Soaring Australian Thermals

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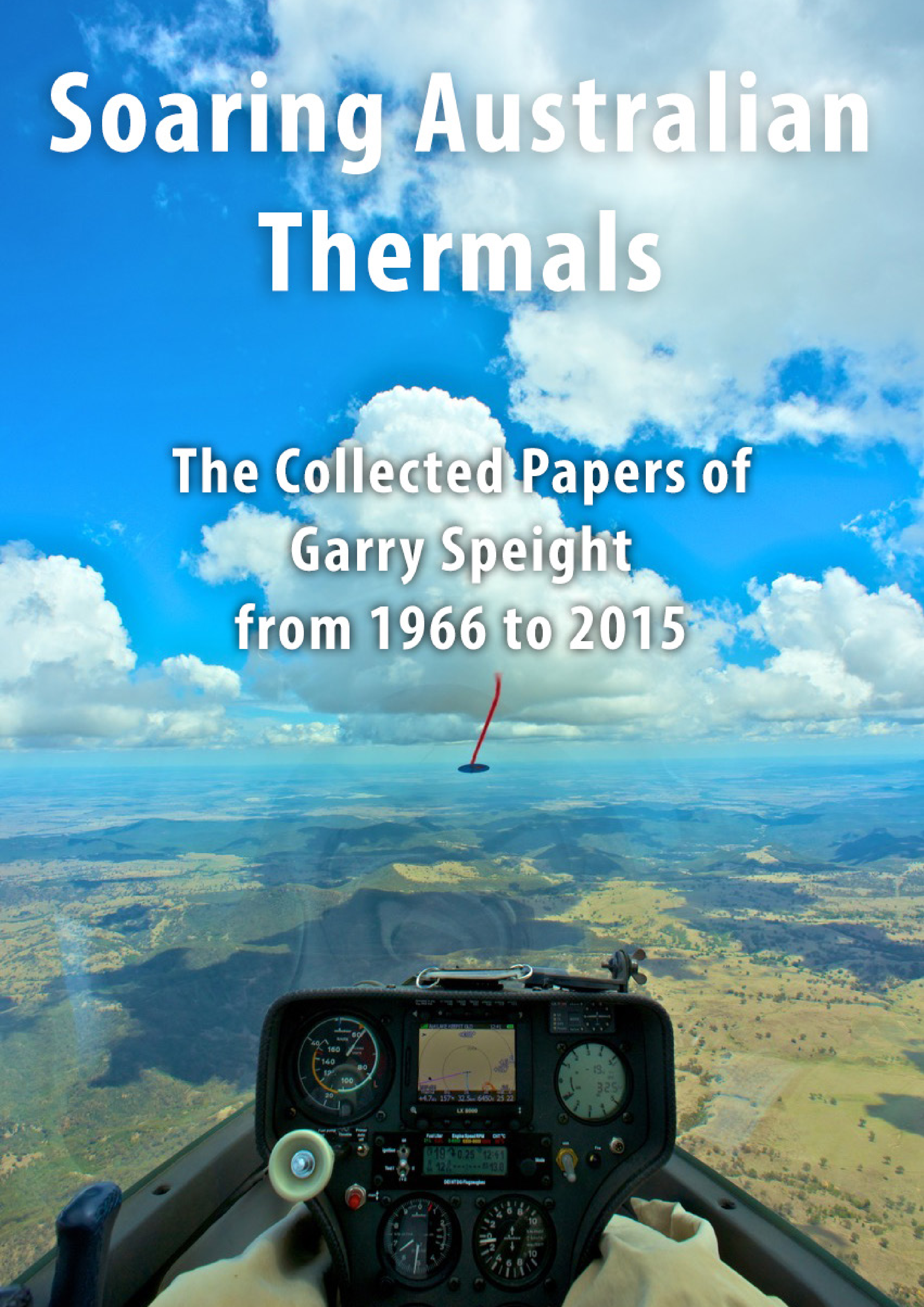

When to Circle: When to Leave!
Decision-Making Features For An Air Data System

By Garry Speight

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Efficient cross-country flying depends on the use of the MacCready ring or a speed director based on the same principle. The MacCready ring indicates the best speed to fly between thermals for a given value of thermal rate-of-climb.

The choice of this rate-of-climb amounts to adopting a consistent policy about which thermals are to be accepted and which rejected.

In an article called "The Arm-Chair Pilot", published in the October 1964 issue of Sailplane and Gliding, Anthony Edwards invented the term "critical rate- of-climb" for a rate-of-climb to set on the MacCready ring.

Whereas, when using MacCready theory for flight planning or task setting, cross country speed may be estimated by using the forecast average thermal strength, and whereas maximum cross country speed is theoretically achieved by flying according to an accurate estimate of the initial rate of climb in the next thermal, the critical rate-of-climb is neither an average nor a forecast about the next thermal.

Instead, it is a value consciously chosen by the pilot to distinguish lift that is strong enough to be worth using from lift that is too weak to bother with.

Last year, S & G humorist. Platypus, wrote a piece in the August issue called "Kissing MacCready's Ring". In it he also put forward the idea of flying according to a consciously-chosen critical rate-of- climb: "Always set your speed-to-fly ring to the rate-of-climb that you would be happy to accept RIGHT NOW". Platypus called this the MAIROC : minimum acceptable instantaneous rate-of-climb.

To save space, in the rest of this article I will refer to Edwards' "critical rate-of- climb" as CROC.

While the estimation of the strength of the next thermal is little more than a guessing game, decisions on when to circle and when to dolphin through the lift are of crucial importance, and call for the sort of consistent reference point that the MacCready setting can provide.

The enormous success of the early exponents of MacCready theory, such as Heinz Huth and Paul MacCready himself, may well have been due more to their consistent use of only the stronger, yet sufficiently numerous, thermals that exceeded the value set on the MacCready ring, than to the increase in cross-country speed achieved by optimal inter-thermal glide speeds.

MacCready Flying Technique

A speed director, with audio signals for "fly faster" and "fly slower", is especially useful in flying to the CROC concept because, as the glider enters rising air, the instrument advises reducing the speed to the point where, if the thermal exceeds the CROC, the glider will already be back at thermalling speed before the thermal core is reached.

On the other hand, if the thermal is weaker than the CROC the instrument will not advise such a low speed, and the pilot will not be tempted to circle.

Speed directors also advise speed variation in increased and reduced sink. MacCready theory shows that the speed should be varied in this way.

However, a too slavish pilot response, particularly if it includes pull-ups and push-overs with significant "g" loads, is likely to be harmful: drag will be increased, the aircraft may be damaged by fatigue or by gust loads, and the pilot will be kept so busy that his performance and safety may suffer.

The instrument indications should be followed reasonably promptly, though, to avoid persisting with a slow speed in heavy sink, or a high speed in lift, and to take advantage of the way the instrument can bring you to a thermal at thermalling speed.

When thermalling one should continue to circle only so long as the CROC is exceeded. As soon as the lift drops below that value it is time to leave.

If the thermal is considerably stronger than the critical value that you have previously set on the MacCready ring or knob, you should consider whether to shift to a higher critical value.

This will depend on whether you think that the average strength of all the thermals has increased (or is stronger than you thought at first) or whether the thermal is an unusually strong one and not likely to be equalled again.

The correct setting of the MacCready ring will result in long glides that often use up most of the available convective depth, and high climbs in the strongest thermals.

If one knew where the strongest thermals were, one could use the whole depth of the convective layer in this way. Not having this knowledge, one must use a lower ring setting as a defence against bad luck: if you insist on waiting for a really strong thermal to circle in, you may land before you find it.

Dolphin Soaring

Flying straight through thermals that do not come up to your CROC value is the essence of dolphin soaring. If you set the ring too high you will dolphin down to the ground, or at least down to a height where you will be glad to accept zero sink to stay up. If you set it too low you will be stopping to circle in nearly every thermal.

The correct setting, producing the fastest speed, will use most of the available height without dropping you out the bottom. Having said that, if all the pilots in a race were equally efficient MacCready flyers, the one who flew through the most thermals would win. He could go much further before he lost enough height to make it advisable to circle up again.

He would be able to set himself a higher CROC for two reasons. First, the longer stretches of dolphin soaring mean that fewer thermals must be circled in to complete the course: only the very strongest need to be used. Second, among the larger number of thermals that he sampled there would be more strong ones.

Even though the proportion of thermals exceeding 8 knots, say, might be the same for all pilots, the one who sampled the most thermals might find ten of them, enough to get around the course without circling in anything weaker, while a pilot who located only half the number of thermals would find only five 8-knot thermals and would have to circle in weaker ones to get around.

An even higher level of skill (or luck) in thermal finding results in a flight completely within the dolphin soaring regime, without any circling climbs. In this case, if the CROC is set too low there will be a net climb around the course; if it is set too high, a net descent.

The correct setting gives neither net climb nor net descent. In this case the cross-country speed may be read directly off the polar curve against the still-air sink rate equal to the CROC.

Dolphin soaring is a consequence of MacCready flying when the thermal density is high. Efficient dolphin soaring depends on using the CROC to keep a consistent reference for decision making.

Instrument Audio Signals

As I see it, one of the prime functions of a variometer and speed director system is to signal the decisions: — when to circle, and when to cease circling. Both relate directly to the rate-of-climb setting.

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I find it astonishing that until recently none of the electronic systems on the market has given clear indications for these two decisions.

As the glider runs in to lift, a typical speed director simply signals "Fly slower Fly slower". If you follow its indications alone you will stall!

For the decision to circle you have either to **read** the ASI or to **read** the variometer and compare it with the setting of the MacCready knob, whose pointer is not at all easy to see.

One system (Peschges) has an optional automatic switch from "Cruise" (speed director audio) to "Climb" (T.E. vario audio) controlled by the airspeed.

This implies that the thermal has exceeded the critical rate of climb (or something near it) but, once the switching has occurred, the thermal strength must again be visually monitored against the MacCready knob setting as in other instruments.

Even if the rate-of-climb actually turns out to be well below critical, this may not be noticed for some time in the effort of centring.

During the climb, each system (except the latest Cambridge) signals absolute rate of climb both on the audio and on the dials. These values are not relevant to the cross-country task, which is to circle only in lift greater than the critical value.

The absolute rate-of-climb must then be repeatedly visually checked against the MacCready knob setting to find out if and when the thermal should be abandoned.

On some speed directors there is one way to get an approximate indication of net lift relative to the critical value; by leaving the instrument in its speed director mode while thermalling.

The airspeed in the thermal has to be kept steady to avoid spurious lift in the dives and sink in the zooms. Nevertheless, I have found this trick so useful that for some years I have been thermalling with my VW3SG in the speed director mode all the time except when below 1000 feet.

Since December 1981 the Cambridge instrument has been advertised with audio indication of net rate-of-climb above the MacCready setting. Interestingly, some clients have asked for a net rate above 75% of the MacCready setting, which is contrary to the common idea that the MacCready setting should be less than the achieved rate-of-climb.

Perhaps these pilots think that a thermal somewhat below MacCready setting should be circled in to see if the core is actually much stronger.

A Decision-Aiding Variometer

As I was convinced that existing instruments, except, in some respects, the latest Cambridge, were not designed to give clear and positive signals for the crucial decision points in cross-country flying, I approached Mike Borgelt to incorporate certain modifications in his Air Data System.

The first requirement, as suggested above, was that the audio of the variometer was to signal net rate-of-climb above the MacCready knob setting instead of the absolute rate-of-climb.

This ensures that any lift weaker than the CROC is not considered to be lift at all, but *sink* that should be avoided, either by re-centring or by abandoning the thermal. At very low altitudes I would set the knob to zero, of course.

Next, to get a positive indication when usable lift is met with on the glide, I asked for the audio vario "lift" signal (but not the "sink" signal) to be super-imposed on the speed director signal. (The two signals are not the same on Borgelt instruments.)

Since the zero of the audio vario is at the CROC, this signal comes in only when the lift exceeds that value, that is, when the thermal is worth circling in.

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Circling is begun with the speed director still operative so as to be ready for possible immediate return to a straight glide. The instrument is switched to vario mode once the climb has been established. This brings in the vario "sink" signal and the rate-of-climb averager,

At the top of a thermal the time to leave is when the lift falls below the CROC. This is signalled by the change from "lift" to "sink" in the audio vario sound.

To make this signal quite compelling, I asked for a quiet band on the vario immediately below the critical rate-of-climb. This was to help me to notice when the part of the circle with "beeps" became smaller than the part with "wows", by separating the two parts with sectors of silence.

When I had received and fitted the instrument I found that some adjustment of response rate and width of quiet band was necessary to suit my personal abilities and to make the decision points as clear as possible.

The time constant is now about 2.5 seconds, the quiet band of the vario 0 kt to -2 kt, and the quiet band of the speed director ±4 knots (of airspeed) at 50 knots, broadening with airspeed to ±8 knots at 100 knots.

The instrument now works as I intended, giving clear and positive guidance on all routine decisions about circling in thermals.

Changes to the MacCready setting are made from time to time, according to the conditions, such as average thermal strength, altitude, thermal markers, terrain, and changes in the weather. There is no need to be bustled about this; it can be done calmly at leisure.

Decisions about when to circle and when to leave are not made on the spur of the moment, but follow quite automatically from the MacCready setting. The appropriate action is indicated by the audio sound, as follows:

Beeps begin	: Circle now!
Beeps continue	: Keep circling!
Beeps stop	: Go!
No beeps	: Don't circle!

After more than a decade, this excellent variometer developed a fault. As happens now to every electronic device, it could not be repaired. I bought a new model, but it lacks the feature "beep above the MacCready value in the climb mode". Cambridge also now lacks this feature. It seems that I am the only glider pilot who sees the value of it. At least most modern variometers display the average rate of climb near to the MacCready value. You can make this vital comparison visually but there is no audio signal of it, as there was in my 1983 instrument.