Alfons Rieger’s “Nurflügelprofils”

Alfons Rieger’s tailless sailplanes have appeared in “Faszination Nurflügel,” and *Flüg- und Modelltechnik* and *Aufwind* magazines. These models, of the numbered “Sirius” series, are all of plank planform and designed primarily for slope flying.

In an effort to achieve incremental performance improvements, Mr. Rieger has taken to designing his own reflexed airfoil sections. The AR 193-S75 is based on the Eppler 193, while the AR 2411-S77 was initially based on the Eppler 205. The AR 2610-S80 is entirely of Mr. Rieger’s own design. All three sections have been used successfully. Despite their thickness, they exhibit relatively low drag at Reynolds numbers of 150,000 and above, and are capable of producing large amounts of lift with good stall characteristics.

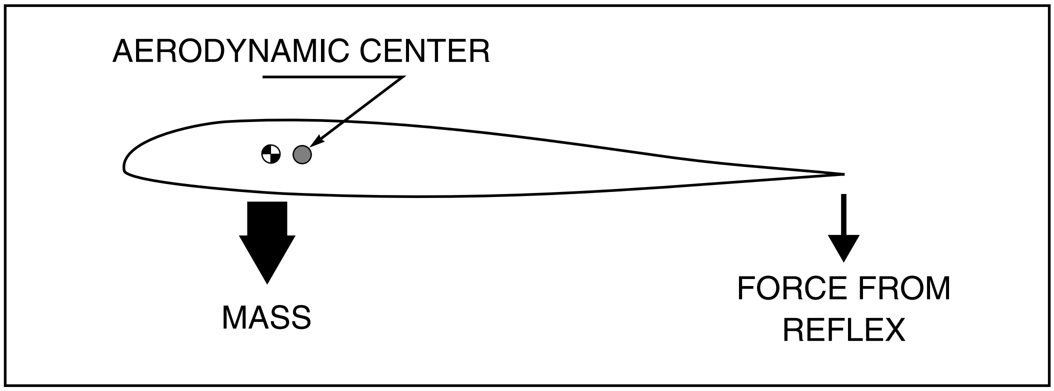
The aft portion of each section’s camber line has been reflexed to achieve a substantial positive pitching moment. The crossover point is at the percent chord denoted by the number following the “S.” Zero lift angles, moment coefficients, percent camber and percent thickness for each section are noted within the included data table.

The camber line of most “self-righting” airfoils is of an “S” shape. For dynamic stability, the center of gravity must be forward of the mean aerodynamic chord (MAC), and the reflexed portion of the airfoil must provide sufficient downforce for the airfoil’s pitching moment to be positive.

While the amount of reflex camber has a direct effect upon the pitching moment, the shape of the camber line ahead of the crossover point is important as well. If the goal is to modify a conventional section to achieve a specific pitching moment, a highly cambered section will require more reflex than a symmetrical section.

The usual practice when designing sections for plank planforms has been to place the crossover point at 75% chord. Fully 25% of the section’s chord is then devoted to overcoming the strong negative moment generated by the forward portion of the camber line.

When the crossover point is moved back to the 80% chord point, the percent camber of the reflexed portion of the section will need to be much greater if the pitching moment is to be held constant. Such sharp changes in the



camber line are not usually desirable, as the surface develops sharp curvatures and the possibilities for flow separation increase dramatically. As can be imagined, flow separation over any part of the stabilizing portion of the airfoil will most likely lead to disaster.

There are instances, however, where strong positive pitching moments are not required, or where the forward camber is low enough that not much reflex is required to achieve the needed pitching moment. In these cases, the crossover point can be safely moved rearward and the camber of the reflexed portion reduced to maintain a smooth camber line. Reducing the reflex usually lowers section drag.

These three sections demonstrate how the camber line reflex point and the amount of camber in the reflexed portion of the section can be adjusted to provide a required moment coefficient without unnecessarily increasing drag.

The camber line of the AR 193-S75 (C_m = +0.058) crosses the mean chord line at 75% chord, while the camber line of the AR 2411-S77 crosses the mean chord line at 77% chord (C_m = +0.027). The camber line crossover point of the AR 2610-S80, on the other hand, is at 80% chord, and its positive pitching moment is lower still (C_m = +0.026). It should be noted that the AR 2610-S80 would not usually be considered for use on a plank planform, yet Alfons has used it as the sole section for his Sirius 90 which performs extremely well.

Reflexed sections with large amounts of camber may sometimes benefit from artificial turbulation — at about 10 to 15% chord on the upper surface, and just forward of the crossover point on the lower surface. Sections such as the three described here, designed for the relatively high Reynolds numbers of slope flying (Re_{min} = 150,000), may then be suitable for the thermal-duration environment.

	AR 193-S75	AR 2411-S77	AR 2610-S80
$\alpha_{l=0}$	1.068°	0.11° *	-0.15°
C_m	0.058	0.027 *	0.026
camber	2.47%	2.33%	2.57%
thickness	10.23%	10.82%	10.0%

* = datum determined via Walt Lounsbery's computer program, SoarTech 1.

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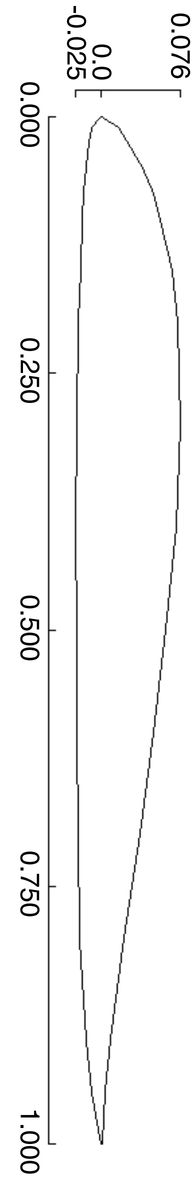
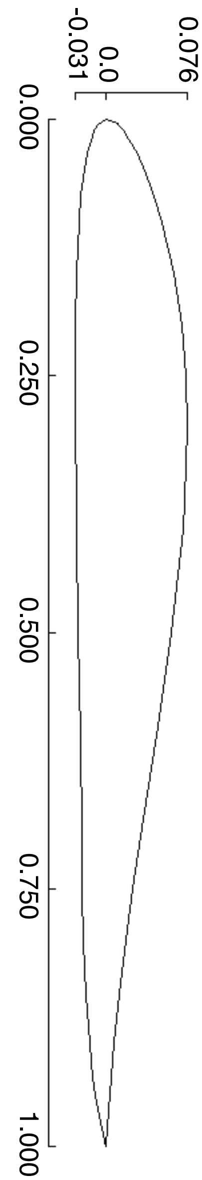
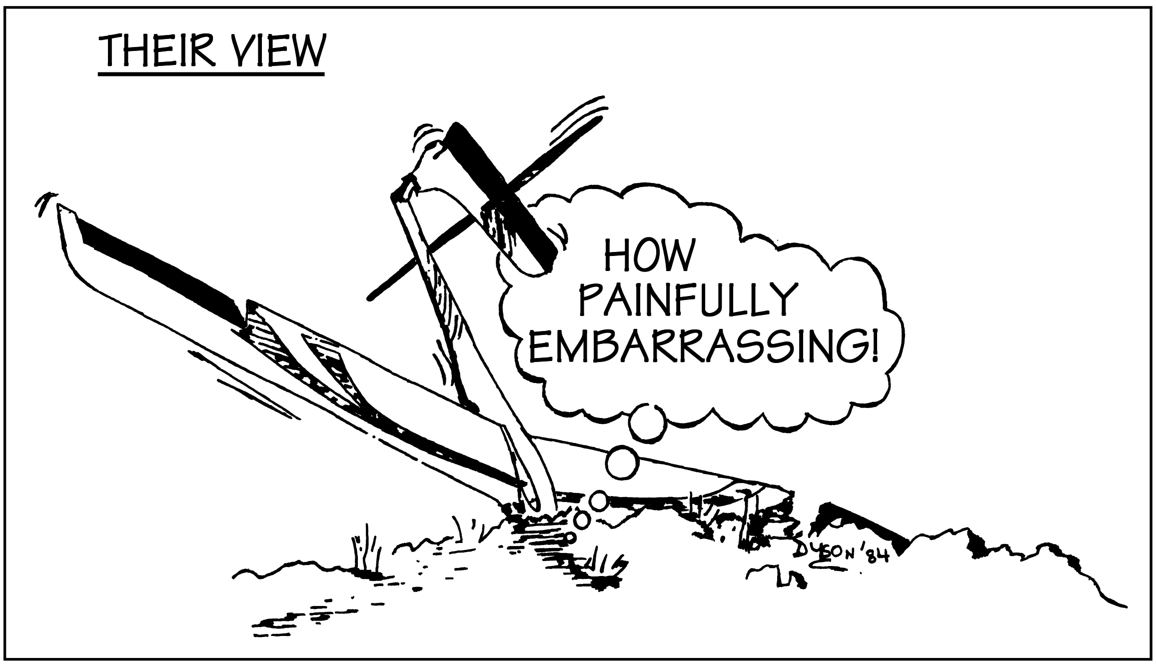
Simple Calculation of Airfoil Moment Coefficients, Walter Lounsbery. *SoarTech 1*, Herk Stokely, Editor. Herk Stokely, 1504 Horseshoe Circle, Virginia Beach VA 23451.

AR 2610-S80			
X upper	Y upper	X lower	Y lower
0.0	0.0	0.0	0.0
1.25	1.73	1.25	-1.035
2.5	2.58	2.5	-1.265
5.0	3.925	5.0	-1.535
7.5	4.955	7.5	-1.715
10	5.69	10	-1.85
15	6.76	15	-2.04
20	7.29	20	-2.235
30	7.55	30	-2.45
40	7.17	40	-2.51
50	6.15	50	-2.45
60	4.95	60	-2.40
70	3.65	70	-2.25
80	2.09	80	-2.09
90	0.815	90	-1.55
95	0.36	95	-0.94
100	0.10	100	-0.10



AR 2411-S77			
X upper	Y upper	X lower	Y lower
0.000	0.000	0.000	0.000
0.5	1.042	0.5	-0.736
1.25	1.710	1.25	-1.209
1.7	2.035	1.7	-1.410
2.5	2.510	2.5	-1.676
3.5	3.020	3.5	-1.920
5.0	3.685	5.0	-2.193
6.7	4.350	6.7	-2.415
7.5	4.636	7.5	-2.500
10	5.408	10	-2.715
15	6.553	15	-2.977
20	7.280	20	-3.080
25	7.670	25	-3.100
30	7.816	30	-3.050
37.06	7.637	37.06	-2.925
40	7.430	40	-2.875
50	6.351	50	-2.737
60	4.900	60	-2.587
70	3.314	70	-2.432
75	2.534	75	-2.350
80	1.829	80	-2.208
85.3	1.180	85.3	-1.990
90	0.700	90	-1.683
93.3	0.430	93.3	-1.323
95	0.312	95	-1.073
98.3	0.126	98.3	-0.425
100	0.000	100	0.000





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