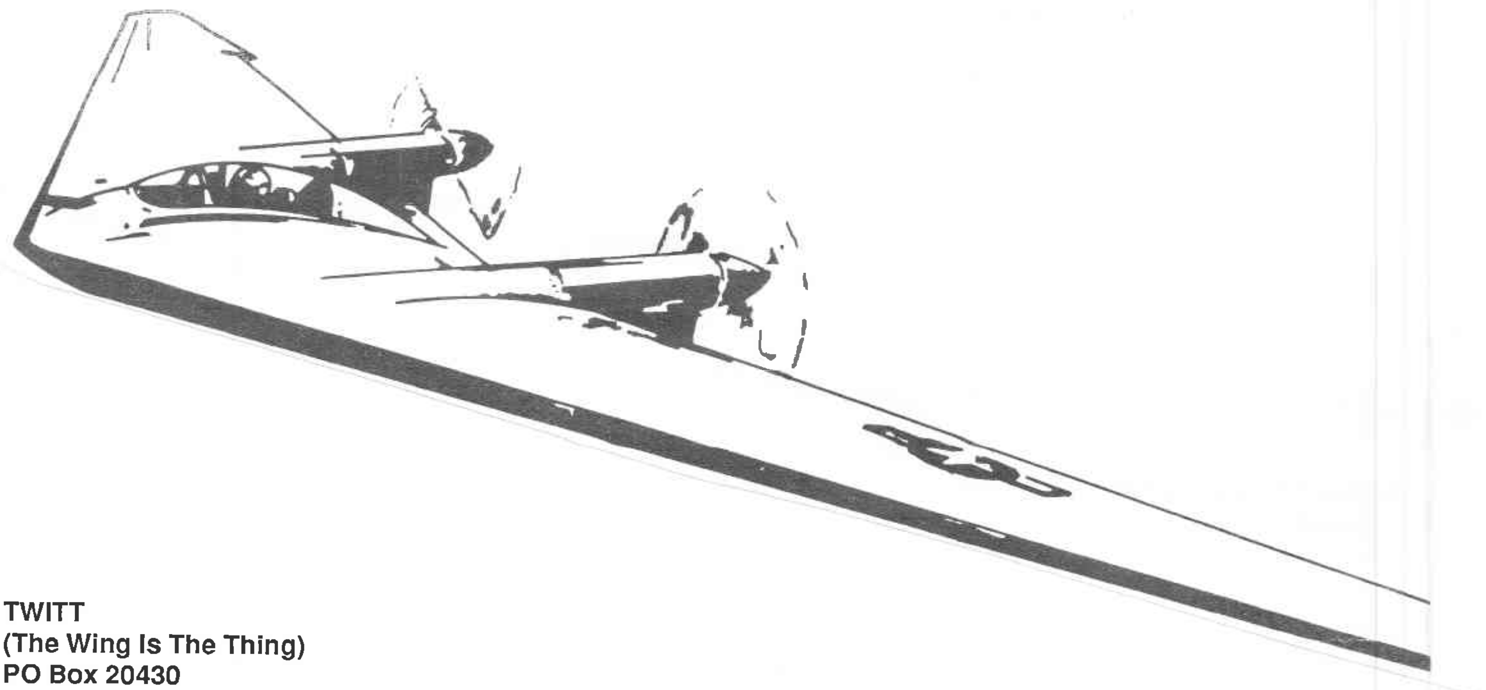
TWITT NEWSLETTER

F. Marc de Piolenc, Editor and Publisher



TWITT
(The Wing Is The Thing)
PO Box 20430
El Cajon, CA 92021
USA

The numbers in the upper right corner of your label indicate the last issue of your current subscription, e.g. 8904 means this is your last issue.

NEXT TWITT MEETING: Saturday, 15 April 1989, beginning at 1330 hours. As always, the location is Hangar A-4, Gillespie Field, El Cajon, California, in the first row of hangars on Joe Crosson Drive.

CONTENTS

MINUTES OF TWITT MEETING, 18 MARCH 1989

The meeting opened with the showing of a videotape on Alpine ballooning. Afterward, Bob Fronius asked visitors to introduce themselves. They included Kyle Swanson of Advanced Aeromechanisms in La Jolla, Frank Schulz, former president of EAA Chapter 14 and Bill Rickson, a hang glider builder (Icarus 2 and 5) and owner of an electroplating business. Bob then asked your friendly Editor to describe his misadventure on the freeway (Interstate 5) while returning from preparing Newsletter #33. This was quickly done (ran out of gas on the freeway around midnight, got back to the car with gas around 0600 to discover that the battery had been stolen). Bruce Carmichael introduced his guests Clayton Ward, who started flying in 1928 and Jack Lambie, who mentioned that he had bought a Fauvel from a Mr. Jukitch and found it uncomfortable to fly. It was heavy because American sizes of lumber had been used to build it, most of which were too thick. Trim was sensitive to cg position; the pilot leaned forward to go fast, back to slow down. The machine would ground–loop on the slightest provocation and was damaged once on takeoff by its own takeoff dolly. Bob then asked Harald Buettner to report on his trip to Reno, in the course of which he visited Rod Schapel, designer of the SA–882 featured in a previous issue. Harald's talk was short: he didn't know how much of the information he had was proprietary and wanted to consult with Mr. Schapel before giving TWITT a report. Bruce Carmichael then rose again to discuss airfoils. Years ago, when designing what was intended to be a cheap sailplane, Bruce had done a thorough survey of the then existing low speed airfoil sections, including the Liebeck sections, Eppler 748, Wortmann and some highly aft-loaded sections, before finally settling on an old Wortmann section. When asked by Jack Lambie why he did not use the Liebeck airfoils, which achieved spectacular performance at very high lift coefficients in the wind tunnel, Bruce answered that the Liebeck sections had a very high C_{dMin}, giving them poor performance below their maximum lift coefficients. Bob then introduced Barnaby Wainfan, who had come to San Diego to participate in the airfoil program at the Aerospace Museum and had graciously consented to talk first to TWITT. Barnaby led off by discussing the basic criteria for airfoil selection: C_{lMax}, drag at cruise lift coefficient, stall speed and so forth. He ascribed the fact that a relatively small variety of sections (compared to the number developed over the years) was actually in use to "technical Darwinism," those having chosen unsuitable sections having gone back to the Great Drawing Board in the sky. He felt that aft loaded airfoils, like the NASA NLF series, were unsuitable for light airplanes because of their considerable trim drag penalty, noting also that nearly identical performance at moderate lift coefficients could be achieved with airfoils having slightly positive or zero C_{m0}. Barnaby compared an airfoil that he designed using the Eppler code (the same computer program used at NASA by Dan Somers to design the NLF sections), with a positive zero-lift pitching moment of about .02, to an NLF section with the same design lift coefficient. Barnaby noted, however, that Somers was the first designer of laminar flow airfoils to give thought to maintaining lift and trim when the boundary layer is prematurely tripped. Thus the airplane can continue to fly with dirt or raindrops on the leading edge, albeit with higher drag. He also noted that aft camber has one useful function, namely delaying compressibility drag rise at high subsonic Mach numbers. That said, he noted that aft loading leads to very high aileron loads and "sticky" control linkages, and that every airplane he knows that is using aft-loaded sections has been modified (usually by filling in the lower cusp of the section) to reduce aft loading. Finally he noted that Al Backstrom had used a NACA 8–H–12, a helicopter blade section which places all its reflex curvature very near the trailing edge, on a tailless machine. The aileron loads were excessive and the machine was abandoned for that reason. Barnaby's own brain children—airfoils that he has designed to his own criteria using the Eppler code—are prefixed LMA for "Low Moment Airfoil."

APRIL MEETING

On 15 April 1989, TWITT will feature Ladislao ("Paz") Pazmany, a noted aircraft designer based in San Diego. Paz will give a presentation, originally prepared for delivery in his native Argentina, on his 40 years as an airplane designer. Your editor had the pleasure of taking the Pazmany Aircraft Design Course in 1981–82 and has heard snippets of the material that will make up this month's talk. Paz' delivery is irresistible and, for a designer known for his conservatism, he has been involved in a real smorgasbord of bizarre projects. This one should be well worth your time.

Bill Curry of Aero–Tech Aviation Hardware & Supplies, El Cajon has donated two caps and two tee–shirts to TWITT as raffle prizes. We will raffle off one cap and one tee–shirt at the April meeting.

TWITT ORGANIZES

Despite our earlier resolve to "keep it simple", TWITT's rapid growth has made some sort of framework desirable, if only to insulate its founder and principal sustaining patron, Bob Fronius, from the day–to–day concerns of keeping the group alive. Andy Kecskes has contributed a set of draft bylaws, which will be available for inspection at the April meeting, and a vote to elect officers is tentatively scheduled for the June meeting. Officers appointed *pro tempore* are:

- President............................Andy Kecskes
- Vice President.................. Philip Burgers
- Treasurer .... Robert Fronius
- Secretary and Editor......Marc de Piolenc

LETTERS

Kuhlmans Come Through Again

We received TWITT #33 a few days ago and noticed that there were several spots [in the Letters column—Ed] in which the figure (?) appeared. We're hoping tthat the following information will assist in clarifying some of these items:

(1) In the letter by Charles R. Fox, "Bryon Ohio's"" possibly refers to Bryan Aircraft (Bryan, Ohio) and R.E. Schreder. An information sheet on that firm's pulse-jet prop engine was run in TWITT #7. The information that Mr. Fox presented at the MARCS (Madison Area Radio Control Society) Symposium will most likely appearr in the Symposium Proceedings, to be published before the end of the year.

(2) The RG–15 is a slightly undercambered relatively aft–loaded section for model aircraft designed by Rolf Girsberger. There was quite a write up on several of his sections (the RG–12, 14 and 15) in SOARTECH several years ago. A few issues later Rolf wrote an article describing a method of changing the thickness and camber parameters for these sections. The RG–15 is the most popular section, and is used on several European F3B ships. Enclosed are data sheets for these sections. SOARTECH is a journal for RC sailplanes and is put out by Herb Stokely, 1540 Horseshoe Circle, Virginia Beach, VA 23451. The most recent issue was a "Flying Wing Special."

(3a) The Marske Pioneer series started with a (NACA) 23112-75, but the Pioneer II–D sections, according to the blueprints and information sent to us by Jim while we were constructing our model, are as follows: root section = NACA 43012A–75/24112–75, tip section = NACA 43012Ax.833-75.

(3b) We received a letter from Jim—a copy is enlosed. Please note the information concerning the new flying wing sections! As an aside, Michener's Pioneer is actually Marske's "super-ship" of a few years back, and it includes a larger fin, extended wing span and a sliding weight trim system.

(4a) The 4061 is a Mike Selig section. The coordinates were released a few years ago in SOARTECH. Its performance is <u>excellent</u>. Enclosed you'll find plots and coordinates for his 4061, 4062 and 4063, along with the same information for an airfoil that he's designed with John Donovon—the SD7032. These sections, and those of Rolf Girsberger, are all for low Reynolds number aircraft.

(4b) The 5010, and the 5020 as well, were designed for Dave Jones by Mike Selig and published in SOARTECH. See enclosed data sheets. You might make your own comparison between the 4061 and 5010.

(4c) Selig and Donovon have just completed an extensive wind tunnel study of low Reynolds number sections, including Epplers, Quabecks, Seligs and a couple of NACA sections, among others. Their reports will be printed in two volumes of SOARTECH. Cost is $5.00 for each volume, directly from SOARTECH/Herb Stokely; all previous issues of SOARTECH are still available, but the prices of the earliest copies are slightly higher as they are substantially larger and now in their second edition.

(5a) Martin Lichte's book *Nurflügelmodelle* is available from Verlag für Technik und Handwerk GmbH (publishers of the magazine *Flug– und Modelltechnik*), Postfach 1128, 7570 Baden–Baden 1, Federal Republic of Germany. Ask for Best.–Nr.

51

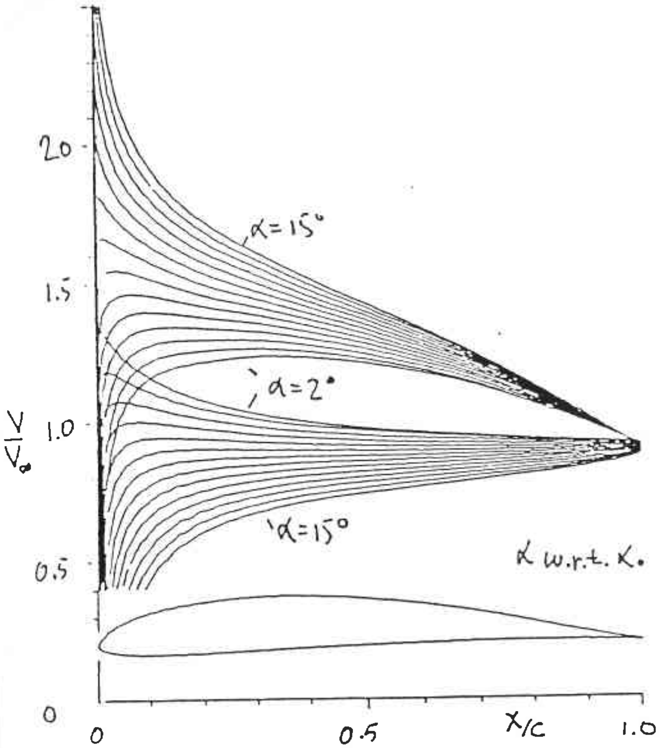


FIG. 36- VELOCITY DISTRIBUTIONS FOR THE S4061-096-84.

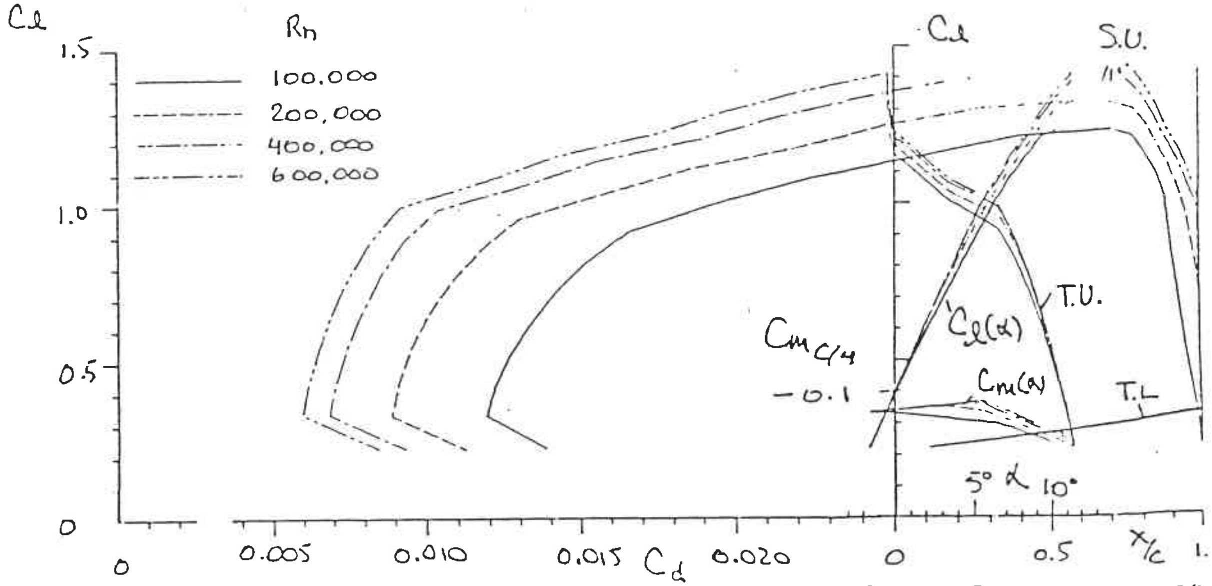


FIG. 37-THEORETICAL SECTION CHARACTERISTICS FOR THE S4061-096-84

THEORETICAL BOUNDARY-LAYER SUMMARY TABLE

AIRFOIL 4061-096-84

*-LAMINAR SEPARATION BUBBLE WARNING
O-NO SEPARATION BUBBLE WARNING
●-NO BUBBLE, TRANSITION BEFORE 0.05C
--SEPARATION AT LEADING EDGE (STALL)
+-ANGLE OF ATTACK WITHIN DRAG BUCKET

ALPHA (deg)	REYNOLDS NUMBER		100000		200000		400000		600000	
	us	ls	us	ls	us	ls	us	ls	us	ls
2			*	*	*	*	*	O	*	O
+ 3			*	*	*	*	*	*	*	*
+ 4			*	O	*	O	*	O	*	O
+ 5			*	O	*	O	*	O	*	O
+ 6			*	O	*	O	*	O	O	O
+ 7			*	O	*	O	*	O	*	O
+ 8			*	O	*	O	*	O	*	O
+ 9			*	O	*	O	*	O	O	O
+10			*	O	*	O	O	O	O	O
+11			*	O	O	O	O	O	O	O
12			*	O	●	O	●	O	●	O
12			*	O	●	O	●	O	●	O
13			*	O	●	O	●	O	●	O

X	Y
1.00000	0.00000
.99675	.00034
.98709	.00147
.97129	.00363
.94976	.00698
.92304	.01155
.89170	.01729
.85637	.02403
.81764	.03151
.77610	.03945
.73227	.04752
.68665	.05541
.63971	.06283
.59189	.06950
.54359	.07520
.49522	.07974
.44716	.08302
.39979	.08492
.35348	.08543
.30862	.08454
.26555	.08228
.22460	.07876
.18620	.07414
.15074	.06849
.11855	.06186
.08988	.05438
.06493	.04617
.04386	.03741
.02677	.02839
.01380	.01938
.00503	.01069
.00046	.00283
.00079	-.00320
.00681	-.00787
.01835	-.01209
.03499	-.01546
.05666	-.01780
.08328	-.01908
.11474	-.01932
.15085	-.01865
.19129	-.01724
.23565	-.01528
.28345	-.01292
.33413	-.01034
.38706	-.00772
.44159	-.00516
.49702	-.00279
.55265	-.00069
.60776	.00107
.66163	.00245
.71356	.00342
.76207	.00400
.80893	.00420
.85114	.00406
.88893	.00364
.92183	.00301
.94939	.00225
.97128	.00148
.98713	.00074
.99677	.00020
1.00000	.00000

S4061-096-84 COORDINATES

NACA 43012Ax.633-75
P2DTIP SECTION

0	100	0
1	99.9999	0
2	90	1.04
3	80	2.03
4	70	3.08
5	60	4.33
6	50	5.47
7	40	6.42
8	30	7.14
9	25	7.46
10	20	7.73
11	15	7.77
12	10	7.31
13	7.5	6.69
14	5	5.77
15	2.5	4.28
16	1.25	3.24
17	0	0
18	1.25	-.69
19	2.5	-.95
20	5	-1.28
21	7.5	-1.54
22	10	-1.76
23	15	-2.14
24	20	-2.46
25	25	-2.72
26	30	-2.92
27	40	-3.27
28	50	-3.36
29	60	-3.27
30	70	-3
31	80	-2.28
32	90	-1.25
33	99.9999	0
34	100	0

NACA 43012A-75/24112-75
P2DROOT SECTION

0	100	0
1	99.9999	0
2	90	1.28
3	80	2.48
4	70	3.66
5	60	5.08
6	50	6.37
7	40	7.44
8	30	8.25
9	25	8.51
10	20	8.63
11	15	8.45
12	10	7.7
13	7.5	6.97
14	5	5.94
15	2.5	4.37
16	1.25	3.22
17	0	0
18	1.25	-.9
19	2.5	-1.23
20	5	-1.73
21	7.5	-2.13
22	10	-2.45
23	15	-2.93
24	20	-3.31
25	25	-3.55
26	30	-3.81
27	40	-4.18
28	50	-4.23
29	60	-4.15
30	70	-3.64
31	80	-2.65
32	90	-1.41
33	99.9999	0
34	100	0

S4062

0	100	0
1	99.9999	0
2	99.67	.041
3	98.696	.178
4	97.107	.438
5	94.954	.836
6	92.297	1.374
7	89.2	2.036
8	85.727	2.799
9	81.936	3.628
10	77.881	4.487
11	73.609	5.339
12	69.165	6.147
13	64.5860001	6.881
14	59.909	7.513
15	55.168	8.024
16	50.397	8.399
17	45.626	8.63
18	40.887	8.717
19	36.217	8.673
20	31.661	8.51
21	27.271	8.239
22	23.092	7.864
23	19.171	7.393
24	15.55	6.828
25	12.259	6.173
26	9.326	5.435
27	6.769	4.627
28	4.604	3.765
29	2.843	2.876
30	1.499	1.986
31	.99	1.55
32	.578	1.124
33	.26	.694
34	1E-03	.339
35	0	0
36	.061	-.262
37	.18	-.43
38	.38	-.595
39	.608	-.725
40	1.2	-.96
41	1.719	-1.145
42	3.342	-1.482
43	5.47	-1.716
44	8.097	-1.844
45	11.211	-1.868
46	14.793	-1.8
47	18.813	-1.659
48	23.229	-1.462
49	27.993	-1.224
50	33.049	-.965
51	38.336	-.7
52	43.788	-.441
53	49.336	-.119
54	54.909	.015
55	60.436	.196
56	65.845	.337
57	71.006	.437
58	76.031	.495
59	80.673	.511
60	84.932	.491
61	88.751	.439
62	92.078	.364
63	94.869	.273
64	97.086	.178
65	98.695	.09
66	99.673	.025
67	99.9999	0
68	100	0

S4063

0	100	0
1	99.9999	0
2	99.673	.038
3	98.704	.166
4	97.122	.41
5	94.972	.784
6	92.314	1.29
7	89.207	1.918
8	85.714	2.646
9	81.896	3.444
10	77.806	4.279
11	73.496	5.114
12	69.01	5.917
13	64.391	6.655
14	59.679	7.303
15	54.909	7.839
16	50.118	8.247
17	45.341	8.517
18	40.613	8.643
19	35.967	8.628
20	31.439	8.483
21	27.074	8.222
22	22.921	7.854
23	19.024	7.387
24	15.425	6.823
25	12.156	6.167
26	9.241	5.428
27	6.702	4.619
28	4.554	3.756
29	2.807	2.865
30	1.475	1.974
31	.98	1.55
32	.565	1.113
33	.26	.694
34	.077	.329
35	0	0
36	.065	-.269
37	.18	-.43
38	.38	-.595
39	.619	-.728
40	1.2	-.96
41	1.736	-1.141
42	3.365	-1.469
43	5.5	-1.693
44	8.134	-1.81
45	11.256	-1.823
46	14.847	-1.744
47	18.877	-1.593
48	23.304	-1.386
49	28.079	-1.142
50	33.148	-.878
51	38.447	-.611
52	43.909	-.353
53	49.465	-.117
54	55.044	.09
55	60.573	.26
56	65.981	.39
57	71.197	.476
58	76.151	.521
59	80.78	.526
60	85.023	.496
61	88.824	.437
62	92.133	.357
63	94.907	.265
64	97.108	.171
65	98.705	.086
66	99.675	.024
67	99.9999	0
68	100	0

SD7032

0	100	0
1	99.9999	0
2	99.67401	.048
3	98.712	.204
4	97.155	.485
5	95.054	.894
6	92.464	1.42
7	89.436	2.041
8	86.02101	2.731
9	82.264	3.46
10	78.208	4.199
11	73.892	4.925
12	69.356	5.62
13	64.64601	6.27
14	59.812	6.861
15	54.902	7.381
16	49.967	7.816
17	45.058	8.154
18	40.222	8.385
19	35.506	8.5
20	30.953	8.493
21	26.604	8.359
22	22.499	8.096
23	18.671	7.703
24	15.146	7.182
25	11.948	6.548
26	9.104999	5.809
27	6.627	4.976
28	4.524	4.078
29	2.812	3.145
30	1.502	2.206
31	.606	1.293
32	.115	.448
33	0	0
34	.038	-.223
35	.532	-.701
36	1.649	-1.088
37	3.308	-1.403
38	5.491	-1.635
39	8.18	-1.787
40	11.351	-1.862
41	14.974	-1.867
42	19.01	-1.81
43	23.42	-1.699
44	28.153	-1.547
45	33.154	-1.363
46	38.364	-1.152
47	43.724	-.922
48	49.176	-.678
49	54.659	-.43
50	60.112	-.19
51	65.469	.03
52	70.664	.224
53	75.634	.379
54	80.31301	.485
55	84.635	.535
56	88.53399	.526
57	91.942	.458
58	94.797	.35
59	97.054	.226
60	98.684	.113
61	99.67	.03
62	99.9999	0
63	100	0

MBR3. The price is DM 14.80 plus DM 3.00 postage, about $12.00 at current exchange rates. VTH will accept personal checks made out in US Dollars.

(5b) Another book which TWITTs might enjoy is Reinhard Werner's *Nurflügelsegler Ferngesteuert* (Radio Controlled Wing-Only Sailplanes) [Mr. Werner edits the excellent modelling magazine *DELTA*, devoted to tailless RC models—Ed]. Our copy came from Wishire Model Center in Santa Monica, California, now out of business. Copies can probably be had directly from the publisher: Neckar-Verlag GmbH (publishers of the magazine *Modell*), Klosterring 1, 7730 Villingen–Schwenningen, Federal Republic of Germany. Our cost from Wilshire in 1985 was $ 14.95 plus $ 1.50 for mailing.

Hope that all of the above has been able to shed a bit of light on things.

Miscellaneous notes:

(1) A set of enlarged plans of the SB-13 has been sent to Kenneth Carpenter via *RC Soaring Digest*, per his request in TWITT #32. A few days later we got a note directly from him, with a beautiful pen sketch at the top!

(2) The design forum sounds absolutely wonderful! When does it all get started?

(3) Our quest is to find a copy of Werner Theis' book *Handbuch für den Modellflug—Schwanzlose Segelflugmodelle*, published in 1982. This was a title seen in the bibliography submitted to TWITT by Warren Berger and printed in #11. Any help that TWITTs can offer to help us track down a copy would be most appreciated! (Two other books by Theis, his *Handbuch für den Modellflug—Band 1* and *–Band 2*, are available and this has caused us no end of grief as the titles are easily confused.)

That's about it for this time...

B^2

The Kuhlmans enclosed a number of airfoil plots from SOARTECH, and plots (source not noted) of the NACA root and tip sections listed in their paragraph on the Pioneer II-D,as well as plots of the S4062, S4063 and SD 7032 and coordinates and pressure distributions for the S4061. You'll find the Pioneer sections in this issue, as well as the unattributed Selig and Donovon airfoil info. I'd rather not publish the SOARTECH material without permission. I've reproduced below some excerpts from Jim Marske's letter to the Kuhlmans that concern

TWITT. Many thanks, B^2, for all that information!

New Airfoils
Marske Pioneer Scale Models

Jim Marske writes:

The most recent development is that new laminar flow airfoils will soon be available for flying wings. The wing section I have used in the past date back to pre–World War II vintage. Coaxing knowledgeable researchers to get involved in this area has been futile. However, six months ago, I received a phone call from a computer analyst, Dave Lednicer, who is showing an interest in flying wings. He had assisted John Roncz in airfoil development on several of Burt Rutan's projects, such as the "'round the world" *Voyager*, the Beech Aircraft *Starship* and several projects now underway. So far. we have two promising sections. One is for minimum drag at low speed, good for sport and ultralight sailplanes, and the other for minimum drag at high speed for competition and racing sailplanes. He claims a magnitude of performance improvement over previous sections. This has been a long-awaited breakthrough.

This spring I flew my Monarch Ultralight Sailplane with the local hang glider club at their tow site. They found a remote, seldom used stretch of country road free of poles, fence posts and trees. They have two tow vehicles, each with 3,000 feet of 3/16" poly line. Pulling at 200 lbs tension, I can reach 2,000 feet in three to four minutes on their tow lines. The best part of the two is the charge, only $ 2.00! I have noticed that if there is a 10 to 15 mph wind the hang gliders have difficulty finding that second thermal upwind if they are flying locally. On the other hand, my Monarch has better than 4 times their glide ratio going upwind. I can pretty much go where I want and stay up until the thermals are dead. It's very impressive by comparison.

Going over my logbook I find that my average soaring flight time is over 2 hours per flight. Also, I have been able to get away on everry flight where I released form tow above 950 feet. All tows this year were made via auto tow. My most expensive tow was $ 2.00. Thermals were very strong this summer [1988]. Climb rates were as high as 1,000 fpm and rarely below 400 fpm.

Last winter I received several inquiries for three–views plus enough details in order to build a 1/4 scale model of the Pioneer II. Three builders completed their models. I have photos of each of these ships and quite a few in-flight shots. They all claim good performance and excellent handling qualities. Several have flown in 1/4 scale competition. "A real show stopper," one said. A Frenchman has already built two but wants to build another to perfect scale. His model Pioneer was recently featured on the cover of the French model magazine *Modèle Magazine*, July 1988. The builders of these three models are:

Bill Kuhlman, PO Box 975, Olalla, WA 98359-0975, USA

Rene Marucco, 263 Route des Vignes Poisy, 76330 La Balme de Silligny, FRANCE

John Lynch, RMB 161, Tocumwal, NSW 2714, AUSTRALIA

Mr. Kuhlman's model is a "D" model with a swept tail and was built accurately from full size aircraft drawings. It was flown in a scale event in Richland, Washington (May 88) with much success.

A close friend of John Lynch built a "B" model version. John owns a full size Pioneer II–B. From a closeup photo of the cockpit I cannot tell that it is a model. The instruments, the pilot and the controls look "real". I don't know if it has flown.

Mr. Marucco's model is a Pioneer II–D. this model not only looks good bu flies very well also. Mr. Marucco sent me several in–flight photos made while soaring in the French Alps.

Jim Marske

Tailless RC, Hang Glider, Sailplane Enthusiast

Mike Nelson of Union, Michigan writes:

I have a great interest in flying wings. I have flown several flying wing hang gliders, have seen full size flying wing sailplanes in action and have recently been started in RC sailplanes. My next project (as soon as all the others are finished) will be a HLG of the flying wing variety. I'm planning one similar to Jim Marske's designs (straight leading edge and reflexed airfoil) with a large root chord and medium size tip chord. The overall large chord will help keep Reynolds numbers up and wing loading down for good HLG performance.

Mike

Has Questions About A.R. Weyl Articles

Thank you for sending me the issue #30. You may now rest assured that my file is almost complete, in two three–ring binders, but there is still one flaw. The replacement issue that you sent me ended on page 12, and Mr. Weyl's article ended abruptly with "...this suction"(the last page or pages were missing). If you can rip off or copy this last page or pages, I'd be most obliged.

And while I'm at it, can you add a note on how Mr. Weyl gets the entering table to plot, to wit:

Angle of Effective Sweep	Aspect Ratio
60°	2.52

45°	3.56
30°	4.36
0°	5.0

(Span constant and width normal to leading edge constant)

I can do the last one, but the rest elude me. Can you give me a clue?

P.S. Please do lots of us a favor: identify drawings. For example, the Backstrom pusher plank on Pg. 7 issue #30 is what (not the EPB–1 for sure)? How about TWITT #26 p 10 or Cover #23 [SB-13] or #11 p 15 [Ho–?] or #11 pg 16 [Ho–?].

Syd Hall

Postage cost limits each issue to a maximum size of six sheets of 20 pound bond paper (lighter paper won't feed reliably through the high-volume photocopiers our printer uses to reproduce the Newsletter), so everybody's issue #30 ended in mid-sentence. You'll find the missing page in this issue. As for the table, it simply states the characteristics of the models tested by NACA. Some hints as to how they arrived at that particular combination are contained in the installment published in NL #23—something to do with a structural efficiency criterion. Maybe someone else can enlighten us (hint, hint).

Encouragement

Curtis J. Cole of Fort Collins, Colorado writes:

I fancy myself something of a dilettante amateur aerodynamicist, and my publications in the field certainly bear this out. Having had a go at managing some small private design/build projects, I can certainly appreciate your desire to keep the project down to a hard-working hard core.

Based on the list of key people (most of whom I know only by reputation, however), I would say the project should go well. It has certainly seemed to me that the wing holds great promise, if put together right. Best of luck to all concerned.

Curt

Questions about Wortmann Airfoil, Wing-Body Interaction

William Heijn of San Francisco writes ordering reprints from the library, and adds:

On page 11 [issue #33] a comment is made on the 8-H-12 for tailless aircraft. The FX05-H-126, which may be in the Stuttgarter Profilkatalog, has a high L/D, wide drag bucket and gentle stall; can someone comment on its use for tailless?

A question regarding the Culver recommendations on twist: in the case of a tailless aircraft, with a fuselage, the flow field of the body will affect the flow field of the wing; would this effect, assuming a high-wing configuration, be in the same sense as the recommended twist, and would it be quantitatively equivalent?

William Heijn

News (and Reflections on Flying Wing Design) from Don Mitchell

I haven't sent you anything for some time but I sure enjoy the TWITT newsletter—keep up the good work.

Did you notice in the March '89 issue of *Hot Kits & Homebuilts* the article by Mike Brawner where he flew a Mitchell A-10 (that is the foam and metal skinned B-10) to a new world's record? That is the 6th world record the wings hold, and I believe there are two more being verified by NAA and FAI.

The other day I got a letter from Richard H. Gunther, who lives in Anchorage, Alaska. He sent three pictures of an outstanding B-10 that he gave to the Fairbanks, Alaska Air Museum; the ship now stands in the Fairbanks Industrial Air Terminal for all to see. He left it uncovered so all of the wood ribs in the trailing edge could be seen. It has a Zenoah engine, 3 wheel gear and pod. He built it from a kit, Ser #865. The "wings" are in five museums in the US, so TWITT can be proud that a lot of people are *looking* at "wings."

In the last TWITT, B. Wainfan showed a Marske Pioneer airfoil. That airfoil looks to me like a 23015 with a little reflex. I have been using a 23015 on the B–10/A–10 and Mitchell Wing hang gliders from the start, 13 years ago. It works just fine. I think it is an outstanding airfoil with or without reflex. I have a hang glider that has a 23015 with a cusp in the upper and lower surface to get a thinner trailing edge, and it is flying like it doesn't know any better.

I keep reading and hearing about these new super computer airfoils. The computers and computer "nuts"are working on airfoils that are out of this world, but I never seem to see or read about any wings performing with them. Am I missing something? Where are they?

A case in point is the Schapel Wing (TWITT, February '89). I have seen the wing. Mr. Schapel spend untold hours working with his computer to get just the correct airfoil from c/l to tip, just the right twist, just the right sweep-back and planform, etc. from his wing. He spend long hours and many dollars building the molds for the wing so that the surface would be smooth and true. A lot of effort went into building the actual wing. He must be given a great deal of credit for his effort. He did a super job from start to finish. The only trouble is it *won't fly*. It won't fly because the concept was wrong from the start. In my opinion designers are trying to make "wings" too complicated. Make them simple. The is no need to change airfoils from c/l to tip. There is no need to use a so-called laminar flow airfoil unless you are sure you can get a surface that is good enough and you sure can't get it with a "D" tube and fabric trailing edge. I believe in simplicity; my ships may not be the greatest in the world, but they have been flying successfully for 13 years, have won more awards, set more records and won more contests than any other wings that I know of, and I firmly believe it is because they are simple with a super airfoil for the purpose at hand. Keep it simple.

What is the address of Todd Hodges? I need to contact him.

I will be sending you a lot more stuff on a project I am working on. Yes, it is a wing; what else is there?

Todd Hodges' address is on its way. We have very little information on Schapel's machine here, so further comments on it would be very interesting. The article on the SA-82 in ***Ultralight Aircraft,*** *April 1985, describes a flight down the runway in ground effect, but says nothing more about actual flying qualities. Looking forward to the information on your new project.*

STALLING PHENOMENA AND THE TAILLESS AEROPLANE

A.R. Weyl

Previous installments of this article appeared in Newsletters 20, 23 and 30. They were originally published in 1947 in the British magazine ***The Aeroplane****. For those of you who don't feel like piecing the entire series together from back issues of this rag, a complete copy of the entire 7-part series is available from the TWITT Library at $0.10 per page. Part 7 (3 pages) will appear in a forthcoming issue.*

IS THIS YOUR LAST ISSUE?

Beginning with Newsletter Number 21, mailing labels have had on them a four-digit code for the year and month of the last newsletter the subscriber will receive under his current subscription. If your label reads "8904," for example, your last Newsletter will be this one. Please check your label now, and take the time to renew if your subscription is nearly expired. While we're at it, let us remind you that all back issues are still available at $ .75 apiece. Subscriptions still cost $ 15.00 per year. Payment must be in US Dollars.

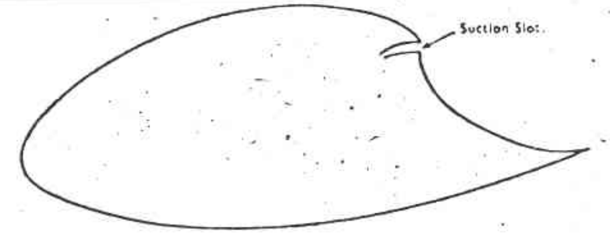


Fig. 15 —Shape of a very thick suction aerofoil of the Griffiths type: the thickness ratio is 38 per cent. of the chord. The aerofoil has a stationary centre of pressure and a maximum lift coefficient of 2.5.

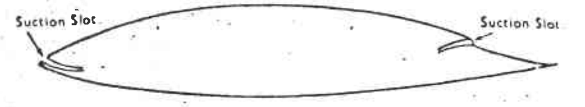


Fig. 16.—Shape of a suction aerofoil of the Lighthill type with two suction slots.

method has given satisfactory results. The wing to which it was applied was of the laminar-flow type with sections having a theoretical transition point at 40 per cent. chord.

Boundary-layer removal by suction on wings with sweep-back is by no means as effective as it is on unswept wings. The reason is that the boundary layer on the swept wing is rather thick in the region of the tips and at the incidence at which the removal is wanted for prevention of premature tip stall. Consequently, a considerable quantity of flow material will have to be removed in order to make the method effective.

From theoretical estimates it would appear that, for effectiveness, between 75 per cent. and 100 per cent. of the "displacement thickness" of the boundary layer (i.e., one-fourth to one-third of its entire thickness) will have to be removed. Possibly, experimental evidence will enable this considerable quantity to be reduced, but up to now tests have not given much hope in this direction for tailless aeroplanes. Regenscheit and Schwier, for instance, found at Göttingen that suction on wings with pronounced sweep-back had but little effect on the tip stall. In any case, it is obvious that the plain removal of the boundary layer by sucking it away from the tips is rather inefficient, i.e., expensive in power, while its effectiveness for larger angles of sweep is still in doubt.

As to the inefficiency, it may, however, be reasoned that the suction method does not necessarily require additional machinery, or even power, to function. With gas turbines or turbo-jets, the suction may well be obtained from the intake side of the compressor or by way of injector arrangements from the expelled gases of the jet or exhaust. Moreover, the suction is only required at transient conditions of flight and for short periods, such as for take-off, climb, glide and landing. It is even conceivable that, from the aspect of overall economy of the aeroplane, boundary-layer removal will not mean expense of power at all when the sucked-in air is utilized for specific purposes (e.g., for cooling).

On the Armstrong Whitworth glider the provision of wing-tip discs—usually promoters of premature tip stall—actually seemed beneficial in combination with the boundary-layer removal. The reason for this is that they prevent excessive flow around the wing tip, from the lower to the upper wing surface, when the suction operates.

Boundary-layer removal by suction will, unfortunately, not guarantee complete stability in stalled flight. While longitudinal stability can be secured for an unswept wing, boundary-layer suction may cause, on a stalled wing, acute lateral dynamic instability. Stueper observed in stalled-flight tests with a suction flap (Ref. 82) that the rolling moment derivative to rolling (lp) may, with suction, give rolling oscillations of increasing amplitude when flight in a stalled condition is maintained. The reason is that when one wing droops, due to the suction, the lift at this wing is more than restored, at the expense of the lift at the other wing.

On tailless aeroplanes with swept-back wings and suction at the tips only, the dynamic longitudinal stability also would most probably be affected to some extent. A remedy may be found in automatic regulating devices, adjusting the air intake to the lift requirements and preventing more air from being removed from one wing-tip than from the other. Considering the unstable flow pattern during and after development of the stall, wing dropping is unavoidable at the stall (due to temporary loss of lift) with or without suction. This implies a pressure increase on the suction side of the dropping wing and the removal of more air from this wing tip, while the up-going wing has initially more lift and less air sucked away. A motion similar to a Dutch Roll may follow for a tailless aeroplane.

As distinct from this simple method of removal of the boundary layer from the tip region, G. H. Lee (Ref. 84) investigated the adoption of laminar-flow suction-aerofoils of the Griffiths or Lighthill type to swept-back tailless aeroplanes.

Superficially, the difference would seem to be only one of quantity, yet effects and results are greatly varied. The plain removal of the boundary layer from an aerofoil is able to delay the separation of the flow up to very high incidences, and hence a very high maximum lift can be obtained. The intensity of the suction applied has to increase with the incidence.

The laminar-flow suction-aerofoils developed in this country should retain a laminar state in the boundary layer over a major part of their chord in order to reduce the frictional drag of the aerofoil. Hence, a very much smaller intensity of suction is required. One peculiarity of such "stepped"-section profiles (Ref. 85) is that the chord-wise pressure (or velocity) distribution varies from that of ordinary aerofoils, in that the adverse pressure gradient on the upper surface towards the trailing edge is reduced. The adoption of such sections for the tip regions of a swept-back aerofoil should thus have the twofold effect of reducing the intensity of the outward flow over the wing (because of reduced span-wise pressure gradients at equal chord stations), and of a reduced tendency to flow-separation at the tips (because of the decreased pressure gradient towards the trailing edge).

There is, therefore, the possibility of achieving a substantial improvement for far smaller expenditure in suction. The suction may be applied at the aft step of the suction-aerofoil. Lee suggested double-suction profiles with an additional air intake at the pointed leading edge. Though this may promise a further improvement in the chord-wise velocity distribution, the suction at the leading edge can easily cause a loss of lift due to adverse effect on the circulation if not properly adjusted. There are reasons to believe that this is difficult to arrange for all angles of incidence. As a result, the lift does not remain a linear function of incidence and the stability qualities vary for different conditions of flight.

Another advantage arising from the adoption of suction-profiles is that very thick sections may be used without disadvantage from the point of view of profile drag. This is not only structurally desirable and vital for flying wings, but also promises very gentle "rear"-stall qualities, even in the case of suction failure. Moreover, these thick suction-profiles give high maximum lift coefficients, though at greater expense in suction power.

When suction-aerofoils of the Griffiths or Lighthill type are adopted for the entire wing system of a tailless aeroplane, the premature tip stall would not be entirely eliminated with substantial degrees of sweep-back. As a remedy, G. H. Lee (Ref. 84) suggested the application of more suction at the wing-tip region than over the central parts of the span.

Since the outward flow over the upper surface of a swept-back wing is most noticeable near the trailing edge, while over the nose of the wing inward flow exists in the boundary layer, E. J. Richards has recently made an interesting suggestion for the improvement of the stalling qualities of swept-back wings (Ref. 80). The gradual rear stall (form "C") should be seriously affected by the boundary flow of the swept-back wing—which is not evident from the collected N.A.C.A. results. Most of all, sweep-back should actually delay the gentle laminar front stall (form "A"). Richards therefore suggests tests with very thin wing-tips, because it is to be expected that for these, sweep-back will eliminate their tendency to the stall-form "A" and convert it to the turbulent rear stall of the form "C." The local flow along the nose would emphasize the small curvature of the leading edge.

The discharge of air from slots located near the leading edge on swept-back aerofoils has hitherto been investigated in wind-tunnels only, and the results indicate a better effect than plain suction. In spite of this, the tests of Regenscheit and Schwier at Göttingen have not given results which can be considered satisfactory for tailless aeroplanes with substantial sweep-back.

There is, however, the possibility that a combined system of suction and discharge may remedy the premature tip stall in an effective and efficient way. Systematic experimental research in this direction is required. Since with identical arrangements control could be effected without incidence-linked control-surface deflection, the author has recommended the adoption of pressure-controlled suction-discharge wing-tips for flying wings at an early date.

Another way to remedy the tip stall is to decrease the outward flow in the boundary layer by decreasing the angle of sweep towards the tips. This was a feature of the Henschel tailless (by F. Nikolaus) and model tests proved promising. The modification of the plan-shape by reduction of the sweep would undoubtedly be effective, but will result in structural problems. It is not recommended for aeroplanes operating near the range of impending compressibility stall.

(To be continued)

THE AIR MUSEUM

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The Air Museum Presents:

FLYING WING

the N9MB *Restoration Project*

FLYING WING UPDATE 1989

Progress on the museums Northrop N9M-B Flying Wing is going at a steady pace. Winter flu and colds have taken a toll of the volunteer workers and the cold weather, low temperature snap has delayed the wood glueing process, however wood is being cut and is set aside for glueing during a warm period.

John Benjamin reports that most of the parts sent out for overhaul have been returned, and are in house, ready for installation. Ron Hackworth has had to miss a few Saturdays of work due to being sent out of the country by his employer. Some of our volunteer workers have picked up the pace by coming in on Thursday and spending the day. This makes Saturdays work load run much smoother.

The N9M-B Flying Wing center section is almost complete except for its wood skinning, and electrical wiring installation, both of which are in progress.
Both air cooled, Franklin engines, the fluid drive couplers, and driveshafts are installed The aircraft bubble type canopy is being fitted, and trimed to fit. A special wood mold was carved by hand to make the aircraft canopy and windshield.

The left wing frame has been completed. Stringers and spar caps are in place on the top surface. It will be shortly turned over to work on the bottom stringers and spar caps. After this the wing leading edge will be skinned and the panel attached to the center section.

We were fortunate to find a third Franklin air cooled XO-540-7 engine and acquire it. These engines were specially built for the fourth and last Northrop N9M Flying Wing and are exceedingly rare. This third engine is ready for assembly. Dennis Trevino has already assembled the crankshaft and piston rod assemblies.

The working crew feel in 1989 the Wing center section will be completed with both outer wing panels attached and fitted. 1989 is the year that it all comes together.

Ron Hackworth ,Ed Maloney, John Benjimin. Don Lykins,

Thanks to all our volunteer workers we are making progress.