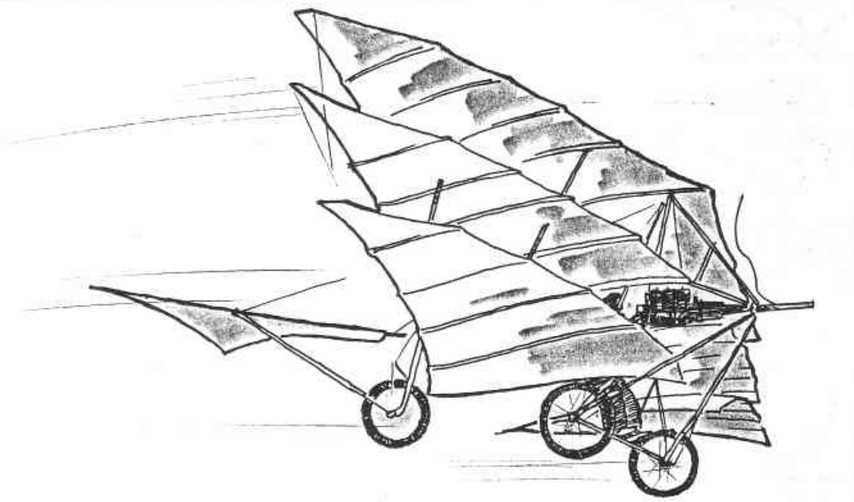
NUMBER 29 NOVEMBER 1988

TWITT NEWSLETTER

F. Marc de Piolenc, Editor and Publisher



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

The numbers in the upper right corner of your label indicate the last issue of your current subscription, e.g. 8811 means this is your last issue.

NEXT TWITT MEETING: Saturday, 19 November 1988, beginning at 1330 hours. As always, the location is Hangar A-4, Gillespie Field, El Cajon, California, in the first row of hangars on Joe Crosson Drive.

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COVER DRAWING

The minimally–tailed machine on our November cover was the work of one Jacob Christian Hansen Ellehamer. It was first built in 1905 as a monoplane, rebuilt in 1906 as a biplane and finally became a triplane in 1907. Mr. Ellehamer also built his own engines—first a 3–cylinder and later a 5–cylinder radial

MINUTES OF THE OCTOBER MEETING

TWITTs convening in October learned that our featured speaker had not been able to make the meeting. On motion made, seconded and carried, it was decided to fritter away our precious time watching videotapes. The highlight of the afternoon, in your Editor's opinion, was a video from Ryan's pre-Teledyne days showing what might be called the lighter side of certain exotic aircraft projects. It included spectacular closeup footage of terminal nosewheel shimmy on the Hummingbird fan–in–wing prototype and footage of tests of the Flying [?] Jeep, about which it solemnly stated that "...its greatest selling point was ease of assembly: Anyone with a 16–ton crane and sixty helpers could have it ready to fly within a week..." You get the idea. A good time was had by all.

19 NOVEMBER MEETING PROGRAM

Our November speaker, Maurice Brockington, is already known to TWITTs as the developer of the BEC twin–rotor Wankel engine, now in advanced stages of testing. He invites his fellow TWITTs to a brainstorming session, the subject of which will be an original airplane design. As Maurice puts it:

"This project originated as a response to an associate's question: 'If you were going to design an airplane around the BEC engine, what would it look like—I mean, a practical airplane that almost any pilot could fly, one which could carry four people?'"

The project is intended to be:

- 4 place
- powered by the BEC engine (normally aspirated, 185 HP)
- certificatable
- high performance
- aesthetically exciting
- marketable.

We feel it's only fair to point out that this machine possesses a **tail**. It is therefore our sacred duty as TWITTs to teach Maurice the error of his ways and to lead him back on the path of righteousness.

BEC 4PL SPECIFICATIONS:

SPAN	30.67 ft
LENGTH	23.33 ft
EMPTY WT	1150 lb
GROSS WT	2200 lb
POWER	185 hp
WING AREA	100 ft^2
WING ASPECT RATIO	**
WING LOADING	23.0 lb/ft^2
POWER LOADING	12.4 lb/hp
MAX FUEL CAPACITY	84 gal
STD FUEL CAPACITY	60 gal
MAX BAGGAGE	250 lb
DESIGN LIMITS @ 1800 lbs	6 g pos
	4 g neg

* At Gross Wt

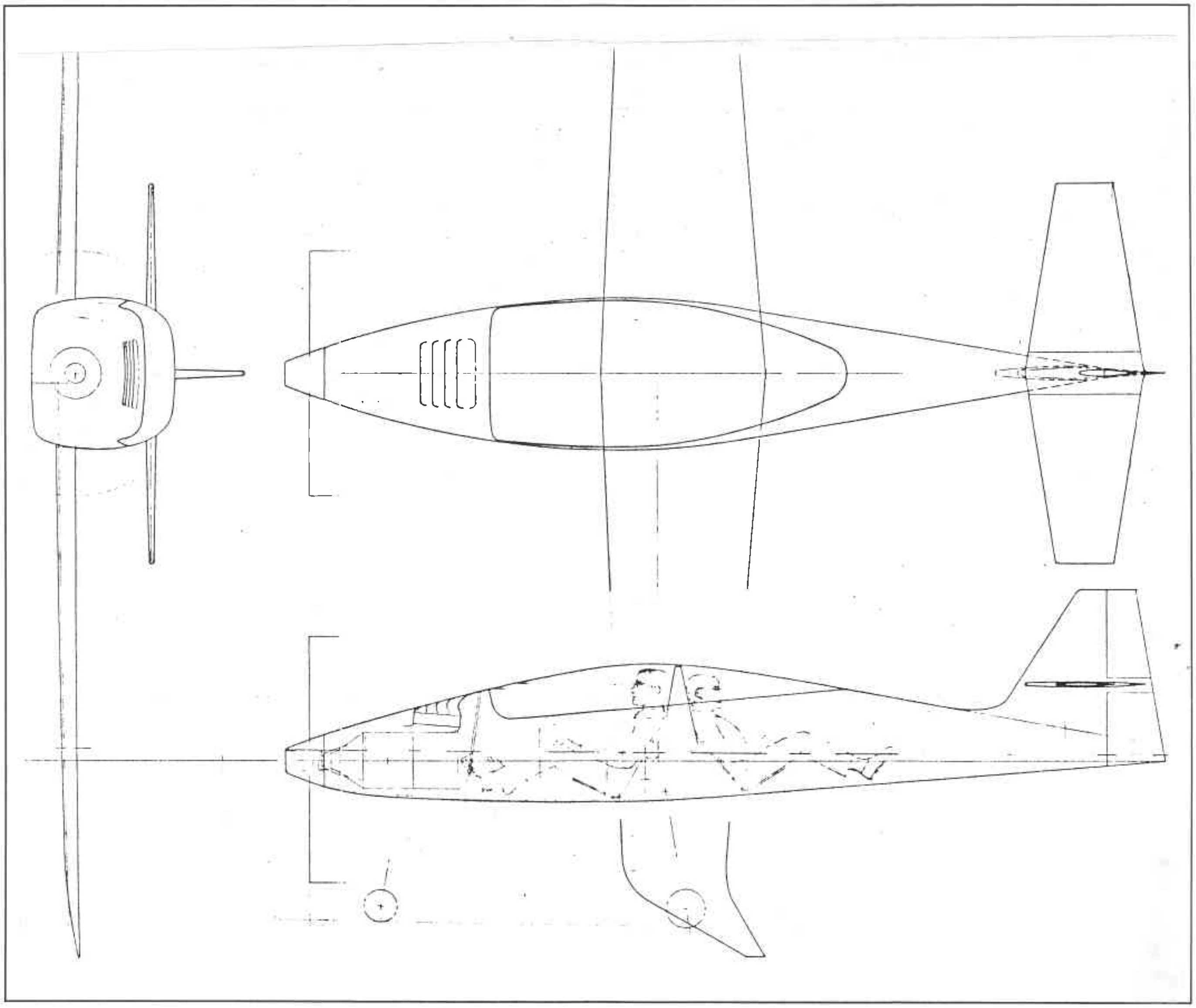
** With Sheared Tips	9.4:1
Without Sheared Tips	7.8:1

NOTE: The foregoing specifications are minimal and the related drawing unfinished. At the TWITT meeting you will be furnished a more complete print of the drawing and a more extensive set of specifications.

LETTERS

MORE GREAT STUFF FROM THE KUHLMANS

Our copy of TWITT Newsletter #26 arrived in the mail a few days ago. Quite surprising to see so much of our correspondence in print, but wish to thank you for the comments that you included. As amateur aerodynamicists, we are of course excited by any small amount of relevant information which alters the direction of our thinking. Just as it



The BEC 4-Place Airplane Proposed by M. Brockington

seems that we are having one question answered, several more arise to take its place; this time is no different, and so below you will find a number of questions, mixed with a few comments (or vice-versa), that we are hopeful that you (or someone else) can answer for us.

Our letter to Harald Buettner concerning his replacement for conventional control systems was based on our effort to increase performance. We had always assumed that one of the advantages of controlling flight path with rudder and elevator is the lack of gaps and abrupt surface deformations from deflected ailerons, thus making the wing more efficient. We are currently finishing off a Dodgson "Windsong" and find that the aileron hinge method leaves a large gap in the lower surface, while the flap mechanism uses a "figure 8" hinge made of the covering material. There simply has to be a better way! So while we are forced to complete an already started wing with conventional control surfaces, it seemed that Harald's method is certainly an improvement and could be incorporated in future models.

We know that maintaining laminar flow at low Reynolds numbers is next to impossible (Eppler had in fact made statements that aerodynamics below a Reynolds number of 60,000 should be made illegal). Most of the articles dealing with laminar flow sections for models state that laminar flow ceases at about the maximum thickness point, so the airflow has already transitioned to turbulent flow by the time time it has reached the 75% chord point and the hinge gaps. Still, we cannot help but think that eliminating the hinge gaps and eliminating the abruptness of the angled control surface would be of benefit. Are we wrong in this regard? It seems to us that model sailplanes without ailerons and/or flaps have stalling characteristics equal to or better than those with these devices. Given your comments on laminar flow and the stalling characteristics of wings, why might this be? You mentioned the NACA 65-series section on an ultralight.

We recently found two articles, one in Kitplanes and the other in Sport Aviation, written by Harry Riblett. Mr. Riblett has four papers currently available which deal with general aviation airfoils: (1) *GA Airfoils, A catalog of airfoils for general aviation use;* (2) *NACA Low Cm Laminar Flow Airfoils (a=0.5 Mean Lines);* (3) *A Comparison of Dimensioning Methods for Airfoils;* (4) *Performance Notes—NACA 747A315 and NACA 747A415 Airfoils.* The first two promote a method of lmproving the stalling characteristics of selected NACA sections. As these were originally designed for Reynolds numbers of 10 million and more, it is little wonder that they do so poorly in general aviation use. Mr. Riblett recommends that the mean line of these sections be changed so that the initial camber angle equals the stalling angle of the airfoil (usually from 12 to 15 degrees, versus the original 3 to 5), and that the section be created by simple algebraic methods rather than the trigonometric method as outlined in Abbott and Doenhoff's *Theory of Wing Sections..* The algebraic method allows retention of even station locations and has the added benefit of providing a more suitable nose shape when compared with the "leading edge radius" method. **Harry Riblett, 16 Riblett Lane, Wilmington, DE 19808.** Mr. Riblett uses AIRFOIL–II from AIRWARE, and can provide performance analysis and airfoil tracings up to 90 inches in length. Mr. Riblett was kind enough to tell us that he had received other inquiries regarding sections for flying wings. He included an analysis of the NACA 747A315 with a 3 degree reflex at 80 percent chord. This may be an answer to Ed Gabriel's question about a section for his U-2! Perhaps you would pass all of this information on to him? We'd like to let you know how much we've enjoyed the last few issues of the TWITT newsletter. Several articles deserve comment:

#21—the synopsis of the Nurfluegel Symposium was most excellent, and we found ourselves making immediate comparisons between "Bumerang" and some of the other recent wings from Germany, notably the SWALC (swept wing automatic lift control) of Hansjorg Ackerman. The more detailed plans of the SB-13 were most welcome, but still rather small to use in modelling. By the way, we have a photocopy of the original sketches of the SB-13 done by Werner Thies. Shows the original straight wing, includes some airfoil pressure distribution data (mistakenly labelled as coordinates). Interested?

#22—the 3-views of the Weiss 1909 glider had us contemplating a scale model for next year's Richland meet, to include utilization of the original's control method. This may still come to pass, but see below...

#23—more mouthwatering data for the SB-13! And still looking forward to a 3-view of the Schapel SA-882.

#25—the 3-view of the SZD–6X "Nietoperz" has us so excited that we've already built the rudder and nearly completed a fuselage in 1/4 scale; we're waiting on a block of foam to construct the wings. this will be one of our scale entries at Richland next year. Some data for the original: 12 meter span, 4 meter length, 1.3 meter height; wing area = 14.4 m, aspect ratio = 10, empty weight 150 kg, flying weight 235 kg, 16.3 kg/m^2. The glide ratio was 17.5. 1.7 m/sec sink at 100 km/h, 3.5 m/sec at 140 km/h. Max. permissible speed was 300 km/h, minimum speed was 54 km/h. The SZD-20X "Wampir 2" was quite an improvement but did not utilize any forward sweep.

#26 & 27—with so little to recommend forward sweep on a sailplane, why did Akaflieg Berlin utilize forward sweep on the B-11? It would appear that the forward sweep allowed the elevator to operate with a good moment arm, while the ailerons were close enough to the CG that pitch wasn't affected by their use. By the way, we've been fascinated by this sailplane ever since seeing a 3-view in *INTERAVIA* magazine around 1960. With but a little more information we'd consider a model in 1/4 scale.

Lastly, we have issues 4 through 7 of a publication called *DELTA*. It is the quarterly magazine of the FSV Versmold, a West German model club devoted exclusively to flying wingsailplanes. The technology of some of the models is quite impressive. Are you interested in photocopies of relevant information, 3-views, etc.? Do any TWITT members have copies of other issues?

TWITT!

Your Editor's reply:

As for your surprise at seeing so much of your writing in print, there is no cause for surprise. Your material is relevant, informative and well written, so it would be very odd if I did not choose to print it.

My comments in NL 26 were not intended to disparage Harald's camber-control device, which should improve efficiency by eliminating sharp kinks in the camber line and in the upper surface of the wing. Rather I wanted to emphasize that the pursuit of laminar flow at low Reynolds Number, which appeared to be your reason for favoring Harald's invention, is a very bad idea. It is, unfortunately, quite possible to achieve a long laminar "run" under those conditions, but the result is anything but desirable. I am referring of course to laminar separation. As you know, airfoils operating at high RN have four distinct flow regimes on their upper surfaces (it is possible, and usually desirable, to have extensive laminar flow on the lower surface):

- 1. Laminar, attached,
- 2. Laminar, separated,
- 3. Turbulent, attached and
- 4. Turbulent, separated.

Initially, the pressure gradient is favorable (decreasing pressure in the direction of flow) and the flow is laminar. When the boundary layer encounters an adverse (increasing) pressure gradient, near the maximum thickness point, it becomes unstable and soon separates from the wing. Shortly after separating, it changes character and becomes turbulent. The mixing caused by the turbulence re-energizes the boundary layer, causing almost instant reattachment. The laminar separation "bubble" shows up as a distinct dark spanwise band when a wing is tested using the sublimating-coating technique. The turbulent boundary layer, less desirable from an energy-consumption standpoint, has the virtue of being much more separation resistant than the laminar type. Despite the adverse pressure gradient over the aft part of the upper surface, the turbulent layer stays attached to within a few percent of chord of the trailing edge. Many popular articles about airfoil sections simplify the above picture by simply saying that the flow changes from laminar to turbulent, but laminar separation is a feature of all airfoils with a considerable run of laminar flow; it's what happens after laminar separation that distinguishes supercritical from subcritical Reynolds Numbers. In subcritical flow, a laminar boundary layer encountering an adverse pressure gradient separates and does not reattach, making the laminar section useless for most purposes. The modeler with a very clean, non-wavy wing with a laminar section is asking for trouble. In extreme cases, he may need to deliberately trip the flow (say, by cementing a wire spanwise on the upper surface well forward of the max. thickness point) to get his model to fly at all! Fortunately, even molded wing skins usually acquire enough waviness during assembly to guarantee early transition; the boundary layer that encounters the adverse pressure gradient is then turbulent and does not separate. The model behaves itself and the modeler congratulates himself on having an efficient, laminar section! It is obvious from all the above that control surfaces, unless they have unusually deep chord, have no influence on boundary layer development; their contribution to drag comes from leakage flow and from increased camber when they are deflected downward. There is no reason, then, to expect any sailplane with ailerons to have different stalling properties from another without ailerons, but otherwise identical.

Mr. Riblett's airfoil camber-line modifications are well founded...and well-known. The "droop snoot" modification used to tame sections with nasty stalling properties has the effect of steepening forward camber, and it works very well, with little loss of efficiency at cruise if it's done carefully. You should note that increasing forward camber slope causes a suction "spike" on the lower surface near the leading edge; this tends to cause lower surface separation at fairly low negative angles of attack. I mention this only because it might cause trouble for a machine designed to fly inverted a lot, say a stunt glider or a pattern ship, but if I remember my reading those mostly use symmetrical sections these days. How a change in the mathematical form of the camber line equation can clean up nose shape, which after all is a function of the thickness distribution, is not clear to me at all. As for the NACA 747 series sections, I like them very much for full-scale airplanes because of their reasonably high efficiency coupled with low pitching moment. They do, however, maintain a long run of laminar flow in the smooth condition and are therefore not suitable for models in my opinion. If you do choose to use them, consult the curves for "standard roughness," which tell you what happens when the flow is prematurely tripped, and base your design on them. I don't understand the reference to "3 degree reflex at 80 percent chord." Does this mean he puts a kink in the camber line at .80c?

About your SB-13 material: you bet I'm interested! The 3- view of the Schapel machine got crowded out of the issue that featured that machine [actually, it didn't get crowded out—TWITT has no three-view of the SA-882. We'll try to get one from Mr. Schapel]; thanks for reminding us that we owe our readers more information. The very strict space limitation that we work under often forces us to publish 3-views in one issue, text in another. It's a pain in the neck for our readers, but very hard to avoid. Glad you liked the Nietoperz 3-view; I hope your model has better flying properties than the original. I would be very interested in whatever info you have on the Wampir 2. We seem to have the same issues of *Delta*, from which we got all the info we have on the Nietoperz. It is a very impressive effort...*Delta,* I mean!

Where did you get the idea that forward sweep was undesirable in a sailplane? Besides its aerodynamic advantages, it allows the main spar to pass comfortably behind the pilot while he sits on the cg; the machine then does not need to be reballasted for different pilots. I'll dig up what I can find on the B-11.

FMP

FOLDING PROPS IN GERMANY AND NEW MPA PRIZES

We're still getting fallout from Tasso Proppe's talk about the hazards of incorporating bright ideas into airplanes. Here's Peter Selinger's contribution:

Dear friends,

Finally now I could fetch the time to read the newsletters I got in the past months, and I have to add or correct some things. First I enclose you a survey of the current certified folding props in Germany, as a further reply to Tasso Proppe, whom I revere, finally also for his history of ultralight flight, which you published in the July issue of the TWITT-Newsletter.

Sorry that my business does not allow me to write more often to you to give you informations of what happens here, on the other side of the big bathtub.

To the August issue I have to add, that I read with great interests the report of Klaus Savier's visit in Germany. But the image you built up of Guenter Rochelt is not in the right direction. Rochelt is a fantastic designer, but not an aerodynamicist, as he says from himself too. His creativity and high efforts in time and force make him able to realize things in months to which others need years. To build the mpa's musculair, as for his new hang glider FLAIR, he has help of specialists in various matters, but this not will reduce his merits ! ! !

Perhaps it will be of interest also for all readers, that the Royal Aeronautical Society of Great Britain has announced two new Kremer mpa competitions:

A marathon competition for an high speed endurance course of about 45 km (28 m.) to complete in less than an hour, which includes at least two figure of eight flights around two pylons of a distance of more than 4105 m, in sum 5 times around.

And a competition for a mpa–floatplane, which has to be started and landed on water!

The flight evaluation and testing of the flying wing glider SB 13 of the Akaflieg Braunschweig seems to come in a very important phase. The boundary-layer-fences brought a great progress and should be the solution to realize the calculated cg without the troubles in flight-handling characteristics, and thereby get the performances sought.

For today best wishes from Germany for a growing TWITT-family.

P.F. SELINGER

Certified Folding Propellers for Gliders and Motorgliders in Germany

Compiled by Peter F. Selinger

Model:	Turbo	TOP	Piccolo
Manufacturer:	Schempp-Hirth	Fischer	Technoflug
Engine:	SOLO	Koenig	SOLO
	2 cylinders	3 cylinders	2 cylinders
	in-line	radial	in-line
RPM:	5500	4200	6300
Reduction Ratio:	1:1	1.7:1	2.1:1
Power:	19.6 kW	18 kW	17 kW
Propeller:	5-blade	3-blade	3-blade
Diameter:	0.88 m	1.30 m	1.18 m
Fold Direction:	Forward—asymmetrical in angle and diameter	Backward—symmetrical	Backward—symmetrical
Propeller Material:	Glass/Aramid reinforced plastic	Glass/Aramid reinforced plastic	Glass-fiber reinforced plastic
Airplane Launch Technique:	No self-sustaining capability intended	For self-sustaining gliders up to 420 kg gross and 17 m span	Self-sustaining motorglider with 13.3 m span
Certification by LBA, Braunschweig:	December 6, 1984	Powerplant and ASW 20 installation, 1987; Astir installation, 1988	December 15, 1987 for complete aircraft and powerplant

DEFENDS CANARDS

Some of you remember Vic Saudek's letter, published last month, which contained some rather negative views of canard and tailless airplanes. This is Klaus Savier's reply, an OPEN LETTER TO VIC SAUDEK:

In engineering it is simply performance and cost which rule. If one configuration consistently shows better performance than others, it is wise to accept the fact that this configuration is better. Aerodynamic performance cannot be evaluated adequately by looking at skin friction drag and induced drag alone; there is more to the story!

Most canard configured airplanes generate a drag problem during turning flight, and thus are not a good choice for an airplane which is required to turn 80% of the time, i.e. sailplanes. This problem does not disqualify canards when they are evaluated on a broader spectrum. For the past seven years, general aviation aircraft performance has been meticulously measured and evaluated at the cafe race in Santa Rosa, CA. CAFE stands for Comparative Aircraft Flight Efficiency, and we score: $mph^{1.25}$ x $payload^{.75}$ x mpg, which can also be written $mph^{2.25}$ x $payload^{.75}$/gph. As you can see, speed and efficiency are of greatest value. The airplanes are flown at or near gross weight around a 400 km course—climbing, descending and turning around pylons. There is no doubt that low drag is highly desirable in this event, yet it has always been won by canard configured airplanes. I entered the CAFE race four years ago. Since then the three top places in the two-seat category have always been taken by canards! This year Gary Hertzler (VariEze), Gene Sheehan (Q200) and I scored within 3% of each other. Fourth place went to Mike Maxwell and co–pilot Ray Cote in Mike's meticulously race-prepared Lancair. Its score was 25% lower!

I would like to invite all believers in the "old configuration" to perform in the CAFE race or fly your old configuration nonstop, unrefuelled around the world. My hat and goggles to you if you win. Until then: put up or shut up.

Klaus Savier

SB-13 WING CONSTRUCTION

Presented at the IDAFLIEG Winter Meeting 1987 in Aachen, 11 January 1987

[Author's name not given]

In this presentation I will discuss the above-mentioned theme by discussing the materials used in construction, what we expected of them and the experience which we derived.

Next I will discuss particularly the spar cap fabrication technique.

Finally I will mention detail problems and solutions which I consider sufficiently interesting.

The wing is the most costly component of the SB 13.

The wing skins were laminated from two + and –45° layers of a 90 g/m^2 unidirectional HT-carbon material (Aerotex) manufactured especially for us. This material was chosen because it offered weight advantages over two 200 g/m^2 layers of twill weave and we wanted an extremely smooth surface with no weave showing.

It appeared, however, that this extremely thin layup did not allow itself to be laid in a highly curved shape and that the areas with paper stop strips, being slow to wet out, showed through the finish.

The core material was a standard hard foam, 6mm thick.

The inner layup consists of a diagonal layer of 150 g/m^2 twill. It is made up of very thin individual yarns and is very tightly woven. It is therefore easily wetted out and layed up, even in small patches or narrow strips, without falling apart like the loosely woven 200 g/m^2 with its thick yarns. Unfortunately, it is extraordinarily expensive.

In terms of weight, the largest chunk of the wing structure is the spar cap, which had to be dimensioned for maximum stiffness for technical reasons related to flutter. The number of rovings was determined according to the amount of room available in the spar root. For aeroelastic reasons the spar is also de-swept with respect to the wing planform, as clearly shown in the drawing. This means that it lies inboard somewhat aft of the maximum thickness point and extends outward toward the leading edge.

The cap is made of a carbon fiber in which higher stiffness is achieved at the expense of strength. The fiber itself has an E–modulus of 4 x 10^5 N/mm^2, so that even with the resin the stiffness nearly reaches that of steel. These fibers are very vulnerable to damage in fabrication and have a large radius of rupture. In addition, the 5,400 rovings per cap had to be wetted out rapidly enough to avoid exceeding the pot life of the resin and to allow the spar structure to be improved by the vacuum bag technique.

The spar cap fabrication technique which allowed us to fulfill these goals finally looked like this:

Thirty spools of roving were fastened to a frame and fed together in such a way that they were laid parallel on a large resin–coated wheel in the impregnation machine. The rovings are then compressed by a belt of synthetic material, wetting them out evenly and quickly. Upon leaving the machine, the strip is further compressed into a rectangular shape. The rovings are then taken up by a crew that lays it out on silicone paper in strips laid out in advance. In this way we achieve a dense, uniformly thick roving sheet with exact dimensions and composition and correct curvature. The charged paper is then handed on a board to the layup crew, carefully laid, and the paper withdrawn. The pre-wetout crew then lays a diagonal 150 g/m^2 layer in the curved area [of the spar], over the cap to the skin and extending clear to the root. In the meantime, the next paper strip is being charged with rovings.

The reason for the intermediate layers in the curved area is shown in Figure 2. It depicts a curved segment of roving loaded tangentially at its ends. There results a load on the outer surface of the roving, a distributed outward force $p = F/r$.

Such loads necessarily occur in the curved portions of the cap. Figure 3 shows it in cross-section. If the wing is bent upward, the upper cap is compressed, the lower one loaded in tension. The resulting forces normal to the cap axis, shown in the figure, create a torsion which must be reacted by the wing skin. Because there is no experience with this problem, and because moreover torsional stiffness, like bending stiffness, is very desirable inboard and the intermediate layers laid on the flange at the spar root solve the glueing surface problem there, we decided to lay an "interleaved" layer on each layer of roving.

The same phenomenon occurs with a different effect at the winglet joint bend. Figure 4 shows how the winglet spar extends through the bend to the control surface flange. Figure 5 shows a front view of the bent portion of the caps. If the winglet is bent outward, the structure is loaded as shown, tending to delaminate any ordinary angular layup. It is for this reason that we chose the construction shown in Figure 6, which is very demanding from the standpoint of fabrication.

In dimensioning the parachute attachment on the fuselage, made up of two roving loops on the fuselage side, an effect appeared which should not be neglected. There is a tension peak (Figure 7) on the inner fibers, because the outer ones are longer and therefore appear to be less stiff. The tension peak decreases with the ratio of thickness to inner radius and with the E-modulus.

In conclusion I would like to mention a result of the finite–element analysis of the wing. In it there appeared a compression peak in the spar flange behind the root rib, which was not anticipated in preliminary design. The loads measured in the wing tested to destruction showed that the predicted load distribution was qualitatively correct. One can only speculate on the cause. If the load transmission structure and the resulting load paths, which are similar in all sailplanes, play a role here, then these loads could contribute decisively to the failure of a wing.

Translated by F. Marc de Piolenc

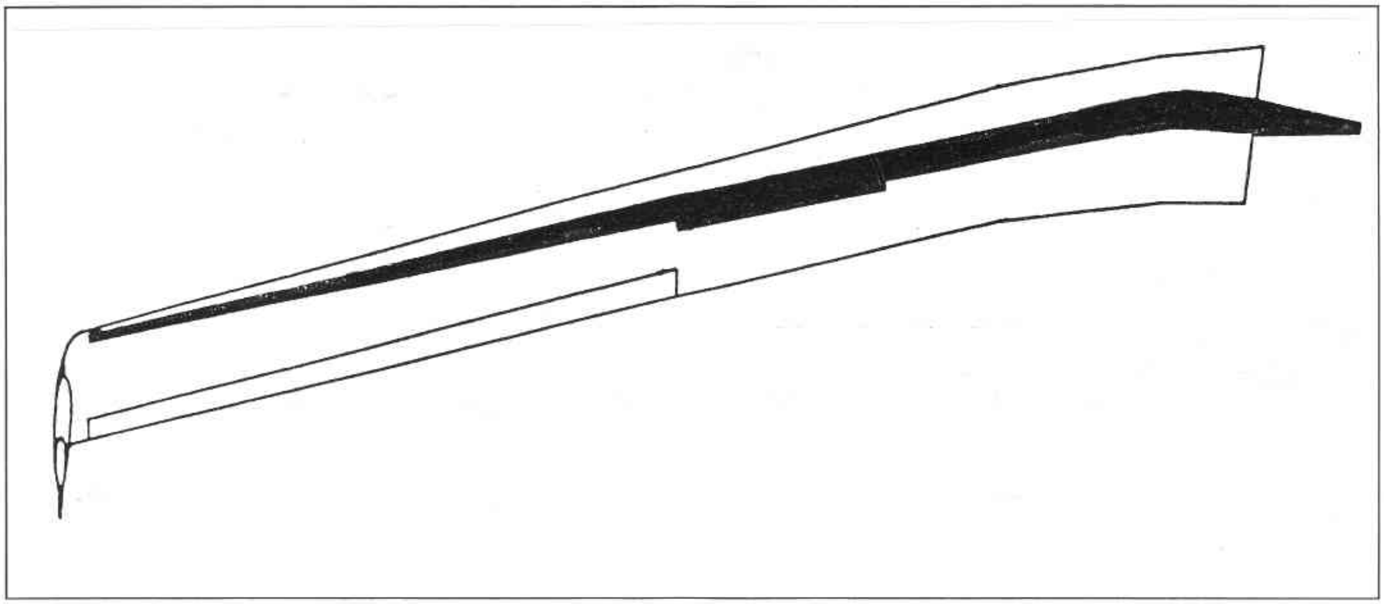


Figure 1

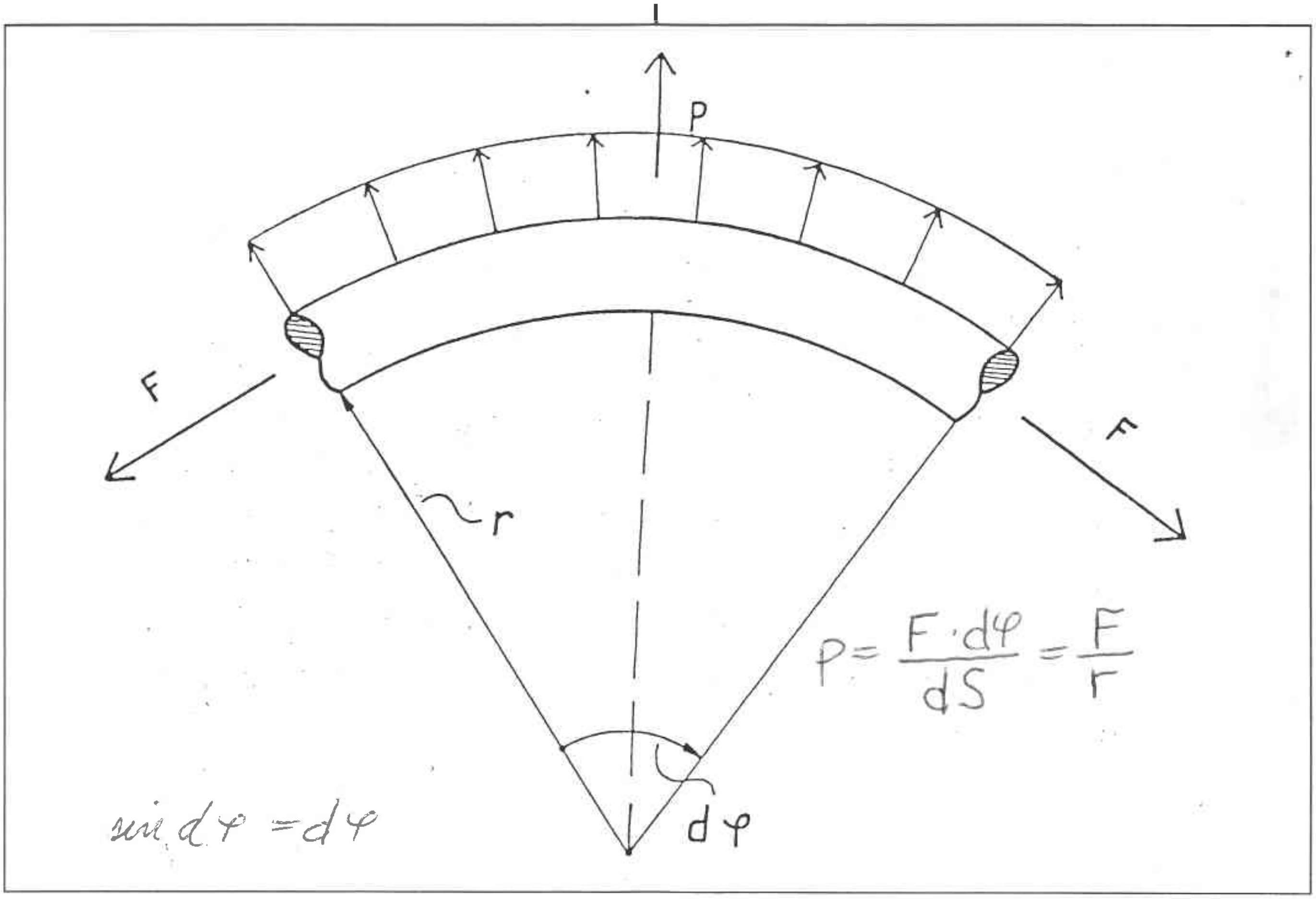


Figure 2

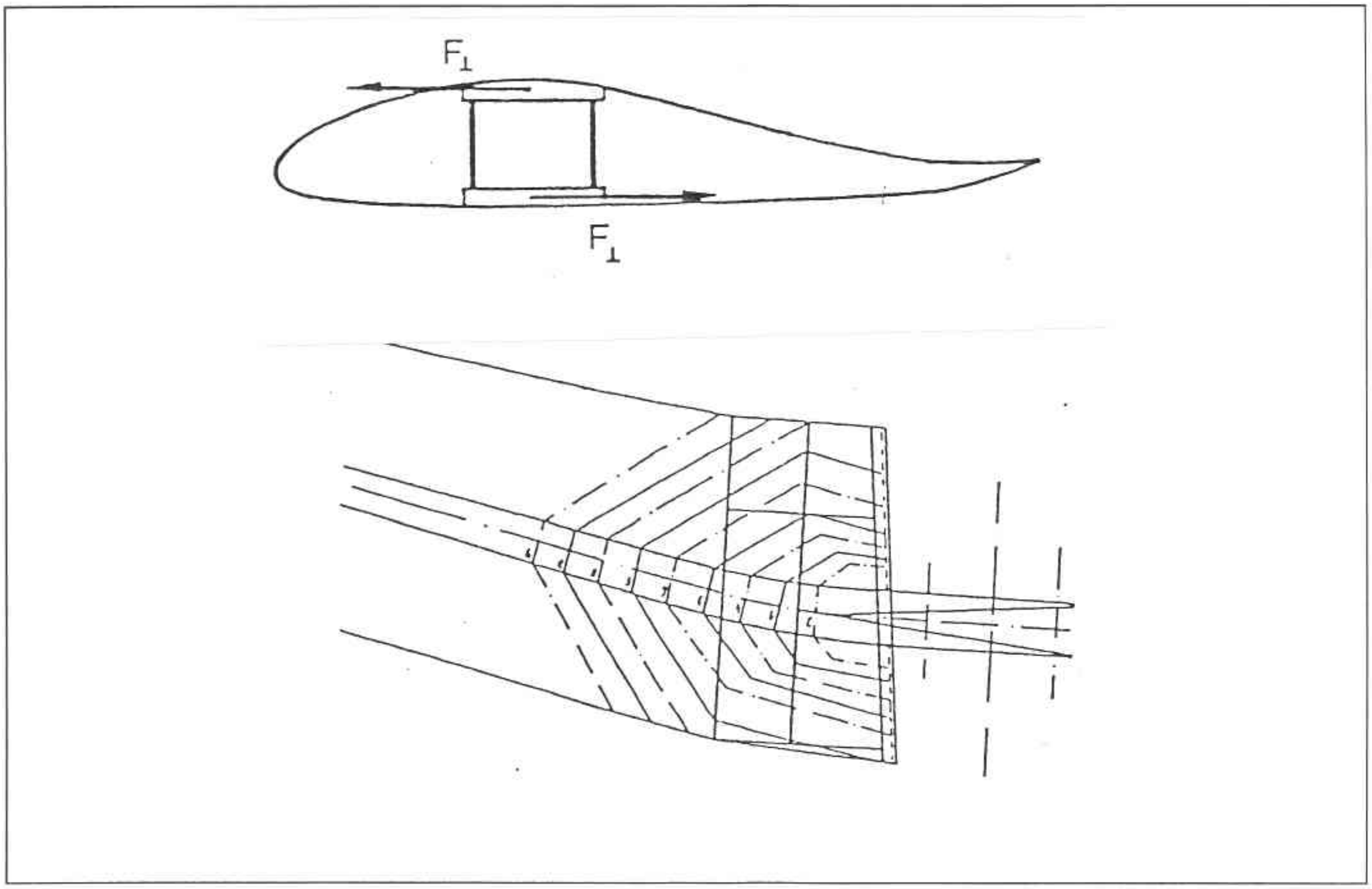


Figure 3

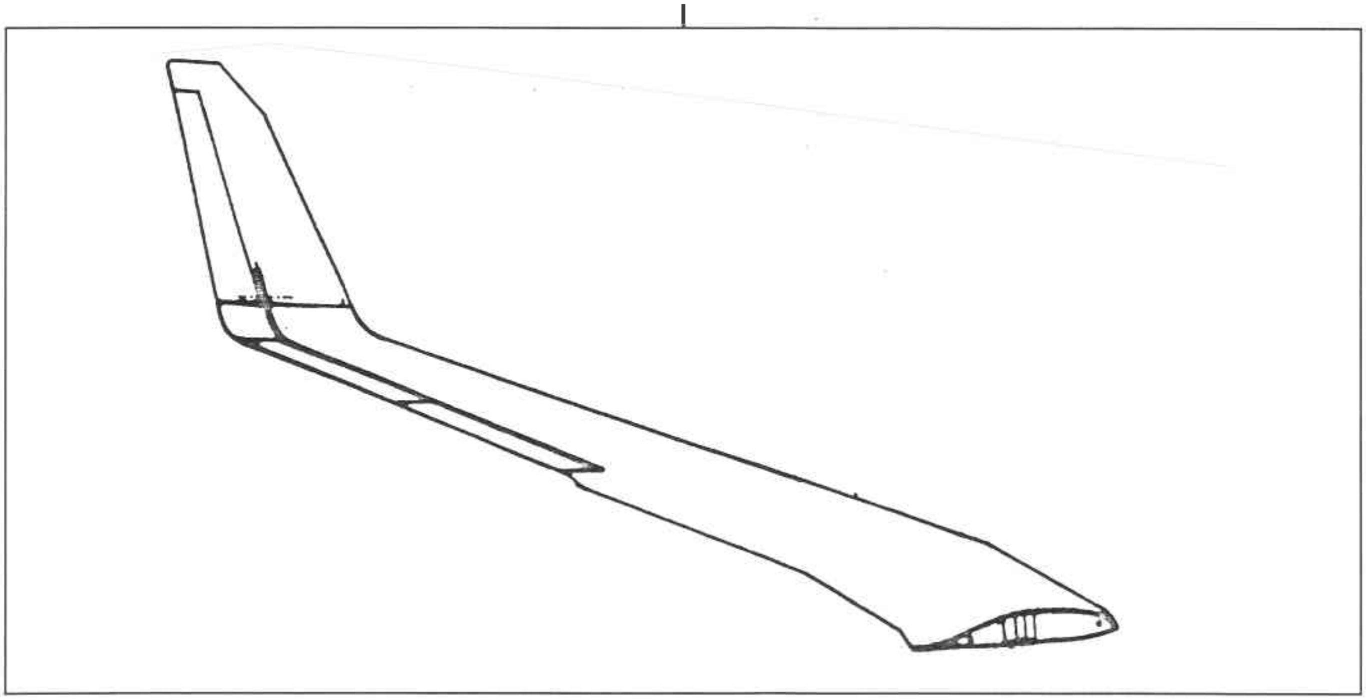


Figure 4

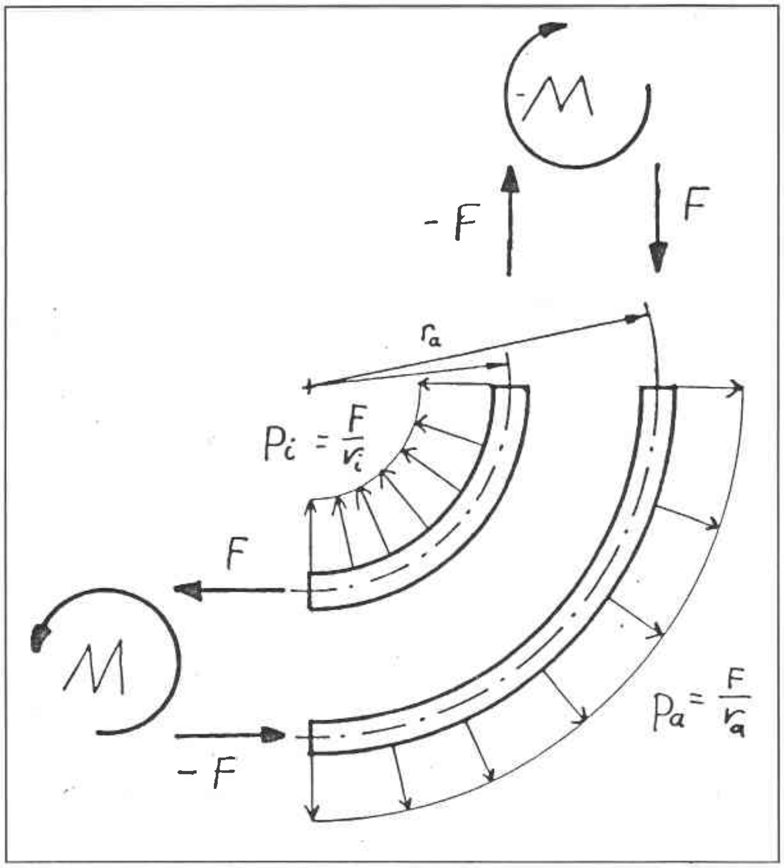
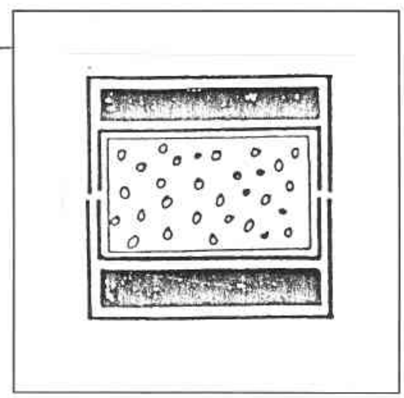


Figure 5

Figure 6



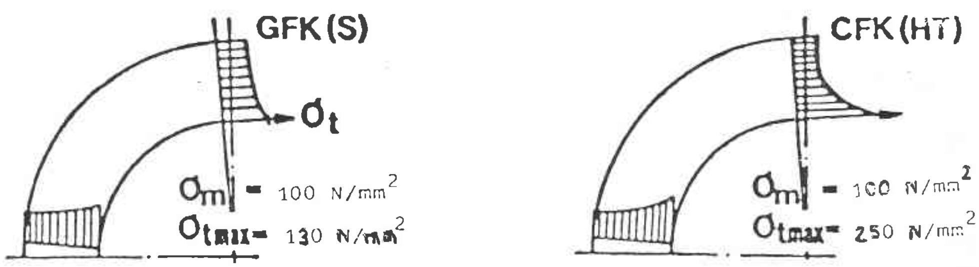


Figure 7 [Strand geometry same for both sketches]