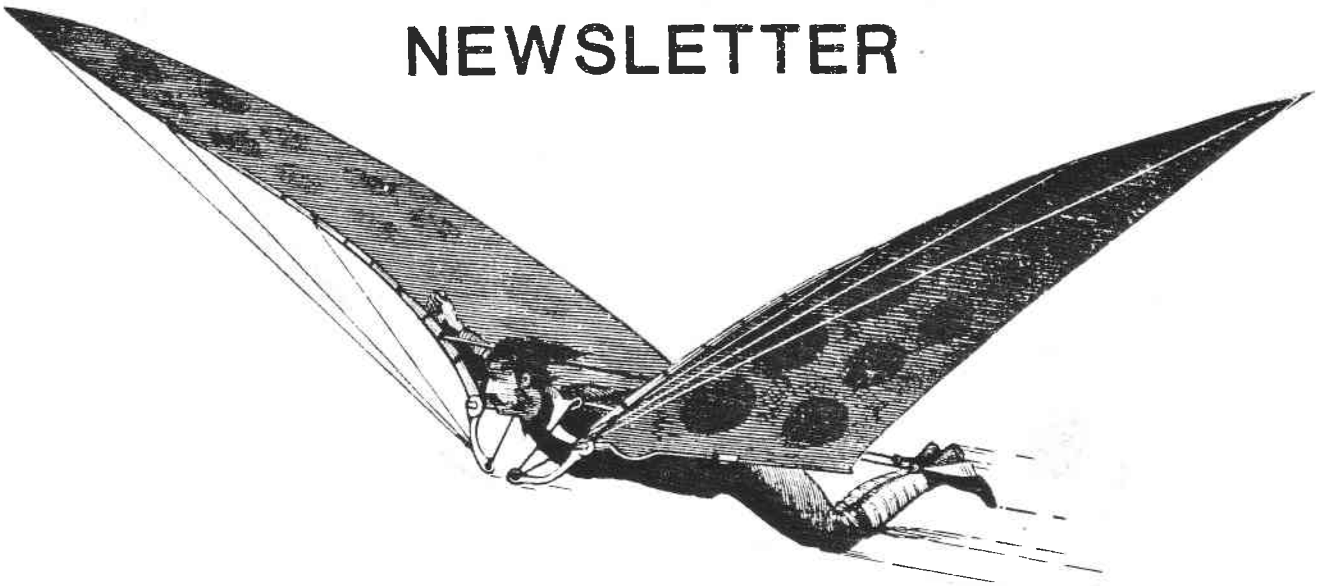
No. 12, June 1987 1st Anniversary Issue

F. Marc de Piolenc
Editor and Secretary

TWITT NEWSLETTER



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

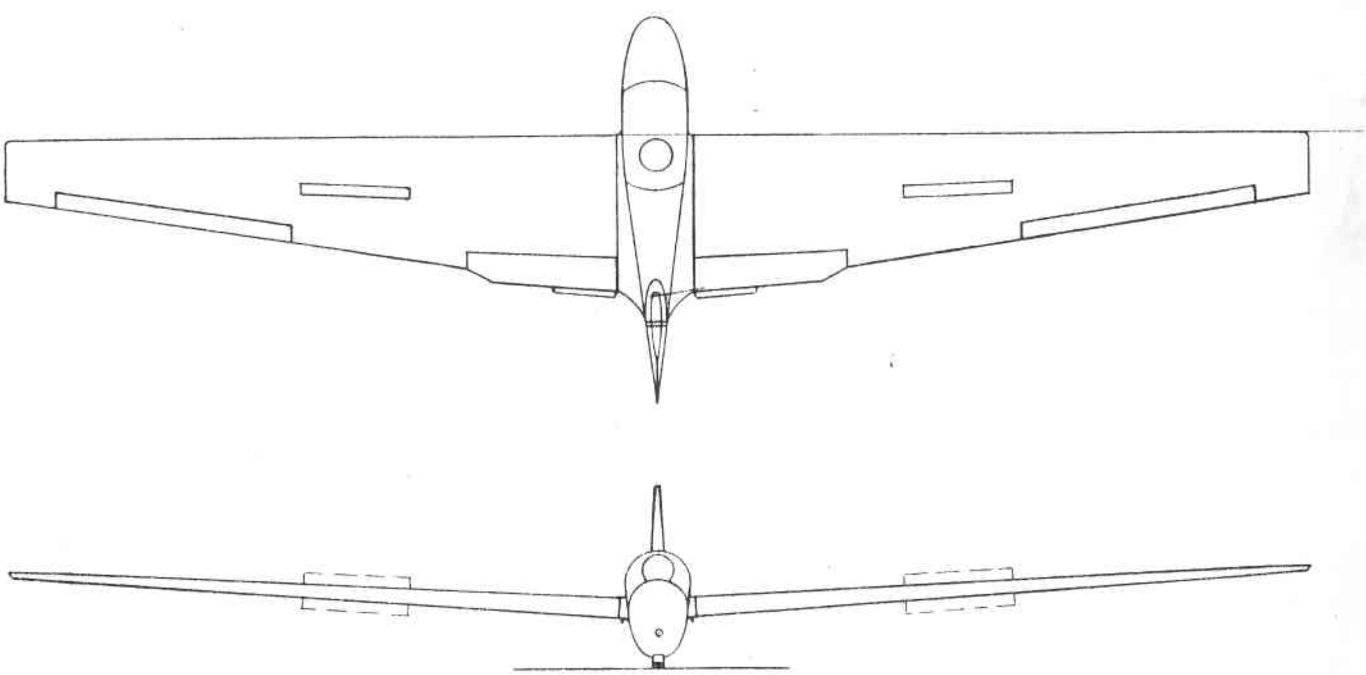
NEXT MEETING: Saturday, 20 June 1987, 1330 hrs, Hangar A-4, Gillespie Fld.

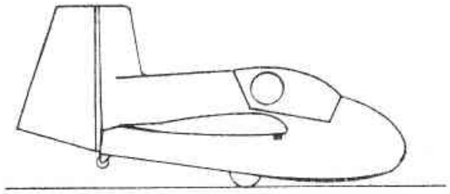
Telephone: (619) 224-1497 before 10 AM or after 10 PM

MINUTES OF THE 16 MAY 1987 MEETING

The meeting began about a half hour late because several members (including your Editor) were late in arriving. Bob Fronius opened the meeting with an announcement of Phil Burgers' talk on TWITT to the forthcoming EAA Chapter 14 meeting (see NL 11 for details). Phil will have a copy of each of our newsletters on display. Don Westergren will have video footage of his scale Shuttle model in flight. Bob also repeated his announcement of the upcoming tour of the San Diego Aerospace Museum workshop, published in Newsletter 11. He then introduced Bruce Carmichael, our featured speaker.

Bruce then presented a study he had made for the Sailplane Homebuilders' Association four years ago. It was based on a design philosophy which Bruce shares with Tasso Proppe: take the pain out of soaring. His ideal is a kit which would sell for five thousand dollars and could be assembled in a standard 1-car garage. This limits span of a two-piece wing to about 10 m., in turn requiring very light construction to get decent performance. Bruce felt that for Western conditions, a higher wing loading was better all around. Bruce had been seriously contemplating electric propulsion using solar cells to charge a storage battery to provide self-launch capability to a light soaring machine. He calculated that with 12-14% conversion efficiency and a cost of $4-5 per peak watt, 50 square feet of wing area devoted to solar cells would get a sport ship to 2000 ft with one 2000 foot relight every hour, at a cost of $ 8,000. Bruce had done extensive research into existing sailplanes, hang-gliders and ultralights and his talk was illustrated with plots of those data and of key aerodynamic and structural relations. Bruce yielded the floor to Klaus Savier, who said he does not recommend all-composite construction for airplanes under 500 pounds empty. Rod Chapell in Reno has built a low AR wing and has molds for it. The SB-13's airfoil section (he gave Bruce data on it) performs very well. It is nearly 100% laminar on the bottom surface; the top is highly cusped. Reg Finch took the floor temporarily to discuss his pet project, a Microturbo-powered two-place fun machine. Ray Hicks at NASA designed a low pitching-moment airfoil; Reg plans a full span t.e. flap to displace the narrow drag "bucket" of the airfoil to match flying speed. The machine will have split t.e. spoilers for drag rudders, a 36 foot span and a gross weight of about 1000 lbs. The twin vertical tails will be for stability only--no movable surfaces. The turbojet exhaust will be routed through a slot-shaped ejector to increase thrust. "Tuto" Figueroa commented that there is an additional "efficiency" consideration for solar cells caused by the fact that they are rarely oriented normal to the incident light. In designing ejectors, he added, there is a minimum length which must be provided, in which the primary and secondary flows mix. He discussed the criteria used to calculate that length. Hernan Posnansky commented that, while solar cells in a vacuum might have reduced output as a result of not being exactly at right angle to the flux, atmospheric diffusion and reflection made a solar cell's output far less dependent on orientation. Billy Gray mentioned a party in Sky Harbor Hangar 19c following the TWITT meeting and the Perris (CA) annual Air Show on 6 and 7 June. Bob thanked the speakers and introduced Ed Lockhart, who related his latest adventure. Ed broke his femur falling off a ladder in Riverside. Not content with the idea of going into hospital in Riverside, he drove himself--unsplinted--to the VA hospital in La Jolla. One and a half weeks later he is recovering nicely with four stainless steel pins in his femur. Bob then introduced Bernie Gross, who built a Marske Pioneer II and is flying it. The machine will fly hands off, with a 35:1 glide ratio at 52 knots. Spoilers have no effect on pitch trim. Bernie designed several tailless gas free-flight models, one of which was featured in the January 1948 Air Trails. The Pioneer II is now based at Crystal Soaring, near Pearlblossom. Details are in the February 1986 issue of Soaring. Bob gave most of Bernie's presentation because Bernie is deaf; it doesn't seem to slow him down much. Reg Finch announced that EAA Chapter 14 is preparing an airplane to enter the CAFE 400 efficiency race; they need volunteers to groom the entry and to actually run the race. Bob mentioned that Jim Marske, designer of the Pioneer, may soon be moving back to southern California.





PIONEER II

SPAN	42 FT.
AREA	147 SQ. FT.
ASPECT RATIO	12
AIRFOIL	23112-75/23110-75
FUSELAGE LENGTH	12.5 FT.
EMPTY WEIGHT	370 LBS.
FLYING WEIGHT	600 LBS.
WING LOADING	4.1 PSF

NEXT MEETING, 20 JUNE 1987

Our next meeting will feature Brad Powers, who will discuss the use of scale models in testing new designs. An article by Mr. Powers appears in this issue. It will introduce many of our non-engineer readers to the concept of dynamic similitude, which is vital to getting realistic results from reduced-scale testing.

ANNIVERSARY CELEBRATION!

TWITT will also celebrate the first anniversary of the June 14, 1986 meeting at which the organization was formed. It will be our first opportunity to lay aside (just for a moment) the considerable burden of just keeping TWITT running and to reflect on what we have accomplished in our first twelve months. Whether by design or by sheer good fortune, we have created an organization with most of the desirable features of a very large group, but without the massive administrative overhead. Our meetings are small, with rarely more than thirty people attending, but our members and correspondents span four continents and many man-years of experience. We have asked for technical and historical information on flying wings...and must now beg for a strong used filing cabinet to house it. We have competed for speakers with the many aviation groups in southern California (and with no budget for honoraria), and they've come. We had no budget for recruiting members or for advertising, but inquiries reach us from all over the world. Our membership is diverse--everything from sculptors to engineers--and of consistently high quality. And it is growing faster than we had any right to expect. And so, fellow TWITTs, if you should happen to be in the neighborhood of El Cajon, California, USA on 20 June 1987, please drop in. There will be a cake and refreshments, of course, and we will welcome the chance to thank you personally for a very good year.

The San Diego Hang Gliding Association
P.O. Box 81665
San Diego, CA 92138

Pilot Achievements

As a new addition to the Flier, a section on XC or unusual flights will be added. Send your descriptions to the editor at the address shown in the Flier. Congrats to the pilots shown below and best of luck on future flights.Thanks to Mark Anselmi for this month's report.

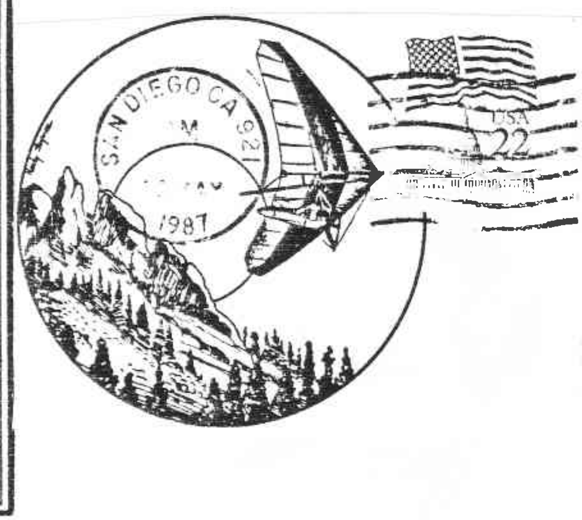
Al Adams
Flew from Laguna to Blossom Valley

Al Adams & Howard Hall -
Horse to Seely, aound 45 miles east

Steve Koji
Horse to Amvoy (almost), 130 miles northeast

Butch Peachy & Joe Hang
Horse to 29 Palms, 98 miles northeast

Airsick Volk
Horse to Palm Desert, 65 miles northeast



A LIGHT APPROACH TO CONVENIENT, ECONOMICAL SPORT SOARING

BY B. H. CARMICHAEL

THE DREAM

I WOULD LIKE TO DESCRIBE MY DREAM RECREATIONAL SOARING MACHINE OF THE NEAR FUTURE. PERHAPS IT WILL REQUIRE A DECADES DEVELOPMENT, BUT I WOULD HOPE IT MIGHT APPEAR IN FIVE YEARS.

ASSEMBLED FROM A KIT PURCHASED FOR 5000 1983 DOLLARS, IT WOULD INCLUDE A SELF LAUNCH SYSTEM. AN ADDITIONAL 500 DOLLARS PURCHASES A KIT FOR AN ENCLOSED TRAILER WHICH WOULD FIT IN A ONE-STALL GARAGE. SAILPLANE AND TRAILER ASSEMBLY WOULD BE COMPLETED IN HALF OF ONE'S EVENINGS AND WEEKENDS OVER A ONE-YEAR PERIOD.

ONE PERSON WOULD BE ABLE TO WITHDRAW THE SAILPLANE FROM THE TRAILER AND ASSEMBLE IT IN 15 MINUTES. THE SILENT, VIBRATIONLESS LAUNCH SYSTEM WOULD PROVIDE TAKEOFF FROM 500 FOOT ROADS OR TURF AND PLACE YOU 2000 FEET ABOVE GROUND LEVEL WITHIN 10 MINUTES. A FLICK OF A SWITCH WOULD KILL THE POWER AND PLACEMENT OF A LEVER IN THE CLOSED DETENT WOULD ESSENTIALLY ELIMINATE PROPELLER DRAG.

ONE WOULD NOW BE SOARING IN A SAILPLANE WITH A MINIMUM SINKING SPEED NO GREATER THAN 2.5 F.P.S. AND AT LOW ENOUGH SPEEDS TO WORK SMALL DIAMETER THERMALS. AN EXTENT OF LAMINAR FLOW EQUIVALENT TO THE BEST RACING SAILPLANES WOULD BE OBTAINED THROUGH LIGHT, SMOOTH, STIFF, WAVE-FREE SANDWICH CONSTRUCTION SKINS FORMED AT THE FACTORY IN ACCURATE FEMALE MOLDS. FLIGHT WOULD BE INCREDIBLY SILENT AND THE VIEW SIMILAR TO THAT FROM A HELICOPTER BUBBLE. PENETRATION WOULD BE REASONABLY GOOD THANKS TO THE VERY LOW DRAG IN SPITE OF THE MODERATE WING LOADING.

THE THERMAL WEAKENS. MOVING THE LEVER TO THE OPEN DETENT EXPOSES THE PROPELLER. ANOTHER SWITCH BRINGS ONE RIGHT UP TO POWER WITHOUT ANY DANGEROUS HIGH DRAG CONDITION MULTIPLE START ATTEMPTS. ONE PURRS ALONG WITH ONLY A MURMUR FROM THE LOW SPEED, LARGE DIAMETER, RESILIENT, SILENCED PROPELLER IN SEARCH OF NEW LIFT. SAFETY WOULD BE ENHANCED THROUGH INCORPORATION OF ALL THAT HAS BEEN LEARNED ABOUT HANDLING CHARACTERISTICS AND LIGHT WEIGHT ENERGY ABSORBING CRASH PROTECTION. AT DAY'S END, ONE RETURNS TO THE TAKEOFF POINT, MOVES THE LEVER TO THE DESCENT DETENT, ENGAGING A POWERFUL GLIDE PATH CONTROL, LANDS, DISASSEMBLES, ROLLS THE COMPONENTS INTO THE TRAILER SINGLE HANDED, AND TOWS IT HOME TO THE GARAGE.

WITH THE EXCEPTION OF THE SILENT VIBRATIONLESS PROPULSION SYSTEM, MANY OF THE ELEMENTS OF THIS DREAM ARE ALREADY AVAILABLE IN MORE EXPENSIVE VERSIONS OR LESS CONVENIENT VERSIONS OR IN ULTRALIGHTS WITH VERY HIGH DRAG AND EXPOSED

PILOT POSITION. LET US LOOK AT SOME OF THE CONSIDERATIONS AFFECTING THE ACHIEVEMENT OF THE TOTAL DREAM OF CONVENIENT INEXPENSIVE LIGHT CONDITION SOARING.

DETERMINING THE SPECIFICATION

THE WINGSPAN PROBLEM -

BUILDING THE SAILPLANE IN A TYPICAL HOME GARAGE WILL LIMIT THE LENGTH OF THE LONGEST COMPONENT TO ABOUT 17 FEET. ALLOWABLE WINGSPAN THEN BECOMES A FUNCTION OF WING ASSEMBLY DETAIL. A SIMPLE LIGHT TWO PIECE WING IS LIMITED TO A 32 FOOT SPAN. A 6 FOOT CENTERSECTION BUILT INTEGRAL WITH THE FUSELAGE WILL ALLOW A 40 FOOT SPAN. A REMOVABLE CENTER WING ALLOWS A LARGE INCREASE IN SPAN, BUT CONVENIENT SINGLE PERSON ASSEMBLY IS UNLIKELY. REMOVAL OF THE CENTER WING CAN BE AVOIDED IF IT IS MADE INTEGRAL WITH THE FORWARD FUSELAGE, WHICH DOES NOT EXCEED A 100 INCH LENGTH. THE BOOM AND TAIL MUST NOW BE REMOVED, AS WELL AS THE WING OUTER PANELS, FOR TRAILERING AND GARAGE STORING. WING PANELS TOO LONG FOR CONVENIENT GARAGE STORAGE COULD BE DESIGNED WITH A FINAL ASSEMBLY JOINT TO PERMIT BUILDING IN THE GARAGE, WITH SUBSEQUENT ENCLOSED TRAILER STORAGE OUTSIDE. DESIGN BECOMES A TRADE-OFF BETWEEN LOW ENOUGH WINGSPAN TO ACHIEVE CONVENIENCE AND COST GOALS, AND SUFFICIENT WINGSPAN TO ACHIEVE SOARING IN LIGHT CONDITIONS.

THE WEIGHT PROBLEM -

WITH LIMITED WING SPAN, THE PROBLEM BECOMES ONE OF BUILDING LIGHTLY ENOUGH TO ACHIEVE A LOW ENOUGH SINKING SPEED FOR SOARING IN LIGHT CONDITIONS. WE ALSO NEED LOW GROSS WEIGHT TO MINIMIZE SELF LAUNCH POWER REQUIREMENTS. THE VERY LIGHT PARACHUTES AND INSTRUMENTS DEVELOPED FOR HANG GLIDING WILL MINIMIZE EQUIPMENT WEIGHT. WE CAN ALL PROBABLY TRIM OUR OWN WEIGHT TO SOME EXTENT BUT CONSIDERATION FOR TALL PILOTS WILL PROBABLY REQUIRE ANY PRODUCTION SAILPLANE TO BE DESIGNED AT LEAST, TO THE TRADITIONAL 170 POUND PILOT WEIGHT ALLOWANCE. THIS WILL STILL EXCLUDE A NUMBER OF POTENTIAL CUSTOMERS BUT OTHER HEAVIER MORE COMPLEX OPTIONS WILL BE AVAILABLE FOR THEM.

WE CAN GET AN IDEA OF POSSIBLE EMPTY WEIGHTS BY LOOKING AT THE DATA IN LOWER FIGURE 1 WHICH COVERS UNPOWERED LIGHT SMALL SPAN SAILPLANES. THE MONERAI AND THE GERMAN KRIA WERE DESIGNED TO USE HIGH PERFORMANCE SAILPLANE TECHNOLOGY AT REDUCED SPAN AND RESULTED IN EMPTY WEIGHTS NEAR 300 POUNDS. THE WOODSTOCK AND MONARCH WITH SPANS OF ABOUT 40 FEET HAVE EMPTY WEIGHTS STILL A BIT ABOVE 200 POUNDS, WHILE THE METAL PRUE 160 WEIGHED 185 POUNDS. THERE ARE QUITE A NUMBER OF SAILPLANES WITH WEIGHTS BETWEEN 100 AND 150 POUNDS. THE RENSSELAER CAP GLIDE 1 REPRESENTS THE LATEST IN COMPOSIT TECHNOLOGY AND HAS AN EMPTY WEIGHT OF 116 POUNDS AT A 37.7 FOOT SPAN. I HAVE DRAWN A LINE BASED ON STENDERS $(SPAN)^{9/8}$ THROUGH THIS POINT. WE FIND THE SOLAR CHALLENGER ON THIS LINE WITH 155 POUNDS AT A 47 FOOT SPAN. PROJECTING DOWNWARD TO A 32 FOOT SPAN, 100 POUND EMPTY WEIGHT APPEARS POSSIBLE. CLAUS HILLS SUPERFLOATER

AND THE ANCIENT LA PRUVO FALL BELOW THIS LINE BUT MAY NOT MEET THE GLIDER DESIGN HANDBOOK LOAD FACTORS. KLEMPERERS BLAUE MAUS IS NOT FAR ABOVE THE LINE.

SIMILAR DATA IS PRESENTED FOR SAILPLANES WITH AUXILIARY POWER IN UPPER FIGURE 1. WE FIND A NUMBER OF SHIPS BETWEEN 100 AND 300 POUNDS. THE GOLDWING, U-2, EAGLET, AND ZIA ARE ALL VERY NEAR 200 POUNDS. DOWN IN THE 32 TO 34 FOOT SPAN RANGE WE FIND 3 SHIPS WITH EMPTY WEIGHTS BETWEEN 130 AND 165 POUNDS.

THERE ARE NOW A LARGE NUMBER OF POWERED ULTRALIGHT AIRCRAFT WITH SPANS BETWEEN 28 AND 36 FEET. UPPER FIGURE 2 PRESENTS DATA ON RIGID WING EXAMPLES WHILE LOWER FIGURE 2 COVERS THE SAIL OR COLLAPESABLE WING CASES. IN BOTH CATAGORIES WE FIND EMPTY WEIGHTS BETWEEN 120 AND 190 POUNDS. THE RIGID WINGS SEEM A LITTLE LIGHTER THAN THE SAILWINGS. IT APPEARS THAT A SMALL SELF LAUNCHING SAIL PLANE WITH A SPAN OF ABOUT 32 FEET CAN BE BUILT AND POWERED FOR AN EMPTY WEIGHT OF ABOUT 150 POUNDS.

WING LOADING -

ONCE THE SPAN HAS BEEN FIXED BY CONSIDERATION OF COST, BUILDING, STORING, AND TRANSPORTING CONVENIENCE, THE CHOICE OF WING AREA MUST BE MADE. LOW WING AREA MEANS HIGHER WING LOADING, HIGHER FLIGHT SPEEDS, AND SOMEWHAT LARGER TURN RADIUS, BUT FOR A FIXED SPAN. THE SINKING SPEED WITH LESS WING AREA IS SLIGHTLY LESS THAN THAT OF A LARGER AREA WING. THE HIGHER ASPECT RATIO MORE THAN COMPENSATES FOR THE INCREASED FLIGHT SPEED. ONE MUST ACCOUNT FOR THE REDUCED CHORD REYNOLDS NUMBER OF THE SMALLER WING AREA BY PICKING AIRFOILS WITH GOOD CHARACTERISTICS AT THE PARTICULAR REYNOLDS NUMBERS.

A SAMPLE CALCULATION WAS MADE FOR 32 FOOT SPAN WINGS OF 80, 90, AND 100 SQUARE FEET OF AREA. THE WING WEIGHT FORMULA OF STENDER PREDICTS THAT THE 80 $FT.^2$ WING WILL WEIGH ONLY 5 POUNDS MORE THAN THE 100 $FT.^2$ WING, IN SPITE OF ITS SHALLOWER ROOT DEPTH. SINKING SPEED VS. TURN RADIUS AT A LIFT COEFFICIENT OF 1.6 (EPPLER 748) IS SHOWN IN FIGURE 5. THE TURN RADII OF THE 80 $FT.^2$ WING SEEM ADEQUATE FOR LIGHT CONDITION SOARING, ALTHOUGH THOSE FOR THE 100 $FT.^2$ WING ARE SIGNIFICANTLY SMALLER. THE ADVANTAGES OF INCREASED PENETRATION AND THE SAFETY OF HIGHER FLIGHT SPEED, IN MY ESTIMATION, OUTWEIGH THE SMALLER TURN RADIUS OF THE LARGER AREA WING.

SOARABILITY -

FIGURE 3 HAS BEEN PREPARED TO SHOW THE RELATIVE LIGHT CONDITION SOARING POTENTIAL OF SEVERAL DESIGNS. THE HORIZONTAL SCALE GIVES THE AIRSPEED AT A LIFT COEFFICIENT OF 1.0. AIRSPEEDS AT OTHER LIFT COEFFICIENTS CAN BE FOUND BY DIVIDING THE AIRSPEED AT $C_L = 1.0$ BY $\sqrt{C_L}$. THE VERTICAL SCALE GIVES THE VALUE OF W/b^2, A LOW VALUE OF WHICH INFERS A LOW SINKING

SPEED. POWERED SAILPLANES APPEAR IN THE UPPER PLOT AND LIGHT UNPOWERED SAILPLANES IN THE LOWER PLOT. SPEED AT C_L = 1.0 IS AROUND 28 MPH FOR ULTRALIGHTS AND INCREASES TOWARD 50 MPH FOR TRADITIONAL SAILPLANES. IN THE UPPER PLOT, THE HORNET AND MONI ARE ARV DESIGNS WHICH WILL REQUIRE LOW POWER ASSIST UNDER LIGHT SOARING CONDITIONS. WE FIND 8 POWERED SAILPLANES WITH W/b^2 VALUES LESS THAN 0.30 INCLUDING THE MITCHEL B10, BLUE LIGHT SPECIAL, MINIBAT, EAGLET, LAZAIR, SUN FUN, ZIA, AND SOLAR CHALLENGER. IN THE LOWER PLOT, THE MONERAI HAS A $SPAN^2$ LOADING = 0.363 EQUAL TO THE 1-26. A DOZEN SAILPLANES HAVE W/b^2 LESS THAN 0.3, WHILE THE REMARKABLE SWISS AVIA FIBRE CANARD HAS $W/b^2 = 0.135$.

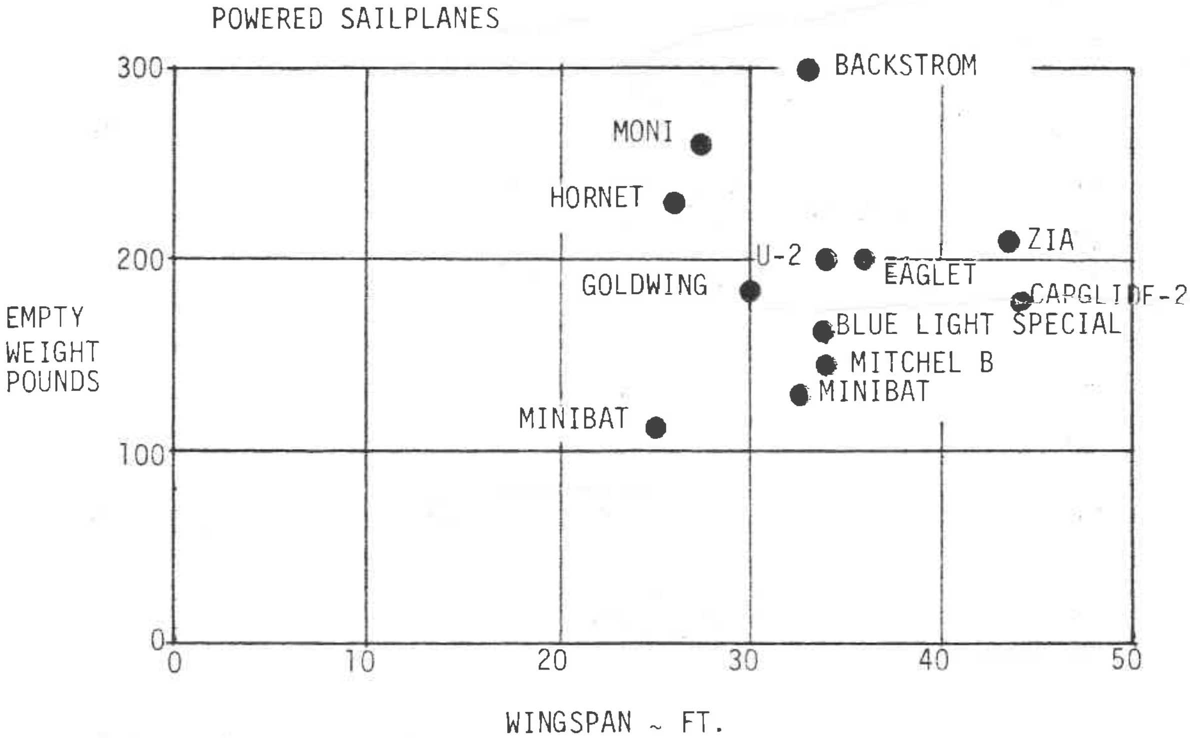
SIMILAR DATA IS PLOTTED FOR ULTRALIGHTS IN FIGURE 4. FOR RIGID WINGS (UPPER PLOT), THE SPEED AT C_L = 1.0 CLUSTERS AROUND 30 MPH WITH WEIGHT/$(SPAN)^2$ VARYING FROM 0.445 DOWN TO 0.225. THE JENSEN SUNFUN AND ITS DERIVATIVE, THE NOMAD, AS WELL AS THE LAZAIR, SHOULD DELIVER EXCELLENT LIGHT CONDITION SOARING. MANY OF THE COLLAPSIBLE WING ULTRALIGHTS (LOWER PLOT) HAVE VALUES OF W/b^2 IN THE VICINITY OF 0.3. THE EAGLE HAS THE LOWEST SPAN LOADING OF THE SAIL WINGS, BUT NOT AS LOW AS THE RIGID WING SUNFUN OR LAZAIR.

FROM THE FOREGOING STATISTICAL DATA, IT APPEARS POSSIBLE TO BUILD A SOARABLE (IN LIGHT CONDITION) 32 FOOT SPAN SELF LAUNCHING SAILPLANE FOR AN EMPTY WEIGHT OF 150 POUNDS WITH A 170 POUND PAYLOAD CAPACITY. TO DO THIS, FULLY MEETING THE GLIDER CRITERIA HANDBOOK STRUCTURAL REQUIREMENTS, PROVIDING REASONABLE CRASH PROTECTION FOR THE PILOT, AND RETAINING ALL THE CONVENIENT FEATURES MENTIONED EARLIER WILL CONSTITUTE A REAL CHALLENGE TO THE DESIGNER. IT WOULD BE DIFFICULT ENOUGH IN A PURE SAILPLANE. THE ADDITION OF EVEN A LIGHT POWER PLANT COMPLICATES THE PROBLEM IMMENSELY.

SINKING SPEED -

THE PARABOLIC APPROXIMATION OF THE LIFT-DRAG POLAR RESULTS IN A CONVENIENT FORMULA FOR MINIMUM SINKING SPEED. SINKING SPEED IN FT/SEC. = $K_W (W/b^2)/\sqrt{W/S}$, WHERE W = GROSS WEIGHT, S = WING AREA, AND b = WING SPAN. THE LIFT COEFFICIENT REQUIRED TO ACHIEVE THE THEORETICAL MINIMUM SINKING SPEED IS OFTEN MORE THAN THE AIRFOIL CAN DELIVER. THIS DISCREPANCY GETS GREATER AT LARGER WING ASPECT RATIOS. DATA FROM A LARGE NUMBER OF CLEAN SAILPLANES, AS PLOTTED IN FIGURE 6, PROVIDES K_W AS A FUNCTION OF ASPECT RATIO AND ALLOWS US TO PROCEED WITH OUR DREAM MACHINE CALCULATIONS.

TO BE CONTINUED



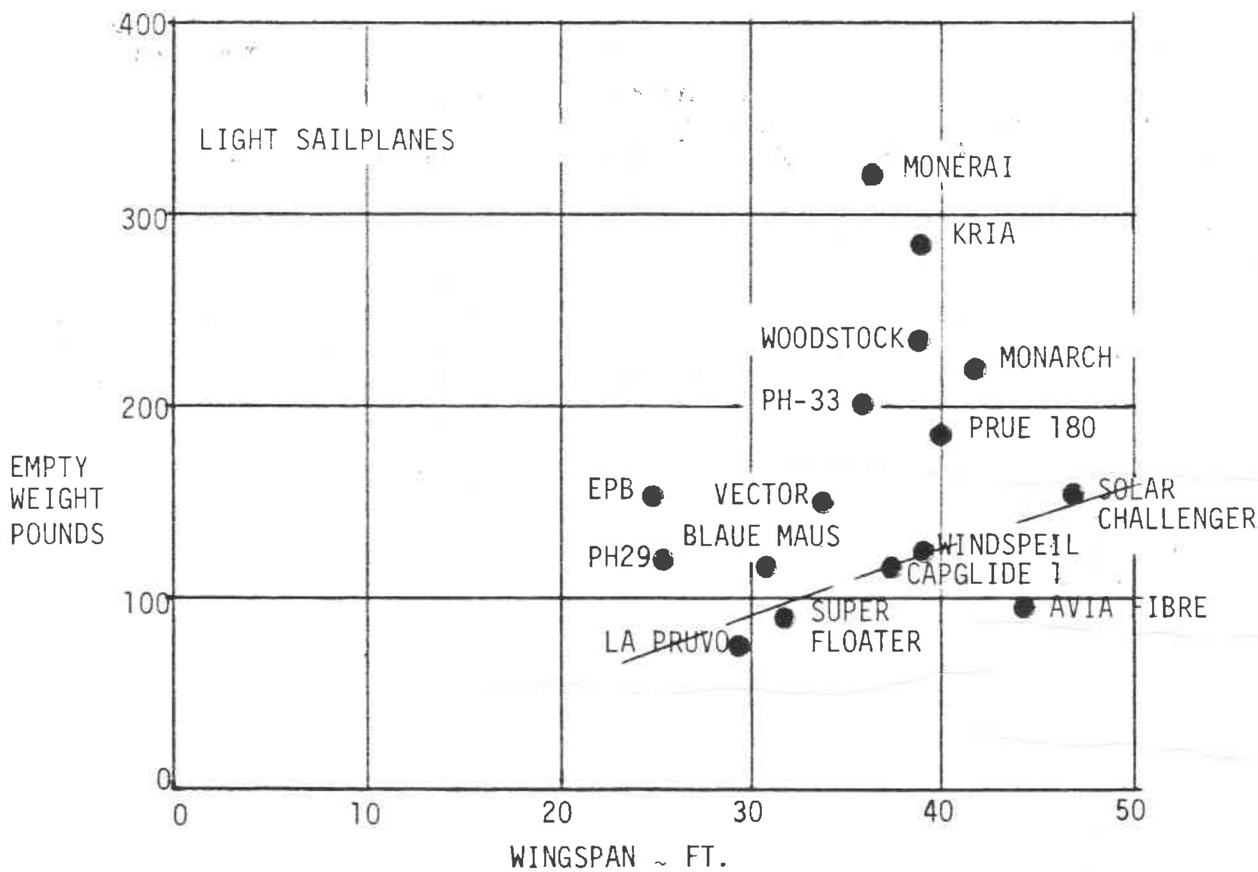
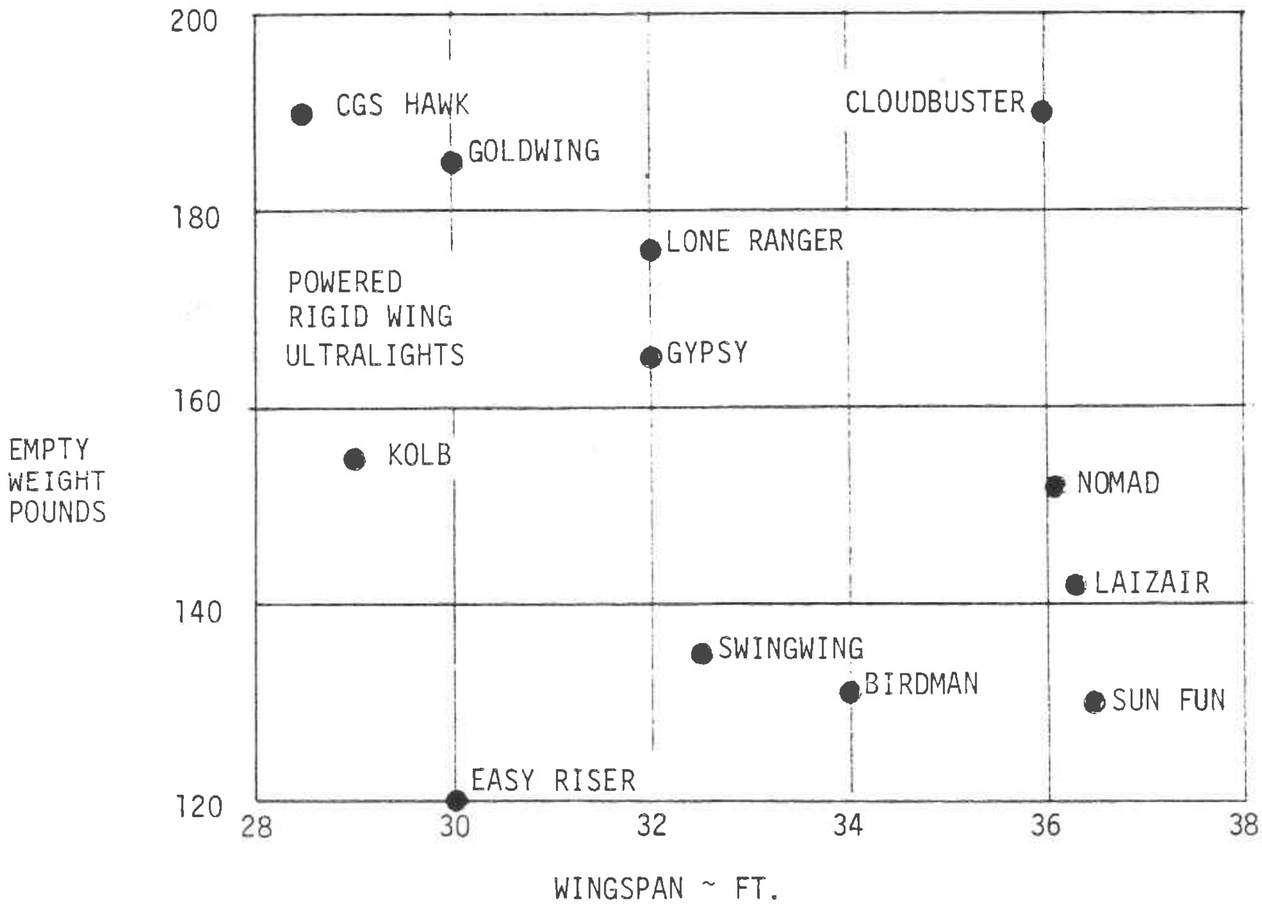


FIGURE 1 - EMPTY WEIGHT VS. WINGSPAN



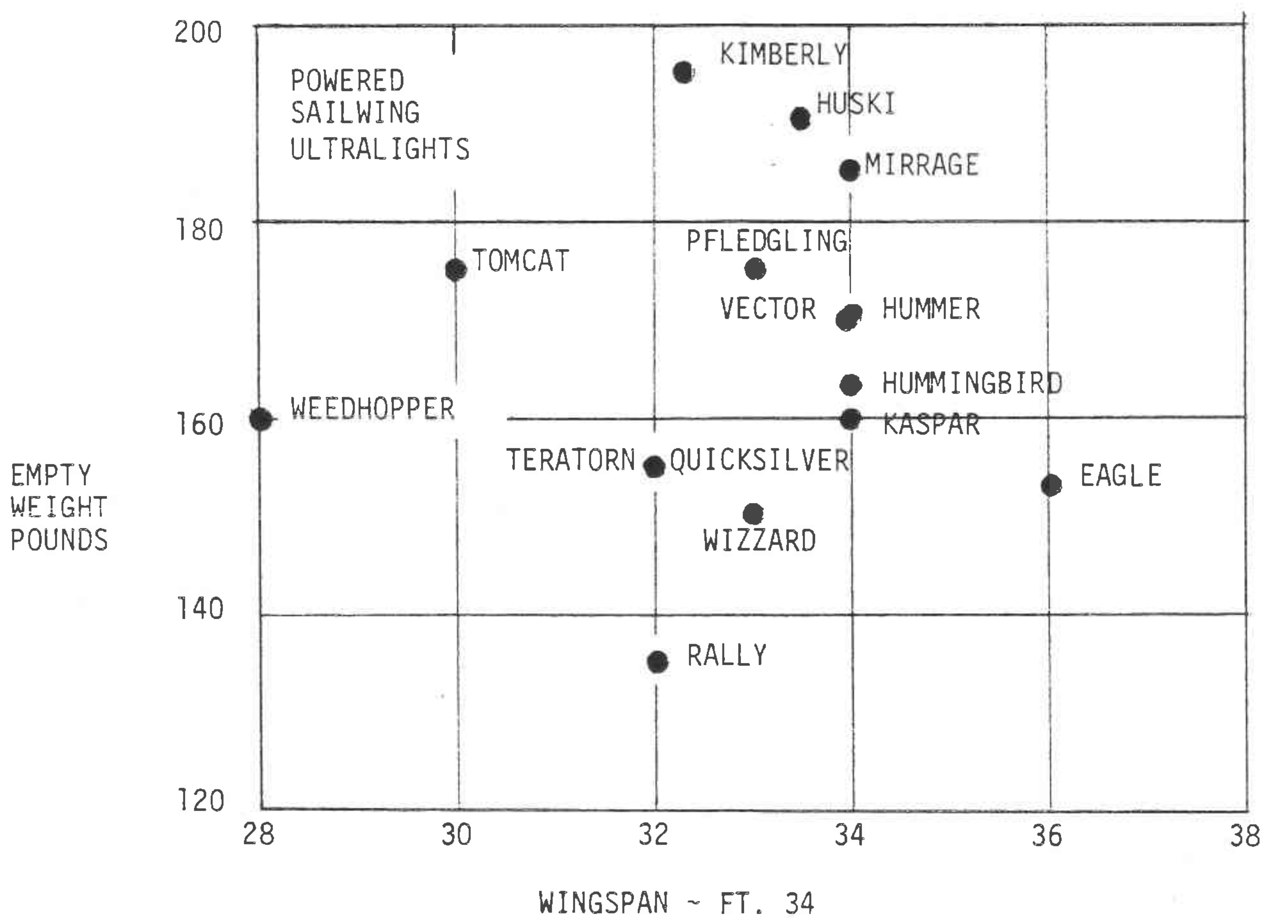
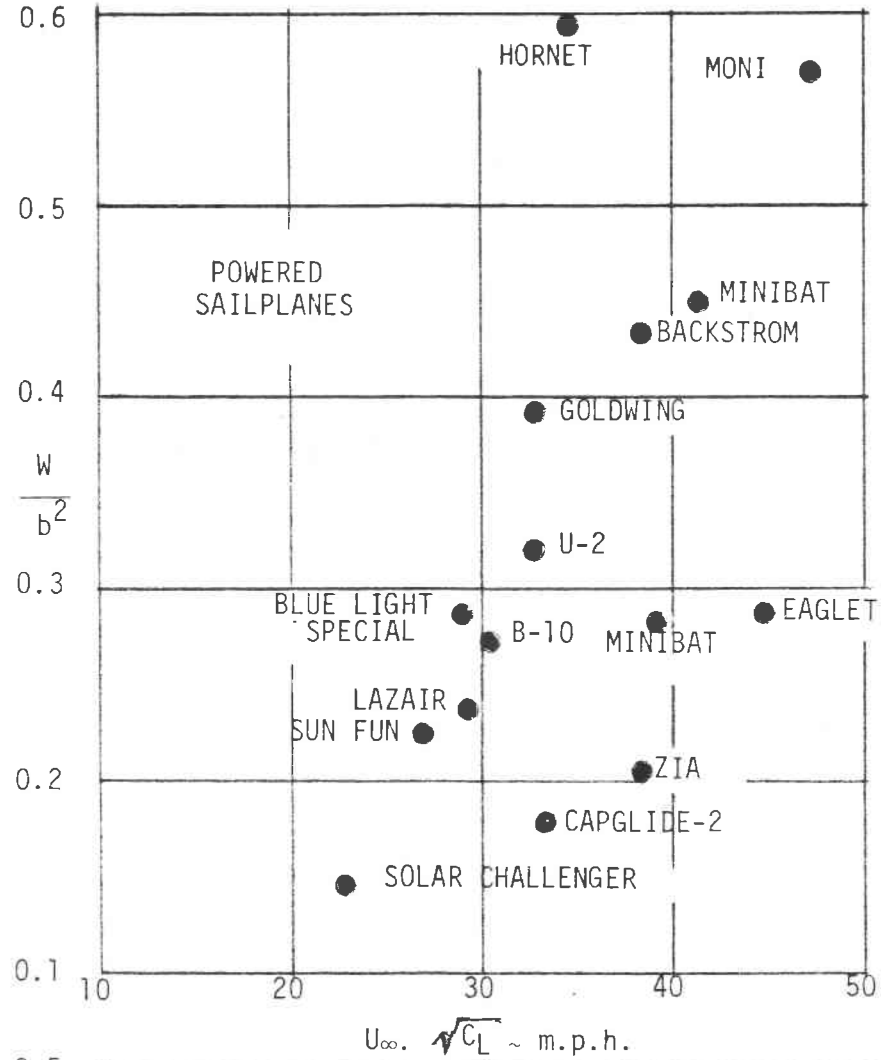


FIGURE 2 - EMPTY WEIGHT VS. WINGSPAN



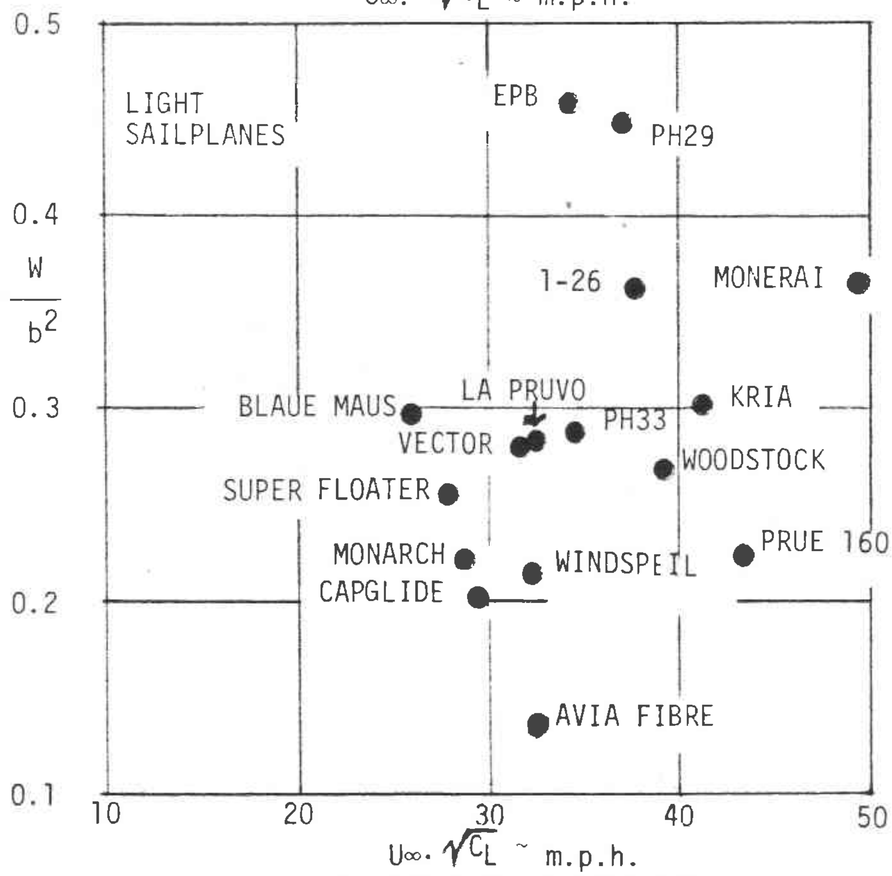
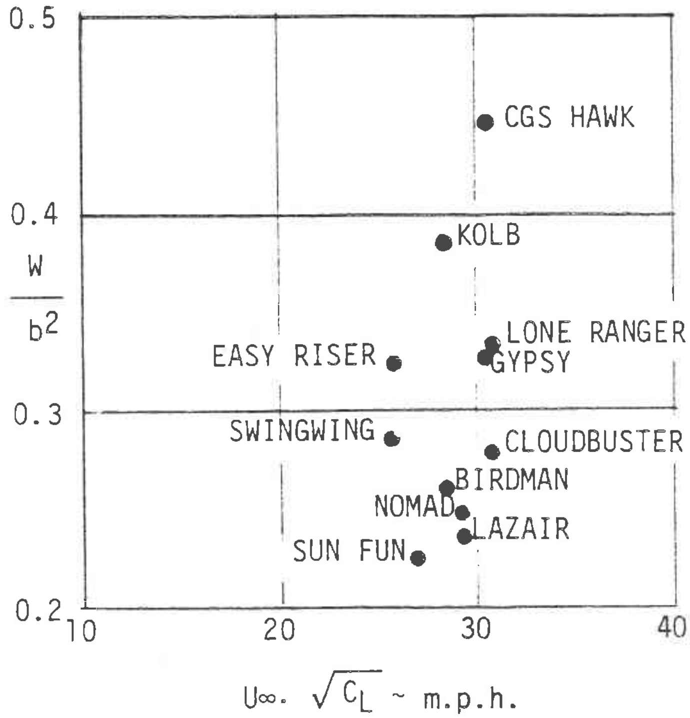


FIGURE 3 - LIGHT CONDITION SOARABILITY



RIGID WINGS

COLLAPSABLE WINGS

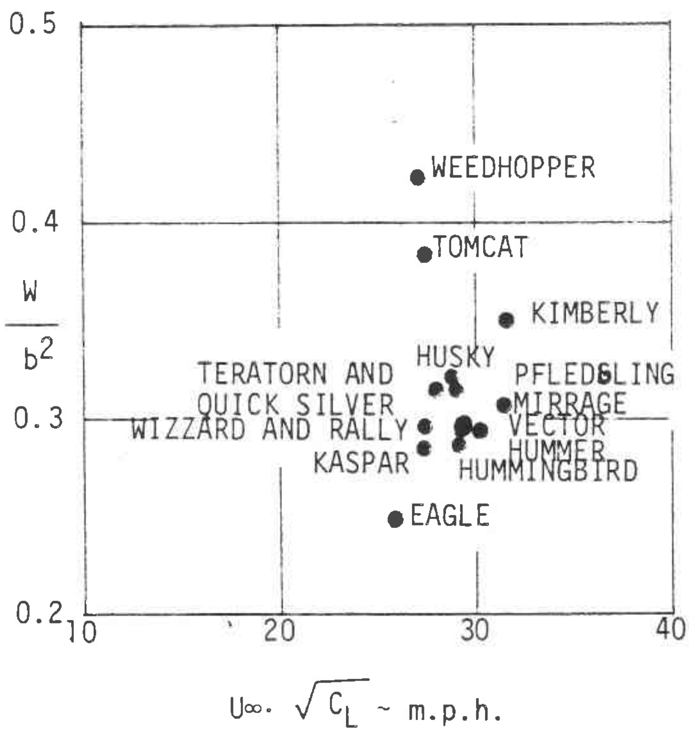


FIGURE 4 - LIGHT CONDITION SOARABILITY

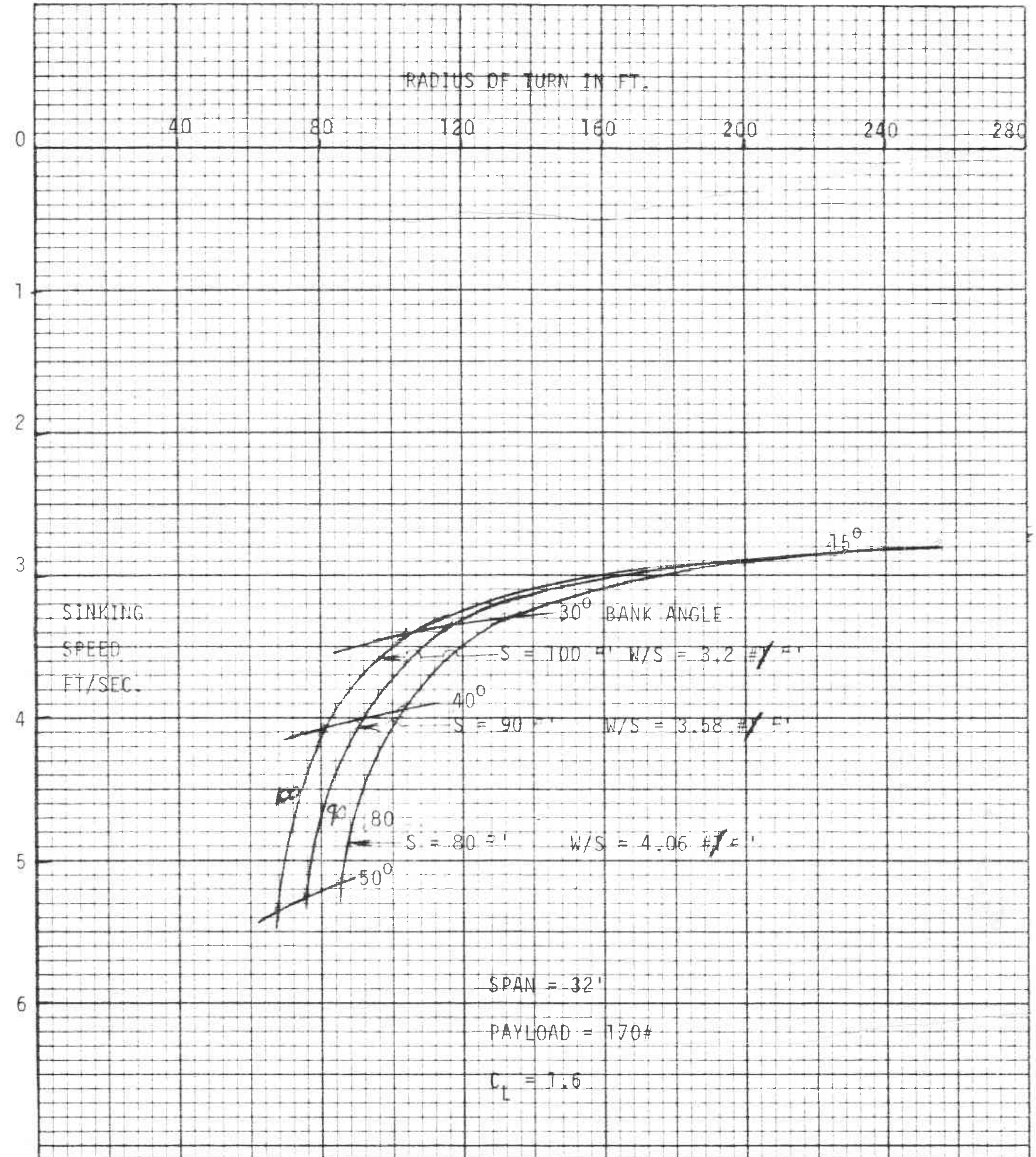


FIGURE 5

EFFECT OF WING LOADING ON TURN PERFORMANCE

SQUARE 10 X 10 TO THE INCH AS-0807-OY
GRAPH PAPER GRAPHIC CONTROLS CORPORATION Buffalo New York Printed in U.S.A.

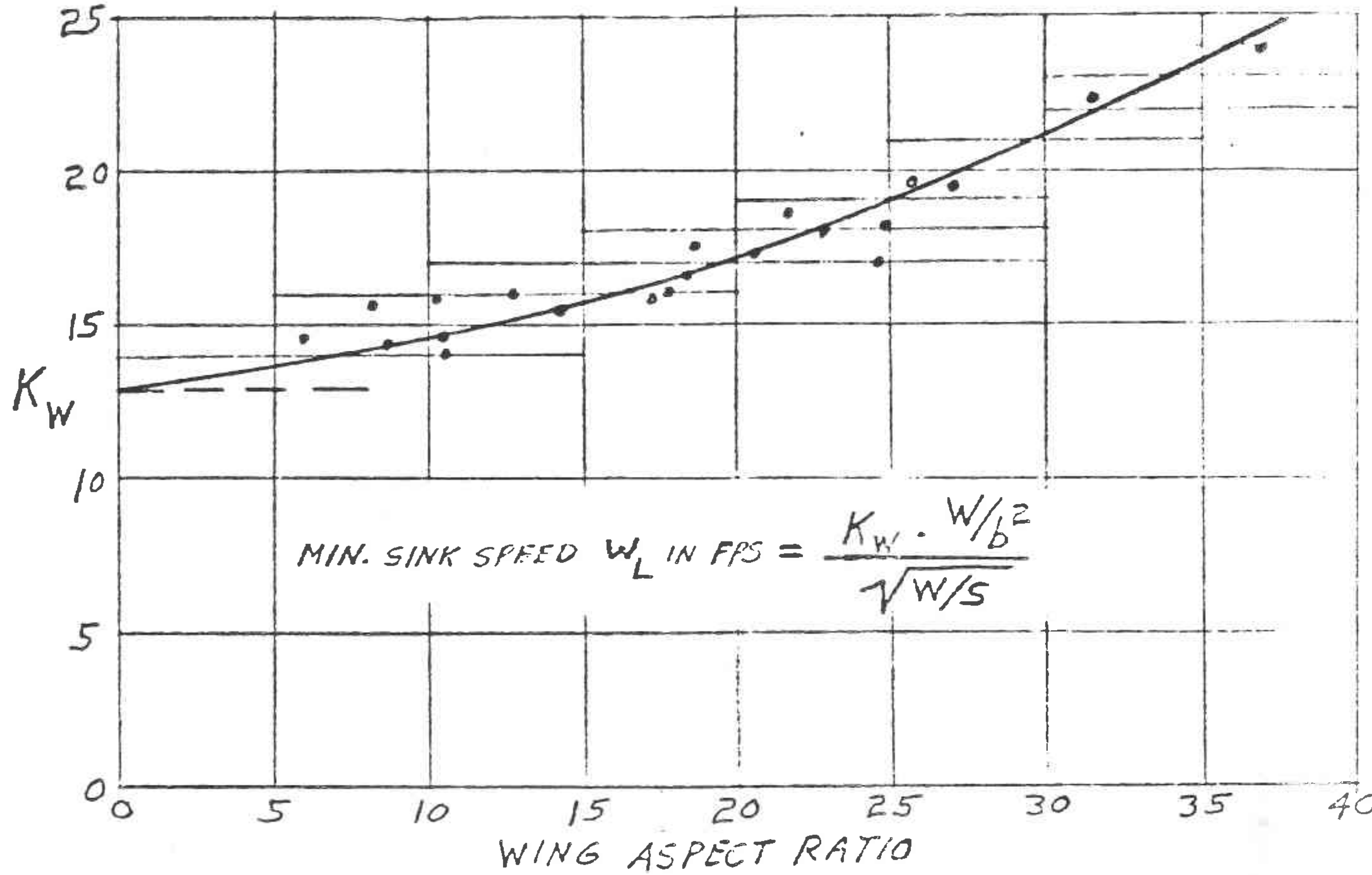


FIGURE 6 - SINKING SPEED CONSTANT VS. ASPECT RATIO