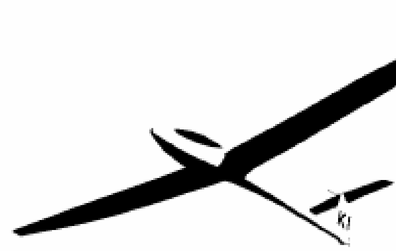
INTRODUCTION TO CROSS-COUNTRY SOARING

This publication does not offer any new, brilliant strategies, nor does it reveal any deep guarded secrets. Most of the material presented here can be found in other publications, and have been used by glider pilots for many years. In fact, some of the techniques presented herein were used by pilots as far back as in the 1930s.

This is merely an effort to compile most of the practical aspects of cross-country soaring in one handy booklet for the aspiring cross-country pilot.

As the same techniques apply to contest flying, this material is also helpful for those intending to join the world of competitive soaring.



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Introduction to cross-country soaring

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INTRODUCTION TO CROSS-COUNTRY

AS YOU READ THROUGH THIS, you may get the impression that it applies to racing, and it does. However, though you may only be interested in recreational flying, you need to apply most of these techniques to some degree if you want to go somewhere.

In bygone days when most of our flights were downwind dashes we didn't need to worry too much about efficient flying in order to get some sense of accomplishment. On most reasonable soaring days the wind usually blows at 15 mph, so if we managed to add a mere 25 mph we would cover a respectable 160 miles on a four hour flight, at 40 mph. Times have changed, 'Out & Returns' have now become fashionable. With that same performance, in similar conditions, it would take the same amount of time to complete an 'Out & Return' flight to a turnpoint 32 miles upwind.

In contest flying where every minute counts, you need to know and apply all of this material to the fullest.

Type of glider

While the latest ultra-performance glider with an L/D approaching infinity would be nice, an intermediate type with a glide angle of 30:1 will do well enough. On the other hand, on the average eastern day, it is simply not possible to successfully practice many of the following cross-country techniques in anything with much less performance.

However, making your very first cross-country flights in a glider with a low wing-loading, such as a 1-26 or K-8 is not such a bad idea as the low stalling speed and short landing characteristics will make those first off-airport landings considerably less stressful. When flying a glider with this level of performance the best policy is to stay as high as possible and don't pass up too many thermals. Also, chances are you will have more fun and less aggravation going straight downwind.

Map preparation

While navigation is done almost exclusively by GPS these days, it is still a good idea to have a map available in case the GPS decides to close up shop. In a sailplane, we do not have the time or space to unfold and fold sectional charts. To be useful, the map needs to be prepared for the occasion.

We need a single, one-sided map which covers the area we intend to operate within. Unfortunately, the sectional charts have been carefully arranged such that most glider ports are located near the border of charts, so that typically two or more need to be joined together to create a one piece, single-sided map. This can be done by using clear tape.

The next step is to draw five or six concentric circles centered around home base. The purpose of these circles is to enable you to readily estimate your distance from home when you are in the vicinity, and the altitude required to get there, basically turning the map into an oversimplified glide calculator. Space the circles at five mile increments. When working out the altitude required to get home, figure on losing 200 feet per mile or 1000 feet per circle. These are nice handy, round numbers to work with and this gives you plenty of margin as it works out to an L/D of 26.4 to 1. Some allowance of course, has to be made for the effect of wind, which on most soaring days amounts to about 15 mph. A rule of thumb is to anticipate covering about 3-1/2 miles per 1000 feet, or losing 1400 feet in 5 miles if going into wind. Downwind should get you about 6 miles for every 1000 feet loss of altitude.

In addition to the circles, mark all the turnpoints you intend to use in the future. If you operate within a contest area, mark your map with all the official turnpoints. When all done, it's a good idea to cover your map with clear vinyl to protect it from sweat and tears. The type made for covering kitchen cabinet shelves works well.

Navigating by map

Navigating by map need not be all that complicated; here is a simplified version. Before starting – with reference to the map and a prominent terrain feature such as a lake or town, point the glider on the heading you need on the first leg. Don't forget to make some allowance for crosswind. Note the compass reading, and now you know the compass heading for the first leg. Repeat this process after rounding each turnpoint.

If you are low and momentarily confused with respect to your position (in other words, lost), concentrate on getting as high as you can before trying to sort out your navigational problems.

GPS use

If you will be using a GPS on your first cross-country, be sure you are well versed in its operation beforehand. By no means try to figure out how to use a GPS during you first flight away from home, you will be busy enough as it is. Drive around in your car with it and practice the button pushing.

When navigating by GPS it is very useful, for quick reference, to have an 8″x11″ map with all the turnpoints.

Off-airport landings

At some sites it may be possible to lay out a route which will permit airport hopping. The idea is that you don't go beyond reach of one airport until you are within reach of the next so as to avoid having to make an off-airport landing. This is an excellent way to get initiated and, if possible, the first few cross-countries should be done this way. However, serious cross-country soaring cannot be done without an occasional visit with a farmer. Field landings are not to be taken lightly, there is more to this than might be expected. On the other hand, don't let your apprehension of a potential field landing prevent you from pursuing the thrill and excitement of cross-country soaring. There is no question that off-airport landings entail a greater risk than landing at an airport, but if you are fully prepared, the risk can be contained to an acceptable level. Just be sure you are ready to cope with this challenge before setting off. Off-airport landings are 99% skill and 1% luck.

THERMALLING

Efficient thermalling is a prerequisite for successful cross-country flying. In contest flying, it is absolutely imperative. On an average day, a couple of minutes more in each thermal can add 15 or 20 minutes to a 150 mile flight. That much time can be lost in the initial centering process alone if your performance is not up to par. Also, when thermals are feeble, the right thermalling technique can make the difference between going up or going down.

Prior to solo flight, most training is concentrated on takeoffs, patterns, and airmanship, as it should be. Occasionally, when a thermal is encountered the student is instructed to circle, then to straighten out here and there. This is done mostly for the purpose of prolonging the flight. Some will get some limited instruction in the basic principles of thermalling, but learning to center quickly and maximize the rate of climb needs special attention, and cannot be mastered before airmanship is fully developed. Consequently, some pilots are a little short on thermalling technique, so it seems appropriate to cover this subject at the onset.

Some people believe going around in circles is all there is to thermalling. This is far from the case.

Instrumentation

A total energy compensated variometer is a necessity. Without it, any variation in airspeed will give false readings of lift distribution. As we must be vigilant at all times for other traffic and at the same time monitor the variometer constantly, an audio variometer is also essential.

Skill level

The prerequisite for being able to center thermals with a reasonable level of efficiency is the ability to make well-banked, coordinated, steady speed turns. In addition to increasing the rate of sink, any slipping and skidding also changes the noise level, which is a major input we use in controlling airspeed.

It is absolutely essential to maintain a constant airspeed, as any variation in speed will skew the circle.

There is good reason to be proficient and comfortable at turning in either direction. When entering a thermal it generally pays to turn in the direction of the rising wing. When entering a thermal which is already occupied you have no choice, you must conform with the direction of turn of the other gliders. Accordingly, you will be greatly handicapped if you have a weak side. You may not be aware of it. If you use a data logger, check the flight statistics regarding direction of thermalling. If you are consistently make more than 50% of the turns in one direction, you have a problem. The solution is to practice your weak side at every opportunity until you feel equally comfortable turning in either direction.

Airspeed

It is said that you should speed up in sink and slow down in lift, which is all well and good but that doesn't apply in thermals. I have had the thrill of occupying the rear seat with a novice in the front who tried to apply this technique while thermalling. The demonstration resembled a roller coaster ride and, of course, obliterated any sense of lift distribution.

The airspeed should be constant, and the optimum speed will depend on the type of glider and angle of bank. Some gliders climb better when flown near the stalling speed; in other types, performance improves if flown a little faster. It is imperative that you not be afraid of stalling the glider, or you most certainly will tend to fly too fast. If the thermal is broken up, or consists of a number of small cells, it may be advantageous to fly a little faster to maintain crisp, fast control respond to increase maneuverability.

Angle of bank

The most common mistake is not banking steep enough. Except when flying a glider with a very light wing loading, it is simply not possible to stay within the thermals without using well-banked circles. Most often, if your angle of bank is not at least 35 degrees you are going to fall out of the thermal somewhere along the way. Keep in mind that 35 degrees of bank will seem like 45 degrees.

Thermals vary in size and structure from day to day, and the optimum rate of bank will vary accordingly. On a few occasions, if the thermal is fairly big, 35 degrees of bank might be optimum. If there is a strong gradient in the lift distribution, ie. the lift is considerably stronger near the core, a steeper angle of bank works considerably better. Close to the ground, thermals are smaller and more broken up than they are at altitude. So if low, circle tightly at first, then as you gain altitude it may be advantageous to reduce the bank a little.

The ideal angle of bank will be somewhere between 35 and 60 degrees. A bank angle of 60 degrees generates a force of 2G, the stalling speed increases by 1.4 and the rate of sink increases correspondingly. Nevertheless, a couple of 60° turns in a strong surge can be well worthwhile.

Centering and optimizing the climb

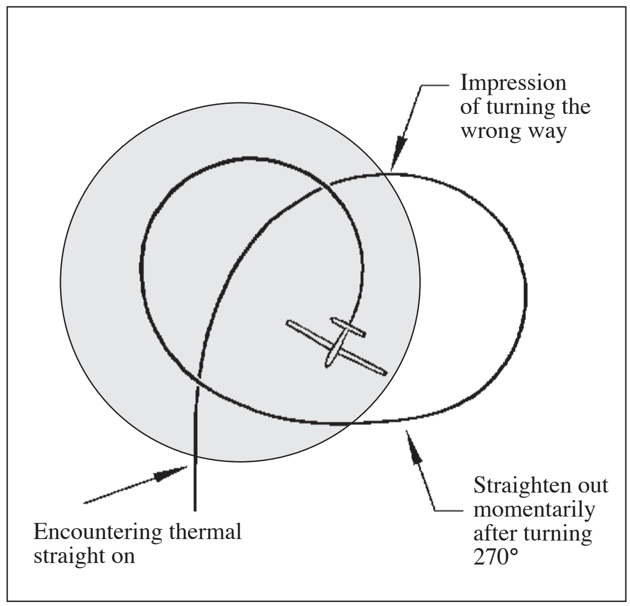
The objective is to center as quickly as possible and maintain the optimum rate of climb until it's time to leave.

When looking for a thermal, the first indication that lift is near is an increase in the rate of sink. If you are heading in the right direction you are likely to encounter some turbulence as the rate of sink diminishes. Now get ready, and pay close attention to which wing wants to come up, as that will be the direction in which you will want to turn. This does not guarantee success, but it works more than 50% of the time.

In spite of having turned toward the rising wing you will, in all likelihood, get the impression of having turned in the wrong direction. By the way, the chance of this happening is nine times out of ten. Don't get paranoid, this happens to everybody, and there is a logical explanation. In years past, when demonstrating thermalling techniques on a piece of paper, we indicated our flight path by drawing a circle tangential to a straight line. This, of course, is impossible. The path from the point where the turn is initiated to the point where the circle is established is not circular but elliptical. Thus, even though we turned in the right direction we may come out the side, creating the impression we went the wrong way. This is the reason it most often is necessary to straighten out completely after 270 degrees for a second or two. When back in the lift, immediately tighten the turn again. With a little bit of luck this should place you closer to the center. The objective is to form a mental picture of the lift distribution as soon as possible.

If the variometer shows some rate of climb all the way around, continue to shift your circle in small increments by reducing the angle of bank when lift is increasing, and then increase the angle of bank when the lift has peaked – timing is all important.

If the variometer actually shows sink on part of the circle you need to take a more drastic corrective action and straighten out completely to move the circle away from the sink. In this situation it's a common mistake not to straighten out completely, and not move over far enough, dreadfully going through the same sink twice. I think every glider pilot should have a plaque right across the instrument panel saying, *"I will never fly through the same sink twice."*



Don't make the mistake of tightening the turn when you are in the sink in an effort to expedite the process of getting back into the lift, if you hold the turn on a bit too long it may have the effect of centering in the sink. Simply maintain the same angle of bank till it's time to straighten out.

Take time out occasionally for a glance skyward. There is a lot of information to be gained by observing the development of the cu you are circling under. It is especially beneficial to keep track of what's going on up above when beneath a small, thin, and short-lived cu. If the lift begins to taper off, intermittent checks will tell you if the cloud is dissipating, which is a good indication that it's not your centering that's gone wrong, but that it's time to move on. At other times you may notice another wisp forming next to the one you are under. This likely indicates another cell and since it is just reaching the condensation level chances are it is at its peak of development – better move over. Incidentally, there usually two cells to a thermal. It also pays off to keep track of the more mature specimens. Bigger clouds are sometimes fed by numerous cells. The darker areas is where the cloud development is the deepest, and that is where the strongest lift is to be found. Be careful not to fall victim to 'the grass is always greener' syndrome. "Is that dark patch over there really any better than the one I am under? Or would the one I am under look the same from over there?" – but that's what makes it interesting.

One mistake is to change direction of turn. In the rare instances when this maneuver is successful it is generally attributable to pure luck by accidentally stumbling into another core. As a means of centering, this strategy is totally useless.

If you lose the thermal entirely, you might consider making one shallow banked 360° circle, then tighten the turn if and when you re-enter. At times, it is tempting to prolong the search, but unless you are desperate it pays to move on after one circle.

When maneuvering within a thermal, control movements have to be timely but smooth and not excessive. Any control movement causes drag, which in turn increases the rate of sink. Be careful not to over-control. Look at it this way; if you are sharing a thermal with another pilot he should not be able to see any control movements.

Though you may have perfectly good instrumentation, don't ignore the sensations you get from your hindquarters. The first indication of entering lift will be an increase in: "G" load, nose down pitch, noise level, and airspeed. This feedback always precedes the response on the variometer.

Thermals are not the nice well-defined, smooth columns of rising air that we depict them to be, but consist of a turbulent mass of bubbles and individual cores which are evident by surges of stronger lift. In addition to constantly shifting the circles toward the better side, you can further improve on the rate of climb by tightening the turn in these surges. A good strong surge is evident by an exceptionally pronounced boost from the seat pan. When you feel a surge, dig the wing in right there and hold a tight turn as long as the lift is solid. A strong core will have the tendency to push you out of it, when that happens tighten the turn even further, if possible. The instant the lift tapers off a little reduce the angle of bank ever so slightly, perhaps 10 degrees, but no more. This will cause a small shift, either bringing you back to center or bring you in contact with another core. Then tighten the turn again on the next surge. This may seem contradictory to the method outlined for centering, but think of this process as adjustments, rather than centering. Only maintain a steep angle of bank as long as the rate of climb is maximized. When hawks are thermalling they constantly make sharp turns here and there to take advantage of such surges. Efficient thermalling is a combination of constantly shifting the circles toward the better part of the thermal and tightening the turn in the surges.

One key to maximizing the rate of climb is to *never* be satisfied. Achieving the ultimate rate of climb requires total concentration. I believe it was Justin Wills who said, "If you can make a radio transmission without some loss in the rate of climb, your rate of climb wasn't maximized to begin with". Centering is a neverending process – you are not likely to see a fixed rate of climb all the way around for very long. When the rate of climb is slightly different on part of the circle you need to take action, it won't improve on it's own.

In the interest of safety, when sharing a thermal with other gliders, do not make any erratic moves, the other pilots should be able to anticipate your intentions. For example, changing direction of turn just as another glider approaches to join your thermal could possibly put you at risk of a mid-air. When in a sizable gaggle, you will not be able to implement all of the tactics proposed in this section. If you did, you most certainly would be unpopular. When joining a congested thermal, you don't have much choice but to jump on the carousel, pick a slot and follow the crowd. You simply have to settle for a slower rate of climb. But that's the price you pay for the security of staying with a gaggle.

When low

For safety reasons, low level thermalling should always be performed using well-banked, coordinated turns with an additional 5–10 knots of airspeed.

Many stall and spin accidents are caused by circling close to the ground in gently banked turns near the stalling speed. It is far easier to stall and spin from a gentle turn than from a well-banked one. In level flight or shallow banked turns, the stalling speed is lower and control response gets sluggish when approaching the stall. Should a stall occur, greater control input is required, and recovery cannot be made without a significant loss of altitude. In turns of more than 35 degrees of bank, due to the higher stalling speed the control response remains firm and crisp until the last moment before the stall, and recovery can be made instantaneously without any loss of altitude by simply relaxing the backward pressure on the stick.

The good news is that using well-banked turns and a little extra speed is no disadvantage as at lower levels, thermals tend to be small and broken. Steep turns and more speed for increased maneuverability, are necessary in order to climb well.

Other methods

After all is said and done, thermalling is more of an art than a science. I can only recommend what works for me, but many top pilots advocate techniques which, in some cases are not only different, but entirely contradictory to my approach. Yet, these various methods obviously work for them. Indeed, it is difficult to find two books on the subject of soaring which are in agreement on the subject of thermalling. Here is a sampling of recommendations from other publications, written by some of the best:

- Instead of straightening after 270°, change direction of turn,
- wait 5 seconds before turning,
- tighten the turn in sink,
- straighten out in a surge, then change direction of turn.

These various techniques obviously work for them, but they don't work for everyone. From this, you may think anything works, but that's not the case. On a few occasions I have watched in amazement from the rear seat as a student (having read the wrong book) consistently shift the circles out of every thermal.

There have been a few world champions who do not even believe in tight turns; they merrily go around in 25 degree banked turns, outclimbing everyone else – it seems like pure magic to me.

Ultimately, you will settle on a style which works for you, possibly consisting of a combination of different methods. Occasionally getting outclimbed is an indication that a change in your method may be in order.

Centering by using lift gradients

There is another method of centering which utilizes gradients of lift to seek out the position of the core by the amount of tilt these lift gradients impose on the glider. This method is based on the cross-section of thermals being roughly circular and consisting of lift gradients centered around a core, with the strongest lift at the core and gradually diminishing toward the perimeter. Here is how this works:

- If the lift is minimal and the tilt is pronounced, you are near the perimeter with the core at about 90°. Make a medium turn toward the rising wing.
- If the lift and tilt is moderate, you are somewhere between the core and the perimeter. Turn more aggressively toward the rising wing.
- If the lift is strong and there is no tendency for either wing to come up, your course is straight for the center. Weave slightly to one side and then turn sharply in the other direction.

Due to the size of thermals and the speed at which we approach them, to use this method you must rely on your physical sensations as your reactions would be too slow if using the variometer. Yet, there is a world record holder who doesn't even believe in turning toward the rising wing, claiming that tilt is totally random.

Racing pilots hate all thermals, and spend as little time in them as possible.

Once you have mastered the art of thermalling there are really only four things you need to know to successfully go cross-country:

1. HOW TO FIND THERMALS
2. WHERE TO GO
3. HOW FAST
4. WHEN TO THERMAL

HOW TO FIND THERMALS

As with anything else in the art of soaring, when it comes to finding thermals nothing is for certain. But unquestionably, if you know and seek out the places and conditions where thermals are likely to be found, your rate of success will be much better than if you simply rely on running into thermals by chance.

Finding the first thermal

A ground launch takes you to a fixed release point every time and, unless there happens to be a thermal right there, you will need to go look for one. An aerotow takes you to a thermal. That is the prime advantage of an aerotow over a ground launch (winch or auto tow,) not necessarily the additional altitude.

The advantage of releasing in a thermal is obvious, especially in a low performance glider. In a low performance trainer you will have more time searching for a thermal while on tow than after release. Many pilots have become programmed to tow to 2000 feet on every flight, and would never think of doing anything different. They will get dragged through perfectly good thermals but insist on "getting their money's worth" and stay on tow till they reach 2000. By this time they are generally in sink, and will frequently be on the ground in record time.

Even in a high performance sailplane, it is advantageous to get off in a thermal at a thousand feet rather than hanging on. Releasing before you reach the conventional tow height also gives you more practice at thermalling.

So how do we go about releasing in a thermal? The first step is to get in the right mind set. Change your objective, instead of towing to a fixed altitude, tow to a thermal. The timing is crucial so it is important to be mentally prepared. Decide beforehand the minimum altitude at which you are prepared to release. This could be a thousand feet, or whatever you feel comfortable with. When the towplane enters a thermal it will be evident by a sharp increase in climb rate. It is crucial to maintain a steady tow position, so when the towplane rises above the horizon it really is the towplane going up and not the glider going down. Watch the towplane closely; if it hasn't flown out of the thermal by the time you reach the edge of it, release right then and there.

The timing is critical, this is the reason it's important to have predetermined the altitude you are willing to release at, there is no time to think about it, a couple of seconds hesitation can make the difference between success and failure. Immediately upon release make a well-banked 360° circle to the right and then proceed to center the lift.

Keep tab on the rate of climb during the tow. Entering 'normal air' after having gone through a prolonged stretch of sink, the towplane's rate of climb will increase. If you had not been keeping track of the climb rate, this could lead you to believe a thermal is at hand.

It is normal to be somewhat reluctant at first to release at a lower altitude than you are accustomed to, but keep working on it. Once you get the hang of it, you will need fewer relights, get more satisfaction and more thermalling practice.

Find the relationship of lift to cloud

Exploring the conditions before pushing off is a good idea. A half hour can be well spent in establishing where the lift is with respect to the clouds. It is not always upwind, or on the sunny side, but whatever the relationship is, it will tend to hold true for the rest of the day. This bit of knowledge should minimize the amount of searching and fumbling associated with getting established in each thermal.

The tilt of thermals due to wind is more pronounced at lower levels, and it becomes more vertical as the thermal approaches cloudbase.

Spacing of thermals

Spacing of thermals is proportional to the height of the convection layer. There are few things in gliding which are for certain, but this is one of them. When the convection layer is shallow the thermals will be closely spaced. This is the reason cross-country flights are possible on days with low bases. Conversely, expect a long way between thermals when cloud base is high. Therefore, if you find yourself at 2000 feet on a day when the thermals go to 8000, you may be in trouble.

Strength of thermals

There is a 'rule of thumb' relationship between the depth of the convection layer and the strength of thermals. For example, if cloudbase is 4000 feet agl, you can expect to find a couple of 4 knot thermals, the rest will be roughly two-thirds of that. If the base is at 6000, a few thermals will be 6 knots, the rest 4 knots. When the lift goes to 8000 feet… and so on.

Evaluating clouds

A sharp, well-defined base and a cauliflower, crisp outlined top is what you should be looking for. A large cu is likely to be fed by several cells, the darkest part of the base is an indication of the deepest vertical development, and that is where you are likely to find the strongest lift. A sure sign of strong lift is a domed shape base. A ragged base with a broken, crumbling top is a sure sign of decay.

As I am sure you already have discovered, on a day of cu, all clouds do not have a thermal. On a good day, about one cloud in three works well. When the air is dry a greater percentage of cu's will be active. On a day with high humidity, only about one in four or five will have a thermal feeding it. Amazingly, there are also days when there does not seem to be any connection whatsoever between thermals and clouds.

Do not confuse long vertical tendrils of vapour with a ragged cloudbase, these tendrils are signs of exceptionally strong lift. Tendrils are mostly found when flying along the border of two air masses with different moisture content.

When the sun is low, as at noon in mid-October, the clouds will appear to be better defined when looking toward the sun than they do when looking away from the sun.

When low, evaluating the terrain for likely trigger spots as you do on blue days will be more helpful than cloud reading. It's difficult to judge the degree to which a column of rising air is leaning. Also, a cloud may be as good as it looks, but the lower portion of the thermal has expired, and your search will be futile. This is especially the case on windy days when the thermals get sheared off from their source or trigger point and rise as isolated bubbles.

Just as there are clouds with no thermal attached, there are thermals which have not yet formed a cloud. If, while heading for an attractive cu, you stumble upon a good thermal out in the blue, by all means take it.

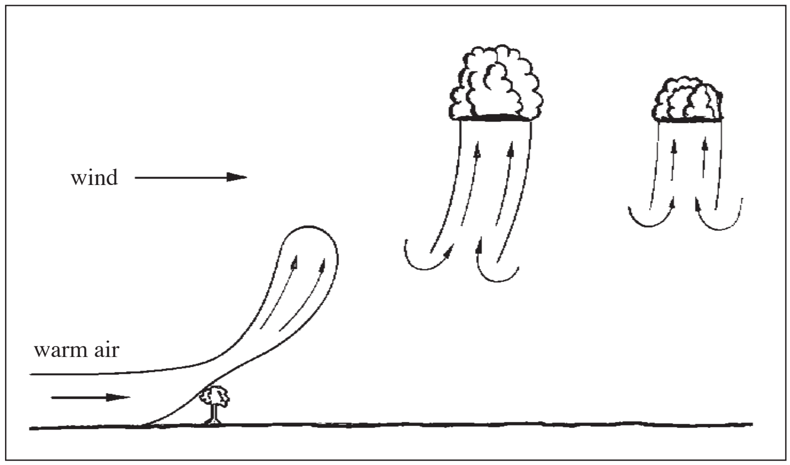
Follow terrain features on blue days
Don't be discouraged by the absence of clouds. Paul Bikle once remarked that the advantage of blue days is that you don't waste a lot of time chasing after dead cu. Reading the terrain not only applies to blue days. If you get low you will do better reading the terrain than the clouds. It is difficult to predict how much a thermal is leaning. Also, the thermal feeding the cu you are aiming for may have left the ground long ago.

You can expect thermals at the higher levels of upward sloping terrain facing the wind. As the air from the lower levels moves up the slope to higher elevations with cooler surrounding air, it becomes unstable. Such areas tend to be fertile ground for thermals.

At times, thermals stop just short of reaching the condensation level but are close enough to form haze domes. These haze domes are excellent markers; always look for them on blue days.

A long ridge with the terrain sloping up on both sides to a crest can be used to great advantage, even in light winds or when the wind is parallel with the ridge. On most days there will be thermals along the spine, often spaced closely enough to permit straight cruising.

Windy days
On windy days, a warm air bubble over a heat source gets displaced by the wind before it has a chance to gain enough buoyancy to break away. It will drift with the wind, gathering more warm air as it moves over the terrain until it reaches a triggering feature which can be just about any discontinuity in the terrain such as a line of trees.



On such days look for features in the terrain that might trigger thermals such as rivers, border of woods, and the end of ridges. The cold air over small lakes can often trigger thermals. The dome of cold air above the water makes an excellent trigger for thermals as they drift with the wind across the terrain. This is especially the case in early summer when the temperature differential is significant. On the diagram on page 15, envision the wind being at 90° to the lake and you have a classic example. This is the reason we often find ourselves thermalling over small lakes. Of course, the thermal is not generated by the lake, but is triggered by the shore and leaning out over the lake.

On days with moderate winds
When the wind is not too strong, domes of warm air are able to remain in place to attain buoyancy and rise up directly from the heat source. The thermals will be either columns of rising air or a series of closely spaced bubbles. This is when you will want to go for the hot spots like ridges facing the sun, dark patches, gravel pits, towns, and ripe wheat fields — wherever you wouldn't want to be walking around on a hot day.

A bubble over a field which hasn't quite reached the buoyancy needed to break free on its own can be released by a tractor driving across the field. It's even possible for you to trigger your own thermal by flying through such a bubble. Well over 50% of the time when launching by car or winch, there will be a thermal right at the top of the launch. This is not likely to be coincidental. No doubt the thermal is triggered by the cable/rope, and glider cutting through a bubble, thus releasing it from the boundary layer.

In the beginning I mentioned that some of the techniques described here have been used for many years. Here is an extract from *The National Geographic Magazine, ca. 1936:*

> *A modern sailplane flight in competition is never over until the ship is actually on the ground, and stubborn pilots, fighting to the last for a breath of breeze that would keep them in the air, discovered something.*
>
> *They found that if a man dived his ship at high speed, 70 mph or so, above a promising source of a thermal current such as a corn field, banked sharply when only 100–200 feet from the ground, and spiral upward in tight climbing turns, a surprising thing sometimes happened. A sudden thermal current caught the ship and carried it up, up, up, to the neighbourhood of the clouds again. The swirling sweep of the 50 ft wingspread, travelling at 70 mph and suddenly twisting upward in a corkscrew fashion, had apparently dislodged a thermal bubble which had been on the verge of rising.*
>
> *When the first report of this came from a pilot in Germany, most American soarers were sceptical. But they tried it and found it often worked. Meteorologists say it is entirely credible.*

I suspect this article was embellished somewhat.

Birds and other sailplanes

A soaring bird circling, or a swarm of swallows chasing insects caught in a thermal is a good indication of a worthwhile thermal. A circling sailplane may not be. There are some pilots who never met a thermal they didn't like, and will go around in just about anything. Avoid needless detours; before joining another sailplane, be certain that it is climbing at a worthwhile rate. If it is, don't hesitate, move over right away.

If you encounter another cell before you reach another glider in a thermal it pays to make a turn in case the one you stumbled into is better. That is the best chance you have to gain on the glider above you.

You can generally find lift when entering a thermal above another glider. Entering below another glider is another matter. There are times when it is in a bubble and you happen to be below it, your sink continues as the other glider climbs away. That sort of thing can get on your nerves.

Another glider as a thermal probe

Sharing a thermal with another glider is like having a remote thermal probe to indicate where the best air is. By closely watching the vertical displacement of the other glider around the circle you will get a perfect picture of the lift distribution. You must be at the same altitude for this to work.

Smelling thermals

There has been claims made that thermals can be located by smell. While it is true that smells do get carried aloft by thermals it has been my experience that by the time my nose picks up the scent the variometer is already telling me what I need to know. Your nose won't lead you to a thermal. Be careful, the aromas drifting skyward do not all derive from freshly baked bread or sizzling bacon. Some fertilizers are potent. Once I encountered a thermal coming off a fertilized field. It didn't take long before my eyes started burning, it got so bad it was almost impossible to keep them open. It took quite some time before my condition improved. I was thankful a landing was not imminent or I would have been in serious trouble.

Approach thermal sources aligned with the wind

The possibility of intercepting a thermal if approaching a potential source at ninety degrees to the wind is not very good as it is difficult to estimate how much a thermal is leaning, especially on days when the wind is rather brisk. The chances of connecting are much better if you approach the thermal in line with the wind. The same technique applies when attempting to connect with a cloud, when some distance below it.

Early evening sources

These days we seldom use the entire soaring day. In competitions we race around for a couple or three of the best hours of the day. When flying for pleasure, most like to be home for cocktail hour. Nonetheless, in the unlikely event you should get caught out as the sun gets low, here are a couple of prospects to keep in mind.

- Wooded sections, having soaked up heat throughout the day, will be releasing it as the surrounding terrain cools down. These evening thermals only seem to be workable at some reasonable altitude – stay high when the end of day approaches.

- In hilly country, as evening comes on, and the wind is light or calm, the air on the high ground cools and slides down the hills into the valleys (katabatic wind), forcing the air in the valleys to rise. This kind of lift is as smooth as wave lift.

Elements of thermalling

- Timing is all important.
- Always turn towards the rising wing (you may not notice this if you fly with a death grip on the stick – relax).
- When encountering a thermal low, do not hesitate, turn immediately.
- If you have enough height, don't turn until the climb rate approaches your expectations for the day.
- On deciding to turn, bank a minimum of 35° *now*. If you seem to have gone the wrong way, straighten out for a few seconds after 270°.
- Establish a mental picture of the lift distribution.
- Do not change your direction of turn.
- Shift position aggressively if there is sink on one side. *Never* fly through the same sink twice.
- If there is some lift all around, shift in small increments.
- When lift is increasing, reduce the bank angle to move your circle in that direction in small increments.
- Do not overcontrol. Control movements must be timely but they increase drag.
- Take advantage of surges. Tighten the turn on the surge then decrease again when the lift drops off.
- If you lose the thermal make a wide 360°, then tighten the turn when you re-enter. Limit the search to one turn.
- Steeper turns are needed, and are safer, when low.
- When low, do not leave what you have for the hope of something better.
- When sharing a thermal, do not make any erratic moves, and keep track of everyone.
- Concentrate and never be satisfied.

WHERE TO GO

Resist temptation to turn back

In the event you encounter a prolonged stretch of sink immediately after heading out on your first few cross-country attempts, you may be tempted to make a 180° and go back home. This is generally a mistake as you will then be flying through the same area of sink you just went through on the way out, and may find yourself with marginal altitude to reach the airport.

If encountering a long stretch of sink, turn 90°

If you are in sink and it persists, the chances are that you are on a street, unfortunately the wrong kind. Your best bet in this situation is to change course by 90°. Stay on that heading until the sink subsides, then get back on course.

Cycling

Generally, the cycle time for thermals on an average soaring day, in the eastern part of the country at least, is twenty minutes or so. As heat is in short supply in the beginning of the day, the first cu only last for a few minutes. As the day matures the cycle times gets longer.

Although small wisps of cu with a lifetime of a few minutes mostly occur during the early hours of a soaring day, there are times when that's all we get throughout the day. Even though you may not be able to reach them before they evaporate, it can be worthwhile heading their way as they will probably recycle, and the time between cycles are short.

Keep in mind that thermals will tend to trigger from the same source throughout any given day.

Higher terrain

In hilly or mountainous regions stay over the higher terrain. That is where small wisps of cu will first appear and where the soaring conditions will be notably better throughout the day.

Watch conditions ahead while circling

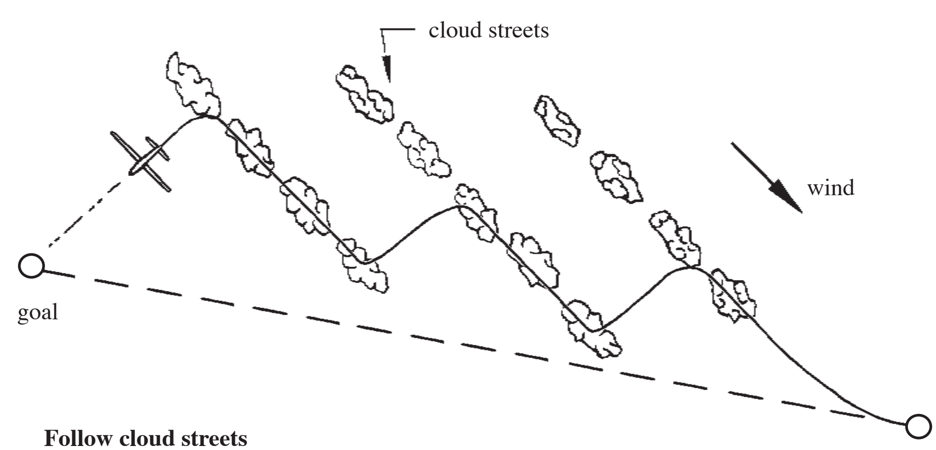
You should know where to go *before* reaching the top of your climb. Since we need to limit the number of thermals we use, try to select the next climb some distance out, ideally with some cu along the way that you can string together. Guard against selecting a good looking cu which may have reached its peak of development; it may be all spent by the time you get there. To prevent falling into this trap you need to have some idea of the cycle time, how long the cu has been there and how long it will take to reach it. A better bet may be to choose a cu in the early stage of growth. If you see a promising wisp, check on it every 360°, this will give the effect of time lapse photography, revealing whether it's developing or dissipating. Have a backup or two in case your first choice doesn't work out. As in chess, always think two or three moves ahead.

degrees of zig-zag	dist. increase over 20 mi.
15	0.75
20	1.2
25	2.0
30	3.0

Follow paths of lift

Judging cloud distance

Judging the distance to the next cloud can best be done by looking at the cloud's shadow on the ground. It is virtually impossible to get any sense of distance by looking directly at a cloud. Also, when close to cloud-base, the best indication of how the cu line up and the direction of cloud streets is to look at the shadows.



Follow cloud streets

Follow cloud streets

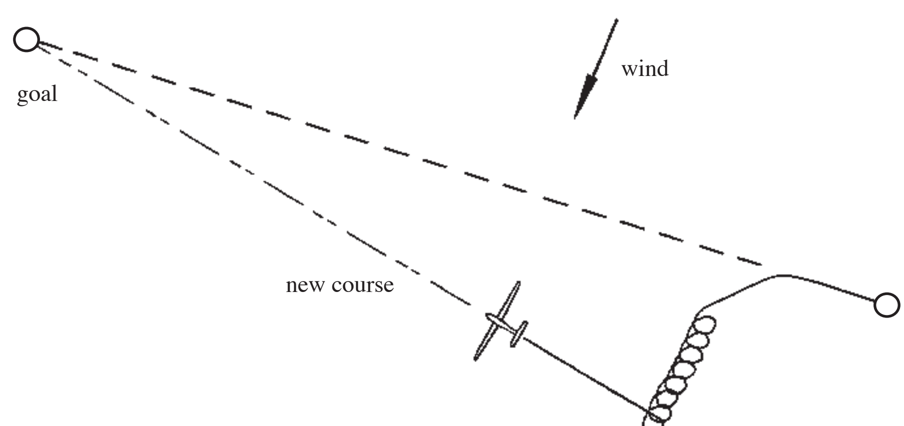
It usually pays to follow streets even if they are as much as 30° off track. Cross over to the next street at 90° to spend the least amount of time in the sinking air between the streets. The rate of sink between well-developed streets is likely to be much greater than what we normally encounter between cu. When flying beneath a street while going downwind, don't expect the last cu in the street to be of much help.

Follow paths of lift

Following paths of lift will significantly improve performance in spite of such detours not always delivering what they promise. Supposing you go out of your way to follow some scattered wisps resulting in a zig-zag course of 15°, and the result was disappointing, only reducing the sink rate by half. Nonetheless, it was well worthwhile. Think of it this way; your glide ratio got doubled, and the extra distance flown over a 20 mile stretch would be a mere three-quarters of a mile. Even greater detours do not add as much distance as you may think.

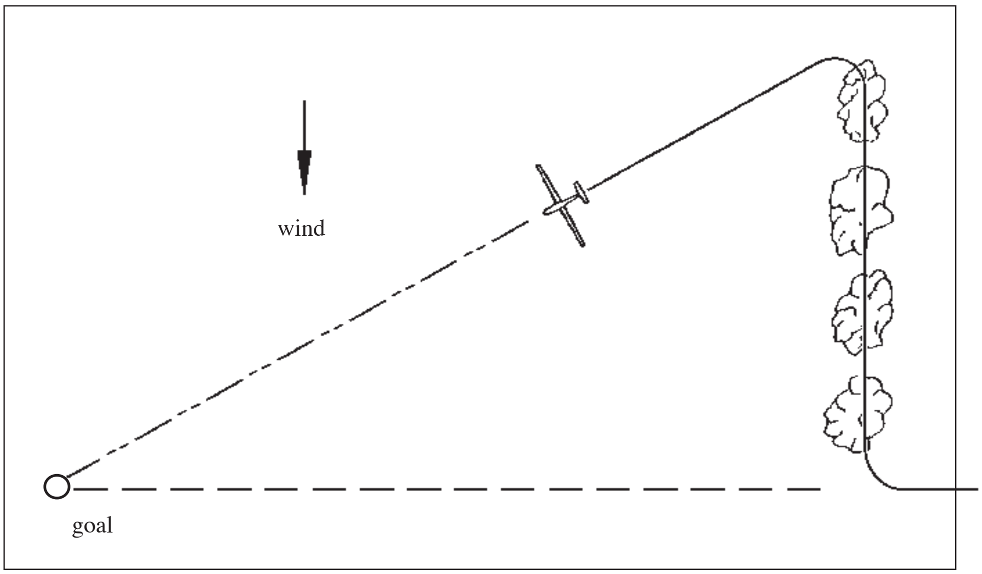
Stay upwind of the courseline

On a windy day, strive to stay upwind of the course line at all times. Heading downwind should only be done in desperate situations, e.g. to remain airborne. Of course this becomes less significant on days with light winds. But on a day when the wind is 20 knots, getting back on course after a slow climb originating downwind



Stay upwind of course

can be difficult, exasperating, and time consuming. If you have drifted significantly off course, the prudent thing to do is to draw a new courseline (your GPS will do it automatically) from your position to the goal and abandon the original. Remember, your compass heading will now be different. Beware, you may experience an urge to get back on the original track.



Using cloud streets 90° off course

Occasionally a cloud street as much as 90° off the intended track can be helpful. You are about to cross a sizable hole, and the crossing looks marginal because of a strong crosswind. Supposing there is a good, solid looking street going upwind at the edge of the hole. If it is good enough to enable straight cruising at cloud base, it can be worthwhile to follow it upwind for a few miles. You can then set off across the blue with a quartering tailwind with a much better chance of reaching the other side. This technique also comes in handy when you are on a ridge running mission, and the thermals don't go high enough to get you across a gap. If the wind is blowing hard enough to make the ridge work, the thermals are likely to be streeting. So when topping off a thermal just short of the gap, fly directly into the wind. With a little bit of luck you will be able to use a line of thermals to penetrate far enough upwind to get across.

Line up with streets before you reach them

If there is a cloud street ahead, the likelihood of flying in better air is increased if you line up with the street long before you actually reach the clouds.

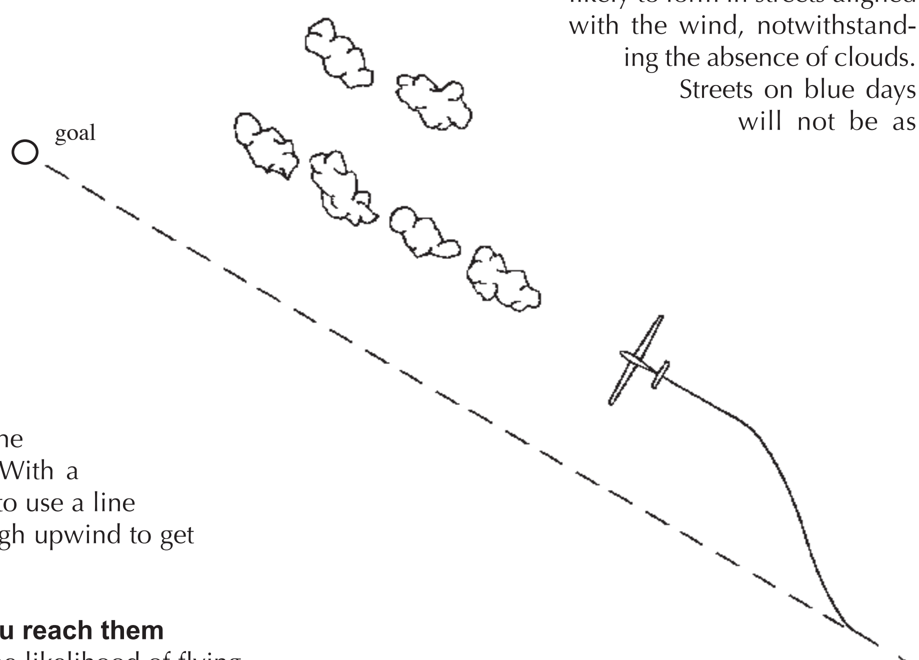
Formation of streets

Thermals will tend to organize into streets whenever the wind velocity is 12 knots or more, and there is no radical change in wind direction up through the convection layer. The streets are commonly spaced at roughly three times the depth of the convection layer. Also, it helps considerably if the sun is at 90° to the wind. The cloud shadows between the streets will reinforce the streets by blocking thermal formation between them. If the sun is in line with the wind the cloud shadows will fall directly below the street hampering its development. In fact, this may prevent formation of streets altogether.

On most days, if there is any wind at all, some form of streeting will take place, although there may be no visible evidence. Hence, the next thermal is probably closer either upwind or downwind.

Streets on blue days

As is the case on days with cu, if the wind is 12 knots or more and there is no significant change in wind direction up through the convection layer, the thermals are likely to form in streets aligned with the wind, notwithstanding the absence of clouds. Streets on blue days will not be as



well defined as they are on days with cumulus clouds, as they are not being reinforced by cloud shadows.

Ridges as last minute saves

A ridge can often be used to prevent a premature land-ing. If there are ridges in your area, always plan ahead so that you can reach a workable ridge if all else fails. Preferably one with a suitable field at the base. Then you simply stay on the ridge until a thermal comes by.

When a hawk hunts on a ridge, it will tend to hover directly into the wind, making it an excellent weather vane and a good indicator of the angle of the wind to the ridge.

A thermal will ruffle the tree tops in a rotary motion as it drifts across a ridge. When you are ridge soaring, waiting for a thermal, this kind of vortex in the tree tops is a helpful sign.

Thermals are often triggered at gaps, and at the end of ridges. A funnel shaped, upward sloping ravine, perpendicular to a ridge facing the wind, is almost certain to produce thermals.

When getting a thermal off a ridge, and the combination of wind and rate of climb is such that you are drifting downwind faster than you are climbing, making it difficult to get away, look for the next thermal well upwind of the ridge. If the wind is strong enough to make the ridges work, the thermals will probably be streeting. Head directly into the wind from the thermal you just left. Go as far out from the ridge as you feel comfortable with before taking a thermal, and you will

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PLACES TO AVOID

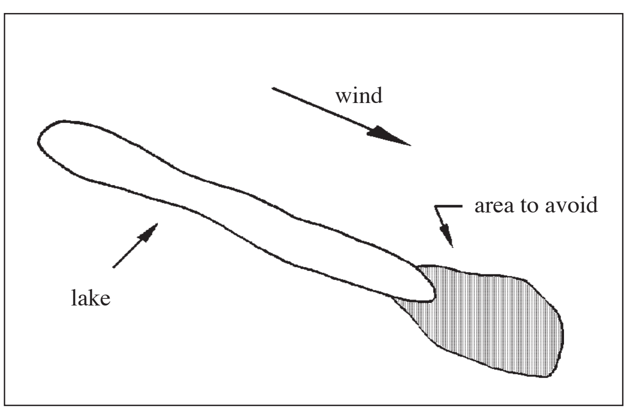
Wet ground

It pays to avoid wet terrain. It's helpful to have some idea where it rained, or what areas had the heaviest rainfall the night before. If it's not possible to avoid such areas, proceed with caution. River valleys are usually troublesome, avoid them if possible. If you must cross a riverb valley, expect soft soaring conditions.

Nothing is certain; in March half of Florida is submerged yet the soaring conditions are often quite good.

Downwind of lakes

Given the right conditions, even small lakes can generate clamps. If the lake is elongated, 10 miles or more in length, and the wind direction is along the lake, you may find a significant area of stable air downwind.



Rain showers

On some occasions, a rain shower may save the day. When an overgrown cumulus has reached the stage at which it's producing rain there will often be a row of thermals just ahead of it marked by small wisps of cu. You may also find lift in the rain, actually more often than you might think, but mostly the air will be descending and sometimes at a high rate of speed. As if that isn't bad enough, the performance of most sailplanes degrades significantly when wet.

Most often it pays to avoid rain. If that's not possible, plan on losing a lot of altitude in a short period of time.

Expect dead air just behind a shower. Behind a cumulonimbus, the entire area will be flooded by cold air, totally void of any convection and may remain so for several hours.

Downwind sloping terrain

Here is a trap you need to watch out for. Don't get caught downwind of down-sloping terrain. The air is displaced from the higher, colder surroundings down to warmer levels, thus stabilizing the air mass, inhibiting convection.

Uphill sloping terrain with the wind on it is fertile ground for thermals, it becomes a desert when the wind blows the other way.

Snow showers

Treat snow showers with a lot of respect. An innocent light snow shower from an average size cumulus cloud can develop into a monster snow squall with zero visibility in an astoundingly brief period of time.

Once I car-towed into light snow flurries, at the top of the launch I lost sight of the field.

HOW FAST?

As you leave each thermal, the objective is to get to the top of the next as quickly as possible. Of the four things you need to know, 'How fast' is the least important. 'Where to go' and 'When to thermal' have a much greater impact on the average cross-country speed than how fast you fly between thermals.

The MacCready ring

Back in the early 1950s, Paul MacCready derived the optimum speed to fly between thermals. That speed is based on three things:

1. Performance of the glider.
2. Rate of sink between thermals.
3. Rate of climb in the next thermal.

To establish and display this optimum speed he devised a speed-to-fly ring, consisting of a rotary ring fitted around the variometer face, calibrated for the specific glider's performance. You set the ring to the expected rate of climb of the next thermal and the variometer needle will point to the optimum cruise speed. These circular slide rules have now been replaced by computers, but we still need to enter the rate of climb expected in the next thermal.

Average rate of climb

Don't be mislead by the variometer. The *achieved* average rate of climb, which is what we are concerned with, is the altitude gained divided by the total time in the thermal, including the time spent centering and fumbling, plus whatever procrastinating we do at the top before leaving. Taking all that into account the net effect is that the actual average rate of climb is about half of the variometer reading during the better part of the climb. Consequently, the correct MacCready setting is half the variometer reading.

MacCready setting and inter-thermal speeds

The expected average rate of climb in the next thermal, which becomes the minimum acceptable rate of climb, is referred to as the "MacCready setting". The correct MacCready setting enables the computer to tell you what the optimum cruise speed is between thermals, whether going through sink or lift.

It became customary to select the MacCready setting based on the previous thermal, on the assumption that all thermals are the same on any given day. This works well enough in west Texas where all thermals are alike. However, on most days in the eastern part of the country do not expect the next thermal to resemble the one you just left. You will likely do much better by estimating the rate of climb in the next thermal to establish the MacCready setting. Keep in mind, the thermal you just left is history, it is only the strength of the next thermal that matters.

A simpler and very effective method to determine the MacCready setting is to simply *set it at the rate of climb you are willing to stop for*. This will always be changing depending on how low you are, etc. If in doubt, it is better to err on a lower setting.

When in the thermal from which you anticipate starting the final glide, it does pay to match the MacCready setting with the rate of climb as the computer will then indicate the optimum altitude at which to start your final glide.

The problems with MacCready

Attempting to fly at MacCready speeds has it's problems. In the first place, unless you have the uncanny ability to predict what the air is doing ahead of you, your timing will be off. On a good eastern day with climbs of 3 knots (that's achieved rate of climb, not variometer reading), following the MacCready speed director as you penetrate the sink surrounding a thermal you will be doing 90 knots by the time you reach it. Entering the thermal, you zoom up to reduce speed. Having reduced the speed in accordance with MacCready, but being a little behind the curve, you will be down to thermalling speed just as you get to the other side of the thermal and before you have decided whether to use it or not. If you elect not to use the thermal, you will be regaining cruising speed while in heavy sink, which will not do much to enhance your performance. Also, the 'G' loads in these zoom-ups conceals the little bumps associated with thermals, making it very difficult to sort things out and figure out what is going on.

Another disadvantage is that attempting to fly at MacCready speeds requires a great deal of concentration which will draw your attention away from the myriad of other things you need to keep track of such as clouds, streeting, wind, terrain, trends in conditions, other traffic, etc. In the eastern part of the country, where the lift varies from thermal to thermal, the MacCready value must be reset constantly.

An alternative to MacCready

On further investigation it turns out you will do equally well by not varying the speed all that much. (The difference in performance between the different models produced over the past 20 years, 15 Metre or Standard, are not enough to worry about when it comes to cruising speeds.) On that same good eastern day, flying a 15 metre glider you will not go far wrong by maintaining 75 knots, ±5 knots will not make a whole lot of difference. Favouring the slow side has the advantage of increasing the range, thus giving you a wider selection of thermals to chose from. This, of course, is only advantageous if it leads to using stronger thermals. In better weather favour the high side.

The advantage of varying the speed in accordance with the ups and downs are negligible. Even going through heavy sink, 80 knots is about optimum, going much faster will likely reduce your range. An exception to this is when flying in conditions the southwest have become famous for; then the optimum cruise speed may be 90 knots, whether you are in sink or not.

Of course, there are situations where it makes sense to deviate from these guidelines. If you are heading for a good sized, very well defined cu it may pay to speed things up, especially if there is a glider beneath it already, climbing like a rocket.

Whenever the vario indicates positive lift slow down to 65 knots, but not any slower until you decide to circle. If you elect not to stop, just ease the stick forward a bit and you will be back to cruising speed. Only when flying along a line of lift will it pay to get down to 60 knots.

There has been much said about dolphin flying, but that requires strong conditions with closely spaced, well defined, reliable clouds. The kind of conditions we are rarely privileged to see in the east.

I suspect that a good number of our top pilots use the MacCready method, others use it only partially, and some have adopted the 'Alternative to MacCready' method. Yet, they all perform equally well. No doubt, you will eventually settle on a method which works best for you.

Be prepared to change gears
Even it you chose not to adhere to MacCready, your mean cruising speed needs to be in accordance with the conditions. In the previous example, the speeds were for a day with 3 knot thermals. Add a few more knots on stronger days and step it down when thermals are weaker. It is rarely pays to fly below 70 knots.

Conditions may vary throughout the day, or conditions can be different in some areas along the task. There are days when we fly through two, or even three different air masses. It's essential to be on the lookout for changing conditions, and be ready to shift gears. If for instance, the clouds ahead appear to be cycling, it may be prudent to slow down a little. Several cu in a row with no lift could be an indication of cycling. Any sign of overdevelopment is a good reason to be cautious. In extreme cases you may have to hold up and wait for an overdeveloped area to recycle. Conversely, you may have been in survival mode for a while, but you must be prepared to start pushing again as soon as conditions improve. When crossing a sizable hole of dead air, slowing down to the speed for best L/D is an option to be seriously considered.

Reference: Soaring Symposia. "The price you pay for MacCready Speeds " Wil Schuemann.

WHEN TO THERMAL

Minimize circling
The most effective way to improve your average cross-country speed is to minimize circling. Whenever you are circling you are going nowhere. Consequently, you want to be sure that whatever circling you do is worthwhile. Every time we stop for a thermal there will be time spent centering. For this reason it pays to take as few thermals as possible.

Acceptable rate of climb also depends on altitude
Aside from the MacCready setting, your present altitude will also influence your choice of thermals. The closer you are to cloudbase, the more selective you should be. Assume that shortly after pushing off at cloudbase after a 5 knot rate of climb you encounter another thermal of the same strength after losing only 500 feet. You may consider an "S" turn, but anything else would be a waste of time, the most you could hope to gain is a mere 500 feet, while risking losing a few hundred if you turn the wrong way. A thousand feet lower down it may be advantageous to stop for another 5 knot climb but you are too high for a 3 knot thermal, and so forth. Eventually you may get as low as you want to get, in which case you will be willing to stop for anything.

Another situation to guard against is the tendency to hang on to a mediocre thermal from a low save after reaching an altitude at which you would have passed up a thermal of that strength had you encountered it while cruising. Move on until you find a stronger thermal. On the other hand, if you have sampled several thermals, and not found what you are looking for, it may be prudent to take a weaker one to the top.

Operating band

Theoretically, the operating band is considered to be the upper two-thirds of the convection layer. If the maximum altitude is 6000 feet, the operating band should be 2000–6000 feet. So much for theory; in real life the general practice is to stay within the upper half. Another factor to consider when establishing your height band is the level of experience. When first starting out, stay on the high side.

Here are some of the reasons it pays to stay in the upper zone of the convection layer:

- Clouds can better be used when you are reasonably close to them, individual cells are much easier to pinpoint. But don't get too close, visibility is not too good at cloudbase, making cloud reading difficult.

- Using clouds becomes impractical when you get low. A cu may look and be active, but the thermal may have expired at the lower level. Furthermore, thermals lean with the wind, and it is not easy to judge the degree of leaning. Incidentally, the leaning is more pronounced closer to the ground, as the column approaches cloudbase it becomes nearly vertical.

- Thermals are weaker and not as organized at lower levels. On some days this band below which the climbs are slower and more difficult can be at an altitude of several thousand feet. Once you discover what height it is, strive to remain above it.

- When the wind gets up around 25 knots, thermals will be blown apart close to the ground. On these days it can be very time consuming to get back up.

- A notable shear can be troublesome, as well. The thermals may not necessary be all that bad below the shear line, the problem is that it may be a real challenge to penetrate through it. Once you determine what that level is, it pays to stay above it.

- The depth of convection is a consideration. If the thermals do not go much higher than 2500 feet, you will probably want to stay in the upper one third.

- As you get lower you cannot be as choosy in thermal selection.

- At 1200 feet, rule number one is: Don't leave what you have for something better. You may even be losing slightly at first, but nine times out of ten, if you stay with it, the rate of climb will gradually improve, probably due to the combination of a new bubble breaking free, and your centering efforts. Anyway, at that altitude your chances of finding another thermal is slim unless you happened to notice a bird or a sailplane cranked into a tight circle and climbing smartly. If the thermal is drifting into a shady area the thermal is unlikely to improve. If no other opportunities are in sight, your best bet is to head into a sunny area or where the sun was a short time ago.

- Unless you have a considerable amount of experience, regard the flight as having ended when you get down to 800 feet, and concentrate on the pattern and landing.

When you do get low keep things in perspective, it's important to think positively. There is no need to get panicky at 2000. Remember, that's your normal release altitude, and how often are you not able to stay up from a 2000 foot tow? Pretend you just got off tow. Nor is there need to consider the flight over and done with when you reach 1200 feet. Think of how many times you have got back up from that altitude when flying locally. For 18 years I used only car tows, except at contests. Whenever I got down to a thousand feet or so, I regarded the situation as being at the top of a launch with the world of opportunities before me.

When to turn on entering a thermal

When you are low, and can no longer afford to be choosy, the best bet is to turn right away. Any hesitation and there is a good chance you may miss the thermal altogether. If you turn immediately your circle will at least be in part of the thermal, then commence centering by shifting your circle in small increments so as not to risk losing it.

Remember, thermals are smaller near the ground, so you will do much better with well-banked turns, about 45°. Steep turns are also safer, as stall recovery can be accomplished quickly and with very little loss of altitude. But to be safe, carry a little extra airspeed. Don't ever perform slow, shallow-banked turns close to the ground. That is definitely risky business.

At higher altitudes there are a couple of situations when you should hold off for a few seconds. Of course you don't want to turn before reaching your predetermined minimum rate of climb you are willing to stop for. An exceptionally large cu with a broad, alluring, dark base, may give you good reason to believe the lift to be a good deal better than average for the day. In that circumstance, hold off until the rate of climb meets your expectation. When encountering lift that is fairly strong, but not quite good enough to circle in, or you are too high, a figure eight is often a good compromise.

Large clouds are sometimes fed by a single cell and some exploring may be necessary to find it. A word of warning: be careful not to be overly persistent in your search, even though the cloud looks great, whatever you expected to find may have expired. The sooner you face reality and move on, the better. If you make more than one searching circle it's easy to fall into the trap where you thinking goes something like this, "If I leave now I will have wasted the time I've spent, it must be over here somewhere, I'll just make one more circle, and so on – cut your losses and leave.

Some large cu are sustained by several cells. If you suspect there's better to be had than the one you are in, it might be worthwhile to look around. Whenever you find what you are looking for, or it's as good as you can expect; don't hesitate, turn immediately and establish an angle of bank of no less than 35°.

If your glider is equipped with flaps, the question is when should you shift them into thermal position? Should you lower them while slowing down as you approach the thermal or wait till you start the turn. There are different opinions on this subject, but I leave the flaps in the cruise position until starting a turn. If I don't stop for the thermal, I leave the flaps alone.

Entering an occupied thermal

When entering a thermal with other gliders in it, rule number one is, always circle in the same direction. The first glider in a thermal establishes the direction of turn. If you approach a thermal with another glider in it, but he is a thousand feet higher, does it really matter which way you turn? It sure does. The problem is if you circle in the opposite direction, what does the pilot do who later joins up somewhere in the middle? If more gliders arrive there is going to be mass confusion.

Never pull up in the center. This has resulted in several collisions where a glider entering a thermal pulls up into another glider.This may be the most efficient entry, but it's dangerous. Be sure to avoid pulling up directly below another glider. It is impossible to predict the gain in altitude due to the combination of slowing from cruising to thermalling speed and entering the lift. When in a thermal, it is extremely unnerving to watch a glider entering below you at high speed, then proceed to pull up from behind and below where you cannot see him. The only thing you can do is brace yourself for the impact. Pulling up in front of another glider is a recipe for disaster.

The correct procedure for joining an occupied thermal, whether the other gliders are at your level or not, is to enter tangentially, outside the thermal. Then move in, after having slowed to thermalling speed. The gliders already established in the lift must not be inconvenienced, they should not have to alter their flight path in order to accommodate you.

When to leave a thermal

It is time to push on when the rate of climb drops to two-thirds of the mean. This usually happens a few hundred feet below the top of convection. There are of course times when it makes sense to climb to the top, as when faced with a hole or when approaching deteriorating conditions.

How to leave a thermal

The most efficient way to leave a thermal is to tighten the turn when on the opposite side of the circle to the direction you are going, cutting straight through the center on the way out, picking up speed in the process. You must not use this technique if there is someone else at your level, it would be very unsafe. In any case, cruising speed should be established before entering the sink. Entering the sink, typically surrounding thermals, at minimum speed is expensive in terms of altitude lost.

If you are faced with a sizable hole and you need all the advantage you can get, there is another trick you can use to extract the maximum amount of energy from the thermal. It requires a strong thermal which doesn't weaken at cloudbase. Make an additional circle at cloudbase (500 feet below), converting lift to extra speed before setting course. Remember, no erratic moves if there is someone else with you.

Base decisions on what lies ahead

Situational awareness is crucial at all times. Remember, what you do at any given time depends on what the conditions look like on course. Always be ahead of the glider — don't let the glider take you where your brain hasn't been five minutes before.

When low

In the interest of safety, when you get down to the 1500 feet level the most important thing you can do is to turn the radio off. Being low on a cross-country flight is likely the most demanding situations you will ever encounter in your flying career. Aside from trying to stay up, you must also select a suitable field, with the many tasks that entails. You will definitely not be in need of other things to occupy your mind. The radio will not help you stay up, nor will it help you land. It will only distract your attention from the task at hand, at a time when you can least afford it.

On rare occasions I get a chance to fly with my best friend who happens to be a high ranking competition pilot. Whenever he doesn't respond to one of my radio transmissions my heart skips a few beats in joyous anticipation – he always turns off his radio when in trouble.

FINAL GLIDE

First, you need to decide on your arrival height – 1000 feet is reasonable. Many pilots use 800, and the brave-hearted plan their arrival at 500 feet. When first starting out, plan to get back at whatever height you feel comfortable with. If using a GPS, set the altitude window to read, 'altitude needed to reach destination' rather than 'altitude above sea level,' this makes life a lot simpler.

Preparing for the final glide is one instance where MacCready definitely comes in handy. Set the MacCready value to the rate of climb of the last thermal and the computer will tell you the optimum height to leave for home. In some cases it is prudent to add some margin, depending on how long the final glide is and how the sky looks. On a long final there is a greater chance for things to go wrong than on a short final.

On a long final, say 30 miles, an additional 1000 feet makes sense, especially if the day is still active. Also, keep in mind that if there is a tailwind component your glide ratio will degrade somewhat as you get down in the lower layer where the wind speed decreases. Conversely, if there are clouds, and better yet, streets going in the right direction, no margin is necessary. In fact, many contest pilots blessed with this situation will start their final glide a thousand feet below glide slope, counting on gaining enough altitude along the way to make up the difference.

When on a shorter final glide of ten miles, whatever arrival altitude you have chosen ought to work out just fine. Gaining any further margin would simply prolong the flight.

In short, when deciding on the altitude for the final glide you need to take all the factors into account such as distance, conditions, and wind velocity changes with altitude.

Allow for higher terrain enroute, the computer does not take that into account.

Then there is the dreaded 'finger-nail-biting' final glide. In spite of all our planning, things will every so often go wrong, and we find ourselves on final much lower than we want to be. This not only happens during contests when points are at stake, but just as often when flying just for fun. We all know the proper thing to do is to select a field while there is plenty of time and altitude. Nonetheless, if the gauges indicate we should make it back with two hundred feet to spare, it can be very tempting to give it a try.

A finely tuned final glide at the end of the day is tricky business. On a marginal final, another couple of hundred feet significantly eases your mind so it's very tempting to try a turn if you hit a little bump. Be careful, more than 50% of the time it doesn't pay off; if there is really nothing there, or you turn the wrong way, you can easily lose 200 feet. This is further aggravated if there is a headwind; now you haven't just lost 200 feet, but distance as well. To justify a turn, the lift has to be fairly solid; often pays to simply slow down, or just make an 'S' turn through the lift.

When getting closer to home — and the ground — you will be faced with one of the most treacherous situations in gliding. When a few hundred feet above the ground, and the outcome is uncertain it is crucial to have a plan, you need to know exactly where and how to get the glider safely on the ground, at all times. This is an undertaking many good pilots have not handled successfully.

LOW FINISHES

This is one of the most controversial subjects in gliding. There are those for whom crossing the finish line at high speed, followed by a victorious pull-up is one of the most exhilarating experiences in our sport. Then there are others who consider this maneuver extremely hazardous, and should never be performed. Perhaps it is because of the controversy that this subject have been shunned in all text books. Regardless, there will be pilots who will not be able to resist temptation, so I believe it's appropriate to cover this subject, and perhaps we can reduce the number of accidents.

- Preparation needs to start several miles out. If carrying water ballast, open the dump valve, you don't want to fiddle with that later.
- Be sure you have plenty of altitude.
- Give the safety belts an extra tuck.
- Be aware of any potential traffic around you.
- Have a firm grip on the stick.
- Beware of getting fixated on the finish line. Thoroughly scan the entire area around the airport. Note any traffic and anticipate where it will be when you get there.

- Plan what your flight path will be after crossing the line. You don't want to arrive at the top of the pull-up wondering what to do next.
- If there are any other finisher behind you, tell them what your intentions are.
- The absolute minimum air speed to cross the line at is 110 knots.
- If there is any doubt about reaching the minimum prescribed speed, slow down, pull out the spoilers and land straight ahead.
- Be careful not to get too slow at the top of the pull-up. The airspeed drops rapidly when the nose is pointed upwards.

There are three conditions in which you should never to do a high speed finish:

1. In a brisk tailwind. Pulling up through a wind gradient going downwind will deplete the airspeed at an alarming rate, and very little altitude will be gained during the pull-up.
2. High winds and turbulence.
3. Rain.

The most common causes of accidents:

- Lack of planning.
- Failing to abort a high speed finish and land straight ahead when too slow.
- Pull-up through a wind gradient, going downwind.
- Loss of control due to high winds and turbulence.
- Attempting a full pattern when too low.
- Spin-in due to inadequate spin training or currency.

EFFECTS OF WIND

Keep track of wind direction and strength
A change in wind direction may influence the relationship of lift to clouds. Also, should you get to the point where you need to evaluate fields you ought to know the direction you will want to land in. If you need to search for a ridge for a last minute save, knowing if there is enough wind to make the ridges work, and the direction of the wind is obviously essential.

Impact on strategy
Rather than the air moving over the terrain, it may help to think of it in terms of the terrain being on a conveyor belt moving beneath you. Unless you are striving to reach some point on the ground, your flying is strictly relative to the air. Whatever speed is optimum for the conditions will be the same whether going downwind or upwind. The only difference is that any inefficiency will be more noticeable going into wind.

Approaching turnpoints
There is one situation when the wind direction should influence your strategy and that is when approaching a turnpoint. The objective is to do as much of the thermalling as possible while drifting on course. Consequently, when approaching a turnpoint upwind it pays to go into the turn relatively low, but don't over do it. If going in to a turnpoint downwind, get as high as possible just before rounding the turn.

Final glide
One situation in which the optimum speed to fly will be influenced by wind direction and strength is when the immediate destination is a point on the ground, as when on final glide. To cover the greatest distance, slow down when going downwind, and additional speed will get you further when going into the wind.

Task planning
Even on days with light winds there is nearly always some streeting taking place along the wind line. Although streeting may not be discernable and much disorganized, it can have a positive effect on performance. On task legs in line with the wind, attempts to string cu together will require less course deviation, the air between cu seems to be better, and it will be easier to connect when approaching cu upwind or downwind.

When planning a task, align as many legs along the wind line as possible.

Ridge flying
There are excellent publications on this subject, so I will leave that to the experts, except for the following situation which I have not seen covered elsewhere.

When the wind is on the ridge by a mere 10 or 20 degrees it will be deflected by the ridge and flow parallel with it just below the crest, but it may be flowing over the ridge at the very top. If this is the case, sustaining altitude may be possible as long as you stay above the crest, but once you get slightly below the top the game is over.

HOW TO GET STARTED

Two-seater training

Making the first cross-country flight in a two-seater with coaching from the rear seat by a qualified instructor is an excellent way to enter the world of cross-country soaring.

On their first cross-country flight most people have three shortcomings that will require some effort to overcome:

1. Not turning steeply enough when thermalling.
2. Flying too slowly between thermals.
3. Not being selective, stopping for every thermal.

The more local flying you have done and the more ingrained these habits have become, the more difficulty you will have in overcoming them. It's also possible that your thermalling skills will need some polishing.

Weather

Basically, if you can stay up, you can go cross-country. Nevertheless, select a reasonably good day for your first solo cross-country flight. A day with 3 knot ther-mals and scattered cumulus at 5000 feet or so, will do just fine. If you are going to wait for the perfect day with an 8000 foot cloudbase you will probably never go. Remember, I am talking about the eastern part of the country. By all means check the weather report. There are several excellent sources on the internet, including Dr. Jack. I want to point out, in case you haven't already noticed, meteorology is not an exact science. At contests, where we have the best soaring weather forecasters to be found, many predicted glorious days do not come to pass. Conversely, I have seen many days with a totally hopeless forecast, and a dismal looking morning, blossom into a glorious afternoon. If you stay home whenever predictions are not favourable you risk losing out on some fine soaring.

My Diamond distance flights took place on days I should have stayed home, had I believed the forecast.

There are also days when our old standby indicators for a good soaring day do not hold true, such as: the height of cloudbase being proportional to the spread between dewpoint and temperature (predicted high temperature, minus dewpoint, divided by 4.3, multiplied by 1000;) and cool nights followed by high daytime temperatures. Even the most positive indicator of good soaring weather, the passage of a well-defined cold front, can let you down.

It is a good habit to check the forecast, but remember it is only a prediction. The only sure way to find out what the weather has in store is to take a tow. Besides, weak and difficult conditions are wonderful opportunities for some real meaningful practice.

LEAD AND FOLLOW

Following an experienced cross-country pilot around a task is a fabulous learning experience. It does not need to be an official course, but thorough preflight planning is desirable. The procedure to be followed should be clearly understood beforehand. One leader should not take on more than three followers.

Objective

To give you the opportunity to fly a task in the company of an experienced cross-country pilot, gaining practical experience in cross-country technique while flying your own sailplane. Learn how to do successful cross-country flying in spite of perhaps less than ideal weather conditions.

Advantages over two-seater training

- Although following a leader, some decisions will be yours, e.g. landing out.
- More so than in a two-seater, you will have a sense of responsibility for the success or failure of the flight, which will greatly enhance the sense of achievement and build confidence.
- Practical demonstration of your glider's performance, thus building confidence.
- Demonstrating what *you* can do with *your* glider will significantly expand your horizons and your enjoyment of the sport.

On course

- The group must start together, with the leader on the bottom.
- When the group enter a thermal, the leader should spiral down with brakes open to the lowest follower. This procedure should be followed throughout the flight.
- If there is a difference in altitude when it's time to press on, the lead glider should be at the bottom.
- It is very likely the leader will fly through thermals which you normally would not pass up. You must resist the temptation to circle. Even one turn will

place you far enough behind to make it impossible to catch up. To get the full benefit of this exercise, it is imperative the followers stay close to the leader. Consider yourself attached to the leader by a long tow rope.

- It is important for the group to stay together, but never fly close behind and just above another glider. Keep in mind, if the glider ahead pulls up in lift, it will also move back relative to your position, resulting in a high risk of collision.
- Flying behind and off to one side of another glider is strategically ideal. It gives you a chance to connect with a thermal he might miss, and if he finds a thermal you can join him. In a contest it is an especially neat place to be if the other pilot doesn't know you are there. But from a safety standpoint it is definitely not advisable. If he finds a thermal and makes a sharp turn toward the side you are on you will immediately be facing one another head on. Don't ever be in that position unless you are sure he knows you are there – even then it's not recommended.

PRACTICE FOR CROSS-COUNTRY WHILE FLYING LOCALLY

First, let's define local flying. Local flying is by no means restricted to the perimeter of the airport. It simply means that we are within glide distance of the airport with some allowance for the pattern and other eventualities. Even a moderate glide ratio of 30:1 gives us a considerable range to practice in. At 5000 feet you are still local at 20 miles out; staying upwind provides a further margin of safety. The objective of practising is to have as few undeveloped skills to cope with as possible when the time comes for the real thing.

Local flying is generally detrimental to cross-country flying. It is all very well and wonderful to float around at cloudbase over the airport enjoying the view, but you don't learn much. Worse, because there is little incentive to optimize performance bad habits tend to creep in which are not always easy to break.

To be beneficial, each flight should have an objective. Define your weak areas and concentrate on those.

Set altimeter to sea level

Set the altimeter to sea level on all flights. Chances are that when you go cross-country there will be other gliders around. When someone announces being in your proximity at a certain altitude it's nice to be using the same language, especially on a hazy day.

Thermalling

If you have done a lot of local flying, chances are you probably do not bank steeply enough to optimize your climbs. Of course, there is little motivation to optimize the rate of climb when flying locally; after all, as long as you are staying up, there is no incentive to do better. There are no time constraints, you could be in the same thermal all day. Make a genuine effort to get out of that mode and really concentrate on getting the best rate of climb possible out of every thermal. Getting outclimbed from time to time, or failing to stay up when others remain airborne, is an indication there is room for improvement. If you get out-climbed while flying a 1-26 don't blame it on the glider's performance. Because of its low wing loading a 1-26 can make very tight circles, enabling it to outclimb everything else. Remember, *never be satisfied*.

If you favour thermalling in one direction, make it a point to practise your weak side whenever you can. Don't stop working on it till you are equally proficient at turning in both directions. It is a significant handicap to favour one direction of turn over the other. When joining others in a thermal, the direction of circling has already been decided for you. A weak side may discourage you from turning toward the rising wing, as you should when encountering a thermal.

Speed between thermals

Almost everyone who have been restricted to local flying maintains the same speed whether thermalling or cruising. Since you are not going anywhere it doesn't seem to make much sense to worry about your speed, even though at times altitude is lost by going too slowly through areas of sink. On any local flight, make it a point to establish a cruising speed in accordance with thermal strength and sink between thermals.

Always have a map with you

Orient the map in the direction of flight. Practise map reading, note terrain features and how they relate to the map. Even if you do have a GPS, being able to navigate by map will come in real handy when it stops working some day.

Locating and centering thermals

To effectively practice locating and centering thermals limit your climbs to 2500 feet, then spoiler down to about 1500 feet and look for another thermal. Making lazy circles near cloud base is very nice, but it won't do much to improve your soaring skills.

Practice not circling

Take the first thermal to the top. Then see how long you can stay up without circling. This exercise makes you more keenly aware of the conditions and the importance of planning ahead. This is something you can practice very nicely when flying passengers if you are involved with this activity at your club. Passengers generally do not enjoy going around in circles, and if you keep them up for more than twenty minutes or so they either get sick, bored, or both.

Leave thermals efficiently

Get in the habit of leaving thermals as soon as the rate of climb drops down to two-thirds of average. Practise leaving the thermals as you would on a cross-country flight, making a sharp 180° when opposite the point of exit so as fly through the center, picking up speed in the process.

Always carry a barograph if no GPS

A barograph trace will show if you exit the thermals in an expedient fashion. The trace at the top of each climb should be in the form of a sharp peak. A trace with rounded tops is a sure sign that you linger too long. It is also important to get accustomed to operating the barograph and preparing the barogram so you no how to do it when it counts.

If you are using a GPS, don't forget to evaluate the vertical trace.

GPS use

If you plan to use a GPS, get well acquainted with it while flying local. Trying to figure out how to operate your GPS on your first cross-country flight is definitely not a good idea. GPS use on local flights is very helpful. Select your airport as the next waypoint and you will know, at any time, how far you are from the airport, and the height you can expect to arrive at. I know of one incident where a pilot made an unsuccessful field landing close to home. Being over elevated terrain, he got the impression of being too low to make it back. Had he used his GPS (which he never did) he would have known that home was within easy reach.

Concentrate on efficient flying

Be selective, use only the strongest thermals. It's easy to drift into complacency when flying local. Don't get into the habit of being content with simply staying up.

Keep track of conditions

Keep track of conditions while you are climbing so that you know where to go next before reaching the top of the thermals, just as you would on a cross-country flight.

Final glides

Just about everyone underestimate the distance which can be covered from any given altitude. Aside from final glides, knowing the performance of your sailplane is invaluable when crossing blue holes and hostile terrain.

An excellent way to develop this judgment is to make a lot of final glides. Fortunately, final glides can easily be practised on local flights. In the beginning, start the final glides some 10 miles upwind, and plan to get back with 2000 feet. As you gain experience and confidence, lower the arrival altitude and start the finals further out. You will be surprised how much practice it takes before you totally believe your sailplane's performance.

Mini-triangles

Practising triangles with turnpoints 6–10 miles from the airport is an excellent way to monitor your progress. Establish a start and a finish line and be sure to take turnpoint pictures, or use a GPS for turnpoint verification. If you do not validate the turnpoints, there is a temptation to cheat just a little, and the benefit of the exercise will be lost.

FIRST CONTEST

Once you have a number of cross-countries under your belt you ought to consider entering a Regional Contest, but don't enter with the expectation of winning. Your first contest should be regarded as a golden opportunity to gain experience which cannot be gained by any other means. Furthermore, it's simply marvellous to be surrounded by so many people sharing a common interest which also happens to be yours.

When the time comes, do not select a contest where off-airport landings are unduly challenging. You most certainly will land out at one time or another before the contest is over. Previous field landing experience is a must. Your first off-airport landing, and your first contest is not a good mix. One or the other will provide all the stress you could possibly want to cope with. Although your intention is to merely participate, it is easy to get caught up in the spirit of competition and push on when you normally wouldn't, creating a more challenging field landing.

When it comes to contest strategy, I strongly suggest you read, "The SRA Guide to Soaring Competition." This is an excellent, 17-page publication published by, and available from the SSA's Sailplane Racing Association.

Good reasons to enter a contest

- It provides an excellent opportunity to fly cross-country. Towplanes, towpilots, ground crews, retrieval crews and all the rest of the support needed for cross-country flying are in place.
- Flying in less than ideal weather, on days you normally would not even consider rigging your glider, you will discover the extent of cross-country flying possibilities in marginal conditions.
- Flying with other pilots is an excellent learning opportunity.
- At the pilot's meeting you can learn how other pilots flew the task and what you might have done differently. This is an excellent debriefing session. You will have also gained a much better appreciation for the day's potential.
- You gain a realistic evaluation of your performance.
- You will probably learn more during a one week competition than you do in a whole year of flying by yourself.
- You will have the time of your life.