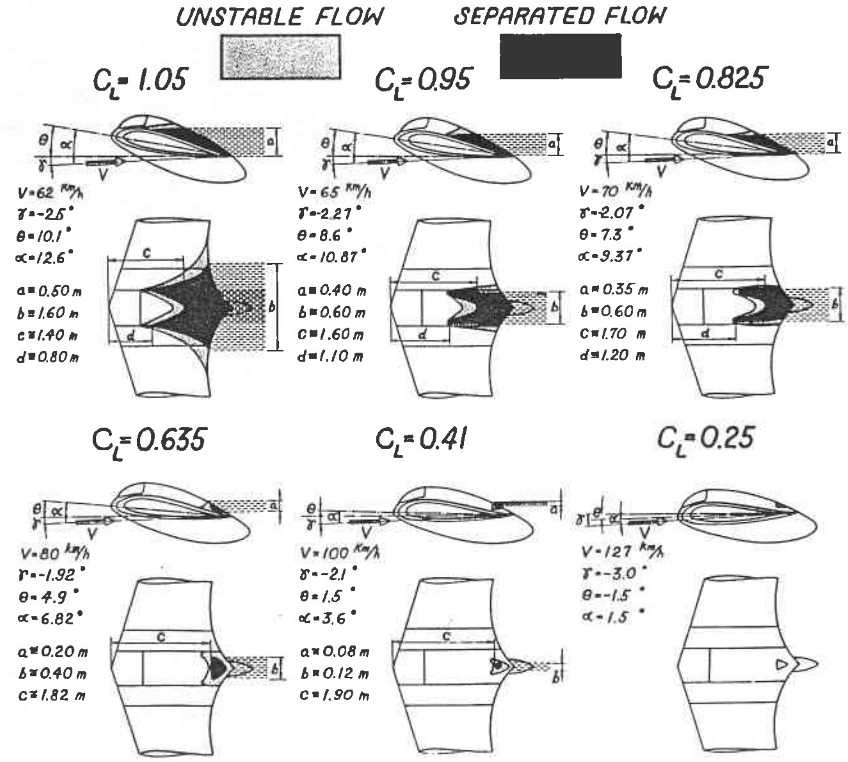
No. 108 JUNE 1995

T.W.I.T.T. NEWSLETTER

The parasite drag of a flying wing is supposed to be negligible, since the frontal and wetted area of the fuselage are very small compared to the entire wing area. Tuft observations on the Horten IV, however, indicated intense separation on the rear part of the cockpit hatch which implies genesis of considerable parasite drag. The diagrams on the left present the extent of separation evaluated from tuft photographs. The attitude of the plane as well as the angle of flight path, pitch, and angle of attack are also given. The steep nose up attitude of the canopy at high lift coefficients, which incorporates severe adverse pressure gradients, is apparently the major source of the separation.

SOURCE: "Performance Analysis of the Horten IV Flying Wing", by Dezso Gyorgyfalvy, The Aerophysics Department of Mississippi State University, June 1960.

TURBULENT SEPARATION AT THE CENTER SECTION



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., **9506** means this is your last issue unless renewed.

Next TWITT meeting: Saturday, July 15, 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

Boy, what a turn out for the May meeting. At times we had over 35 people present listening to Bruce talk about laminar flow and boundary layer control. There were a lot of good questions from the group that kept him on his toes and should prepare him well for his forthcoming presentation of this material at the EAA Convention. He thanked everyone for their offers to help with some better view graphs and where to tweak his talk.

The newsletter may reach you a little late this month, again. I find it hard to keep the in between meeting ones high on my priority scale with other commitments at work and with other professional groups. So don't be alarmed if your newsletter comes in a week or so late the month following a meeting in the future. You will get it and to head off the question, no we are not considering going to an every other month format on the newsletter like we have with the meetings. The newsletter is the main life blood of the organization and I feel it must be published on a monthly basis.

I have had a little negative feedback on whimsical stories in last month's newsletter. They started as filler and I kind of got carried away. You won't see that type of "filler" in the future.

I want to thank those of you who have already responded with contributions for the library and newsletter index projects. I don't have a progress report on either at this time, but I will give you one with the July issue. We are having a slight computer software compatibility discussion concerning the library, but I hope it will be resolved in the near future and work will continue.

The vintage gathering at Hemet-Ryan this year was a little sparse compared to other years, but this may be partly due to the lousy weather and somewhat to the upcoming "really big show" at Elmira that some of the Southern California pilots will be attending in July.

Keep those cards and letters coming, and thanks for your continued support.

Andy

JULY 15, 1995 PROGRAM

The program for next month will feature **Jack Norris**, a retired Northridge (CA) Aerospace Executive, will be talking to us about his procedures for performing zero thrust glide tests. For those of you who can't make the meeting he has published articles on this topic in the March and April 1995 issues of Sport Aviation. These might be good reading even for those who will attend so you can have your questions ready. We would like to thank Bruce Carmichael for coordinating this visit by Jack.

We will give you a little of his background this month and more in our final announcement in the July issue. Jack was a honors graduate in Mechanical Engineering at Ohio State University. While in the USAF he became the leader and spokesman for the Aircraft Laboratory at Wright Air Development Center in Dayton, Ohio, at all the mock up and engineering inspections of all the new Air Force planes of the early 50's like the F-100, F-102, F-104 and B-66.

Throughout the ensuing years he has been involved in a number of high profile projects in the private sector, including aileron servo controls for the Boeing 727 and spacecraft maneuvering controls on the Mercury, Gemini and Apollo programs.

To whet your appetites a little for the September meeting, we are pleased to announce that **Phil Barnes, a Northrop Engineer**, will make a presentation on his equation based method of calculating airfoils. From the introductory material he has given us we are sure will enjoy this program and find it very educational.

MINUTES OF THE MAY 20, 1995 MEETING

Andy opened the meeting by welcoming the big crowd (almost all the available seats were full) and asked for everyone to introduce themselves. Some of the more notable guests included Bud Evans (Evans Volksplane), Charlie Akerman, Andrew Bauer, Dick Baxter, and Ladislao Pazmany (PL- series of homebuilts).

After the intros, Andy announced the upcoming Wind Fair at Tehachapi where alternate forms of energy generation are shown and promoted, and the 8th Annual Vintage Sailplane Meet at Hemet-Ryan over the Memorial Day weekend.

Pat Oliver was present with some more of his original design flying wing paper airplanes. These are intended for use in a high school level scientific study program that unfortunately has been put on hold for a few months. He also had one especially designed for TWITT that was passed around for all to see and he had samples available for those who wanted to "play" after the meeting.

The raffle prizes for the day included a package of 9' extension cords and a multi-outlet plug, and a large package of cloth shop towels, both items being donated by Bob Fronius.

Andy laid out the program for the day indicating Bruce's presentation would be done in two parts so everyone could stretch their legs and take advantage of the finger foods donated by **Chris and Connie Tuffli** (Many thanks go out to them for keeping us in munchies each meeting. They have become our official hospitality chairpersons). The raffle would also be held during the intermission for those who might have to leave early.

But before the main program, Andy asked **Paul Stahlhuth** to come up and tell us about his newest version of a joined wing R/C model. This one has a 5' wing span and is much lighter than the 4' version he had last time. The new one has lifting airfoils versus symmetrical and only has a 6 oz. wing loading instead of 10 oz of the smaller plane.

The model is stable longitudinally with or without a small vertical fin, however, the biggest problem is it won't turn. This has resulted in a lot of chasing it through the weeds and up and down hills. He has tried several things to resolve the problem, like disabling the out half of the forward wing elevators, and putting in a greater degree of differential aileron on the aft wing. Unfortunately, this last change caused the nose to pop up during turns. He thinks it can be corrected by disabling the inner section of aileron and only using the smaller out portion.

Paul originally was going to call the aircraft the Five of Diamonds due to the span and overall shape. However, he got to thinking about on the drive down to San Diego and thought a better name might be Tandem Wing Including Touching Tips (TWITT) [ed. - we agree it would be more fitting].

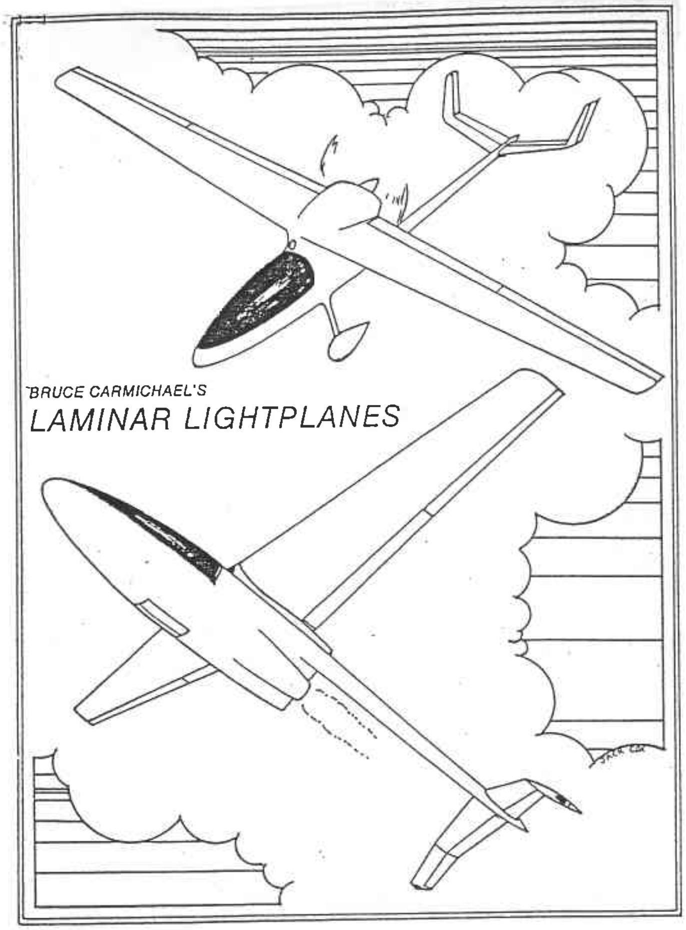
Craig Roberts had a prototype scale model of what will eventually become a light weight sailplane he and Floyd Fronius have been discussing. It is of flying wing design (well of course) with the pilot in a reclined position below the wing similar to the SWIFT.

The airfoil is Eppler's Profile (E6-20 to E6-23) sweep which has a progressively changing airfoil from the root to the tip that adds pitching stability similar to washout. The wing does have about 1½° of washout for these hand launched glide tests. It is meant to determine the range of fore and aft cg positions and stability. This 1/6th scale version will be followed by a ¼ scale R/C model of what will be a 15 meter sailplane. It is projected at about 250# with elevons, drag rudders and camber changing flaps, a 17 aspect ratio, with a 48" root chord and a 1½' tip chord.

The fuselage section has a very appealing shape, similar to a bird's body and will be of tubular construction. It has a wider lower half to provide adequate clearance for the pilot's hip area with the pilot's head being just behind the trailing edge of the wing.

Bob then took the floor for a few minutes to introduce the group to two pieces of material he has prepared for members to purchase covering a performance analysis of the Horten IV and computer aided design by John Roncz, designer of the Gemini I. **(See the section New Items Now Available later in this issue for more information on how to get this material.)**

(ed. - Bruce's presentation lasted about an hour and contained a lot of technical information along with the citation of works by numerous authors and aerodynamicists. The material below is a summation of his talk, however, if you are interested in listening to the entire text it is being offered on two audio cassettes at $4.00 postage paid (add $1.00 for foreign postage). If you are into laminar flow and boundary layer control this would be a good addition to your library.)



ABOVE: Bruce's design proposals for a laminar flow aircraft that would take the best advantage of boundary layer control.

Andy then introduced **Bruce Carmichael** our feature speaker for the day. Bruce opened by stating he would be giving us a concise history of some aerodynamic building blocks that have been responsible for the improvements in performance we are seeing in some of the composite airplanes and over what the manufacturers built in the way of personal aircraft in the past, and taken to extremes that there will be much large performance gains in the future. There are three time lines he would be guiding us through: the first is the theory, the second is the experimental confirmation of the theory and, the third started in about 1950 to the present time and involved the review of thirteen of his favorite flying machines.

Another area he will be covering is designing for the ultimate in performance improvement through extensive natural laminar flow and the problems involved in getting there. Finally, he would be talking about after you have that prototype built and the associated problems you will have trying to decide what is impacting your performance, i.e., power, drag, etc.

The theory started with 1883 with the introduction of Reynolds numbers that describes what happens to our aircraft. This ratio is simply the relative important of an air mass's inertia compared to its stickiness of the friction against the surface. At high Reynolds numbers you have lots of inertia and lots of speed, and at low Reynolds numbers you have lots of stickiness and not as much inertia. You compute this ratio by taking the length of the wing chord or fuselage and multiply it times the speed and add four zeros, which results in a number usually in the millions.

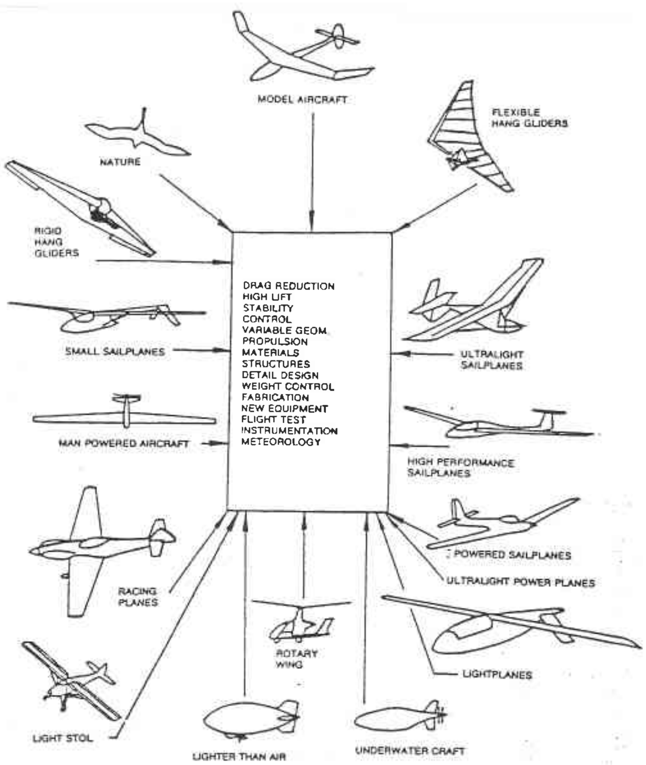
In 1904 the engineers and mathematicians were fighting it out on how to best to calculate lift and drag. The mathematicians came to the conclusion that at zero airspeed the drag was zero, whereas, the engineers knew that there was still some drag at zero airspeed. So this is were we came up with the idea there are really two layers of airflow over the surface, a thin layer (boundary) on the surface and another layer just above it with a different flow rate. For the flow outside the boundary layer you could neglect the friction and then calculate the lift coefficient.

In 1908, a mathematician came up with a perfect solution to the laminar boundary layer. He could tell you what the shape of the velocity profile was and more importantly what the friction was, and that there was a tremendous drop in friction with an increase in Reynolds numbers.

In 1929, it was determined that once all the major disturbances were removed from a wing a smooth, low friction boundary layer would go turbulent, high friction layer due to the amplification of very small disturbances.

Throughout the 1930's there was more work done on the measuring of boundary layers and how streamlining of aircraft affected its performance. We quickly jump into the 1960's with works on flow control and boundary layer, and in the 1970's came a better method of calculating the transition prediction.

In September of 1976 Bruce published a two part article in Sport Aviation that covered a presentation he made at a symposium in San Diego earlier in the year. In this article were two designs, one with a 130 hp pusher airplane with the propeller behind a pod type fuselage, and the other a 200# mini jet propelled airplane of similar design style. The intent was to have laminar flow along a majority of the fuselage and tail area. Projections based on optimistic predictions showed the propeller version would do 320 mph and the jet would achieve about 480 mph.



ABOVE: It is Bruce's belief that progress can be enhanced by cross-fertilization of ideas from the many somewhat isolated air vehicle design groups illustrated above.

Although these aircraft were never built, the articles inspired Alex Strojnik to write his three books on laminar aircraft and low speed aerodynamics.

In the 1990's the theoreticians had methods for calculating all the necessary pressures and the lift and drag coefficients on every point on an aircraft. One view graph he showed demonstrated the degree of information these new methods provide with results probably rivalling that of the best wind tunnels.

With the theory part of the time line now behind us, we moved on to the experimental part. The first slide shown was how Reynolds came up with a practical method to demonstrate and prove his theory. This involved the use of a long tube with water flowing through it and showing the breakdown on smooth flow as it gets further and further down the tube.

In 1934 wing profile drag measurements in flight for the first time using a rake to determine the loss of momentum of the air across the wing. This would allow the separation of that part of the drag from other calculations. And in 1938 Jones in England did extensive in-flight tests that led to the finding that laminar flow was more extensive than the theoretical tests had been showing.

(ed. - at this point Bruce showed a series of view graphs that really can't be adequately described in this type of forum. I will attempt to pass on some of the more relevant points he made that don't take a slide to understand.)

In 1945, Smith and Higton in England took a Bell King Cobra, smoothed up the leading edge and got a measured drag coefficient of .0028 and 13 million chord Reynolds numbers. However, they also looked into the practical problems in the design, construction and maintenance of a wing, and in flying in order to retain laminar flow. Their work is a very important document to have for anyone desiring to build a truly laminar flow aircraft. (The reference for this work is: Smith, F., and Higton, D.J., "Flight Tests on King Cobra FZ-440 to Investigate the Practical Requirements for the Achievement of Low Profile Drag Coefficients on a Low Drag Airfoil", R&M 2375, 1945.)

During the 1955-57 time period Bruce came to California to do some work at Northrop where they put a laminar flow cuff around part of the wing of an F-94 jet interceptor. This 65 series, low drag airfoil also had suction slots in the aft part to hold the boundary layer on the surface past the 45% natural point of separation. With this method they were able to maintain laminar flow to the trailing edge with a drag coefficient of .0008.

While doing the suction tests they also mounted a body of revolution under the wing. This long, slender body with a length to diameter ratio of 9 had laminar flow to 80% chord at 3 million Reynolds numbers and very low drag in a wind tunnel. However, in flight laminar flow only lasted to 20% which showed the flow acceleration on long, slender bodies was in the right direction but was not large enough for the Reynolds numbers being achieved in flight.

Bruce was also involved in a series of experiments that used a body with a length to diameter ratio of 3 1/3 to one which was dropped vertically into the ocean to evaluate laminar flow. The results were laminar flow to minimum pressure at 30 million Reynolds numbers and the body had only 40% of the drag of a normal torpedo body of the same volume. For Bruce it showed him that if you design things right you can maintain natural laminar flow on bodies to very aft locations.

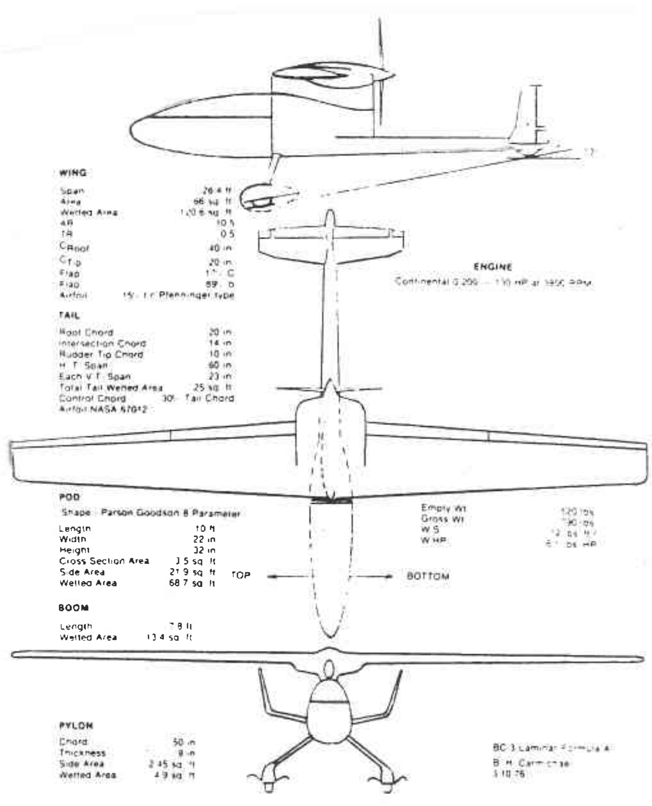
He then went through some of the planes he felt were the greatest contributors to the further development of laminar flow for the improvement of performance. These included the first composite sailplane built in Germany, a modified B-66 bomber with a full suction wing, the Teal Racer with its propeller behind the tail, and some of the Burt Rutan designs utilizing a canard. Bruce showed us the work of A.J. Smith with his high speed composite airplane he used to win many races throughout the years using natural laminar flow. A lot of what he got was through special farings to help keep the flow smooth through areas where pieces of the aircraft joined together.

Rutan's Voyager was on Bruce's list of remarkable aircraft that pushed the use of laminar flow. To our surprise the Daedelus man-powered airplane also contributed much to this research due to what it achieved at very low speeds.

Bruce got called to look at Mike Arnold's plane that was achieving very high speeds on a low horse power Rotax. What he found was a very smooth wing and less than a square foot of drag area.

The last airplane had in his list was the Nemisis racer with one of the lowest drag coefficients of any airplane to date. He also showed some pictures of the computer generated streamlines of the aircraft which demonstrate where the various pressure points were and where the boundary layer was breaking down. This airplane has done speeds of up to 318 mph on 150 hp in smooth air over the Mojave Desert.

BELOW: Bruce's 135 hp pusher propeller design with a 26.4' span, 40" root and 20" tip chord, 15% thick, 66 sq.ft. area wing.



We took a short intermission at this point and took advantage of the goodies and conduct the raffle. Mark Motley won the power cord set and Bob Barbour won the package of work rags. After gathering everyone back from the snack table and warm San Diego sun, Bruce began the second part of his presentation.

Bruce began by talking about designing a new aircraft to take advantage of natural laminar flow. He started with the wing by commenting that you want to reduce the area which can be done with additional lift devices, but don't use leading edge devices. One good item to use is a cruise flaperon which is a 17% chord trailing edge flap, full span that you can adjust up or down to keep the wing in a low drag condition throughout a whole range of lift coefficients and speeds. They also can act as the ailerons since they are full span. If you want more complexity you can put them at the back end of a 30% chord slotted flap. This can be difficult mechanically in a sailplane so probably only the most experienced engineers and builders should be experimenting in this area.

Aspect ratio was the next area of concern. This depends on what is you want the airplane to do, such as cruise long distances or race fast around pylons. There are certain ratios for each application that yield the best overall results as far as reducing drag by helping the laminar flow characteristics of the wing.

The fuselage came next with the suggestion to reduce wetted area by using a pod and boom arrangement. You can reduce the pod wetted area with a low length to diameter, but you have to be careful not to neck the fuselage in to quickly so you don't slow down the flow and get premature separation.

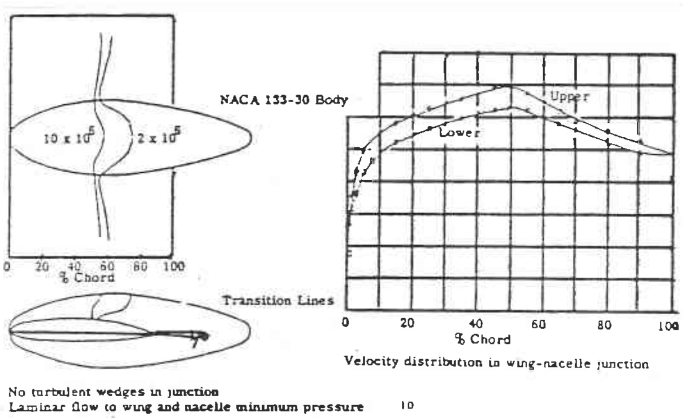
The question is now how to get better laminar flow over the fuselage. First get the propeller off the front end and put in the back similar to the Teal Racer. Then you have to use unit construction of the forward part of the fuselage. This means keeping everything as smooth as possible and avoiding having any place where air can flow from inside to disturb the boundary layer. One piece front ends that cant upwards or slide forward are ways of accomplishing this configuration.

Bruce talked a little about some of the techniques he had thought about on his 1976 designs. For instance, on the fixed gear of the propeller version he planned on having clamshell gear doors that would close over the wheels to smooth out the pants and avoid the turbulence of the opening. The jet version uses a single main gear retracted into the fuselage with the stabilizing wheels mounted on an inverted tail arrangement.

On retracting gear, make sure not to suck it up into the wing. The areas around the doors create as much, if not more, drag than if the gear were left down. The best solution is to retract them into the fuselage so the wing surface remains undisturbed.

For fixed gear use low drag sections if the Reynolds numbers based on the chord of the gear leg is above 400,000. You can use low length to diameter pants and minimize the intersection drag by having the leg join the pant at the side versus in the top middle section.

The wing-fuselage intersections are very important areas to work on to keep the flow rate high and the boundary layer attached. The ideal would be to have the nose stagnation point of the body and the stagnation point of the wing at the same point which kept laminar flow very far aft. However, it meant a design that probably wouldn't work due to CG problems based on the layout necessary to achieve the low drag configuration.



ABOVE: The deceleration of the fuselage boundary layer as it approaches the leading edge of the wing will cause a turbulent wedge to form on both the wing root and the fuselage with a half angle of 7 to 10 degrees. The configuration for achieving this result may not be practical because of the forward location of the aerodynamic center.

Now he got into construction considerations. With composite methods now available the waviness of the surfaces can be very well controlled and provide very smooth wings. The spar usually creates the waviest points but there are ways to overcome it. If you can afford to use a constant airfoil sections and constant chord over most of the wing, you have a better chance of producing a low drag wing. Again, you want to avoid steps, gaps and air leakage which can be achieved through unit construction.

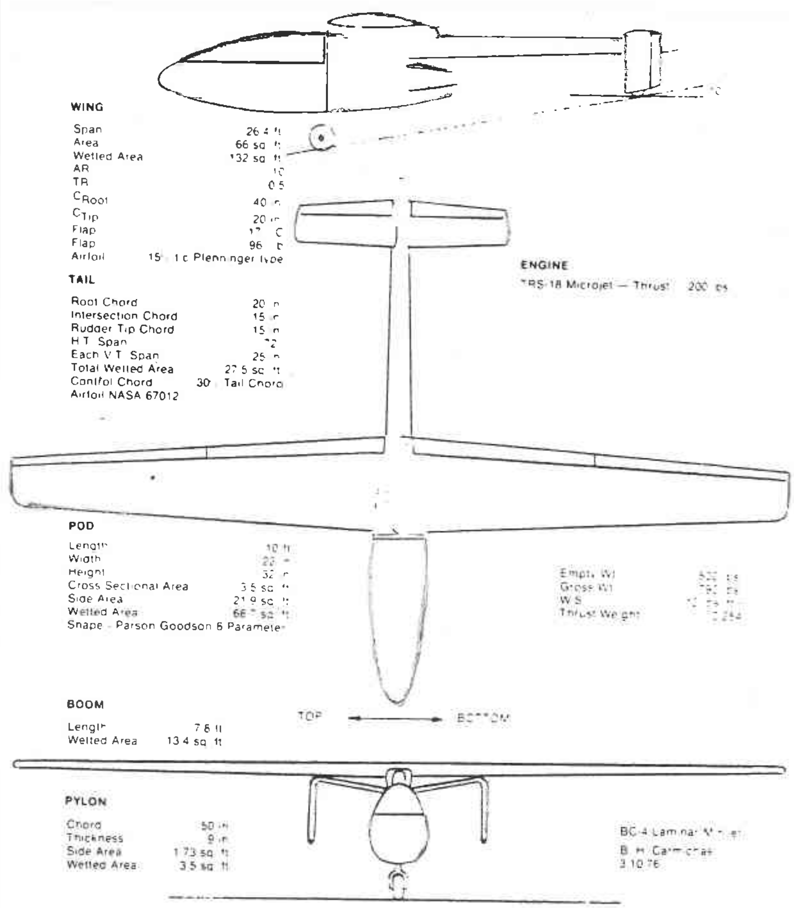
Hinge lines should be sealed to prevent leakage through this area to help retain the boundary layer further back. Keeping protective covers on the wings when not flying is also necessary to prevent things from causing disturbance points along the leading edge. The other problem is one of bugs picked up on the leading edge during lower levels of flight. Rain and turbulence also can cause the loss of laminar flow due to the increase in disturbance of the boundary layer. Getting out of both conditions will usually restore the flow and reduce the resultant drag.

Bruce then moved on into the last subject for the day, development and flight test. He talked about various methods for evaluating the drag of an aircraft and how much of the power is required to overcome structural drag. He mentioned the numerous tests done by Dick Johnson on high performance sailplanes as contributing to the vast amount of data now available for designing better aircraft. He also mentioned the technique used by Andy Bauer and Jack Norris for simulated zero thrust so that deadstick landings wouldn't be necessary for flight tests. **(ed. - Don't forget our July meeting will feature Jack Norris talking exclusively about this procedure.)**

Bruce went through a series of view graphs that show some of the results from various types of testing over the past several years. These tests are getting more refined each year and are allowing engineers to better define where the gains and losses are occurring in the new designs.

He closed his presentation with this little poem:

I've looked at flow from both sides now,
It's mostly turbulent and still some how,
It's the laminar cases I recall,
And the quest for them has been a ball.



ABOVE: The three-view of Bruce's proposed jet powered laminar flow vehicle, with single main wheel, outrigger wheels on the tail fins, and a raised pylon.

During a short question and answer session, Bruce was asked about power plant efficiency in the real world. He felt that aircraft engines appear to be producing their advertised output. Some the automotive and other types of conversions may or may not be getting the power their manufacturers claim. He mentioned that Rutan's VariEze predictions for propeller efficiency was not as expected after some wind tunnel tests were performed. This was due in part to its location behind a blunt engine, but improvements could be had by putting the engine further forward and running an extension shaft out the rear. This obviously causes other design problems, but it does result in better propeller performance.

After a few more comments by members of the audience, Andy thanked everyone for coming and adjourned the meeting.

LETTERS TO THE EDITOR

5/17/95

TWITT:

I was delighted to read your article on page 3 of the May 1995 issue titled "Birds of a Feather" and would be grateful for any references you may have explaining the concepts such as the main function of the tail is to unload the main wing, etc. I have noticed that aerodynes with large tails at low speeds tend to balance and find their own angle of attack. My only reading on the mechanics of bird flight has been an article in the Herk Stokely SOARTECH SERIES and books by Pennyjuick (UK).

Therefore, any references you can provide on bird aerodynamics may improve my understanding.

Yours sincerely,

Bob Peirson
13 Park A
CHATSWOOD
NSW 206
AUSTRALIA

(ed. - We will have to look through the library and see if there are any articles that might help you. We are also asking Phillip to help in this respect since he probably has a much more extensive reference listing on this area of flight. It would seem beneficial if both of you corresponded directly with each other to help each better understand the flight characteristics of birds.)

5/25/95

TWITT:

(ed. - Here are some comments from Karl Sanders in response to Phillip Burgers article on birds and other items in last month's issue.)

Dear editor, I do **not** "champion the worse cause for the sake of argument": Webster's definition for a devils advocate. *(ed. - This refers to Phil's comment about Karl being an excellent D.A. for flying wings. We all appreciate the comments by Karl since they create a framework of open mindedness in trying to resolve the various aspects of developing flying wing designs.)*

Birds are not flying wings, nor tailless. Most of them have relatively large "fuselages" and are short-coupled, quasi coplanar aft-tail configurations. The thin wings have only an aerodynamic and structural purpose. They have evolved as truly variable geometry wings: variable camber, twist and sweep angle. Variable sweep we've had: F-111, F-14, B-1, Boeing's 1967 SST proposal. Opponents countered with just a lower AR (Delta wing), for nearly same landing speeds, less complexity, weight and cost. The Navy's F-14, however, offered a higher deck spotting factor (wings full swept) compared to an equivalent fixed wing!

Variable camber and twist were seen in the late 60's as the last frontier to reach for the super maneuverable and gust controlled combat aircraft. ("Varicam" by BAC, in the UK, MAW - mission adaptive wing by General Dynamics, and Grumman in preliminary design studies.) Aerodynamically advantageous and mechanically feasible on paper, the structural and kinematic complexities, excessive number of actuators, hinges, locks and AFCS integration, weight and cost problems were prohibitive.

The variable chord (area) principle is with us for six decades in the form of Harlan Fowler's flap, since modified to single and double slotted variants.

An interesting bird configuration feature is that all (?) of them are shoulder wings. Frits Koolhoven was asked why his very advanced FK-55 fighter (1936 Paris exhibition) was a shoulder wing. His reply was just that. The center section lifts efficiently as in an isolated wing; this effect is also called (≈100%) lift carry-over.

(From ZFW 16 ('92), D. Hummel, Aerodynamic Investigations of Tail Effects in Birds (in English; copy in TWITT library) this:

"Comprehensive wind tunnel experiments on an A = 5 rectangular wing with a large variety of plane tails with deflections up and down have been carried out in symmetrical flow. In addition for one tail shape plane and twisted tails without and with deflections up and down have been tested in unsymmetrical free stream flow. In comparison with conventional aircraft the following results have been found:

1) The presence of a tail in birds increases the stability of the longitudinal motion as in airplanes.

2) The tail in birds acts as an elevator as in airplanes.

3) Long tails are devices to increase longitudinal stability rather than control effectiveness.

4) Spreading a tail at constant base width increases stability and control effectiveness of the longitudinal motion.

5) Configurations with forked tails are less stable than those with unforked tails. Spreading of forked tails at constant base width leads to a larger increase of longitudinal stability than spreading of unforked tails.

6) Twisting a tail in any direction increases the directional stability of the lateral motion. This measure is used by birds instead of the vertical fin of airplanes.

7) Twisting of a loaded tail leads to a sideforce and to a yawing moment. Their directions depend on the combination of loading and twist. This measure is used by birds instead of the rudder on the vertical fin of airplanes.

(ed. - Karl included the list of references which accompanied the article. For those of you who might be interested in reviewing the entire article, contact us and we will be glad to send you a copy for postage and handling costs.)

True that Anthony Fokker (or Reinhold Platz?) may not have known of the vortex lift of their low AR tail surfaces. Neither R. Horten in 1954 initially expected its full magnitude on the IA-37 plywood experimental sharp-leading edge Delta-wing glider. J. de Krasinski, (now in Canada) was tasked by the AMC to investigate the phenomenon (in a landing flare at V_{mc} the AOA exceeded 30°; pilot in prone position!) Results were published in I.Ae.C.e.I. No.C-11 (1955). However, 10 years before, NACA and Convair knew about the Delta's VL., encourage by captured German DM1 and other data.

If for the cruise condition the download on a horizontal is not nominally zero, the mean CG, the wing or both sit in the wrong place. The trim moment equation shows this at a glance. The rest is balance (i.e., locating the CG at a desired % MAC by means of wing-location and/or sweep angle (DC-2, -3, ME 262), relocating other items, or by putting ballast in nose or tail ends. In any event, trim tail-lift of the well laid out airplane is very small compared to total lift, and more than compensated for by the wing working optimally (i.e., unencumbered by reflex camber, differential ailevators, split ailerons and so forth).

Optimum configuration: the one of several candidates (e.g. Davis vs Bede 5 or Questair), which has the least wetted area and drag for given payload, volume, and performance requirements, its powerplant (if any) working at economic cruise power, and that satisfies or exceeds operational requirements (flexibility in seating and cargo accommodation, comfort & furnishings, entrance, egress, visibility, safety in forced landings, easy access to all vital systems and parts; and has adequate and trimmable CG travel, and flying and handling characteristics that meet or exceed established criteria, guidelines and ratings). All at purchase and operating costs affordable to the buyer. Is so happens that the "conventional" airplane dominates the field for most common purposes, because it best meets these conditions. No charisma, symphony and marketing conspiracies here, only what works best goes. The un-conventional AVRO Vulcan, SR-17 and the B2 were selected for these very same -and no other- reasons. They also were/are successful. Other tailless of the 50's were less successful. I highly recommend reading the paper "A Synopsis of Flying Wing Development, 1908-1053", January 1986, by Dr. Richard Pl Hallion, Chief Historian, AFFTC, EAFB, CA 93523-5000. (ed. - Karl has sent us a copy of this document for the library. See a later section for full details of what is in it.)

Results from testing free flight scale models are useful for the full scale design only if obtained with models that are dynamically similar to their full scale equivalents. (Scaling relationships are given in Journal of Aircraft, March-April 1995, p. 405.)

The Custer Channel wing demise was primarily due to excessive channel slipstream friction and structure weight; there were some lateral-directional problems too. NACA/NASA evaluated the concept. I suggest to request a bibliography of technical reports (NACA, NASA, Air Force, Universities) from NTIS; perhaps through a friend at a library. If STOL, or even hovering, is the objective one might find that a good Fowler flap, possibly in a deflected slipstream design (e.g., Ryan YO-51, 1940) will fulfill it better for higher cruise speeds and less weight.

Canards are not categorically inferior to conventionally tailed planes. The short-coupled canard with it trailing edge just at or barely behind the wing root leading edge, and about 1/3 canard root chord above the wing plane (created by SAAB with the -37 Viggen in 1966) has proven to be a formidably maneuverable fighter concept. Interestingly, there are also structural advantages due to the canard normal force which relieves the forward fuselage inertia shear and bending moments. A Convair study 20 years ago showed that about 5% of fuselage structure weight could be saved on a canarded, hence more manueuverable F-106. Civilian long-arm canards have the bad feature of a CG location forward of the wing, making it not suitable to carry fuel. So, fuel must be carried in the fuselage (or on it like the OMAC!), and close to the CG. Authorities dislike that for passenger safety reasons and special approval must be obtained upon proving safety in a forced landing test. Proposed mammoth flying wing airliners also face this situation: wing volume is shared by passengers and fuel...

5/16/95

TWITT:

Re: Custer Channel Wings, the diagram is my idea of the basic Custer Channel Wing, with or without a tail; a single engine Custer Channel Wing. The appearance of such wings suggests that they also might function as semi-ducted propeller aircraft; such a ducted propeller type could have been the human powered aircraft picture that I saw.

Could Custer wings be designed as a single or double channel wing without a conventional tail or stub wings? With stub wings and tail they seem to have some of a helicopter's capabilities and might possibly be safer aircraft than helicopters to fly.

In the book by Peter M Bowers, Unconventional Aircraft, I thing that the Custer Channel Wing the CCW-2 is the most interesting type. With stub wings there should be some glide capabilities, but without them? It will be of great interest to read the comments of the membership as regards the intriquing channel wing designs.

As to external fan jet engines, in September 1981 an AP wirephoto showed a multi-blade Lockheed propeller model.

Best regards,

Edwin Sward

(ed. - As you have already read, Karl had some thoughts on channel wings and there will probably be a few more come in over the next several weeks. It sort of sounds like the complexities of construction and the weight might be handicaps to an effective design.)

NEW ITEMS NOW AVAILABLE

As mentioned in the minutes of the May meeting, we now have copies available of:

Performance Analysis of the Horten IV Flying Wing, by Dezso Gyorgyfalvy, as presented at the VIII Congress of O.S.T.I.V., Köln, Germany, June 1960, published by The Aerophysics Department, Mississippi State University.

This paper has been made available by Bruce Carmichael, and represents work done under the sponsorship of the US Army Transportation Command and Office of Naval Research. Dr. August Raspet, Head of the Aerophysics Department, took the initiative in this study and gave full support and inspiration. Rudy Opitz also contributed by passing on his knowledge of the aircraft and flying wings to the author.

The paper contains a thirteen page narrative discussing results of performance measurements, analysis of drag components, profile drag, parasite drag, the drag polar, the maximum lift coefficient, and possible performance improvements. It includes two tables, ten references, and thirteen figures, photos and diagrams. It is presented in a spiral, protective binder.

Cost $5.00 postage paid
Add $1.00 for foreign postage

Also available is a copy of the article "Software Helps Launch a World-Class Glider", by John G. Roncz, President, Gemini Technologies, Inc., Design News, September 12, 1994, A Cahners Publication, pp. 58-62.

Internationally known aerodynamicist John Roncz has designed airfoils for about 36 aircraft, including the Voyager which flew around the world without refueling. This is an article on how he and assistant Mark Mangelsdorf went about modeling the development of the Genesis 1 competition sailplane (nearly a flying wing). Along the way he discusses some of the available CAD tools and how they were used to produce the final results.

Priced at: $1.00 postage paid

Contributed by Karl Sanders, a copy of:

"A Synopsis of Flying Wing Development, 1908-1953", by Richard P. Hallion, History Office, Air Force Flight Test Center, Edwards AFB, CA 93523, January 9, 1986, pp. 52. Some illustrations (not very good photo copy quality) and a list of about 20 references to support the material presented.

"This paper has been prepared to furnish readers with a quick overview of flying wing development from the Dunne aircraft of pre-World War I vintage through the Northrop flying wings of the immediate post-World War II years.

"The flying wing is one of the most enduring and appealing of aircraft design concepts, and thus has attracted a great deal of attention from writers and commentators. Hopefully, this paper will provide a useful reference point for discussions concerning the evolution of the wing."

NOTE: We don't have a price on this yet, but if you are interested give us a call or drop a note and we will get you a quote for reproduction, postage and handling.

AVAILABLE PLANS & REFERENCE MATERIAL

Tailless Aircraft Bibliography

by Serge Krauss

4th Edition: An exten-sive collection of about 2600 tailless and over 750 related-interest listings. Over 15 pages of tailless design