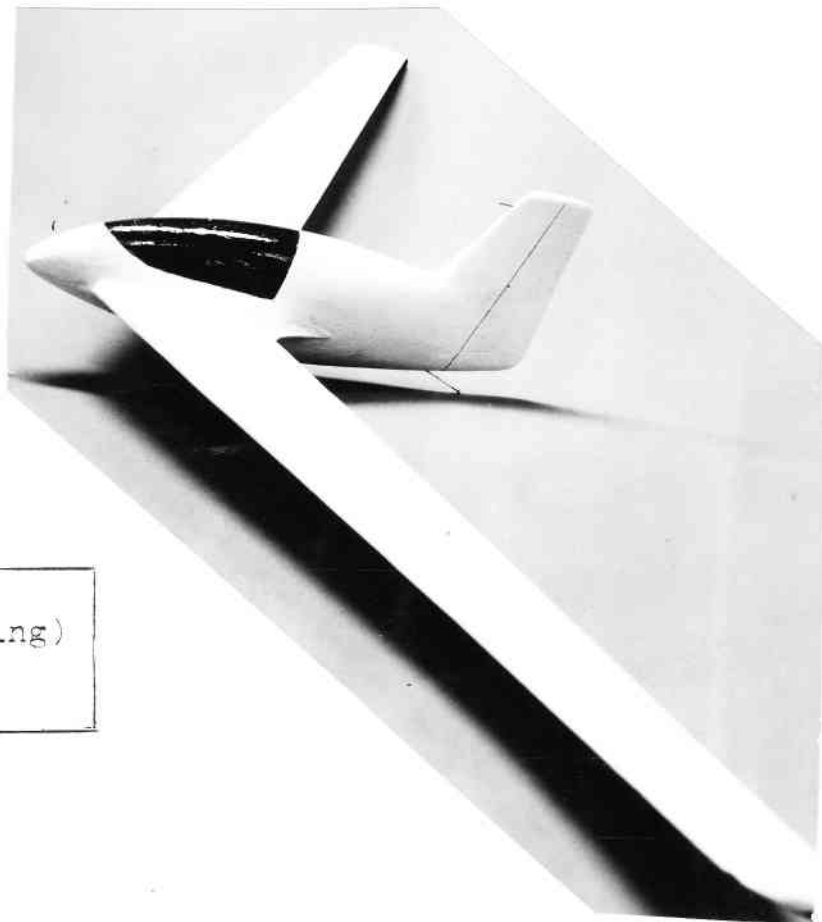


TWITT NEWSLETTER



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

The numbers to the right of your name indicate the last issue of your current subscription, e.g. 9002 means this is your last issue.

Next TWITT meeting: Saturday, February 17, 1990 beginning at 1330 hours. The location is Hanger A-4, Gillespie Field, El Cajon, CA in the first row of hangers on Joe Crosson Drive.

MINUTES OF THE
JANUARY 1990 MEETING

The meeting was called to order by President Andy Kecskes. He announced that the raffle prizes were a heavy-duty extension cord, and a corresponding three outlet adaptor.

After outlining the meetings events, he showed the group a copy of the bibliography of literature concerning subsonic tailless aircraft and related topics published by Serge Krauss. This has been added to the TWITT library and is available for review if anyone would like to see it before ordering one of their own. They can be ordered from: Serge Krauss, 3114 Edgemoor Road, Cleveland Hts., OH 44118, at a cost of \$20. Some of the members have already heard from him through the roster published in the newsletter some months back. Fortunato proposed we approach Serge with an offer to buy a number of the bibliographies in one order if he would give a quantity discount, which will be done after we find out how many people are interested.

Bob asked if everyone had noticed the outlined area in the January President's corner explaining the tax exempt status of membership dues and donations made after November 1, 1989. If you didn't, make a note of it so you can take advantage of it in 1990. If anyone donates something other than money we need them to assign the item a dollar value for our reporting purposes.

Andy went over some of business items to include a financial report on TWITT and that 1989's financial statements had been prepared for submission to the Hunsaker Foundation. As of yearend, TWITT had a positive cash flow and that continuing increases in membership, along with renewals, was maintaining a good cash balance.

Bruce briefed the group on some material he had picked up on a new German foot launched tailless sailplane with improved performance capabilities for a hang glider, about 28:1 glide ratio. Apparently it has passed most of the German required flight tests. Bob has the article so we can get Harald to translate it for eventual publication.

After a short film on hang gliding and base jumping at Angel Falls, Andy introduced Craig Roberts and his Sceptre aircraft project. This unique aircraft was an outgrowth of the ultra-light movement during the sev-

enties, and was meant as an alternative to the then group of inferior aircraft. Health constraints of his fathers dictated design and building of a self-launch aircraft and he originally wanted to go with a flying wing. Unfortunately, his father had plans he developed years before and it was decided to use them instead of the wing.

The original plan was for a single aircraft comprised of a steel tube fuselage and wood wings that would allow both of them to have some fun. But as the aircraft design game goes the project turned into building a proof of concept experimental aircraft. To keep costs down the original plane used the nose section from the Miss Budweiser unlimited hydro-plane since it was readily available in the Seattle area. Once the nose was enclosed, it was decided to also put a faring around the engine.

The prototype was completed in July 1983, and so impressed one of their customers that he signed a contract to produce the aircraft. Flight testing began on the proof of concept with an experienced test pilot doing the honors. The first flight was quite successful with the aircraft proving to be very stable and the ability to climb at about 45 degrees while retaining excellent controllability. It was powered by a 50 h.p. Rotax, 2-cycle engine which gave it a very good power to weight ratio.

The whole project was proceeded by a series of radio control dynamic models to prove the concept. Once these had proved successful they built the full scale prototype, and then began the redesign work to produce an aircraft that would be useable by the average sized pilot.

The construction method selected was composite tooling lofting up the wing and fuselage masters using plywood, foam, fiberglass and lots of bondo to get it completely smooth. The spars were all composite unidirectional epoxy wound around aluminum fittings held together by a single NAS bolt. This enabled the wings to be removed for easy trailering. The main spar was stressed to at least 9 Gs. They made a computer controlled oven for curing, a clean room for layup, jigs for parts assembly, and a freezer for material storage. This was all put together into an assembly line for the first production model. After about twenty months of work this aircraft was in the air using several dedicated production staff members and some high school kids.

We cannot identify the wing on the cover. HELP!

The aircraft's specifications are presented on the page following these minutes. It was built to fit in the air recreation vehicle category since the sponsor could not obtain insurance for production and distribution of an aircraft in the ultra-light category.

The configuration provided airflow over the rear control surfaces for good control authority, and the propeller being in the rear also helped reduce the cockpit noise level. Visibility from the cockpit was extremely good. The double-tapered wing was chosen in order to get the wing area necessary to meet the FAR 23, 24 kt stall speed, with a different airfoil and configuration for a later two place version.

Andy then introduced Rod Schapel, who offered to give a brief talk on his flying wing project. Rod gave an overview of the basic aircraft. It has a wingspan of 34', with a gross weight of 1960 lbs. It is powered by a two chamber rotary, turbo-charged, fuel-injected pusher engine that runs at 6000 RPM producing 180 hp. The 54" propeller turned at 3000 RPM through a 2:1 reduction system. The engine gave them some problems during the dyno testing phase, but a successful combination was finally developed.

The aircraft was built in female molds using an epoxy system, vacuuumed, and cured at 240 degrees F. in an oven. The upper and lower surfaces are a foam sandwich with a three spar system out to the landing gear position and then two spars out to the tip. The wing has five ribs per side and uses a non-laminar flow airfoil of his own design with a very low pitching moment. The wing has alot of twist between the root and tip, with about 9 degrees negative by the time you reach the tip. This was designed to achieve a zero pitching moment, which has since been confirmed through the flight testing. Max CL came out to about .85, and was driven by the fact that all the actuation mechanisms had to be enclosed.

The actual construction involved using unidirectional material, laid up at different angles as required by the results of a computer analysis. They built a male plug (this is available to anyone or TWITT), a set of one piece female molds for everything, and then the PVC sandwiched skins constructed. This type of construction gave it about a 1300 lb empty weight, with a fuel capacity of 57 gallons right at the CG. The spars were made up separately, then added to

the laminated lower skins along with the ribs and then bonded all together. The upper skins, in their mold, were then bolted on-top of the lower portion so a spar cap could be cast to measure the thickness between the spar and upper skin. Once the shim was constructed, the whole thing was bolted together and put in the oven for curing.

According to the Harald, the aircraft was hanging on the wall at the Chino Airport Museum (California), along with a Horten wing.

Rod added a comment about making sure you put a steerable nose gear on any plane like this, which they had not. Low speed controllability during the initial phases of takeoff required using alot of brakes, since the drag rudders were ineffective. This was due to them being at the MAC rather than the wingtips so the pitching moments wouldn't be changed during flight.

Several things Rod said he would change if he did it again were: put the drag rudders out at the wing tips; instead of having separate elevator and ailerons he would combine the two; and he felt it would be much simpler to put a jet engine (about 400 lbs thrust) in it versus the rotary.

At the completion of Rod's presentation we had the raffle. Harald Buettner won the extension cord, and Jim Neiswonger won the multi-plug adaptor. After the winners claimed their prizes, the meeting was adjourned.

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FEBRUARY'S PROGRAM

Don Westergren, who showed us his scale radio control space shuttle some time ago, now show us his latest, a 1/4 scale Voyager model. Built of foam, balsa, fiberglass and carbon fibers, it spans 27 1/2'. He will have it set up and will describe its construction, as well as answer any questions. Don is a Sr. Project Engineer with GD Space Systems Division. Don says it hasn't flown yet, but the day is not far off.

There will also be a demonstration and discussion of self-launched parachute systems by a group currently operating from Torrey Pines and Little Black Mtn. These devices have performed amazingly well off the slopes and the presentation should be interesting.

PRESIDENT'S CORNER

This will be short this month since we have a lot of material to squeeze into the limited number of pages. The membership continues to grow and we now have about 110 current members from all over the globe. We are finding new ways to advance the cause of TWITT through other flying associations as can be seen by the letter from J. Sile in England.

I hope that all this new activity will bring with it many new ideas on flying wing concepts. In this way we can pass them on so everyone will be able to benefit from their association with TWITT.

In an effort to serve more of the members, at least in the Southern California area, we are looking for ways to have an occasional meeting in the Los Angeles area. More information will follow as we can work it out.

Another way we can promote flying wing concepts would be to hold our own Nurflugel (flying meet). There are several ways this can come about, and as soon as we have more details we will pass them along to you. If anyone has some ideas on how to expand our coverage or provide more forums for the exchange of ideas, please send them to us.

That's it for this month. (Told you it would be short.) Keep your letters coming letting us know what's happening out there.

Andy



Rockin' with Rollin!

Rollin Klingberg's hang glider uses state-of-the-art model construction techniques.

MORE PROGRAM

Bob Peck of Peck Polymers has donated the raffle prizes. Bob will have a video on R.C. Blimps and discuss the flying of the Stringless Wonder.

(Ed. Note: The following was received along with a subscription from Robert Randall of El Segundo. We do not know which modeling publication it came from.)

FULL SCALE K-WING!

You've seen Rollin Klingberg's flying wing kit, right? Now there is the real thing! Test pilot Martin Bell says that it's the nicest foot-launched aircraft he's ever flown, and he's been flying hang gliders since 1971.

SPECIFICATIONS

Span	38 ft
Area	168 sq ft
Weight	93 lbs
Max Speed	70 mph
L/D	25:1 with lower door and full canopy
Materials:	Graphite, Kevlar, fiberglass, foam, wood.

The photo shows it flying at Marina Beach, Calif. At the time it had about two hours flying time on it.

LETTERS TO THE EDITOR

(Ed. Note: The following was sent to us by Bernie Gross, an original TWITT and great supporter of the flying wing concept. It was written just after the Sailplane Homebuilders and Vintage Sailplane get-together at Tehachapi, however, got lost in the shuffle of material we have received. Bernie makes a good point about talk and no action, which will be a subject discussed in the near future.)

Dear Bob,

September 27th

Enclosed you'll find the photos in this letter and hope you will enjoy seeing them. At the SHA workshop on Labor Day weekend I was disappointed because all TWITTERs seemed to have not gotten together with me for flying of my only pure flying wing sailplane. What is TWITT good for? Just talking and talking?

Be seeing you soon down in El Cajon.

Bernie Gross

Dear Robert,

12/18/89

Recently I sent you a check to finish out the funds I had already sent for renewal and an additional years subscription. The information sent to me is a mistake since I did not request it and I have most of it anyway. I believe you got me mixed up with someone else, so I've sent these back to you.

Soon I will send some Horten H1c plans for TWITT members to review at your meetings. The plans include return postage if no one decides to buy them. I trust these plans to you and ask that you not let them be copied. I will donate a set of plans in the future for the TWITT library, if I can get some sales through TWITT members. Fifteen plan sets have been sold, several people very interested in construction and a Horten newsletter is in the works.

Sincerely,
Henry

(Ed. Note: See the advertisement elsewhere in this issue for price and ordering address.)

Jack A. Sile
Box 2069
APO NY 09755

Dear Editor,

I am the newsletter editor for the British Association of Radio Control Soarers, and as it happens I am an American living in England. As you may know we have quite a few RC enthusiasts here and they are particularly interested in American ideas. As editor, I would like to include as much information as I can in our newsletter. I saw your notices in the R/C Soaring Digest, and wondered if you would like to enter into a reciprocal agreement with us. You are welcome to use anything you find in our newsletter as we would hope to do with yours. We publish five times a year and have a readership just below 1000. I would be pleased to publicize your organization if you will send me some information about yourselves.

Sincerely,
Jack A. Sile

Dear Mr. Fronius

January 6, 1990

Enclosed is the current (initial) version of the tailless aircraft bibliography I was working on and promised you last March when we talked. It may include some items not already on your lists, although I suppose you have a few TWITT members who could add substantially to it, especially regarding gliders. Perhaps it will prove a useful contribution to your library; I only ask that members use it for information only, not as a master for duplication. Having spent the time on this very labor-intensive undertaking, I now understand why no one else has offered such a work recently.

I enjoyed reading your newsletter and see that it has received some attention nationally. I would be interested in whether you feel that its contents will prove accessible enough that they should be included in a future expanded bibliography, should such a project come to pass.

I'm continuing to find tailless bibliography items and to maintain my personal file as an ongoing hobby. If sales demonstrate sufficient interest, I may offer an expanded version (perhaps several hundred more items and/or expanded format) sometime in the future, but there is a long way to go just to "break even." It is also meant to open the project to possible contributions from other tailless aircraft enthusiasts. Comments and criticism are welcome, but sales are necessary to its continued availability and any expediting of further development. So, if any of your members like this thing, please encourage them to send in an order!

Incidentally, if any of your members have ordered this bibliography but do not receive it soon, please have them send me a copy of their cancelled checks with endorsement. Early Wednesday morning while we were in Michigan, our house was burglarized, and the first thing the thieves did was to take mail from the box (they dropped a letter under a back window they attempted to open). It is possible that checks too could have been stolen this way.

Well, enough! Gotta ship some of these things. Best wishes for success in your continuing tailless aircraft activities.

Sincerely,
Serge Krauss

(Ed Note: The following are parts of Serge Krauss' letter concerning publication of some of his material in the newsletter.)

TWITT

January 27, 1990

Thanks for your letter of January 20. Your plan to introduce the tailless aircraft bibliography to the TWITT membership does meet with my approval. It will allow more potentially interested people than I am presently able to contact to hear of it and seems a good way for them to learn whether it suits their desires or needs.

I have been keeping track of revisions I'd like to make and have accumulated about two more pages of material; it's hard to stop this thing once it has been carried on for so long. I don't believe that response will be overwhelming, but an augmented version may turn out to be justified at some future time. So far it appears that I may just about break even - not such a bad result, since it at least justifies the effort. Like most things one does for the sake of personal values and interests, the uncounted other efforts and expenses which accumulate over the years are chalked up to personal development and often to a very good and interesting time.

If you have any other concerns influenced by your deadline, you may reach me at (216) 321-5743. Best wishes.

Sincerely,
Serge Krauss

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SAMPLE OF SERGE KRAUSS' BIBLIOGRAPHY

The following information was extracted from Tailless Aircraft - An Extensive Bibliography for Subsonic Types, compiled and annotated by Serge Krauss, Jr., with his permission. We will include these excerpts over the next several months, hopefully to peak your interest in owning a copy. If you are interested in more information he can be contacted at 3114 Edgehill Road, Cleveland Heights, Ohio 44118, (216) 321-5743.

SCOPE: ...this work covers material on subsonic tailless and closely related aircraft topics dating from the late nineteenth century through the present. Transonic types of the late forties and early fifties are less well represented, and supersonic literature is seldom included, unless it provides low speed information...

GENERAL: References listed are widely diverse with respect to type and topic, ranging from magazine articles on tailless evolution to highly theoretical technical papers. Opinion, proposals, speculation, and overviews from different periods are also scattered throughout this literature.

SUBJECTIVITY: For purposes of this bibliography, the term "tailless" receives a fairly liberal interpretation, naturally allowing for characteristics assigned to the sub-categories "all-wing" and "flying wing."

AQUISITION: Material listed in this bibliography comes from a wide variety of sources, only some of which I am qualified to discuss. While my several hundred hours of searching may save you some effort, this is an area where some of you can be of more help to me than I to you.

REFERENCE SAMPLE

NACA AAL RM A9B16: "Wind-tunnel Investigation of a Tailless Triangular-wing Fighter Aircraft at Mach Numbers from 0.5 to 1.5"; Lawrence, L. and Summers, J., 6/24/49 (56pp., 13 figs., tab.)(confidential c.1976 LMAL unex.)

Proposed GAD-4 Suction-Wing Tailless Glider; Air International; 7/76, p.30 (3V and caption only)(ex.c.)

Young, Bill; "Northrop XP-56 'Black Bullet'", Model Builder, 4/85, pp. 13-17, (actual plane: short txt., 2 ph, 1 drwg; model: 7 ph, full-pg. scale plans, plans for counter-rot. props, flt. properties)(ex.o.)

=====

WANTED

MITCHELL WING or other powered glider or truely soarable ultra-light, perferable with trailer.

Have cash or will trade for high performance (L/D 34:1) sailplane with enclosed trailer, oxygen, and instruments

Call Chuck at (619) 447-2519 (San Diego)

AVAILABLE PLANS

Horten H1c construction drawings with full size airfoil layout. 30 sheets 24" x 36" with specification manual. Price: \$115. Inquiries to: Flight Engineering and Developments

2453 Liberty Church Road
Temple, GA 30179
(404) 562-3512

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The following was found in Arizona Highways Magazine (issue unknown).

SILENT CREATURES OF THE WIND

by Paul Dean

You come to me and I will give. But accept my moments as a loan, for I award no full citizenship to man.

From Icarus, through Kitty Hawk, to Tranquility Base, I have tolerated earth's wise couriers but forgiven no impious trespassers. Shakespeare called me a chartered libertine. Gerard Manley Hopkins believed my blessings mother-ed the world. True. Their descriptions touch my unpredictability, the invisible irritation, and seductive sanctity of my element.

I am the air. And foolhardy, magnificent, stubborn, implacable, anxious, breakable, indomitable, questing man persists in taunting me.

Why your urge? What do you relish by rising in me, falling through, or moving against air and in pursuit of sport, not simply as a medium of exploration or transportation?

The quest certainly cannot be to survive my risks. That's falderal. Nature offers as much if not more of this on mountainsides and in oceans. Nay, you find a unique freedom in me. It's common to all airmen, this severing of an umbilical tie which then transforms man's earthbound, clumsy lumberings into effortless movements of smooth motion.

I know a pilot's perceptible surge when tires stop clattering and squeaking against ground, lift conquers drag, and a machine is thrust aloft and once again borne to the air, borne to me.

Sky divers actually talk of the rebirth of free-falling, when I become their sensory isolation tank, and the necessity of tugging a rip cord produces mild disappointment, and end to this bathing. In a sailplane, I produce only restlessness to flight until, clack, steel jaws open and a rope is detached, and that noisy, struggling towplane no longer is a jailer. The moment I am beneath a hot air balloon and my forever is above it, a man's fetters are in suspense, and the liberty is absolute.

Soaring, Skydiving, Balloning. To each his own, and, although there is no similarity among vehicles, I allow the three avocations to merge into a single population. My citizens, in turn, harvest common benefits which transcend my gift of freedom.

You find an inner superiority with me. I give you a taste of immortality unknown to lesser persons who live among concrete cubes and travel asphalt strips. You can look down. You have preeminence.

There is no clarity like mine, when wind and rain have done their scrubbing. My purity becomes yours. I cleanse you.

You play among my clouds and chase my winds, and I can make conundrums of both for your pleasure. Sometimes I'll leave you alone to hang in stillness, and there you will find peace like no other. And sometimes build a silence you can actually hear, and the only invasion will be your breathing.

Dawn is my replenishment and your refreshment. I dare. You challenge. We meet again. Then we achieve communion.

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B-2 BANQUET

F.D.E.S. is sponsoring a banquet at the Town and Country Hotel in Mission Valley featuring Dr. John Cashen, Vice President of Northrop, whose subject will be the B-2 Bomber. Specifics are:

No Host Bar	6:00 PM
Dinner	7:00 PM
Speaker	8:30 PM
Cost	\$20.00 per person

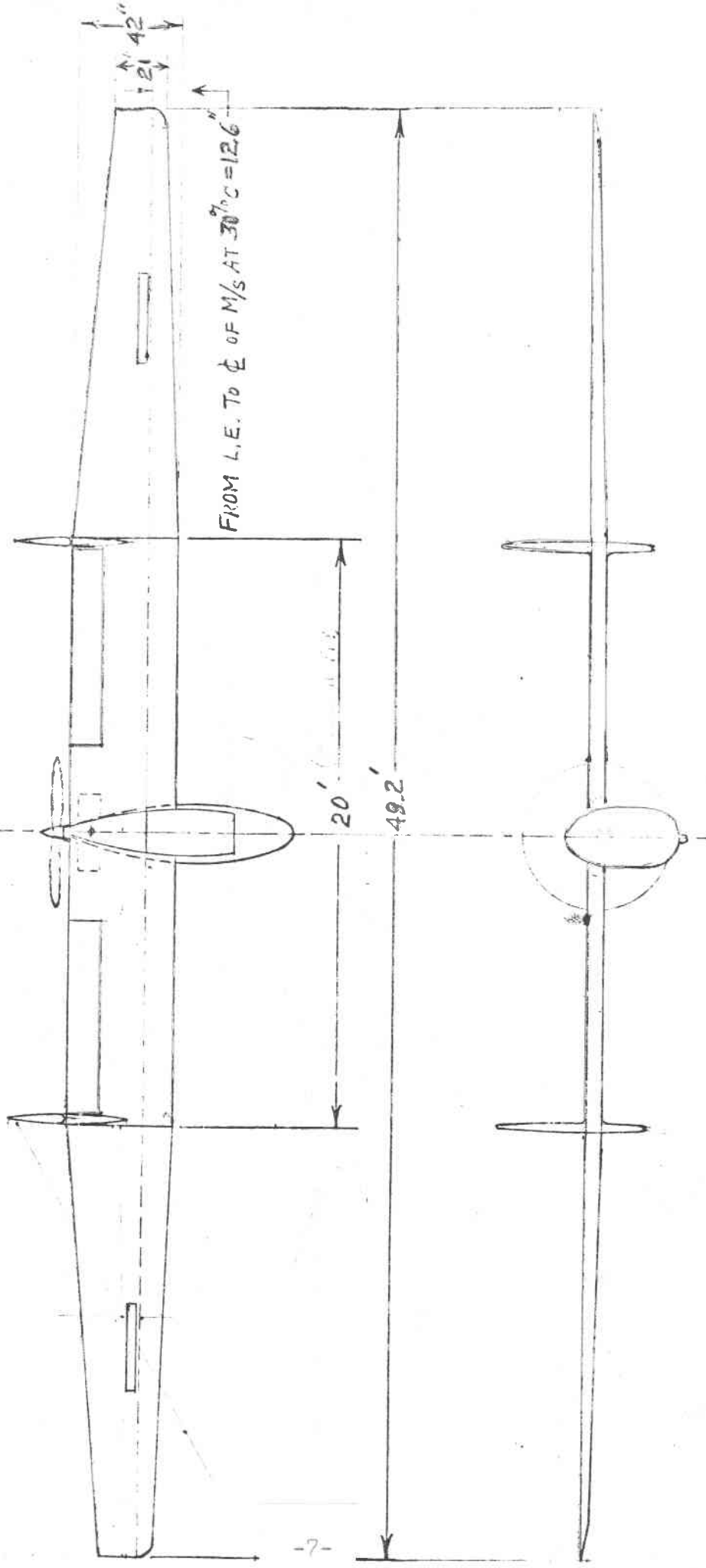
Contact: Jim Peterson
279-1940 Home
496-7212 Work

$$20 \times 3.5' = 70 \text{ FT.}^2$$

$$29.2 \times 2.625 = 76.7''$$

$$\Sigma A = 146.7 \text{ FT.}^2$$

10 x 3.5' 271.5 sq ft
 32.5 x 2.625 85.3 sq ft
 2 1.4 x 2.625 7.3 sq ft



FROM L.E. TO C OF M/S AT 30" C = 12.6"

$$V_s = \sqrt{\frac{825 \#}{1.00256 \times 1.4 \times 144}}$$

$$= \sqrt{1600}$$

$$= 40 \text{ MPH}$$

$$\frac{W}{S} = \frac{825}{144 \text{ FT.}^2} = 5.73 \frac{\text{LB.}}{\text{FT.}^2}$$

$$R = \frac{49.2^2}{144} = 16.8$$

RAY BROWN

R. A. Brown
MARCH 2/74

PARASITE DRAG OF 15 METER TAIL-LESS SAILPLANE

<u>PROTOTYPE</u>	<u>RATIO</u>	<u>WIND TUNNEL MODEL (SOARING, MARCH 1974)</u>
FUSELAGE WIDTH = 24 INCHES.	3.05:1	7.87 INCHES.
" DEPTH = 40 "	5.08:1	7.87 "
WING ROOT CHORD = 42 "	4.27:1	9.85 "
" SPAN = 49.2 FT. = 15m = 590 IN.		MODEL WING AREA = 0.183 m ²
" AREA = 144 FT. ² = 13.4 m ²		" " CHORD = 0.25 m.
		" " SPAN = 0.73 m.

CONSIDER THAT THE AVERAGE SCALE RATIO OF $\frac{\text{PROTOTYPE}}{\text{MODEL}} = 4.27:1 =$

MODEL WING SPAN MUST BE INCREASED TO $\frac{15\text{m}}{4.27} = 3.51\text{m} = 11.51\text{m}$.

" " AREA " " " " $\frac{13.4\text{m}^2}{4.27^2} = 0.736\text{m}^2 = 7.82\text{m}^2$

DRAG COEFFICIENT MAY BE REDUCED BY $\frac{0.183\text{m}^2}{0.736\text{m}^2} = 0.248$ FACTOR.

DRAG COEFFICIENTS FROM FIG. 6, PAGE 18, SOARING, MARCH 1974.

DRAG OF VERTICAL TAIL SURFACES

AREA " TWO " " " " = 25 FT.²

DRAG OF " " " " " $D_T = .00256 \times .0080 \times 25 V^2$
 $= .000512 V^2$

BASED ON WING AREA, $D_T = .00256 \times .0080 \times \frac{25}{144} V^2 = .00256 \times .0014 \times 144 V^2$

DRAG OF SAILPLANE $D = .00256 (\Sigma C_D) 144 V^2$
 $= 0.368 \Sigma C_D V^2$

Bruce Carmichael contributed the design information received from R.A. Brown, who is deceased.

R. A. Larson
FEB. 28/74

CENTER SECTION OF 15 METER TAIL-LESS POWERED SAILPLANE

WEIGHT & BALANCE WITH OUTER WING PANELS REMOVED

	WEIGHT (LB.)	ARM (IN.)	MOMENT	CUM. Σ
MAIN SPAR AND FITTINGS (AT 30% CHORD)	40 LB.	60.6	2424.	
.032 SKINS	55	67	3685.	
RIBS	10	65.6	656.	
REAR SPAR (.032 CLAD 2024-T3)	3.1	78.0	242	
FITTINGS	1.9	78.0	148	
	110.			7155
FUSELAGE POD	50	38.	1900.	
INSTRUMENTS	15	24.	360.	
MAIN WHEEL	15	60	900.	
NOSE "	7	24	168.	
FINS & RUDDERS	10	90	900.	
TAILWHEELS	5	96	480.	
	212			11,863
PILOT & CHUTE	190	40	7600	
	Σ W = 402		7600	19,463

ENGINE {	LYCOMING O-145-B2 163.4 LB.		
	FRANKLIN 2 CYL. 60 HP. 167.5 #		
	VOLKSWAGEN ENGINE		
	167.5	81.6	13,680

PROPELLER	10	96.	960.
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FUEL 16.7 GAL. (4 HRS.)	100.	55	5,500.
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OIL 3 QTS.	5.6	84	470.
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Σ = 685.1 LB. 40,073. INCH LB.

$\bar{X} = 58.5 \text{ IN.}$

$\frac{10.5}{42} = 25\% \text{ MAC.}$

WING CENTER SECTION LEADING EDGE IS AT X=48.0

WITH NO FUEL, C.G. IS AT $\frac{34,573}{585.1} = 59.0$ (26.2% MAC)

STALLING SPEED $V_s = \sqrt{\frac{685 \#}{.00256 \times 1.3 \times 70}} = \sqrt{2940} = 54.2 \text{ MPH.}$

ASPECT RATIO $R = 5.72$

PERFORMANCE OF 15 METRE FLYING WING AT SEA LEVEL

1	2	3	4	5	6	7	8	9	10	11	12	13	14
V MPH	V ²	$C_L \cdot \frac{825 \cdot \pi}{0.0256 \cdot \pi \cdot V^2} = 2240/V^2$	C _L ²	$\alpha_i = 1.087 C_L$ DEGREES	α_o TR824 + 1/2° MACA 23012 + 1/2°	α (5) + (6) DEGREES	$C_{Di} = \frac{C_L^3}{16.8 \cdot \pi} = .01897 C_L^3$	C _{D0} WING	C _{Dp} FUSELAGE	WING TIP DRAG $C_{D_e} = 0.1 C_{L^3}$	$\Sigma C_D = (9) + (10) + (11) + .0014$	DRAG $= .368 C_D V^2$ LB.	L/D
6.0	1600	1.40	1.96	1.52	13.4	14.9	0.0372	.0175	.0114	.0274	.0949	55.9	14.8
5.04	2025	1.106	1.22	1.20	10.0	11.2	.0232	.0108	.0074	.0135	.0563	42.0	19.6
4.65	2500	.897	.805	.975	8.0	9.0	.0153	.0083	.0057	.0072	.0379	34.9	23.6
4.66	3025	.74	.548	.80	6.5	7.3	.0104	.0078	.0048	.0041	.0285	31.8	26.0
4.94	3600	.622	.387	.68	5.5	6.2	.0074	.0073		.0024	.0233	30.85	26.7
6.06	4900	.457	.209	.50	3.8	4.3	.0040	.0068		.0010	.0180	32.45	25.4
7.98	6400	.35	.1325	.38	2.6	3.0	.0025	.0067		.0005	.0159	37.4	22.0
10.4	8100	.276	.0762	.30	2.0	2.3	.0015	.0066		.0002	.0145	43.3	19.1
13.5	10000	.224	.0502	.244	1.5	1.74	.0010	.0065		.0001	.0138	50.7	16.3
17.5	12100	.185	.0342	.20	1.1	1.3	.00065	.0064		.0001	.0134	59.6	13.8
22.2	14400	.156	.0243	.17	0.8	1.0	.00046	.0064		.00003	.0131	69.5	11.9
27.8	16900	.133	.0177	.145	0.6	0.7	.00034	.0064		0	.0129	80.2	10.3
34.6	19600	.114	.013	.124	0.4	0.5	.00025	.0064	✓	0	.01285	92.7	8.9
42.4	22500	.100	.010	.11	0.3	0.4	.00019	.0064	.0048	0	.0128	106.0	7.8

PERFORMANCE OF 20 FOOT SPAN TAIL-LESS CENTER SECTION AT SEA LEVEL

1	2	3	4	5	6	7	8	9	10	11	12	13	14
V	V ²	$C_L \#$ = $\frac{685}{.00256 \times 70^2}$ = $\frac{3820}{V^2}$	C _L ²	C_{D_i} = $\frac{C_L^2 \pi}{5.72 \pi}$ = $.0555 C_L^2$	C _{D₀} WING	C _{D_c} WING TIP ³ C _D = .03 C _L	C _{D_p} FUSELAGE $\frac{1}{2} \times \text{FIG. 6}$ SOARING MARCH 1974	ΣC_D = ⑥ + ⑩ + ⑦ + ⑧ + .0028	DRAG = $179 C_D V^2$ LB.	α_i = $3.19 C_L$ DEGREES	α_o	α ⑪ + ⑫ DEGREES	HR. REQ. = $\frac{D.V.}{375}$
55	3025	1.26	1.588	.0881	.0135	.0600	.0200	.1844	100.	4.0	11.5	15.5	14.7
60	3600	1.06	1.124	.0625	.0100	.0358	.0142	.1253	80.9	3.4	9.5	12.9	12.9
65	4225	.905	.819	.0455	.0083	.0222	.0115	.0903	68.3	2.9	8.0	10.9	11.8
70	4900	.78	.6084	.0338	.0078	.0142	.0103	.0689	60.4	2.5	7.0	9.5	11.3
80	6400	.597	.3564	.0198	.0073	.0064	.0100	.0463	53.0	1.9	5.2	7.1	11.3
90	8100	.472	.2228	.0124	.0069	.0032	↑	.0353	51.2	1.5	3.9	5.4	12.3
100	10000	.382	.1459	.0081	.0068	.0017		.0294	52.5	1.2	3.2	4.4	14.0
110	12100	.316	.0999	.0055	.0067	.0010		.0260	56.3	1.0	2.5	3.5	16.5
120	14400	.266	.0708	.0039	.0066	.0006		.0239	61.6	.85	1.9	2.8	19.7
130	16900	.226	.0511	.0028	.0065	.0003		.0224	67.7	.72	1.5	2.2	23.5
140	19600	.195	.0380	.0021	.0064	.0002		.0215	75.4	.62	1.25	1.8	28.1
150	22500	.170	.0289	.0016	↑	.00015		.0210	84.5	.54	1.0	1.5	33.8
160	25600	.149	.0222	.0012		.0001		.0205	94.0	.47	0.8	1.27	40.1
170	28900	.132	.0174	.0010		.00007		.0203	105.0	.42	0.6	1.0	47.5
180	32400	.118	.0139	.0008		.00005		.0201	116.5	.38	0.4	0.8	55.9
190	36100	.106	.0112	.0006	↓	.000036	↓	.0198	128.0	.34	0.3	0.6	64.9
200	40000	.095	.0090	.0005	.0064	0	.0100	.0197	141.0	.30	0.2	0.5	75.2