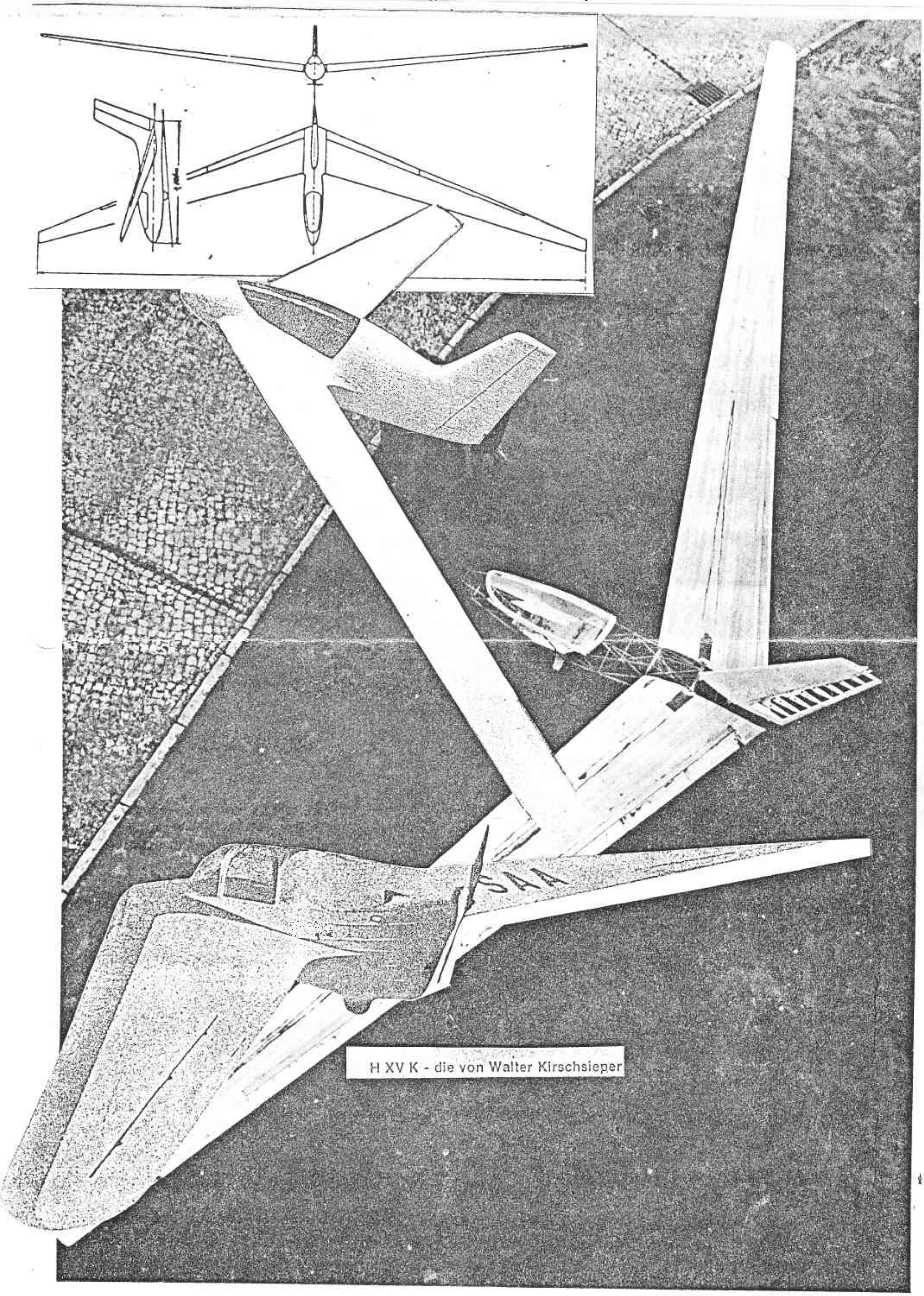
TWITT Newsletter No.1, June 1986



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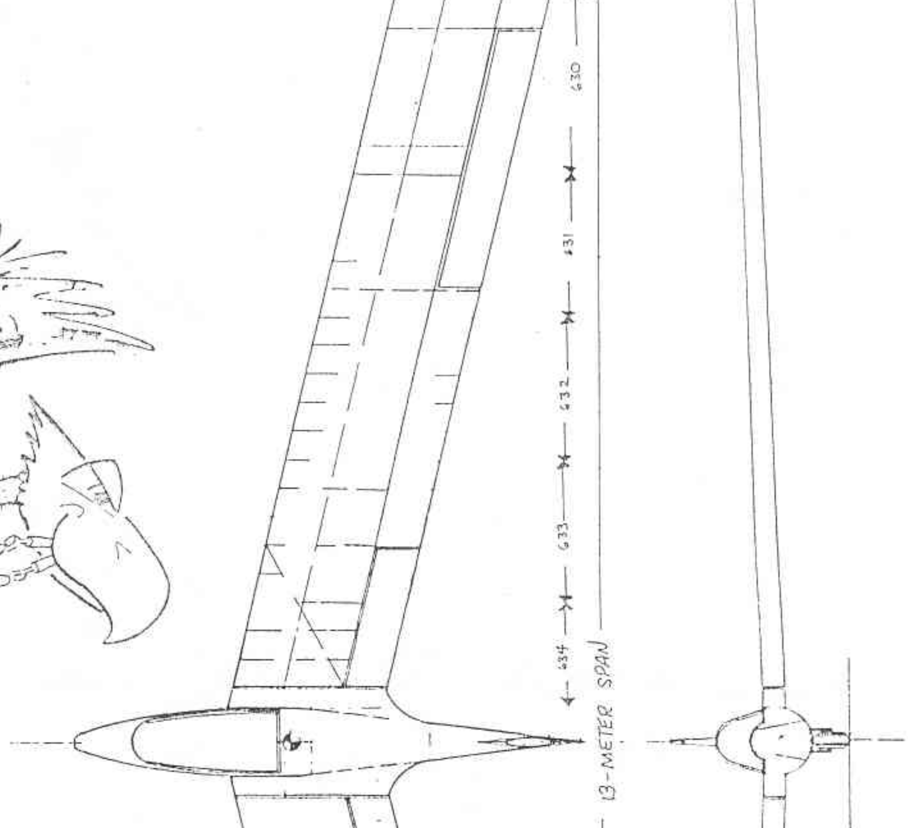
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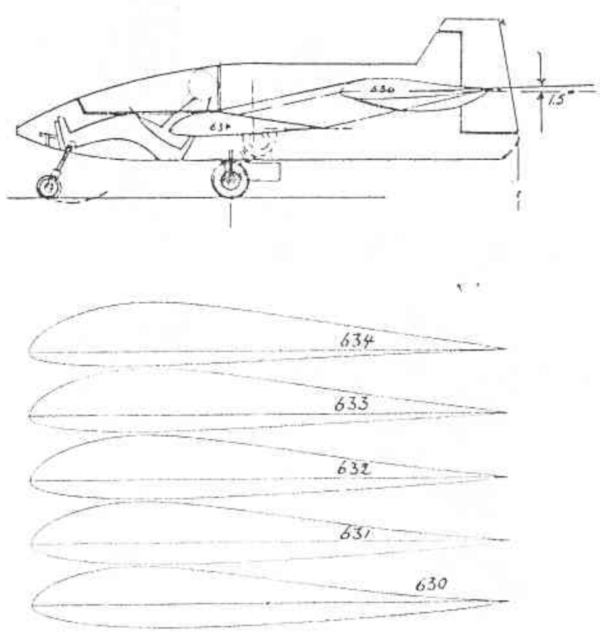
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SCHWALBE II.

Richard Miller
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6/22/86

The Wing is the Thing

The meeting convened in the Fronanski Hangar (thanks, Ed, I needed that) at Gillespie Field this 14th of June did not begin, as intended, at 1:00 p.m. It did not begin until almost 2:30 P.M. because some of the participants had dawdled on their way and lost track of the time. They know who they are. Bob Fronius, on whose invitation folks had gathered, had a couple of tables and a dozen chairs set up in the southwest corner of the hangar, almost under the wing of the Beech Duke. On the west wall, behind the speaker's position, was a board to sketch on and, on a table near by, colored pens to sketch with. It was a comfortable and appropriate setting in which to discuss the days topic: an all-out attack on the problem of designing and building a flying wing.

Robert Fronius, to begin, did these things. He welcomed the participants. He passed out a 5-page contribution by Francois Marc de Piolenc. He said some kind words about the flying wing and Mentioned that there are currently more flying-wing gliders in use than those of conventional configuration. He spoke of his early years in aviation, his contributions to the science, the help he gave the Wrights when they were struggling bicycle mechanics. Stuff like that. He said that everyone present would have a record of the day's events in a newsletter that would appear soon. Then he elected Richard Miller as recording secretary of the meeting and, by extension, newsletter editor. Richard derived limited amusement from this assignment. He knows that he probably appears to others as the kind of person who doesn't have much to keep him busy. In fact, the backlog of his work - five books in progress, none of which he has had a chance to do serious work on in almost two years; an electronic-music workshop he is trying to assemble, but which is little more than some loose wires at the moment; several full-size glider designs he has been eager to build for more time than he cares to remember; model designs and articles he has in mind for the appropriate market as soon as he can clear time to get started on them; plus the work he is obliged to do just to try to keep abreast of last week - is such that he dreams, at times, of cloning himself into the number of individuals required to make some kind of beginning into this mass of unresolved work. Well, he'd do it - this time.

That settled, the first order of business was self-introductions. These began, at Bob's right hand, with Harald Buettner. He had, he said, been a model builder since he was very young. He had worked in Germany as a fiberglass tooler and mold maker and was now employed in the fabrication of drone wings and fuselages. He said that he felt fiberglass was his life's work and that his experience was available to the group. Don Webb identified himself as a hang-glider and sailplane pilot, spoke of his interest in all things that fly, and said that he is an employee of a company that makes auxilliary jet engines. Francois Marc de Piolenc (who was thoughtful enough to give the recording secretary his card) is, like Don, interested in all phases of flight and is carring through with an education as an aeronautical engineer at UCSD. Pat Oliver has been around airplanes all his life and is a hand-glider pilot. He confesses he has much to learn.

Bruce Carmichael spoke of his time at the University of Michigan, his work on the Horton IVa with Gus Raspet at Mississippi State. He sounds the keynote of the meeting when he speaks of the dream of "the wing is the thing" then coming, by degrees, to terms with the difficult problems involved in realizing that dream. Floyd Fronius stated he has been in aviation all his life, first as a model builder, then as a hang-glider pilot and builder of light aircraft. He has a small workshop where parts could be made. Hernan Posnanski says not much more than a few words about his engineering background and a few words about the active control system which would be his principal contribution to the project and a crucial part of It. Ed Lockhard has been in aviation all his life, and a longer and fuller life it's been than most. He began with model building and went on to work for Stinson and Tucker, among many others. He was WWII pilot, has been involved in auto racing, has owned five airplanes including one with a nosewheel and a rotating beacon. (Does this man have a problem?) Richard Miller said he was an aviation person, like the rest. That when the curtain went up on his life he was gluing some little sticks together to make a Fokker D-7. When, in the late 40s, he edited "Hot Air" (the newsletter of the Ames Soaring Club) he had written a glowing testimonial to the flying wing. He adds that he has something to say about diffusor tips and their applicability to flying wings and will probably jump up at the first apportunity to say it. Ralph Wilcox, who slipped in late, states only that he has been active on the field for 25 years. Robert Fronius assumes we'll know all about him because...well, because there he is. Of course we don't.

During all this the recording secretary sometimes occupies himself more with listening than with recording. He is sure he's gotten some points wrong and missed others completely. Each individual, he realizes, merits at least a full page of copy, and the few details he has managed to set down are subject to revision, and amendment.

A little lull followed the introductions and into this, the recording secretary lept, true to his word, to give a bare-bones outline of the configuration and dynamics of the continuously-variable diffusor tip. He does this because of his conviction that proper wing-tip design could mean the difference between the success and failure of the wing project.

Following this Bruce went to the board. In response to his request for a set of performance figures to begin with he gets, from Bob Fronius an L/D of 40, which is not surprise, and a minimum sink rate of 1.1 ft./sec., which raises at least one set of eyebrows. A general discussion of parameters, proportions and dimensions follows. Hernan talks about performance, working down from a section L/D of 200 to a real-world figure of, perhaps, 50. This with a span of 18-20 meter There follows a discussion of the pilot position, the prone and the supine, the advantages and disadvantages of each. After Bruce sat down Hernan spoke about the active control system which, it is hoped, will solve otherwise insoluable problems of stability and control. He said that he was in favor of using existing airframes, such as "The White Knight" (Ka.Bi.Vo.) for testing such a system than a brand-new, expensive prototype. The point is made that a glider eqipped with such a system must be able to function in a fail-safe, stable mode.

A spate of general comments followed: Marc said that he was certain that the group could do better than Horton had done. Don Webb suggested using gas expulsion for control. Harald Buettner spoke of a central hinge and variable sweep. Hernan talked more about planforms and lift distribution. The recording secretary got the subject of wing tips activated again and drew out Ralph Wilcox who now gave some account of his work with various tip configurations. A general discussion on this topic followed until break time. This, roughly, was the half hour between 4:15 and 4:45. When the meeting resumed Don Webb spoke of the small engines with which he is involved and the possibility of getting one, on loan, for experimental purposes. These engines are small, light, and have reasonable fuel consumption. They are, however, very noisy. Hernan spoke of his experience with small jet engines in Europe - the powered Diamant, the two-seat Prometheus. He and Bob showed off the engine pod for "The White Knight" and the Hoffmann feathering prop. All this related to self launching.

It had grown late. Bob asked Bruce to give a summary. Bruce did so. He said that we had discussed various aspect of s high-performance flying wing and that the discussion had pointed up the nature of the difficulties to be overcome in undertaking to design and build one. He said that we had gotten off the subject, into the area of wing-tip design, but that he trusted Bob to get us back on the track. Bob finished with a summary of his own, a statement of what he and Hernan hoped to do. He said that he wanted a commitment to the ideal and, within a month or two, to the first steps in construction. He said that he thought it might be possible to get outside financing but that he preferred that the project be financed by the participants.

Work space, he said, is required. He welcomes any contribution and expresses his thanks to those who attended the meeting. There are reciprocal thanks to Bob for bringing us together. End of meeting. (5:10)

The recording secretary, as each one certainly did, went away with his impressions of the meeting and his assessment of the practicality of the proposed project. for the moment, however, these were secondary to the sense of gratiication he experienced from having been thrust into association with such a fine bunch of people as he had met that afternoon. He hoped that there would be other afternoons when he could get to know at least some of them more intimately. Then it was time to go. Floyd has a gig that evening, and Floyd was his ride home.

Richard Miller took home with him, along with his strong feelings about the group at the design conference, a reprint from "Aircraft Engineering" for Sept. 1945 - "Wing Tips for Tailless Aeroplanes" by A. R. Weyl (borrowed from Marc) - and he was barely in the door before he plopped down on the bed and began to read it. He had gone throught all the Weyl material, he thought, years before at Bruce's, but he didn't remember this. Here was the information about the origins of raked tips and diffusor elements that he had been looking for such a long time. It was precisely what he should have had at his fingertips when he got up to talk to the group. It was also what he needed to write a summary article on the subject, incorporating other material of a similar nature and including his own experience which included building dozens of diffusor-tip models and one man-carrying wing with a continuously-variable diffusor tip. That, he realized, would take some weeks of work, and he didn't have any spare weeks of work. The best he could manage at the moment, he realized, was rough paste-up job, with some notes. It would have to start with some kind of expression of indignation (it does) and go on in a more reasoned manner (it does). If either of the indignation of the reason got anyone's attention that person could dig out the original material, from Bruce, from Marc, from the Aerospace Library, and carry on from there.

What's going on here? Is anybody listening? Why, given the very sound case for the use of raked and diffusor tips, material dating back to before the first World War, have three generations of a'craft designers gone on drawing pretty ellipses? When you see Richard running around with his arms in the air and looking like he's ready to throw plates, you can take it for granted he may be exercised about this kind of willful ignorance, although there are other absurdities of human conduct that clamor for his attention. Why are people who, one would think, should know better, straining at performance gnats - 1% here, .05 there - while gains of perhaps 5 or 10 or 15% go unattended at the wing tips?

So much for indignation. Now to the voice of reason. I have extracted about 4,000 words from the Weyl article and with the exception of the shifting of one small snippet it appears here in the same sequence as it does in the 1945 original in "Aircraft Engineering." The material I have chosen emphasizes, but does not in any way exaggerrate the points I wish to make. The comments below follow the general order of the Weyl article: (1) Jedelsky tested two model wings years ago using a common fuselage-empennage combination in his experiments. The l.e. of one wing swept back to the t.e. (positive rake) and the t.e. of the second swept forward to the l.e. The per formance of the wing with positive rake was about 10% better than that of the other. (2) Mervyn O'Gorman did a lot of good things too, and it's hardly fair to lay the entire responsibility for those pretty elliptical tips at his doorstep. Perhaps he set a precedent, but even that is in doubt. The fact is that it's difficult to build so-called reverse ellipses and non-planar flying surfaces using standard construction and with the main spar in the forward half of the wi I'm working on such a wing now and it's a bother. Were it a simple constant-chord/surface such as, say a Starduster wing, I would have it covered by now instead of half way framed up. When the bother gets too great you abandon functional considerations in favor of easy struc tural solutions. The availability of composite structures seems to be shifting things more in favor of function. (3) A chap by the name of Holbrook did some experimental work, including wind-tunnel testing, on a small (30" span) diffusor-tip model at Mississippi State University back in the 50s. He got some very attractive figures. The paper has lain largely neglected since then. There is a copy in Bruce's file, available at the airport. (4) I had not really given much thought to spanwise flow aa a concommitant to tip losses, nor to the gains that might result from straightening the flow, but there it is. (5) Wouldn't it be fun to build an up-to-date Weltensegler. (6) I have checked the planviews of the Northrop flying wings and in no case have I found any convergence of the (wing) fold angle with the plane of symmetry of the aircraft.

To sum up; There are gains to be obtained from the use of positive rake and gains to be obtained from the use of diffusor tips.

There are sound theoretical bases for such gains. The wing tips of birds give us examples of such tips. The configurations have been measured by responsible individuals working in Establishment facilities and have been documented in accordance with standards generally found acceptable by aerodynamicists and aeronautical engineers. They have been used with conspicuous success on models and on full-scale aircraft. Why they continue to be ignored by the majority of aircraft designers is a fact that is difficult to account for. I bring them to your attention.

Sept. 16, 1987

Dear John McMasters, Boeing Aircraft Company;

Irv Culver, who will speak to the TWITT group October 18th, suggested sending you a copy of our publication. This is the first issue--number three will be mailed this week.

We have all of Bruce Carmichael's flying wing file. We have articles from Tasso Proppe, Al Backstrom, Reimer Horton, Irv Culver. We do have copy ready material for several issues, but we could use more. Can you contribute?

We have nine aircraft in two hangars on Gillispie Field in El Cajon, Ca. A Baby Bowlus, LK 10, Lil Dogie (Screaming Weiner), White Knight (the prototype Diamant), a 19.5 meter Diamant, a MacCready Mojave Gossamer prototype, the prototype PL-4, a Stinson 108-3, and a Beech Duke. Three gliders are flying. Also the Stinson; the Duke is up for an annual. The others are in work.

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Introduction

THE study of the flight of birds has provided and will still provide much valuable information for the progress of human flight. Many suggestions for the improvements of wings by the use of special wing tips owe their existence to the observation of nature. In spite of such suggestions, free-flight experimentation —as far as published work goes—is still rather rare and restricted in scope. This reluctance may be due to practical design considerations (handling) as well as to the necessity of making the conventional aileron as efficient as possible; it may also be caused by the impression that experiment in this direction is not worth the effort.

Admittedly, for a conventional aeroplane of mediocre aerodynamic efficiency, not much can be hoped for in the way of improvement by the adoption of a special wing tip. But when it comes to a struggle for the last ounce of aerodynamic efficiency, nature can be made to concede to us: research along the lines indicated may well become a paying proposition. This is especially the case with the Flying Wing where, moreover, the demands for stability and controllability are apt to interfere seriously with the aerodynamic performance and the practical adaptability.

The conventional aileron is also greatly to blame for the reluctance to shape the tips of a wing in a more efficient manner. The history of the plain wing with positively raked tips (i.e., leading edge shorter than the trailing edge) provides a good example of this.

Importance of Tip Shape

E. W. Lanchester very early recommended such raked tips for higher efficiency as they were able to suppress or delay the pressure equalization at the ends of the wing. A wind-tunnel investigation made by O. Foeppl in 1910[9] on the basis of Lanchester's recommendations in fact proved beyond doubt that positive rake gave either higher lift (at equal incidence) or better lift/drag ratios up to moderate incidences, in comparison with square or rounded wing tips, and that this holds particularly well for cambered aerofoil sections. Saenger's experiments, to which further reference is made later, also confirm this result. N. A. V. Piercy found[1] that with suitably shaped raked tips (Alula type), cored vortices were not present in the downwash at incidences of normal flight, and that this meant a direct saving of drag of the order of 10 per cent and more.

The influence of wing-tip shape on stability is also of importance. Lanchester suggested in 1910 that square wing tips would be of great benefit for the lateral stability although by this expedient, an increase of drag would result (~~cf. R. & M. 59 of 1911, p. 193~~). It is experimentally established to-day, that square tips indeed improve the roll-damping at and near the stall, and since in 1910, aeroplanes flew usually very near the stall, Lanchester's suggestion was a very sound one, besides proving how far in advance of his time his aerodynamical insight must have been in those days. Mervyn O'Gorman, then Superintendent of the R.A.F. at Farnborough, did not follow Lanchester's suggestion, for the reason that "Nature had provided no bird with square wing tips". Thus the modern elliptical wing tip was created at Farnborough.

Superficially, the ordinary diffuser tip has much in common with the gull wing, i.e. with a wing having anhedral in its outer portion, while the inner portion has positive dihedral. Gull wings of this kind have, for aerodynamic reasons, often been employed with high-performance sailplanes, while their adoption for aeroplanes is usually dictated by purely structural considerations.

In normal flight the air at the side of a lift-generating wing has an ascending component. Lanchester referred as early as 1907 to upcurrents which are generated beyond the tips due to the finite span of the wing; he also stated quite correctly that a flow of air around the wing tips from the under surface of the wing (positive-pressure region) to the upper surface (negative-pressure region) forms a sort of vortex fringe. Such equalization of pressure is a loss of energy expended for obtaining lift and a diminution of the lift which is theoretically available in two-dimensional flow.

Part of this "induced" drag can be avoided, i.e. wasted energy recovered, by the adding of appropriate wing tips. Lanchester who realized this, suggested his "capping planes"; he also recommended raking the wing tips so that the trailing edge of the wing becomes greater than its leading edge. Both devices are indeed effective but, for various reasons, are not practical.

In 1914, C. Wieselsberger calculated[2] the strength of the ascending component of the air beyond the wing tips on the basis of the horseshoe vortex system; he also proved the economy of flight in V-formation (which migrating birds had already found out many thousands of years ago), thus giving a clear indication that the energy recoverable from this ascending component is by no means negligible. [redacted]

The energy represented by such span-wise flow components is wasted. The flow deflexions caused by the pressure gradient on the wing surface result, for a given lift, in drag which is additional to the profile drag (caused by skin friction and form drag). This additional (induced) drag increases with the square of the lift:—

$$C_{D_i} = \frac{C_L^2 \cdot S}{\pi \cdot b^2}$$ (for elliptical lift distribution over the span)

Apart from this loss and judging solely on the evidence of wind-tunnel experiments, span-wise flow components appear rather insignificant for the aerodynamical characteristics of wings, except at incidences near the maximum lift and for wings having pronounced sweep-back. There are, however, reasons to suspect the general validity of this common and convenient conclusion. Aerodynamicists agree that wind-tunnels tend to interfere with the three-dimensional flow of the boundary layer at wings of finite span.

Wings at which span-wise flow components are impeded, for instance by rib webs protruding from the wing surface (e.g., the Kon. E. HI monoplane of Rethel) have proved outstanding flying qualities which might have had their cause in a fuller lift distribution and in decreased induced drag. Span-wise flow com-

It is logical to apply the same principle to span-wise flow components on aeroplane wings. *A priori*, it would seem possible to derive from this wasted flow energy, forces and moments which are beneficial to stability, trim or control. Also it might be conceivable by conduction or restriction of span-wise flow to delay stalling phenomena near the tips. Both these possibilities lead to the consideration of diffuser wing tips.

The observation of soaring birds shows that their wings assume an attitude with downwards tilted tips. Moreover, these wing tips seem to be the main device by which control and trim are effected during the soaring. E. J. Marey, in about 1880, appears to have been the first to try the effect of such tips on paper gliders. K. Steiger-Kirchhofer to whom we have already referred, also came from the observation of soaring gulls to the conception of diffuser tips. J. W. Dunne arriving at the same solution, emphasized the yawing stability secured by this device and made the first successful full-scale application. Another full-scale application was made by Horatio Barber on his Valkyrie tail-first monoplanes in 1910; it remained an experimental feature.

Wald. Geest, the German experimenter, derived his diffuser-wing shape also from studies on bird flight. He arrived at the importance of this shape for tailless aeroplanes in 1906 by noticing a gull flying merrily with the tail feathers removed. He secured in 1907 patents for a wing the surface of which was bent from inward to the tips with simultaneous twist so that the inner part had positive and the outer part negative incidence. A variation of the aerofoil sections along the span was also provided. Conventional aeroplanes provided with this diffuser wing built and tested before 1914 gave very promising performances, and if their difficulties in construction (bent and twisted spars), rigging and transport could have been overcome, the Geest wing would not only have been in extensive practical use, but would have given cause for a thorough study of the diffuser wing tip.

A theory of the "negative wing tip" considering the stability in horizontal gust on the basis of Bryan's method, was put forward by J. H. Hume-Rothery. According to this investigation, the "negative" tip makes the rolling and yawing stability quite independent of each other. Hume-Rothery realized that tilted-down tips must be compensated for because of their anhedral effect, by some dihedral in the main part of the wing. F. Wenk's original patent of 1919 (Lit. 77) contained all characteristic features of the diffuser tip, though an explanation of its action was not offered. From this the Weltensegler tailless airplane was derived.

L. Bréguet tried to prove, in 1925, that the M-shape of the wings of soaring birds (seen from the front), is essential for the exploitation of horizontal pulsations of the wing, in dynamic soaring. Without the gull shape, he maintained, the internal energy of the wind cannot be utilized. . Budig also recommended the *M*-shape of wings (in front view) and of wing-like parts. In a side-slip, with wing tips of this shape, in Budig's view, the leading tip will not only be free from separation of the flow, i.e. from loss of lift due to stalling, but will, on the contrary, experience higher lift and diminished drag. Thus a stabilizing effect takes place.

Anhedral of the wing system caused by a diffuser tip needs consideration, since it has often been the predominant feature. Dihedral gives static stability in roll (L_v, rolling due to side-slip). Anhedral of the tips seems to imply a tendency for the wing to "dig in" when side-slipping. Thus the advantage of purely tilted-down tips is by no means obvious. For gull wings, the moderating influence of the wing bend on the effective dihedral can be calculated. A closer investigation, however, indicates that the contribution to the stability in roll by tilted-down wing tips is not quite so straightforward to assess. Effects of oblique air flow will influence the aerodynamic forces in side-slips; thus one partial effect of side-slip may well cancel the other with the result that—in spite of apparent anhedral—the stability in roll is not markedly deteriorated by tilted-down tips, especially in a wing having effective sweep-back.

Moreover, with birds, the wing tips are not simply tilted downwards. The axis of curvature of the plane of the wings is not in the direction of flight, but intersects the plane of symmetry of the wing in front of the leading edge. J. W. Dunne was probably the first to realise this; he incorporated this oblique tilt in his "negative wing tips". Also, it does not seem to have escaped Steiger's attention, and it forms the principle of the Geest wing.

Characteristics of Diffuser Tips

Diffuser-type tips are thus not simply tilted-down tips; their characteristics are

(*a*) deflexion of the plane of the wing tip against the plane of the wing, in combination with:—

(*b*) axis of the deflexion of the plane of the wing tip arranged under such an angle to the plane of symmetry of the aeroplane that the two axes of deflexion of both tips intersect forward of the leading edge of the wing. This results in a twisting distortion of the wing at the tip.

In general, model experience indicates, that diffuser tips tend to keep an aeroplane on its original course, i.e. that the weathercock stability is either zero or very small, while a Zanonia type wing tends to turn against the relative wind. It was stated that Northrop had to reduce the tilt of his diffuser tips, because the weathercock stability in flight had become excessive, in comparison to model experiments.

When discussing the longitudinal stability of isolated wing systems*, we found that the damping in pitch ($\frac{\partial M}{\partial \alpha}$) made the main difference in the flying qualities of the tailless aeroplane, as compared with conventional types. We then pointed out that any improvement of the aerodynamic damping would be beneficial for the problem of the flying wing. The diffuser wing tip might bring about such an improvement. It would seem that the span-wise flow component induced by this device is tending to increase the mass of air which will be set in motion by a pitching oscillation of the wing. Admittedly, this effect may also express itself as an apparent increase in the moment of inertia about the lateral axis**. But if the diffuser tip itself is considered, it would appear obvious that, in pitch, its air damping qualities will differ greatly when the angle of incidence of the wing is increased to that when it is decreased. This unilateral damping assisted by the air flow at the tip and unaffected by the phenomena of unsteady lift permit one to suppose that the diffuser tip will be beneficial for the aerodynamic damping in pitch.

Due to its inherent wash-out, the diffuser tip also influences the static longitudinal stability; in the extreme case, it is possible to render any, in itself unstable wing into a longitudinally stable system by fitting appropriate diffuser tips.

From this it is evident that a diffuser tip exerts a profound bearing on the stability qualities of an isolated wing system, and that this influence is far greater than that which can be expected from an equivalent ordinary wash-out or anhedral. It can therefore be assumed that it forms an excellent device for tailless aeroplanes and flying wings, and its adoption at modern Northrop tailless aeroplanes is evidence that designers begin to awake to this fact.

Suitability of Diffuser Tips

With every stability device two main aspects deciding adoption present themselves to the designer: the effect on performance and the structural implications. For the diffuser tip, the structural disadvantages are obviously those that to a purely lift-generating wing, tips are added which do not conform to the plain constructional lines of this wing and which may be subject to considerable forces and moments of their own. Compared with wing-tip disks, such structural disadvantages do not seem great; moreover, parts of diffuser tips may well replace control surfaces or trimming tabs otherwise necessary, so that it will on the whole be reasonable to assume that for tailless aeroplanes, from the structural point of view, the designer might well favour the device.

Aerodynamically, the diffuser tip is, of course, an element which by itself causes drag and, in the general case, also down-lift. But since it can take the place of wing-tip disks (fins and rudders) and also that of wing twist (as required for longitudinal stability), the deficiency in performance caused by it, can be considered to be tolerable. Beyond this, however, the diffuser tip could even become superior in performance to all other devices applicable to isolated wing systems. The utilization of span-wise flow components may well permit the achievement of stability and trim without the expense of additional drag.

Nearly all discoverers and experimenters of diffuser wing tips have also employed the tips for control purposes and/or trim: Dunne fitted curved controllers to both wing and tip; Schul suggested that control devices are best fitted to the ends of his "hollow cones"; Kupper attached not only controllers but splitting air-brake rudders to the diffuser tips of the tailless MU.5 sailplane; Huettmann employed tilting of the entire tip for control; Northrop used the same idea, but employed in addition controllers fitted to the wing tip.

One of the greatest advantages of diffuser tips for stability and control is that they will not be fundamentally affected by the stall of the lift-generating part of the wing. Though it has yet to be established if and how far a complete separation of flow at great incidences can be delayed by the effect of a diffuser tip, it seems fairly obvious that control by way of such tips will have an advantage by remaining less impaired at and beyond the stall of the aeroplane.

It will also seem that the diffuser tip is not only an interesting subject to explore for aerodynamical research, but a device which is of so much promise for practical application that it deserves more interest and study than it has received in the past.

Notes

Plans for the Horton HXVK are now in the National Soaring Museum. Hernan Posnansky received them from Walter Kirschsieper, Who was Hernan's flight instructor in Switzerland. The Wing, powered by a 65 H.P. Continental first few in 1959. Marc de Piolenc helped catalog the plans engineering papers and notes. The ship is pictured on page 186 of Nurflugel.

Flexible material additive for softening any painted surface, particularly fabric, is available at professional paint supply stories. The material is "Super Sem Flex," and can be used with acrylic lacquers, acrylic enamels and urethanes.

John Selig flew his LP-49 at Warners. Interested helpers were his wife , June Wiberg, Jerry Pekin, Jack Haister and Bob Fronius, The champagne flowed. Laister

UHMPE is ultra high molecular polyethylene that can be mechanically fastened as a sailplane skid or machined into wheels (small).

The next meeting of the TWITT group will be in July in the same hangar. Date will be announced.