# DELPHIN, THE DEVELOPMENT OF A VARIABLE-GEOMETRIE GLIDER

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**Summary**

**In the last few years several designers started developing a glider with variable wing geometry. The performance advantage of such a concept is undisputed, but there hasn't been a real success in any of the already realized projects. One of these designers is Fritz Mahrer from Bettingen/Switzerland. Ten years ago he set himself the target to develop a wing with a highspeed airfoil and "something" that allows an optimal adaptation for low speed flight. To obtain an economical construction, he wanted the concept to be as simple as possible. While his first step, Delphin I, was a study of feasibility for his idea of a slotless fowler-flap, his second glider, Delphin II, shows already some of the performance potential. The principle of moving a wedge-shaped flap between the rigid upper surface of the wing and an elastic lip is proved in many flight hours. The flaps can be operated easily and stepless within the whole operation limits of the glider. The construction is done very simple and the flap and it's drive can be replaced within minutes. The maximum lift-coefficient of the wing is 40% higher than with an ordinary airfoil. The possibilities of this concept are still not exhausted and the development has to go on.**

The aim of each glider designer, to raise the performance of a glider, is restricted by the strongly different demands in low and high speed flight. Whereas in circling and in low speed flight the maximum lift beside lowest possible wingloading are the important factors, minimal drag with a wingloading as high as possible are the demands for high speed flight. A concept with variable wing geometry offers the best solution for this task. According to calculations of Thomas and Eppler (1), (2) a gain of 15% in average cross country speed compared with a standard class glider can be reached. Different airfoils show the potential of such a concept with Wortmann flaps (Fig. 1 and Ref. (3)). The main difficulties with already realized gliders AN 66C, Sigma, Mü 27, fs 29 and SB 11 have been mechanical problems, operating of flaps and flight characteristics.

## From Delphin I ...

Fritz Mahrer decided one day, rather than copying a conventional glider, to develop a wing with high speed airfoil and a flap with optimal adaptation for low speed flight. The mechanic Fritz Mahrer, who started his soaring in building a Scheibe

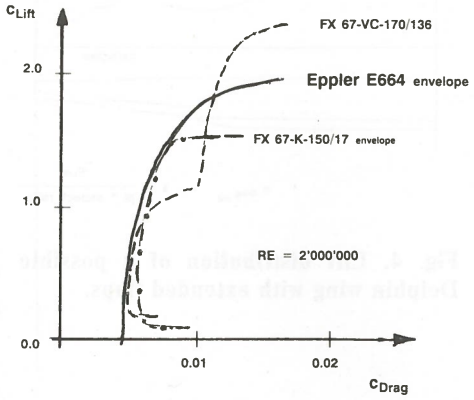


**Fig. 1. Polar diagram of different airfoils.**

Spatz and home-built gliders and learnt later to fly himself, focused his main effort on a simple construction and a perfect inflight handling. Delphin I was a test platform with a 20% deep Wortman flap on the inner part of the wing. The flap can be operated stepless in the whole speed range without any effort. The construction allows a smooth and undisturbed shape of airfoil, since a wedge-shaped flap is moving between the rigid upper part of the wing and an elastic lip (Fig. 2).

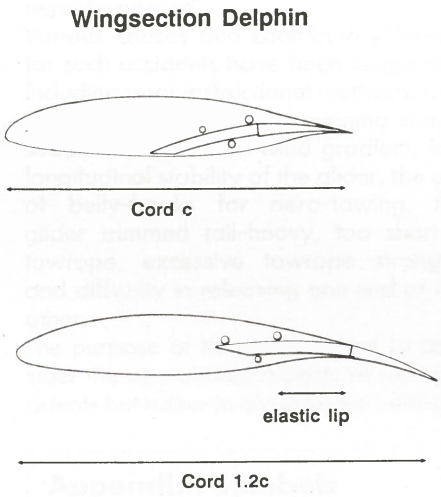


**Fig. 2. Cross-section of Delphin wing with flap.**

The whole flap and its kinematic parts consist mainly of two parts which can be replaced within minutes. The simple construction allows an economical manufacturing and easy maintenance. The support of the flap enables any deflection of the wing without influence to its operation. The friction has been constructively kept as low as possible and therefore the driving forces of the flap are as small as a conventional camber-changing flap. The reliability of this flap has been proven until now in numerous flight hours without any troubles or maintenance.

## ... to Delphin II

The well-proved flap delighted Professor Eppler to calculate a new airfoil in very short time, the basic idea of Delphin II, (Fig. 3 and 4). After four years and about 4000 man-hours Delphin II made his maiden flight in June 1982. The flight characteristics have been of good nature and the first measurements gave the following results (Table and Ref. (4)):

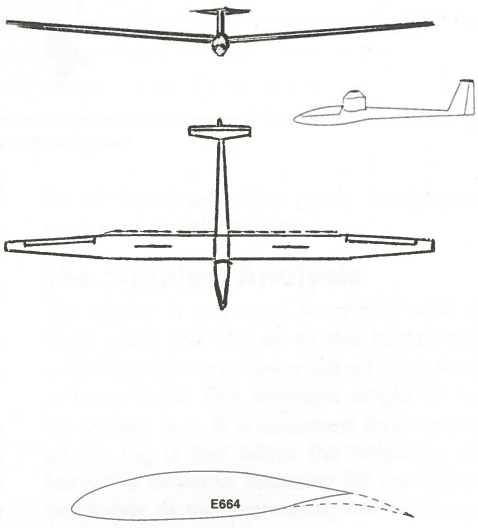


**Fig. 3. Views of Delphin II.**

**Table:** Delphin II* - Data sheet

| | |
|---|---|
| Span | 15.0 m |
| Length | 7.2 m |
| Wing area, flap retracted | 10.0 $m^2$ |
| Wing area, flap extended | 11.4 $m^2$ |
| Aspect ratio | 22.5 / 19.7 |
| Weight, empty, equipped | 245 kg |
| Minimum Speed ($W/S = 34.5$ kg/$m^2$) | 62 km/h CAS |
| Best Glide Ratio (at 100 km/h) | over 1 : 40 |

*Built by Fritz Mahrer from Bettingen/Basel. GRP-Sandwich wings with continusly extendable Wortmann flaps. Modified Elfe S4A fuselage with T-tail and dampened elevator. Wing section: Eppler 664 (Ref.)

In comparison Delphin II has about the same performance data than existing racing class gliders, but it is able to fly at about 8 km/h lower speed. Besides start and landing this capability offers mainly an advantage in circling, allows smaller circles and less bank. The climbing performance can be compared with a Ka 6. Without exact calculations for the optimum layout and with an old-designed fuselage the performance is considerably good. But the development potential of this concept is still open for improvement. The lift distribution of the wing with extended flaps should be optimized first. Though the Wortmann flaps are mounted only at the inner part of the wings, a nearly elliptic lift distribution can be achieved (Fig. 4). The aspect ratio has to be increased too, because higher lift coeefficients and wingloadings as usual are used also. The fuselage and the airfoil could be further improved and adapted.

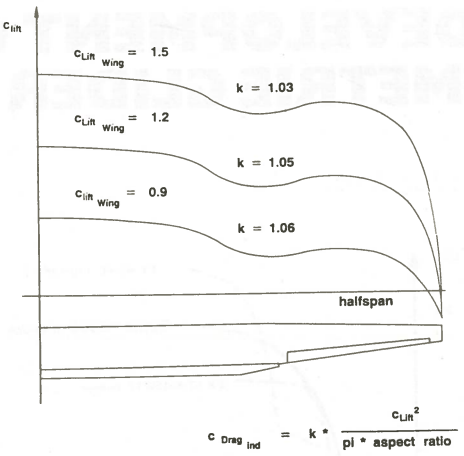


**Fig. 4. Lift distribution of a possible Delphin wing with extended flaps.**

To summarize: The variable wing geometry allows a remarkable increase in glider performance. The construction expenses should not be higher than using other possibilities, e.g. increasing the span. The Delphin has shown the feasibility and the potential performance for further improvement.

## References


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