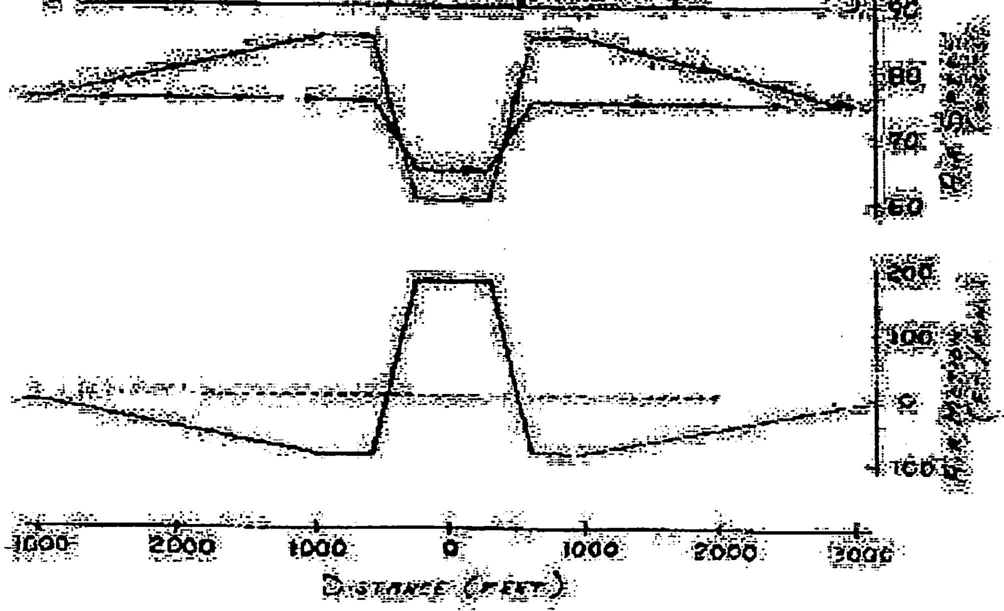


Figure 7

We still haven't really answered the question: "How much do you gain by flying McCready as opposed to some other system"? In Figure 7 we will examine the situation. On the lower part of the graph I have plotted what is essentially a thermal. It shows the center of the thermal and goes out 3000 feet on either side. (This is air motion not what the variometer reads.) It shows about 170 feet per minute up in the middle and has some sink surrounding it. I will not argue about the model, all I am stating is that you've got a thermal and usually around thermals there is sink. I have balanced out the mass flow so this may not be a perfect model, but at least it illustrates what you fly through. We have two pilots for examples. Pilot #1 is the smartest guy that ever lived. I have plotted his airspeed as a function of his position in the thermal. He comes in from the left and starts to fly into sink. He speeds up and holds his speed through the heaviest sink, then zooms to get slowed up for the thermal, crosses the thermal and dives to get his speed way up to come out through the sink. Then gradually slows up until he is out on the other side. Now he's clever. He is able to anticipate what the thermal is doing ahead of him so he can arrange his speed to be exactly optimum – that's hard to do. He's clever in that he can pull the G's that are required to perform this maneuver and still sense the thermal – that's also very hard to do. Pilot #2 is kind of lazy. He pokes along at 75 knots just watching what is going on. When he gets in the vicinity of the thermal, gets the little bumps or whatever, he just pulls back a little bit and cruises through the thermal at about 65 knots. He finds out that it is really not strong enough to circle in and then leans it over a little bit and cruises on out through the sink at 75 knots. The question is: who did better and what were the prices paid? Well I took the two flight paths and went back through the previous curves – integrated it all to get the average speeds flying through this 3,000 feet and what they would have to make up thermalling to get back to altitude. What the thermalling time would be to get back up to altitude. Well, the lazy guy poking around watching what he is doing achieved 37.9 miles per hour through the 3,000 feet. The real hotshot achieved 38.0.

So by flying true McCready speed the best you can do on a theoretical basis is about a quarter of a percent. But considering the thermalling time the lazy guy is going to require .96 minutes to get back to altitude and the hot shot is going to take 1.01 minutes to get back to altitude. If you assume that Pilot #1 is as smart as we said he is; which assumes he has prior knowledge of the thermal so he can arrange his speed, and pulling G's doesn't detract from his ability to know what the thermal is doing he still pays a 5% penalty for that leg of the course.

Based on this I have to conclude that the guy who is looking outside the cockpit and not worrying about his variometers and airspeed in the McCready sense is doing better. He's paying a quarter of a percent in speed but is saving 5% on his thermal requirements. I don't think that the average guy flying McCready speeds can do that good. I think he's always a little bit late. He's pretty darned fast when he zooms up into the thermal but he's late and so he's still going slow about the time he hits the sink, then he dives to get up speed. About the time he finds that he shouldn't be going so fast as he comes out. He's pretty inefficient, so I don't think he achieves the speed that is theoretically possible by a long ways. Yet, even if he did fly that profile, he would still pay a thermalling time penalty. These are my conclusions and are a philosophy to fly by. People should use McCready in moderation. The way to use McCready speeds if you have a McCready ring in your sailplane is to set it at zero. Set it for still air and use it to choose the speed between thermals unless you fly through some lift. There is little to be gained by speeding up beyond 75 knots in sink. The reason is that if you are in heavy sink you are also in a situation where you may have a problem coming up. You may not have too much altitude on the other side of the sink and so you must maximize your range. You maximize your range by flying at 75 knots and this also gives you time to think. That's worth doing in such a situation. There is little to be gained by hauling back on the stick to slow up for a thermal. You are pulling G's and can't feel the bumps. You are busy in the cockpit trying to manage your speed and not looking out to see what is going on. I think most people should just slow down a little bit and watch what is going on and if they don't like it, switch over and go back up to speed.

Question: Please survey the panel to see if they agree with this philosophy.

Answer: A.J. Smith: Although I agree with the philosophy, I would tend to deviate a little bit with the recommendation at the end. I would probably operate in a very narrow band of cruising speeds. I vary the cruising speed during the time of day according to the general thermal strengths we're having on that day, the thermal frequency, the sources of the thermal, the visual signs and all that sort of thing. I may be doing generally as Wil says, using 75 knots on pretty weak days. As the lift gets better and you get more streets, or more dependable clouds or whatever, I might push it on up another 10 knots, but not much more than that. As long as conditions remain fairly constant during the day, I keep the airspeed fairly constant between 75 and 85 knots. I don't do this sort of porpoising bit. I tend to slow down a little bit more than Wil suggests when there are a series of thermals in some pattern, but I certainly don't slow down very much with an individual thermal. I vary my operating airspeed a little bit towards the high side when the weather is really good.

George Moffat: I believe I do just about the same as A.J. Contrary to reputation I don't believe in flying very fast. Usually, I use one of two speeds about 75 or 85 knots, for general cruising purposes. It takes a fair amount of persuasion to vary much one way or the other. I have considerable reservations about porpoising unless you get Texas-type thermals that are very well-defined by clouds. These are predictable and usually quite large. In the east, I imagine as often as not, you'll lose more than you gain, by all this porpoising stuff. Wil, I have a question about one of your figures. Your charts were all based on the rising air mass of 430 feet per minute and a rate of sink of sailplane of around 130 feet per minute, but in climb attitude the rate of sink is probably more near 220 feet a minute in a standard class sailplane. That might move all your figures a little bit one way or another.

Question: Which way would it move them?

Answer: Slower.

Ben Greene: The glider (ASW-12) I'm flying now seems to me to be a little different. I don't exactly fly like that, which is why I am the low man on this totem pole, I guess. The one thing I have noticed is that with the inertia of the ASW-12 often times the 300 and 400 feet you zoom gives the real prize that puts you up higher where the thermal is better organized and probably stronger. This is perhaps an indirect gain from the zoom that might compensate for the G load loss. Ordinarily I generally fly a reduced McCready which gets back pretty close to what Wil is saying.

Dick Johnson: Well, I see we've got everybody committed to my technique. But I'm a little bit surprised that you admit it. As far as the zooms and the dives I have some very strong preferences about not flying with somebody that's doing that all the time because it makes me very nervous. I may have to armor-plate my floor board and canopy. Wil, I'd like to ask a question. Did you take into account the added flight path as you make a zoom and a climb and add that to the distance that the pilots had to go?

Wil Schuemann: That's not considered and is an additional loss. But surprisingly not as much as you would think. When I prepared the slides, I computed it. It's so small that it wasn't worth introducing the additional complexity.

Ben Greene: In zooming if you come in fairly low in a thermal strata, the thermal strength increases as you zoom and you gain that way. But if you are approaching the top where the thermal might have a tendency to weaken the zoom would be a negative thing. If you are zooming after you have made a glide you enter the thermal at a lower level. From this level up the thermal strength generally tends to increase. So you are zooming into an area of stronger lift whereas the guy who didn't zoom is down below, working weaker lift until he gets to the level you have zoomed to.

George Moffat: One more think about this zooming business. You really ought to practice it a lot if you really think it's going to pay. Because your timing has to be absolutely perfect. As Wil showed, all too often you're just nicely slowed up when you reach a 1,000 feet a minute sink on the far side of the thermal. That, somehow, doesn't improve your chances one bit.

Question: This presumes that you are flying through thermals and not intending to stop and circle?

Answer: George Moffat: Yes. You hardly ever know for sure what you intend to do until you come to the top of the zoom. I think I probably speak for the panel if I said that while we all do about what Wil suggests, we also keep in mind that there are quite a number of other factors such as the size and shape of the thermal, frequency of the thermals, the predictability of the next thermal. These are just a few of the various things you have to think about when you are flying.

Question: In coming down to a lower level [like a 1-26 Regatta] how would those speeds be applicable? 75 knots is close to the red line.

Answer: Wil Schuemann: This is a computed for a fiberglass ship without water. For a 1-26 these curves would be bunched up at the low speeds. Most 1-26 pilots know that you fly at 60 mph.

Question: Could you give us some idea of the effect of adding water to a standard class ship; 50 lbs. of water, 100 lbs. of water, 150 lbs. of water as far as effect on these speeds is concerned.

Answer: Wil Schuemann: Almost none. When you are flying with water, you can't afford to slow up as much, but you don't gain a lot by flying faster. You get the extra performance because of the added range between thermals.

"What's the best way for a novice t
The answers turned out to be quit

Competitio
Tactics for

by MICHAEL TETER

Most articles on competitive soaring assume that the reader can, with a few pointers on tactics, low-loss flying, and "climbing straight ahead," leap into the Top Ten in any given contest. Unfortunately, almost everyone in the contest reads the same articles. Also it can be shown that there are usually no more than ten pilots in the top ten. This leaves from thirty to sixty unfortunates to fight it out in the nether regions of the scoresheet, somewhat disillusioned and certainly financially poorer. When George Moffat expounds on seconds per mile or how he conserves his personal energy to psych his way to the World Championship, the relevance to the beginning competition pilot (whose primary problem is the choice between the landing field with the cows or the one with the rocks), is somewhat limited. The fewer errors a pilot makes, the less margin for error he needs, and his tactics are based on those margins. The source of strategy is invariably some world or national champion telling us how we should fly. This is appropriate for some, but in many cases, it is like Jack Nicklaus telling some duffer how to make 350-yard drives, 30-foot putts, and win the Masters' Tournament. If a pilot will admit that he and his machine are a little slower than most, there is a great deal that he can do to improve his score.

If one will observe the accompanying table, it will be seen that there are several factors affecting average cross-country speed which are under the partial control of the pilot or his pocketbook. The speed of maximum glide ratio, for example, may be affected by the carrying of water ballast. (The improvement is not quite as great as shown since there is usually an accompanying decrease in the rate of climb.)

FACTORS AFFECTING CROSS-COUNTRY SPEED OF A STANDARD CLASS SAILPLANE ON AN AVERAGE DAY

Factor		Change to yield 1-knot difference in x-country speed	Typical variation of factor	Effect on average speed
Max L/D	36	9%	5%	0.5 kt.
Speed of max L/D	50 kt.	10%	15%	1.5 kt.
Cruising speed	65 kt.	7%	20%	3.0 kt.
Rate of climb	4 kt.	6%	50%	8.0 kt.
Sink rate of air between thermals	.8 kt.	23%	300%	13.0 kt.

Average speed is 37.9 kt.

The single factor which influences cross-country speed greatly, and which the pilot can do the most about, is the rate of climb. A 1-26 can climb with a *Nimbus* in most thermals, so there is no excuse for not climbing well. A pilot must work extremely hard to find the region of maximum climb and watch other sailplanes in the thermal to see where they go up the fastest. If a ship is older, it is probably slower and will turn inside most of the glass birds. This and any other advantage must be used to claw, kick, scratch, and bite to go up faster. Weak thermals should not be used if it is possible to avoid them, but once in one, work for the greatest possible rate of climb. If lucky enough to get a boomer, work just as hard to get the most out of it. While climbing and cruising, look for lift patterns, hawks, wisps in the haze, top competitors, anything—as long as the eyes are kept out of the cockpit.

The other most important factor occurs while cruising. Simply put it is, "Stay out of sink." Shifting your course slightly sideways when in sink to get out of it—or when in slight lift to stay in it—is far more productive than chasing the speed ring and has the secondary advantage of keeping your mind outside the canopy and on the weather. I have made many 10-20 mile glides in active air in a 1-23 against *Libelles* and *Cirruses* which bored holes in the sky flying their speed rings. By sliding back and forth from my course line to minimize sink and maximize lift. I was able, at worst, to lose only 100 feet instead of the expected 400-500, and at best, gain several hundred feet on them. A Schuemann compensator which tells what the air is doing helps immensely. Unfortunately, in still air, no instrument or technique helps. Also, the better pilots do not bore holes in the sky.

These two factors will do more than any others to improve cross-country speed and everything else is minor, including speed-to-fly, thermal entry-and-exit techniques, ballast, starting techniques, and many more. These factors make the difference between champions and near-champions, but a

'ly contests?" he asked the computer.
…ferent from the champions'.

Strategy and Beginners

slightly higher rate of climb will overcome many other faults, and these other factors may be worked on as the more basic skills of climbing and cruising are improved.

With apologies to any offended national champions, the three things which influence a beginner's scores more than any others are landing out, getting low, and getting lost. The penalty for not finishing a speed task is horrible, getting low can cost a half hour or more to get back up, and as Moffat says, "Lost is slow." With due care given to navigation, there are many things which can be done to ensure staying high and completion of the task. Unfortunately, most of them run counter to accepted championship practices.

Start early on the task. The best thermal indicators are other sailplanes, and by being among the first to start, you will ensure yourself of markers as the better pilots catch and pass you. They are also more reliable than the typical pilot since they will usually circle only in the better lift. You will not be influenced by slower pilots, since they will not catch you. By starting early, you also have more flying time to help ensure that you complete the task. As you get faster, start later, but it is still better to err on the side of being too early than too late.

Cruise slowly. The two limiting speeds in cross-country soaring are the speed for best glide, at a speed-ring setting of zero, and the speed for maximum average cross-country speed, which is at a speed-ring setting of the average rate of climb in the thermals. The latter is known as the speed-to-fly. It does no good to fly slower than the best glide speed nor faster than the speed-to-fly. At the slow speed one pays a large penalty in average speed. At the high speed, one pays a similar penalty in glide ratio which increases the chances of landing out. At a setting of half the achieved rate of climb, a compromise is reached which results in a remarkably high average speed and still maintains a high glide ratio. Typically, although cruising 10-15 mph slower than the speed-to-fly, one loses only 1-2 mph on average cross-country speed. This is made up for by three distinct advantages: a decreased chance of going down, more time to think and observe, and the increased ability to reject weak thermals. The ability to achieve a higher average rate of climb by flying somewhat slower and having a greater freedom of choice is somehow never mentioned, yet rate of climb is far more important in determining average cross-country speed than any particular cruising speed.

On marginal days try to be the last one into and out of the thermal. As you are climbing, the others will be leaving on course. When the risk of going down is high, it pays to have those other guys out there trying to find something for you. Don't press on by yourself unless you have a reasonable idea where your next lift is coming from.

When in doubt, climb. You are told to leave a thermal when the lift starts declining, or to pass up a thermal if it is weaker than you have been experiencing. Weather does change, however, and if conditions seem to be changing in front of you, or if it is late in the day, or you almost have altitude enough for a final glide, carefully consider investing a few minutes toward ensuring completion of the task. The second day at the 1975 Chester Regionals was a lovely exam-

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ple of this particular point. In a gaggle of about ten ships, we came to a booming thermal 20 miles out. At 4300 MSL the thermal died down to 150 fpm and everyone else left. Needing another 1500 feet to make a final glide into a 10-knot headwind, and noticing that it was getting late in the day and that high cirrus was beginning to shade the last 20 miles ahead, I spent 10 minutes alone climbing the extra 1500 feet while the impatient ones pressed on. It was an interesting feeling passing over their ships in fields 3-5 miles out and I recommend it most highly to beginning competition pilots. When the lift starts to weaken, ask yourself if what you expect to get in the next thermal is any better. If not, stay. Higher is better.

The most useful characteristic for a beginner is sheer tenacity. To be over beautiful landing fields at 500 feet climbing at 10 fpm after five hours of flying is a situation in which one's motivation is in the worst possible condition. Knowing that you won't win, place, or even show makes the fields look terribly inviting. But climbing out and finishing is imperative, if at all possible, since giving in to excuses is probably the one habit that will stifle the growth of any promising competition pilot. Such situations become even more critical when drifting out of range of landable fields while low. In these cases, the pilot must come to terms with what he really wants from competitive soaring. Future champions will usually keep climbing and may eventually bend a ship because of such decisions. Most beginners should land.

On final glides, be conservative. There are a lot of good pilots who have made rather scary rolling finishes after having barely cleared the trees at the end of the runway, or even worse, landed a half mile out for lack of 50 feet to clear those trees. I must plead guilty to both, although it was never a matter of choice. Had it been possible to gain another 100-200 feet 20 miles out, I would have. Some pilots, however, cut their final glides too closely and on occasion land out when the sink was heavier than anticipated. To sacrifice 400-500 points in an effort to gain typically one minute is hardly ever excusable. If you *can* make it back, make *sure* you make it back. On most Standard Class ships, figuring 25:1 will usually get you home; in case of a medium headwind 20:1, and these figures are *not* conservative. If you count on 38:1, you might make it, but you probably won't.

Most of all, a beginner, especially one with an older ship which climbs well, should practice in and pray for weak fitful weather, since this strategy will work best in such conditions. In strong predictable weather, however, flying the task is much easier and even the beginner should make it around without too much trouble.

This entire article is predicated upon the observation that the strategy and tactics of national and world champion pilots leave too little margin for error for the average soaring pilot, and is dedicated to the proposition that finishing a task is a lot more fun than landing out. To sacrifice a few minutes from one's optimum time to ensure completing a task seems only reasonable and prudent. My only regret is that I did not do it more often.