WINGLETS

We've received several letters, and even a few 'phone calls, from RCSD readers who are designing, building, and flying their own swept 'wings. A common area of interest is "winglets," and so it is this month's topic.

Nearly all modern swept wing tailless soarers have fin area at the end of each wing. These winglets usually incorporate some sweep in their form and are mounted vertically, with their trailing edge meeting that of the wing itself.

Swept wings have some inherent directional stability. This is because as the wing yaws the span of the forward wing is effectively increased, creating more drag, while the drag of the receding wing decreases. The devilish problem which arises is yaw-roll coupling. This occurs because the forward wing creates more lift, as well as more drag, while the receding wing produces less lift. Yaw-roll coupling is not inherently bad, but it is something which needs to be kept under control.

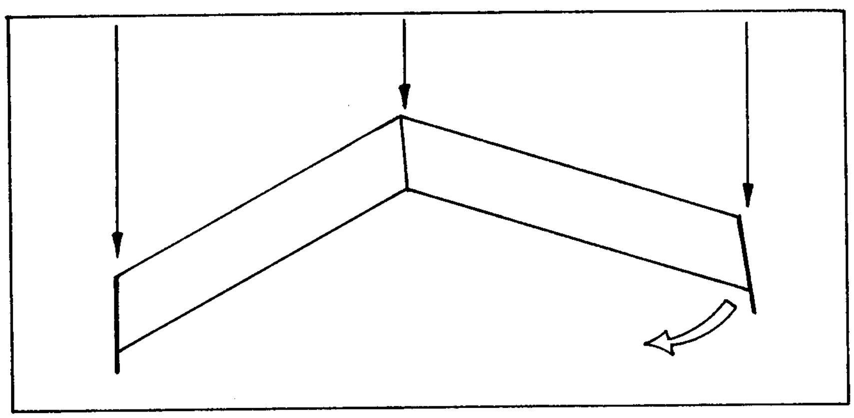
The first purpose of fin area, then, is to provide additional directional stability, hence reducing yaw and the associated roll. The second purpose is to prevent a steeply banked 'wing from sliding span-wise toward the ground.

If these were the only reasons for fin area, we'd be likely to see only a single fin mounted on the centerline of the wing, perhaps on the end of a small boom if the sweep angle is large enough.

But by splitting the fin area in two, and placing each of the resulting smaller fins at the ends of the wings, we are able to effectively inhibit the vortex usually formed there. This increases efficiency. Some designers have taken this a step further and extended the elevons all the way to the winglets, allowing the winglets to seal the outboard tips of the elevons, thus increasing their effectiveness.

Most of the winglets that we've seen extend only upward from the wing, apparently because the smaller downward projecting portion of a true Whitcomb winglet would be easily broken off during landing. These winglets are commonly made of sheet balsa, with the leading edges rounded and the trailing edges sharpened. These "flat plate" winglets are prone to stalling, and are therefore mounted parallel to the direction of flight and aircraft centerline.

Admittedly, the flat plates seem to work well and are easily constructed, but the relationship of tip fin airfoil and toe-in is certainly a topic worthy of investigation.



The above diagram shows a positively swept wing yawed slightly to the left. Notice that if the tip fins are toed in just a couple degrees then the right fin tends to correct the yaw. The left fin would similarly correct a yaw to the right. No drag penalty would be incurred at low yaw angles (compared with a flat plate mounted at 0 degrees) if the symmetrical airfoil used is chosen carefully. A list of possible sections is included at the end of this column.

In an attempt to smooth the lift distribution at the end of the wing, a few designers have tipped the winglets outwards at a 5 to 10 degree angle from the vertical. The effectiveness of this technique is probably variable.

One final note: The term "winglet" does not properly describe the tip mounted fins we've talked about here. Neither does the term "tip plate." Personally, we're rather fond of the descriptive term used by Dr. Martin Lichte in his book "Nurflugelmodelle" - "Ohren" or "ears."

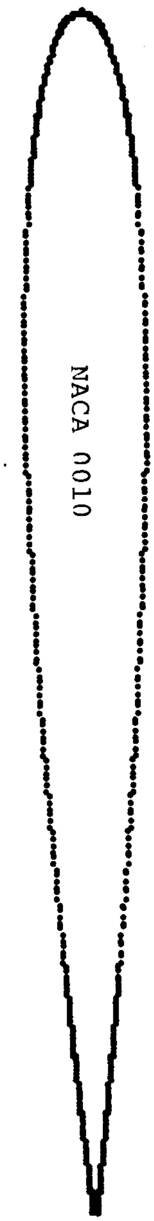
AIRFOILS OF NOTE FOR USE AS WINGLETS

NACA 0010
NACA 63-010/0
NACA 63A-010/0
HQ 0.0/10.0
RG15A-0/10

Coordinates and plots for the above sections begin on the next page. To reduce the 10% thickness to the thickness of your choice, simply multiply each Y ordinate by the suitable constant. For example, multiplying each Y ordinate by 0.9 will give the coordinates for a 9% thick section, multiplying each by 0.65 gives the coordinates for a 6.5% section.

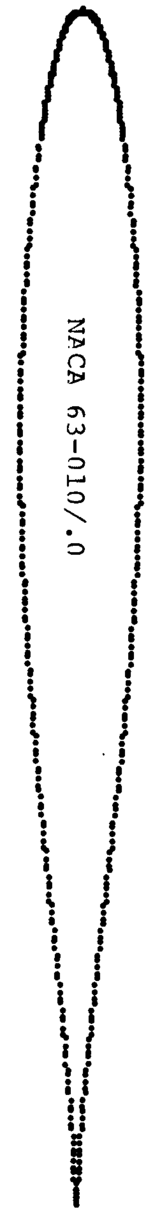
NACA 0010

X	Y
0.0	0.0000
.75	1.2374
1.25	1.5782
2.5	2.1789
5	2.9622
7.5	3.4999
10	3.9023
12.5	4.2128
15	4.4543
20	4.7813
25	4.9510
30	5.0014
35	4.9572
40	4.8358
45	4.6506
50	4.4117
55	4.1270
60	3.8028
65	3.4437
70	3.0533
75	2.6336
80	2.1859
82.5	1.9517
85	1.7105
87.5	1.4621
90	1.2064
92.5	0.9432
95	0.6721
97.5	0.3929
98.75	0.2500
100	0.0000



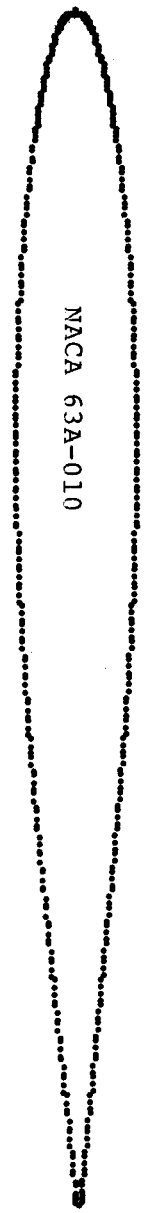
NACA 63-010

X	Y
0.0	0.000
.5	0.829
.75	1.004
1.25	1.275
2.5	1.756
5	2.440
7.5	2.950
10	3.362
15	3.994
20	4.445
25	4.753
30	4.938
35	5.000
40	4.938
50	4.496
60	3.715
70	2.712
80	1.618
85	1.088
90	0.604
95	0.214
100	0.000



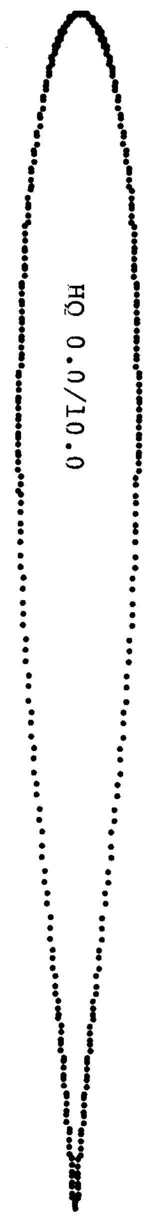
NACA 63A-010

X	Y
0.0	0.000
.5	0.816
.75	0.983
1.25	1.250
2.5	1.737
5	2.412
7.5	2.917
10	3.324
15	3.950
20	4.400
25	4.714
30	4.913
35	4.995
40	4.968
50	4.613
60	3.943
70	3.044
80	2.040
90	1.030
95	0.525
100	0.021



HQ-0/10

X	Y
0.0	0.000
.5	0.722
1.25	1.278
2.5	1.889
5	2.667
10	3.556
15	4.222
20	4.556
25	4.778
30	4.889
35	5.000
40	4.833
50	4.556
60	3.778
70	2.778
80	1.722
85	1.167
90	0.778
95	0.333
100	0.000



RG 15A

X	Y
0.0000	0.0000
0.3049	0.6203
1.1040	1.2661
2.2646	1.8706
3.8801	2.4693
5.8987	3.0163
8.3313	3.5123
11.1535	3.9442
14.3469	4.3071
17.8876	4.5956
21.7489	4.8075
25.8995	4.9414
30.3054	4.9982
34.9280	4.9791
39.7260	4.8875
44.6543	4.7256
49.6654	4.4978
54.7148	4.2026
59.7459	3.8348
64.6897	3.4110
69.4954	2.9611
74.1168	2.5074
78.5038	2.0665
82.6063	1.6519
86.3751	1.2749
89.7635	0.9428
92.7258	0.6611
95.2171	0.4280
97.2166	0.2359
98.7164	0.0935
99.6695	0.0190
100.0000	0.0000