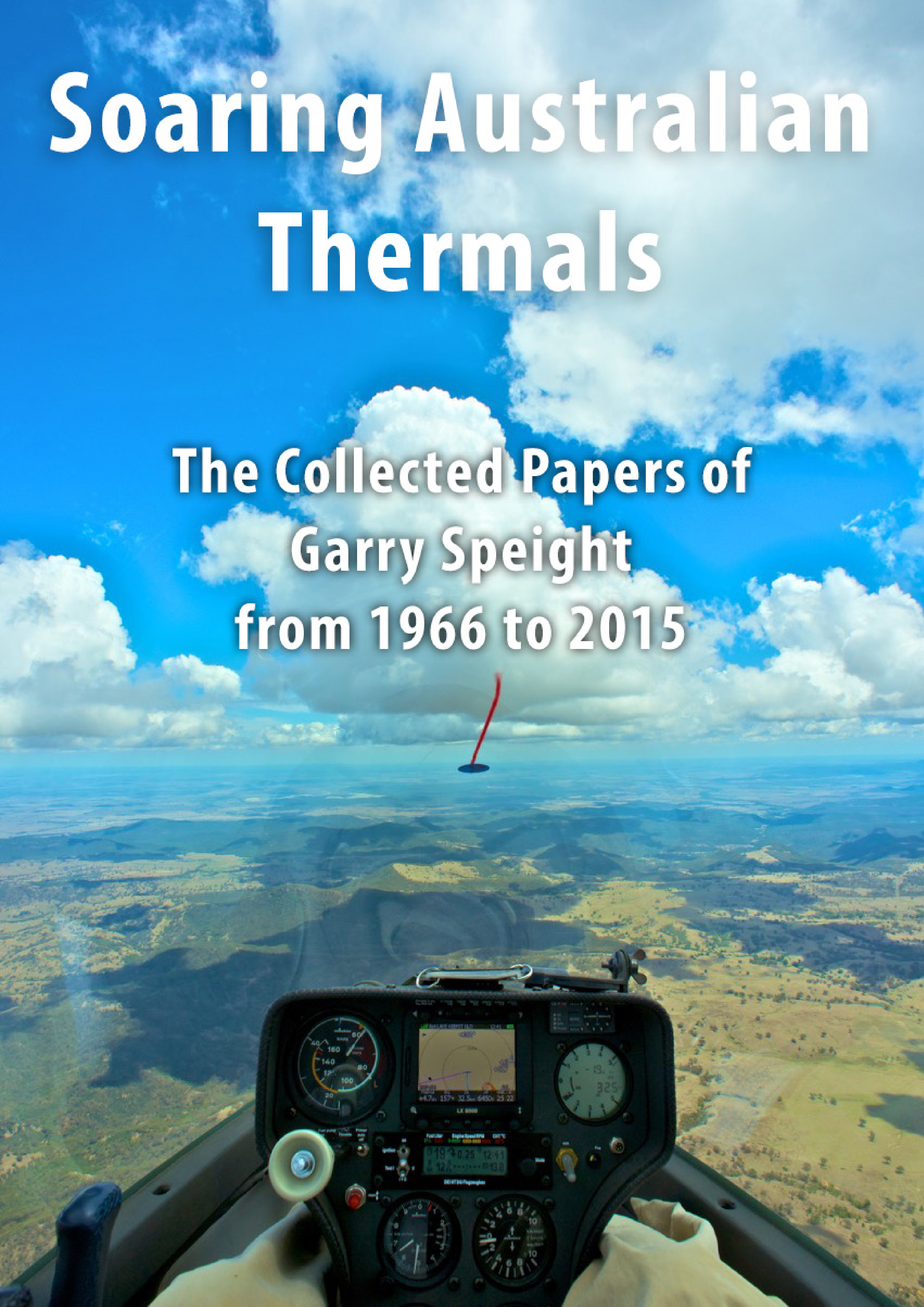
Soaring Australian Thermals

The Collected Papers of Garry Speight from 1966 to 2015



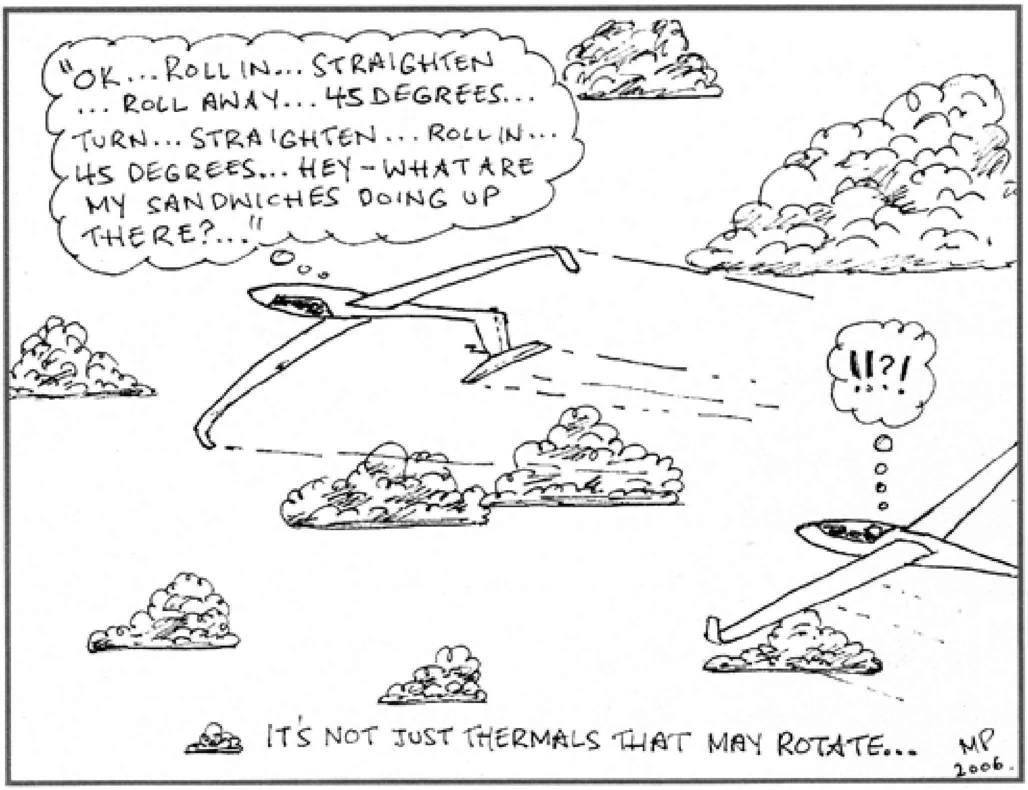
Thermals That Rotate, Part 4

By Garry Speight

Originally published in Soaring Australia, September 2006

Many thermals rotate, and they may be the strongest of the day. You can soar better if you learn to work them, circling against the rotation is a dream; circling with it, a nightmare!

Part 4: How to Soar in Them



The Story So Far

When thermals rotate, they are like very weak tornadoes. This pattern of winds makes the orbits of a soaring glider small and stable when the pilot circles against the thermal rotation, and large and unstable when the pilot circles with the thermal rotation. Clues that the pilot is circling with the rotation include: poor rate of climb, very rough air, a core that seems very small and seems to jump around, having to fly with the nose of the glider pointing down, and surges in airspeed. Circling against the rotation gives a higher rate of climb in a smooth core that seems large, and the glider stays in the core by itself at a steady airspeed, with its nose pointing up.

What To Look For

Take every chance to look for signs of rotating air flow. Watch willy-willies from the ground. As it is easy to misread their direction of rotation, I always check if they could be rotating the opposite way to that which I first thought. Two or more windsocks, or one windsock near a willy-willy, can also show rotating flow.

A big willy-willy, seen from the air, usually has an obvious direction of rotation.

It is clear which way one should circle to fly against it. I find it helpful to say my choice aloud, for example: "I must circle to the right!" It may take some time to get there, and most of the dust will have gone.

If there are four or five small willy-willies, things are not simple. Small willy-willies, like planetary gear wheels, may surround a larger one or a thermal that rotates the other way. Many small willy-willies do not rise above the hot layer of air on the ground surface (the super-adiabatic layer).

When I see rotation in a thin cloud above me, I find this trick useful. I trace out the rotation of the cloud by making circles in the air with my finger. Still making circles, I lower my hand until I can look down on it. Then I decide to circle the opposite way.

Even without visible signs, you can use your mind's eye. For example, if the corner of a forest seems a likely thermal trigger point, the wind must curl around the corner. Work out the direction of rotation, and plan to circle against it.

Learn from the soaring birds! Eagles, ibises and pelicans have had millions of years of practice. If a thermal is rotating, they will surely circle against the rotation. Birds of prey, forever scanning the ground, hunt better if they fly in calm air in small circles at the slowest ground speed. If you meet an angry eagle head on, you may think she is defending her territory. That may not be the problem. She could be furious that you are so rude, ignorant and stupid as to circle the wrong way!

Techniques

Caution

These techniques are for skilled glider pilots. Trying to master rotating thermals without enough skill will bring danger and little gain.

I have listed the nasty effects of flying with the thermal rotation. Reading this, some pilots may joke "...but all my thermals are like that!" If this is no joke for you, you must first master thermal skills. In thermals, you should fly almost perfect circles. Airspeed should not change at all, and angle of bank should not change except on purpose: to shift the circle to a new centre (see Note 1).

I am speaking of three levels of learning. The first is to make perfect circles by careful flying. The second is to circle in the thermal core, never leaving it for more than a few seconds. The third is to make sense of other things, like thermal rotation. All are based on:

- looking at the horizon and the yaw string above it,
- listening to the wind and the audio-vario,
- feeling the way the glider moves, and
- (now and then) reading what the instruments say.

Pilots who have techniques for coping with rotating thermals generally have more than 1,000 hours cross-country experience.

Variometers

Some pilots are slow to learn thermal skills because of faults in their variometer systems. Variometers are very well made, but not all are well installed and few are well maintained. Work on your variometer system until there are no leaks, no false readings, and no stick lift. Adjust the response rate to match the way you fly; instruments can respond to pulses of lift that are too small to use.

Habits of Circling

Pilots form a habit of circling one way rather than the other. Because we turn right after aerotow release, many pilots circle to the right much more often than to the left. Contest organisers add to this with a safety rule that thermalling in the start point area must be to the right.

When they should circle the other way, some pilots fly badly or do not circle at all.

If you are serious about your skills, practice the direction of turn that you like less. Since our rotating thermals are more likely to rotate to the right, a habit of circling to the right is worse for you. On the other hand, some thermals rotate to the left. Do not join every thermal in a circle to the left just to make the odds a little better.

Thermals That Rotate, Part 4

Thermal Entry And Thermal Rotation

If a thermal is rotating, the pilot's best efforts to centre it may result in circling the wrong way, that is: with the rotation.

When one wing goes up, it is generally best to put it down, to begin a turn towards it. This action assumes that the glider is meeting the edge of the thermal at an angle, and the thermal core is on the side of the wing that went up.

The wing may have gone up not due to rising air, but due to a crosswind gust from that side. A higher airspeed on that wing (and the glider's dihedral angle) causes more lift.

If this crosswind is part of the flow in a rotating thermal, the turning glider is now meeting a headwind (see Figure 4.1), and the airspeed will increase. This allows the pilot to pull back and climb well for a few seconds. However, the centre of the turn is well outside the thermal core; the glider will soon go back into rough, sinking air, and the airspeed will fall again.

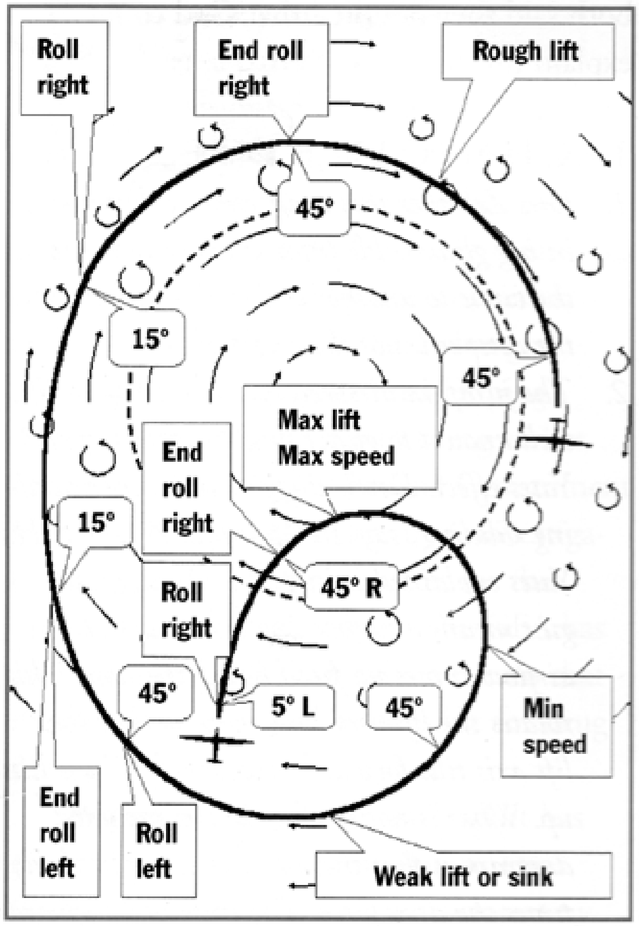


Fig 4.1. Turning towards a lifted wing in a rotating thermal. There is a sudden surge in lift and airspeed. Normal re-centring gives a bad result: a large circle in the direction of rotation

The standard thermal centring action is to note the point (Figure 4.1) where the sink is worst, and decide not to fly through it again. Keep the glider well banked for several seconds, then roll out (along the left edge of the figure) to move the circle away from the worst point. Then roll in to the new circle. This will take the glider back to the core, but in a large circle that goes with the rotation of the thermal.

When the glider first meets the edge of the core of the rotating thermal (Figure 4.1), its higher airspeed comes not only from the stronger headwind, but also from the upward gust of lift, which makes the glider fly faster (see Note 2). If the thermal is both strong and strongly rotating, you get a great burst of speed that you can use for a very high rate of climb. Then, as the glider leaves the core, its airspeed suddenly falls off - even below stalling speed - and drops out of control. The glider has 'bounced' off the thermal. The pilot feels like a squash ball hitting a wall. I have had that feeling! Not thinking that thermal rotation could be the cause, I have even come back to bounce off the wall again and again!

How To Detect Rotation At Once:

A) If Airspeed Rises

When you hit a thermal suddenly and hard with the airspeed rising, as above, this is a strong clue that the thermal is rotating. You are flying into the wind, but not circling the right way. Roll over the other way at once (Figure 4.2). This roll will take at least four seconds, even in a short-winged glider. However, because your ground speed is low, you will not go very far from the thermal core.

Thermals That Rotate, Part 4

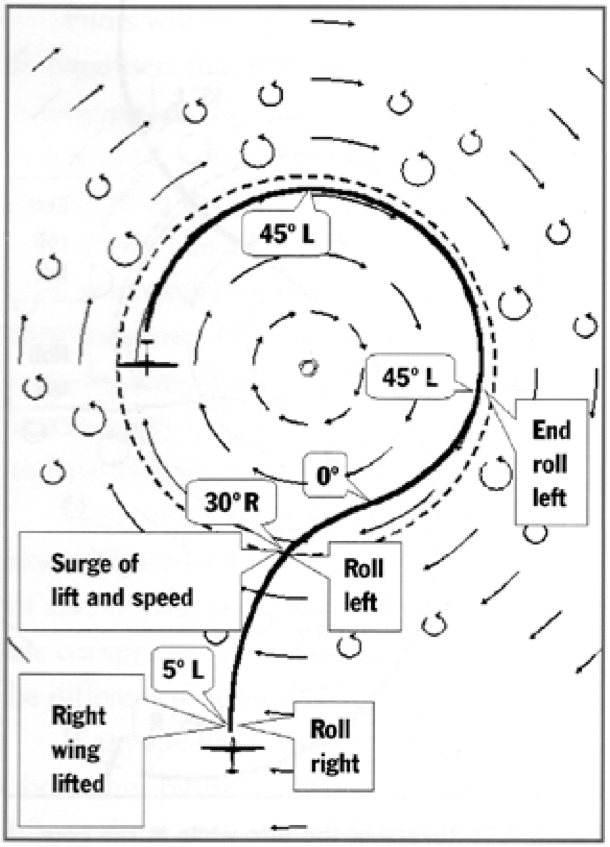


Fig 4.2. Reversing the turn on entry to a rotating thermal, as a response to a big surge in both lift and airspeed

I have seen top-ranking pilots, after turning some 60 degrees one way and gaining height, then circle the other way - as in Figure 4.2. One reason for doing this (without thinking about thermal rotation) would be that to continue the circle would carry the glider from a point with strong lift back into air with no lift a few moments earlier. The air ahead is likely to be better.

British National coach John Williamson taught that the manoeuvre in Figure 4.2 is quite normal. It happens when a pilot, using no variometer but only his feelings of 'lift' and tilt' has met a thermal square-on (see Note 3).

The pilot who changes direction like this must keep a sharp lookout. The danger may be a little less than it seems: A following pilot who is a 'leech' will not be shaken off; others may be far enough away to wait until the leader has clearly chosen a circling direction.

B) If Airspeed Falls

The airspeed, as you bank in to strong lift, may fall sharply instead of rising. This also could be due to thermal rotation. It suggests (see Figure 4.3) that your circle is in the correct sense (opposite to the rotation), but is mainly outside the thermal. As a result, there is a tailwind during your time in the core. The standard centring action will work well. The turn radius will be large during the first entry to the thermal, due to the tailwind. It will be smaller in the second circle which (with luck) could be all inside the core.

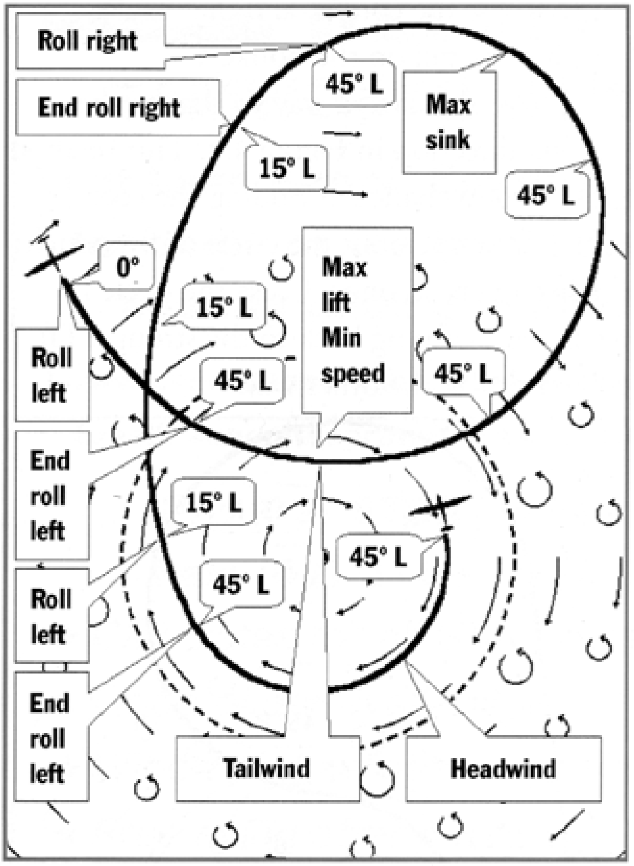


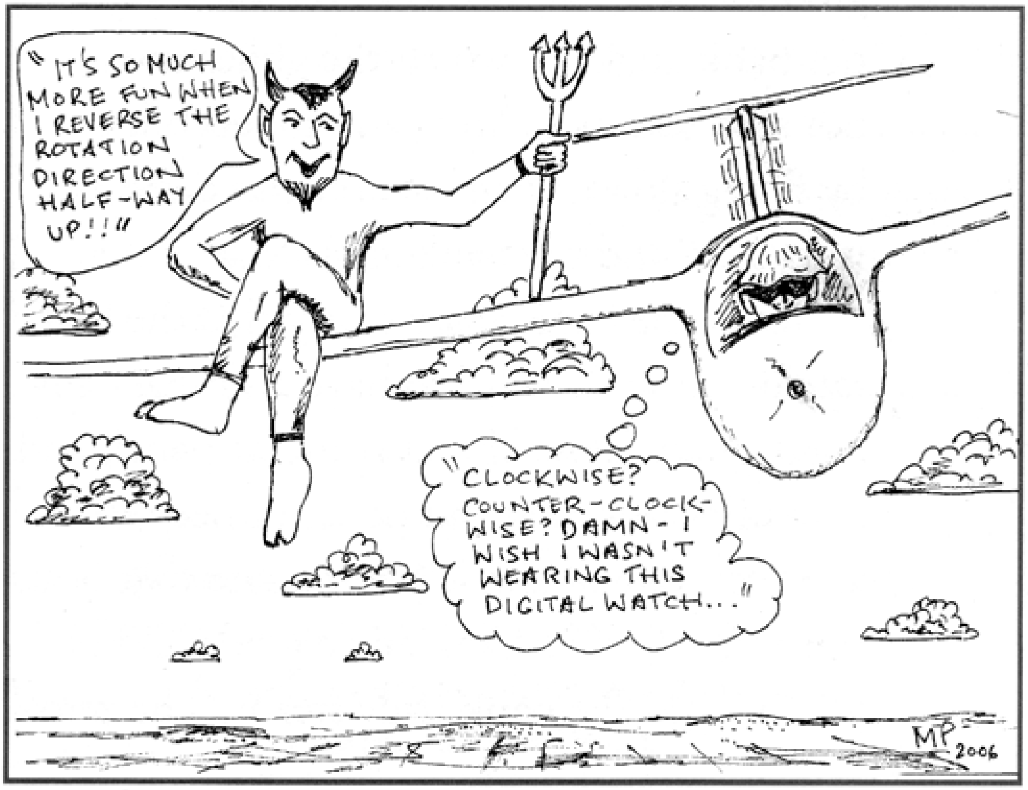
Fig 4.3. Entering a rotating thermal, with airspeed dropping because of a tail wind. Normal re-centring gives a good result: a small circle against the rotation

Reversing The Circle

When you have done two or three circles, various features of the thermal will appear.

If these suggest that you are circling with the thermal rotation, you should do something!

Thermals That Rotate, Part 4



A poor rate of climb, by itself, says: Leave the thermal and look for a better one. Other features favour staying and circling the other way. Count them off:

1. There have been strong surges of lift.
2. The air is very rough.
3. You have to hold the nose low.
4. You can't hold the airspeed steady.
5. The core seems too small.
6. The core seems to jump around.

There are some problems. If other pilots are already circling in the same thermal near the same level, reversing the circle is against the law. Perhaps if you are flying with a friend, you could agree to reverse at the same time. If you think you may not be alone, make a radio call on the gaggle frequency.

It is hard to change direction without losing the thermal. It may take time that could be better spent moving on. You must guess where the core is, and that is like pinning the tail on the donkey!

I have sketched a way to change the circling direction in Figure 4.4. This method gives a good chance of finding the core again. First open out

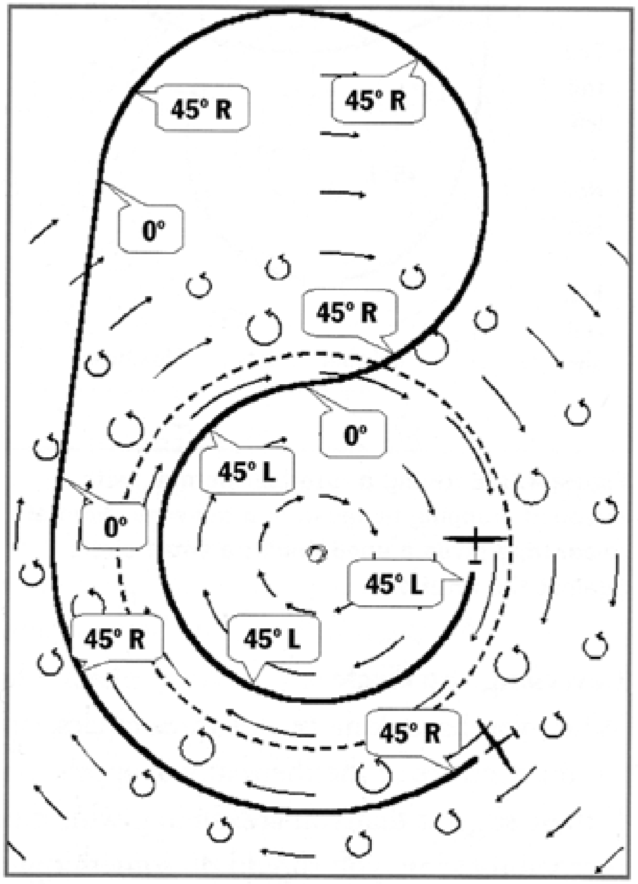


Fig 4.4. Reversing the turn after flying away and coming back to the core

the circle to fly straight for five or six seconds. Close the circle in again and, coming back to the stronger lift, roll hard over the other way.

During the next circle, note the point of weakest lift or worst sink, and move away from it as usual. Sadly, this circle is often all in sink. Begin

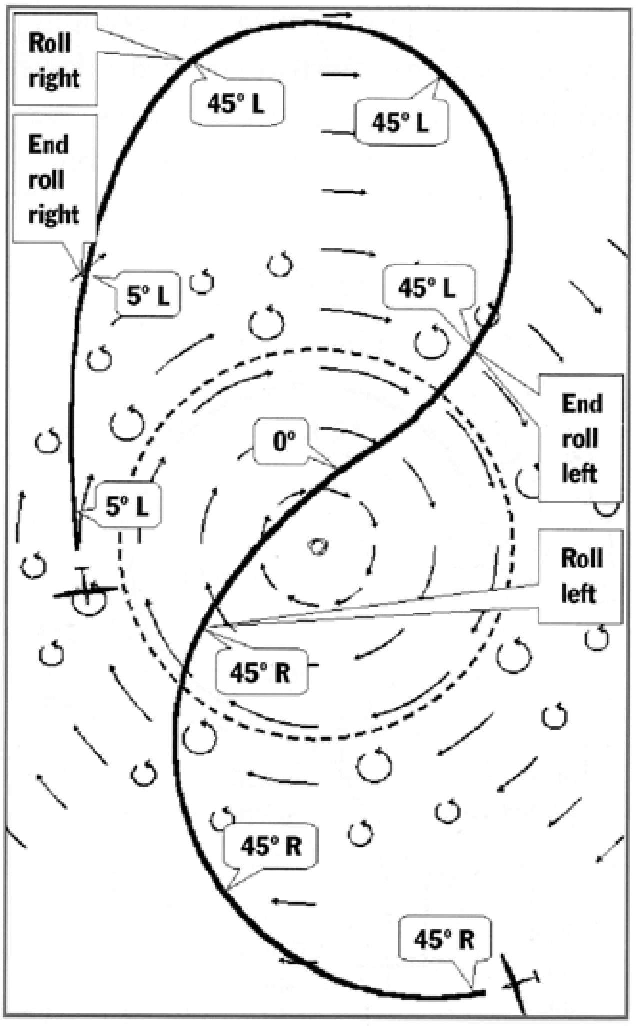


Fig 4.5. Reversing the turn while in the core

a new search for the thermal, and remember not to circle the same way as before!

Another way is simply to reverse the turn while the lift is strong (Figure 4.5). Due to the long distance travelled while rolling in a tailwind, the next circle is almost bound to be in sink.

Success in reversing the circle will not come without practice.

Making The Best Of It

When circling against the rotation of a thermal, keep your mind on the job, even though the glider seems to fly itself. Your usual bank angle is likely to be too steep. The rotation spreads the highest lift out from the centre to a larger radius. This, as well as the low ground speed, means you need only a gentler bank angle, at which the glider does not sink so much. You can sink even less by flying slower than usual because the air is so calm and the bank angle low.

Seek the bank angle that yields the best rate of climb. It helps to have a simple bank angle guide above the instrument panel, and an audio-vario that can be set to beep only at a high rate of climb (or at a rate that beats the average). The bank angle guide allows you to hold the bank truly steady. The zero-shifted audio-vario tells you clearly when the climb is best.

Another idea is to try to make the circle as large as it can be without flying out of the smooth core. A method used in flying sea breeze or storm fronts (and even in basic aerotow) is to 'bump' the turbulent air. Open out the circle until the outer wing buffets in the turbulent eddies outside the core. Then close the circle in a bit, and keep the angle of bank steady.

Is It Worth Changing Direction?

Changing circling direction may waste time, or even fail; but think what you will gain if you succeed. Rotating thermals, when flown against the rotation, are very easy thermals to soar. They give a higher rate of climb than non-rotating thermals of the same lift strength at the axis. Added to that, the thermals most likely to develop rotation are those that began with a lot of energy. They may be the strongest thermals of the day.

How much you gain depends on the time the glider will be in the thermal. Near cloudbase, it is not worth changing direction. The lower down you start to circle against the thermal rotation, the better. However, lower down there is also more risk. At circuit height over a paddock that looks bad, trying to reverse the turn in a gusty, fitful little thermal can make your heart pump.

Thermal Soaring Sport And Science

Few soaring pilots have spoken or written about rotating thermals. Soaring is both a sport and a science. In sport each pilot tries to gain an advantage. Knowing how to work rotating thermals may be a 'secret weapon' for some racing pilots. If so, I am sabotaging it!

I like to think that soaring pilots are field workers researching turbulence. This is a subject of Satanic difficulty. Physicists Werner Heisenberg and Horace Lamb both said they doubted that God could explain turbulence!

Technical Notes

1. Lars Zehnder uses a different technique in big gliders. He finds it easier to move the circle to another centre by changing the airspeed, not the angle of bank.

2. The jump in airspeed due to a surge of lift, well known to glider and tug pilots, is the Yates effect. Derek Piggott, in 'Understanding Gliding, says in Appendix A how A. H. Yates explained it in 1951. An upward gust means a higher angle of attack: the airflow comes up from below the nose. This rotates the lift and drag axes, so that the lift axis tilts forward, and the drag axis tilts up. What is not so clear in the included diagram is that the lift force is about thirty times the drag force. The increased forward component of the lift tending to pull the glider along can be several times greater than the total drag tending to hold it back. The glider (or aeroplane) accelerates like a drag-racing car. The pilot can feel the push or hear the wind noise, and see the needle rising on the airspeed indicator.

3. John Williamson published these ideas in 'Come Soaring' (Sailplane and Gliding, February/ March 1987, pp 4-15). (I thank John Hoye for this item.):

Using a paper plate, slit and fastened with a paper clip, he made a model thermal shaped like a cone. He showed how the pilot who happens to hit the thermal in the middle will not feel any tilting to one side, but only a lift upwards. The pilot must turn one way or the other to stay in the thermal, and will then feel the stronger lift in the thermal core tilting up the raised wing. That wing should be rolled down, and the glider will then circle around the core. In the case of a rotating thermal, the feelings of lift and tilt are in reverse order. The pilot responds to a tilt by banking, then to the lift by reversing the turn.

4. I would like to thank a number of pilots who have discussed rotating thermals with me. I am very grateful to those who have reviewed drafts of this article: Patrick Burke, Graham Holland, Hartmut Lautenschlager, Brian and Carol Marshall, Harry Medlicott, David Shorter, and Jim Stanley. Mitch Preston kindly agreed to do the cartoons.