How to Find the Core of a Thermal

Constant Speed and Accurate 45° Angle of Bank

If we want to find the core of a thermal and stay in it, we need to maintain a constant speed and a 45° angle of bank.
To understand the importance of this we need to look firstly at the structure of a thermal.

1. Thermal Structure

When a thermal bubble is rising through the atmosphere, there is drag on the side of the bubble making the edge of it rise slower than the core. This is further extenuated by the law that says that every action has an equal and opposite reaction. To replace the rising air there will be sinking air around the side of the bubble thus causing more drag on the edge of the rising air and making the core of the thermal even smaller.
What does this mean in practice?
Although the thermal diameter can vary according to weather conditions the core of the thermal is going up faster than the air around it. To go up faster we need to get tight into the centre of this core - all the way up

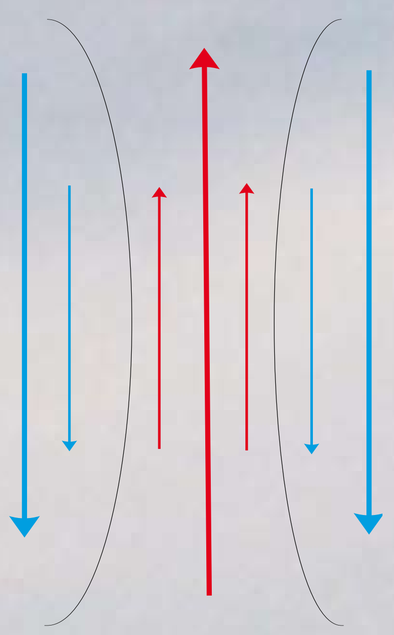


Fig 1

2. Circling Polar

The radius of a circle flown by a glider depends on the speed flown and the angle of bank. (Refer to Fig. 4) The slower we fly the smaller the radius of the circle. However, the limit is the glider's stalling speed. Also note that the steeper the angle of bank the smaller the turning circle.
Figure 2 shows that the vertical lift component needs to increase with the bank angle. The greater the wing loading, the higher the stall speed so the faster we have to fly in order to prevent a stall. Also, the greater the weight of the glider the more it is affected by the centrifugal force and the faster we need to circle.
The turning polar shown in Fig. 3 gives an indication of the vertical lift component against the angle of bank. You can see that after around 45° the vertical lift component starts to drop off rapidly. Consequently, at angles of bank much greater than 45° thermalling becomes inefficient. However, with bank angles much flatter than 45° we get a large circle diameter which, unfortunately, will see us fly around the edge of the thermal. Figure 3 shows how the thermal strength with diameter, the circling polar and the blend between the two, show that around 45° gives the best rate of climb.

3. Flying accuracy

Before we start to look at the perfect combination of angle of bank and speed let us look at flying accuracy. Assume that a pilot can fly at 45° angle of bank and 50 knots. Fig 5 indicates that he will achieve a circle radius of 67.5 meters. A pilot who fails to fly accurately and increases his speed by 5 knots after half a circle and simultaneously reduces his angle of bank by 5° will have a new circular radius of 97.3 meters. The diagram shows that the circle has been shifted inadvertently by 59.6 meters or nearly 50%. At the start of the turn the pilot was 67.5m from the core but now he is 112.2 meters away.
A pilot who has problems maintaining a reasonable angle of bank gets even worse. Flying at 50 knots and at 40° angle of bank results in a diameter of 80.4m - only a 12.9 meters larger radius. This pilot also tolerates inaccurate flying and reduces his angle of bank by 5° and increases his speed by 5 knots his circle will now be 116.6 meters in radius. Now he has shifted 72.4 meters, he is positioned 134.7 meters from the core, and 2 times further away from the core than the first pilot was at the start of his first turn!
The trace in fig 7 was flown by a polished pilot. He turns accurately and finds the core after a number of circles. In contrast the pilot in Fig. 8 is unable to circle accurately and never manages to find the core.
The message is clear, fly accurately, fly very accurately.

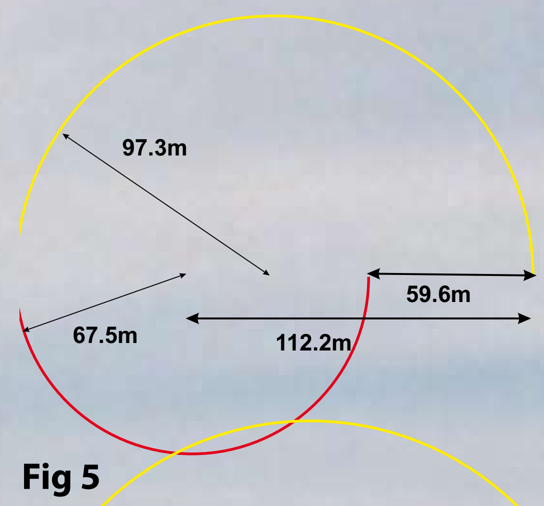


Fig 5

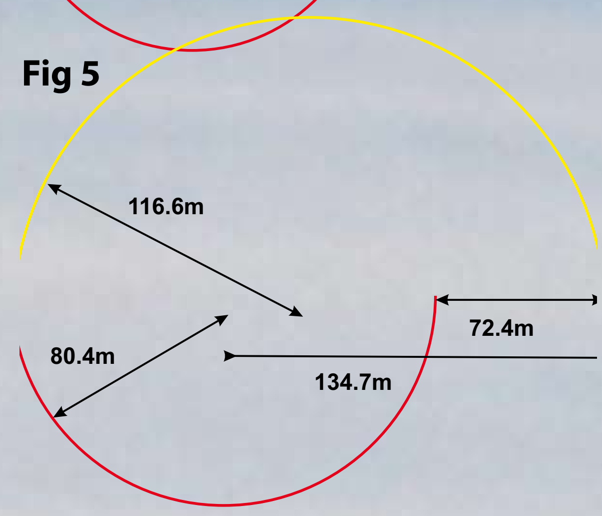


Fig 6

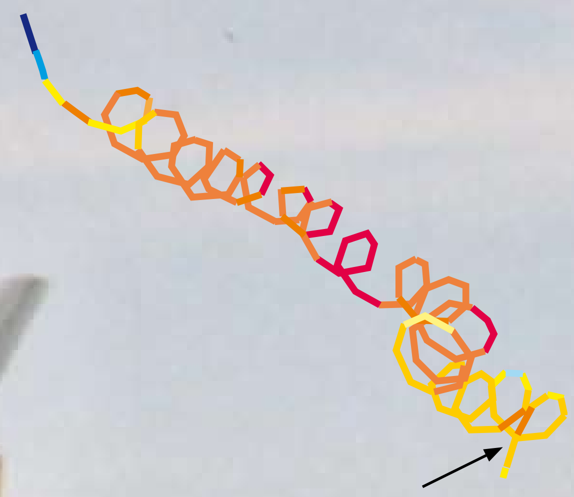


Fig 7. After an initial search the pilot finds the core and stays in it.

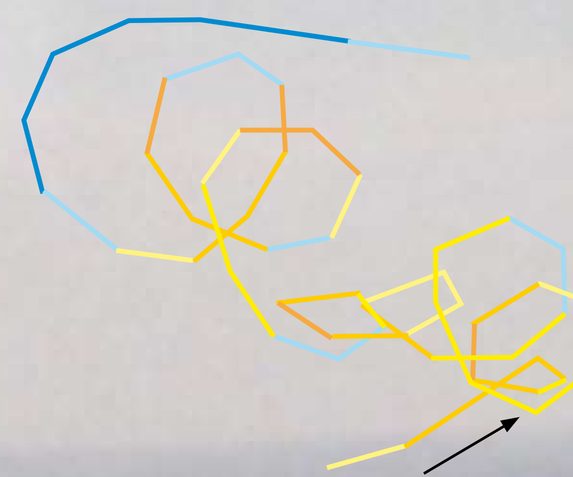


Fig 8. In this case the pilot cannot maintain his position and therefore never cores the thermal.

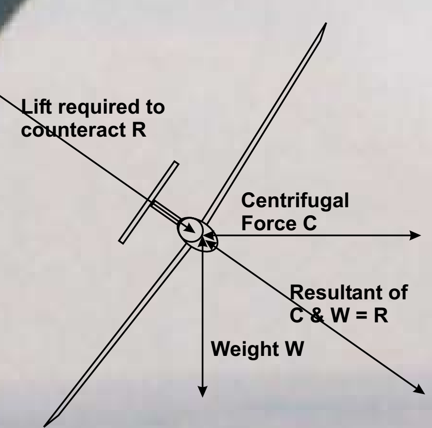


Fig 2

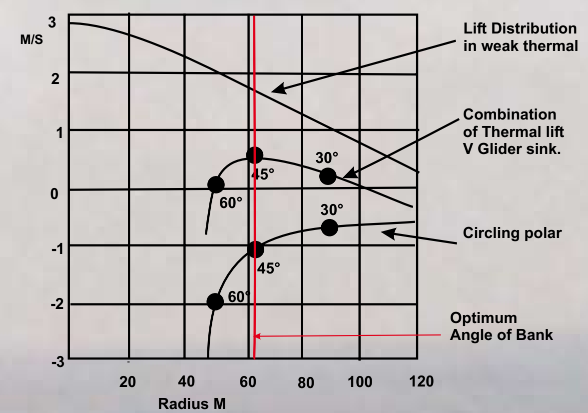


Fig 3

Circle radius in meters at different angles of bank and speeds.

	40 Kts	45 Kts	50 Kts	55 Kts	60 Kts	65 Kts
5°	493.8	625.0	771.5	933.6	1111.0	1303.9
10°	245.0	310.1	382.8	463.2	551.3	647.0
15°	161.2	204.1	251.9	304.8	362.8	425.7
20°	118.7	150.2	185.5	224.4	267.1	313.4
25°	92.6	117.3	144.8	175.2	208.5	244.6
30°	74.8	94.7	116.9	141.5	168.4	197.6
35°	61.7	78.1	96.4	116.6	138.8	162.9
40°	51.5	65.2	80.4	97.3	115.8	136.0
45°	43.2	54.7	67.5	81.7	97.2	114.1
50°	36.3	45.9	56.6	68.5	81.6	95.7
55°	30.2	38.3	47.3	57.2	68.1	79.9
60°	24.9	31.6	39.0	47.2	56.1	65.9

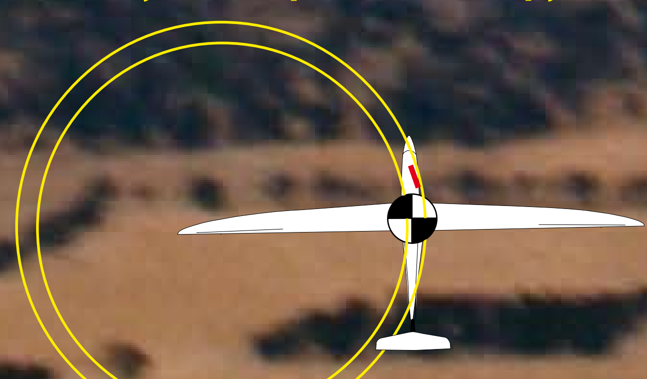
Fig 4.

4. Manoeuvrability and Feel

Of equal importance is the thermalling speed. Contrary to popular belief the lowest possible speed is not the best thermalling speed. In order to fly accurately we need to have good control of the aircraft. Flying a glider with a lot of pre stall buffet makes thermalling very difficult. The thermal will be tossing us around and the pilot will have little feel of the air. The optimum speed to fly will be close to the minimal speed that gives the pilot the ability to feel the air. In more turbulent conditions it will be necessary to have a little more speed to manoeuvre the aircraft quickly and more efficiently. To sum it up, an angle of bank of 45° and the lowest speed that allows us to maintain a good feel of the air is close to the optimum.

5. Yaw String

The yaw string is the final component that is required to assist in getting a good turn. Looking at the diagram below of a glider turning in a circle with the centre of gravity being the reference point, you will notice that the air flow lines around the extremities of the aircraft, the nose and tail are not parallel. So fly with the yaw string pointing about 10° to the outside of the circle, in effect top rudder. The angle of the yaw string is extenuated by the shape of the canopy and the angle of bank.
If you fly with the yaw string straight in reality the nose is pointing down into the centre of the circle.
Once the top rudder is applied the control of the turn becomes so much easier.



6. Practice

So if you want to be able to fly accurately put a couple of straws on the canopy at 45° or on the instrument panel, and practice, practice, practice. Do not let other than 45° be your standard.

When you can do this it will be time to find the thermal core, and learn to centre it.

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For more gliding articles go to James' website www.jamescooper.com.au