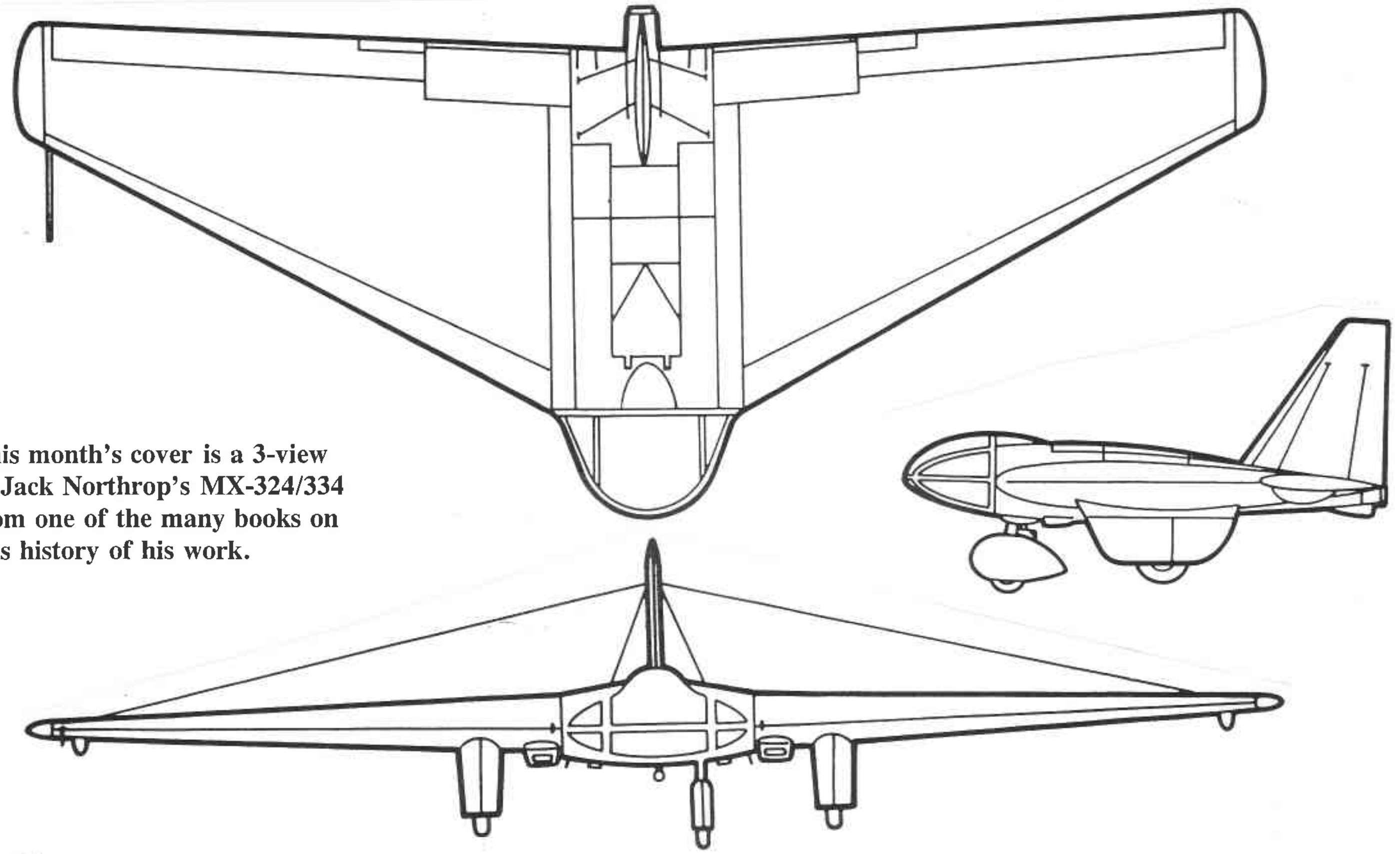
No. 110 AUGUST 1995

T.W.I.T.T. NEWSLETTER



This month's cover is a 3-view of Jack Northrop's MX-324/334 from one of the many books on this history of his work.

T.W.I.T.T.
The Wing Is The Thing
P.O. Box 20430
El Cajon, CA 92021

The number to the right of your name indicates the last issue of your current subscription, e.g., **9508** means this is your last issue unless renewed.

Next TWITT meeting: Saturday, September 16, 1995, beginning at 1330 hrs at hanger A-4, Gillespie Field, El Cajon, CA (first hanger row on Joe Crosson Drive - East side of Gillespie).

THE WING IS THE THING (T.W.I.T.T.)

T.W.I.T.T. is a non-profit organization whose membership seeks to promote the research and development of flying wings and other tailless aircraft by providing a forum for the exchange of ideas and experiences on an international basis. T.W.I.T.T. is affiliated with The Hunsaker Foundation which is dedicated to furthering education and research in a variety of disciplines.

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Meetings are held on the third Saturday of every other month (beginning with January), at 1:30 PM, at Hanger A-4, Gillespie Field, El Cajon, California (first row of hangers on the south end of Joe Crosson Drive, east side of Gillespie).

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PRESIDENT'S CORNER

As you can see from the minutes, we had a rather small turnout for the last meeting. I hope it was because of the I-5 problem preventing our northern members from getting down in time, or because everyone is on vacation with their families.

Just a reminder about the SHA Western Workshop over the Labor Day weekend at Tehachapi. Last year there was a large gathering of SWIFTs and Mitchell wings, so if you are interested in getting more involved in flying wings this event may be your opportunity to meet those who already have one.

As of press time I didn't have an update on the library and index projects, but I will definitely have a progress report for you next month. I appreciate all of you who have sent in advance orders, since it shows there is a real need for both of these products.

I have noticed we are having a slight drop off in membership over the last several months. I'm not sure if this is due to a loss in interest by those dropping, or whether they are not finding what they need through the newsletter and meetings. Please, if you are thinking of not renewing your membership next time it comes due because we are not covering some aspect of flying wings you are particularly interested in, write us a letter and tell us what you are looking for. In many cases there are other members out there with the same desires who will be willing to talk or correspond with you to your mutual benefits.

What gets published each month is based more on opportune material rather than any prearranged plan of attack to cover certain subject matters. I do dig into the library from time to time to basically get filler material, however, if you have seen something enter the library that you think should be included in an expanded version in the newsletter, then let us know and we will do what we can to accommodate you. Hopefully, it will simulate further discussion about a topic, which everyone is interested in.

Andy

SEPTEMBER 16, 1995 PROGRAM

This one should prove to be one of those you don't want to miss, especially if you are looking at new ways to help you design that ultimate flying wing. Our speaker will be **Phil Barnes**, one of our newer members, who is also an engineer with Northrop. He has developed computer software that uses equations to calculate airfoil shapes instead of the conventional method of coordinates. (You'll get a better idea of what this program can do when you see the September newsletter's cover.)

We will be publishing a full run down of Phil's presentation for you next month, so stay tuned since this has something for everyone.

MINUTES OF THE JULY 15, 1995 MEETING

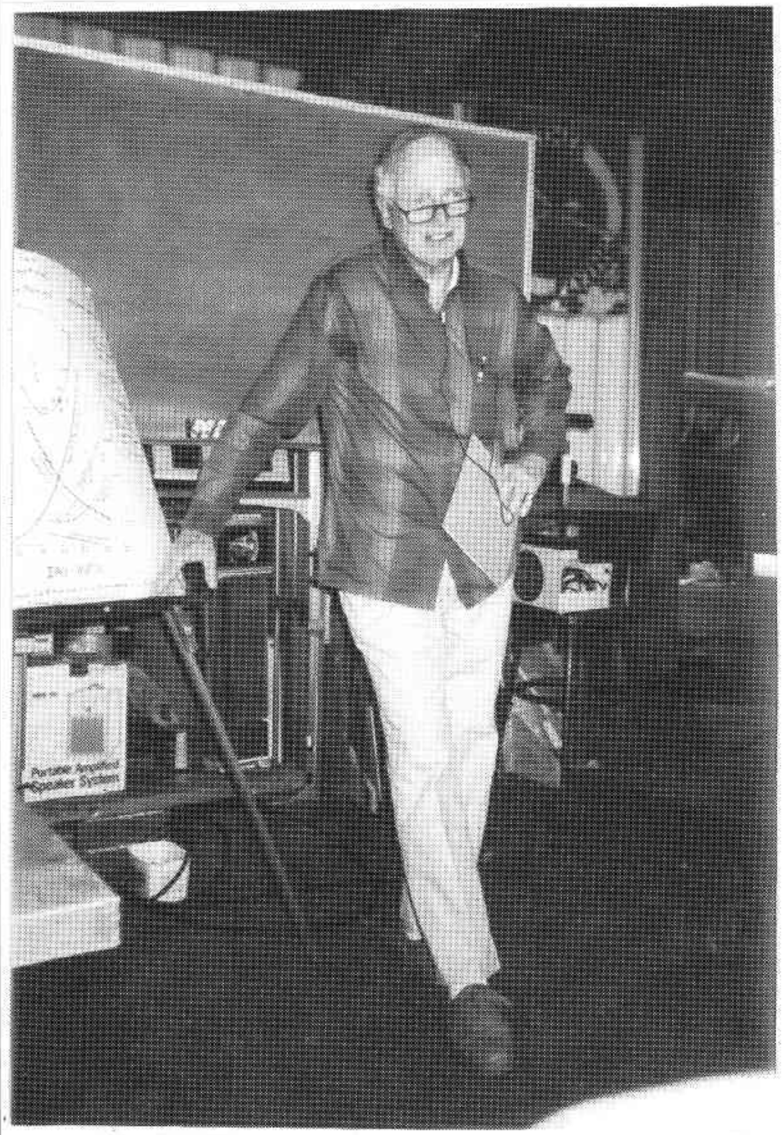
The meeting was started about a hour late due to an accident on Interstate 5 that delayed our speaker, and as it turned out about half our audience. It was a disappointingly small turnout for a speaker and topic that would be of value to anyone interested in achieving the best performance possible from his aircraft. (I assume some of our other Los Angeles county members gave up in the traffic once it started getting later in the afternoon.)

Andy thanked Chris and Connie Tuffli, our Hospitality Chairpersons, for bringing in a huge stack of Arby's roast beef sandwiches with both hot and mild sauce. They hit the spot with our late arrivals since they didn't take time to stop for lunch due to the already lengthy traffic delay. He also thanked Dominique for being our new "Chair"person after he worked diligently to get the gallery of chairs set up for the meeting.

Bruce mentioned that he would have more information available on the SHA Workshop on Labor Day weekend at Tehachapi. *(See the announcement later in the newsletter.)*

Bruce was then asked to introduce our guest speaker for the day, Jack Norris. Bruce first learned about Jack by reading his book covering the Voyager around the world flight for which he was one of the mission coordinators. He then met Jack at Tehachapi and learned more about this unique individual *(ed. - you have been given just a hint of his background in the last two newsletters)*.

Jack's opening statement went something like this: "We are blessed to live in the greatest country in the history of the world and the great time in the history of man." He pointed out that if this were just 200 years ago we would be out grubbing around for something to eat tonight instead of enjoying an exchange of ideas on an interesting subject. He related this to his own life where he feels that opportunities abounded all around him and he was able to do almost anything he dreamed about.



ABOVE: Jack Norris explaining how to use the drag curve chart for his Luscombe 8E. Photo by Bruce Carmichael.

He started building model airplanes as a kid and learned how to be an engineer before he even knew what engineering was all about. The planes he built kept on crashing, but he finally discovered that it was a problem in free form physics and nothing counted other than he had to really understand how it really worked. It didn't matter how hard you worked or how much you wished it to work right, if you built it wrong it would crash.

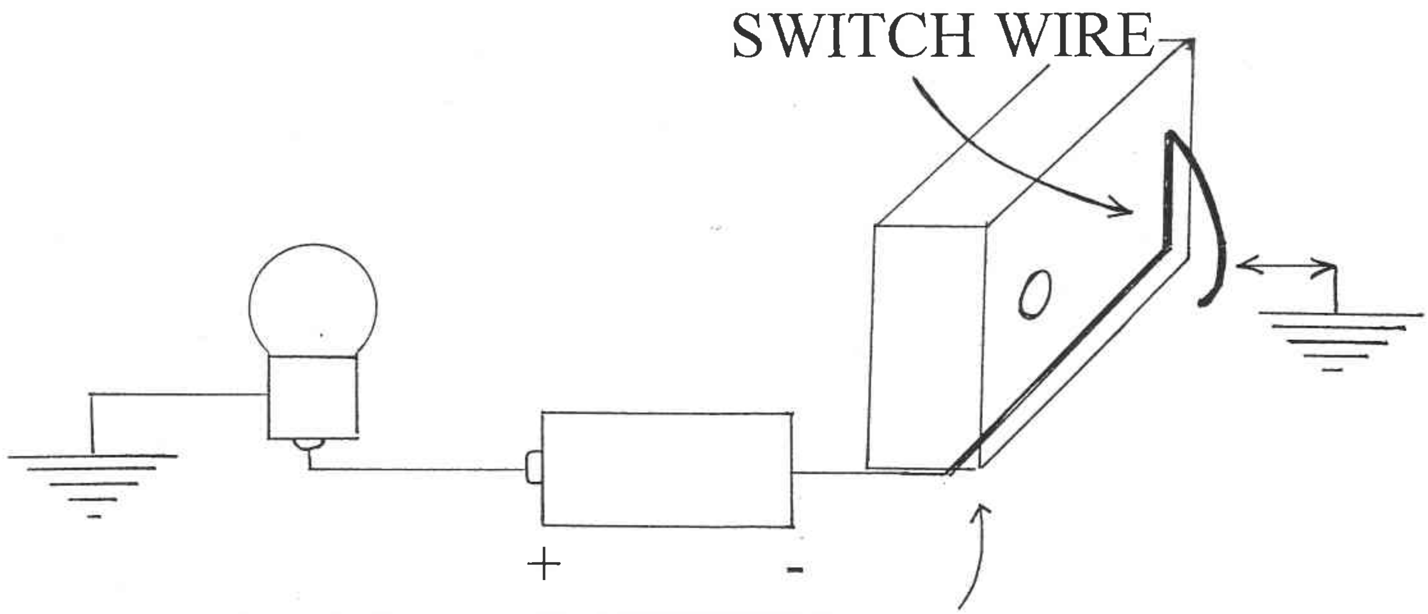
After that revelation he decided to become an engineer because of the honesty it required in order to get something to work right. He got his education at Ohio State, then joined the Air National Guard where he "played" with B-26's, AT-6's, and twin Beech's. Looking back at it now he realizes how scared he should have been while making touch and go landings in a B-26 with only 70 hours under his belt.

To prove the point of his opening comments, he related that when the Korean War started his Guard unit was called up. However, he was able to transfer to the ROTC and finish his degree program before being called to active duty in the Air Force. But the good side to this was being stationed at Wright Field where he became the spokesman and group leader for the aircraft lab that did the engineering and mockup inspections of new airplanes (F-100, F-102, F-104, B-66, T-34, L-19, and B-52).

involved in putting together Walt Disney's audio animatronics group that makes machines into believable characters from history. Talk about it being a great country with unlimited opportunities to do almost anything.

In transitioning from his opening to his primary subject, he wanted to make sure everyone went to see the new movie Apollo 13. He felt it was a most truthful presentation of what really happened. (ed. - I have seen it and you go away in tears with sweaty palms even when you know the outcome, its that good.)

Jack then entered into his presentation on zero thrust glide testing. When he retired he decided he wanted to get back to some unfinished items he had thought about during his early days of flying. One of these was



ABOVE: Zero Thrust Glide Test Thrust Switch made from a 1/16" piece of music wire. Kisses or misses the prop flange moving back and forth in the thrust bearing clearance.

This job enabled him to meet some of the greats in the aerospace industry at the time and gain valuable insights and experiences not available to almost anyone else. Chuck Yeager was his right hand man.

He resisted the temptations to take one of the many job offers from these aviation giants and went to work at the Cleveland Pneumatics, the landing gear company. He worked down in the shop learning how the gears malfunctioned and what it took to repair them. This taught him stress analysis and design, metallurgy, and manufacturing, and where you got in trouble. He got to know quickly what the right answers were without having to ask other people.

After years of working in the aerospace arena designing and selling flight control systems and other related items, he got

how you really fly an airplane and how do they really work. He wanted to know more than just how to drive the thing. The first thing he wanted to find was the drag curve on his Luscombe, but everyone told him couldn't do that.

Jack related that although we became airborne in 1903 and the Wright Brothers solved the problems of lift and control, they hadn't completely licked the stability issue. They figured out how to get power into a structure and make it fly. What they hadn't done was go to the next step and find out the drag levels and the efficiency of the propulsion system. Even though there has been lots of work over the years in the area of drag, determining its true values has never been solved, at least to Jack's satisfaction, so he decided to find out how it really works. *(ed. - Notice the constant theme here of "how does it work?")*

The first step was to understand what a drag curve looked like, but no one knew what this should be for the Luscombe (his high priced test vehicle for developing this new method of testing drag). The work of Dick Johnson on performing glide testing gliders caught Jack's eye so he knew there must be a way of getting the same types of results on a power plane.

One day he took the propeller off his Luscombe and put it on a granite plate to test the trueness of the pitch. He found it to be within 1/10 of a degree of what it should be, whereas the acceptable tolerance was 2/10.

With this information he could now figure out at what RPM versus true airspeed he would need to turn the propeller to achieve a 4 degree negative angle of attack which would roughly eliminate the prop for glide testing purposes. Within a weekend of testing he got what he considered pretty good answers but they didn't agree with the factory specifications at all.

He talked with some other aero engineers many of whom said that the prop was about 80% efficient, so all you have to do is take the horsepower multiply it by the 80% and divide by the velocity and then plot a drag curve. When Jack did the calculations he was coming up with something like 60% efficiency, so obviously more work was needed to come up with a true drag curve.

Jack went to his old friend, Andy Bauer (who also was at our meeting today), for some needed brainstorming ideas on how to come up with better answers. Andy mentioned that although the air had to speed up to go around the fuselage, it slows down in the prop plain. Andy went to work trying to find a method for getting around this part of the problem, which he did, and they came up with still better answers in the drag curve. This went on for seven years due to both of their very complex work schedules, including Jack's involvement as technical director for the Voyager project.

By 1989 they felt they had come up with a good set of testing criteria and then an opportunity came along to present this in a paper to the AIAA conference in Reno, NV. All of a sudden he paniced a little bit since the objective was to have a test, not seven years of analytical work. The solution to getting the absolute perfect results revolved around determining exactly when the propeller stopped producing thrust, but was also not producing drag. The answer was deceptively simple once it dawned on him.

In most older engines the prop shaft has a certain amount of fore and aft freedom within the bearings. By mounting a thin piece of model airplane music wire in such a way that it rides half way between the prop hub and engine casing, you can activate a light bulb when the shaft is at the zero thrust point. *(See the diagram on page 3.)*

After rigging up this system on his Luscombe, they set out to verify their seven years of analytic work. Jack's original figure was 16.48 revolutions per mile an hour of true airspeed. Andy's calculations got them down to 15.15, but the absolute right answer was 14.94 according to the light bulb method. This meant that Andy's analytical work was only about 1 1/3% off from the final, verifiable solution. He later indicated that once you calibrated this value for your particular airplane then you don't have to worry about the position of the prop hub in future tests. You simply make sure you glide at that value times the TAS. This will also work for pusher type of configurations.

Now we got down to the question "Why do we want to know all this and what does it mean to me?" What it means is that you will know where your optimum performance points are for your airplane. Sometimes you will choose to fly at those points and other times not, depending on the particular flight's objectives. By knowing where they are you will be able to make more intelligent decisions concerning performance and operational efficiencies.

In glide testing, vertical energy and power, supplies and equals, flight path energy and power. The gross weight of the aircraft sinking at some rate in ft/sec exactly equals the drag times its flight path in ft/sec. So:

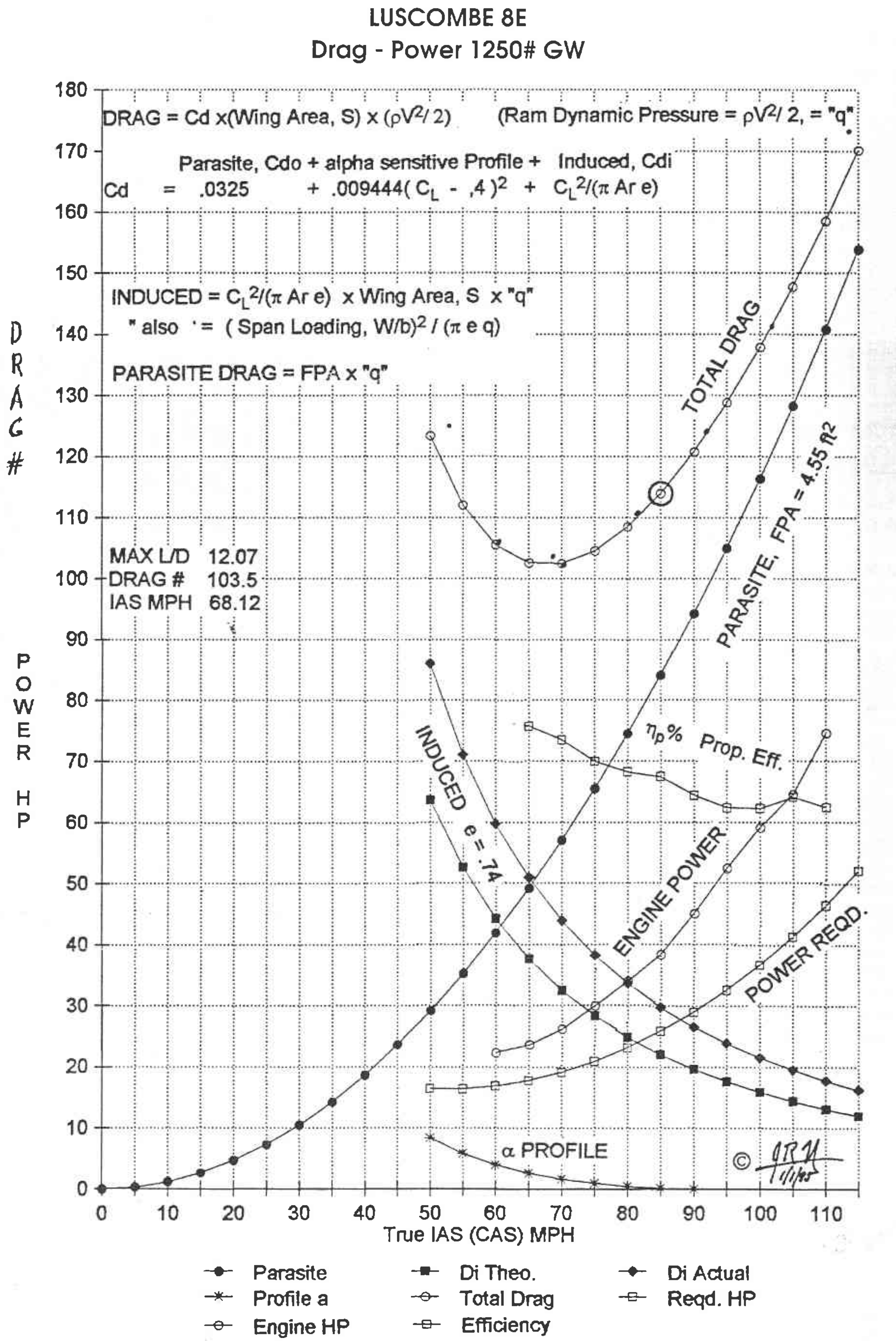
$$\text{Drag\#} = \text{G.W.\#} \times \frac{\text{Sink Rate (ft/sec)}}{\text{TAS (ft/sec)}}$$

The accompanying chart *(see page 5)* was prepared for Jacks's 1947 Luscombe 8E showing the induced and parasite drag curves which when combined yield the lazy J shaped total drag curve at the top right of the chart. All the books tell you the airplane should be flown down at the bottom of the curve at the minimum drag point. Jack contends you will be bored to death flying for very long at this point since you are only doing about 68 mph. However, if you move towards the right and go up to the point where the speed and drag lines meet with a little circle you achieve a gain in airspeed to 85mph with very little increase in drag. Moving much beyond that point and the tradeoff begins to get really uneconomical due to the ever increasing steepness of the drag curve.

Since your miles per gallon is a function of drag, you can now pick the point along the curve that will yield the best results for the prevailing conditions, i.e., headwinds, tailwinds, etc. Jack related an experience he had with another Luscombe driver who liked to go fast. This guy kept flying at the 100+mph point on the curve on the way to Oshkosh and Jack flew the more economical 85mph point. It seems the old slow and steady philosophy not only applied to the tortoise, but to Jack as well since he beat his friend by having to make fewer refueling stops.

An interesting aside to this longer cruising time was the fact that the seat of your pants can only take so much in the hard seat of a Luscombe. The normal human's blood pressure is usually 1 1/2 to 1 3/4 psi, so when you sit upright you concentrate your weight on a smaller portion of you buttocks and exceed this pressure, thereby shutting down your blood

FLYING THE THINKING PILOT'S WAY



flow. If you design a seat that is sufficiently reclined to spread your weight out over a greater area to reduce your contact to less than the 1 1/2 psi, you can sit for much longer periods of time without any pain and discomfort.

ABOVE: Post meeting hanger flying and relaxing by, left to right: Andy Bauer, Ed Lockhart, Andy Kecskes, Dominique Veillard (seated), and Jack Norris. Photo by Bruce Carmichael.

Getting back to the drag curve, you can take the values multiply them by velocity in ft/sec and divide it by 550 and get an actual power required curve. Now you can do level flight speed/power tests and find out what the engine is really putting out. Jack's results turned out to be a lumpy curve which led him to believe he had bad data so he re-ran the tests and verified the data was, in fact, good. The cause is apparently something like detached flow that is reattaching at some point. It also turns out that we are starting with about 75% efficiency at the lower areas of the curve and this falls off to about 62-63%, and when you add cooling into the factors the efficiency drops even further into the 50+% areas.

Jack mentioned that you can almost never be the first to find something like this. Apparently August Raspert found this information out in the 1950's by towing Bellancas, Cessnas and Whitman Tailwinds up and gliding them down in propwash. For some reason the results never caught on and everyone went on thinking that propulsion efficiency was at 80% in most airplanes.

Bruce mentioned that some of the reasons more testing wasn't done by Raspert was that it was hard to get people to fly the test aircraft and make deadstick landings, and it was very hard to find truly smooth air to get accurate results in successive glide tests.

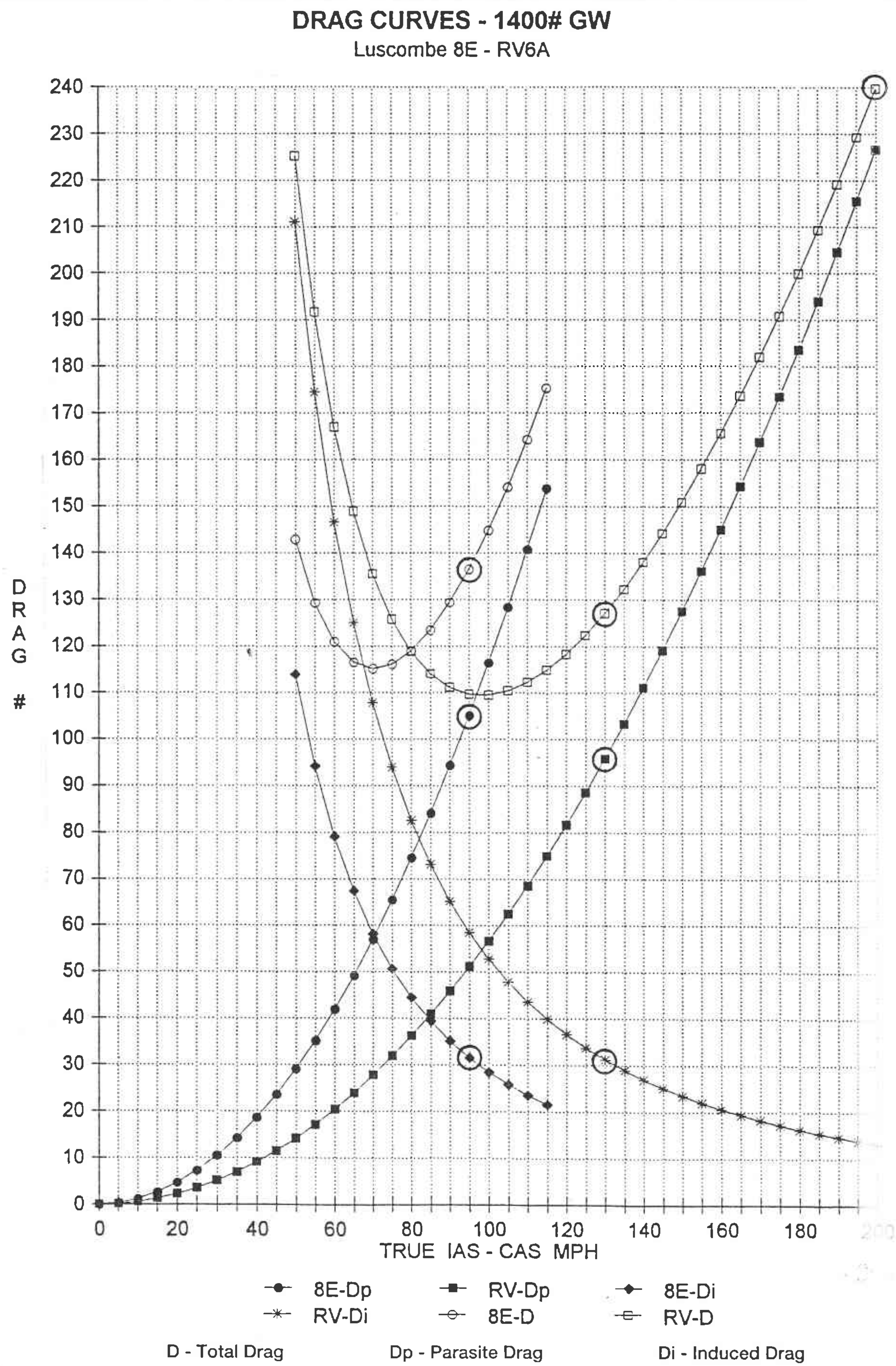
Jack confirmed that the bottom line to all of this is that smooth air is the final key to reducing the erroneous data. He and Andy were able to find some absolutely dead air off the California coast early in the mornings that helped reduce their error rates to a point approaching 1%.

Jack went on to talk about what the CAFE group will be doing in this area over the coming years. It will result in getting true performance curves on all the homebuilts and production airplanes that have not been possible in the past. They will be using the most sophisticated instrumentation available and many of the test procedures have been designed by experts in the areas of electronics, mechanics, and engineering.

The degrees people will go to for accurate data was demonstrated by some friends of Jack's that used electronic proximity detectors to determine the position of the prop hub. The electronic readout enabled them to push the power full up and take a reading, then reduce it to idle for the full back reading and then set the power to get a reading exactly in the middle. Obviously this is much easier and much more accurate than the music wire system, but it also costs more and takes a certain amount of experience and knowledge of electronic systems.

The second drag curve chart *(see page 7)* Jack produced shows the differences between his Luscombe and an RV-6. The main point he wanted to make was that even though the Luscombe had a high aspect ratio wing for low induced drag and the RV had a low aspect ratio wing, the total drag for the RV comes out somewhat lower. If you compare the points on the vertical lines you find that the Luscombe at 95mph is actually flying at a higher total drag point than the RV at 130mph at the same gross weights. The difference is in the parasite drag portion of the curves and the RV ends up being a winning combination even with the lower aspect wing.

Jack reminded us that this entire procedure is explained in his and Andy's two part article in the March and April 1995 issues of <u>Sport</u>


DRAG CURVES - 1400# GW
Luscombe 8E - RV6A
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TRUE IAS - CAS MPH
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150
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190
210
220
230
240
8E-Dp
RV-Dp
8E-Di
RV-Di
8E-D
RV-D
D - Total Drag
Dp - Parasite Drag
Di - Induced Drag

Aviation. For those of you who decide you want to get more detailed information than presented here, we highly recommend you obtain these magazines since they do contain full explanations of the drag curve charts we have included here in the newsletter.

Dominique couldn't resist asking a couple of questions about the Voyager flight. Although Jack didn't come to talk about this aspect of his career, he was gracious and provided some insights into what happened during the planning and flight of this very unique aircraft.

After Jack completed his short description of the Voyager's elastic wings, we all thanked him for persevering the traffic on the I-5 corridor and providing us with a very good program that should help all of our members better decide on the hows and whats of testing their new creations.

LETTERS TO THE EDITOR

7/9/95

From the pen of Karl Sanders comes more on:

Twist - A Designer's Viewpoint

There are only 2 1/2 reasons for applying twist to a wing:

1. **To achieve a (near) elliptical spanloading for one particular lift coefficient** (e.g. for average cruise, or L/Dmax for a glider) on a wing whose aspect ratio and taper ratio otherwise would result in a non-elliptical loading for that (design) C_l. For all other C_ls the distribution is still non-elliptical with an induced drag penalty due that twist! The type of twist is usually a "wash-out": angles decrease towards the tip where it usually equals about -3 degrees. But even if you had a "wash-in" (+3 degrees at the tip) the induced drag penalty due that twist is still the same because induced drag is always proportional to the square of any lift coefficient. Therefore, also the square of any lift coefficient in- or decrement due to twist caused the same induced drag! This drag penalty is most conveniently calculated with Anderson's NACA formulas and charts, reproduced in Abbot and Doenhoff's book Theory of Wing Sections pp. 16-17 for a linear twist angle distribution. However, linear twist causes curved element lines for tapered wings, making tooling and building more difficult than for straights element lines (read: straight loft). For the latter a non-linear twist angle distribution and easy to use charts for induced drag increments were presented in AIAA Journal of Aircraft, July-August 1965, p. 347. If the wing is straight (unswept), a semi-trapezoidal planform (rectangular center panel; trapezoidal outboard panels) is a more efficient alternative to twist because it holds the loading elliptical for any C_l!!

Now the most important one:

2. **To prevent outboard stalling** at the landing C_l (e.g. at V=1.1 V_s, or at 0.8 C_{Lmax}, with aileron down!). This condition requires that all local spanloading C_ls for the wing lift coefficient =0.8 C_{Lmax} must lie safely below all sections $C_{l\,max}$ values. Obviously, the two cases are not independent and must be considered jointly.

Now the 1/2 reason:

3. **The Horten bell shape loading.** The intention here was to apply a twist shape to a **moderately high AR swept back flying wing** such that the resulting down-lift (yes!) over the tip region produces a positive pitching moment for longitudinal trim with minimum induced drag. The truth is that the induced drag of a bell shaped loading IS NOT minimum because of the non-elliptical loading shape! This, and my induced drag blurb above in item 1, are the answers to Alan's query at the end of his letter. The trim drag penalty of any tailless is equal to [induced drag of a non-elliptical loading (trimmed by twist, elevon deflection or both) - induced drag of the ideal elliptical loading + the parasite drag of the deflected elevon(s)]. For that type of flying wing, Pitkin at NACA in 1944 documented and wind tunnel tested a far better **self-trim** concept featuring an inboard flap and just enough twist to prevent tip stall. Reimar Horten had no access to these papers in Germany and Argentina. (KLS cmnt: Pitch and roll **control** could be combined by differentially operated outboard ailerons. In my judgement, that concept involves truly minimum penalties on the loading and drag (*a tail would still be better though....ha, ha, ha.*)

Conclusion: Twist is often a necessary evil. The best twist is infinitely variable, but that is left to the birds. However, there is such a twist type not mentioned above: The proverse **elastic twist (measured streamwise) of a sweptback wing** due to bending under load. This twist angle distribution depends on AR, sweep angle, gross weight, load factor (=1 for level flight), wing weight and stiffness distributions EI (bending) and GJ (torsion). The larger the up-bending, the larger the wash-out and visa versa. The elastic twist is therefore also gust alleviating.

So much for this time.

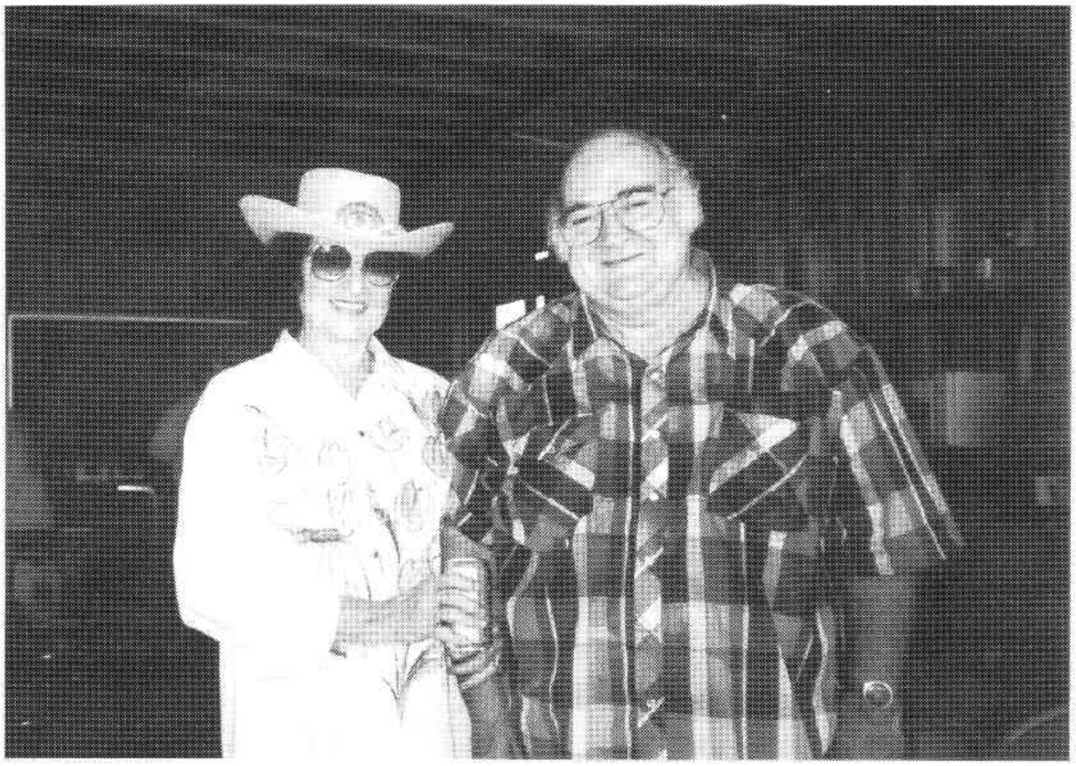
Yours very truly,

Karl Sanders

(ed. - I always enjoy putting Karl's letters into the newsletter. I may not fully understand what it is he is trying to tell us, but I know most of you out there do, and that it will generate more comments and additional discussion of whatever the issue may be.

I want to thank Karl for in continuing support with letters like this one and the many, many pieces of material he has found and sent in for the library.)

information pack days. Just meeting and talking with some of these people is worth more than reading any article or text book in the areas where they have the expertise.



ABOVE: Connie and Chris Tuffli, TWITT's Hospitality Chairpersons. Chris is also a constant contributor of material to the library. Photo by Bruce Carmichael.

LIBRARY ADDITIONS

Bob Chase gave us a copy of:

"Improving on a Winner", by Terrence O'Neill, KitPlanes, August 1995, pp. 14-21. The author is qualified to analyze and modify the Mitchell B-10 flying wing for the better, and he did. Mods included: moving control stick to floor position; lowering elevons 4"; adding an inboard elevon; moving landing gear forward to 23% MAC, and; adding brakes.

Karl Sanders sent us the following item:

"Theoretical Principles of Wing-Tip Fins for Tailless Airplanes and Their Practical Application", by Maurice A Garbell, consultant in aeronautical engineering and meteorology, Journal of the Aeronautical Sciences, October 1946, pp. 525-536. The paper regards the relative merits of wing-tip fins and central vertical fins in their comparative contribution to the static directional-stability derivative, the rotary damping in yaw, and the side-force slope of tailless aircraft.

SHA WESTERN WORKSHOP

Bruce Carmichael reports that eight of the twelve lectures are currently setup for the upcoming **SHA Western Workshop** at Tehachapi, CA over the Labor Day Weekend, September 2-4, 1995.

The lecture sessions so far will be:

Dan Armstrong - Kestrel Light Sailplane Design.
Larry Hall - Superfloater II.
Irv Prue - Modern Metal Primary.
Howie Burr - Monarche Construction.
Roy Barletts - Composite Methods.
Bob Sparling - Prescott Winch Operation.
Clint Brooks - Wood Sailplane Construction.
Paul Liebenberg - Squid Self Launching S.P.

He is also looking for someone to come speak about the Genesis, but didn't have any details as of our publishing time.

This is always a great gathering of premier homebuilt designers and builders from the western United States, and is a don't miss event even if it is only for one of the

AVAILABLE PLANS & REFERENCE MATERIAL

Tailless Aircraft Bibliography

by Serge Krauss

4th Edition: An extensive collection of about 2600 tailless and over 750 related-interest listings. Over 15 pages of tailless design dates, listing works of over 250 creators of