THE DEVELOPMENT OF THE YUGOSLAV SAILPLANE TRIGLAV

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The first beginning of the design goes back to 1947, when the sailplane was designed under the name Karavan (fig. 1) but following the increased experiences of the just established factory "Letov" in Ljubljana, where the ship was to be built, the designers Dipl. Ing. Stojan Hrovat and the author were able to redesign and modify the project so that an advanced sailplane should be the result. The prototype flew in autumn 1948 and gave satisfactory results (fig. 2-3). The first measurements were taken with simple instruments and no speed calibration. Only one point at the best-gliding ratio velocity was controlled through a long glide in the quiet air with a height interval of 1200 m, over controlmarks on the ground and with time measurement. Because of the great height interval, slight technical errors were of little importance. The gliding ratio of 26,4 was in good agreement with other measured points of the polar. The acceptance tests completed, the type was named "Triglav" after the highest mountain peak in Slovenia and first discussions about serial production began. Two prototypes were built.

One year was allowed for collecting experience with both ships before work on modifications for the first series was to begin. The Triglav I flew under guidance of the late Milan Borisek at the second national competition in 1949 and finished third after Weihe (Arbeiter) and Orao (Pušić). The second plane resisted rough handling in cumulonimbus when turbulence of ± 25 m/sec was encountered. A speed of 290 km/h was reached with no damage to the ship. On all test flights the late Milan Borisek participated enthusiastically and gave many advices. The modifications for Triglav II were:

I) Modifications on the internal structure to reduce the empty weight.
II) Weather-cock stability was lessened to achieve better spiral stability.
III) Aerodynamic balance of the rudder was lessened.
IV) Flaps were improved through better slot design.

Flaps of the type NACA 2b were installed, which gave the wanted speed-reduction of about 10 km/h at low speeds. The empty weight was reduced to 167 kg and the needed greater forces for rudder deflections were realised through reduced balance. The reduction of directional stability, while giving the ship a better circling characteristic, produced a reduction in aileron effectiveness, as the adverse-yaw became more pronounced. A series of 10 sailplanes was built and the first had the designed canopy (fig. 5-6) becoming Triglav IIa. Later, Dr. Raspet informed us about plexi-blowing and all other ships of the series got blown canopies. They were named Triglav IIb (fig. 7-8).

One sailplane was taken for further modifications and measurements. In autumn and winter 1950/51 comparative test flights were flown with Triglav IIa and Triglav III, which had a much smaller blown canopy and wing-tip bombs (fig. 9-10). These modifications were made on advice of Dr Raspet. The tests showed that there was no difference between both sailplanes. Triglav III was measured and the flight-polar is given in fig. 11. The polar then (fig. 16) will show, that the drag between lift coefficients of 0,3 and 0,7 was too high and as the ailerons worked badly, we concluded that the reason be a partial flow-break-down at the wing-aileron passage, which differed from the original profile contour from 10 to 20 mm. In winter 1950/51 further modifications were made on this ship. The flaps were removed and the result was a better wing evenness; the wing surfaces were controlled on profile errors and improved. A V-tail was installed giving 20% tail area reduction (fig. 12-13). The flight results are given in fig. 14. As the c. of g. was back at 39% m.a.c., we could not fly at high angles of attack without oscillations in speed and yaw. The deflected elevator also influenced the parasite drag. The c. of g. is now on its correct interval and now we can appreciate the good effects of the V-tail especially in circling flight.

In fig. 15-16 the whole improvement can be seen. We did not get such fine results as Dr Raspet and D. Johnson with their Tiny Mite or R.J.-5 for their ship was cleaner at the beginning, having no slots or external flaps and a wing profile (Göttingen 549), which will not allow many further improvements as any laminar airfoil could do.

Appendix I : Numerical data of performance measurements.
Appendix II : General data of the Triglav.
Appendix III: Figures 1 - 16.

References:

(1) Raspet, A., & Johnson, R.H., Aerodynamics of "Tiny Mite" Soaring 1950/11-12.

(2) Raspet, A., Influence of systematic variation on the drag polar of the sailplane RJ-5.

APPENDIX I.

Numerical data of performances measurements.

I) Triglav I measurements, autumn 1948.

c_L	c_D	v_h	v_s	E
0,487	0,0320	96,2 km/h	1,598 m/sek	16,7
0,598	0,0292	86,7	1,194	20,5
0,763	0,0300	77,0	0,884	25,4
0,933	0,0345	70,3	0,750	26,4
0,992	0,0384	67,5	0,722	25,8
1,152	0,0478	62,5	0,722	24,2
1,351	0,0624	59,7	0;779	21,8

II) Triglav III measurements, autumn-winter 1950/51.

c_L	c_D	v_h	v_s	E
0,198	0,0220	148,7 km/h	4,620 m/sek	9,0
0,300	0,0276	118,6	2,930	11,2
0,445	0,0301	99,2	1,855	14,8
0,553	0,0298	89,2	1,337	18,5
0,698	0,0279	79,2	0,882	25,0
0,800	0,0293	74,3	0,757	27,4
0,912	0,0344	69,3	0,727	26,5
1,065	0,0452	64,5	0,760	23,5
1,252	0,0612	59,4	0,805	20,5

III) Triglav III measurements, summer 1951.

c_L	c_D	v_h	v_s	E
0,335	0,0230	108,8 km/h	1,930 m/sek	14,6
0,403	0,0226	99,0	1,550	17,8
0,554	0,0239	84,5	1,008	23,3
0,631	0,0250	79,1	0,878	25,2
0,766	0,0270	71,7	0,704	28,4
0,878	0,0323	67,0	0,673	27,2

The results given are based on the standard atmosphere at sea level and are transformed for the same wing loading of 20 kg/m^2.

APPENDIX II.

General data.

General data are given first for Triglav I and then for Triglav III.

Span	15 m	49, 2 ft
Wing Area	13, 25 m^2	142 sq. ft
Aspect Ratio	17	
Taper Ratio	0, 29	
Root chord	1, 45 m	4, 75 ft
Tip chord	0, 42 m	1, 38 ft
Root airfoil	Göttingen 549	
Tip airfoil	Göttingen 676	
Washout	7°	
Length	6, 8 m	22, 2 ft
Fuselage cross-section	0, 55 - 0, 52 m^2	5, 12 - 4, 85 sq. ft
Horizontal tail area	1, 85 m^2) 2,02 m^2	20 sq. ft) 18, 8 sq. ft
Vertical tail area	1, 10 m^2)	11 sq. ft)
Empty weight	175 - 168 kg	396 - 380 lb
Flight weight	260 kg	590 lb
Wing loading	20 kg/m^2	4, 14 lb/sq. ft
Load coefficient (n_A)	12, 5	
" " (n_R)	11	
Maximum allowed speed in calm air	250 km/h	155 mph
Max. attainable speed with activated brakes	195 km/h	121 mph
" tow speed in calm air	160 km/h	100 mph
" " " " turbulent air	120 km/h	75 mph

Fig. 1 Karavan, the project in 1947.

Fig. 2 Triglav I in autumn 1948.

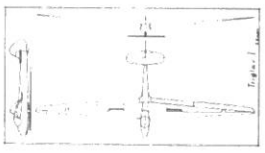

Fig. 3 Triglav I.

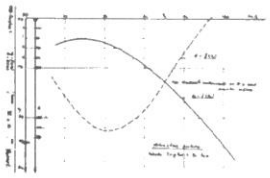

Fig. 4 Flight polar of Triglav I.

Fig. 5 Triglav IIa.

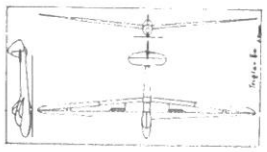

Fig. 6 Triglav IIa.

Fig. 7 Triglav IIb.

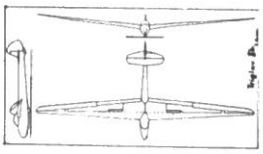

Fig. 8 Triglav IIb.

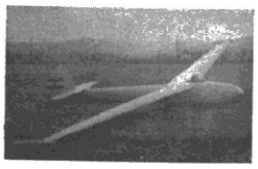

Fig. 9 Triglav III in autumn 1950.

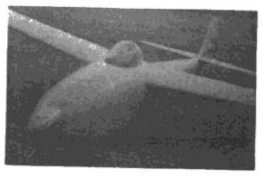

Fig. 10 The little blown canopy of Triglav III.

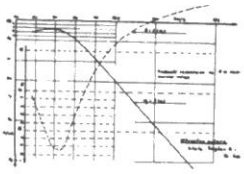

Fig. 11 Results of measurements of Triglav III in winter 1950/51.

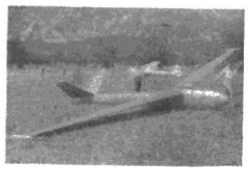

Fig. 12 Triglav III with V-tail in summer 1951.

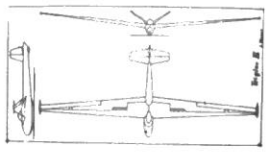

Fig. 13 Triglav III - 1951.

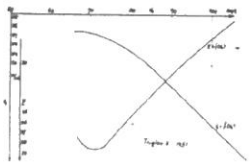

Fig. 14 Flight polar of Triglav III in summer 1951.

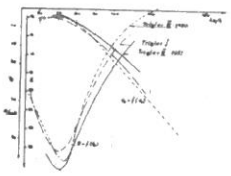

Fig. 15 Comparison of results.

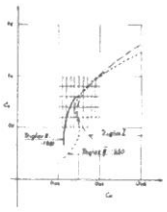

Fig. 16 Non dimensional polars.