THERMALS FOR EVERYBODY–Suggestions for a co-operation of gliders, paragliders and hang gliders thermaling together

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The last few years have shown that pilots of hang gliders and paragliders have freed themselves from soaring merely above slopes or ridges. They have conquered the low-lands and thermals on their cross-country flights as new but equal partners in the airspace. The number of thermals, however, has not increased. Glider pilots will have to get used to sharing the same thermal with new and slower partners. It is quite obvious that problems will arise from this fact. And, whenever we want to solve such problems in a partnership, each partner must both be willing and be able to put himself in the position of the other one and to face the problem as the other sees it.

I am going to divide the problem in two. The first part is that it is in fact possible to thermal together, in spite of the extreme differences of our aircraft, if each partner is willing to do so. The second part investigates what pilots should consider, when they enter and leave a thermal, or when they try to find its center.

One fact, however, is quite clear. It is not enough to stick to the common rule Number 1 of keeping the same rotary direction when we thermal together. To decrease the risk of midair collisions, let us try, as rule Number 2, to keep our relative position to one another when going around in a thermal. You may ask, "Does it work?" Paragliders, hang gliders and gliders should strive for flying around the same center of a thermal at approximately the same angular velocity. Thus the relative position to each other would remain constant.

Another problem must be clarified: Is it possible to keep a sufficient distance from one another when we fly at the same angular velocity? The box shows the correlations in a stationary circle at the bank ϕ. Formula 1 gives the angular velocity w and formula 2 the radius r of the circle. Both quantities depend only on the trim speed v_0 and the bank ϕ, if we simplify and assume that the lift coefficient remains unchanged, no matter whether we fly a circle or straight ahead.

Field I of Figure 1 shows the time for a complete circle $T = 2\pi/w$ over the bank ϕ. Field II shows the ra-

$A/A' = \cos\varphi = v_0^2/v^2$

$v = v_0/\sqrt{\cos\varphi}$ [c_a = const!]

$Z = m \cdot v \cdot \omega = m \cdot v^2/r$

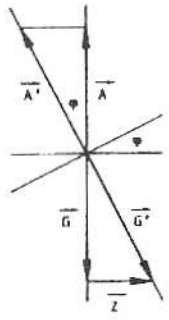
$G = m \cdot g$

$\tan\varphi = Z/G = \sin\varphi/\cos\varphi$

$\omega = g/v_0 \cdot \sin\varphi / \sqrt{\cos\varphi}$ (1)

$r = v_0^2/g \cdot 1/\sin\varphi$ (2)

A = lift
A' = circle lift
v_0 = trim speed
v = circle speed
ϱ = air density
c_a = lift coefficient
F = wing area
G = weight
m = flight mass
g = gravitation acceleration
Z = centrifugal force
r = circle radius
φ = bank angle
ω = angular velocity



In a stationary flight strait ahead the weight $\vec{G}$ is carried by the lift $\vec{A}$

$$\vec{G} = -\vec{A}$$

In a stationary circle with bank φ and the centrifugal force $\vec{Z}$ the circle weight $\vec{G}'$ is carried by the increased circle lift $\vec{A}'$

$$\vec{G} + \vec{Z} = \vec{G}' = -\vec{A}'$$

TABLE 1.

dius r of the circle. Standard gliders (span = 15m; v_o = 90 km/h), hang gliders (span = 10m; v_o = 40 km/h) and paragliders (v_o = 20 km/h). were taken as a basis for my calculations.

Let us try a first example. The hang glider is circling with a bank of φ= 14°. It takes T = 28 sec. to complete the circle of radius r = 50m. If the pilot of the glider wants to fly according to rule 2, if he wants to complete his circle in 28 sec. to, he has to fly with a bank of φ = 31° (Field I) and a radius of 120m (Field II). The pilot of the paraglider joins the 28 sec. circle with a bank of φ = 7° and a radius of 25m.

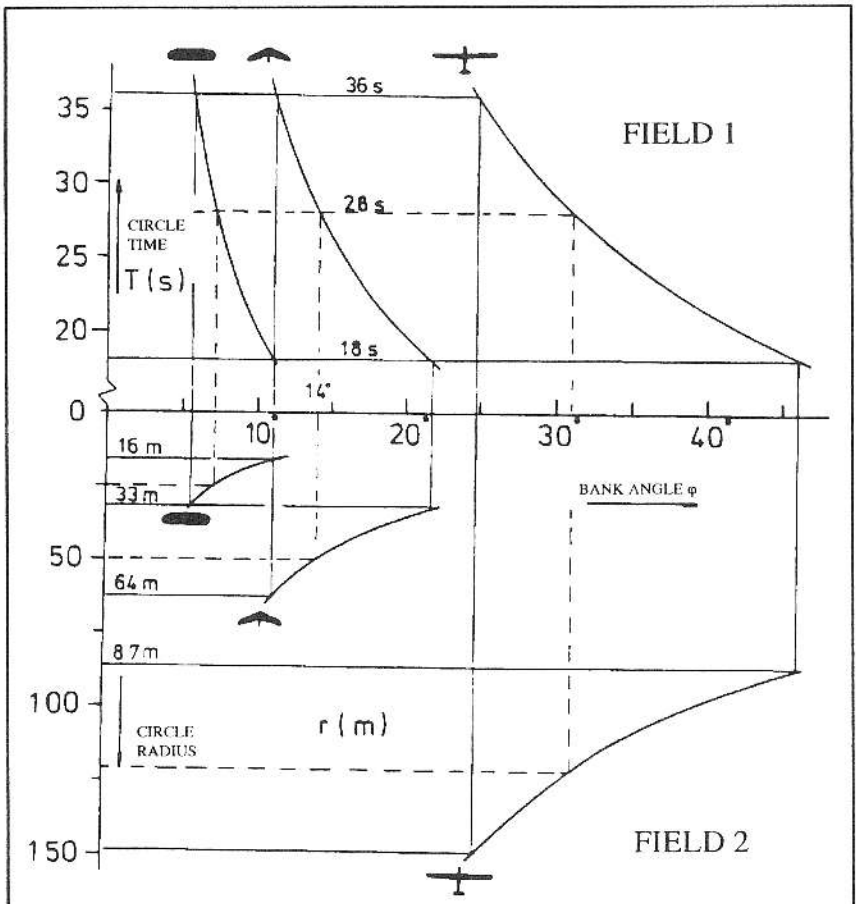


FIGURE 1. Circle time T (Field 1) and circle radius r (Field 2) over the bank φ.

Figure 2 shows the flight silhouettes of the borderline cases with the minimum and maximum banks shown in Figure 1, that is the longest and shortest time for a complete circle. The diagrams are true to scale, with three paragliders, three hang gliders and three gliders which are all thermaling at the same altitude.

These close distances in Figure 2b between the aircraft which circle with high bank, are not safe. The hang glider pilots have to assume that the glider pilots have never flown a hang glider and thus do not know its characteristics, especially its tendency of leaving its flight path unintentionally in bumpy thermals. Nevertheless, the glider pilot, like the others, does have the right to get a safe place in the thermal, whether it is turbulent or not. It follows that we should seriously keep to flat banks in circles of about 36 sec. For hang glider pilots, a bank of 11° may seem unreasonable. However, with a bank of 30° he would force 60° on the glider pilot who wants to stick to rule 2, and this would mean a foolish continual acceleration of 2g.

I believe that three paragliders and three hang gliders on the inside circles and three gliders on the outside circle are the maximum we could demand of ourselves, when we thermal at the same altitude, presupposing the radii are sufficient and the banks are flat enough. And "same altitude" means an allowed difference of ± 50m. Competition pilots may laugh this off; they have to accept narrower and more crowded gaggles but pilots who do cross-country flights just for fun do not have to.

Ever if each pilot in the thermal sticks well to the suggested rules, the matter remains more than thrilling. According to the structure of the thermal, paragliders and hang gliders may climb faster or slower than the gliders in the outside circle. The complete affair requires caution, constant visual contact and a perfect control of the aircraft. Every pilot who has to concentrate too much on controlling his aircraft, should load the risk of circling with a beginner neither on himself nor on the other pilots.

Whenever the pilot of a hang glider or a paraglider comes across a glider turning with bank of 45° or more, he can assume that the thermal is rather narrow and that it is not safe to enter it. Glide on and look for another updraft. I cannot at all accept the argument that you might possibly have to land if you do not catch this thermal.

The hang glider pilot's view upwards to the sides is limited by the wing of his aircraft. If we fly side by side, the glider cannot be seen any more, as soon as it is flying about 35m above the hang glider. This is true with both extremes of Figure 2 with T = 36 sec. and T = 18 sec. The situation improves, if we circle with shifted positions, as can be seen in Figure 2.

Let us now discuss the methods of entering or leaving a thermal in which aircraft are already circling. A glider pilot who approaches a group of hang gliders does not have many problems. He approaches on a tangential course which leads to a clearly bigger radius than that of the hang gliders. Then he adopts his bank and radius, so that he can keep the angular velocity of the hang gliders.

It is quite clear that it is more complicated, when a paraglider or a hang glider wants to join a thermal in which gliders are already circling. The simplest way to do that is when he arrives at a different altitude; ± 50m is not overdone. You may suddenly climb or fall when on the border of a thermal.

When hang gliders are going to enter the gliders'

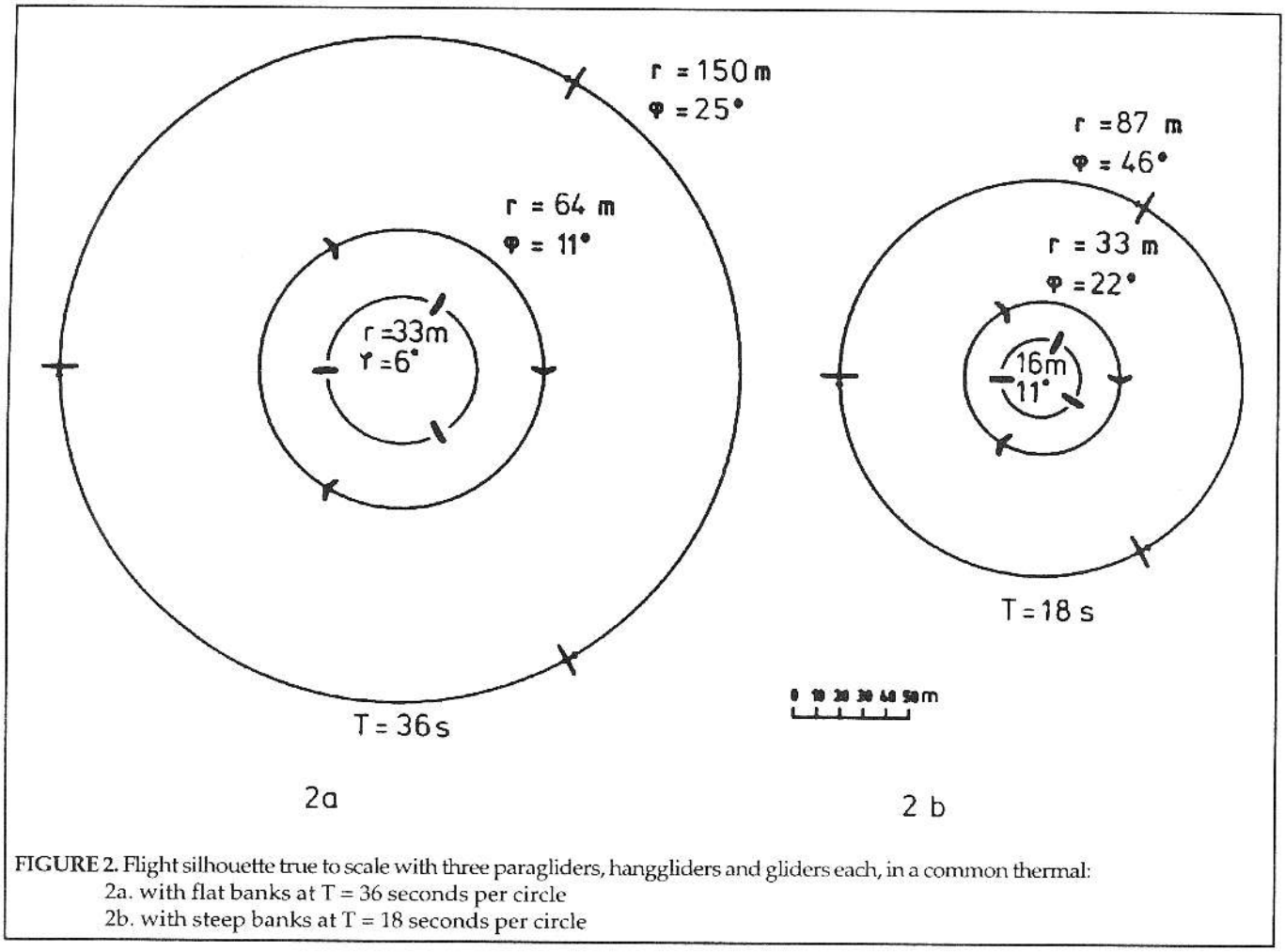


FIGURE 2. Flight silhouette true to scale with three paragliders, hanggliders and gliders each, in a common thermal:
2a. with flat banks at T = 36 seconds per circle
2b. with steep banks at T = 18 seconds per circle

circle at approximately the same altitude, the difference between the speed of both aircraft is critical itself. If more than three gliders are circling together, hang gliders should not try to enter the gliders' circle at all, but wait until they have climbed. Even if there are only three of them or less, the hang glider pilot, whether he likes it or not, has to speed up in order to cross their outside circle. And I guess, 70 km/h is better than 60 km/h. Otherwise, the hang glider pilot plays "Grandpa at green traffic lights" and jams the traffic. That he has to cross shortly after the glider in front of him and far before the next one goes without saying.

In spite of these precautions, the hang glider pilot should only dare to cross the outside circle, when he can be sure that the partner in the glider is on his guard. In this situation, a constant visual contact saves lives. It would be both unfair and fatal to push away the circling partner from his course, having in mind any evasive maneuvers according to air traffic rules.

When the hang glider has successfully crossed the course of the gliders, he has to join the circle of the other at most two hang gliders at the same altitude. This task is not less demanding. Adopt the bank, speed and radius of your partners, but do it carefully.

The extreme difference in speed between paraglider and glider makes it impossible for the former to cross the circle of the latter at the same altitude. The paraglider inevitably has to wait and enter at a different altitude. However, the paraglider can enter a thermaling group of hang gliders safely, if he does it like the hang glider which enters a circling group of gliders, as described above.

If the hang glider wants to leave his inside circle, this maneuver, if it is inevitable, can only be done with utmost caution and according to the rules for entering a thermal: speed up and cross the course of the others shortly after a glider. It goes without saying that, when speeding up, he has to pay attention to what is going on below him.

All the rules mentioned so far only achieve their purpose, if each pilot flies in a most disciplined manner. And each pilot has to see that by shifting his own circle recklessly, it becomes impossible to circle together safely The pilot finding a thermal has to accept that he alone can not be master in his own house and have absolute rule. We have to live with the fact that the complete group climbs worse than the single pilot could.

Think it over carefully and check strictly during several circles, if the intended shift of the circle really increases your and your partners' climbing rate, and thus is reasonable. Do not forget that your maneuver might force the gliders in the outside circle to climb

worse. If you really decide to shift your circle then do it gradually and with complete concentration on your partners. After all, you have imposed on them a reorganization of their circles. This takes time and demands caution and attentiveness.

We all know that there are two ways of finding the center of a thermal or of keeping the climbing rate at its best. Some of us turn more steeply when they find decreasing climbing rates; others flatten the turn when they find increasing climbing rates. In a crowded thermal we can make use only of the second variant. It is easier for all to understand and, therefore, less dangerous. And it avoids a stall, one of the greatest sins against safety, when we fly together in a thermal.

In a crowded thermal, it is extremely dangerous if we try to climb over each other. It will not disturb the hang gliders or the paragliders if a glider climbs faster. However, it becomes extremely dangerous, if hang gliders and paragliders climb over their partners. The latter have to make way, because they are climbing more slowly. They will get into desperate difficulties, since they inevitably get into the course of the gliders outside, when they make way for those who are climbing faster inside. This dangerous situation can only be avoided by utmost discipline. Here we have to give up a little personal advantage in favor of safety again.

Let us now sum up the essential rules we ought to follow, when we enter or leave a group of paragliders, hang gliders and gliders thermaling together:
– approach on a tangential course
– paragliders should never cross course of gliders. They must enter at least 50m above or below.
For hang glider pilots:
– speed up to 60-70 km/h and make visual contact
– cross course of gliders shortly after a glider
– adopt speed and bank to common angular velocity as soon as you have reached the inside circle
– avoid leaving the inside circle at the same altitude
– better do not shift position; if you cannot avoid it, reduce bank clearly when climbing rates increase
– do not try to climb over others.

If we reflect upon what has been written in this paper, we will find that we have talked much about consideration, about the renunciation of little personal advantages and about partnership. I have done that because I am convinced that our problem – to enable paragliders, hang gliders and gliders to circle safely together in the same thermal – cannot be solved without this fundamental attitude.

If the technical development of paragliders and hang gliders continues, the difference in speed between these aircraft and gliders will keep on decreasing. Come what may: if both sides are full of good intentions, we will get along well with each other when circling together in a thermal, even if the airspace of the gliders becomes constantly smaller.