No. 14, August 1987

TWITT NEWSLETTER

Marc de Piolenc, Editor and Publisher

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

NEXT MEETING: Saturday, 15 August 1987, 1330 hrs, Hangar A-4, Gillespie Fld.

Telephone: (619) 224-1497 before 10 AM or after 10 PM

TWITT MEETING, SATURDAY 18 JULY 1987
[from notes provided by Phil Burgers; thanks, Phil!]

The meeting began with a showing of the Davis flying wing video mentioned in the last Newsletter, thanks to Dave Martin. The tape included, in addition to footage of the Davis machine, a short history of the Northrop flying wings and an interview with Jack Northrop [perhaps the famous Clete Roberts interview--Ed.] in which JN told the story of Air Force Secretary Stuart Symington's attempt to force the merger of Northrop and Convair and the subsequent cancellation of the entire Flying Wing program, compounded by the torching of every single airframe. After the video, "Tuto" Figueroa took the floor to discuss the effect of inlet pressure recovery on gas turbine engines. His talk was well prepared and illustrated with charts that helped clarify the subject. He began with an historical overview of jet propulsion and then covered the basic physics of thrust and how it is produced by a turbojet engine. Then came the contribution of the individual components of the turbojet--compressor, combustor and turbine--to the overall performance of the unit. The remainder of the talk focussed on the inlet's efficiency and the factors contributing to it. The lip roundness parameter, a measure of the sharpness of the leading edge, is important because a sharp lip can lead to separation in the inlet passage, hence turbulence and low efficiency. The growth of the boundary layer in the inlet duct also affects the design of the engine. Another important criterion in inlet design is placement; the object here is to locate the inlet away from any outside source of turbulence, e.g. behind a cockpit canopy or other source of flow disturbance. Finally, Tuto discussed the effect of inlet pressure recovery on the thrust of the engine. After a short intermezzo, Phillip Burgers spoke. He had changed his mind, and his topic, at the last moment and chose to discuss some data on the Kaspar Wing provided by Edward W. Krupa of the Department of Aeronautics and Astronautics, University of Washington (Seattle). Mr. Krupa performed some wind tunnel tests to check performance numbers claimed by Witold A. Kaspar, which were reported by Jack Cox as follows in an article for Soaring magazine, December 1973: "...he began his stall as before, at 40 mph the sink rate went from 200 fpm to 600 fpm...As he pulled the stick back further, an amazing thing happened. The speed dropped to 20 mph, the angle of attack indicator showed 35 degrees and the sink rate had dropped to only 100 fpm, half the minimum sink rate in normal flight! The airplane was also completely stable and control response was as good as in normal flight. The lift coefficient required is 3.15..." Interesting, eh? Phillip noted that for some time nobody had verified Mr. Kaspar's claims in flight tests, and that aerodynamic theory does not seem to be able to confirm or deny this alleged phenomenon. Around 1975, Mr. Krupa decided to build a model similar to the real Kaspar wing [what scale?--Ed.] and incorporated many of Mr. Kaspar's suggestions. Several configurations were tested and it was found that the best performance was obtained with the clean airfoil, rather than by deflecting the three surfaces that create vortices and (hopefully) increase the circulation over the wing to obtain a higher CLmax. On the subject of vortices, it was found that some of the vortices rotated opposite to the directions predicted by Mr. Kaspar, a phenomenon possibly caused by Reynolds number effects. The bottom line of this wind tunnel testing was that, without some means of external energy addition, significant vortex lift cannot be obtained at low Reynolds numbers. Phillip felt that this last statement was premature, given that insects operating at very low Reynolds numbers create many small vortices in staying aloft. Phillip felt the statement should be qualified with the phrase "in still air" and asked the author to give a little more time to those who love aerodynamics to learn the secrets of vortex-enhanced flow which nature has kept hidden so far, and which Mr Kaspar, with his experience in high-lift devices on Boeing airplanes, has cleverly begun to unravel.

Twitt member, Jack Green, has flown his recently completed "Monerai" sailplane, designed by John Monnett. Jack reports that he flew 24 June at Warner Gliderport, CA at 10:30 am before turbulance started.

The sailplane has extended tips, 40 feet of span, wing area of 84 square feet, and an empty weight of 271 lbs. which includes the parachute and 10 lbs. of ballast. The wing loading is 5 lbs. per sq. ft. CONGRATULATIONS Jack!

Dear Bob and June

By beint return-addressless, and no pin on the envelope flap, and no "Sandy Ago", I tricked you into not nowing I was me until it"s too late. Afterall, I had to Twitt yoy somehow.

Your newsletter is outstanding, and serves to keep T.W.I.T.T. moving ahead, maybe more than any other single factor. Attendance had been outstanding -- in interest -- not just headcount. May it continue to grow and PROSPER.

Ed Lock Hart

COVER ART-- Our thanks again and AGAIN to Ed Leiser, curator at the Aero Space Museum, for his great cartoons. The one this month is done from a photograph taken in April at Santa Ynez, by Bob Fronius, at a joint Vintage Sailplane Association and Sailplane Homebuilders gaggle.

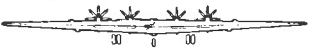
PROGRAM OF OUR NEXT MEETING, 15 AUGUST 1987

Karl SANDERS will discuss Alexander Lippisch's landmark paper, "The Development of Tailless Airplanes." The paper covers Lippisch's work up to WW II. It was translated into English by the US Government's technical intelligence teams after the War, but copies are available only through the Library of Congress at considerable cost. Even the original German paper, like many wartime publications, is hard to get in this country. The TWITT library has a copy of an abstract, in German, from the proceedings of the German Academy of Aeronautics. Don't miss this one if you can help it.

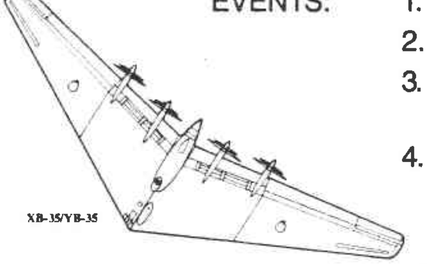
21ST ANNUAL
NORTHROP
FLYING WING
CONTEST

OCTOBER 3, 1987

- Sponsored By: *MODEL BUILDER* Magazine
  Bill Northrop, Publisher
- AMA Sanction #593 — AMA License reqd.
- Site: Condor Field, Taft, CA
- Time: 8:30 a.m. to 3:00 p.m.



- Jr., Sr., & Open combined in all events
- Entry Fee: $3.00 (Jr. - $2.00) each event



EVENTS:

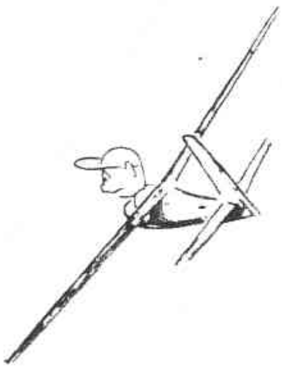
1. Rubber Power
2. Glider (164 ft. towline)
3. Scale — any power
   (20 sec. official)
4. Gas — 25 sec. eng. run, or
   Electric — 35 sec. motor run
   • combined event •

In case of controversy, opinion of Contest Director and Judge will be final.

Chief CD
Carl Hatrak
3825 W. 144 St.
Hawthorne, CA 90250

Scale & Flight Judge
Bill Stroman

- *NOTE:* Proxy entries encouraged. Send models to flier of your choice, *NOT* to *Model Builder* or CD's.



VORTEX LIFT, LEADING EDGE SEPARATION AND THE KASPAR WING

by Marc de Piolenc

As everyone who has had the pleasure of listening to Phil Burgers discuss aerodynamics knows, there are three ways to get lift by moving a solid body through a fluid. The one used by most aircraft through most of their speed range is produced by attached flow, the fluid following the contours of the airfoil. Another means is unsteady lift, the favored flying mode of animals. My topic is vortex lift induced by separation vortices tangent to the airfoil. Every ground school student knows that if you increase the angle of attack of a wing, you reach a point at which the air ceases to follow the contour of the wing; it begins to separate from the wing near the trailing edge. If angle of attack is increased still further, the separated region grows to include the entire upper surface of the wing. The resulting drastic changes in pitching moment and the loss of lift in turn cause a stall, that is a loss of aerodynamic control on at least one axis. Separation is so closely associated with stalling in conventional aircraft that the two terms are often treated as synonymous; they aren't. Certain kinds of wings, notably deltas, achieve extremely high lift coefficients and maintain aerodynamic control in fully separated flow. Here's what happens: flow separates from a delta at the leading edge and the air flowing over (or rather past) rolls into a conical vortex with its axis above, behind and roughly parallel to the leading edge. Because of its shape, this separation vortex is often called a "ram's-horn" vortex. Actually the ram's horn is only the largest in a system of vortices which covers most of the wing surface, leaving tiny wedge-shaped regions where the flow never separates at all, but is deflected outboard. This vortex system, unlike the flaccid eddy flow over a stalled conventional wing, is very energetic and produces a huge amount of lift. Of course the energy has to come from somewhere; it shows up as very high induced drag, low (sometimes fractional) L/D values and very steep approaches. So why an energetic, orderly, steady vortex flow over a delta and only crud over a conventional wing? Well, conventional wisdom says that you need a lot of leading edge sweep, so that the leading edge is also a "side edge" of the wing. The leading edge flow is then stabilized by the natural tendency of high pressure air from below the wing to leak sideways into the low-pressure region above the wing. According to this reasoning, the ram's horn is only an extension of the well-known "tip vortex," and it needs a high leading edge sweep to survive. Enter Kaspar, who says he can produce a stable vortex system over a narrow, constant-chord wing with very little leading-edge sweep...and does it. While there is much skepticism about Kaspar's early claims of high end performance--the max L/D figures were 'way too high--flight tests of Kaspar-wing-equipped gliders and ultralights show safe, controlled flight at angles of attack well beyond the onset of separation. What's more, the elaborate system of control surfaces that Kaspar thought he would need to induce and stabilize the vortices turned out to be unnecessary; only the strange, deeply cusped airfoil section seems to be needed. That it works is pretty well established; how it works is not clear.

A LIGHT APPROACH TO CONVENIENT, ECONOMICAL SPORT SOARING

Part III

BY B.H. CARMICHAEL

FUTURE PROPULSION SYSTEM -

ONE DAY WE MAY HAVE OUR SILENT VIBRATIONLESS LAUNCH SYSTEM. I REFER, OF COURSE, TO ELECTRIC MOTOR AND BATTERY. BOB BOUCHER HAS PIONEERED THE ELECTRICALLY POWERED MODEL AIRPLANE AND HAS PROVIDED THE MOTOR AND BATTERY TECHNOLOGY FOR THE SOLAR POWERED PENGUIN AND CHALLENGER OF DR. PAUL McCREADY. BOB FEELS THE LAUNCH PORTION OF OUR DREAM IS ALREADY SOLVED, DUE TO THE REASONABLE COST AND HIGH OUTPUT FOR A SHORT PERIOD OF RECHARGEABLE NI-CAD BATTERIES. BOUCHER ELECTRIC MOTORS ARE EXTREMELY LIGHT AND CAN BE GEARED DOWN TO PERMIT A LARGE PROPELLER DIAMETER, AS ON THE SOLAR CHALLENGER. FOR OUR SAILPLANE TO PROVIDE THE GREATEST UTILITY, WE NEED RESTART CAPABILITY WITH PROVISION FOR 2 HORSEPOWER CRUISING FOR A LONGER PERIOD THAN THAT OF INITIAL LAUNCH. THIS WILL REQUIRE A DIFFERENT BATTERY THAN PRESENT DAY NI-CADS. THOSE PRESENTLY UNDER DEVELOPMENT FOR ELECTRIC AUTOMOBILES MAY EVENTUALLY SOLVE OUR PROBLEM. MEANWHILE, PROLIFERATION OF SMALL GASOLINE ENGINES FOR ULTRA LIGHT AEROPLANES WILL PERMIT US NOISILY POWERED PROTOTYPES WHILE WAITING FOR THE MAGIC BATTERY.

GASOLINE ENGINES -

REFERENCE 1 PROVIDES AN EXCELLENT SUMMARY OF ENGINES SUITABLE FOR ULTRA LIGHT AIRCRAFT AND SELF LAUNCHING SAILPLANES. DRY ENGINE SPECIFIC WEIGHT IN POUNDS PER HORSEPOWER VS. RPM IS PLOTTED IN FIGURE 11. SPECIFIC WEIGHTS OF 0.6 TO OVER 2 POUNDS/HORSEPOWER ARE OBSERVED. THESE WEIGHTS ARE FOR THE BARE ENGINE.

THE KFM 107 TWIN OPPOSED 2-CYCLE ENGINE APPEARS TO BE ONE OF THE BETTER ENGINE CHOICES. FIVE OTHER ENGINES ARE COMPARED WITH IT IN THE TABLE BELOW.

ENGINE	WEIGHT #	HP	RPM	CYL.	DISPL. c. c.	COST $	START	REDUCTION
KFM	33.5	25	6300	2	294	1250	Electr.	Available
JPX	14.0	15	5800	1	212	879	Recoil	
REBEL	29.8	25	3500	2	410	995	Electr.	
LIMBACH	15.5	22.5	7300	2	275	995	Recoil	Yes
ULTRA	18.5	25.5	7000	2	342	1400	Electr.	Yes

IT SHOULD BE NOTED THAT WHEN AN ALTERNATER, STARTER, EXHAUST SYSTEM, PROPELLER, AND BATTERY ARE ADDED TO THE 33.5 POUND BARE WEIGHT OF THE KFM 107, THE PROPULSION WEIGHT BECOMES 53 POUNDS. TEN TO TWENTY POUNDS CAN BE SHAVED FROM THE BARE WEIGHT THROUGH SOME OF THE OTHER ENGINE CHOICES, BUT ONE MUST CAREFULLY CONSIDER QUESTIONS OF ENGINE LIFE, DEALER SUPPORT, POSSIBILITY OF ELECTRIC START, AND COOLING PROBLEMS.

AIRFRAME CONFIGURATION

FUSELAGE DESIGN -

FOR THE REASONS COVERED IN THE PROPULSION SECTION, I FAVOR A POD AND BOOM FUSELAGE WITH A SINGLE LOW SET BOOM. THIS SIMPLIFIES THE LONGITUDINAL AND DIRECTIONAL CONTROL RUNS, PROVIDES A SIMPLER STRUCTURAL PATH BETWEEN POD AND BOOM, PREVENTS SLAM DOWN LOADS WHEN THE PILOT CLIMBS OUT, AND PROVIDES BETTER PROPELLER PROTECTION. A THIN WALL TUBE DESIGNED TO THE TORSIONAL REQUIREMENT CAN BE BEEFED UP NEAR THE ROOT END TO MEET THE BENDING AND ATTACHMENT REQUIREMENTS.

AN ALL MOVING FORWARD POD SHELL WITH INTEGRAL CANOPY AS PROPOSED BY THE WRITER IN REFERENCE 2 AND REDUCED TO PRACTICE BY THE AUSTRALIAN, SUNDERLAND*, REFERENCE 3, IS PROPOSED TO MINIMIZE FUSELAGE DRAG. IT SHOULD BE POSSIBLE TO KEEP THE ENTIRE POD FORWARD OF THE JOINT LAMINAR UNDER NON-BUG CONTAMINATED CONDITIONS. THE UNIT SLIDES FORWARD ON RAILS FOR PILOT ENTRY AND EGRESS. SUNDERLAND REPORTS VERY LOW OPENING LOADS IN FLIGHT. SINCE THE SHELL IS A NON STRUCTURAL FAIRING, SOME SUPPORT STRUCTURE IS REQUIRED IN THE LOWER POD REGION, AS WELL AS IN THE UPPER POD REGION, TO MOUNT THE WING AND ENGINE.

WING PLACEMENT -

PRELIMINARY DESIGNS WERE MADE FOR A LOW WING (FIG. 12) AND A HIGH WING (FIG. 13) VERSION. THE LOW WING KEPT THE WING WAKE COMPLETELY OUT OF THE PROPELLER DISC, ELIMINATED THE BULKHEAD EXTENSION TO THE HIGH WING ATTACH POINT, BUT REQUIRED A HEAVY, MORE VULNERABLE LANDING GEAR, AND PRESENTED A MORE SERIOUS WING-POD INFERENCE PROBLEM. THE HIGH WING VERSION PERMITTED A LIGHT SIMPLE LANDING GEAR, BUT SEEMED LESS AMENABLE TO A TANDEM WHEEL DESIGN WITH ITS PROVEN TAXI-ING POTENTIAL. AS DRAWN, THE PROPELLER DICS'S OUTERMOST EDGE MUST ROTATE THROUGH A SLOT IN THE WING. AFTER WEIGHING ALL FACTORS, I CONCLUDE THAT EITHER WILL WORK, BUT OPT FOR THE LOW WING LOCATION, TO SIMPLIFY THE DESIGN AND REDUCE WEIGHT.

*POSSIBLY PRECEEDED BY THE SWISS 17 METER ELFE.

WING DESIGN -

A THICK LAMINAR SAILPLANE WING SECTION IS USED TO KEEP THE WEIGHT AS LOW AS POSSIBLE CONSIDERING THE CONSTANT CHORD CENTERSECTION ARRANGEMENT. THIS PLANFORM HAS BEEN WELL DEFENDED BY STROJNIK IN REFERENCE 4 AS THE BEST COMPROMISE OF BUILDING SIMPLICITY, NEAR ELLIPTICAL LOADING AND GOOD STALLING CHARACTERISTICS. THE TWIST IS ZERO FOR THE CENTER 2/3 OF THE SPAN. ALL PLANFORM SHAPING AND TWIST OCCUR IN THE OUTER 1/3 SPAN. IF BUILT AS A 3 PIECE WING THE WEIGHT AND COMPLICATION OF THE ROOT FITTINGS OF A 2 PIECE WING CAN BE ELIMINATED. THE 100 INCH LENGTH OF THE POD PERMITS THE WING CENTERSECTION TO BE BUILT INTEGRAL WITH THE POD AND STILL BE TRANSPORTABLE AS A UNIT ON A TRAILER. THE TAIL AND BOOM INCLUDING CONTROLS AND THE SIMPLE OUTER PANELS MUST BE REMOVED FOR TRAILERING. THE STIFF MATERIALS NOW AVAILABLE ALLOW ONE TO DRIVE INBOARD AILERONS FROM THE ROOT ENDS. WING CONSTRUCTION WILL ENTAIL COMPOSIT FOAM SANDWICH SKINS OVER UNIDIRECTIONAL COMPOSIT SPARS.

TAIL CONFIGURATION -

THE STANDARD PENAUD CONFIGURATION WITH THE TAIL BEHIND THE MAIN WING HAS BEEN CHOSEN TO MINIMIZE DEVELOPMENT TIME AND TO PROVIDE THE BEST SOARING PERFORMANCE WITHIN THE INHERENT LIMITATIONS OF A 10 METER SPAN. A TAILLESS DESIGN WOULD HAVE BEEN LIGHTER AND SIMPLER TO BUILD AND DOES PERMIT THE SIMPLEST PROPELLER BEHIND POD INSTALLATION BUT THE LIMITATIONS IN CHOICE OF AIRFOIL AND IN TRIMMED LIFT COEFFICIENT CAST IT OUT. A CANARD SOUNDS LIKE A GOOD WAY TO CONVENIENTLY PUT THE PROP BEHIND THE POD. IAN CROO FOUND OUT ANALYTICALLY AND GEORGE APPLYBY FOUND OUT BY BUILDING AND FLYING AND STARTING OVER, THAT GOOD LATERAL DIRECTIONAL CHARACTERISTICS ARE DIFFICULT TO ACHIEVE. BURT RUTAN WISELY USED A VERTICAL TAIL ON AN AFT FUSELAGE ON SOLATAIRE AND SOLVED HIS PROP LOCATION PROBLEM WITH A RETRACTABLE UNIT OUT OF THE FORWARD FUSELAGE. TANDEM WINGS WHILE INTERESTING HAVE A LOW REYNOLDS NUMBER PROBLEM AND ASSEMBLY AND DISASSEMBLY SEEMS COMPLICATED.

BY INCLINING THE BOOM UP 5^{o}, A VERTICAL TAIL DISPOSED BOTH ABOVE AND BELOW THE BOOM AND A GROUND CLEARING HORIZONTAL TAIL ON THE BOOM RESULT IN MINIMUM TORSIONAL LOADS ON THE BOOM. CONVENTIONAL 35% CHORD FLAP TYPE ELEVATOR AND RUDDER ARE EMPLOYED. A VEE TAIL IS ATTRACTIVE FROM THE STANDPOINT OF FEWER PARTS AND INTERSECTIONS. THE TOTAL AREA MUST BE A LITTLE LARGER AND THE TORSIONAL LOADS ON THE BOOM A BIT LARGER THAN A CONVENTIONAL CRUCIFORM TAIL. DICK SCHREADER HAS FOUND THE VEE TAIL TO PERMIT WEIGHT SAVINGS ON 15 METER SAILPLANES WHEN COMPARED TO THE POPULAR T TAIL. ON THE PRESENT DESIGN, WEIGHT IS VERY IMPORTANT. A CAREFUL WEIGHT TRADE-OFF AT EQUAL TAIL CONTRIBUTION TO LONGITUDINAL AND DIRECTIONAL STABILITY AND CONTROL WILL BE REQUIRED.

AIRFOIL CHOICE -

THE 10 METER SPAN PREVENTS ONE FROM ACHIEVING AS LOW A SINKING SPEED AS IS OBTAINED WITH THE MORE TRADITIONAL 15 METER SAILPLANE. EXCELLENT SOARABILITY CAN, HOWEVER, STILL BE OBTAINED. ENHANCED MANEUVERABILITY IS INDUCED BY THE SMALL SPAN. THE ABILITY TO WORK CLOSE TO THE THERMAL CORE COMES FROM MODERATELY LOW WING LOADING, AS SHOWN IN FIGURE 5. A HIGH LIFT COEFFICIENT ALSO HELPS, AS SHOWN IN FIGURE 15. THE OPTIMUM ANGLE OF BANK IS ABOUT 35^{o} PLACING ONE AT THE ELBOW OF THE CURVE WHERE LARGE TURN RADIUS REDUCTIONS HAVE BEEN ACHIEVED WITHOUT SUFFERING APPRECIABLE INCREASES IN SINKING SPEED. THE VERY SMALL TURN RADII FROM HIGH LIFT COEFFICIENTS ARE PERHAPS NOT REQUIRED UNDER MOST SOARING CONDITIONS.

SIX THICK LOW DRAG AIRFOILS DESIGNED FOR SAILPLANES AND/OR LIGHTPLANES ARE SHOWN IN FIGURE 16. THEIR LIFT DRAG POLARS ARE COMPARED IN FIGURE 17, WHERE THE DRAG VALUES ARE TAKEN AT THE PROPER REYNOLDS NUMBERS FOR A 37.5 INCH CHORD AND A 3.2 $\#/FT^2$ WING LOADING. THE SOMERS AND FX WORTMAN CURVES ARE ACTUAL TEST DATA FROM LOW TURBULENCE WIND TUNNELS, WHILE THE EPPLER AND RONCZ CURVES ARE PREDICTIONS USING THE EXCELLENT BOUNDARY LAYER CALCULATION METHODS NOW AVAILABLE. IT IS THE OPINION OF BOTH EPPLER AND SOMERS, BASED ON CHECKS WITH EXPERIMENTS, THAT AT REYNOLDS NUMBERS ABOVE 500,000 THE THEORETICAL METHOD IS SO REALISTIC THAT WIND TUNNEL TESTS ARE NO LONGER NEEDED.

A POPULAR 19.6% THICK AIRFOIL (HAVING EXTENSIVE TEST DATA FROM BOTH STUTTGART AND DELFT U.) IS THE FX 66 S 196 V1. THE PROFILE DRAG COEFFICIENT IS 0.0065 AT LOW C_L OR HIGH SPEED AND DOES NOT EXCEED 0.01 UNTIL $C_L = 1.1$. DRAG IS STILL REASONABLE AT $C_L = 1.55$.

THE EPPLER 748 WAS DESIGNED SPECIFICALLY FOR THE TYPE OF SMALL THERMAL OPERATION WE ARE INTERESTED IN. BY ACCEPTING A DRAG INCREASE OF 0.001 AT LOW C_L TO 0.002 AT HIGH C_L OVER THE FX-66-S-196, THE PREDICTIONS SHOW A POSSIBILITY OF EXTENDING FLIGHT TO A C_L OF 1.8. THE NEW SOMERS (1) - 0416 HAS ALMOST IDENTICAL DRAG TO THE FX-66-S-196 UP TO $C_L = 1.1$ AND ACHIEVES A USEABLE $C_L = 1.4$ COMPARED TO 1.55 FOR THE 196. THE OLDER WORTMAN FX-61-184 HAS A LOW C_{Do} OF 0.006 AT LOW C_L AND REMAINS LOWER IN DRAG RELATIVE TO THE 196 TO $C_L = 1.1$. IT HAS A USEABLE LIFT COEFFICIENT OF 1.3. THE RONCZ 517 HAS THE LOWEST PREDICTED DRAG UP TO $C_L = 1.1$ AND A USEABLE C_L OF 1.3. THE RONCZ 1046 HAS LOWER DRAG THAN THE 196 FOR C_L VALUES OF 0.4 TO 1.3 AND A USEABLE C_L OF 1.4.

ANY OF THESE SECTIONS SHOULD BE A GOOD CHOICE FOR OUR DESIGN. PERHAPS A TABULATION COMPARING THEIR CHARACTERISTICS WILL AID OUR CHOICE.

AIRFOIL	t/c	AT 80 MPH	AT 35 MPH	AT 31 MPH	USEABLE C_L	C_{Mo}	STALL
E 748	.196	.0076	.0114	.0136	1.8	-.190	?
FX 196	.196	.0067	.0098	.0118	1.55	-.115	
FX 184	.184	.0061	.0093	.0150	1.30	-.125	
R 1046	.18	.0088	.0087	.0120	1.40	-.120	?
R 517	.17	.0060	.0076	.0236	1.30	-.120	?
S 0416	.16	.0066	.0097	.0130	1.40	-.10	

THE E-748 HAS THE MOST EXCITING USEABLE C_L POSSIBILITIES, BUT IS UNTESTED, STALL CHARACTERISTICS ARE UNKNOWN, AND THE PITCHING MOMENT IS VERY HIGH, WHICH WILL RESULT IN A REDUCED TRIMMED C_L MAX.

THE FX 196 HAS THE MOST TEST DATA, A SOMEWHAT ABRUPT STALL, AND LOW DRAG UP TO THE NEXT HIGHEST USEABLE C_L AT A MORE REASONABLE PITCHING MOMENT.

THE FX 184 HAS TEST DATA, A FLAT STALL, VERY LOW HIGH SPEED DRAG, AND MORE LIMITED USEABLE C_L.

THE SOMERS 0416 HAS EXTENSIVE TEST DATA, A MODERATE STALL, LOW HIGH SPEED DRAG, AND INTERMEDIATE USEABLE C_L.

THE RONCZ SECTIONS ARE UNTESTED, STALL CHARACTERISTICS UNKNOWN, BUT HAVE MODERATE PITCHING MOMENT AND LOW DRAG.

CONCLUDING REMARKS -

THERE APPEARS TO BE A POSSIBILITY TO CREATE A SELF LAUNCHING 10 METER SAILPLANE CAPABLE OF SCHWEIZER 1-26 PERFORMANCE, WEIGHING 150 POUNDS EMPTY, AND ALLOWING A 170 POUND PAY LOAD. TO SIMULTANEOUSLY PROVIDE PILOT PROTECTION AND A ZERO LIFT DRAG AREA COMPARABLE TO PRESENT HIGH PERFORMANCE SAILPLANES WILL REQUIRE MUCH ATTENTION TO DESIGN DETAIL AND USE OF ADVANCED COMPOSITES IN SOME REGIONS.

A FIRST GENERATION SELF LAUNCH SYSTEM USING A SMALL 2 TO 4 CYLINDER GASOLINE ENGINE WILL CONSUME 30 TO 50 POUNDS OF THE EMPTY WEIGHT ALLOWANCE, LEAVING 120 TO 100 POUNDS FOR THE AIRFRAME.

THIS SHIP COULD JUST BE LAUNCHED TO 2000 FEET ON NI-CAD BATTERIES AND BOUCHER ELECTRIC MOTOR TECHNOLOGY. RE-LIGHT AND LEVEL FLIGHT ELECTRIC POWERED CRUISING WILL REQUIRE GREATLY ADVANCED RE-CHARGEABLE BATTERIES. A THIRD ALTERNATIVE OF A GASOLINE AND/OR WINDMILL POWERED GENERATION, NI-CAD BATTERY, PERMANENT MAGNET MOTOR MAY YET USHER IN OUR DREAM SPORT SOARING MACHINE.

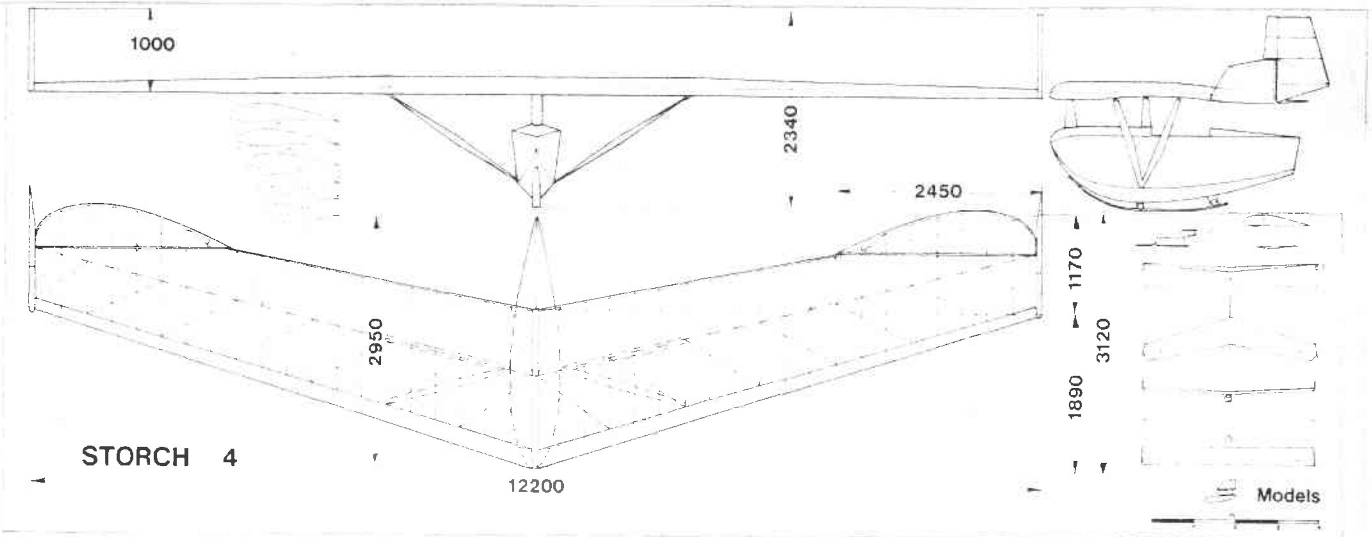
REFERENCES

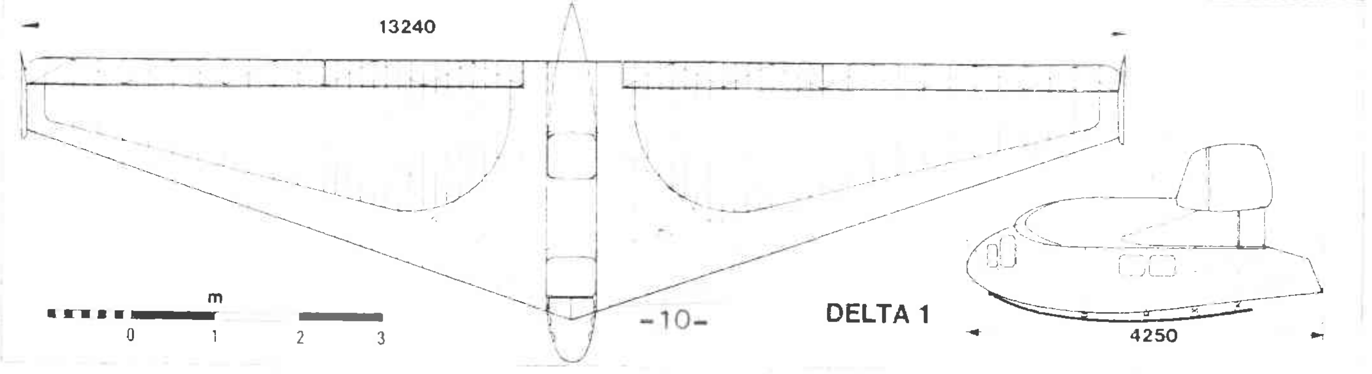
(1) BRINKS, G. ULTRALIGHT PROPULSION. PUBLISHED BY ULTRALIGHT PUBLICATIONS, P O BOX 234, HUMMELSTOWN, PA 17036, 1983.

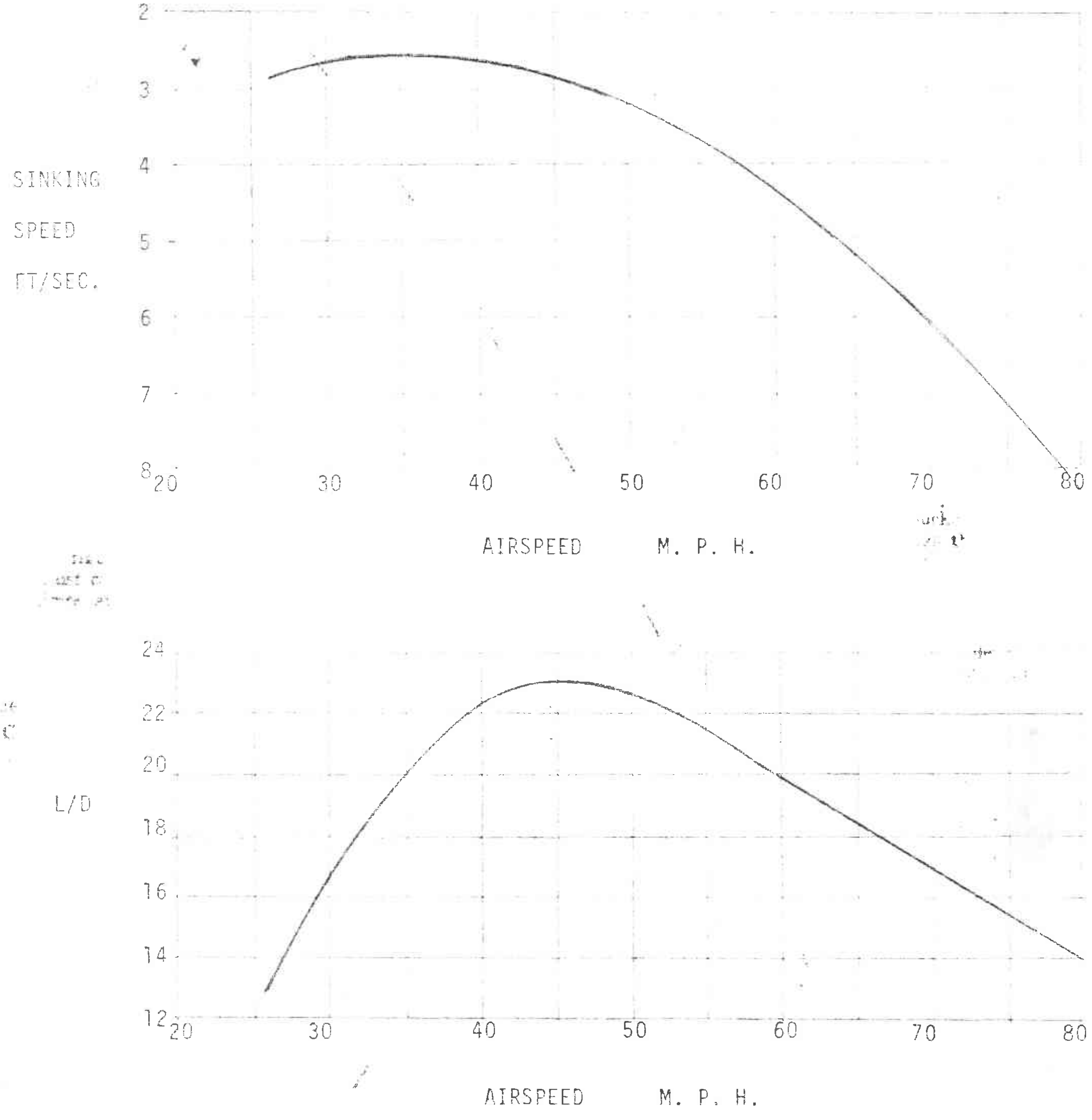
(2) CARMICHAEL, B. H. "LAMINAR LIGHTPLANE - THE DIFFICULT DREAM." SPORT AVIATION MAGAZINE, AUG.-SEPT., 1976.

(3) SUNDERLAND, G. "PROGRESS IN HOME-BUILT SAILPLANES." TECHNICAL SOARING, VOL. VII, NO. 4, JULY, 1982.

(4) STROJNIK, A. "A LAMINAR ULTRALIGHT." SPORT AVIATION, MARCH, 1963.







$b = 32'$ $S = 100□'$ $W = 320\#$ EPPLER 748 $C_{Dp} = 0.005$

FIGURE 14 - STRAIGHT FLIGHT PERFORMANCE

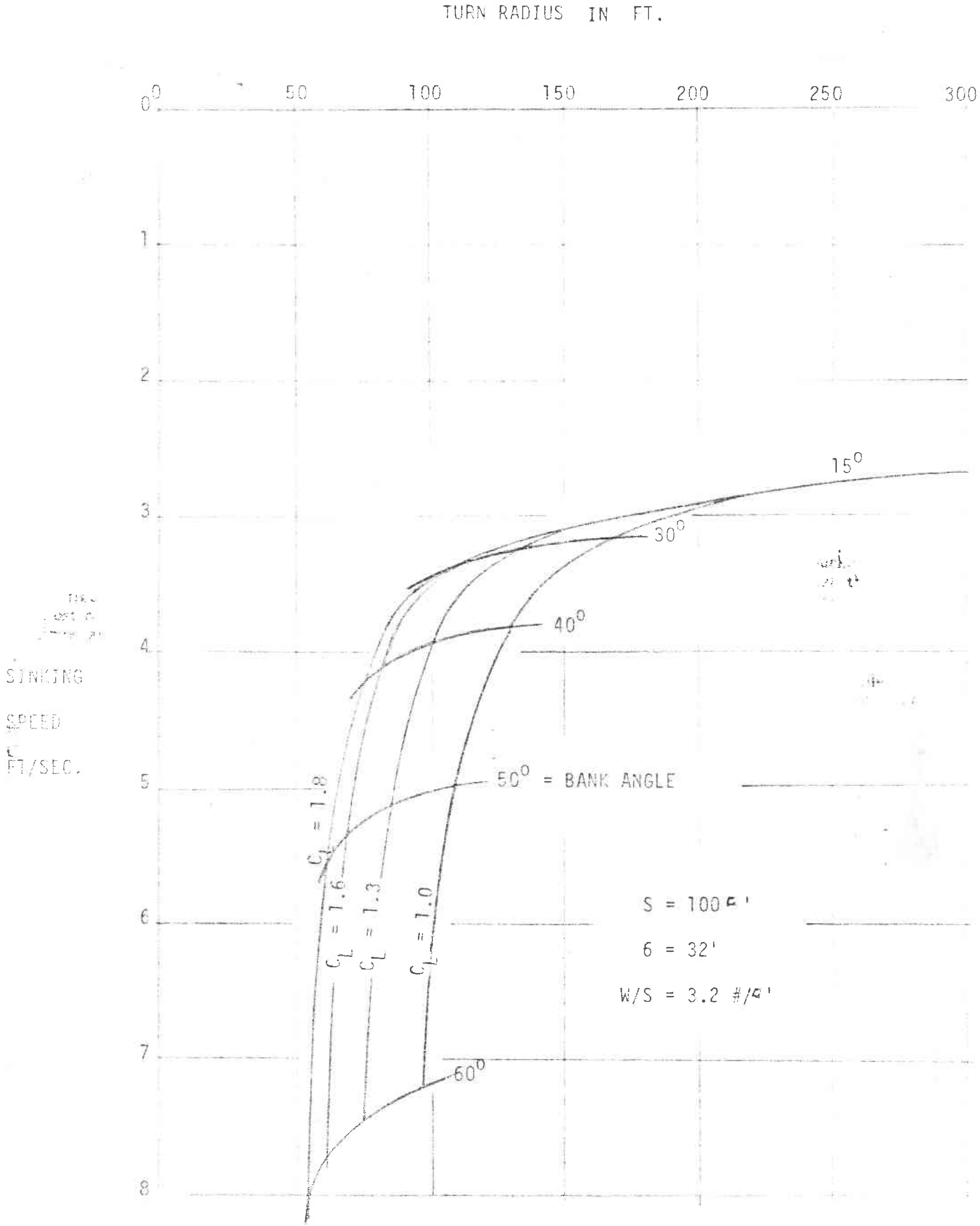


FIGURE 15 - EFFECT OF LIFT COEFFICIENT ON TURN PERFORMANCE

TO BE CONTINUED