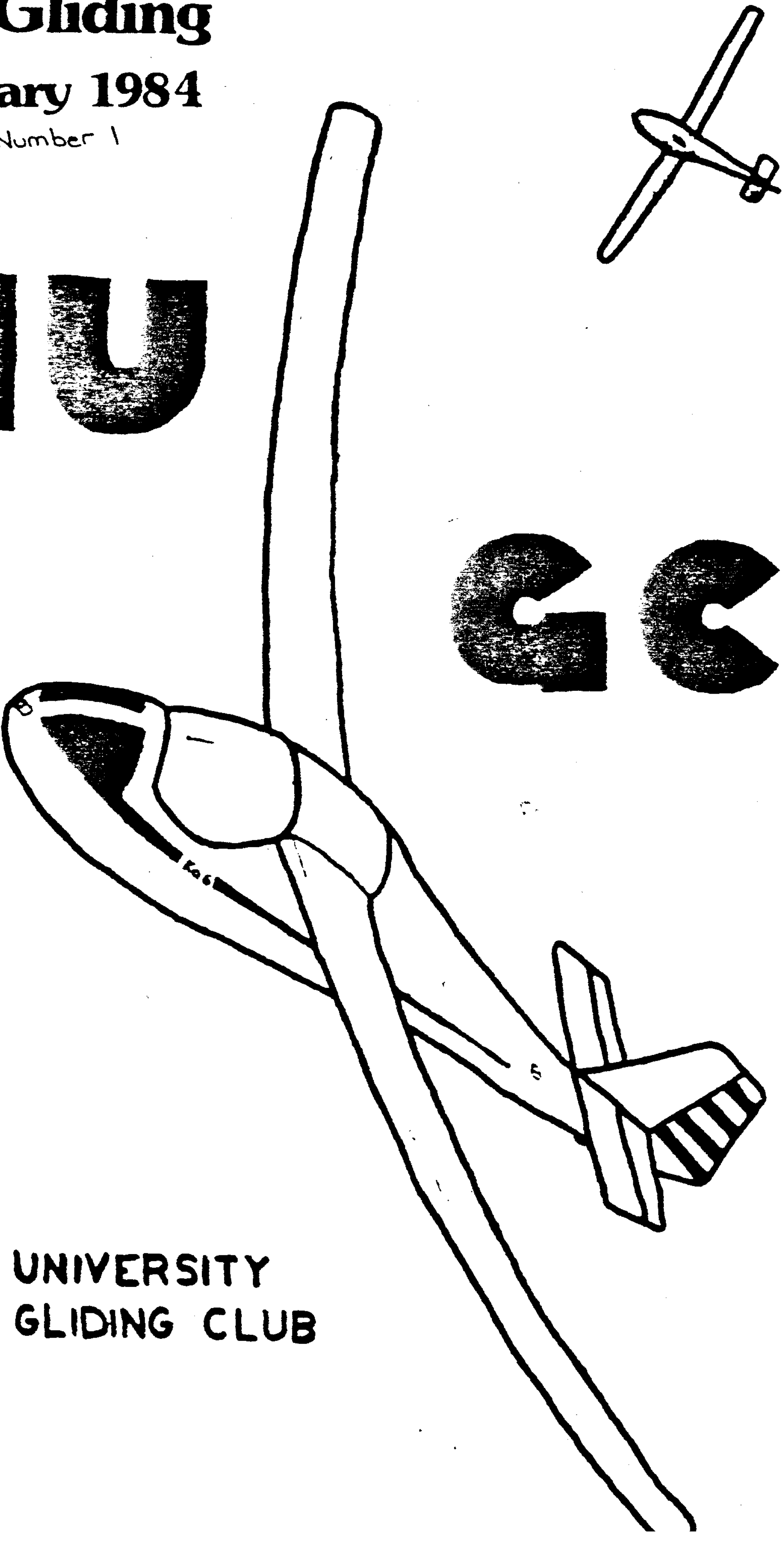
Uni Gliding

February 1984

Volume 9 Number 1

AU GC



ADELAIDE UNIVERSITY
GLIDING CLUB

EDITORIAL !!

Welcome to a bright new year of gliding: a year that has already started off well, with two out of three of our aircraft, and both our two seaters, out of action. Our C.F.I. is digging up pots in Thailand till November, and half of the other instructors are not available, with such weak excuses as 'I'm getting married', etc. Meanwhile, our treasurer is in Sydney, our airworthiness officer, having given up on the club aircraft, and forced club members to work their fingers to the bone polishing Foka wings for days on end, has taken his Foka to Ararat, our secretary has run off with the C.F.I.'s daughter, half the solo pilots in the club are working for petroleum companies about 3,000 miles past the Black Stump, and, worst of all, your beloved newsletter editor missed an issue! (My excuse is that I'm working at Salisbury and can't get to the Uni. during office hours.).

On the brighter side of life, we haven't all been killed in a nuclear holocaust yet.

But seriously, folks, things aren't really as bad as they may sound. I had a cartoon sent to me for publication, and a joke . The joke however, was a bit on the rough side (sorry, Guy) so I left it out (who thinks up jokes like that, anyway?).

Now, out with the big stick again: I was looking through some old (pre 1978) newsletters the other day, and, believe it or not, they were full of interesting articles, drawings, cartoons, poems, reports, stories, etc.! The club is now much bigger, with more gliders, more members, nearly as much money, and some flying, so we ought at least be able to manage <u>something</u>. (Sorry, I meant to say 'something more than a cartoon from one person.'). Especially now that we don't have to publish Don's cartoons any more. So... out with the pens and paper, and make this newsletter ~~a true reflection of the A.U.G.C.~~ interesting to read.

Andrew.

HELP WANTED

We need members to help out during O-week desperately. If you can spare some time before getting down to study and would like to do something for the club, why not sit at the desk for a few hours? Contact our president, Dick Temple, on 390 1827 if you can help.

Minutes of An Adelaide University Cliding Club
Executive Meeting
Held on 23rd November, 1983 at the CFI's
residence, Vale Park

Present: D. Temple (President), D. Medlow (Secretary), R. Norman (Treasurer), A. McGrath, M. Forster (Airworthyness), D. Hein (CFI).

Visitors: A. Sawyer, T. Nemith, G. Harley, R. Quinn.

Apologies: B. Giles.

1. MINUTES of Previous Meeting

The committee noted the minutes of meetings EM11/83 and 10/83.

RES.1 THAT the minutes of the previous meeting be accepted as a true and correct record.

A. McGrath/D. Temple
carried

2. MATTERS REFERRED TO CFI

The CFI stated that the airworthyness inspector status of Mr. Giles unsure and that GFA had required further experience from him. The Executive noted that the club will probably be allocated 2 places on next CofA course. The Executive urged that 5 places be made availab with priority being given to A. Sawyer, K. Frost, B. Giles and other interested members of the club.

The CFI reported that outside instructors can be introduced to the c providing that they have visited the club at least twice before as a visitor, have been introduced to the instructor's panel and then app by the panel. The CFI said that Mr. Giles would have to attend anot instructor's course before being able to instruct.

The CFI reported that the question of non-instructors flying passeng had not been resolved by GFA. Mr. Harley has not seen the GFA circu and will write to the insurance company to clarify the matter.

3. REPORTS

President's: The President reported that he had contacted Mr. Harley insurance matters but has been unable to talk to the farmer re the outlanding incident during the Whyalla visit.

Treasurer's: The Report was distributed to members (copy attached to copy of minutes). The Treasurer explained that $1,000 had been allo to cover the Ka6 for $1 million liability. The Treasurer did not pr any recommendations as to fee increases for '84. Mr. Quinn recommen a fee of 10¢/minute and $1.50/launch. The Treasurer said the Univer pays $2,000 towards insurance cover and rebates from the insurance comapnies can be obtained if dates and times of non-flying periods a supplied.

CFI's: The CFI stated that no flying was occurring due to lack of airworthy aircraft but a calendar was circulated that covered the pe up to the end of the year (including the planned summer camp). The gave no recommendation as to the position of CFI for next year. The President is to contact Bob McDonald re use of Shearer's Quarters fo camp and maintenance on the site that the club can perform.

Airworthyness: Mr. Forster reported that the Ka6 was flying, the For is to be completed and sent in by the Secretary. The Berg Falke CofA proceeding but is hampered by lack of helpers, the aircraft must go Schneiders for wing root inspection. The trailer is currently at R. Quinns with the lamp pole on it.

CFI Report: There were two nominations for the position of Chairman of the Instructor's Panel, viz. Mr. G. Harley and Mr. T. Nemith, there was one nomination for Secretary of the pa viz. Mr. R. Quinn. The result will be available to the next Executive meeting but must still be ratified by the Executive a the RTO/Ops. SA.

Airworthyness: Mr. Forster reported that the Bocian was in the trailer at Lochiel. The left Ka6 rudder pedal was broken and m be repaired before the next flight. The Berg Falke skid is bro and the control cirucit is damaged with some tubes needing to b rewelded, the skid has been repaired. A heaving landing inspec will need to be carried out.

Mr. Giles suggested an alteration to the skid to avoid recurrin damage. If the aircraft is placed back in service as a trainin aircraft then instructors should only be allowed to land it.

Mr. Forster estimated $200-$300 would be required to complete tl Berg Falke repairs.

The Executive noted that the Berg Falke would be quicker to ret to service than the Bocian, so the Berg Falke will come back to Adelaide for repair and inspection by M. Forester next week.

4. GENERAL BUSINESS

Winch: The Executive noted the lack of a port side winch arm.

RES.4 THAT the Executive approach K. Frost to replace the broken wincl and that he be authorised to purchase any required material at a reasonable cost.

D. Medlow/D. Tample
carried

It was noted that Don Hein already has some of the necessary material.

Petrol: A. McGrath to contact the Bute petrol suppliers to orde winch fuel up to $150.

Next General Meeting: Is due on 1st February, 1984, possibly at Don Hein's shed to avoid Union overtime charges, the video of tl Whyalla visit is to be show, advice to members to be sent in the next newsletter.

O'week 1984

RES.5 THAT the Ka6 be utilised as part of the club display on lawn fo O'week '84.

D. Medlow/D. Temple
carried

Dick Temple volunteered to organise rosters and paperwork. A ca for volunteers is to go into the next newsletter.

Next Executive Meeting: On 18th January, 1984 at A. McGrath's residence.

Flying Rates: A short discussion on flying rates occurred and tl following motion passed:

RES.6 THAT flying rates as of 1/2/84 be as follows -

Members	10¢/minute	$1.50 launch
Visitors	15¢/minute	$2.00 launch

with no special passenger rates. Club joining fee $5.

D. Medlow/D. Temple

ADELAIDE UNIVERSITY GLIDING CLUB INCORPORATED

Special Note to all members

From: Secretary February 1984

Your attention is drawn to the date of the ANNUAL GENERAL MEETING of the Adelaide University Gliding Club, to be held on 4th April, 1984 at 7.30 p.m., in the North Dining Room, Level 4, Union House, Adelaide University.

The business of the meeting shall be:

(1) To confirm the Minutes of the previous A.G.M.

(2) To receive reports from the Executive.

(3) To elect members of the Executive for 1984/85.

(4) To elect all other officers of the Club with the exception of the Chairman of the Instructors Panel.

(5) To transact any other business that the meeting is competant to consider.

Full agenda and minute papers will be issued in due course and in any case before 4th March, 1984.

Further items for the agenda MUST reach the Secretary before the 2nd April, 1984.

D.P. Medlow
Secretary AUGC

NEXT GENERAL MEETING

The next general meeting will be held at Don's Shed (NOT the Jerry Portus room). Although Don is away in Thailand, the meeting is being held in his shed (at 1 Yandra St., Vale Pk.) because we have to pay the Union for use of the usual room during the holidays. The meeting starts at the usual time of 7:30 p.m. and refreshments will be provided. Maybe this time we'll get to see the video tape made on field some months ago when the Barossa Valley Club visited Lochiel.

(P.S.- bring your own chair, if you can. If you can't, there will be a few spares anyway.)

WHOOPS! I NEARLY FORGOT — WEDNESDAY, 1ST. FEB.

ADELAIDE UNIVERSITY GLIDING CLUB

NOTICE TO ALL PILOTS

As of 1st February 1984 the following schedule of rates will apply for club activities:

Club membership fee	$5
Flying rates in Club aircraft	
Club members	10¢/minute
Visiting Pilots	15¢/minute

Note: Visiting pilots MUST be members of GFA and CANNOT fly solo unless check flown and converted by a QUALIFIED FLYING INSTRUCTOR.

Launch Rates:	
Club members	$1.50
Visiting Pilots	$2.00

Non-Club members must pay all costs the same day they are incurred. Club members may elect to have fees charged to their account.

Passengers fly as visiting pilots.

*Note only members of the A.U. Sports Association can join AUGC.

D.P. MEDLOW
AUGC SECRETARY

8th January, 1984

MEANWHILE... IN THAILAND...

WHO IS 'OLD BALDY'? STAY TUNED...

Minutes of the meeting of the Executive of the Adelaide University Glinding Club Inc. On the 22nd December, 1983 at 8.00 p.m. at the Secretary's residence, St. Peters — EM13/83

Present: D. Temple (President), D. Medlow (Secretary), A. McGrath (A/g Treasurer), B. Giles, M. Forster (Airworthyness).

Apologies: R. Norman (Treasurer), D. Hein (CFI).

1. MINUTES of Previous Meetings

The minutes were read by the President, there were no amendments.

RES.1 THAT the Minutes of the previous meeting be accepted as a true ar correct record.

A. McGrath/D. Temple
carried

2. BUSINESS ARISING from the Minutes

The forthcoming C. of A. Inspector's course was discussed and the Secretary asked to write to RTO/Air.

RES.2 THAT the Secretary write to RTO/Air SA requesting 5 places for AU club members at the 1984 C. of A. course.

D. Temple/A. McGrath
carried

The Berg Falke (VH-GZM) went to E. Schneider for wing root inspection and commenced service. It is now out of service due t a broken skid and damaged fuselage. M. Forster has been enquirir re the availability of other Airworthyness Inspectors. The truck and automatic transmission have been purchased and are now at R. Norman's residence.

3. REPORTS

President: Reported that the new winch truck had been purchased f $1,550, it is a 1973 Toyota Dyna with approx. 90,000 miles. It w inspected by three club members before purchase. The automatic transmission has been collected.

He also reported that the Berg Falke has broken its skid again, a the Instructor's Panel will not nominate another CFI but instead chairman and secretary of the Instructor's Panel. The President confirmed that he will get the club report to the Sports Associat by the 23rd.

Secretary: The Secretary reported that the Bocian Form 2 and associated documents had been received from GFA. The CofA form f the Ka6 will be complted and sent off as soon as log book entries are available from the a/g treasurer. Official observer and "1" certificate forms have been placed in the radio lcoker at Lochiel

The Executive noted that the Secretary is returning officer for t Instructors Panel elections, results will be given to the Executi at the next Executive meeting (EM1/84).

The Secretary reported that Don Hein (LFI) would leave Australia 2/1/84.

Treasurer: Reported that there was $600 debit and $380 credit in members accounts, with $300 in operating account.

RES.3 THAT the Treasurer contact any member with more than $20 in debt.

D. Temple/D. Medlow
carried

The Bocian needs cabling, wing root repairs, tailplane and wing repairs, fabric and fuselage holes, main wheel, repairs to skid and canopy. The CofA can't start until February under Mark's supervisic Mark is to discuss with RTO/Air regarding what club can do beforehar Mark will also produce a job list for RTO/Air to cost out.

4. OTHER BUSINESS

Mr. Harley gave details of a Commonwealth Scheme for employing labou to complete clubhouse and hanger. Guy will work with R. Quinn to organise a submission.

D. Temple and D. Hein have been checking out possible winch trucks, one possible truck is being sold for $1,550. It was considered the best truck available.

RES.2 THAT the Executive authorise expenditure of $1,550 and registration a Dyna truck from Globle Truck Sales, Enfield.

A. McGrath/R. Norman
carried

The automatic transmission for the V8 needs to be collected, A. Sawy to liaise with R. Quinn to pick it up.

Next General Meeting: To be on 7th December, 1983, the club will hav to pay for use of the meeting room.

RES.3 THAT up to $11 be spent on the December meeting expenses.

D. Temple/A. McGrath

The Executive decided to leave the matter of a Christmas present fo Bob McDonald to the President's discretion.

The meeting closed at 10.30 p.m.

Signed as a true and correct record ....

date ....

Airborne scanners grounded

AFTER 6 months of operation the Monterey Park CA Police Department brought a grinding halt to its first-in-the-world police ultralight program. The final blow to ultralight patrol of the 7.7-sq-mile city came with a bang. The seventh engine failure since the trial program began last September, and the unorthodox forced landing which followed, permanently grounded the program.

Officer Rubin Echeverria was at the controls of his American Aerolite Eagle XL when he received a suspicious person call. He started to respond. But suddenly, at 1500 ft, the 35 hp Cuyuna snowmobile engine quit.

Echeverria attempted a restart which proved unsuccessful and then planned a forced landing. With only marginal sites available due to hilly terrain and numerous obstructions, the 30-hr pilot selected a park located directly behind the police station. Gust factors caused him to change his mind. The ultralight turned toward a schoolyard; rather than risk injury to the children playing, he landed on a roof nearby.

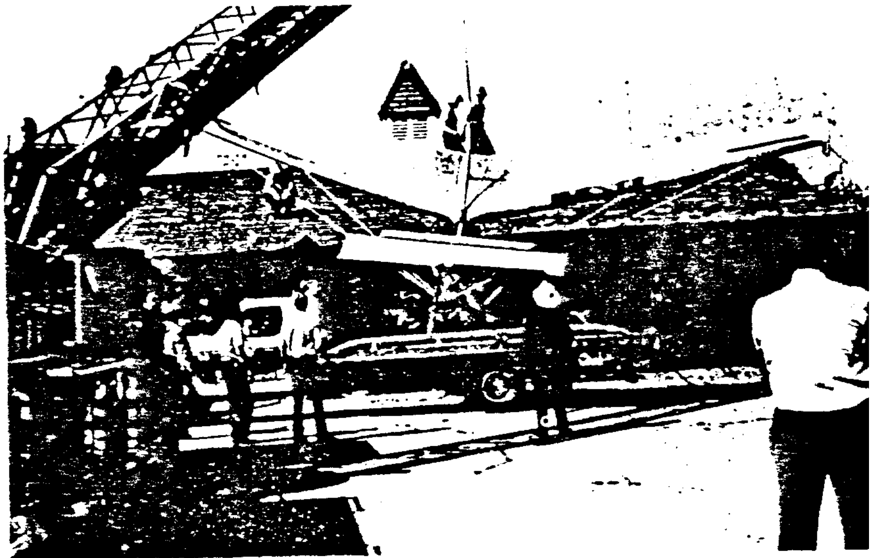
Damage was limited to seven cracked roof tiles, a slightly distorted undercarriage, a broken thumb and bent pride. Lt Joe Santoro stated, "No other aircraft could have made a landing like this doing as little damage."

Santoro, known in police circles as the father of law enforcement ultralights, created the Monterey Park program. After seeing a 10-yr-old boy fly an ultralight on "That's Incredible" he thought, "There might be an application for this in police work."

Despite the outcome of the Monterey Park experiment, Santoro is a firm believer in the ultralight patrol concept. "Our hilly terrain and lack of appropriate forced landing sites do not allow a viable program in this community. But the concept is good."

Santoro's confidence is borne out by the success of the ultralight patrol program now in operation at the nearby Downey Police Department. Downey ultralight patrolmen are flying the new Eipper Police Interceptor model, which is similar to the Quicksilver MX.

The Police Interceptor has several unique features available only to law enforcement agencies; more options are under development. The ultimate Interceptor will sport a siren, searchlight, PA system, two-way police and aviation radios, a more powerful engine and drive train, and a more spacious cockpit.



A Monterey Park Police officer's forced landing atop this tiled roof broke the back o the department's ultralight patrol program. The pilot, fortunately, suffered only a broken thumb.

Downey police are enthusiastic al their ultralight program. In the hour of operation they spotted apprehended a burglary suspect; have now reportedly logged sev hundred hours of safe flying. Downey terrain deserves some cr for the program's success—it is fla than Monterey Park and affords n suitable emergency landing sites.

While the Santoro brainchild become a Monterey Park outcast spirit and enthusiasm for such ects remain undampened. Santo currently investigating possible po applications of a one-man, porta foldup helicopter under developr for military use.

—Mark Pa

Australian modification for the Hornet?

Informed Washington sources state that Pentagon officials may accede to intense lobbying by a group of retired admirals from New York, and order immediate feasibility studies into the possible introduction of an Australian designed modification to all USN and USMC Hornets.

Without this device, the admirals insist, the United States will become a second-rate sea power by 1987.

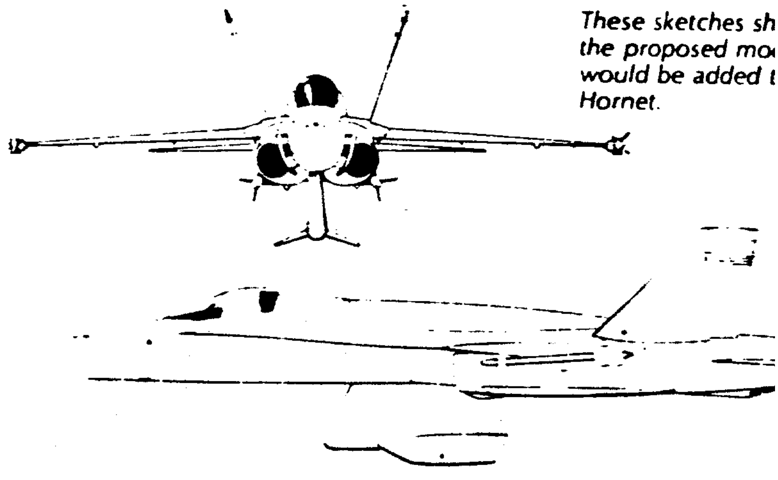
Dubbed the Kinetically Energised Equipment Levitator (KEEL), this revolutionary development is said to provide dramatic improvements in performance throughout the whole flight envelope.

In particular it increases maximum speed down wind and vastly improves turn radius and acceleration in a dog-fight situation.

The inventors of the system, Lexcen Aviation Pty Ltd are jubilant over this Washington development as it promises enormous earning potential for the Australian company under current AIP offset programs.

McDonnell Douglas engineers are meanwhile working around the clock in order to perfect a complementary modification, the Somewhat Taller and Improved Landing and Take-off System (STILTS), without which the full potential of KEEL might not be achieved.

These sketches sh the proposed mo would be added t Hornet.



A technical history of soaring—

From Paleoaeronautics to Altostratus

by M.K. CHEN and J.H. McMASTERS

Acknowledgement
The authors wish to thank Doug Lamont, former editor of *Soaring*, and Bob Storck, archivist of the Vintage Sailplane Association, for providing data and drawings for this article. Thanks also go to Dan Knutzen who transformed the authors' sketches into art.

PART II

Post-WW II Development

With the opening of World War II, the development of high-performance sailplanes came to a virtual standstill. The frantic development of transport gliders and of training gliders for military use is an interesting story in itself, but beyond the scope of this paper. One notable development in this period was the continued experimentation by the Horten brothers in Germany with flying wings. This led to the eventual development of the magnificent-appearing Horten IV (Figure 19) and Horten VI sailplanes. The latter reflected an almost absolute aesthetic, if not technical, triumph in unlimited-class sailplane development.

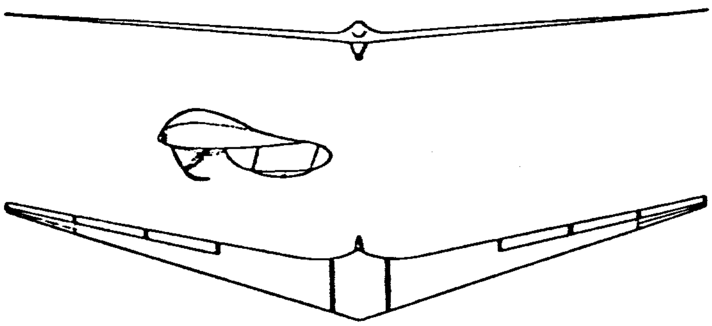


Figure 19. Horten IV (1941)

International competition soaring resumed in 1947, with most pilots flying prewar vintage machines. Perhaps the most successful sailplane in the early postwar competitions was the Focke Wulf *Weihe* (Figure 20), which had been designed by Hans Jacobs in 1938. A *Weihe* had placed fourth in the Rhön competition of 1938. Thus it is an appropriate machine on which to base our discussion of the transition from prewar to postwar sailplane development since it was representative of the better competition machines of the period.

The *Weihe* appears to embody many of the lessons learned from the *Austria*, the D-28, and the D-30. It was no ultra-light, having an empty weight of 230 kilograms. The span was 18.0 meters, a compromise between the low-speed efficiency of the 30-meter *Austria* and the maneuverability of the 12-meter D-28. By now the importance of efficient flight

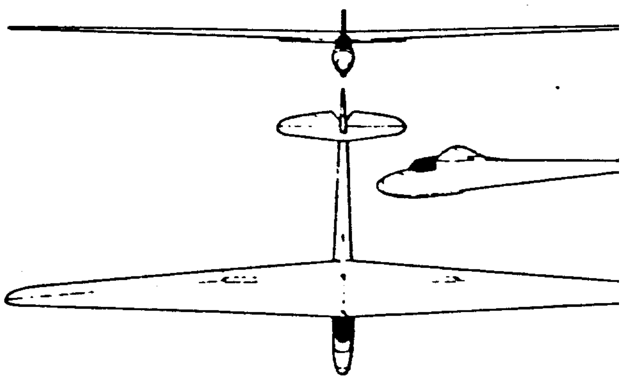


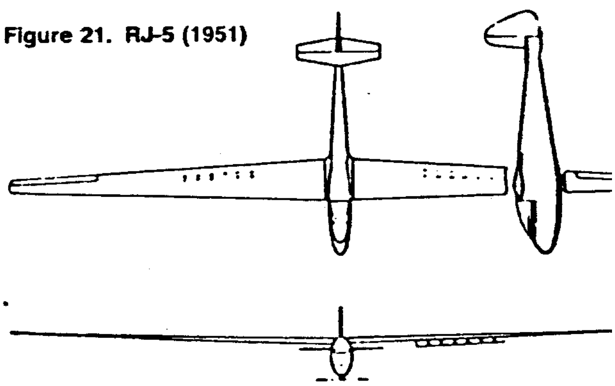
Figure 20. Focke-Wulf Weihe (1938)

at high speeds was recognized; with a wing loading of kg/m² and using the moderately-cambered Göttinger airfoil, the *Weihe* was better suited to this flight regime the *Austria* or D-28. However, it can be seen that the wo *Weihe*, intended from its inception to be a production plane, could not take advantage of the exotic materials construction techniques used in the D-30, which possible its unprecedented efficiency.

Postwar advances in sailplane performance began August Raspet and Richard Johnson at Mississippi College demonstrated the startling performance gains sible by systematically cleaning up a machine of basi good aerodynamic layout. The machine used was the of-a-kind RJ-5 (Figure 21) designed by Harland Ross. RJ-5 was of conventional configuration and constru (wood and aluminum), employing a NACA 6-series lan flow airfoil. Through careful sealing of leaks and gap duction of wing waviness and roughness, and install recontoured canopy in place of the original spherical ble, successive reductions in parasite drag were meas over a period of several years, resulting in an improve in maximum L/D from 30 to about 41. Parasite drag reduced by 25 percent at L/D_{max}, and about 40 perce this reduction was accomplished by simple sealing smoothing. With the RJ-5 the limits of sailplane pe mance were established for the materials and the ai available at the time. Raspet's work heavily influence design of production competition sailplanes for the decade, but production considerations necessarily lir the performance of these ships relative to the RJ-5.

In 1958 the Standard Class was added to internat competition in the World Gliding Championships, helc year in Leszno, Poland. The Standard Class concept a revival of the class competition idea which arose b World War II with efforts to gain recognition of soari an Olympic sport by the International Olympic Comm

Figure 21. RJ-5 (1951)



The Standard Class was inaugurated in order to assure the continuance of a category of competition in which sailplane costs would not climb out of sight as technical innovations were incorporated in the name of increased performance. The Standard Class sailplane was envisaged as being simple (no flaps, fixed undercarriage) and inexpensive, with performance as close as possible to that of contemporary Open Class machines, yet suitable for general club flying. Span was limited to 15 meters. In many respects the Standard Class sailplane was quite similar in concept to the prewar specification for an Olympic sailplane.

In 1957, OSTIV, the branch of the Federation Aeronautique Internationale (FAI) devoted to soaring technical and scientific advance, announced a design competition for the best Standard Class design at the 1958 World Gliding Championships. This competition was won by the Schleicher Ka-6 (Figure 22), designed by R. Kaiser, and primarily of wood.

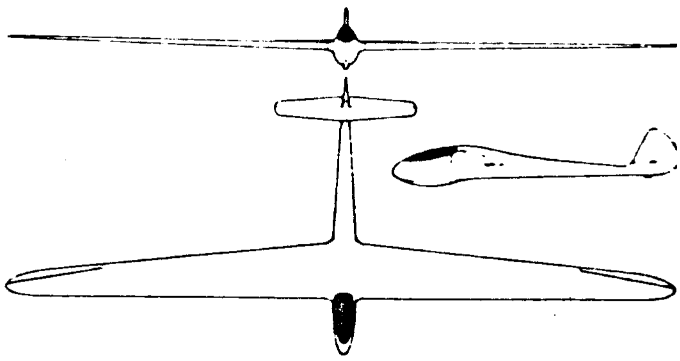


Figure 23. FS-24 Phönix (1957)

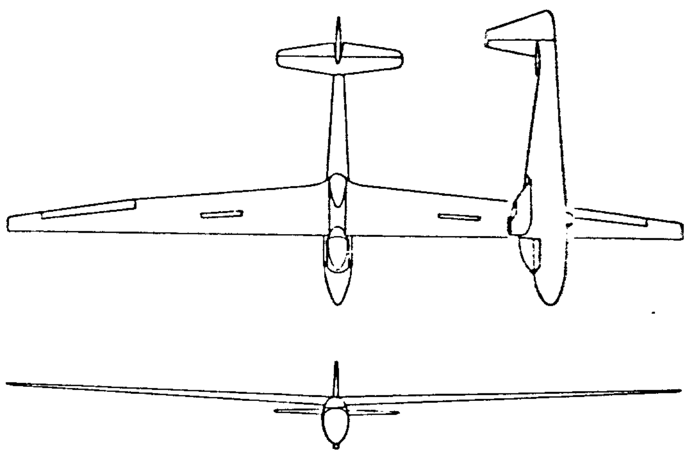


Figure 22. Schleicher Ka-6CR (1956)

The 15-meter span limitation of course limited the achievable performance for the existing level of technology. Nevertheless, the Ka-6, with its NACA 6-series airfoils and generally high degree of aerodynamic cleanness, achieved the same maximum L/D as the *Weihe* (about 29) at a higher airspeed (78 km/h vs. 70 km/h) with 3 meters of span less.

By now, the required characteristics for a high-performance sailplane were well-understood. The basic configuration had been established, and there was some understanding of how to optimize span and wing loading for a given style of flying. The significance of viscous scale effects to airfoil performance was appreciated, and designers and builders had sound recipes for parasite drag reduction. Further increases in sailplane performance could only be realized after a major breakthrough either in materials technology or in the development of more efficient airfoils. Actually, both of these breakthroughs occurred at roughly the same time.

Introduction of Composite Structures

The major development in materials technology was the introduction of fiberglass in sailplane primary structures. Fiberglass is a high-strength material of low specific gravity, but with a relatively low modulus of elasticity. In the interest of structural efficiency it is desirable to fully integrate the load-carrying members of an airframe with the aerodynamic shell that allows it to fly. Such structures are possible with fiberglass. In order to maintain desired levels of torsional and bending stiffness, wing skins must be quite thick and correspondingly stronger than required by existing sailplane airworthiness standards. Fiberglass sailplanes can thus be built with load factors approaching those of modern fighter aircraft, and, due to the low specific weight of fiberglass, this can be achieved with little weight penalty. The use of fiberglass wing skins also allows fabrication of relatively wave-free surfaces of unexcelled smoothness. With the use of molds such surfaces are also highly reproducible.

The use of fiberglass as a material for sailplane primary structures was pioneered by Nägele, Hütter, and Eppler of Akaflieg Stuttgart. They produced the first fiberglass sailplane, the Fs-24 *Phönix* (Figure 23), which first flew in November of 1957. Emphasis in the design of this 16-meter sailplane was placed on weight reduction, and in fact the empty weight of *Phönix* (164 kilograms) turned out to be little more than that of the 12-meter Schweizer 1-26 (Figure 24), a popular American metal-and-fabric sport sailplane of the period. The wing loadings of these two sailplanes were also quite similar, but the *Phönix* had a much lower minimum sink speed, thanks to its superior aerodynamic efficiency. Both achieved L/D_{max} at about the same speed (78-79 km/h). The *Phönix*, however, had an L/D_{max} of 40, compared to 23 for the 1-26. This remarkable increase in performance can be attributed largely to the *Phönix*'s more efficient wing planform and the smoothness of its surfaces, again made possible with no weight penalty by the use of fiberglass. The combination of low sink speed and good high-speed capability enabled the *Phönix* to achieve high average cruise speeds.

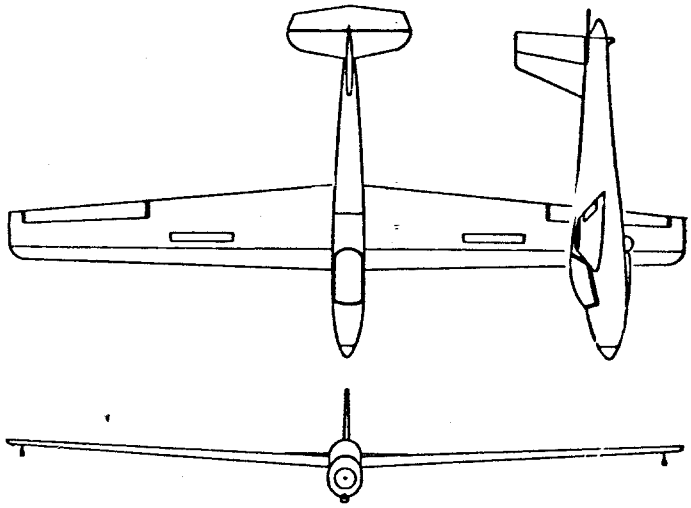


Figure 24. Schweizer 1-26 (1954)

Evolution of Sailplane Airfoils

The first efforts to develop airfoils suited for sailplanes were carried out in the 1920's at the University of Göttingen in Germany. The early Göttingen airfoils were designed using potential flow theory, ignoring viscous scale effects which are now known to have a critical effect on airfoil characteristics, especially at low Reynolds numbers. A large matrix of Göttingen airfoils underwent extensive wind tunnel testing, and of these the Gö 535 and Gö 652 were found to be particularly suited for sailplane applications. As previously mentioned, sailplanes of this earlier period were designed mainly for low sinking speeds at low flying speeds, and the thick and highly-cambered Göttingen airfoils worked well at the high lift coefficients required for this style of flying.

In the 1930's, with the development of cross-country soaring techniques, there was a general awakening to the additional importance of low drag at the lower lift coefficients required for higher cruising speeds. In this respect the Gö 535 and Gö 652 were totally unsatisfactory, for at low angles of attack these airfoils were prone to flow separation on the *lower* surface. Kupper attempted to mitigate this problem on the *Austria* by fitting camber-changing flaps to the wing trailing edge. For interthermal cruising, these were deflected up, thus reducing the camber of the wing section.

As competition led to demands for better cross-country performance, airfoils with less camber were widely adopted in the 1930's. The Göttingen 681 and 549 were popular during this period. Some use was also made of the NACA 4- and 5-digit series airfoils.

After World War II, the NACA 6-series laminar flow airfoils were widely used. These sections were derived using approximate theoretical methods with the objective of achieving very low drag by maintaining long runs of laminar flow within a design-limited lift-coefficient range. Laminar boundary layer flow is sustained over the forward portion of these airfoils by the avoidance of pressure "peaks" and a favorable pressure gradient. However, this flow condition is very sensitive to surface roughness and waviness. Before the advent of fiberglass structures, it was difficult, if not impossible, to build a wing of the requisite surface quality to sustain the full extent of laminar flow possible with these airfoils. Nonetheless, many successful sailplanes have been designed using the NACA 6-series airfoils.

In the 1950's, R. Eppler and F. X. Wortmann started conducting theoretical work on airfoils which showed that, by carefully contouring the airfoil thickness envelope, the boundary layer transition point on low-to-moderate cambered laminar airfoils could be controlled with some precision. Wortmann showed that by carefully contouring the upper surface of a fairly highly-cambered airfoil, the upper end of the laminar flow range can be extended to section lift coefficients required for low sink rate. When a highly-cambered airfoil is operated at low lift coefficient values, however, the airfoil is frequently flying at a negative geometric angle of attack, and thus the lower surface of the airfoil is the one on which transition is of primary concern in maintaining low profile drag. By carefully contouring both the upper and lower surfaces, the low-drag "laminar bucket" of the airfoil polar could be significantly extended compared to the NACA 6-series airfoils of similar thickness. The NACA 6-series were intended for a higher speed and Reynolds number range than is normally encountered in sailplanes, and the low-drag "laminar buckets" in their polars extend over a relatively limited range of lift coefficients. Wortmann, working with the benefit of a digital computer and better analytical methods, was able to exercise greater control over pressure distribution architecture and account

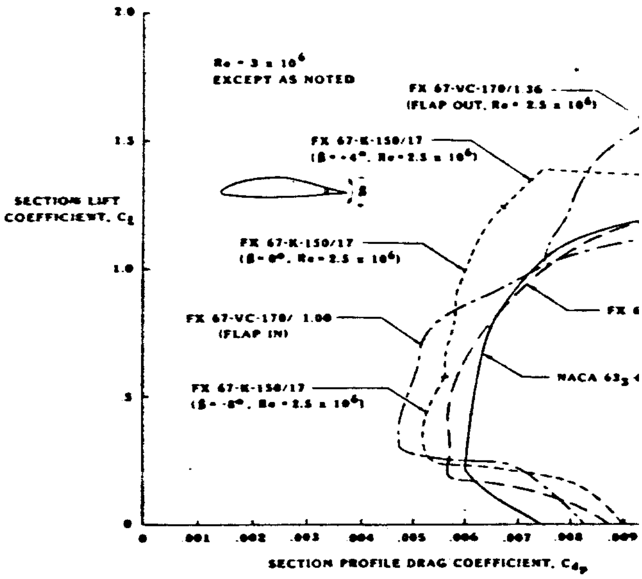


Figure 25. Sailplane Airfoil Performance Comparison

explicitly for Reynolds number in his airfoil designs. A result, the FX-series airfoils have a low drag (laminar buc operating range which extends to both higher and lo lift coefficients than the NACA 6-series, and this is achie over a Reynolds number range more appropriate to s planes (Re = .7-3 × 10⁶). See, for example, Figure 25 wh compares the drag polars for the NACA 63₃-618 and Wortmann FX 61-184 airfoils at a Reynolds number o million. Both airfoils have been widely used in sailplan The extent of the bucket can be further extended by justing the camber line with a small-chord (10-20 perc simple hinged flap at the trailing edge. Wortmann's series of airfoils began to appear on sailplanes in the 196 and by the end of the decade had been almost univers adopted by sailplane designers.

Wortmann's work on flapped airfoils has resulted i return of cruise flaps as an almost obligatory feature Open Class competition sailplanes. As mentioned earl cruise flaps first appeared as early as 1930. Then, as n their purpose was to improve high-speed performance. decambering of the early Göttingen sections served to tially mitigate the flow separation problem encountered the lower surface of these airfoils at low angles of att The function of cruise flaps on wings which use Wortm airfoils is to further extend the low-drag bucket at the hi speed end by controlling the boundary layer transition cation. The drag polar for a popular Wortmann flap airfoil, the FX 67-K-150/17, is shown in Figure 25. The ef of both positive and negative flap deflections may be se

Selected airfoil sections that have been used in som the sailplanes discussed here are depicted in Figure 26

Recent Developments

Akaflieg Stuttgart had begun the fiberglass revolu with the *Phönix*, but it was Akaflieg Darmstadt's D-36 C (Figure 27) that established the pattern for competition planes which continues to influence designers today. D-36 was designed by Lemke, Holighaus, and Waibe 1963 and first flew in March of 1964. Unlike the *Phönix* which fiberglass construction was utilized in order to red weight, the designers of the D-36 took advantage of the specific weight of fiberglass to develop an airframe w was no lighter than sailplanes of conventional structure comparable span (e.g., *Weihe*, RJ-5), but which was m stronger and of high surface quality. The higher speed

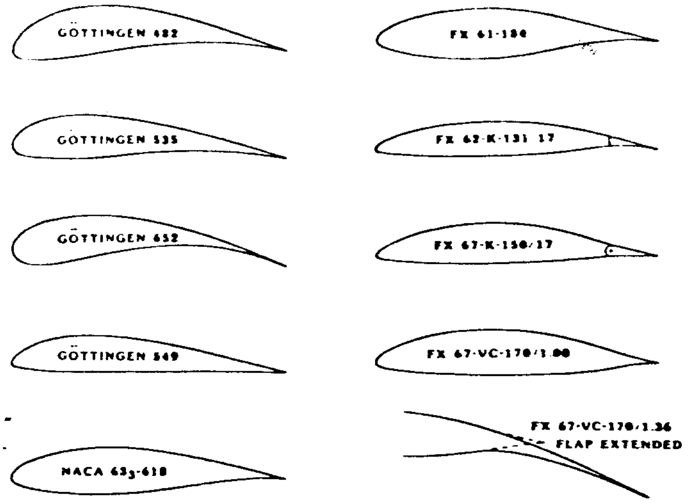


Figure 26. Some Representative Sailplane Airfoil Sections

pabilities of the Wortmann airfoils used, and the smoother surface of the fiberglass skin, enabled the D-36 to achieve an L/D_{max} of 44 at 93 km/h. Despite its high wing loading, the minimum sink speed of the D-36 was lower and was achieved at a higher flying speed than that of any of its adversaries at the 1965 World Gliding Championships, where it placed second in the Open Class. Interestingly, the winner was flying a Polish Standard Class *Foka 4*, of conventional wooden construction, demonstrating that flying skill, weather conditions, and luck remain fundamental ingredients to success in competitions.

The designers of the D-36 have all gone on to establish themselves in the German sailplane industry. The mainstream of Open Class sailplane development over the last decade has not strayed significantly from the D-36 formula. With span increases and careful attention to sealing and smoothing, measured lift-to-drag ratios of over 50 have been achieved, leading to the achievement of the long sought

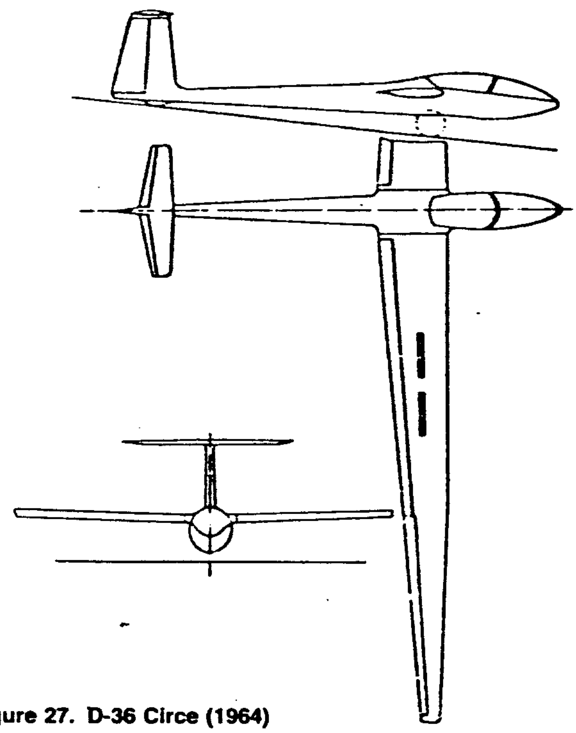


Figure 27. D-36 Circe (1964)

possibility of dolphin-style soaring on a routine basis. Most of the technical advances that have been proven in Open Class competition have also been incorporated in Standard Class sailplanes. Composite structures are now the norm in the Standard Class, and competition rules have been modified to allow the use of retractable landing gear. Some of these machines have achieved measured maximum lift-to-drag ratios of over 40.

There are other fibers suitable for sailplane composite structures besides glass. The most important of these are Du Pont Kevlar and carbon fiber. Kevlar has high specific tensile strength and is two to three times as stiff as glass. However, it has relatively low compressive strength. Carbon fiber is twice as stiff as Kevlar and as strong or stronger than glass, depending on the type, but is expensive in comparison to the other fibers.

A sailplane wing designed for fiberglass construction can be lightened substantially (thus increasing the wing loading *range* to account for flights in both strong and weak lift conditions) and stiffened if carbon is substituted for glass (e.g., *Nimbus 2C*). The full potential of carbon fiber is realized with a sailplane designed from the start to take ad-

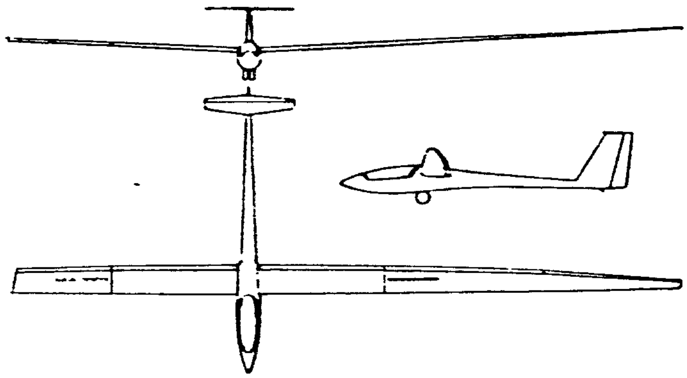


Figure 28. Schleicher AS-W 22 (1980)

vantage of carbon's properties. Span can then be increased with no appreciable weight penalty relative to fiberglass, thus increasing aerodynamic efficiency, and/or thinner wings with reduced profile drag become feasible. Several Open Class and 15-Meter Class racing sailplanes have recently been developed with these objectives. Among these projects, the Schempp-Hirth *Nimbus* 3, winner of the Open Class in the 1981 World Gliding Championships held at Paderborn, West Germany, and the Schleicher AS-W 22 (Figure 28) are particularly notable. Calculated maximum lift-to-drag ratios for these machines are in the 50's, at speeds of over 120 km/h.

In the Standard Class and the newer 15-Meter Class (a less restrictive competition class which retains only the 15-meter span limitation of the Standard Class), the development of airfoils efficient at very low Reynolds numbers will be required in order to take full advantage of the structural properties of carbon. This has apparently been accomplished for the new *Ventus* (Figure 29), a 15-Meter Class sailplane with a carbon wing of 23.7 aspect ratio, considerably greater than most previous 15-meter wings. The wing area is only 9.5m^2. In order to believe the claimed performance (L/D_{max} = 44 at 25 km/h), we must presume that the profile drag characteristics of the new and thinner airfoil section (designed by Althaus and Wortmann) are such that the reduced wetted area of the *Ventus'* wing is more than sufficient to compensate for the increased profile drag

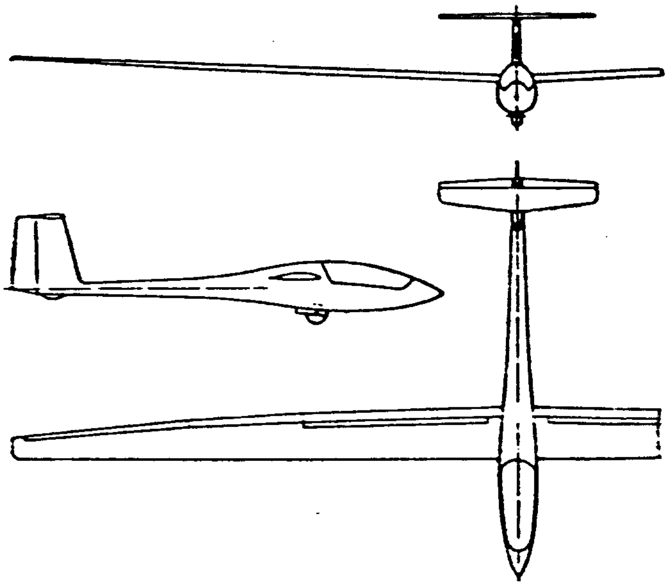
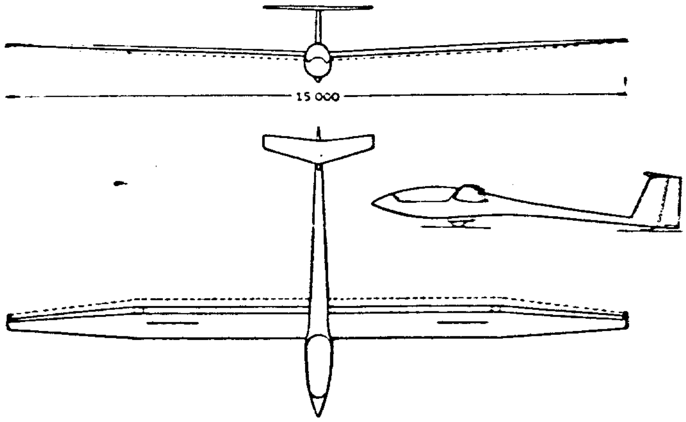


Figure 29. Schempp-Hirth Ventus A (1980)

which is normally expected of wing sections operating at lower Reynolds numbers. A further benefit from the use of carbon fiber in a sailplane wing of restricted span is an increase in the range of wing loadings at which the sailplane can be flown. The reduced empty weight of the wing allows lower wing loadings than have previously been possible (a benefit in weak lift conditions), while the increased strength of carbon (relative to fiberglass) allows more ballast to be carried in the thin wing to achieve higher wing loadings appropriate to strong lift conditions.

In order to further exploit the advantages of a wider range of allowable wing loadings needed to optimize performance in a variety of weather conditions, a number of variable geometry schemes have been developed in prototype form (Reference 32). These range from the use of chord-extending Fowler flaps (e.g., the British *Sigma* project of the late 1960's) to a true variable-span machine, the Akaflieg Stuttgart Fs-29. Of the new, highly complex and sophisticated sailplanes, only the Akaflieg Braunschweig SB-11 (Figure 30) can be considered a success so far, as measured by its winning performance in the 1978 World 15-Meter Class competition in Chateauroux, France. This line of development holds considerable promise for the future, however.

Figure 30. SB-11 (1978)



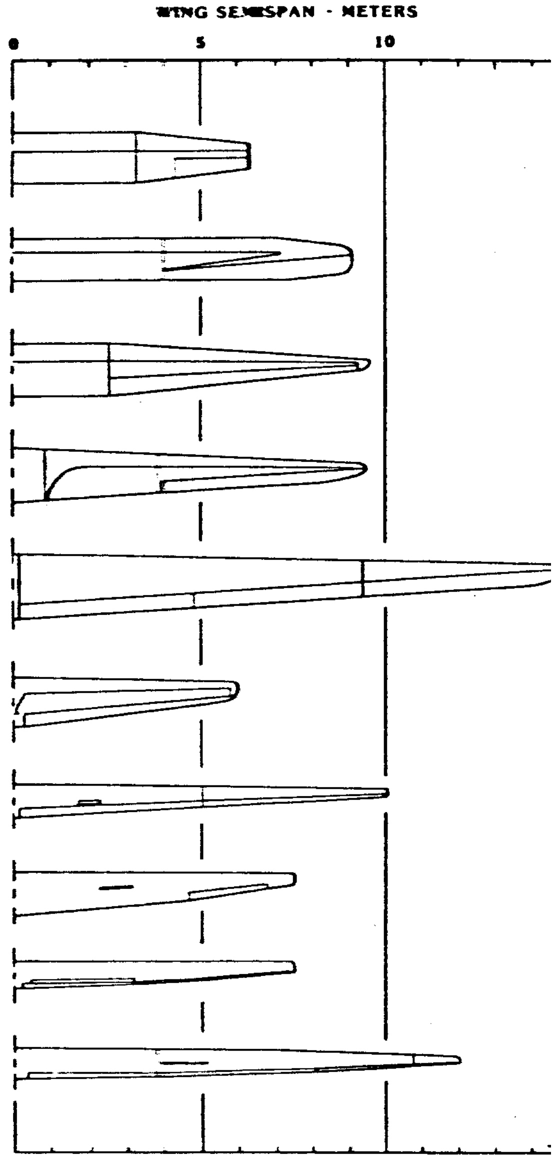


Figure 31. Evolution of Sailplane Wing Planforms

EPILOGUE

The story outlined so far has merely touched upon se lected high points of the course of development which ha led to the aesthetic and technical triumph of the moder high-performance racing sailplane. The reader will observ that while modern soaring began with the Wright brothers the story has been basically one of European (and ver largely German) achievement since that time. It is perhap regrettable that with few (but noteworthy) exceptions (e.g. Raspet's work), the United States has been placed largel in the role of consumer rather than developer of this tech nology. The excellent work of people like Hawley Bowlus Len Niemi, Gus Briegleb, Dick Schreder, George Applebay and others is not to be disparaged. With the exception c Raspet and his colleagues, however, most of the machine developed domestically were largely state-of-the-art and di not embody advanced concepts of the time. While kee interest in soaring, both for recreation and for serious com petition, has been displayed in this country since the 1930' by a relatively small group of enthusiasts (represented b the Soaring Society of America with 16,000 members a present), soaring has never achieved the stature or popularity it enjoyed in France, Germany, and Poland, for example. Domestic manufacture of sailplanes is presently limited to a few small-scale operations.

Only the Schweizer Aircraft Corporation in Elmira, New York, which supplies the bulk of training and sport sailplanes (e.g., the ubiquitous 1-26) to the U.S. market can be considered generally successful. Economic limitations associated in part with certification costs, as well as limited market appeal due to the cost and difficulties of normal sailplane operations are usually cited for this state of affairs. As advanced technology sailplane performance continues to increase, it becomes increasingly difficult, without a major technological and/or market breakthrough, for U.S. manufacturers to compete in this area.

It is at this point that the modern hang glider may be appropriately brought into the story. As mentioned previously, the high equipment costs associated with increased performance have led periodically to efforts to control the situation or provide alternatives. This was the motivation for the formation of the present Standard Class in soaring, and a backlash against high cost and operational difficulties with sailplanes led to modern experiments with hang gliding in the 1960's. This latter line of development was inspired foremost by the absurdly simple Rogallo wing kite which could be transformed (by the outlay of a mere $25) into a man-carrying, bamboo-and-vinyl-sheet "glider." And better, no flying license was required, and the whole thing could be collapsed into a tubular bundle transportable on a van or even a motorcycle. Thus, a new sport and industry was born. Modern evolved versions of the basic Rogallo recipe, manufactured of modern materials (aluminum, carbon fiber, and dacron sailcloth), are certainly capable of soaring, but hang gliding has gone its own route. The overlap in participation and interest between sailplane flying and hang gliding remains minimal. A modern history of these extraordinary developments has recently appeared (Reference 33).

There are other important elements of the overall history of soaring, but space limitations preclude elaboration here. Of these topics, the strong current interest in homebuilt and ultralight sport sailplanes is noteworthy. Here Dick Schreder shines as an almost unique example of just damned fine, truly American ingenuity and persistence applied to practical high-performance sailplane design suitable for home construction! These devices represent further attempts along more traditional lines to restrain the ever-rising costs of soaring. Further discussions can be found in References 34-36. Developments in motorgliding and the peripheral development of sailplane-inspired human and solar-powered aircraft also deserve mention.

The importance of soaring technology to other branches of aviation has been briefly mentioned. Direct applications to other branches of General Aviation have been discussed in Reference 37. Another potentially important use of sailplanes, which has been inadequately exploited to date, is in both atmospheric and aerodynamic research. Recent Lockheed experience in this area is noteworthy.

Returning finally to the racing sailplane, costs continue to rise as does performance, although a temporary plateau appears to have been reached in achievable performance based on known materials and passive laminar flow aerodynamic technology. There is still a great deal of advance possible, however, largely through exploitation of variable geometry and perhaps eventually in mechanical boundary layer control. Given the past dramatic advances in performance, the ultimate sailplane may yet be produced. A possible candidate for this title, the *Altostratus*, has been described in Reference 38 and is shown in artist's conception in Figure 32.

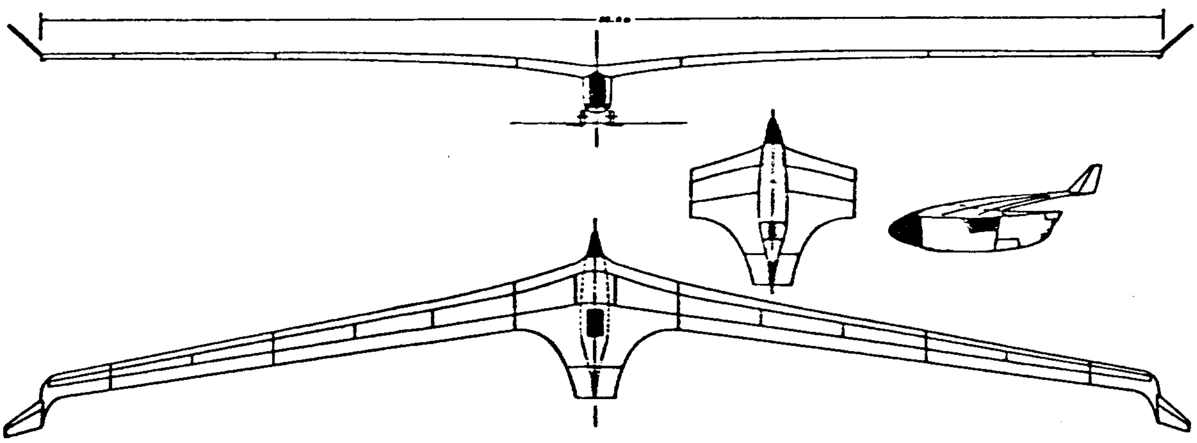


Figure 32. Altostratus I (2001)

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