CROSS-COUNTRY FLYING WITH HANG-GLIDERS STATE OF DEVELOPMENTS AND PROSPECTS

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Summary

The number of cross-country flights of more than 50 km with hang-gliders rose exponentially in the last six years. The relative rate of increase averaged at 90% per year. The reasons for this achievement are being examined. Obviously, the tactics of cross-country flights have been optimized. At the same time, the gliders have become safer and have gained better handling and performance.

Starting in 1987, the tow behind Trikes (weight-steered UL's) is expected. This will bring new impulses to cross-country flying over plains.

Introduction

On March 15, 1973, Mike Harker started from the top of Germany's highest mountain, the Zugspitze, with a primitive glider. With this sensation, hang-gliding started in Europe 13

years ago—more smiled at than admired by the other members of the flying sports.

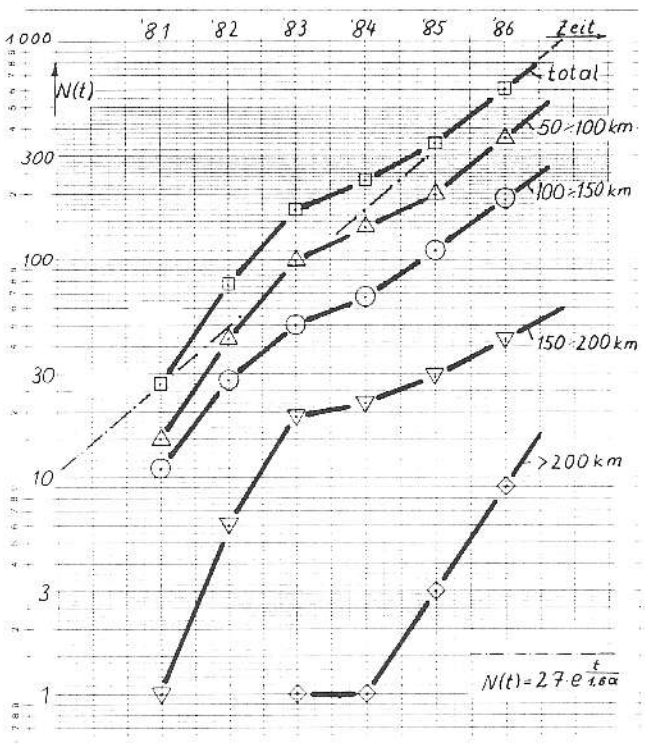
Six years later, on May 26, 1979, Ernst Reichholf flew over 100 km for the first time in the Alps—on the standard route of the sailplanes, in the Pinzgau. Only four years after that, on July 13, 1983, the American Larry Tudor raised the cross-country world record up to 354 km in the Sierra Nevada.

These are spotlights on the new cross-country flying variant in gliding. The fascination coming from the thermal cross-country flying with hang-gliders obviously exceeds the pleasure of flying in slope winds. Actually the extent of cross-country flights with hang-gliders is increasing like an avalanche.

This shall be proven and analysed with this paper.

Statistical analysis

In Picture 1, the uppermost curve shows the total number N(t) of all registered cross-country flights since 1981 with more than 50 km distance, flown in the German-speaking countries (Germany, Austria, Switzerland), according to (1) and (2).



PICTURE (1). Number N (t) of cross-country flights in German speaking countries (D, A, CH) from 1981 to 1986. Parameter: Distance

The curves below are subdivided according to distances: Flights of more than 200 km in the first curve from the bottom, above the curves with flights of 150 to 200 km, 100 to 150 km and 50 to 100 km.

It is not hard to approximate the upper three curves to straight lines. This is not possible for the lower two curves; because of the small amount of registered flights in these two categories, the statement is statistically still too vague. Because the upper curves can be approximated to straight lines, an exponmential equation in the form

$$N(t) = N_o e^{t/T} \qquad (1)$$

describes their course. Exactly this type of function is displayed as a straight line in the halflogarithmic graph-system shown in Picture 1. N_o is the number of flights at $t = 0$ (1981) and T is the time-constant; it is determined by the gradient of the straight line. For the upper curve the equation of the chain-dotted approximation is:

$$N(t) = 27\, e^{t/1.6a}. \qquad (2)$$

These exponential functions suffice the simple differential equation:

$$dN / dt \sim N(t) \qquad (3)$$

This relation is typical for all processes of growth "at their best", like, for example, the unhindered multiplication of wood in forests or rabbits in Australia. In all these cases the rate of growth dN / dt is proportional to the existing amount, N (t).

In our case, the experience gained in successful flights represents the existing amount. The rate of growth, dN / dt is proportional to this amount.

In the last six years, the number of flights increased year after year on the average by the factor 1.9, according to equation (2). Therefore, the relative rate of increase is:

$$dN / (N\, dt) = 90\% / a \qquad (4)$$

This is an impressive development of which there's no end in sight.

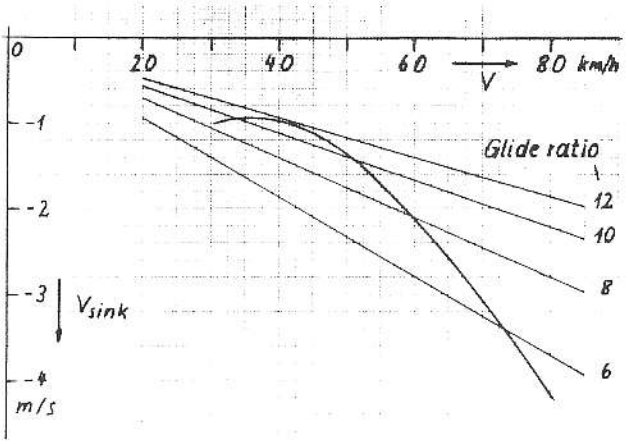
Obviously the knowledge of the pilots about tactics, technics and strategy of cross-country flying has constantly expanded. Some basic knowledge was taken from the know-how in gliding, but by far not all.

Cross-country—tactics

The hang-glider pilot has to live with flight performances, which can merely win a pitiful smile from glass fibre fetishists.

Picture 2 shows the performance polars of a modern hang-glider (Saphir 17) according to (3). It becomes obvious that, when flying cross-country with such devices, just about every single misjudgment leads to an early outlanding. Glide ratios are quite poor at the moment. A careless flight into a downdraft area, for example, cannot—as is possible with sailplanes—be compensated by high velocity: at 890 km/h and a polar rate of sinking of -4 m/s the glide ratio is already below 6 in calm air.

Analysing old sailplane-barograms—for example from BABY II b—one can see that even then the wrong approach to a cloud, which then didn't bring the expected gain in altitude, often led to an outlanding. The consequence is—today it seems absurd—a flying style where the pilot tries to keep his altitude. As you can see in Picture 3A, this produces a rather "round" barogram. BABY had a best glide ratio of 16 at about 50 km/h. Good hang-gliders of today have their best glide ratio of 12 at about 40 km/h. The difference only seems small because in high speeds—for hang-gliders that is about 50 km/h—every gain in glide ratio makes survival easier when crossing a downdraft area.

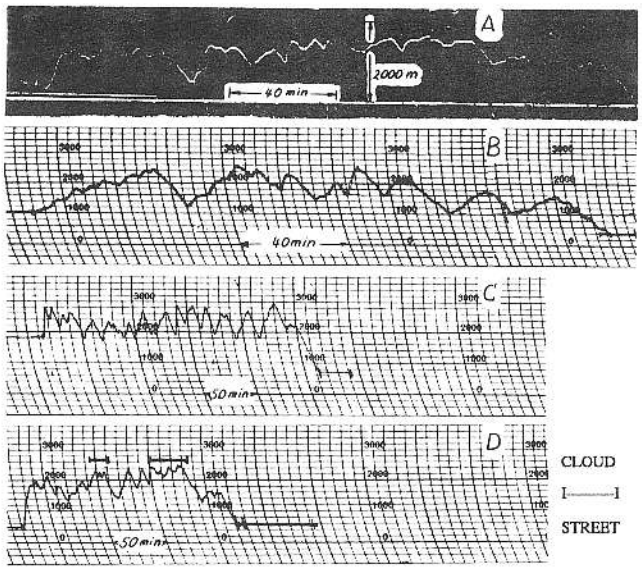


PICTURE (2). Performance polars of hang-glider SAPHIR 17 (wing area 17 m², aspect ratio 6.9, span 10.8 m.)
Manufacturer: BAUTEC Co., D-5500 Trier.

So, in cross-country flying, again the old golden rule counts: Get altitude, keep altitude! Over plains, where local clouds, or slopes, have to be steered at, caution is necessary whenever not in lift.

Barogram B in Picture 3 looks similar in many ways to the BABY-barogram in 3A. In barogram B the flight went over 50 km of hilly landscape in the Bavarian Forest at an average velocity of 14 km/h. Over plains, after subtracting the influence of wind, 10-15 km/h are indeed respectable values.

On the other hand, if the next lift can be reached safely, as for example in the Alps along a mountain chain, a quick cruising according to the MCREADY-theory is sensible. Still, average velocities of more than 30 km/h—even in the Alps—are the rare exception. The goal and return flight according to barogram C in Picture 3 averaged a mere 18 km/h over a distance of 75 km, even though the average climb rate often exceeded 3 m/s and no serious sinking situation came up. The saw-tooth form of the barogram catches the eye and proves the consequently applied MCREADY-way of flying.



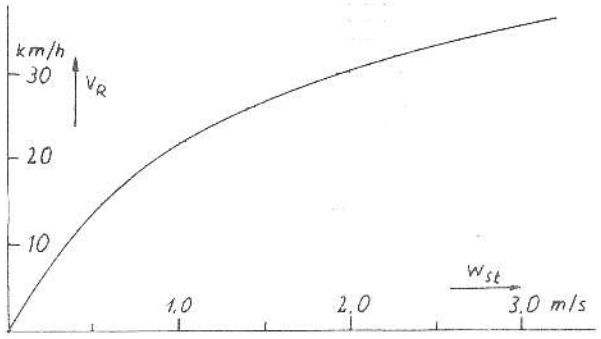
PICTURE (3). Barograms
A. Sailplane BABY IIb, plains 72 km, V_R = 8 km/h
B. Hang-glider MAGIC III, hilly 50km, V_R=8km/h
C.Hang-glider MAGIC III, Alps75km, V_R=18km/h
D.Hang-glider MAGICIIIplain142km, V_R=23km/h
V_R=cross-country speed after subtraction of wind.

In the rare situation where cloud streets over plains can be used, the average velocity can rise to 20-25 km/h. The barogram D in Picture 3 was recorded on a 142 km-flight with two rapid cloud-street parts. The average velocity was 43 km/h with winds at 20 km/h coming from behind.

Despite all the innovations in cross-country tactics, it needs to be said that the highest reachable velocities, according to MCREADY, (Picture 4) surely have not yet been reached. Therefore, triangular flights at wind velocities of more than 10 km/h will remain to be rare exceptions.

Next to the gained safety in flying, two more facts concerning the technics which benefit cross-country flights need to be mentioned.

For one, there is the almost miraculous work of the manufacturers. They managed to increase the performance of the hang-gliders enormously and to optimize handling at the same time to such a degree that flights of several hours have not become the privilege of Tarzan-like Supermen. On the other hand, this does not mean that a cross-country pilot does not need to be thoroughly fit. Actually he needs to be in much better shape than his rival in the sailplane. This is not very obvious because the hang-glider seems so elegant and gravity-less when it's in the air. The thermal cross-country flight is more like a tough constant strain of shoulder, back and arm muscles—and brain muscles too! Here the pilots learned their lesson. They train themselves as well for the next cross-country season as other professional athletes.



PICTURE (4). Maximum cross-country speed V_R (V_{st}) as a function of mean updraft V_{st} as calculated for the SAPHIR 17.

Secondly, pilots are now less stressed physically because of the improved suspension belts. The so-called Integral (or fish-shaped) belt is used more and more. Besides the easy slipping in after the start it also allows flying with almost no exhaustion in the horizontal, face-down position and it protects the body perfectly from cooling off. Only head and arms are still unprotected from the wind.

Also needing mention are flight-instruments. Compass, variometer and instruments for altitude and speed have become absolutely necessary for cross-country flying. Pilots have also learned to value the benefits of a radio. It's sensible and common to let the costs of the instruments and of the hang-glider be comparable. This way there is a lively competition with instruments in all prices and qualities developed on the accessory market. Some electronic instruments are surprising with their small size and power consumption and low price, yet, unfortunately, also noteable is the unreliability.

Pilot reserves

The unexpected growth which I mentioned in the beginning of this paper can and will bew real if the future developments fail to produce additional hindrance or limits. This means that all helping parameters mentioned are developed further—those parameters concerning the technics as well as those concerning the pilot.

The resources of young would-be pilots are sufficiently big for the moment. The achievements of the last few years and the costs for an hour of flying are obvious and encouraging.

Forecast

If the designers don't have some ingenious idea, there will probably be only small steps in improvement on the flexible textile wing as far as handling and performance are concerned. All rigid-wing solutions haven't proven to be competitive. Here, almost all pilots demand to be able to start and land by foot. This way the upper limit of 40 kg needs to be considered: nobody can or wants to carry more.

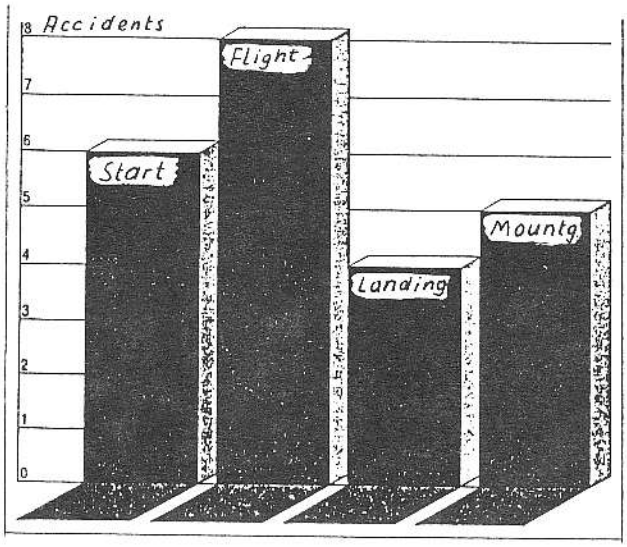
The wide introduction of the launch by winch hasn't—at least for now—fulfilled the hopes set into it. I'm sure that part of the reason for this is the marked individualism of the Delta pilot; he is not as willing as the glider-pilot to work in a team with others. That is why, of all registered flights started in 1986, only one single flight was started by winch. Therefore, this way of starting does not promise a great progress in the near future.

On the other hand, a lot of hope is set into the start tow by an Ultra-light. The test phase has been tested in Germany. We are expecting the general permission of this way of starting in 1987. The French were our teachers. They already flew entire competitions with this system of starting. It is surprising that only the weight-steered UL's (Trikes) proved themselves in practical towing while three-axis steered machines have not.

The pioneer of towing behind UL's is Gerard Thevenot, Delta designer and record pilot (260 km cross-country flying over plains after UL tow). He even managed with his 64 horsepower Trike to pull a sailplane, a KA 8, up to 500 m altitude. It only took 5 minutes and 2 liters of fuel.

Being able to start and to release in the updraft still seems unbelievable to today's Delta pilot. So far, he always had to start into slope updrafts and park there until he could ascend in the thermals and fly off. This took time, nerves and strength.

On days with insufficient slope updrafts, it was a tricky and often unsuccessful game of chance trying to find an updraft in the few minutes of flight between starting and landing. This is why the Alps have become the Mecca of hang-glider pilots because there they have a very good chance of finding thermals when starting in a sufficient altitude. But even in the



PICTURE (5). Analysis of reasons for the deadly accidents in 1985 according to (4).

Alps there are days on which chances of starting are slim, expecially when winds are too strong or the clouds are too low.

With the tow behind a Trike, our sport will definitely lose some of its originality but on the other hand the chance of considerably expanded cross-country strategy will be opened up. Days of weak winds could even be used in the plains, the moment of starting could be chosen more precisely, and the unpleasant question of which starting place is suitable for the present wind direction would finally be eliminated. This way new possibilities of cross-country flights, of which we didn't even dare to dream till now, have opened up for us—almost too good to be true.

Please allow me to end this paper with a very personal comment. I talked about the fascination coming from cross-country flights underneath a hang-glider. Indeed, these flights have become much more attractive to me than cross-country flying in sailplanes.

For one thing, this surely is due to the challenge of flying with technically simple gear. But it also is due to the "contemplative-tranquil" way of travelling while flying cross-country with a hang-glider. It's more like the "airwalking" as propagated by Hans Zacher now and Wolf Hirth in former times than the rapid making-distance with modern glass fibre-speedsters. The landscape doesn't tear by underneath you; instead, it takes you at least three or four thermals until an interesting point in the countryside slowly becomes more distinct before you and then slowly passes out of sight behind you.

And which pilot isn't fascinated by the techniques of landing. In the touch-down phase of landing only the nose of the wing is abruptly pushed upwards, so the entire wing is used as airbrake. You land without making one step forward. Your forward velocity is zero, just like a helicopter.

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