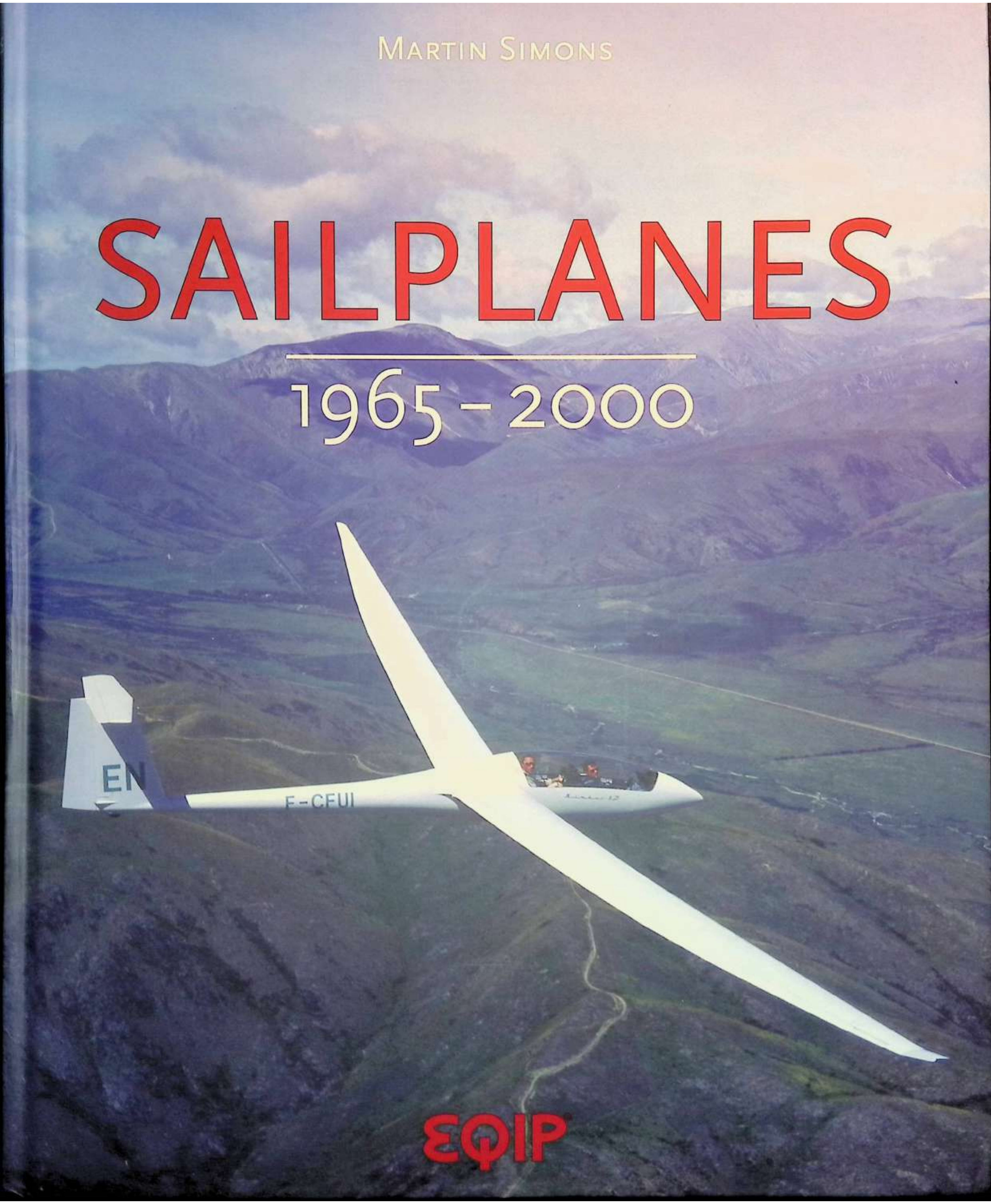
Martin Simons

SAILPLANES

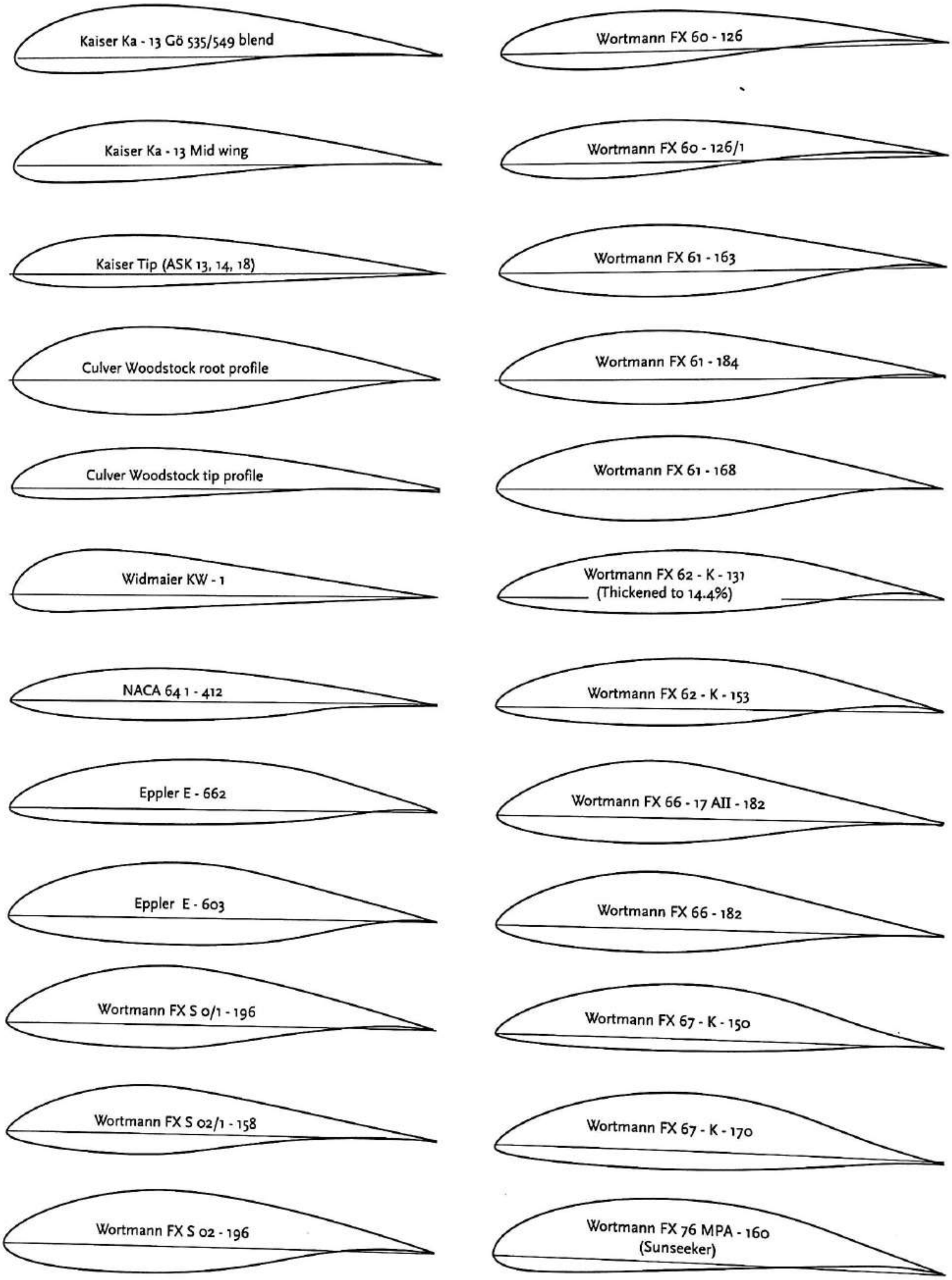
1965 - 2000

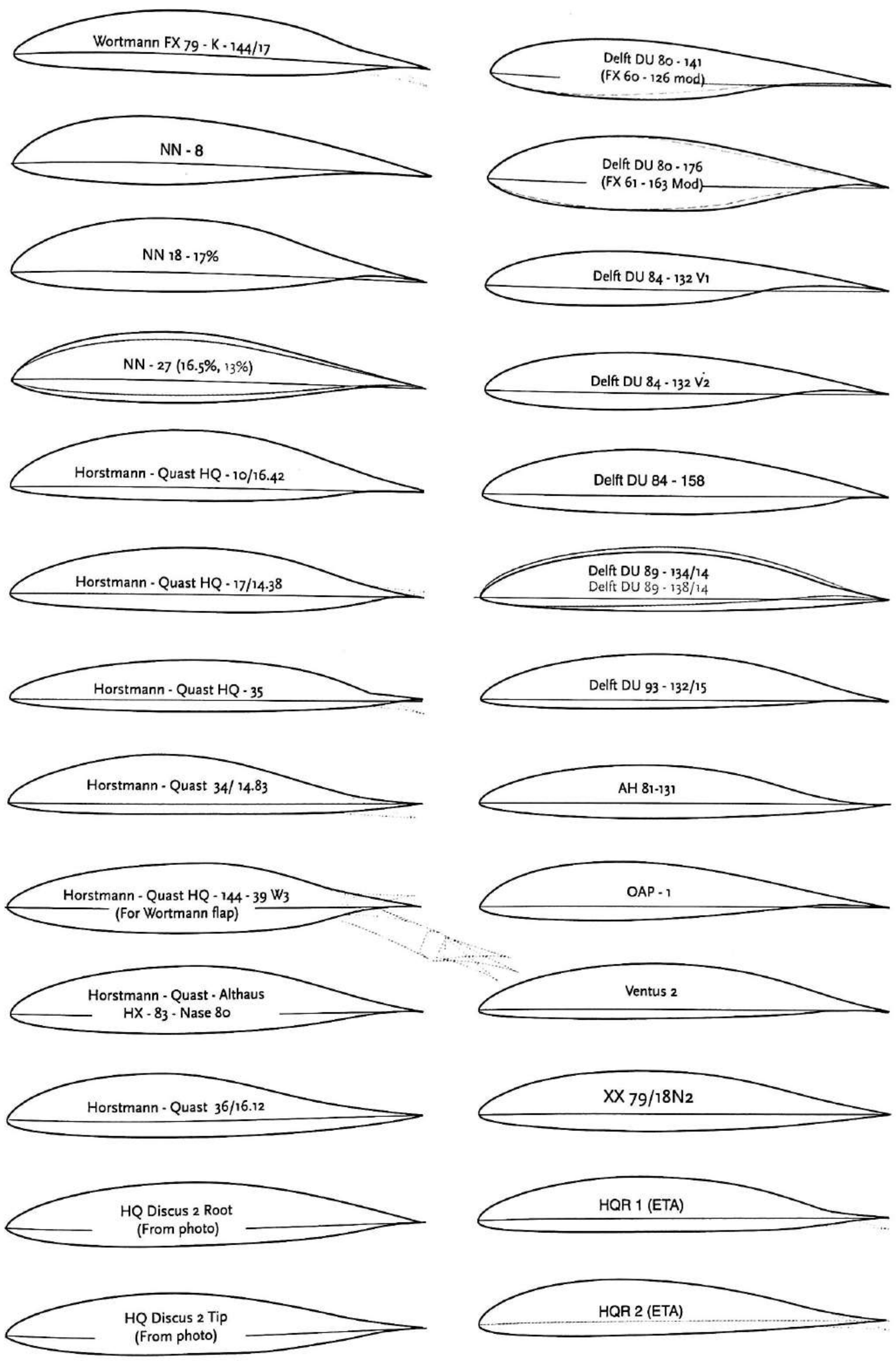


EQIP

Wing profiles
1965 - 2000

(Profiles shown in the previous volume , Sailplanes 1945 - 65, are not all reproduced here

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HX - 83 - Nase 80
Horstmann - Quast 36/16.12
HQ Discus 2 Root
(From photo)
HQ Discus 2 Tip
(From photo)
Delft DU 80 - 141
(FX 60 - 126 mod)
Delft DU 80 - 176
(FX 61 - 163 Mod)
Delft DU 84 - 132 V1
Delft DU 84 - 132 V2
Delft DU 84 - 158
Delft DU 89 - 134/14
Delft DU 89 - 138/14
Delft DU 93 - 132/15
AH 81-131
OAP - 1
Ventus 2
XX 79/18N2
HQR 1 (ETA)
HQR 2 (ETA)

Martin Simons

Sailplanes

1965 – 2000

To Jean, my dear wife, who has tolerated,
crewed for and supported this crazy glider
pilot for fifty years

EQIP

CONTENTS

2nd Revised Edition, 2005

EQIP Werbung & Verlag GmbH
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Cover:
Thorsten Fridlizius, Nimbus 3D in New Zealand

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PREFACE

The nine year old boy who, in 1939, had gazed in fascination at wooden sailplanes with translucent wings, and who as a teenager had hopped and crashed a Dagling, by 1967 had entered a soaring competition and done quite well. A Gold C distance flight in a Ka 6E was achieved from Dunstable northwards to Bishop Auckland. Several failures to complete the 300 km triangle in England followed. Two years of spare time were spent rebuilding and modifying a Skylark 2. We moved to Australia in 1968. My family say this was because conditions there were better for soaring. There was some truth in this. Two jobs were offered. Whichever I chose would mean a change of professional direction as well as domicile. The post in Adelaide was taken because of the prospect of soaring over the Murray River plains that stretch for a thousand kilometres east of the Mount Lofty and Flinders Ranges.

Before leaving England I spent some time wondering whether we should take a sailplane. Glass-fibre-reinforced plastic (GRP) sailplanes were beginning to arrive in England. I spent an hour studying one. It was impressive and expensive. I postponed any decision but soon after arriving at the Waikerie Gliding Club I found myself enjoying the delightful GRP Glasflügel Libelle H - 301. The advance in performance was amazing. Soon afterwards I imported a Kestrel 17. Here were new complexities. As well as the familiar simple controls and basic instruments, with electronic audio variometer and climb averager, there was multi-channel radio, oxygen gear, a retracting undercarriage, camber flaps with combined landing flap, a tail parachute brake, water ballast.

In the following years, other modern sailplanes were owned and flown with occasional contest successes. I achieved a State Championship once and broke the British National speed record for the 300 km triangle. (John Delafield took it in South Africa within a few days.) I never had the consistency required for major competition wins but one day at the Australian Nationals in 1971 I beat the visiting world champion, Helmut Reichmann, in a race round a 428 km triangle. The next day Reichmann did not fly and I won again, exceeding the Australian record for the 500 km triangle. They were exciting years.

By the year 2000, things had changed almost as much again. By this time there were advanced carbon fibre sailplanes over 26 metres span with winglets, retractable motors and data loggers. The nine-year old boy, still lurking within myself, remains totally fascinated and astonished.

Yet the memory and rapture of the early years do not fade. In 1966 I suggested that there should be a special class in soaring for old-time sailplanes.[1] Some six years later, inspired by Christopher Wills, the first Vintage Glider Rally was held at Husbands Bosworth in England. I was not there and had no part in the organisation but attended the next meeting, at the Wasserkuppe in 1974. Since then the international Vintage Glider Club has flourished and expanded. The need to trace and record the whole development from the start of the sport in 1920, was pressing. These books are the result. This volume, following directly from the previous two, brings the story forward from 1965 to the end of the century.

Again, it has not been possible to include all the types of sailplane that appeared during the period. A preliminary list for this volume included more than three hundred. Cutting was inescapable. In retrospect it is easy to see now that the main stream has been the development of plastic composite sailplanes in Europe, particularly Germany and Poland. Revolutionary when they first appeared, these now have become orthodox. At the beginning it was not at all clear that this was to be the future. There was a long period of trial and experiment, a proliferation of ideas, proposals, new ventures, discoveries, new instruments, new techniques.

Some experimental sailplanes were never produced in numbers but were highly influential, pointing the way ahead. Others indicated only where future developments had better not go. Sailplanes were produced in many countries and all deserve their place in the record. Some were and are still being built in wood, metal and other materials. Many of these are highly interesting and original. It was felt that they should be described where possible, if only for the sake of variety. As many as possible have been included. Details of what was done have often been lost, or, in several cases, buried in dark cellars or dusty archives where no-one is prepared to search. The final selection, as before, has depended on the availability of records and drawings but also reflects some personal bias and preference.

Where do we go from here?

It is not easy to see how development will continue from the year 2000 onwards. Among the newest sailplanes, some are huge and enormously costly. Others are small, less expensive, light, ultralight, and foot-launched hang gliders. At the same time, markets have become more competitive. There has been no great increase in the numbers of sailplane pilots, even some decline. Established manufacturers have had difficulties. Some long-established firms gave up glider production during the decades covered here. In future there will be more changes, diversifications, mergers, and possibly closures. There will be another story to tell and another author to tell it, in a few more years.

1 - 'Sailplane and Gliding', December 1966 p. 466 - 9

INTRODUCTION – A GENERAL SURVEY

The direction of development

To comprehend the ways in which sailplanes developed, why they have taken the form they have, it is necessary to consider how the sport of competitive soaring has changed. Soaring Championships are a kind of shop window where the latest wares are demonstrated. New types of sailplane, techniques and instruments are publicly tested and pushed to their limits under the intense conditions of competition. Pilot's reports and technical analyses are studied by gliding club members, most whom have no aspirations to winning championships but who nonetheless want to fly the best available sailplanes, if they can afford them, and exploit new equipment.

In 1920 the contest-winning pilot was one who could stay airborne in a glider for a long time. By 1954 duration records exceeded 56 hours. It was recognised that, given the right weather conditions, duration tests had become only a matter of staying awake. Something of the same happened with altitude flights. For many years pilots in contests could score points by gaining height, proving their claims with barograph charts. Now climbs to the stratosphere have been achieved. To exceed these records requires special apparatus. A pressurised sailplane, the 'Alcor' of Robert Lamson, was completed and flown in 1973[2] for research purposes, but height gains were long ago eliminated from contest scoring.

The emphasis moved to cross country flying. Pilots would choose their day, take off as soon as thermals started and fly, usually downwind, as far as they could, landing sometimes in fading light, often hundreds of kilometres from base. It was important to soar in weak lift at the beginning of a flight and at the end, as evening approached, floating in the lightest of airs to extend the distance. But in the best part of the day, theory showed that much was gained by flying fast in the glides. Designers took note. Sailplanes began to appear with higher wing loadings to allow greater speeds with minimal height loss between thermals. To preserve climbing ability, aspect ratios increased, wing spans began to stretch.

As sailplanes improved, and pilots began to read the weather more skilfully, the so-called 'free distance' task or 'downwind dash', lost its appeal. Political frontiers and natural barriers, areas of inhospitable country like dense forests, deserts or the sea coast, often brought flights to a premature end. Sometimes in competitions the winning distances were so great that the best pilots could not get back in time to fly again the next day. To retrieve aircraft and pilot, a long and costly journey by road (or occasionally by aero-tow) was required.

Goal flights to pre-declared destinations made the distance task more interesting and practical. In some contests during this period, pilots could choose their own goals.[3] The achieved distance was the main criterion for scoring, but a large bonus was added for reaching the goal. This presented competing pilots with difficult choices. A very long distance flight which nevertheless was not quite completed, might score less than a successful, shorter one. Should the chosen goal be near, with high chances of reaching it and getting the bonus, or further off, in the hope of scoring exceptionally well by actually managing to get there?

It was soon realised by rule makers that distance task and retrieving problems could be reduced if courses were directed round one or more nominated turning points, 'out and return' or perhaps zigzag fashion along a set line, allowing large distances to be achieved without necessarily landing far from home. This raised the problems of verifying the turns. This was solved at first by sending observers out with binoculars early and marooning them for the day at the specified points. The idea of using cameras, for pilots to photograph the turning points, was adopted and became a normal part of competition and badge flying. Competition organisers set up dark rooms for film development, skilled photo-interpreters had to be found. To get results out early they often had to work all night. Cameras had to be sealed. The photos were often blurred and dim. Cameras could fail, pilots could point their lenses a few degrees off, missing the aiming point entirely, press the shutter too soon or too late, appearing then to be 'out of sector', even in the wrong county. Brilliant pilots sometimes lost their points because they were bad photographers.

Anomalies arose when, as sometimes happened, a pilot who completed a course in quick time, was scored the same as another who took all day to reach exactly the same place. Surely, the faster pilot was the better? The speed task was introduced. Only the achieved average speed would count for scoring. At first, times were taken from take off to touch down. The choice of launch time became ever more critical. Too early, when conditions were weak, a poor score resulted. The goal might be reached while stronger thermals were still available to the later starters. They would make better time. But after taking off too late, thermals might begin to die before finishing. Before launching, everyone waited to see how conditions developed, watching the most experienced pilots to see what they would decide. Then everyone demanded a launch at the same time. An error in the choice of take off time could sometimes be retrieved. It was allowed, at this stage of development, for a pilot to land short of the goal, and rush back to start again. But this became dangerous on the roads as trailer crews rushed madly back and forth. Gliders might be de-rigged and rigged again carelessly in desperate hurry. Eventually, for safety, such 'relights' after outlandings, were forbidden in contests. But designers at least recognised that sailplanes should be easily taken apart and put together again.

2 – See 'Soaring', November 1973 and OSTIV Publication XIII, 1974.

3 – The 'pilot choice' of goal was still permitted in minor regional and some National Championships in the late sixties, although it had been eliminated from World Championships long before.

It became accepted at last that all competitions would be, essentially, closed circuit races, with controlled starts to equalise everyone's chances. It became necessary to lay out start and finish lines and a proper system of timekeeping. An acceptable start required the sailplane to go through an invisible aerial gate, one kilometre wide with a 'limbo' bar at 1000 metres. Elaborate sighting devices were set up. Observers using these were required to identify and time each sailplane going through, confirming (or not) a 'good start' by radio. Crossing too high, or outside the kilometre wide frame, was not allowed.

More important decisions which, previously, a pilot had to make, were now handed to the contest director. A large fleet of competing sailplanes, perhaps eighty or a hundred, would be waiting. To send anyone off anyone too soon, before soaring was possible, would be unfair. They would have to land again almost at once and go to the back of the line. Therefore launching should begin only when the director knew conditions would be at least soarable for the entire fleet. (A 'thermal sniffer' sailplane might be sent up to help with this decision.) But in addition, no-one should be allowed to start on task while others were still on the ground waiting for a tow. Those airborne must wait till the starting gate was officially open, at a time chosen by the director.

For the sailplane designer, all this meant that soaring in weak thermals had lost much of its importance. The task setters ensured, as far as possible, that tasks would be flown in the best conditions available, the racing sailplanes would fly only during the good part of the day. Early and late hours were no longer of interest except for any unfortunates who, for some reason, had to struggle somewhere out on track to stay airborne.

The search for the strongest thermals was vitally important. If the first 'lift' encountered was weak, the glide with an efficient sailplane was good enough to fly on to find a better one. Even a heavy sailplane can climb in a strong thermal. Wing loadings rose further. Water ballast tanks were fitted, their capacity often exceeding the weight of the pilot. It became necessary to weigh sailplanes on their way out to the launch point, to ensure that no one was loading so much ballast that the airworthiness of the aircraft was threatened. If conditions unexpectedly began to die the water could be dumped.

At the start of the period covered in this book, the contest and task situation was in flux. In the 1965 World Championships there were six contest days and six tasks, all 86 pilots expected to attempt all. Only one day was 'free distance'. Another day was distance along a fixed line round three turn points prescribed by the task setters. One day was a race to a distant goal. Two days were closed circuit races. After this, the closed circuit speed task became almost universally accepted for all major competitions.

The contest day

During most of the following three decades, a typical contest day followed the pattern described here. At a morning briefing, the set task, usually a triangle or quadrilateral of at least several hundred kilometres, would be announced. The entire fleet would be marshalled and assembled ready for take off. If the weather deteriorated, the task could be shortened or even cancelled at a late stage.

Starting gates

Even with perfect organisation and plenty of tugs it might take at least an hour to get everyone off. Some of those airborne early would use the time to explore conditions on track but must return to make a timed start. Shortly before the 'gate' opened, the sailplanes would gather overhead, rather like swarms of bees round a honey pot.

Once the start gate was open all would want to set off at about the same time. Starting early was not advisable because the other pilots would be watching. If the first thermal was a good one, they would all start and race to join, catching up and thus gaining a time advantage. Starting very late, a pilot might be left behind, with no other sailplanes in sight to mark the good thermals.

To get below the 'limbo' bar and still retain as much energy and height as possible, some pilots dared to exceed the maximum permitted speed of their sailplanes, diving through and pulling up steeply afterwards. This was dangerous. Collisions were likely when scores of other sailplanes were doing the same thing at nearly the same time. Collisions could happen also when several pilots arrived together at a turning point, banking steeply to take their pictures.

Gaggling

Under these rules, racing tended to become a matter of great gaggles of sailplanes all following the same track, crowding together in the same thermals, again with considerable danger of collision. A pilot could pursue one gaggle after another to achieve a good time without, at any stage, having to consider strategy. Champion pilots found themselves hotly pursued by others riding on their coat tails, perhaps gaining a few seconds on the 'final glide' at the end. This kind of 'sandbagging' became very common. Some contestants objected that, in practice, there was only one kind of decision remaining for a pilot to make; who should one follow.

The finish line

The finish was checked and timed visually. A large gaggle could arrive all at once. For the timekeepers, even with brief warnings by radio, it was easy to mis-time or miss seeing someone altogether as they crossed the line perhaps just above the ground at very high speed. The airfield, entirely empty a few minutes before, would suddenly become dangerously overcrowded. A score or more of gliders would be shooting over the finish line, pulling up to perform abbreviated circuits, jettisoning water ballast, landing, not always neatly on the specified track or in the prescribed direction, rolling, coming to a stop, then being wheeled away by anxious crews dashing about with cars, ropes or towing bars.

Changing the rules

When cameras with time and data recording on the film became available, the starting problem was eased to some extent. A pilot could photograph a base point and the time would be taken from the film. Alternative start points, without affecting the total distance of the task, could be nominated, which gave the fleet more room. The limbo bar and start gate were dispensed with. There were serious efforts, not entirely successful at first and sometimes not welcomed, to make tasks more flexible, giving the pilots some choice of task and turning points, reducing the size of the gaggles and requiring pilots to make more critical decisions.

The Global Positioning System

Subject at first to various restraints and limitations, GPS instruments for sailplanes were advertised already in 1991. They were very costly at first. One instrument might cost several thousands of dollars. This soon changed. The instruments became reliable, compact, less expensive, and incorporated data logging. Serious experiments with sailplanes began in 1993 in Sweden and by 1995, in the World Championships in New Zealand, every competitor was required to submit a GPS 'black box' to the scorers after flying. Not only was a task flight, course and time verified (or not) but points could be calculated too. Everything could be downloaded to a suitable computer and stored, a complete record of each flight, locations, heights, speeds, all plotted on a map and available for subsequent analysis.

Some of the old skills of navigating by map and compass became almost superfluous. A pilot might complete a long task yet hardly be aware what kind of country lay below. In wave conditions, as sometimes in New Zealand, a task could be flown almost all above cloud without sight of the ground. Gaggling and sandbagging were not abolished but became less prevalent. The data logger encourages the introduction of new, more flexible competition tasks involving much greater degrees of pilot judgment and variety. The GPS is not perfect. Instruments and satellites might still sometimes fail. But these changes are generally welcomed. The long term implications remain to be discovered.

Class wars

At the beginning of the period covered in this book, there were two classes of competition sailplanes. In the 'Open Class' any kind of motorless aircraft, of whatever size, complexity and cost, was permitted. The 'Standard Class' was limited to sailplanes of 15 metres or less span, with few complications, no retracting wheels, ballast or flaps. This simple arrangement soon began to break down. Dissatisfaction with the Standard Class specification led to changes which by 1974 produced some undesirable developments. This led to the introduction of the 'Fifteen Metre' class, sometimes misleadingly termed the 'Racing Class' (misleading because all sailplanes are flown in races). Standard, Fifteen Metre and Open Classes remained in World and National Championships. There was a move to establish an 'Eighteen Metre' class. In an attempt to reduce costs, a 'World Class One Design' sailplane (the PW - 5) was chosen, after a design competition. Championships were held for this. 'Club' and 'Junior' classes have also been recognised internationally. Handicap systems allow many types of aircraft to compete on more-or-less equal footing. Special competitions for women pilots are organised and there are aerobatic championships. To this increasingly complicated scene, it has become necessary to admit motorised sailplanes, for both contest and record purposes. Further changes and adjustments to the class system are likely.

The emphasis is always chiefly on the wing span. All else being equal, a sailplane with a large span and a high aspect ratio, will, in straight flight at least, perform better than one otherwise similar but smaller. In the drawings and descriptions on later pages, the effect of this can be seen clearly. In 1965, eighteen metres was considered normal for the Open Class. As the following pages show, things changed. The 'Eta', flown first in the year 2000, has a span of 30.9 metres. There are other types with spans between 20 and 26 metres.

Glass Reinforced Plastics

In 1965 at South Cerney in England both World Championship classes were won by pilots flying wooden sailplanes. In the Open Class Jan Wroblewski from Poland became World Champion in a Foka 4. This was a fifteen metre span Standard Class glider, with a fixed undercarriage, no flaps or other complications. His team mate, Ed Makula, placed fourth in an identical aircraft. Francois Henry of France won the Standard Class in a Siren C30 Edelweiss.[4] The Swiss Standard Elfe[5] and two more Polish Fokas were not far behind in the scores. All these were made of wood, although some plastics were used in sandwich skins and for streamlined nose caps, wing tips and fairings. They conformed to the Standard Class specification but not to the spirit of the rules which had originally been framed to encourage the development of good, inexpensive club sailplanes. The original Ka - 6, design prize winner of 1958, remained the best exemplar.

The success of the Polish pilots was attributable mainly to their team flying. Any disadvantage in sailplane performance was more than made up by this highly developed technique. Pilots in the team communicated constantly by radio, doubling or more than doubling their chances of finding the best thermals in what turned out to be a mediocre English summer.

Second place in the Open Class in 1965 went to Rolf Spänig in the Darmstadt D - 36. This German sailplane was built from glass-fibre-reinforced plastic (GRP). Sandwich glasscloth skins were stiffened with balsawood filling. Spars were glassfibre rovings with epoxy resin matrix. There were occasional light internal wooden frames. The aerodynamic perfection of the external shape was obvious and the performance showed a huge advance. But, as one technical commentator remarked, the structure of the D - 36 was heavy, expensive and very elastic. At high airspeed the torsional flexibility of the wing caused the ailerons to become relatively ineffective. There had been some tail flutter during the flight tests, necessitating a heavy mass balance and, subsequently, redesign of the tailplane. The epoxy resins might become very weak at high temperatures, not perhaps in Europe but in climates where sunshine was more constant and intense. The Germans themselves nicknamed the D - 36 'Gummiflügel' (Rubber wings). The only other glass-plastic sailplane in the contest was the Phoebus which placed eighth in Standard Class, a good result but not enough to astonish anyone. Two Fokas, two Edelweiss, a Dart and

4 - See Volume 2 for the Foka 4 and Edelweiss

5 - In this volume, p. 224

even a Ka - 6CR,[6] placed higher in the final list. The OSTIV (Organisation Scientifique Internationale du Vol a Voile) design prize was awarded to the Slingsby Dart, a wooden aircraft.

Many well-qualified engineers were at first doubtful about the future of plastic structures. Most probably agreed that for the higher performance sailplanes, traditional methods would soon have to be abandoned. Aerodynamicists pointed always to the need for more and more accurate wing contours and more refined tail units and fuselage shapes. Even with plastic foam filling to support plywood skins, progressive drying out of the wood and shrinkage of the glues affected the aerodynamic form after a few seasons. There was constant demand for more airspeed. To achieve the necessary strength, wooden spars were becoming next to impossible for the thinner wings now required. Metal reinforcements began to seem necessary. Rather difficult techniques of wood-to-metal bonding, outside the experience of most woodworking shops, were required for this. Wooden gliders were mostly hand-built, glued together piece by piece. This was costly in terms of labour.

Plastic sailplanes too required a great deal of handwork in building and temperature control was necessary to cure the resins. Expensive female moulds, at least for the wings, were essential. To prevent flutter the wings had to be stiff and control surfaces required careful mass balancing. The load bearing structures had to contain much more material than was needed to resist static loads, simply to stiffen them. Hence GRP sailplanes tended to be heavy. Nor was it entirely clear that the smooth skins of the glass/plastic wings would remain as perfect as they were on leaving the factories. The resins often shrink appreciably as they age.

Some designers believed that light alloys must be the best way forward. The necessary techniques and design methods for metal aircraft structures were well understood. At South Cerney there were several outstandingly successful designs in metal, the American Sisu and HP - 12, the Yugoslavian Meteor, the Russian A - 15.[7] They were strong, light, stiff and, given the right experience and tooling, easy to build. Imperfections of external form, caused by riveting and skin joints, could be improved by careful filling and smoothing. Metal fatigue was a known factor and could be allowed for, whereas the relevant research into fatigue of glass/plastic aircraft remained to be done. No-one knew what the life of a plastic glider might be.[8]

Nevertheless in 1968 at Leszno in Poland, there were thirty-one GRP (Glassfibre reinforced plastic) gliders in a field of 100 and the top six places in the Open Class went to the plastics. In 1970 at Marfa in Texas, among a total of 79 competing sailplanes, there were only seven wooden and five metal aircraft. In 1972 at Vrsac in Yugoslavia, there were 10 wooden and one metal sailplane, the Italian Caproni Calif A - 15, in a field of 89. By the 1974 Championships in Waikerie, Australia, there were no wooden aircraft and only one metal, the Caproni A -21 two seater.

Carbon and Kevlar

It was already remarked in 1970 that the new plastic sailplanes, for good aerodynamic reasons, were beginning to resemble one another externally. The D - 36 would not have looked out of place in an Open Class competition thirty years later. (One of the two examples built remains in service.) All the designers, with computers and wind tunnel test results, were arriving at similar results. As the years passed the apparent similarities increased. Also, because high temperatures under strong sunlight are not good for the resins, sailplanes were finished in reflective white all over, except for occasional pale registration letters or numbers, the maker's logos and perhaps one or two patches of bright colour to aid visibility. To be sure of what one was looking at, it became necessary to ask, or peer into the cockpits.

There were, nonetheless, important differences, not always apparent from outside. Aerodynamic research, especially at Stuttgart, Braunschweig and Delft Universities, showed that sailplane performance could be further improved by introducing new wing profiles. There were advances in production methods. Balsa wood filling for sandwich skins was soon abandoned in favour of various 'hard' foamed plastics, unaffected by changing humidity. Vacuum bagging the hand-laid skins in the moulds, heating components in autoclaves to cure the resins, became normal practice. Aramid (Kevlar™) and especially carbon fibres, only whispered about in 1965, were introduced. By 1979 the cost of carbon fibre was not so excessive. Soon new designs were produced almost entirely in CRP (Carbon-fibre reinforced plastic). Stiffness and strength were achieved with much less weight. New methods of shaping the crucial moulds were introduced, computer controlled machinery replaced some of the difficult and energy consuming handwork, production lines were tidied up and better organised. There were important changes of emphasis in the design of cockpits. Attention was, at last, paid to protection of the pilot in accidents and heavy landings.

Since the late 'eighties, there have been further aerodynamic refinements. To understand these some technical knowledge is necessary and a brief attempt is made below to provide this.

Turbulators

Turbulators, usually on the undersides of wings and on tails, slightly in front of the hinged control surfaces, began to appear on sailplanes from about 1980 onwards.

Great improvements in sailplane performance had come from the adoption of low drag, 'laminar flow', aerofoil sections, particularly the NACA '6' series of profiles. In these, if the wing is accurately made, smooth and clean, the pressure change across the chord is as shown in Figure 1.

The highest pressure on a lifting wing is slightly under the leading edge. At this 'stagnation point' the flow velocity at the surface is effectively zero. From here, on both upper and lower surfaces, the velocity of the airflow increases until a minimum pressure point is reached. If the wing is at a suitable angle of attack, the acceleration is less below the wing than above, creating a pressure difference between the two. The total difference in pressure between the two surfaces, produces the lifting force. It is important to note that the flow on both sides speeds up at first after leaving the stagnation point.

6 – The D - 36, Phoebus, Dart 15 and Ka6CR were described in Volume 2 of the present series.

7 – See Volume 2

8 – Research on fatigue life of GRP sailplane structures was started at Darmstadt and by the Glasflugel Company in the sixties. It has continued ever since. For a survey see Technical Soaring, Vol 26, No 2, April 2003. Generalising, the metal fittings usually have lower fatigue life than the plastic composite structures.

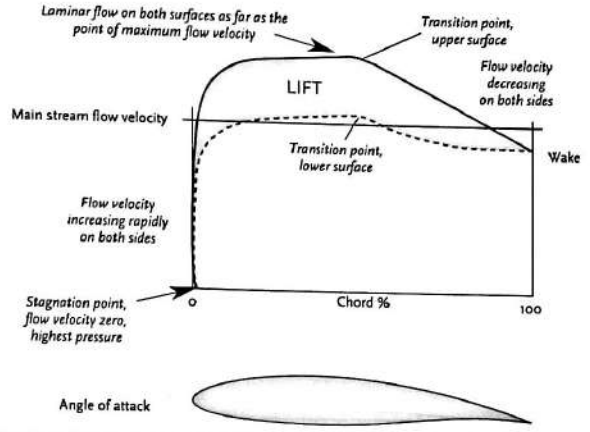


Figure 1

Flow velocity gradients over a cambered NACA 6 profile

After passing the minimum pressure point the flow velocity begins to fall again with the associated rise in pressure. In the forward zone on an accurately made and clean low drag wing, where pressure is falling, the boundary layer close to the skin remains laminar. In laminar flow layers of air slide smoothly over one another with little friction. After the minimum pressure point, the boundary layer on such a profile quickly becomes turbulent. A turbulent boundary layer has a scrubbing action on the wing, with high drag. The NACA '6' series profiles achieved low drag because laminar flow was preserved over much of the forward part of the wing. The second digit of the profile name indicates, in tenths of the chord, where the minimum pressure point should be, for example at 30% (NACA 633 - 618, Ka 6), 50% (NACA 652-515, Zefir 2). Because of imperfections in the wing skins, and because of the accumulation, in flight, of crushed insects on the leading edges, the designed figure was rarely or never reached but there was a great improvement in drag compared with the old Göttingen and NACA four digit profiles.

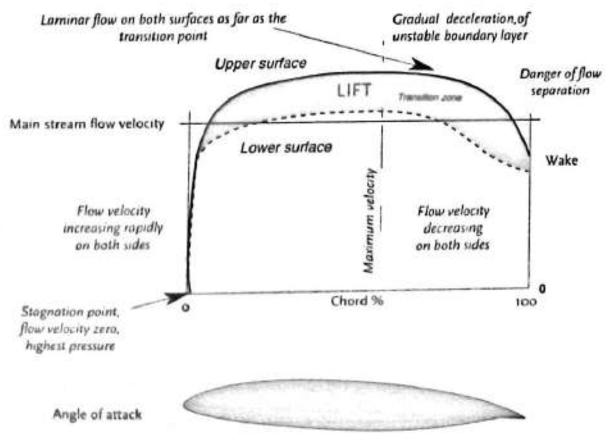


Figure 2

Flow velocity gradients over a modern sailplane profile

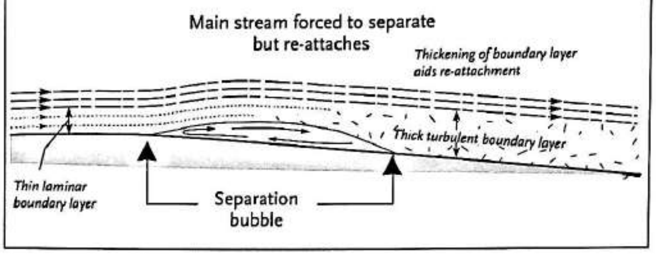


Figure 3: Laminar separation bubble with turbulent re-attachment

The next important steps forward were the result of calculation and research, chiefly by Richard Eppler and Francis X Wortmann, both at Stuttgart University, with extensive wind tunnel testing by Dieter Althaus. Figure 1 shows that the velocity gradient behind the minimum point on the NACA '6' profiles, starts abruptly. The pressure increases thence linearly to the trailing edge. The new profiles, by Eppler and Wortmann, were computed so that the onset of the inevitable deceleration was much more gradual. Air is a fluid and all fluids have a certain viscosity or 'stickiness'. In air, viscosity is relatively small but it exists and is influential at airspeeds applying to sailplanes. This allows the laminar boundary layer to persist, in a delicate state, for a small but useful distance aft of the minimum pressure point. A transition zone, rather than a definite point, can be established. Transition does eventually take place before the trailing edge is reached (Figure 2) but there is a saving in total drag.

With such profiles accuracy of the surfaces is of even greater importance. It is in this region of the highly sensitive boundary layer that many older sailplanes had ripples or humps where main wing spars lay just beneath the skin. The introduction of GRP structures enabled full advantage to be taken of the new principles. Another problem then arose. In flight, especially when low down and flying fast, sailplane wings, like car windscreens, pick up thousands of insect bodies, crushed by impact. Devices, called 'bug wipers', to clean these off in flight have been developed but are not wholly successful. Attention has been paid to designing wing profiles that will pick up fewer 'bugs'.

The detail of how a laminar boundary becomes turbulent has been the subject of much research, especially at Braunschweig and Delft Universities. Often, transition is associated with a separation 'bubble'. In laminar flow the layer of air nearest to the skin of the wing is scarcely moving, relatively to the surface. This is part of the reason for the low drag. When this very slow moving air begins to meet adverse pressure gradients, it comes soon to a standstill. Thus halted, it forms a barrier to the flow immediately behind it. The general stream cannot

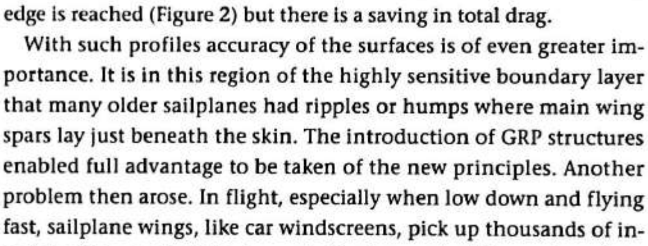


Figure 4: Turbulator forces transition without separation

stand still. Air cannot behave like cars in a traffic jam. The flow rides up over the blockage and separates from the wing surface. Such a disturbance breaks up the smooth laminae. The boundary layer becomes turbulent and considerably thicker. All being well, after a short leap the flow returns to the skin, albeit with the usual scrubbing, high drag action of turbulent flow. Just behind the separation point there forms a small zone of stagnant air, not moving with the general flow but forming a small 'bubble' which, although having no true skin, has its own internal sluggish circulation. The separation bubble behaves like a small air brake, increasing the drag (Figure 3).

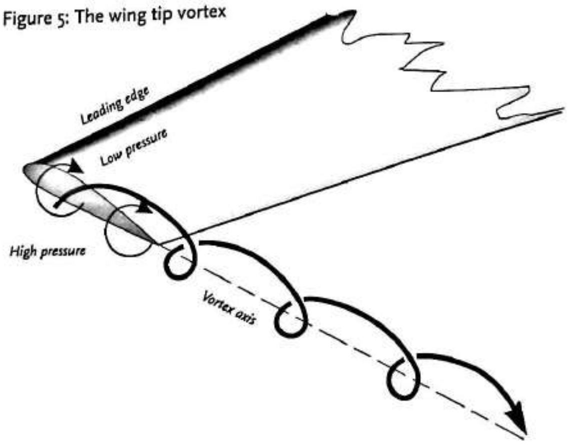
If the boundary layer has already made normal transition to turbulence, no laminar separation bubble will form. On a sailplane wing, the worst effect of the separation bubble can be avoided by 'triggering' transition just before the lowest lamina comes to a halt. This can be achieved by adding a turbulator. (Figure 4. Some of the earliest work on turbulators was done for model aircraft by F.W.Schmidt in the late 1930s [9]. Model wings suffer much more from laminar separation than full scale sailplanes, because the chord may be smaller than the entire extent of the bubble. The boundary layer never re-attaches. Laminar separation is then effectively a complete stall of the wing.) The most common type of turbulator is zig-zag tape glued on to the wing or tail surface at the required locations.

On wings the turbulator tape is usually on the undersurface about 60 or 70% of the chord. Pneumatic turbulators blow air out of the wing at critical points through lines of pin holes in the skin. The air is supplied by small intakes at points of high pressure. There is a slight penalty but this is more than offset by the avoidance of the bubble separation.

Wing tips and Winglets

For any sailplane, soaring in a thermal or other upcurrent, more than 70% of the total drag comes from the wing tip vortices. A tip vortex is formed on a lifting wing because of the difference in pressure between the two surfaces. Instead of moving directly from leading edge to trailing edge, the flow is distorted, that on the high pressure side diverting out and up, and that on the low pressure side inclining inwards. A vortex forms and trails off behind the wing. The loss of energy is very great, especially when the wing is operating at a high angle of attack, as in slow flight (Figure 5).

Figure 5: The wing tip vortex



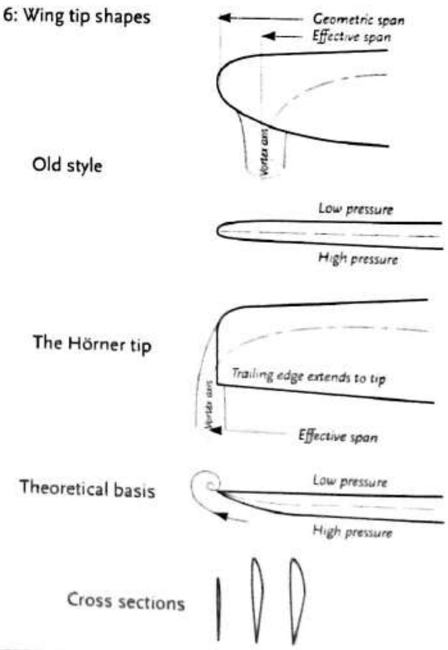
There were many attempts to reduce the very serious drag of tip vortices. Placing large flat plates at the tip, to straighten the air flow, has little effect unless the plates are impossibly large. Adding streamlined tip bodies is unprofitable, barely affecting the vortex, yet adding the surface friction and pressure drag of the body itself to the total. Curving the tip down to check the outward flow from underneath, has little effect. The most hopeful results came from the slightly upswept wing tips devised by Sigmund Hörner. A great many sailplanes have Hörner tips. It is also calculated that a wing tip should be slightly swept back (Figure 6).

In 1976 R T Whitcomb, a NASA aerodynamicist, published results showing that the addition of a very carefully shaped cambered winglet to a wing tip yields a worthwhile improvement. Viewed from the front, the vortex of the left or port wing tip of an aeroplane or glider, in normal flight, rotates anti-clockwise. A well designed winglet deflects the flow above the wing slightly outwards, tending to reverse the rotation. The winglet is cambered and set at such angles to the flow in the main vortex that it develops the required action. The air above the wing, tending to move inwards, passes round the cambered winglet and leaves the trailing edge in a direction against the main vortex flow (Figure 7).

The vortex system as a whole is not totally removed. The winglet itself is a lifting surface and has its own tip vortex. Because it is in the airflow, it also creates surface and pressure drag like any other part of the aircraft. But the total vortex system is more diffuse and less energy is lost.

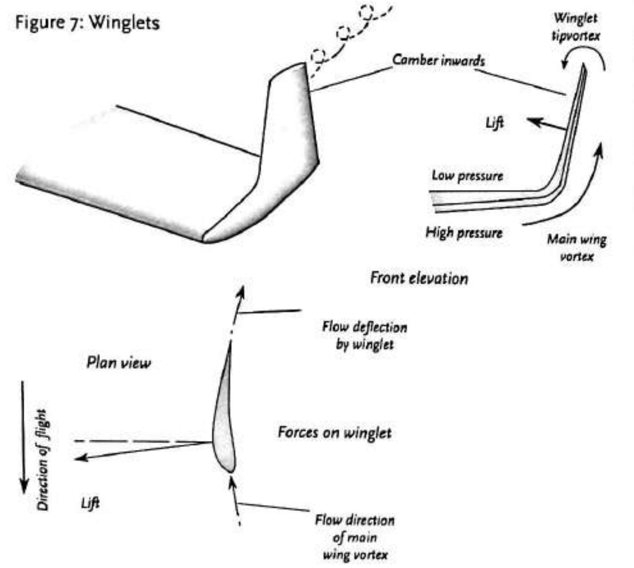
Sailplane designers did not immediately adopt the winglet after Whitcomb's work was published in 1976, partly because the drag saving applies chiefly at high angles of attack and low airspeeds. At high speed, gliding fast between thermals, the tip vortex drag

Figure 6: Wing tip shapes



9 – Aerodynamic des Flugmodells, 1942, later editions available.

Figure 7: Winglets



is a much smaller proportion of the whole and winglets add to the general parasitic drag. Research by students at Braunschweig, on a typical 15 metre sailplane, suggested that to achieve the greatest reduction possible of vortex drag required winglets about one metre tall. Such an extension created too much drag at high speeds. Large winglets also increase the loads on the mainplane, adding considerably to bending and twisting moments and encouraging flutter.

It was subsequently found that relatively small winglets, if correctly placed, cambered and set, are effective in reducing vortex drag and do not measurably affect the high speed glide. Most sailplanes since 1990 have been offered with winglets as options. In addition, older sailplanes have been retrospectively modified by adding winglets. An example is the Standard Libelle.

A small point about winglets is that they should be arranged so that, when the sailplane wing is bending upwards in flight, the inward force produced is horizontal. For this reason winglets are usually set at slightly outward tilt when the sailplane is at rest and in this position may slightly exceed the nominal wing span. Turbulators are also often fitted on winglets.

The performance improvement in flight is not always apparent to the pilot. Winglets do not instantly yield vast improvements in rate of climb when soaring. The gains are small. Where their value does become immediately clear, is in aileron control at low airspeeds. The winglet improves the airflow over the outer wing so that the ailerons become more effective, especially during the early stages of launching and after landing.

Polyhedral

Further research and calculation by Clarence D Cone in the USA and Richard Eppler in Germany, has shown that vortex drag can be reduced if the wing is curved upwards to produce a more or less elliptical form of dihedral. Many of the large 'Open Class' sailplanes approximate this in flight because the wings bend upwards under load. In the smaller fifteen metre classes the wings bend less. It is almost impossible to build a curved wing, but slight polyhedral may be introduced. Again, as with winglets, any improvement in soaring performance is hard to demonstrate but the additional dihedral has noticeable, and usually favourable, effects on stability and handling.

Performance testing

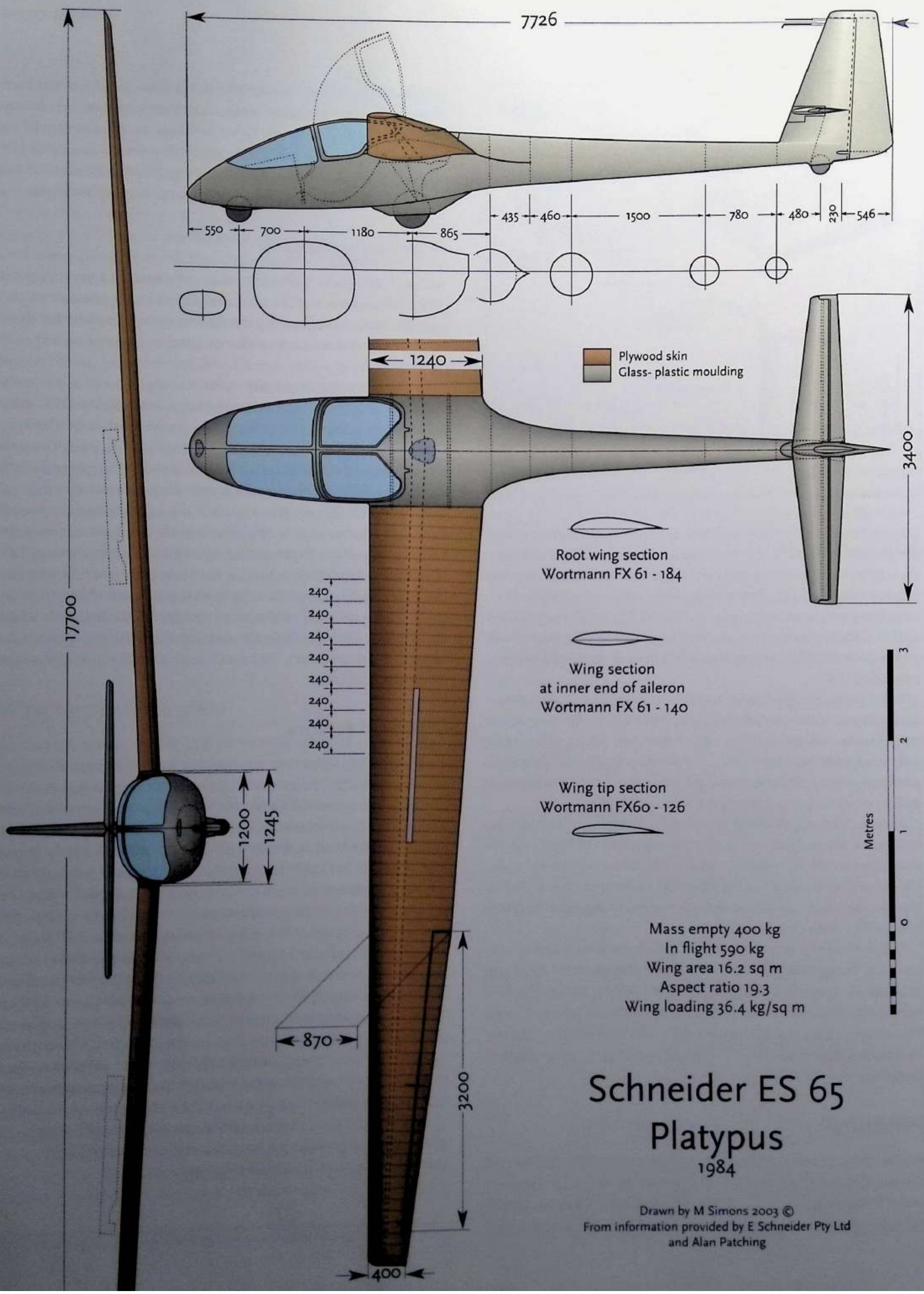
Sailplane designers invariably make estimates and publish polar curves. There are always some imponderables in the equations and such estimates have usually proved somewhat optimistic. For these reasons performance curves were not given in the previous volumes of this series.

Accurate tests in flight were carried out on only a few early sailplanes before the Second World War, notably by the DFS, and a BGA test group measured polar curves of a handful of sailplanes in the early 'sixties.[10] Since then, led by Hans Zacher of the German Aerospace Centre (DFVLR), Paul Bikle and the Dallas group of Dick Johnson in the USA, many more systematic performance tests have been made. Where possible, the resulting published polars are included on the drawings in the present work, to a constant scale for ease of comparison. Flight testing of sailplanes is a notoriously difficult enterprise. Small variations in the air mass where the flights take place affect the results. Pilots flying the tests differ in technique. There are small differences between individual sailplanes, even coming from the same moulds. There is a degree of statistical 'scatter' in all the results. Too much faith should not be placed on the resulting figures.

Outboard motors

More and more sailplanes appear with self-launching or self-retrieving capacity. The idea of fitting a small engine to a glider is almost as old as human flight itself; the Wright Brothers were the first to do it successfully. The first serious rally for motor sailplanes was held in 1959, with rather limited success. It was fair to say at that time that a glider with a motor was neither a very good soaring aircraft nor a very good aeroplane. But improvements in the sailplanes themselves and fully retractable power units, changed this. Most sailplanes produced in 2000, if not all, were available with fully retractable propulsion systems, 'outboard' motors in the same sense as a yacht may have a small motor to get out of the harbour or return to port after sailing. Powered sailplanes became well recognised and may set up their own class records. They are also allowed to compete, without their motors, in championships against 'pure' sailplanes. At a time when most sailplanes are expected to carry large amounts of water ballast nearly all the time in flight, the weight of a motor is of little significance. Once retracted, the glide performance is the same. The introduction of electric and even solar power opens another promising line of development.

10 - Deutsche Forschungsanstalt für Segelflug, British Gliding Association


7726
550
700
1180
865
435
460
1500
780
480
230
546
1240
Plywood skin
Glass- plastic moulding
3400
17700
240
240
240
240
240
240
240
240
1200
1245
870
3200
400
Root wing section
Wortmann FX 61 - 184
Wing section
at inner end of aileron
Wortmann FX 61 - 140
Wing tip section
Wortmann FX60 - 126
Metres
0
1
2
3
Mass empty 400 kg
In flight 590 kg
Wing area 16.2 sq m
Aspect ratio 19.3
Wing loading 36.4 kg/sq m
Schneider ES 65
Platypus
1984
Drawn by M Simons 2003 ©
From information provided by E Schneider Pty Ltd
and Alan Patching

Australia

Modelled largely on the British Gliding Association, the Gliding Federation of Australia (GFA), under official delegation, controls almost every aspect of administration of the soaring movement. Recognising that this relieves the government of much expense the Federation is partly subsidised but there are no funds whatever allocated to the support of research, design activity or production of sailplanes. The GFA can lend moral and verbal support to any project it favours but cannot distribute funds, place advanced orders, or promote particular design groups or companies. Professional sailplane manufacture has always depended on private companies. Only one of these survived for any length of time, Edmund Schneider Pty. No sailplanes have been built by that firm since 1982. There has always been a good deal of amateur building, using imported plans and kits. Some highly original design work never moved beyond the drawing board. Several very promising ventures, such as an advanced tailless sailplane by John Buchanan, despite a great deal of work, did not in the end produce even a flying prototype.

Schneider ES 65 Platypus

The firm of Edmund Schneider was founded in 1928 at Grunau in Silesia. Unable to continue after the region was allocated to Poland at the end of World War 2, Edmund and his sons emigrated and in 1952 established a sailplane factory in the State of South Australia near Adelaide. Production of a series of successful designs followed, the ES - 60 and 60B series remaining in production till 1970.[11]

Harry Schneider, now head of the firm and the only designer, for a few years acted chiefly as agent for the importation and servicing of sailplanes from Europe. However, he felt there was a need, in Australia and elsewhere, for a good two-seater with side by side seating, for advanced training and cross country flying. He began preliminary work on a new design, the ES 64, intending to use the wooden wings of the ES 60 for the prototype, but with a GRP fuselage. There would be a retracting undercarriage and tail braking parachute. There was nothing anywhere comparable at that time, except the all-metal Caproni A - 21 Calif, which was much more expensive. Schneider hoped for some exports as well as challenging imported, tandem seat, aircraft in the local market. He envisaged that after testing, the wing would be made in GRP for production. Only lukewarm interest in the proposed ES 64 was expressed by the gliding clubs and, because the plastic materials were unfamiliar to the airworthiness authorities, it seemed likely there would be difficulties with flight testing a prototype. Schneider became discouraged. Financial support was not forthcoming and work ceased.

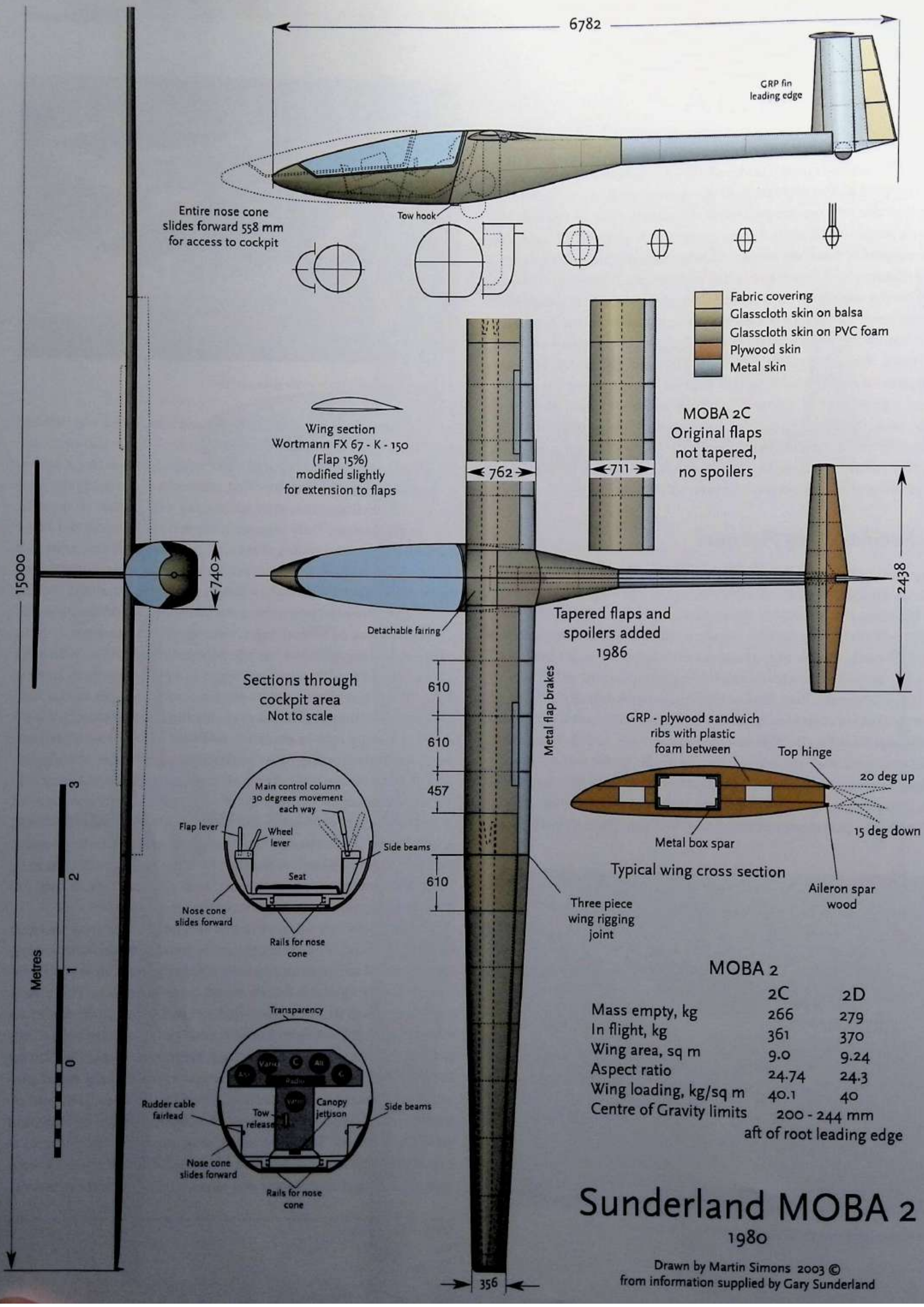
The Platypus preparing for its first flight

The Platypus cockpit canopy in the open position

After a hiatus of several years, during which some partly-built components languished in storage, Schneider decided in 1983 after all to go ahead to complete a prototype as a private venture, hoping that when it was flying, orders would come. Changes in the Australian airworthiness rules had made testing a new prototype easier. Much re-design and re-thinking followed. The more expensive items, like the retracting wheel and tail parachute, were abandoned, but the basic idea of a modern, low drag fuselage with side by side seating was retained. A nose-wheel was built in, with a well-faired main landing wheel and hydraulic brake, slightly behind the laden balance point. The extended ES 60 wing was used, with the prospect of plastic moulding later, as before. The tail was GRP with carbon fibre in the elevator to reduce its mass. Rudi Geismaier, a graduate enginer from Munich, came to work for the small company.

The completed ES 65, now called 'Platypus', was first flown at Gawler in August 1984. It was generally considered very impressive, handling well and performing fully up to expectations when flown comparatively against a locally-based Grob Twin Astir. There were ambitious plans to make the transition to GRP and put the ES 65 into production. Schneider himself could not undertake such a venture without very substantial backing. He proposed that the Gliding Federation of Australia should undertake control of the entire project, development and production. The GFA, however, was (and remains) only a representative body of delegates elected by clubs and state associations. Tentative plans were made by the Federation Council for the foundation of an independent consortium. A referendum among club members was staged to discover if there was suf-

11 – See Volume 2, p. 242



MOBA 2

	2C	2D
Mass empty, kg	266	279
In flight, kg	361	370
Wing area, sq m	9.0	9.24
Aspect ratio	24.74	24.3
Wing loading, kg/sq m	40.1	40
Centre of Gravity limits	200 - 244 mm aft of root leading edge	

Sunderland MOBA 2

1980

Drawn by Martin Simons 2003 ©
from information supplied by Gary Sunderland

ficient interest to launch this scheme. A levy was proposed, and shares in the proposed manufacturing company were offered. Nothing like the required funds was found. More time passed and nothing satisfactory emerged. In 1987, despite touring the country for display purposes and allowing many pilots to fly the Platypus, it became clear that the ES 65 would never enter production. There was some slight expression of interest in licence production in Europe, but this, too, faded. Harry Schneider by now was expecting soon to retire from business. The Platypus was offered for sale as it stood and was bought at last by members of the Gliding Club of Victoria, based at Benalla north of Melbourne. At the time of publication it remains there, popular with pilots and giving very good service.

(Thanks to Harry Schneider and Alan Patching for assistance with this article.)

Above: Gary Sunderland's Moba 2 showing the sliding nose cone partly open
Below: The cockpit and instrument panel of the Moba

Sunderland MOBA 2

Gary Sunderland, an aircraft engineer, had a long-standing ambition to design and build his own sailplane, to compete in and even win the Australian National Gliding Championships in it. It would be, he said, with tongue in cheek, "My Own Bloody Aircraft". The acronym, MOBA, stuck. As a pilot Sunderland already knew the Libelle H - 301, and hoped to improve on this or at least equal it, but with a sailplane that could be assembled easily at home without expensive moulds, jigs, and tooling. After preliminary studies, he began work on the Moba 2. This was to be a 15 metre span sailplane but with a retracting main wheel and landing flaps rather than air brakes. It would not, therefore, conform to the prevailing Standard Class specification. Preliminary general arrangement drawings were completed early in 1970 and some metalwork was done to establish feasible methods.

The main load bearing structures were in light alloy, but the outer form of both wing and fuselage were in glasscloth, supported by plastic foam. A particularly original idea was the nose cone. This was a shell of glass cloth and balsawood, with the transparent canopy in one piece. To give access to the cockpit the entire cone moved forward on rails and rollers. When closed, nothing disturbed the airflow over the fuselage as far back as the wing root. The cone was easily removed, allowing easy access to all the cockpit controls and instruments for maintenance.[12] Instruments and controls, the pilot's seat and the retracting main wheel, were carried on a substantial metal box structure. The cockpit was small and narrow, too small, Sunderland admitted, for pilots much larger than himself. The main control column was mounted on the right side, instead of centrally. This original feature allowed even more space to be saved by conducting all control drives down the cockpit sides, below shoulder height.

Substantial vertical frames supported the wing. The rear fuselage was a built up metal tube of oval section with flat panels above and below, for simplicity in assembly. The vertical tail was metal with a fabric covered rudder, the tailplane metal but the elevator in wood, skinned with plywood for stiffness.

The wing was in three pieces, a rectangular centre section carrying the flaps, with tapered outer panels and metal-skinned ailerons.

12 – Sunderland's removable nose cone was mentioned by the author in an article published in a model flying magazine in 1980. The idea was adopted by the Australian International Team for the World Championships in the F3B category. It was subsequently very widely adopted for model sailplanes.

There was a large, rectangular-section main box spar. Accurately cut marine plywood ribs were fitted around the spar, bolted to it at 610 mm (24 inch) intervals. Large blocks of urethane foam were glued between the ribs, cut and sanded to shape. The ribs acted as templates for this. After final truing up and sanding, the glasscloth skin was added.

In August 1970 the magazine, Australian Gliding,[13] announced a design competition. The intention was to encourage the development of small, inexpensive cross-country and contest sailplanes capable of being built by amateurs. Nothing was stipulated about materials but the span was limited to 13 metres. The performance was to be as good as possible, with the required simple structure. Entrants were required to submit their designs on paper with the necessary stressing justification, performance estimates and details of construction methods. Part of the prize was to be the building of a prototype by one of the sponsor organisations. After successful testing there was the prospect of marketing plans and kits.

Sunderland entered the design competition, which was to be judged at the end of the following year. His entry was the MOBA 2B, the span cut to the specified thirteen metres.

Entries, many of them very promising, were received from all over the world. In 1972 the Moba 2B was one of two judged to be outstanding, the other being a design in metal by Imré Bano in Hungary.[14] Unfortunately, after long argument, the judging committee could not agree on the final award. The competition ended in fiasco. The prize was never awarded and no prototype was built.

Sunderland nonetheless persevered with his fifteen metre design. Before the 1974 World Championships, which were to be held at Waikerie in South Australia, the Standard Class specification was changed. To Sunderland's delight, flaps and retracting wheels were to be permitted and the Moba 2C would now conform. He hoped it would be possible to get the aircraft finished in time for an Australian pilot to fly it in the 1974 contest.

In the event, there was not enough spare time available. Construction of the sailplane took six years. Moba 2C did not complete test flying until 1980, after which it was granted a certificate of airworthiness. It handled well, although even with the flaps fully down for landing, Sunderland found it advisable to add spoilers and increase the flap chord at the root. The result was the Moba 2D.

Although by the time the sailplane flew it was considered out of date it achieved the performance expected. In competition it climbed in thermals with larger 'Open Class' sailplanes although, as expected, it did not glide so well as they at high speeds.

Unfortunately, after some time the urethane foam began to change, expanding enough between the ribs to spoil the wing contours. Much effort was required to restore the correct form. This involved stripping the skin off the wing, sanding and filling the foam to contour, re-skinning and re-painting. After this the Moba 2 was flown again but, having proved his point to his own satisfaction, Sunderland did not persevere with the design. When it was retired from flying, Moba 2 was more or less abandoned.

(Thanks to Gary Sunderland for assistance with this article.)

13 – The Journal of the Gliding Federation of Australia, edited at this period by the author.

14 – Another Hungarian entrant, Kesselyak Mihaly, submitted a design which had some features similar to his KM - 400, see page 177 below. The judges thought it too advanced and difficult for amateur builders.

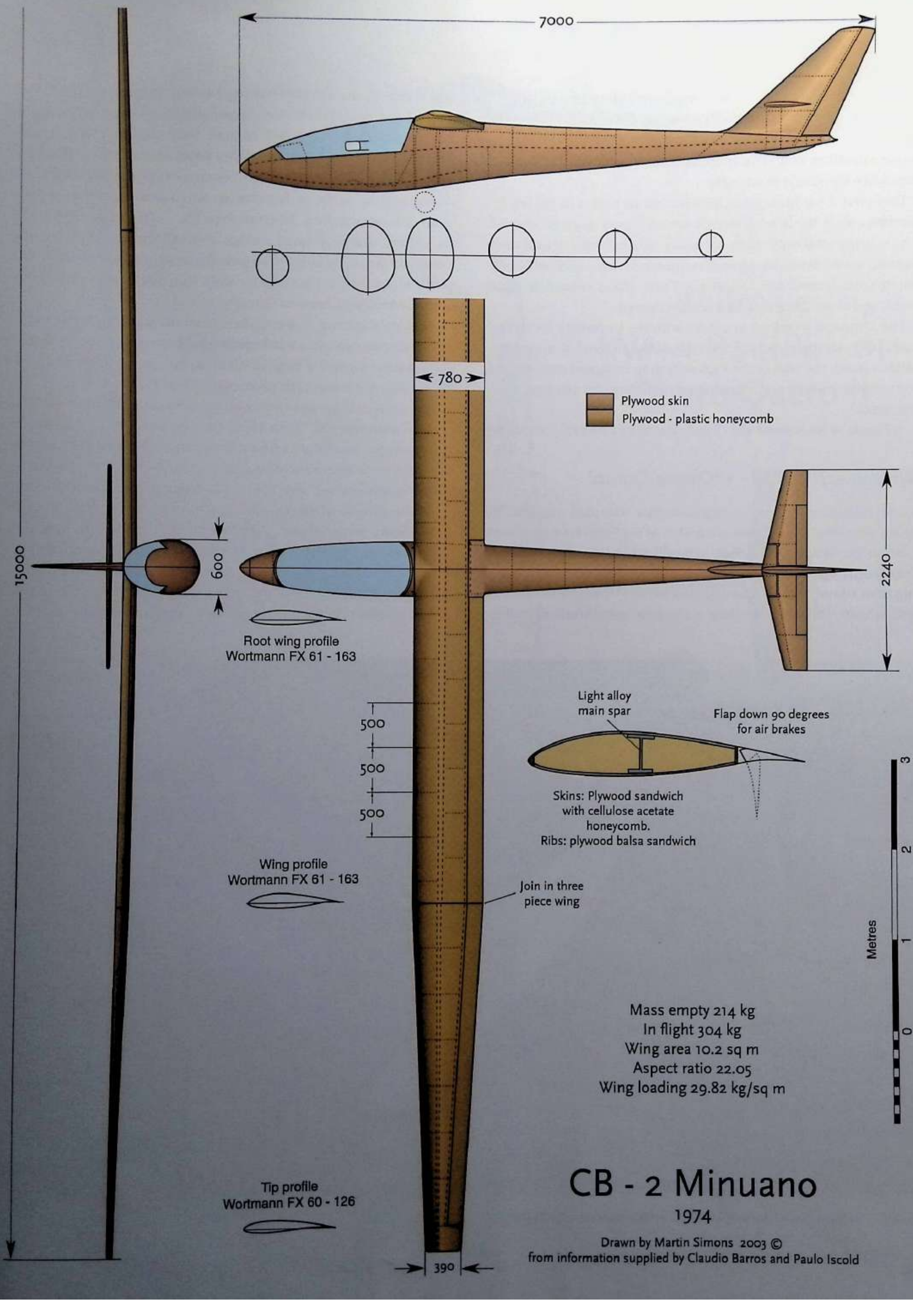
BRAZIL

Gliding in Brazil has never had a very large following but there has been some government support. This has been irregular and not an unmixed blessing. When government funds and bureaucracy are involved, there also come politics, red tape, and the possibility of undue influence from pressure groups. Much of the country is very difficult for cross country soaring, and the small community of glider pilots has always faced severe difficulties. Clubs and private owners have relied to a large extent on imported aircraft, but these are often prohibitively expensive. All attempts to establish a local sailplane design and manufacture industry failed in the long run. Nevertheless there have been some Brazilian sailplane designs. One was the Standard Class IPD Urupema, designed in 1964 by student engineers at the Centro de Estudos Aeronauticos of the University of Minais Gerais. In appearance the Urupema was likened to a Foka 4 but the structure was different. The skins were of sandwich type with honeycomb paper cores. Few other details have been preserved. One competed in the World Championships in 1968 and two in 70, but the pilots were not experienced in contest flying. Although not disgraced, they did not place highly. It is said that twenty of the Urupema were built by the leading Brazilian aircraft manufacturing firm, Embraer.

CB - 2 Minuano

The Minuano (South-west wind), reputedly the best sailplane ever produced in Brazil, was designed by Professor Claudio Barros of the Centro de Estudos Aeronauticos at the University of Minais Gerais. It was Baros' second sailplane design, the first being the CEA - 101 CB - 1 Gaivota (Gull). The Minuano was built in the University workshops during the period 1970 - 74. It employed the latest wing profiles available from FX Wortmann with a high aspect ratio, three piece wing mounted high on the fuselage. The wing spars were of light alloy, cleaned and etched for gluing with epoxy resin glue. Ribs, spaced at half-metre intervals, were cut from a sandwich material of Brazilian pine plywood outer layers with balsa filling. The

The Urubu two seater. Only the prototype was built but it remains in service at Sao Jose dos Campos.



Mass empty 214 kg
In flight 304 kg
Wing area 10.2 sq m
Aspect ratio 22.05
Wing loading 29.82 kg/sq m

CB - 2 Minuano

1974

Drawn by Martin Simons 2003 ©
from information supplied by Claudio Barros and Paulo Iscold

wing skins were also of sandwich type, the filling being cellulose acetate honeycomb. Experience gained from the Urupema encouraged the use of these methods, rather than attempting to make the whole aircraft in GRP. The external surface form was excellent at least when the sailplane was new.

There was a tail brake parachute but no air brakes in the wings. Landings were made with flaps lowered ninety degrees, the tail 'chute being used only when necessary. The fuselage, of oval cross section, was an orthodox plywood semi-monocoque shell with stiffening cross frames and longerons. There was a retracting main wheel and a one-piece moulded cockpit canopy.

The Minuano remained in service with the University for several years but only the prototype was completed. In 1980, during a disastrous flood, the wall of the CEA workshop collapsed and crushed the sailplane which was stored there. Nothing was salvaged from the wreck.

(Thanks to Paulo Iscold and Claudio Barros for help with this article.)

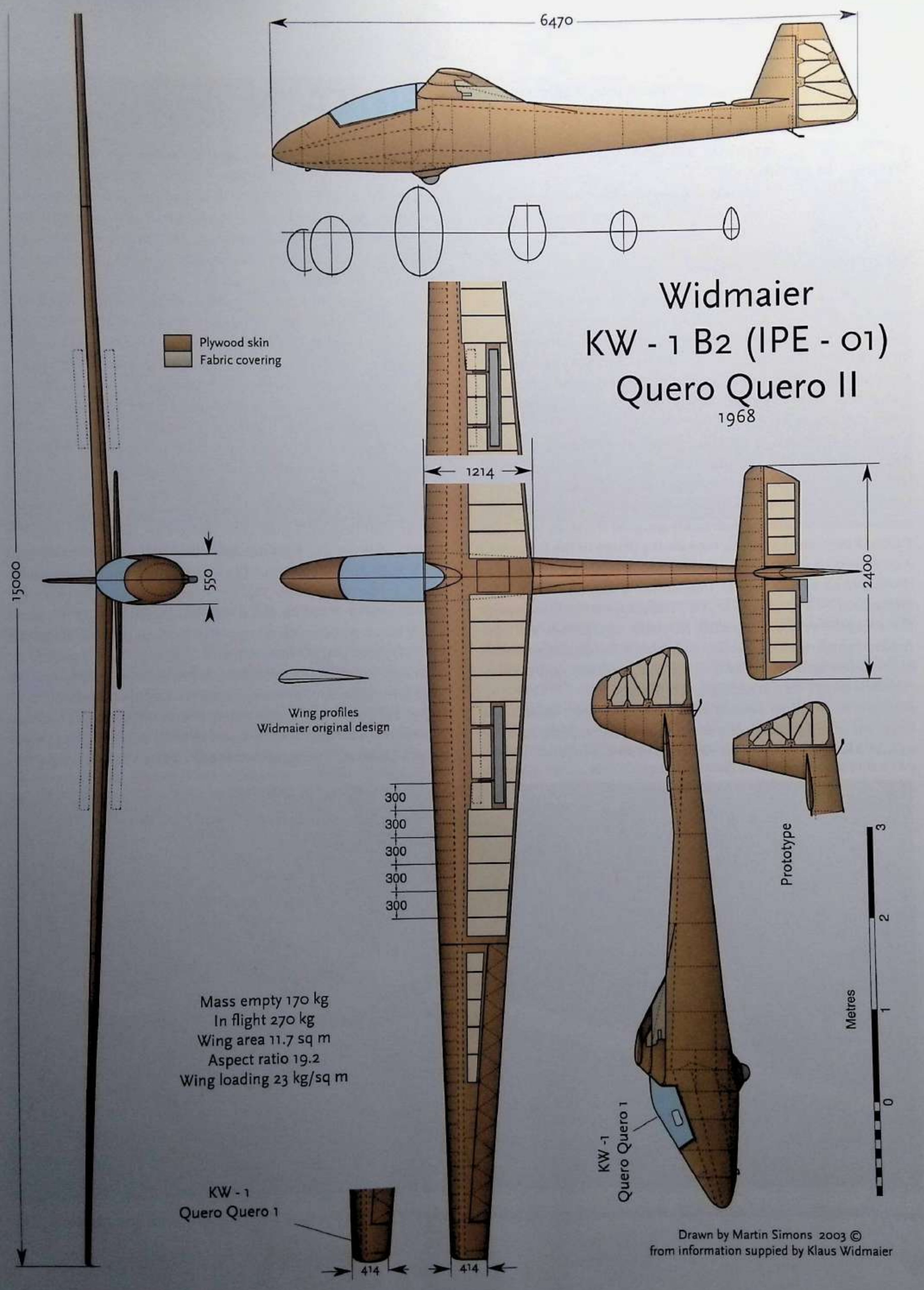
Widmaier/IPE KW - 1 'Quero Quero'

Kuno Widmaier, a German engineer-pilot who had migrated to Brazil after World War 2, was a member of the Novo Hamburg Aero Club in Rio Grande do Sul State. A need for some locally produced, inexpensive and simple club sailplanes was recognised. With backing from fellow members, he designed the KW - 1 single seater of 15 metres span. The glider was built at the club, using Brazilian materials, chiefly Freijo, a timber comparable with Baltic pine. The KW - 1 followed an old tradition. Aerodynamically the wing profiles, apparently designed by Widmaier himself, were similar to the profiles favoured by Egon Scheibe for his Mü series and the earlier Bergfalke types. The structure was entirely of wood, with plywood and fabric covered flying surfaces. The fuselage was a semi-monocoque form with oval cross section. The prototype KW - 1, flown in 1976, had a very short nose with small cockpit, so small that many pilots were unable to get in. Probably Widmaier designed it round himself. The performance, quite adequate for early solo pilots, was comparable with the existing L Spatz in Germany.

A group of gliding club members from the state of Parana, some of whom had experience in building sailplanes from German and Swiss plans, formed a company, the Industria Paranese de Estruturas (IPE), and bought the production rights for the KW - 1.

The small cockpit was improved by extending the nose and the rudder was enlarged. With these changes the KW - 1 was much improved in handling. Further modifications resulted in the KW - 1B, of which five were built and eventually the KW - 1B2, officially re-designated the IPE - 01, became a successful club sailplane. One of these was used for structural testing by the Civil Aeronautics department. Airworthiness certification was approved and production began. The sailplanes were bought by the official Department and thence distributed to gliding clubs. A total of 154 were completed and they became one of the mainstays of the Brazilian gliding movement. Production ceased in 1988.

The KW - 1 B2 Quero Quero, later called the IPE - 01 became a useful club sailplane


Widmaier
KW - 1 B2 (IPE - 01)
Quero Quero II
1968
6470
Plywood skin
Fabric covering
1214
15000
550
2400
Wing profiles
Widmaier original design
300
300
300
300
300
Prototype
Metres
0
1
2
3
Mass empty 170 kg
In flight 270 kg
Wing area 11.7 sq m
Aspect ratio 19.2
Wing loading 23 kg/sq m
KW - 1
Quero Quero 1
KW -1
Quero Quero 1
414
414
Drawn by Martin Simons 2003 ©
from information suppied by Klaus Widmaier

With adequate inspection and maintenance, and mandatory modifications, many remain in service. One of the KW - 1 sailplanes achieved a certain fame by surviving a lightning strike in 1992. The pilot was able to land safely but there was serious damage to the aircraft.

(Thanks to Klaus Widmaier for assistance with this article and the one following.)

Widmaier KW - 2 'Bigua'

Kuno Widmaier's second sailplane design, like the KW - 1, was intended to provide clubs with a useful, safe and inexpensive training aircraft using local materials. It was a tandem two seater with swept forward wings. It was entirely traditional in concept and structure. As with the KW -1, the nose was at first too short, making the cockpit too small. This was corrected. The name 'Bigua' is that of a bird found in southern Brazil.

The first flight was in 1975 at the Novo Hamburg club field. All proved satisfactory and the design was approved, certified airworthy and registered. It was considered for production by the IPE Company but was not, after all, adopted. Instead, the Centro Tecnico de Aeronautica offered their newly designed Urubu in 1977. (The CTA had been responsible in 1964 for the design of the Urupema.) A prototype Urubu was built. The IPE group however, preferred to develop their own two seater. Unfortunately when completed this aircraft, the 17.2 mere span IPE 02 Nhapecan, proved considerably more expensive than imported European equivalents and also needed further work on stability and control. Production of 70 was nevertheless authorised. Many of the clubs were seriously dissatisfied with the IPE 02 and refused to use the type.

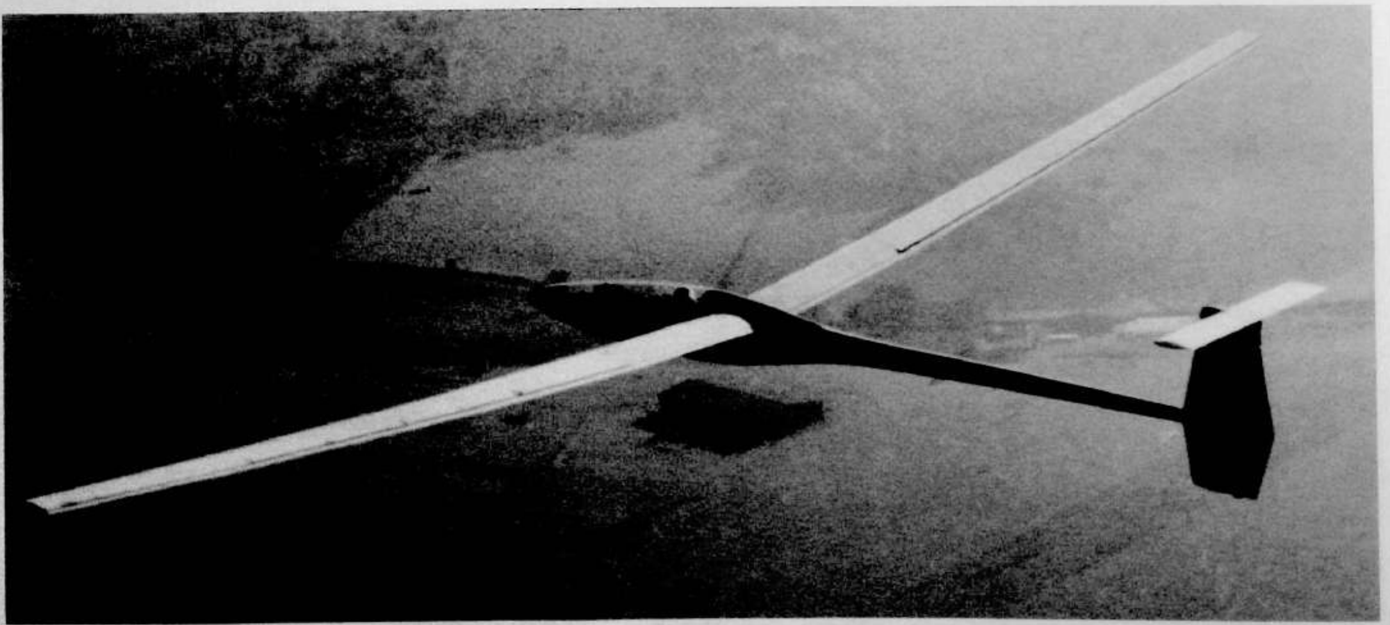
Attempts in Brazil to develop and produce a good two seat two seater for training ended after these unfortunate experiences. The solitary KW - 2 and the Urubu, remained in service in 2000.

BRITAIN

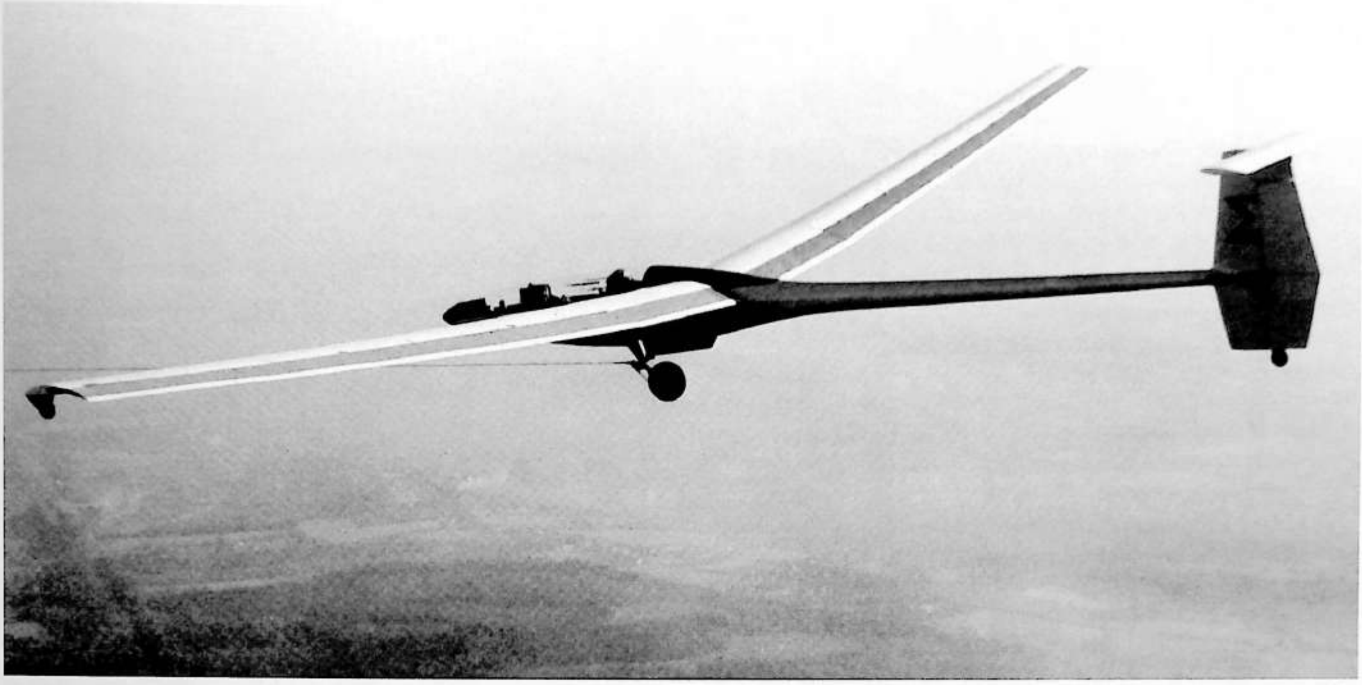
Sailplane design and manufacture in Britain was, from 1931 onward, chiefly centred at the Slingsby factory at Kirbymoorside in Yorkshire. The only other large manufacturer, Elliots of Newbury, beginning after World War 2, ceased glider production in 1966. Other firms, usually small and inspired by one or two enthusiasts, were formed. Some produced a few sailplanes, but had only limited success in the market place.

Among the original designs that flew during the 1965 - 2000 period, was the Torva, a GRP sailplane designed by John Sellars and Chris Riddell. Sellars had been employed by Slingsby and was Chief Designer for the Sigma (see below). The Torva was intended as a club sailplane conforming to the Standard Class rules, optimised for soaring in weak English thermals. A more advanced version with flaps and ballast tanks was also envisaged. Early flights in 1971 were successful and a limited production was undertaken. The clubs, however, did not show sufficient interest in the type and the firm was closed down.

Another attempt to break into the sailplane business was made by the Birmingham Guild Ltd. The design team included L P Moore, J Gibson and K Emslie. They flew their 12 metre Gypsy in 1970. With span extended to 13.46 metres and some re-design for easier production, the BG 135 was completed and offered on the market in 1971. It was all metal with a rectangular wing planform and V tail. It was a small, inexpensive 'general purpose' sailplane for clubs and private owners, with a performance comparable with existing, wooden, Standard Class sailplanes. Early reports were favourable and, flown by experienced pilots, it placed creditably in 'Sport Class' competitions. With minor improvements production was subsequently taken over by another group, Yorkshire Sailplanes, who marketed the BG 135 under the name YS -



Sigma over the airfield at Lasham with the flaps and undercarriage (includiung tailwhell retracted)



Sigma in tow with flaps extendended (Photos Ann Welch)

55 Consort. There were, however, few orders and the firm was dissolved in 1973.

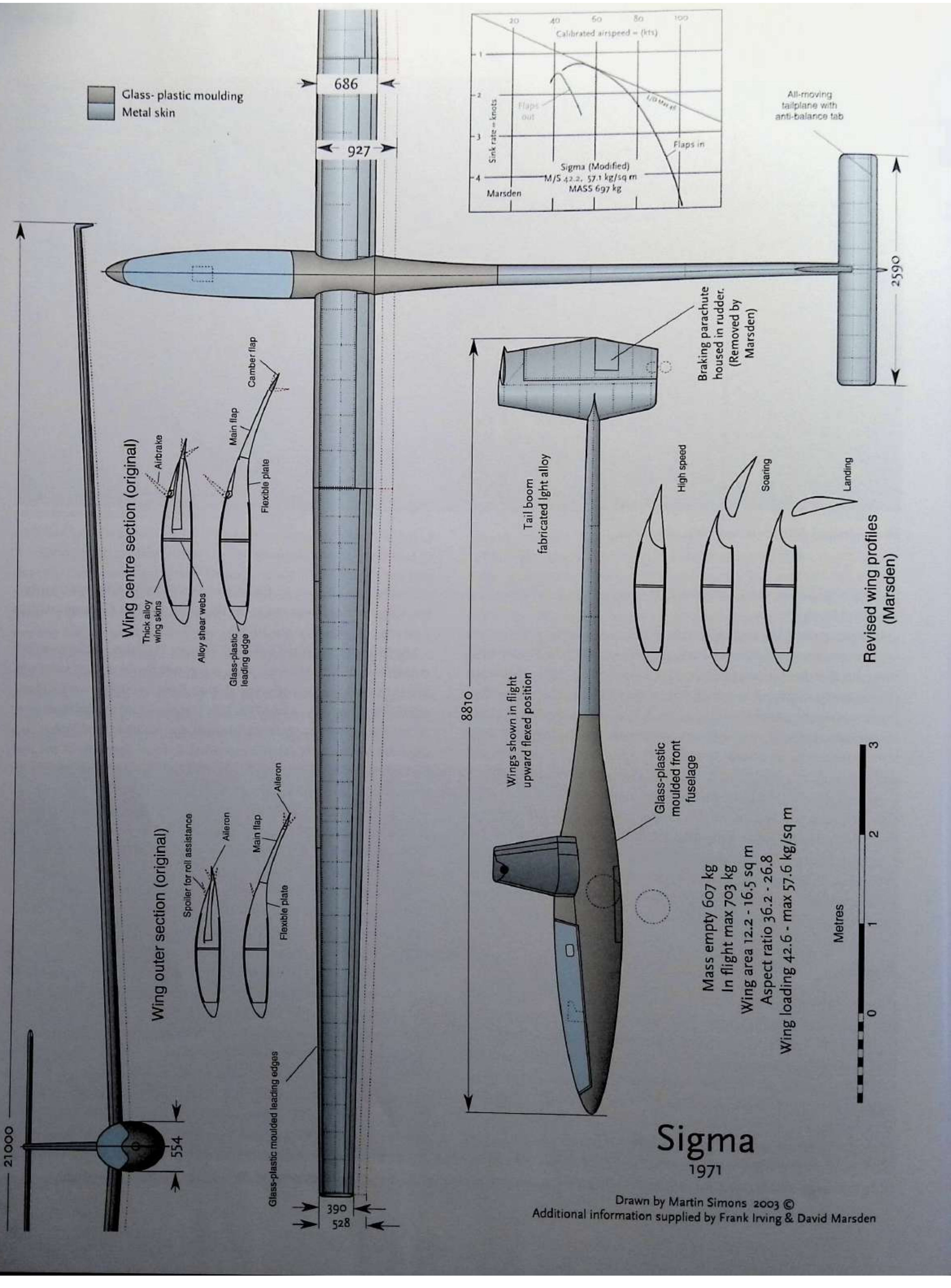
Another serious attempt in Britain to produce a cheap sailplane, in kit form for assembly by amateur builders, was made by Edgley Aviation who flew the prototype Edgley EA 9 Optimist in 1995. This was a fifteen metre sailplane in which extensive used was made of a composite sandwich material known as 'Fibrelam'. This was used in airliners for light but stiff panels, floors and interior walls. Two GRP skins were separated by an aramid honeycomb core. This very light and stiff material was not well suited to moulding in three-dimensionally curved shapes but could be formed into simple curves such as wing skins. The fuselage was made from flat panels, with tabs and slots to join them somewhat like a cardboard cut-out model. Jigging was unnecessary. Wing spar caps were made from carbon fibre 'pultrusions'. In competitions, flown by Derek Piggott, the EA - 9 did very well, flying in its class as a 'club' or 'sports' sailplane. Commercially there was not much interest and production ceased after a few had been built.

Sigma

In the mid sixties it was becoming clear that the British were falling behind in sailplane design. In World Championships leading pilots were compelled to use foreign aircraft if they hoped to win. A major improvement was needed. It was in particular Nick Goodhart, one of the best competition pilots, who decided something radical must be done. A new, different type of sailplane was required, one that would incorporate the sum total of all the knowledge currently available. It would be represented by the mathematical symbol for summation, Σ, Sigma. It should be possible to design and build a magnificent new aircraft, in time for whoever was chosen to fly at the 1969 World Championships. Goodhart himself was the most likely pilot. (The Championships date was later changed to 1970.)

The Sigma represented a serious attempt to design, build and fly a sailplane with variable wing area. It was not the first such sailplane, nor the last. Large Fowler type slotted flaps had been used before, notably on the AFH - 4 of 1938. This was designed by the Hannover Technical University students Eppman and Vollmer, and flown successfully. When such a flap is extended, a whole segment of the rear part of the wing moves back and down on guides and rollers, to form what is in effect a second small wing behind the main plane. A large, carefully shaped slot opens between the two surfaces and the air flows smoothly through this. A considerable increase in the lift coefficient results. On the AFH - 4, with flaps extended the wing area was increased by 14.4%.

More recently the South African BJ - 2, which had flown at South Cerney in 1965, and the Blanik L - 13 two seater, successfully adopted the same type of flap. Flaps out, the stalling speed was reduced and turns on small radius could be flown, allowing the sailplane to keep in the strongest core of thermals. The effect on the rate of climb was, however, disappointing. The flaps did not extend across the whole span. When deployed, large vortices arose at their outer ends where the wing chord changed abruptly from wide to narrow. At soaring airspeeds, most of the total drag of any sailplane comes from vortex drag. To extend a flap over a part of the span increased the drag greatly with very serious effects on the rate of sink. Despite the small turning circle, the rate of climb in thermals suffered. Another factor is that fitting such large flaps and their operating mechanism to a wing increases the weight of the completed sailplane. This, too, tended to increase the sinking speed in slow flight.



Sigma
1971

Drawn by Martin Simons 2003 ©
Additional information supplied by Frank Irving & David Marsden

Outer section of the original Sigma flap when retracted (above) and extended (middle) Below: Outer end of the centre section, showing how Marsden's flap retracted.

In February 1966 Goodhart gathered together a group of nine leading sailplane engineers and pilots to form a small company, Operation Sigma Ltd. No staff were appointed at first. Much preliminary work was done by the directors themselves. It was agreed that the Sigma should be an 'Open Class' sailplane, with variable wing area, but the flaps should extend from wing root to wing tip. Inexperience with the new composite plastic materials and doubts about aeroelasticity led the committee to decide on a metal structure, a well understood manufacturing technology. Carbon fibre seemed out of reach at this time, as did special, very costly metals such as titanium. The Sigma wing would be in light aluminium alloys, which offered adequate strength and stiffness.

A provisional budget of £30,000 was drawn up. Funds had to be raised. Sponsors came mostly from within the aircraft industry, and after interviewing various promising candidates, Neville Beckett, an aerodynamicist with Hawker Siddley Aviation, was employed as consultant. Professor Wortmann in Stuttgart was also asked to help. He devised a wing profile that would perform well at high speeds, and, with a very large extension of chord, would provide the required low rate of sink and high lift coefficients for circling flight. Extensive comparative studies of wingspans, areas, drag coefficients and likely weights, produced the general outline of the design. It would have a span of 21 metres, would weigh about 560 kg, would have a minimum rate of sink comparable with the old Slingsby Skylark 3, and, with wings in the minimum area position, a glide ratio of 50 : 1 at 56 knots, and 31 at 100 knots.

Early in 1967 John Sellars, previously at Slingsbys, was appointed Chief Designer. Facilities for him to work were provided by his former employer, Slingsby. He designed a mechanical system of levers for extending and retracting the flaps. The flaps must work smoothly even when the wings were bending under loads. Hydraulic power would be needed to drive them. The pilot would pump up the pressure in the system from time to time, by pushing the rudder pedals back and forth, both together. With such a large span, to avoid severe adverse yawing moments when entering and leaving turns, the ailerons needed help in the form of drag spoilers at the tips. Air brakes were required, and a tail braking parachute too. To support the weight on landing, a very substantial main wheel and retracting mechanism was necessary. A hydraulic unit was supplied by one of the sponsors, Dowty - Rotol Ltd. As the design began to take definite form, work on producing the components was started, in a workshop adjacent to the main Slingsby factory. Things apparently were going well and the first flight was expected early in 1969.

On November 18th 1968 the Slingsby fire destroyed everything, including all Sigma records, drawings, jigs, tooling and the partly built prototype. This disaster set the project back very badly. Work was restarted slowly in part of the factory still standing. Sellars left the Company at this time and the liquidation of Slingsby a few weeks later, in July 1969, forced the entire operation to be transferred elsewhere. A home was found in a vacant British European Airways workshop at Heathrow (London Airport) and work started again in September, under the supervision of Lorne Welch, one of the Sigma board. Finance became a very serious problem. It was obvious that the prototype would not be ready for the 1970 Championships.

The first flight was at last achieved on September 12th 1971 at Cranfield in Bedfordshire. Difficulties were very far from over. There was a marked tendency to fly one wing low, requiring the ailerons to be used constantly. Turns in one direction were quite hazardous. Small errors in the upper surface of one wing were found responsible and had to be corrected before further flying. The rudder tended to flutter and required a mass balance, adding weight at the tail. To restore the centre of gravity to its right place, quantities of lead were needed in the nose. Pumping up the hydraulic reservoir required about twenty vigorous strokes on the pedals. Goodhart, as test pilot, found this difficult and tiring but it must not be neglected. If the pressure dropped too far neither the flaps nor the undercarriage would operate.

In fact it proved virtually impossible to move the flaps at all in flight. Sigma could fly with the flaps out all the time, or in all the time, but even with the full hydraulic pressure they could not be moved from one position to the other. The whole objective, to change the wing geometry in flight, was defeated. The directors of the company believed that guides and rollers instead of the lever system would be preferable but the cost of such a thoroughgoing rebuild was beyond their financial resources. A subsidiary problem was that the flaps were supposed to be sealed and airtight in both the retracted and extended positions. The Wortmann flap would not work as intended if there were gaps or discontinuities. Flexible plates were intended to fit closely over the junction of main wing and sliding flap, but in flight as the wing bent under load, the seals lifted. Many attempts to rectify this were made but all failed in the long run. The best glide ratio was a disappointing 41:1.

It was with considerable sadness in 1977 that 'Operation Sigma' was finally wound up. The question remained, what should be done with the sailplane? The basic airframe was still sound. To scrap it was hardly thinkable. Applications were invited from anyone prepared to do something constructive with it. The best proposal, of about twelve applications, was judged to be that of David Marsden, Professor of Aeronautics at the University of Alberta. Marsden had already built a successful two-seater, variable geometry, sailplane, the Gemini, which had full-span slotted flaps. He proposed to replace the Sigma flaps with the same type of mechanism. He was currently at Cranfield on sabbatical at the Institute of Technology, and began work on the Sigma there. It was flown in 1978 and then taken to Alberta for further work in 1979.

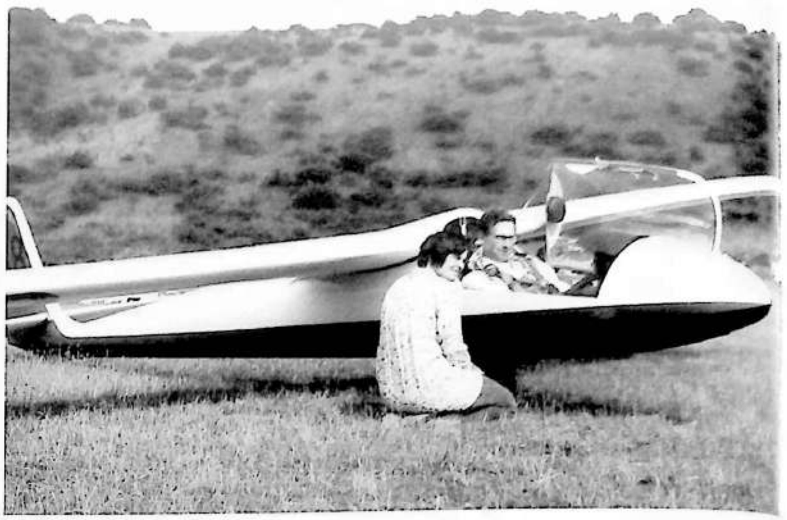
The entire flap system was removed and replaced. The outermost sections of the flaps became the ailerons. The drag spoilers were removed. The results were very good. Marsden also made other changes, removing the tail parachute, so reducing the weight at the rear, balancing the rudder better and helping to get the centre of gravity right with less lead in the nose. The tailplane was increased in area when it was found lacking during a landing with flaps down. The hydraulic system was removed and other simplifications made. The Sigma as reconstructed had the same stalling speed as the original, 36 knots, but with excellent lateral control. The best glide ratio was 47, and Marsden was able to climb in thermals with 15 m sailplanes which had much lower wing loadings. He carried out systematic performance tests which indicated that the new Sigma could keep up with the Schempp Hirth Nimbus 3 at high speeds, but could circle, flaps out, on much smaller radius, if both sailplanes were at the same wing loading. With the Marsden modifications, the Sigma became a practical proposition although, since it was still very heavy, rigging and de-rigging was never easy.

At the time of writing, Sigma remains in service in Kansas, where Gary Osoba is investigating the possibilities for dynamic soaring. In 1997 Osaba used the Sigma to set the US national record for the 300 km triangle at 151 km/h.

(Thanks to Frank Irving, Nick Goodhart and David Marsden for help with this article.)

Slingsby Sailplanes Ltd

Fred Slingsby himself, who founded the Company that bore his name, was not a qualified aircraft engineer but became a successful designer and employed specialists when necessary. Slingsby himself retired in 1964. There was a disastrous fire in 1968 and with increasing competition, ownership and management difficulties, all sailplane production at the factory ceased after 1982. Slingsby Aircraft went over completely to production of powered aircraft.



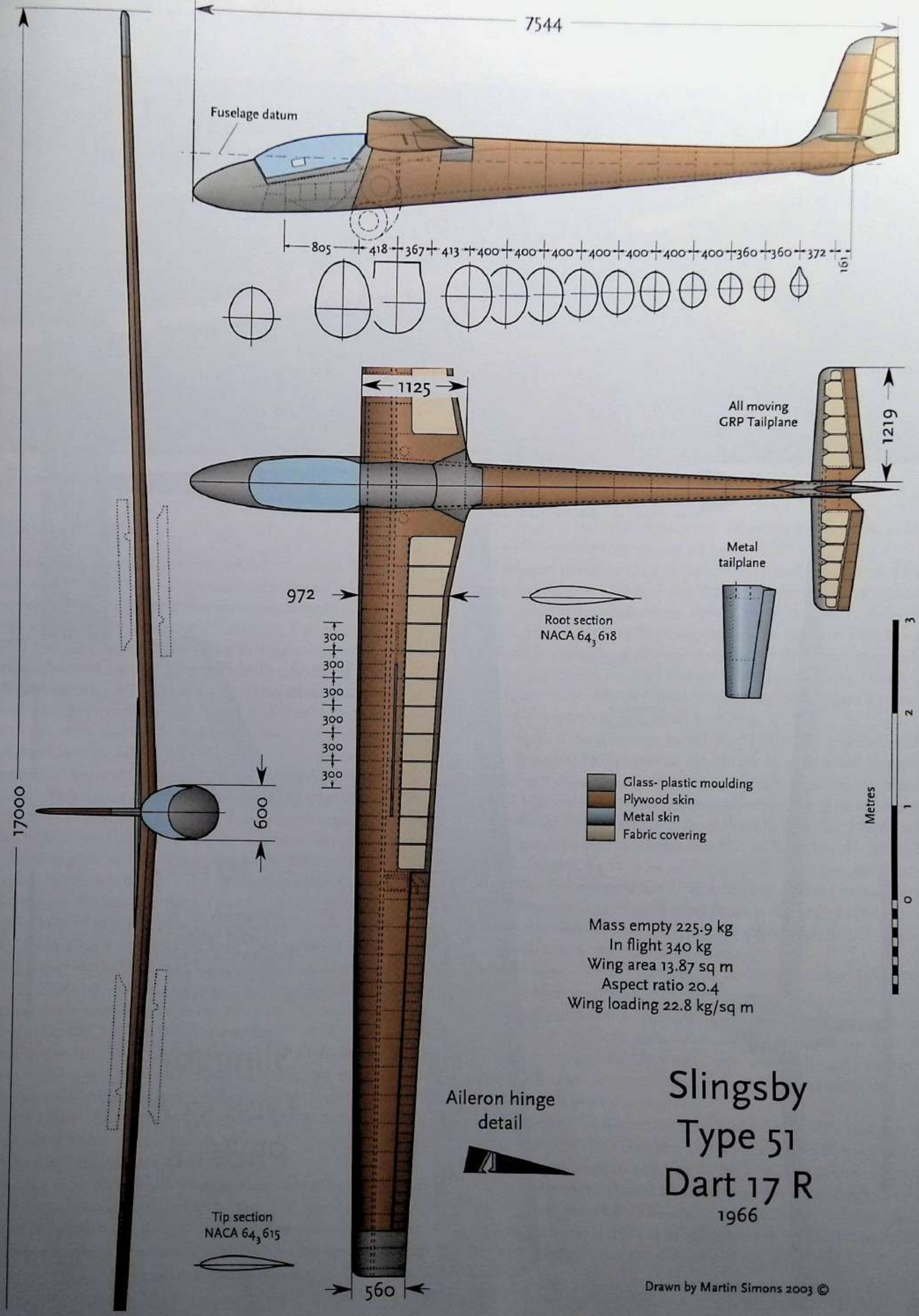
The author prepares to take off in a friend's Dart 17R at Dunstable. Jean, my faithful crew chief, is ready to run with the wing tip.

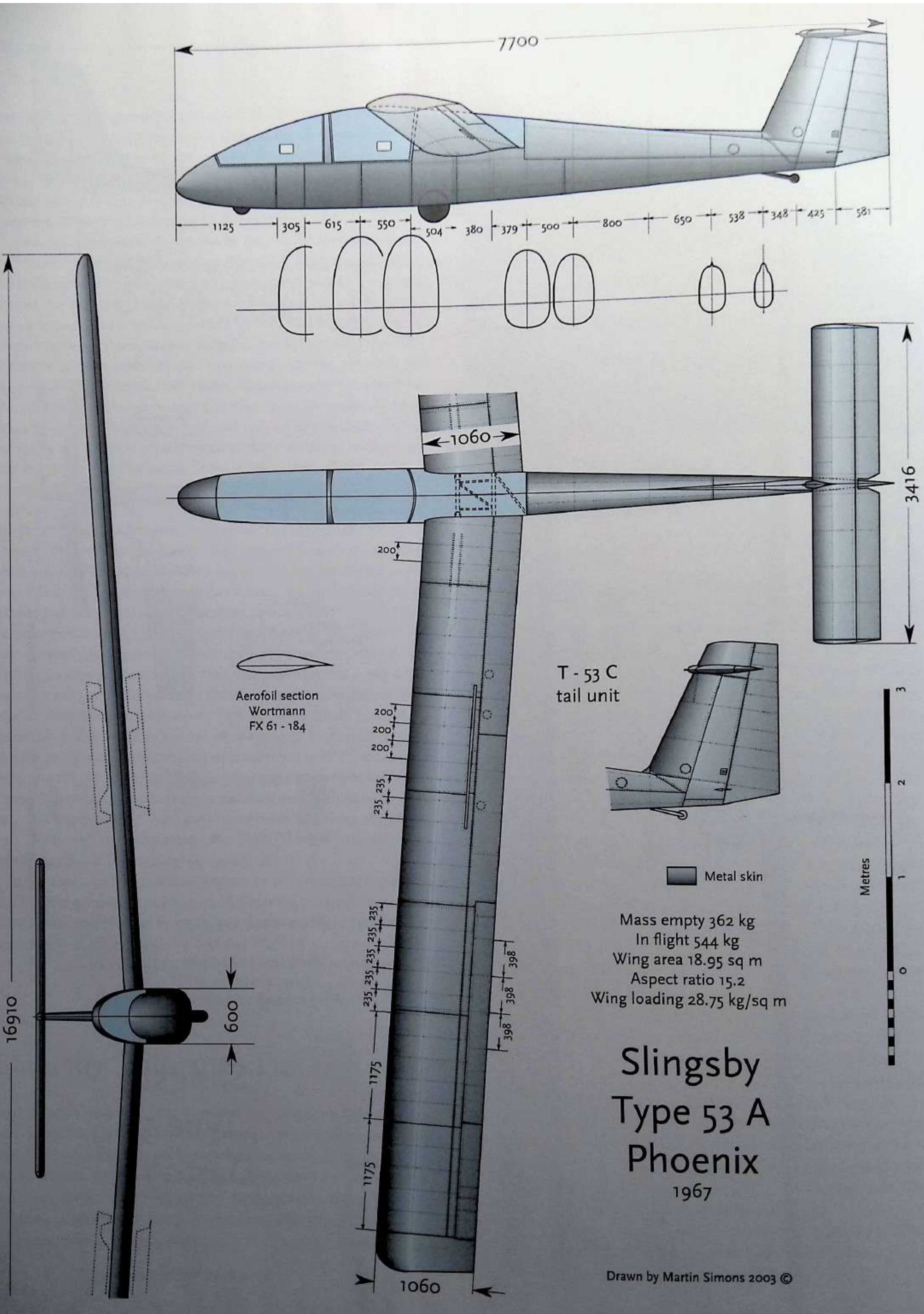
Type 51 Dart 17 R

The Dart 17 R was the last wooden sailplane produced by Slingsby Sailplanes. It was a direct development from the Dart 15 which had been awarded the OSTIV Standard Class design prized in 1965. The original Dart 17, flown in 1964, was a Dart 15 with an extra two metres of span. There was also a version with interchangeable wing tip extensions which could be flown at either 15 or 17 metres, an idea that was later to become much more usual. As with the Dart 15, the main wing spar was reinforced with metal alloy flanges bonded to wood veneers and glued in place. The excellent rigging system of the Dart 15 was retained. This was descended from the old German Weihe of 1938. Each wing was first attached to the fuselage with two steel pins, one at the main spar position and one at the leading edge on the same axis. Both wings were then raised and a fifth pin joined the upper spar flanges. The first Dart 17 still had the fixed undercarriage of its Standard Class forerunner and the wing was set the same large positive angle of incidence on the fuselage. This allowed landings and take offs to be made easily at stalling speed, but in fast glides the fuselage was distinctly nose down, creating more parasitic drag than desirable.

To improve the performance and to allow safe 'tail down' landings, the Dart was provided with a retracting main wheel. This allowed the wing incidence to be reduced by 5 degrees. The Dart 17R was welcomed in 1966 by British pilots who were anxious to fly in competition with the highly successful Schempp Hirth SHK - 1. Both had a wing span of 17 metres. The Dart handled more easily than the SHK and was pleasant to fly, but with its orthodox wooden structure and plywood wing skins, it did not equal the performance of its chief competitor. In any case, the first GRP sailplanes were becoming available and demonstrating their superiority.

A total of 44 Dart 17R were built, with two kits exported to New Zealand and completed there. Production ceased in 1967.


7544
Fuselage datum
805
418
367
413
400
400
400
400
400
400
400
360
360
372
161
1125
1219
All moving GRP Tailplane
Metal tailplane
972
Root section NACA 64_3 618
300
300
300
300
300
300
17000
600
Glass- plastic moulding
Plywood skin
Metal skin
Fabric covering
Metres
0
1
2
3
Mass empty 225.9 kg
In flight 340 kg
Wing area 13.87 sq m
Aspect ratio 20.4
Wing loading 22.8 kg/sq m
Aileron hinge detail
Slingsby
Type 51
Dart 17 R
1966
Tip section NACA 64_3 615
560
Drawn by Martin Simons 2003 ©



Mass empty 362 kg
In flight 544 kg
Wing area 18.95 sq m
Aspect ratio 15.2
Wing loading 28.75 kg/sq m

Slingsby Type 53 A Phoenix

1967

Drawn by Martin Simons 2003 ©

The only Yorkshire Sailplanes YS - 53 "Sovereign"

Type 53 Phoenix

In 1966 the Slingsby Company decided to change from wooden sailplanes to metal. The decision was to have adverse long term consequences but the reasons for it were convincing at the time. The firm had been among the first to use GRP for sailplanes. The original Skylark 2 of 1953 had quite large parts moulded in glass-plastic, using polyester resins. The front fuselage, wing tips and fairings were of this material. Slingsby himself predicted that all-plastic sailplanes would follow when more experience had been gained. But there it seems to have stopped. No systematic research or development of the methods was ever undertaken at Kirbymoorside. GRP was restricted to non-load bearing components until, hesitantly, the Dart 17R tailplane was adapted to this material. Even then, the last few Darts produced had metal tailplanes.

Having decided on metal, there were to be two main projects. In the USA Richard Schreder, already a well-known designer and champion pilot, was producing kits for his HP - 14, a type which, unlike previous Schreder types, seemed likely to be suitable for soaring conditions in Britain. The Slingsbys began negotiations with a view to producing the HP - 14 under licence. The first two kits arrived from Schreder in 1967. Concurrently, John Sellars joined the Company as chief engineer and began design work on a new, all metal two seat sailplane, the Type 52. The Air Training Corps had for years been using Slingsby two seaters for basic flight training, but these aging, wooden T - 21 and T - 31 types were out of date. The T - 52, with span of 14.63 m (48 ft) and tandem seating, was intended to replace them. It was hoped that civilian clubs would be interested but the main objective was to obtain a bulk order from the ATC. Before the T - 52 had advanced beyond the basic outlines Sellars decided to enlarge it to 16.76 m (55 ft) span. This became the Type 53.

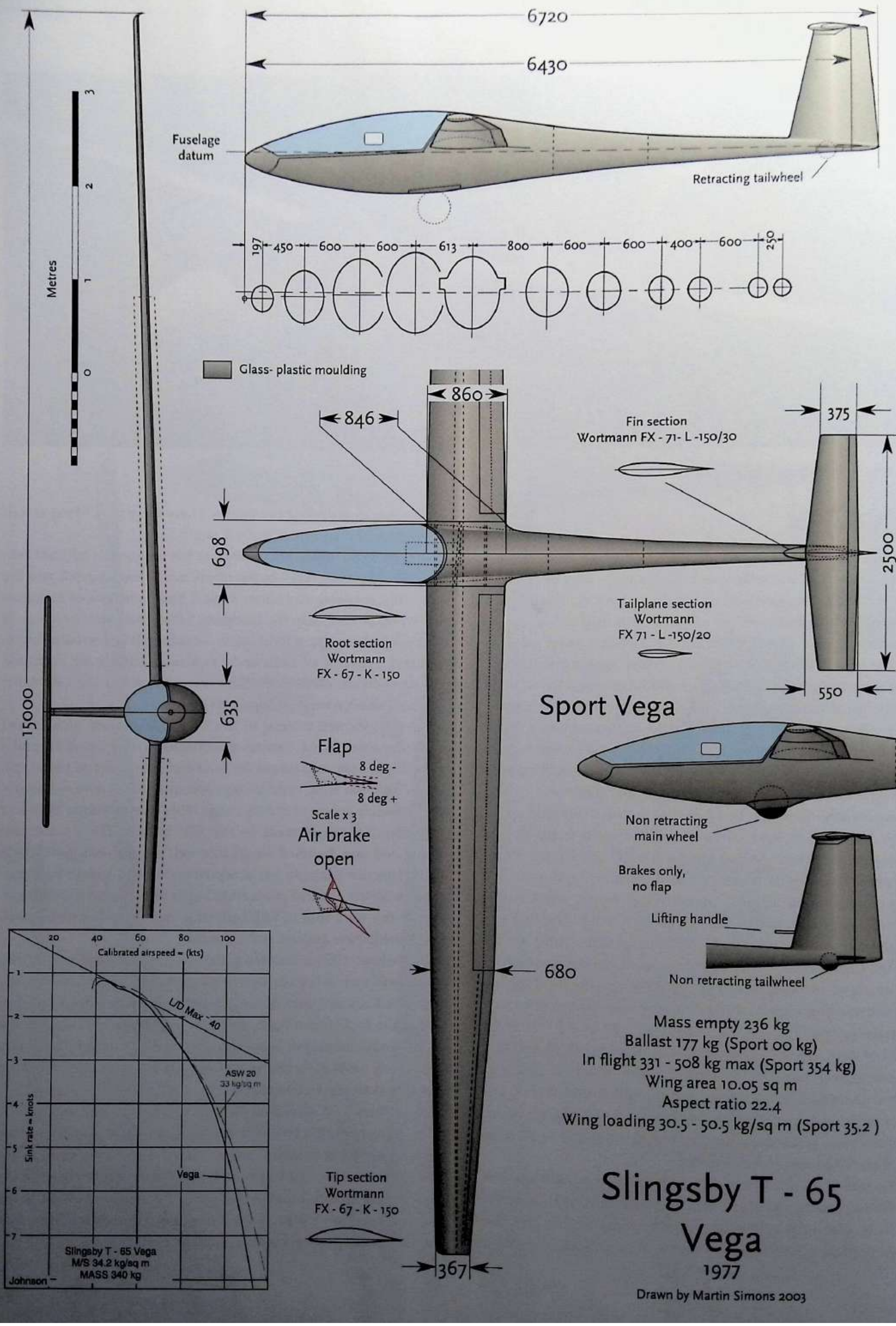
For the sake of structural simplicity and ease of production, the wing was of rectangular planform, swept forward, with a Wortmann wing profile, and flaps. Flush riveting was used to preserve the smooth profile. The fuselage was oval in cross section, the skin pop-riveted to the light cross frames. There was a nose wheel as well as the normal main wheel, and a T tail.

The prototype flew in March 1967. At this time Sellars left the Company. His place was taken by Pat Monk but he too soon left and the new chief engineer was James Tucker. These changes of technical leadership did not help the Company, which was, after a change of ownership, diversifying ambitiously into other fields including building replica aircraft for films and a vast aerial advertising hoarding, the Camcoliner. Another division was mass-producing GRP toilet ware and wooden window frames for houses.

The ATC showed interest in the T - 53. After their officers had done some test flying, various modifications were asked for and a provisional order was placed for forty aircraft. A second prototype, the T - 53B, was built, without flaps and with longer nose to improve the allowable centre of gravity range. This flew in March 1968 and was offered for assessment by the ATC in May. The T - 53B was strong and safe, handled reasonably well but was not particularly liked. This one example was accepted by the ATC but no bulk purchase followed. Limited production began in the hope of civilian orders. A few were sold in England, with exports to the USA, Israel, Switzerland, New Zealand and Australia.

In November 1968 a disastrous fire destroyed a large part of the Slingsby factory. All production tooling for the T - 53 and four partly completed aircraft, were destroyed. After strenuous efforts, production of the T - 53 began again slowly. A further modified version, the T - 52C was completed. However, early in 1969 Slingsby Saiplanes Ltd, which never fully recovered from the fire, was in receivership and all aircraft production ceased.

The solitary T - 53C, and all rights in the design, were sold to Yorkshire Sailplanes Ltd, a company that previously had been a glider repair and servicing business. The T - 53C was now advertised as the YS - 53 'Sovereign'. (Yorkshire Sailplanes also bought rights in the BG - 135, see above). This Company also did not survive long, going into receivership in 1973. A total of eighteen T - 53s was built with another finished by an amateur constructor from parts



6720
6430
Fuselage datum
Retracting tailwheel
197
450
600
600
613
800
600
600
400
600
250
Metres
0
1
2
3
Glass- plastic moulding
860
846
375
Fin section
Wortmann FX - 71- L -150/30
698
2500
Tailplane section
Wortmann
FX 71 - L -150/20
Root section
Wortmann
FX - 67 - K - 150
550
15000
635
Sport Vega
Flap
8 deg -
8 deg +
Scale x 3
Air brake
open
Non retracting
main wheel
Brakes only,
no flap
Lifting handle
Non retracting tailwheel
680
Calibrated airspeed – (kts)
Sink rate – knots
L/D Max – 40
ASW 20
33 kg/sq m
Vega
Slingsby T - 65 Vega
M/S 34.2 kg/sq m
MASS 340 kg
Johnson
Mass empty 236 kg
Ballast 177 kg (Sport 00 kg)
In flight 331 - 508 kg max (Sport 354 kg)
Wing area 10.05 sq m
Aspect ratio 22.4
Wing loading 30.5 - 50.5 kg/sq m (Sport 35.2)
Tip section
Wortmann
FX - 67 - K - 150
367
Slingsby T - 65
Vega
1977
Drawn by Martin Simons 2003

Slingsby Type 65 Vega

The Slingsby factory was closed entirely for three months from July 1969, but Sir Leonard Redshaw, a keen glider pilot and Chairman of Vickers, the large Shipbuilding Company, decided that sailplane production in Britain should be revived. The remnants of Slingsbys were bought by Vickers. George Burton, a well known British soaring pilot with business experience and engineering qualifications, was appointed Managing Director. It was accepted at once that the new start should be made with GRP sailplanes. By agreement with Eugen Hänle of Glasflügel, licence production of the 17 metre H - 401 Kestrel was undertaken. The first Kestrel produced by Slingsby flew in August 1970 as the Type 59. Further development led to the Kestrel 19 and eventually to the 22 metre Type 59H Kestrel.

Sales of these 'Open Class' sailplanes were not large. Only two of the T - 59H ever flew. When the rules for the new 15 metre contest sailplane were announced in 1975, Burton decided that there should be a Slingsby product in this new field. Redshaw agreed to back the project and design work began on what was to become the Type 65 Vega.

The Slingsby Vega prototype

Cockpit and instrument panel of Sport Vega

The fuselage was based directly on that of the Kestrel. The moulds were already available and could be easily adapted. The wing was also similar, although of smaller span, and used the same Wortmann profiles. What was more significant was that carbon fibre was used for the main wing spars. Other sailplanes had already flown with CRP spars, notably the Finnish PIK - 20, but this had been an adaptation of an existing, successful, all GRP sailplane. For the Vega, carbon was incorporated from the start as an integral part of the design. The wings would therefore be stiffer, and lighter, than contemporary 15 metre sailplanes. There was, however, no attempt to take full advantage of the new material by designing a new, thinner wing for it.

Every care was taken to reduce drag. The tail wheel was retractable and the nose cone built integrally with the canopy. The canopy had an inflatable pneumatic seal, pumped up by the pilot, to make sure there were no leakages to disturb the boundary layer flow. Most interesting was the flap and air brake arrangement. The brakes were of the trailing edge pivoting type, extending from the wing root to the inner end of the ailerons. When deployed they presented a very large braking area above and below the wing. The camber-changing flaps were hinged to the brakes but there was a continuous GRP flexible skin over the hinge joint. No air leakage or abrupt change of flow direction arose when the flaps were in their various settings.

When first advertised the Vega was expected to be on the market by 1977 but in the event the prototype flew only in June of that year. Much remained to be done before production could start. Leonard Redshaw retired and from this time the Slingsby factory became increasingly occupied with other projects. These included building motor gliders (under licence from Egon Scheibe in Germany), small airship gondolas and maritime things required by the shipbuilding company, miniature submarines, deep sea diving equipment, fittings for naval minesweepers and devices for cleaning up marine oil spills. Work on the Vega was in danger of being squeezed out. By the time of the World Gliding Championships at Chateauroux in 1978, only one production Vega was available for prospective customers to see and fly. It was favourably received but had no advantage in either performance or price. It was, indeed, judged by Burton himself to be 3% worse than German sailplanes of the same class which were already in full production. The reasons were fairly evident. Close examination of the Vega wings showed small waves in the profiles. The Slingsby factory was not yet able to reproduce wing contours to match the required standards.

Burton, unable to persuade the Company of the need for improvements, left in 1978. He was replaced by James Tucker, who had been Chief Engineer since 1967 but much involved in the marine side of the business.

When production and deliveries of the Vega finally went ahead and outstanding orders were satisfied, it did the future prospects no good when the Dutch pilot, Baar Selen, who had won the Standard Class at Chateauroux, had his new Vega break up while he was flying in Italy. He saved himself by parachute. The investigations afterwards suggested that he must have been flying too fast. But the inspectors also found that some vital steel components, the spigots joining the wing to the fuselage, had been incorrectly heat treated and were under strength. Slingsby's themselves had not made the spigots and were not responsible for the steel, but confidence in the aircraft inevitably suffered, even after the mandatory replacements of the dubious parts.

Recognising at last that the Vega would never be a fully competitive in the 15 metre class, a simplified version, the Sport Vega was produced and flown first in 1980. This had no flaps, no ballast tanks, and a fixed undercarriage. Few were sold, this end of the market being already well served by 'sport' class sailplanes from other manufacturers.

The total of all Vegas built by Slingsby was 70. From 1982, the Company ceased glider production altogether.

Czech Republic

Before 1965 Czechoslovakian sailplane production was dominated, in numerical terms, by the LET National Corporation which produced the all metal L - 13 Blanik two-seater. A total of 2649 were built and many were exported, 1300 to the USSR alone. Production of this model ceased in 1979. The same company in earlier times had also built the Lunak aerobatic sailplane. There were other designs, less known abroad; the Sohaj and Krajanek[15] in the late forties and the VT - 16 Orlik of 1959. The VSB - 66S Orlice, a wooden, V-tailed Standard Class sailplane by the Orlican National Factory, flew in 1970.

Political changes had profound effects. Under domination from Moscow, there was large- scale production of military aircraft. A change of government seemed imminent in 1968, but was prevented by military intervention and occupation by the USSR. The communist regime was peacefully overthrown in 1989. This was followed by partition of the country. The Czech Republic and the Slovak Republic came into existence on January 1st 1993. Surprisingly, perhaps, the Czech Aero Club continued in being and sailplane production revived after the national reorganisation. The sailplane factories remained in the Czech Republic. Apart from the LET Company, most sailplane production in the Czech republic is of German plastic composite aircraft, notably the Schempp Hirth Cirrus, Discus CS, the Duo Discus, and the Glasflügel 304.

15 – See Volume 2

The K-23 "Super Blanik" at Lasham in 1992

The L - 23 Super Blanik

The LET Company survived in Kunovice. Five years after production of the L - 13 Blanik ceased, the decision was taken in 1984 to produce a new version of the Blanik. The original L - 13 in its day had been a high performance aircraft, with aerobatic capabilities and many distance, altitude and speed records to its credit. It was now used almost entirely as a trainer. Demand for this class of two-seater remained, especially since there was some feeling in the gliding movement generally that the new generation of GRP trainers was not ideal for the early stages. They were perhaps too good, aerodynamically very clean, rather heavy, and so tended to pick up airspeed very rapidly if the student pilot was a little clumsy.

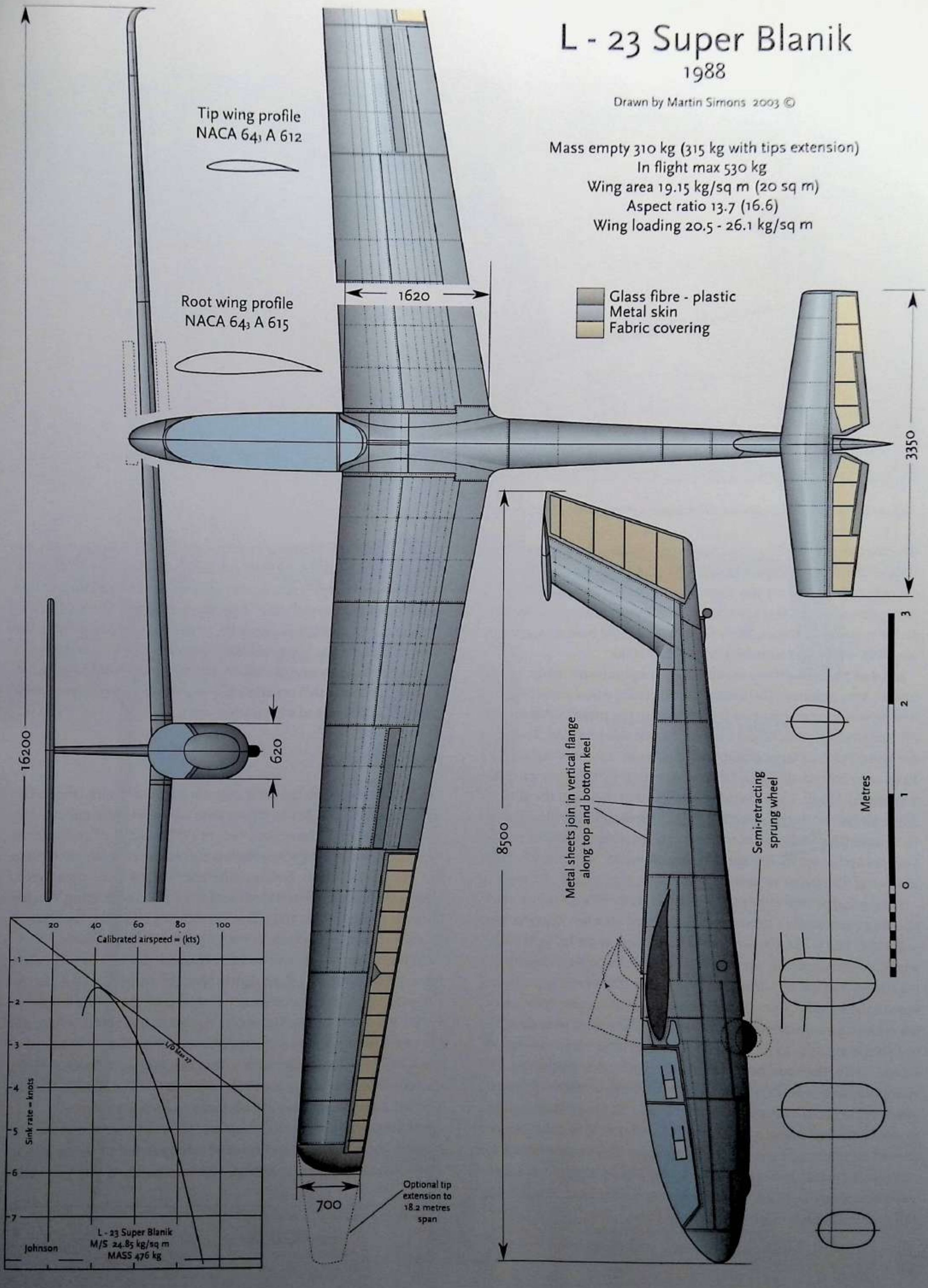
The old Blanik was too complex, with large Fowler type slotted flaps which in practice did little for the performance and added considerably to construction and maintenance costs. Very few instructors bothered to use the flaps when teaching beginners. There was all-round simplification of the structure. Other improvements included a T - tail mounted on a slightly swept-back vertical fin, instead of the old, two-part tailplane with dihedral. The cockpit also was changed to improve the view from the rear seat and give the in-

Detail of the T Tail on the L - 23 here at Caddo Mills in Texas

L - 23 Super Blanik
1988

Drawn by Martin Simons 2003 ©

Mass empty 310 kg (315 kg with tips extension)
In flight max 530 kg
Wing area 19.15 kg/sq m (20 sq m)
Aspect ratio 13.7 (16.6)
Wing loading 20.5 - 26.1 kg/sq m



VSO 10 "Orlican" flying in Zbraslavice, Czech Republic (Photo Jochen Ewald)

structor more room. The rear cockpit canopy, supported on a special sliding strut, was hinged to open up and backwards. The front canopy was hinged on the right hand side. For flying solo with a light pilot, a special seat incorporating ballast was supplied. Another factor was metal fatigue. The new sailplane must have a long useful life, 6000 hours was aimed for rather than 3000.

Most of the well-proved features, the swept forward wings and air brakes, were retained. The semi-retracting main wheel remained, this having proved useful for training students in the correct drills for take off and landing. A tail wheel instead of a skid was provided. The original wing tips had large streamlined bodies or 'salmons' which may have been intended to reduce tip vortex drag. In this they probably achieved nothing. Their main benefit was that they kept the ailerons from contact with the ground. In the new Blanik the wing tips, of GRP, were simplified and turned down to provide equivalent protection. An option for those hoping for slightly better performance was to have wing tip extensions to increase the span from16.2 to 18.2 metres.

The prototype flew first in 1987 and full airworthiness certification, allowing export orders to be fulfilled, followed after test flying in 1988 and 1989. The L - 23 was welcomed and orders came in. In the USA, where metal sailplanes were familiar in training schools because of the widespread use of Schweizer aircraft, over fifty of the Super Blanik were in use by 1996. Outside the country of origin, some criticisms of the cockpit arrangements have been voiced. The seats were designed to take parachutes more bulky than those in general use outside Poland. With more compact parachutes they are uncomfortable. The view from the rear seat is still somewhat restricted by the wing leading edges. These faults have not prevented the L - 23 from being regarded as one of the best training sailplanes. It handles well, is stable but can be used for training in spins and spin recovery. This cannot be said for some of the plastic two-seaters. The Super Blanik is light and easy to handle on the ground, and has an adequate performance for training and even early cross-country flying instruction.

To accompany the Blanik, a 14.12m span all metal single-seater for early solo pilots, the L - 33 Solo, was designed and successfully marketed. The prototype was entered in the design competition for the World Class but did not win.[16] A special feature was the fatigue life, in this case 10,000 hours. As a rule, when the nominal fatigue life of any sailplane has been reached, a system of careful inspections allows further extensions. While 10,000 hours sounds a lot, in training schools which operate every day throughout the year, such a figure can be reached within a few years.

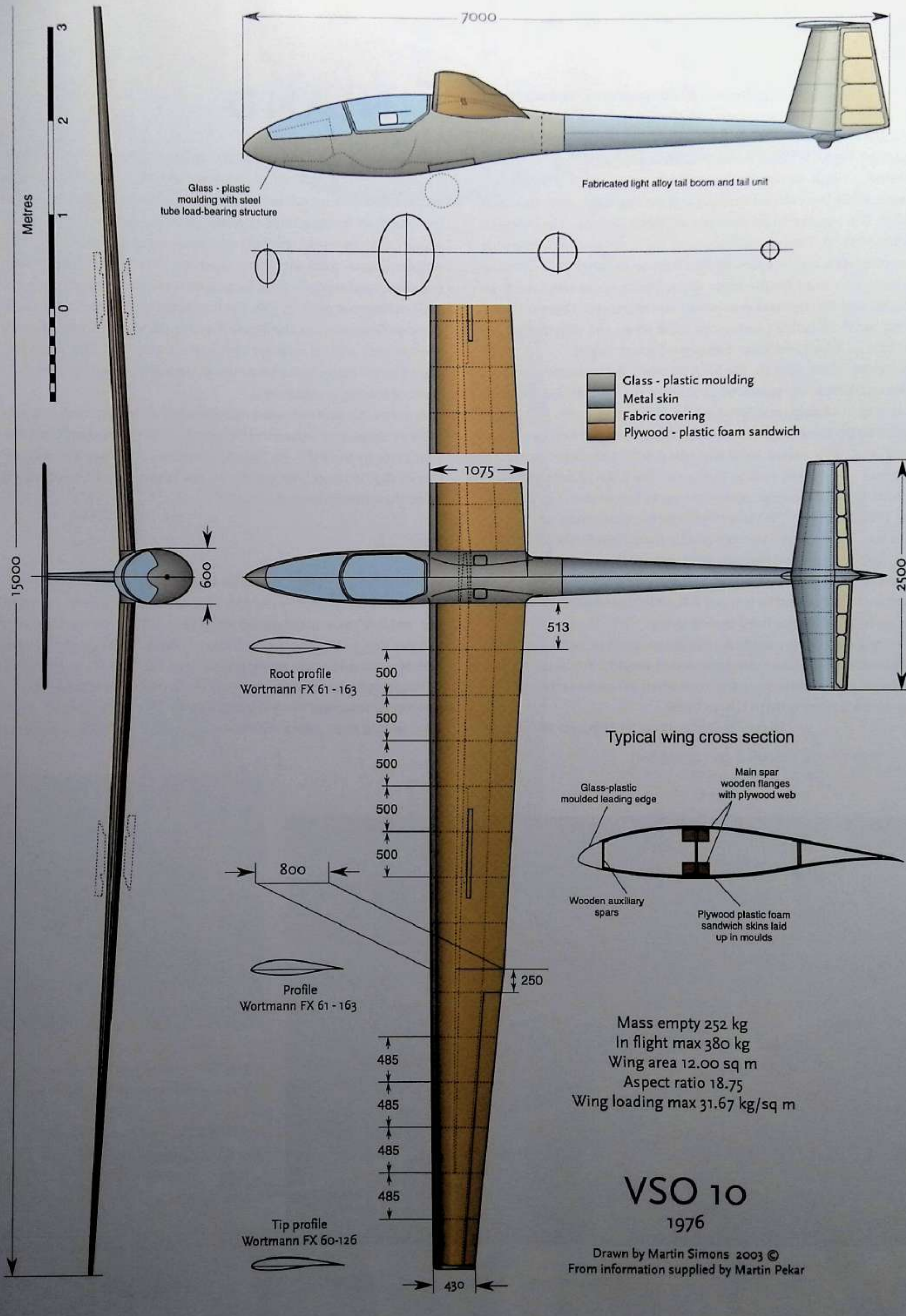
The VSO - 10

The VSO - 10 became the most popular single seat sailplane in the old Czechoslovakia. 221 examples were built and every gliding club operated least one. The origins were in 1972 when the Czechoslovak Aero Club was seeking a new high performance sailplane to replace the old VT-116 Orlik. Several different designs were considered, among them an improved version of the Orlik, the existing V tailed Orlice and the WK - 1, and a new project still on paper, the VSO - 9 from the factory at Chocen, Vávojoy Skupina Orlican (VSO).

All the types considered had 15 m span but differed in wing planform, profiles and detail. None was thought entirely acceptable. Finally the WK-1 of 1970, originally designed by the young engineers Tadeas Wala and Anton Kralowice, was taken as a suitable basis for the new type. Re-design was required, including the replacement of the all-moving T-tailplane with a fixed tailplane and elevator. Major decisions were necessary about the method of construction. The design work and production was allocated to the VSO team.

Lack of experience with GRP materials led to a mixed structure. The fuselage main frame of welded steel tubes carried the wing attachments, retracting undercarriage, seat and controls but the entire

16 – See PW – 5, p. 191



Mass empty 252 kg
In flight max 380 kg
Wing area 12.00 sq m
Aspect ratio 18.75
Wing loading max 31.67 kg/sq m

VSO 10

1976

Drawn by Martin Simons 2003 ©
From information supplied by Martin Pekar

nose shell ahead of the wing was a GRP moulding. The tail boom was a fabricated light alloy tube and the tail unit was all metal with fabric covered rudder and elevators. The wing was generally similar in outline to the Schleicher ASW-15 but in wood rather than GRP. Plywood - balsa sandwich wing skins were laid up in female moulds. Only the extreme leading and trailing edges were moulded in GRP. The wooden main spar was of I beam section. The outcome was the VSO 10. Three prototypes were built, static structural testing was completed, and the first flights were in October 1976. Test flying revealed a need for the angle of incidence of the tailplane to be adjusted and the elevator movement was increased. There followed a long series of further tests until 1978 when the sailplane at last obtained its Type Certificate. Series production began.

A version of the VSO 10, the VSO 10C with the undercarriage fixed down and faired, was produced in time for the first official European 'Club Class' championships, held in Sweden in 1979. The Czech team, Martin Brunecky and Jaroslav Vavra took the first two places flying against a varied field including GRP sailplanes and older 'Standard Class' types such as the Ka 6E. The VSO-10 attracted much favourable attention from potential buyers, but production was slow.

In 1982 came the VSO 10A in which the upper wing skin core of balsa was replaced by Conticell plastic foam. Ten further sailplanes later, the VSO 10B had the sandwich cores on both wing surfaces replaced by Conticell. By 1989 (when the radical change of national government occurred) a total of 221 sailplanes had been reached, among them 12 of the fixed undercarriage VSO - 10 C.

Tentative plans were made for the design and production of a new, fibre-reinforced -plastic sailplane which would have been the VSO 12. These proposals were abandoned when sub-contracting production of the Schempp Hirth Discus began.

(Thanks to Martin Pekar for help with this article.)

FINLAND

Sailplane design in Finland has always been closely associated with the Helsinki University of Technology and the student flying club, Polyteknikkojen Ilamailukerhon, PIK, similar in many respects to the Academic flying groups or Akafliegs of the German Universities. As part of their work, students may draw up the outlines of a new sailplane type. Staff members supervise, advise and help. When qualified, students may look for permanent employment in the aircraft industry or perhaps join the teaching and research staff. Commercial firms turn to the University for advice and consultation. The country and its aviation industry are small enough for everyone to know almost everyone else, particularly where the minority sport of soaring is concerned.

As far as the world beyond Finland was concerned, the most notable event was the award in 1963, of the OSTIV Standard Class Design Prize to the PIK - 16 Vasama sailplane. This was followed by one of the first ever GRP sailplanes, the Fibera KK - 1 Utu of which more than twenty were produced.[17]

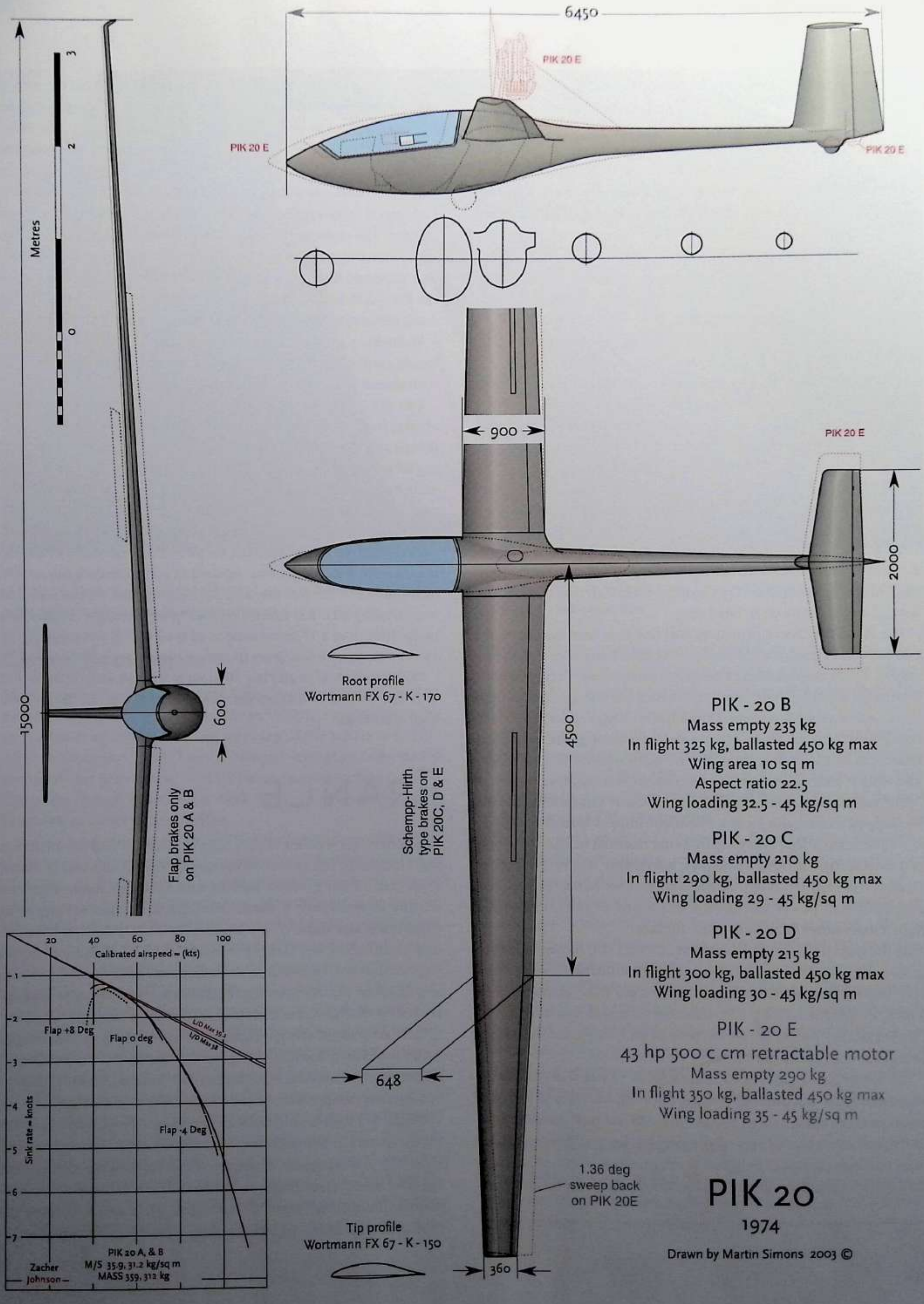
PIK- 20

The original Standard Class rules required full air brakes to be fitted, capable of restricting the sailplane in a vertical dive to less than the 'red-line' maximum permitted airspeed. The rule was based on the fact that a sailplane, flying blind in cloud, might get out of control. Structural collapse would probably result. There were examples of this happening from the time before air brakes were invented.
A vigorous campaign was mounted by some American designers to allow landing flaps instead of brakes. Such flaps were demonstrably

Above: Worldchampion Ingo Renner flying the PIK 20 B 1976 in Finland (Photo Peter Selinger)

Left: The PIK 20 D had Schempp-Hirth Airbakes instead of the 90-degree landing flap

17 – Both the Vasama and the UTU are described in Volume 2.



PIK - 20 B
Mass empty 235 kg
In flight 325 kg, ballasted 450 kg max
Wing area 10 sq m
Aspect ratio 22.5
Wing loading 32.5 - 45 kg/sq m

PIK - 20 C
Mass empty 210 kg
In flight 290 kg, ballasted 450 kg max
Wing loading 29 - 45 kg/sq m

PIK - 20 D
Mass empty 215 kg
In flight 300 kg, ballasted 450 kg max
Wing loading 30 - 45 kg/sq m

PIK - 20 E
43 hp 500 c cm retractable motor
Mass empty 290 kg
In flight 350 kg, ballasted 450 kg max
Wing loading 35 - 45 kg/sq m

PIK 20
1974

Drawn by Martin Simons 2003 ©

good landing aids but they could not be forced down if the airspeed was already high. The pilot in a blind flying emergency, unaided, would not be strong enough to do it. If the flaps were forced down by a hydraulic or pneumatic drive (as was tried by Slingsby for their version of the HP - 14), the loads would be quite excessive and, again, structural failure was likely. In any case, it was argued, the situation was unlikely to arise. Cloud flying, especially in contests, was already disallowed in most countries because of the danger of collisions.

The Standard Class rules were changed in 1969. Flaps were permitted, but only for landing, not capable of being held in intermediate positions between fully down and neutral, and not coupled with the ailerons to alter the camber of the whole wing in normal flight.

This was the situation when the PIK - 20 design was started. Pakka Tammi, a student, had written a thesis on sailplane design. Guided by Ilkka Rantasalo, head of the Aircraft Research Laboratory and Raimo Nurminen, a leading soaring pilot and chairman of the PIK group, the PIK - 20 took definite shape, Tammi becoming the chief designer. In 1972 the entire project was transferred to Jämijärvi, where the small firm, Molino Oy, with sailplane manufacturing capabilities and experience, was located. The aim was to get the new GRP sailplane ready for the 1974 World Championships. Knowing there was a potential for export, the Finnish Government provided some financial support and preparations were made for series production. Wind tunnel tests, load and fatigue tests were performed in the University. The Molino Oy Company was taken over by EIRI and, later, changed the name to Eiri-avion,

The PIK - 20 followed principles that had now been developed for GRP sailplanes generally. The main wing spars flanges were glass rovings in epoxy resin matrix. The flying surfaces were skinned with laminated glasscloth with PVC foam sandwich filling. The fuselage was a GRP shell with stiffening cross frames where necessary to take concentrated loads. Epoxy resins were used throughout, with heat treatment in the female moulds. The main wheel was retractable. The wing profiles were from the well proven Wortmann series.

The prototype was test flown and made ready just in time for it to be shipped to Australia for the Championships at Waikerie in January 1974. It surprised everyone by being finished in all-over bright yellow. Among the other sailplanes, universally white, it stood out clearly. The heat treatment of the components during production gave sufficient protection against weakening of the resins in the high temperatures of an Australian summer.

In the contest, Raimoa Nurminen placed 13th, having failed to score on the first, very difficult day. The PIK nonetheless performed very impressively against the other Standard Class aircraft, all of which, except the LS - 2,[18] had orthodox air brakes and no flaps. At the Eiri factory orders began to come in and sailplanes were soon being produced at the rate of two or three per week.

The weakness of the revised Standard Class rules was quickly realised and there was another change, allowing the flaps to be combined with the ailerons after all. The PIK - 20 was well placed to take immediate advantage of this relaxation. All that was needed was to make the flaps capable of being set at intermediate positions between fully down and slightly raised. This was done with a wheel control on the left hand side of the cockpit. In cross country flight the setting could be varied from 8 degrees down to 8 up. For landing the wheel allowed the flaps to be wound fully down to 90 degrees. The Wortmann 'K' wing profiles were already adapted for flaps. The resulting PIK - 20B achieved immediate success in competitions, including the Finnish, British and Australian National Championships in 1975, and, flown by George Moffat and Helmut Reichman, the first two places in the transcontinental Smirnoff Derby in the USA. In 1976, Ingo Renner won the World Championships with the PIK - 20B, second, third and fifth places also were taken by the PIK. Most owners of the PIK - 20A took advantage of the conversion kit offered by the manufacturers to bring their sailplane up to the new configuration.

Meanwhile, the Eiri Avion team, after careful experiments, began to use carbon fibre and soon carbon spars became normal, with corresponding benefits in structure weight.

The PIK - 20C followed. This was in response to yet another change in the Standard Class rules, which required flaps to be removed and airbrakes to be fitted, although ballast tanks and retracting wheels were allowed. The PIK - 20D, intended for the newly established fifteen metre unrestricted class, was first flown in 1976 with both flaps and brakes. The series came to an end with the PIK - 20E, one of the first truly successful self-launching sailplanes, fitted with a fully retracting Austrian Rotax 501 engine. A slight adjustment to the wing sweep was required to accommodate the weight of the motor in the rear fuselage, but in other respects the PIK - 20E was virtually identical to the previous 'pure' sailplane. Production under licence of a 17 metre version of the PIK 20E was proposed in 1983 by the Issoire Company in France, but did not proceed.

Total production of all PIK - 20 models reached 425. Of these 103 were the E version with motor, and 167 of the D. No more were built after 1980.

FRANCE

A tradition of excellent French sailplane design and construction was established in the years immediately after World War 2, with a great deal of government backing and financial support for the soaring movement as a whole. Administration and management came under the Ministry of Transport (DGAC, Delegation Generale á la Aviation Civile.) Large, professionally staffed gliding centres were established, especially at the famous site of La Montagne Noire and St Auban sur Garonne. The manufacturer of a sailplane type approved by the DGAC was almost assured of large production orders.

Later economies saw government interest fading. La Montaigne Noire was closed down. The Breguet Company, Arsenal and Fauvel withdrew from sailplane manufacture but Wassmer, Siren, CARMAM (Co-operative d'Approvisionement et de Reparation de Materiel Aeronautique de Moulins) and Centrair continued. By the 1980s the gliding movement, now administered by the Federation Francais de Vol a Voile (FFVV) was required to become financially self-supporting. Issuing pilot licences and checking qualifications remained (and still remains) under DGAC control. The Centre at St Auban became the chief centre for instructor training and preparing French Internation-

18 – See p. 127

The Centrair Pegase had a fuselage derived from that of the ASW 20 but a new wing for Standard Class competitions

al Competition teams. CARMAM and Centrair became engaged in manufacturing Italian and German sailplanes under licence.

Centrair C-101 Pegase

The Centrair Company, based at Chauvigny, was founded by Marc Ranjon and his wife Genevieve early in 1970. In the first place the firm acted as agents for sales and servicing of the Schleicher ASW - 20 from Germany. In 1977 when currency exchange rates moved favourably for the venture, Centrair began to manufacture the ASW - 20 under licence. The Centrair-built ASW - 20 received its French certificate of airworthiness in 1978.

Research on wing profiles at ONERA (Office National d'Etude at de Recherche Aerospatiale) encouraged Ranjon to think in terms of a new Standard Class sailplane, using a thinner profile than the existing German ASW - 19. The wing would be different from the German design, but an ASW - 20 fuselage, with minimal modifications, could be adapted for the new prototype. The outcome was the C - 101, named Pegase after the mythical flying horse. The prototype flew in November 1981. Early flights and comparative tests against other Standard Class sailplanes, especially the LS - 4, currently the best available, were considered to justify continuation of the project. Type approval was awarded in June the following year.

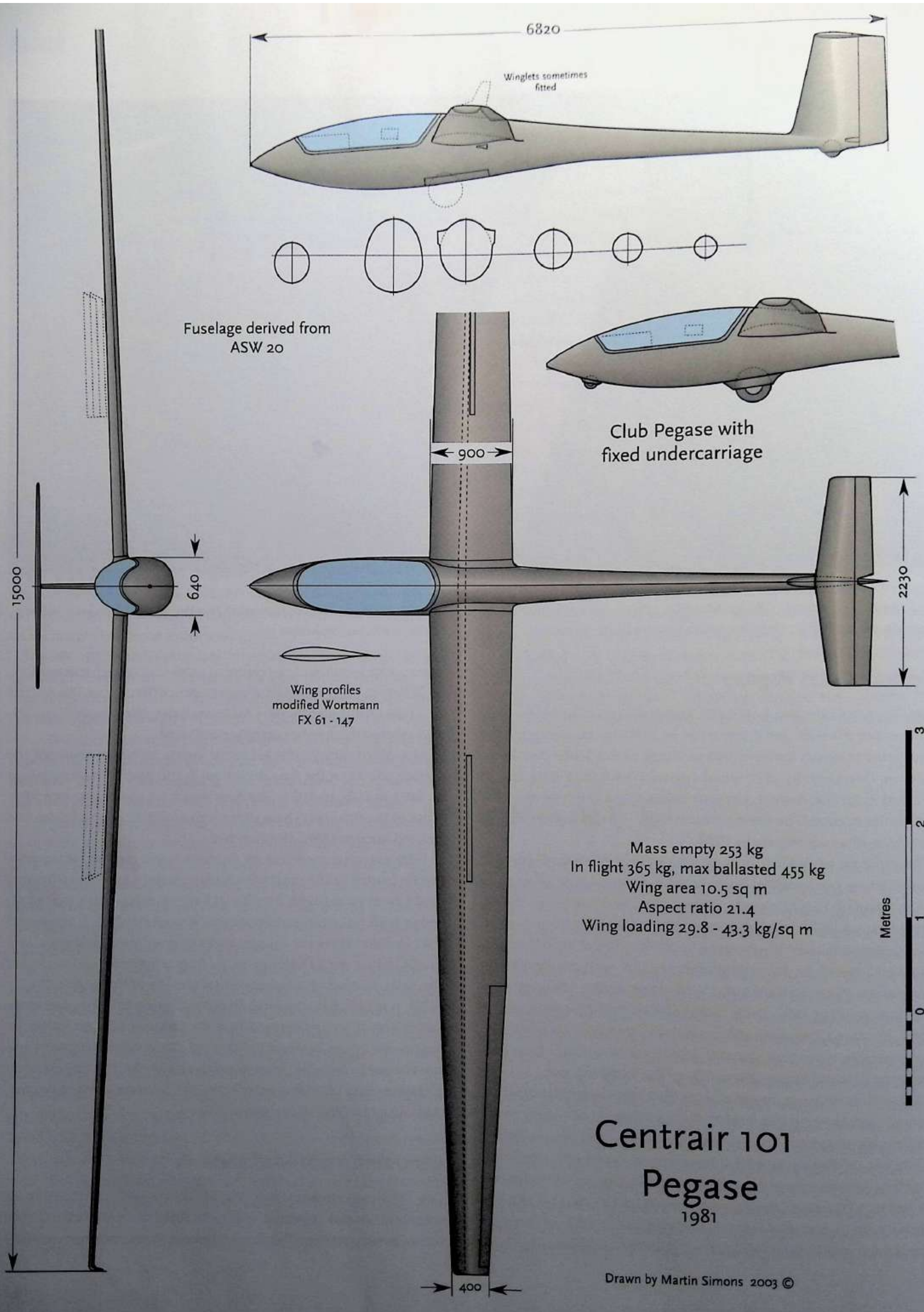
Schleichers were not happy to have their French agent competing directly with them in the market, with a sailplane so closely based on their own product. The dispute was settled. Centrair continued producing the Pegase. Several sub-types were developed, the 'Club' which had a non-retracting undercarriage and no provision for water ballast, a 'Standard' version with ballast up to 120 litres and the Pegase B which had four separate ballast tanks capable of carrying 160 litres. A small ballast tank in the tail allowed adjustments of the fore and aft location of the centre of gravity, to accommodate pilots of different weights. Small winglets were offered, and kits for the addition of turbulators were made available after research by ONERA allowed them to be correctly positioned.

A modified wing profile led to the Pegase BC which equipped the French pilots and the lone Australian at the World Championships at Rieti in Italy in 1985. The best result for the Pegase was 10th place in the final list. There were seven of the SH Discus in the first ten and not one ASW - 19 competed.

1986 was not a good year for Centrair. It was reported that with a Pegase loaded to the maximum ballast, serious lateral oscillations could develop in flight. An official ban was temporarily placed on flying with full tanks until the cause was established. It was found that in some cases the aileron mass balance was inadequate and might initiate wing flutter of 10 to 15 cm amplitude. Kits to correct the mass balance were issued. A new version of the Pegase, the C - 101D, was held back by long delays in issuing the Type Approval. Before this it was recognised that the Pegase could no longer be considered in the forefront of Standard Class contest sailplanes and sales began to dwindle. It remained a very useful and popular club and sport class sailplane. More than 300 were built before production ceased in 1988. Many were exported.

Centrair C - 201 Marianne

The FFVV was anxious that French design and construction of sailplanes should continue and from time to time made positive moves to keep the small industry in being. A new two seat sailplane


6820
Winglets sometimes fitted
Fuselage derived from ASW 20
Club Pegase with fixed undercarriage
900
15000
640
2230
Wing profiles modified Wortmann FX 61 - 147
Mass empty 253 kg
In flight 365 kg, max ballasted 455 kg
Wing area 10.5 sq m
Aspect ratio 21.4
Wing loading 29.8 - 43.3 kg/sq m
Metres
0
1
2
3
Centrair 101
Pegase
1981
Drawn by Martin Simons 2003 ©
400

GRP doubleseater Centrair 101 "Marianne" in Namur / France (Photo Jochen Ewald)

was needed to replace the 250 or so aging Wassmer Bijave aircraft that almost all clubs were still using. In 1983 a design competition was announced. There were four entries, on paper. Marc Ranjon's proposal for the GRP Centrair 201 Marianne was preferred but all the detail design and development remained to be done. Three versions were projected from the outset. There was to be the Marianne 1, a basic, 18.5 metre trainer, Marianne 2, a more advanced type with flaps, and Marianne 3, with span extended to 20.9 metres and an expected best glide ratio better than 44:1. A self-launching version was also envisaged for a later time. Application was made to the DGAC for financial help with the development, testing and production of the new aircraft. This was forthcoming to the tune of 50%. Assistance with wind tunnel testing and computing was made available by ONERA and the Dassault Company also sponsored the project, making computers and computer-aided-design facilities available. A group of students in aeronautics carried out much of the work.

Two prototypes of the basic version were built. First flights were in December 1985.

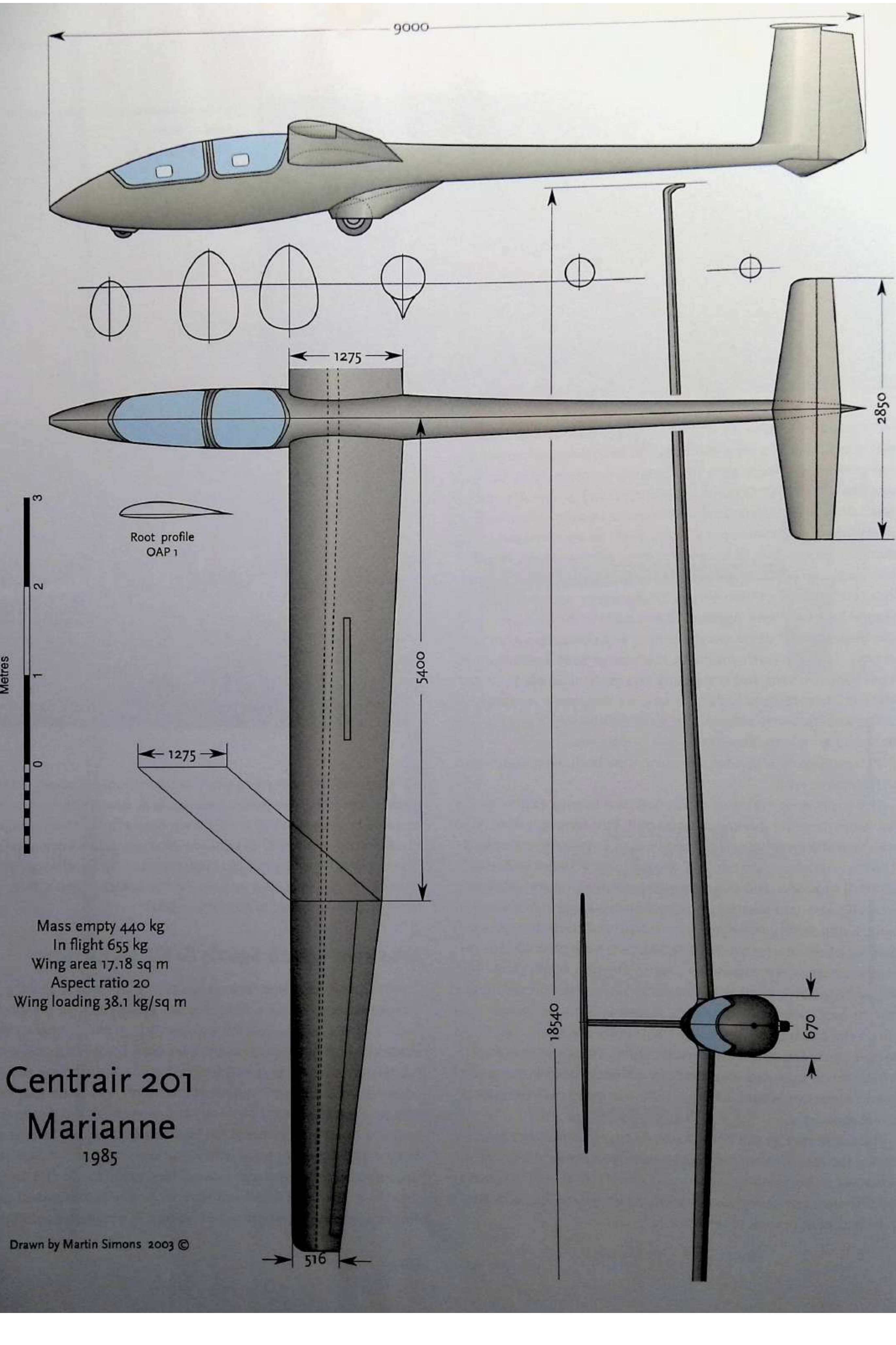
Prototypes were evaluated by the St Auban Soaring Centre, and by the Air Force gliding centre at Romantin. First impressions of pilots who flew the prototype were good though not wholly enthusiastic. The rear cockpit in particular was said to be very uncomfortable, difficult of access, and the view restricted. Rigging and de-rigging were not easy and details of the cockpit layout were not to everyone's liking. It was, nonetheless, well built and strong, free of vices, easy for a beginner to handle. The airbrakes were good and the performance up to expectations, probably superior to the Grob Twin but perhaps not as good as the SH Janus, both from Germany. It was not the best looking of sailplanes. Placed as it was under the wing where the fuselage contracted to the slender tail boom, the wheel looked obtrusive, although carefully faired. There was a small nose wheel. It was expected that the more advanced Marianne 2 would have a retracting wheel. Most of 1986 was taken with testing and minor changes.

Still supported by the FFVV, Centrair expected to begin production at the rate of three or four per week from January 1987. There was some adverse comment. It was claimed that the FFVV was under pressure to promote the Marianne merely for the sake of national feeling, despite some shortcomings.

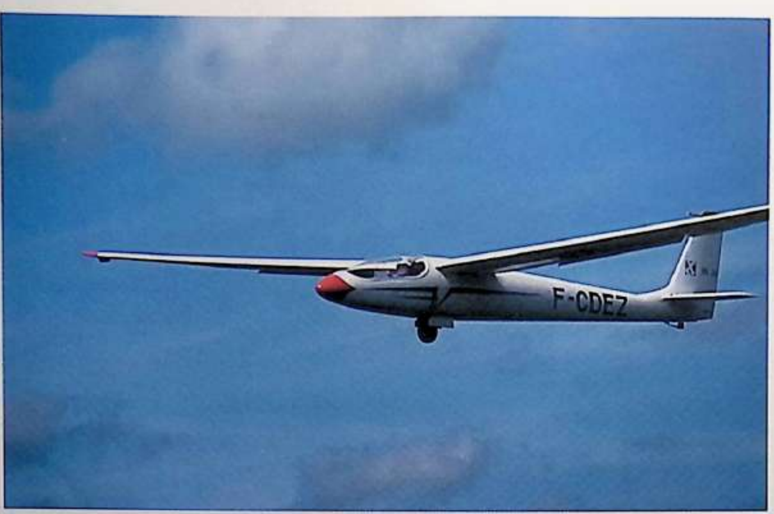
By early 1988 some forty of the C 201 had been delivered, five of these to the FFVV who loaned them to clubs around the country for evaluation. A total of eighty were built before the Centrair Company dissolved. With this, all sailplane production in France came to an end. Very few of the C - 201 were exported. Three, after registration in France, were later entered on the British register. One, in need of repairs, arrived in Australia in 2003.

Wassmer WA 26 Squale & WA 28 Espadon

The WA 26 Squale (Shark) first flew in 1967. It represented an attempt by the Wassmer Company which had previously produced the WA 20 and 22 Javelot, series, and the two seat WA 30 Bijave, to enter the market with a high performance single seater. The fuselage and vertical tail were moulded in glass -fibre-reinforced polyester resin, but the wing was of traditional wooden construction with main spar and ribs, and thick, 2.5 mm, plywood skins to preserve the Wortmann profile. The air brakes were of the trailing edge type. The horizontal tail was all-moving, in wood with fabric covering. The WA 26M was introduced with anti-balance tabs on the elevator to increase the pilot's 'feel'. The main wheel was retractable. The Squale proved successful and more than eighty were ordered. It was recognised never-



9000
1275
2850
Root profile
OAP 1
Metres
0
1
2
3
5400
1275
18540
670
Mass empty 440 kg
In flight 655 kg
Wing area 17.18 sq m
Aspect ratio 20
Wing loading 38.1 kg/sq m
Centrair 201
Marianne
1985
Drawn by Martin Simons 2003 ©
516



Left: *Wassmer WA 26 Squale approcaching to land*

Below: *The WA 26 Squale had trailing edge airbrakes and an all moving tailplane. The fuselage was built in GRP, the wing wooden with plywood skins*

theless that wooden wings were becoming out of date and in 1972 work began on an all-composite version. The outlines of the WA 28 Espadon were identical to the WA 26 but the entire structure was in GRP, still using polyester resins. The air brakes were replaced with the more orthodox Schempp Hirth vertical type. Production of the WA 28 began in late 1974. By this time it was evident that types such as the Glasflügel H - 201 Standard Libelle and ASW 15 were well in advance of the Espadon. Production ceased soon afterwards.

(Thanks to Richard Ferriere, Louis Kulicka and Francis Humblet for help with this article and those on other French sailplanes.)

GERMANY

The sport of soaring was discovered and developed in Germany in the early nineteen twenties. There have always been thousands of active enthusiasts. Supported by these, a flourishing design and construction industry developed, satisfying the home market but also exporting sailplanes, and ideas, to every country where there were glider pilots.

At all times, academic flying groups at the technical universities, Akafliegs, have tended to lead the way. Research into aerodynamics and new structural materials was done in the Universities. Students with imagination and high ability devised adventurous projects. These were argued about, modified, redrafted. The most promising ones were built and flown. Theoretical studies and practical engineering were thus brought together. Some of these imaginative constructions proved impractical or disappointing, but important lessons were learned from all of them. In many cases, the outcome was a brilliant synthesis promising great advances.

The various Akafliegs kept in touch with one another, in friendly rivalry, through their association, Interessengemeinschaft Deutscher Akademischer Fliegergruppen (IDAFLIEG). This brought the students together annually, with their latest aircraft and futuristic ideas, to talk, test and fly.

Individuals who had been prominent Akaflieg members often moved immediately into the industry after leaving college. Time and again, the result was a new, superior series of production sailplanes. When fibre-reinforced plastics were being adopted for sailplane construction, the established firms, particularly Alexander Schleicher, Schempp Hirth and Egon Scheibe, which had all been founded in the years before World War Two, found themselves facing competition from a new generation of manufacturers. In 1957 came Eugen and Ursula Hänle's Glasflügel Company with the BS - 1 and the Libelle H - 301, which were already in production before 1965. Bolkow began production of the Phoebus in 1966, Wolf Lemke with Walter Schneider in 1967 started production of Lemke-Schneider (LS) sailplanes, in 1967, Burkhardt Grob began in 1971, Wilhelm Dirks and Gerhard Glaser (DG) in 1973. There were others, some short lived. The older companies continued at first with traditional materials but soon changed to plastics.

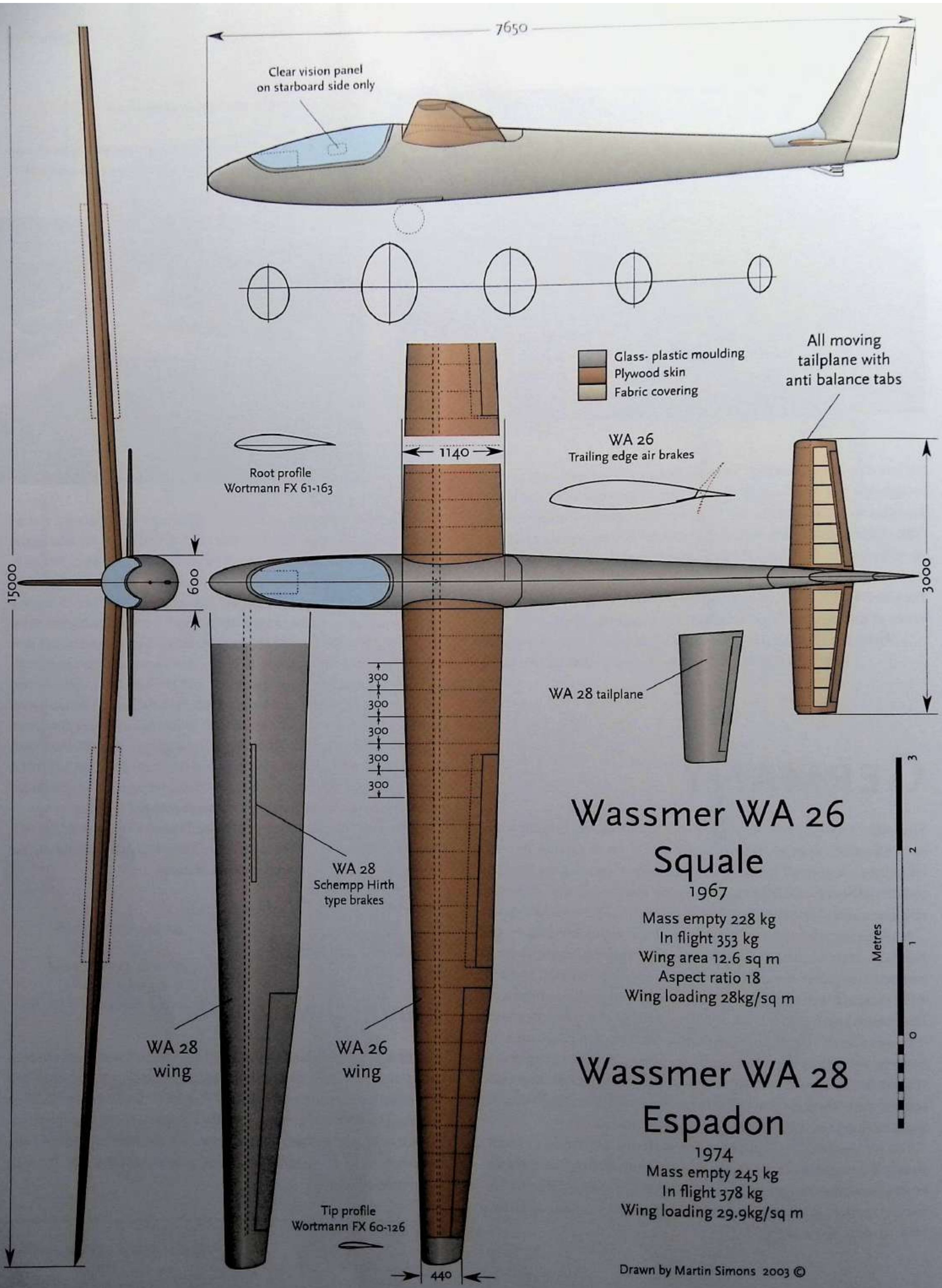
In the following pages, the narrative begins with some of the outstanding products of the Akafliegs. After this, the sailplanes are arranged by companies in alphabetical order.

The Akafliegs

Braunschweig

The first plastic sailplane developed by the Braunschweig student group was the SB 6, designed by Bjorn Stender, which led to the Glasflügel production of the BS 1.[19] The SB - 7 followed. Methods of building in GRP (glass -fibre-reinforced plastic) now were well understood. The main spar flanges were of glass-fibre rovings and the sandwich skins of resin-impregnated glasscloth with PVC foam or balsawood filling.

19 – See Volume 2



Wassmer WA 26 Squale

1967

Mass empty 228 kg
In flight 353 kg
Wing area 12.6 sq m
Aspect ratio 18
Wing loading 28kg/sq m

Wassmer WA 28 Espadon

1974

Mass empty 245 kg
In flight 378 kg
Wing loading 29.9kg/sq m

Drawn by Martin Simons 2003 ©

SB 9 on tow. With 22m span one of the largest sailplanes of its time (Photo Peter Selinger)

SB - 8 & 8V2

The SB - 7 had an excellent performance but the wing profile was not satisfactory and it proved difficult for all but the most experienced pilots to fly. In 1967 the SB - 8, with wing span 18 metres, was built. This was successful but there was no provision for water ballast. The wing loading was not high and average cross-country speed in good weather was not as good as had been hoped.

It was always recognised that there might be aeroelastic problems with GRP. Glassfibre has very high tensile strength but is not very stiff. During high-speed test flying the SB - 8 fluttered. The maximum permitted speed had to be restricted to a modest 170 km/h. A second SB - 8, the V2, was built. To stiffen the wings, more material was used, which increased the total weight. This was entirely acceptable because the SB - 8 as first built was considered too light for modern cross-country flying. Provision was now made for water ballast. The maximum wing loading was 32 kg/sq m and the maximum permitted speed could be increased safely to 200 km/h. The glide ratio was measured at better than 40:1 (see the polar curve on the drawing).

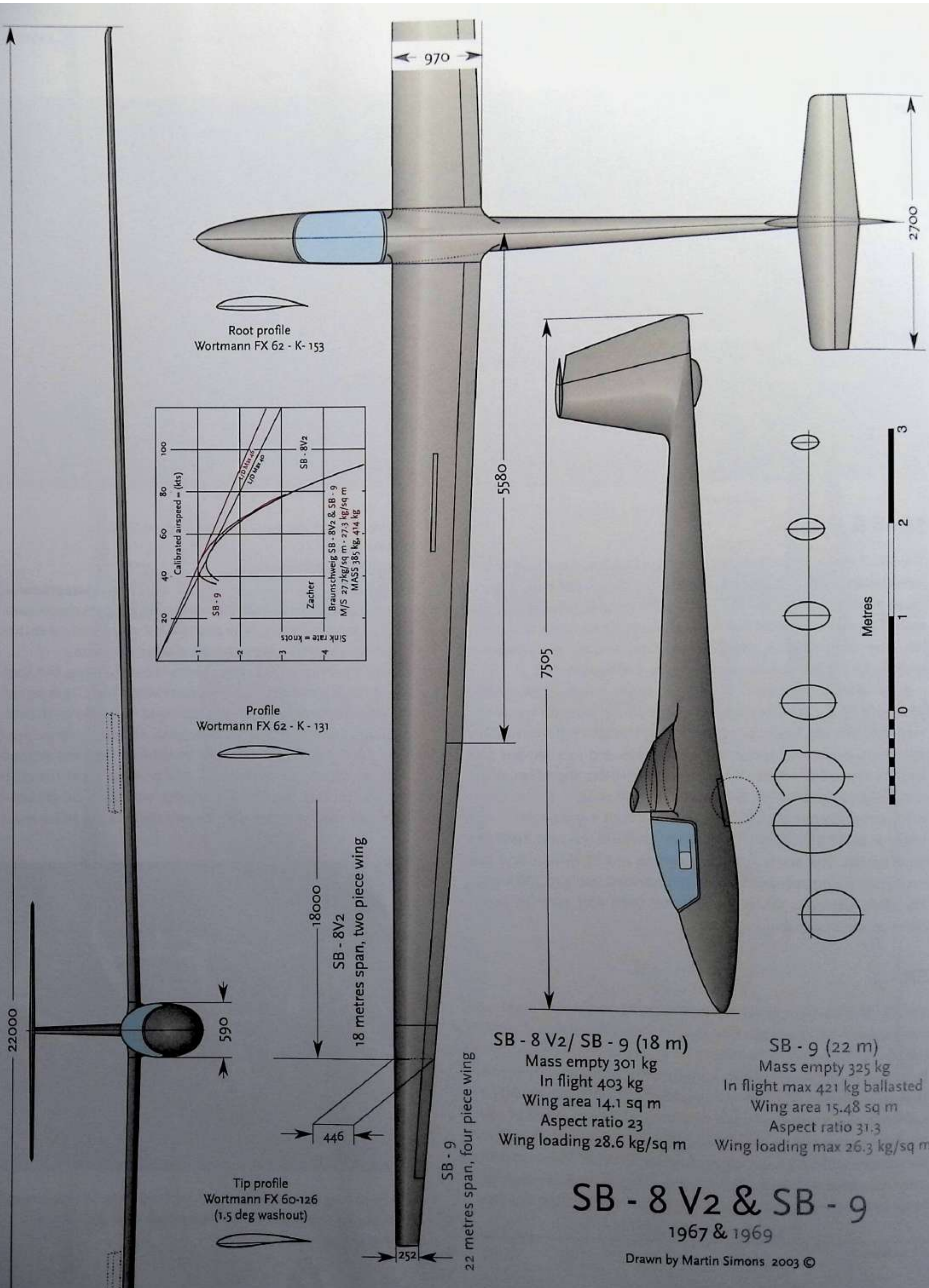
SB - 9

The SB - 8V2 having proved satisfactory, it was decided to develop a new version with span increased to 22 metres. The result was named the SB - 9. This was, in its time, one of the largest sailplanes ever built, making its first flight in January 1969 (three days before the Holighaus Nimbus 1 of similar dimensions). It was a spectacular aircraft with aspect ratio 31.3 and a measured glide ratio at best of 46:1. A special feature was the elastic flap. This idea was first realised for the wooden HKS sailplanes of the nineteen fifties.[20] The usual difficulty associated with flaps, discontinuities in the wing profile at the hinge line, with leakage disturbing the airflow, was avoided. The flexible upper surface skin of the wing acted as the hinge. A simple parallel linkage drove the flaps. (The Jantar 1 & 2 of the early seventies, and later the Speed Astir, used a similar elastic flap system.)

The SB - 9 provided the students with some alarming, but fascinating and highly instructive, experiences with flutter. They recorded these on a remarkable film, shown round the world to all interested groups, especially the OSTIV congress. At a moderate airspeed, aileron flutter of a simple kind could be induced, the wing responding with asymmetrical oscillations, one bending up as the other bent down, rocking the fuselage rapidly around its longitudinal axis. The tail unit oscillated with its own rhythm, not in harmony

Famous Braunschweig designs from right to left, the SB-13, SB-7B, SB-5 (foreground), SB-8, SB-9 (fuselage), SB-14 (foreground), SB-12 (middle) SB-10 (background) (Photo Peter Selinger)

20 – See Volume 2


970
2700
5580
7505
22000
590
18000
SB - 8V2
18 metres span, two piece wing
446
252
SB - 9
22 metres span, four piece wing
Root profile
Wortmann FX 62 - K- 153
Calibrated airspeed = (kts)
20
40
60
80
100
Sink rate = knots
1
2
3
4
L/D Max 46
L/D Max 40
SB - 8V2
SB - 9
Zacher
Braunschweig SB - 8V2 & SB - 9
M/S 27.7kg/sq m - 27.3 kg/sq m
MASS 385 kg, 414 kg
Profile
Wortmann FX 62 - K - 131
Tip profile
Wortmann FX 60-126
(1.5 deg washout)
Metres
0
1
2
3
SB - 8 V2/ SB - 9 (18 m)
Mass empty 301 kg
In flight 403 kg
Wing area 14.1 sq m
Aspect ratio 23
Wing loading 28.6 kg/sq m
SB - 9 (22 m)
Mass empty 325 kg
In flight max 421 kg ballasted
Wing area 15.48 sq m
Aspect ratio 31.3
Wing loading max 26.3 kg/sq m
SB - 8 V2 & SB - 9
1967 & 1969
Drawn by Martin Simons 2003 ©

with the wing. The flutter did not run out of control but could be maintained more or less indefinitely, once started. It stopped when the airspeed was sufficiently reduced.

At higher airspeeds a more complex type of flutter arose, with a shorter period and faster rhythm. On the film it appears as if a rapid wave-like distortion is moving from wing tip to wing tip, the crest of the wave moving laterally, somewhat reminiscent of a 'sidewinder' snake in motion. As before, the fuselage and tail vibrated out of phase; a very unpleasant and potentially dangerous situation for the pilot. After these tests, which rather surprisingly caused only minor damage, the ailerons were mass balanced and the span decreased to 21 metres.

SB - 10

Extending the span of the SB 8 by four metres from 18 to 22 for the SB - 9, yielded an improvement in glide ratio from 40 to 46. A further similar span extension should have an equal or even greater effect. The aspect ratio would be higher and the fuselage, relative to the larger wing, would create proportionately less drag. A best glide of 52:1 or more should be within reach. With an even bigger span, a better figure would be obtained.

The next development was the SB 10, a two-seater. This flew in 1972. The wing now was in five pieces. An entirely new 8.7 metre centre section of constant chord was built. To allow solo flying with the pilot in the front seat, this was swept forward slightly. It was a composite structure. The main spar flanges used carbon fibre rovings, with plywood webs. The skins were sandwiches; glassfibre on one side, 6 mm thick balsa filling, and carbon fibre reinforced plastic (CRP) on the other surface. The result was immensely strong and stiff. Carbon fibre at this time was very expensive but without it the SB - 10 could not have been built.

With modifications and necessary stiffening, the SB 9 wings were mounted on this new centre section. To reduce the operating loads for the pilot, ordinary hinges replaced the elastic-hinges for the flaps. The wing tip extensions already used on the original SB - 9 brought the SB - 10 to 26 metres span.

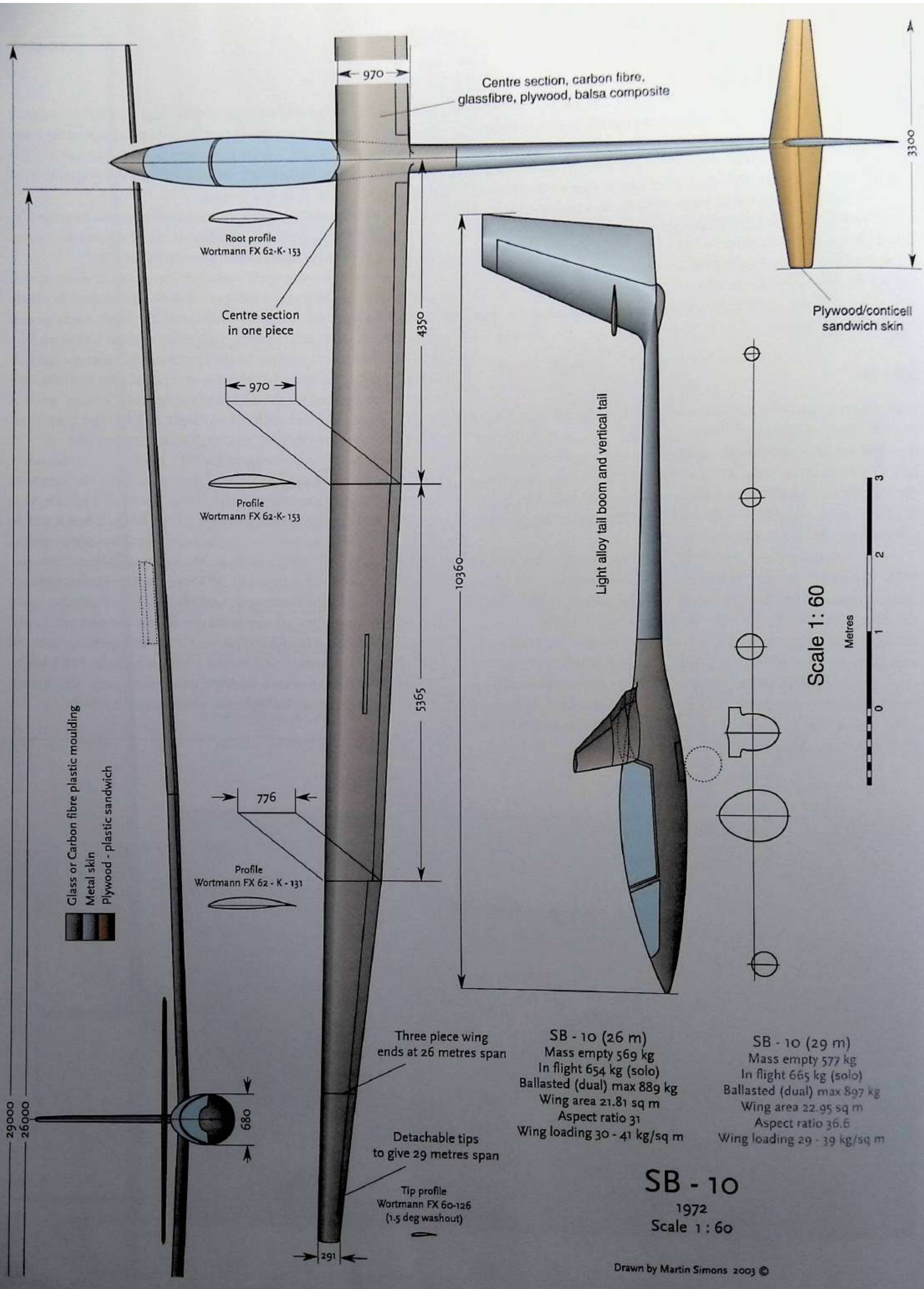
New interchangeable extensions were built to allow the aircraft to fly with 29 metres span. Nothing of this size had been seen since the famous 30 metre Kronfeld / Küpper Austria of 1931.[21]

For the SB 10 a completely new, two-seat fuselage and tail unit were required. There was a substantial steel tube framed structure to take the main concentrated loads, retracting undercarriage and wing, pilots' seats and controls, all hidden under a GRP shell fairing and transparent canopy. To the central steel structure a light alloy tail boom was attached, with the vertical tail also in metal. The dominant criterion for this long and narrow rear fuselage, was not only strength but also stiffness and light weight. The horizontal tail had a plywood-Conticell sandwich skin, light and stiff.

The first public appearance of the SB - 10 caused a sensation. It was nearly twice the wing span and more than twice the weight of existing wooden standard class sailplanes. To rig and handle it on the ground a crew of at least ten was required. When it flew it proved to be everything that had been expected. It won a two-seater competition in France in 1973 and broke the German national distance record with an 896 km flight. In 1979 Hans Werner Grosse, with co-pilot Hans-Heinrich Kohlmeyer, took the SB - 10 to Australia. Based at Alice Springs, they set the world records for out-and return distance at 965 km, triangular distance 1112.6 km, speed for the 750 km triangle 131.8 km/h, and for the 1000 km triangle, 129.5 km/h. These were also of course German national records. The Braunschweig student group had achieved what they set out to do.

21 – See Volume 1

SB 10 at Gawler in South Australia, 1979



970
Centre section, carbon fibre, glassfibre, plywood, balsa composite
3300
Root profile
Wortmann FX 62-K-153
Centre section in one piece
Plywood/conticell sandwich skin
4350
970
Light alloy tail boom and vertical tail
Profile
Wortmann FX 62-K-153
10360
Scale 1: 60
Metres
5365
Glass or Carbon fibre plastic moulding
Metal skin
Plywood - plastic sandwich
776
Profile
Wortmann FX 62 - K - 131
Three piece wing ends at 26 metres span
SB - 10 (26 m)
Mass empty 569 kg
In flight 654 kg (solo)
Ballasted (dual) max 889 kg
Wing area 21.81 sq m
Aspect ratio 31
Wing loading 30 - 41 kg/sq m
SB - 10 (29 m)
Mass empty 577 kg
In flight 665 kg (solo)
Ballasted (dual) max 897 kg
Wing area 22.95 sq m
Aspect ratio 36.6
Wing loading 29 - 39 kg/sq m
29000
26000
680
Detachable tips to give 29 metres span
Tip profile
Wortmann FX 60-126
(1.5 deg washout)
291
SB - 10
1972
Scale 1 : 60
Drawn by Martin Simons 2003 ©

SB - 11

Above: Helmut Reichmann flying the Braunschweig SB-11 placed 1st in World Championships 1978 in Chateauroux, France.

Left: Extending the large flaps increased wing area by 25%.

What next for Akaflieg Braunschweig? The competition class rules were changed in 1975. After much controversy, a new, unrestricted 15 metre class was now in being. The strict span limitation prevented performance improvements by stretching the span. A new generation of sailplanes appeared, many of them adaptations of the old Standard Class types, with camber-changing flaps and the wing profiles to suit them. There seemed only one other way to make substantial gains in performance: variable geometry. The British had tried this with their large, and disappointing Sigma. That was an Open Class aircraft and some of its difficulties had arisen because it was so large. A variable wing sailplane of 15 metres span ought to be easier to design and build.

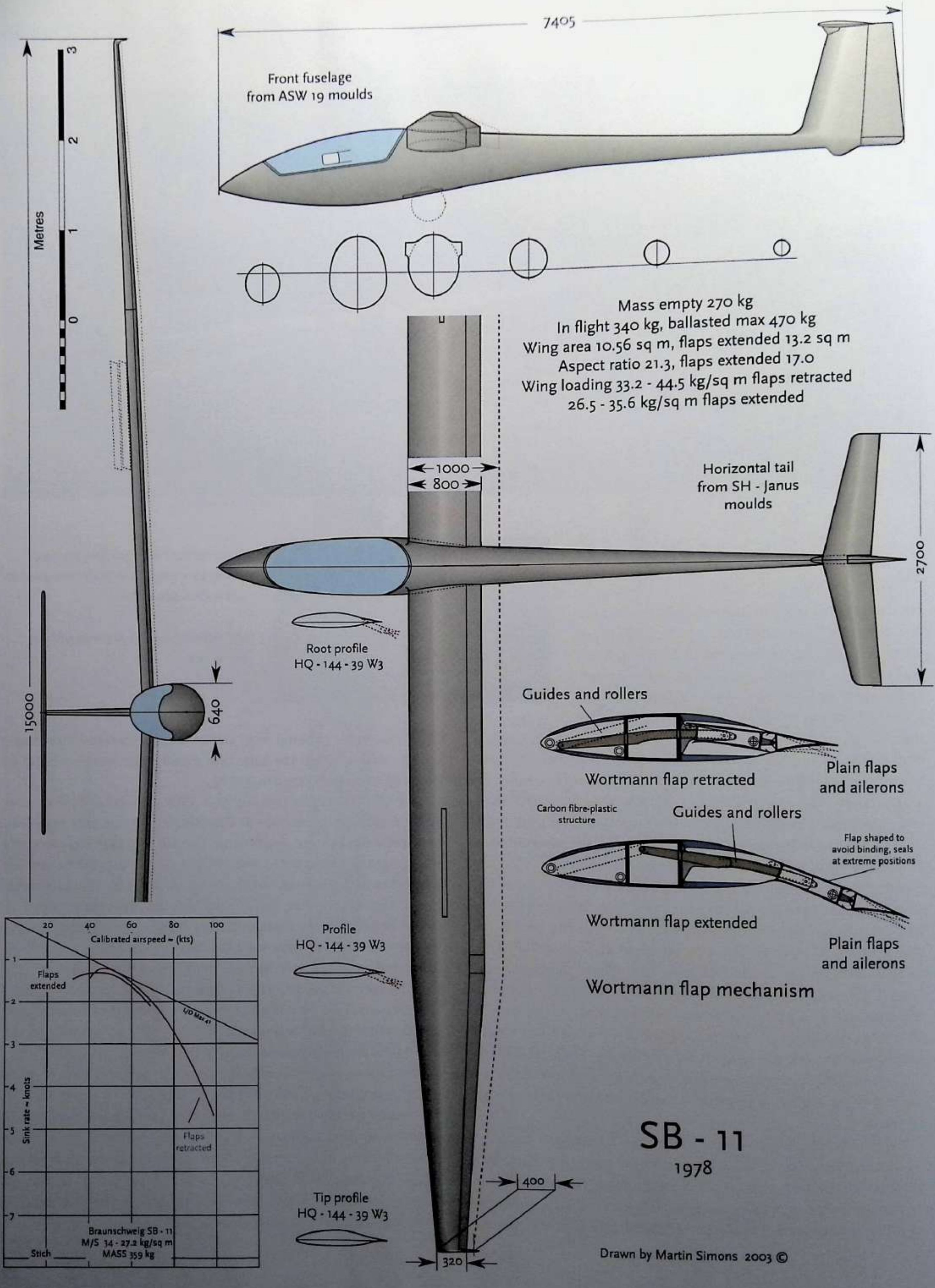
The outcome was the SB - 11. Many innovations were made. The chief difference between this and the other 15m sailplanes was the large Wortmann flaps which allowed the total wing area to be changed from 10.56 to 13.2 square metres, an increase of 25%. One commentator wrote, the SB - 11 was clean where the Sigma was 'messy'. The flap was cleverly shaped to be well sealed in both the retracted and the open positions. Between the two it moved smoothly on guides with rollers. Operating loads were fairly light so there was no need for mechanical aids like hydraulic, pneumatic or electric drive. Water ballast was allowed for and the very large flaps carried the ailerons and simple camber flaps on their trailing edges too.

The front fuselage was taken directly from the moulds used for Schleicher ASW - 20. The tail boom and tail unit were from the Schempp-Hirth Janus, with careful blending of the two forms. Since the flaps created large pitching moments when extended, the fuselage length and tail moment arm was greater than usual for such a span.

The structural material was almost wholly carbon-fibre-plastic (CRP), which raised the total cost greatly, but was successful in keeping the weight down to 270 kg.

The SB - 11 made its first flights in 1978, and was in time to enter the World Championships at Chateauroux in late July that year. The pilot was Helmut Reichmann, already a World Champion. He had originally expected to enter with an LS - 3 but when given the chance to fly the SB - 11, took it gladly. He won the championships. On reflection, however, it seems the sailplane did not perform very much better than the more orthodox aircraft. The winning margin at the end of eleven days was only 44 points in a total over 10500. Performance tests later tended to confirm this. Flaps out, the stalling speed of the SB - 11 was slightly less than that of the ASW - 20. It could circle on a slightly smaller radius but this would only matter if the thermal was unusually narrow. With flaps fully in, the SB - 11 did not seem quite as good in the fast glide as the ASW - 20.

Reichmann, at the top of his form, would probably have won the 1978 Championships if he had been flying any of the orthodox fifteen metre aircraft. He himself later said that the pilot's workload in a cross-country race was already high and to have the variable geometry wing to contend with was too much. It was far more important for the pilot to find, and use, strong lift, than to make large changes of wing area and trim every time a thermal was encountered. Deploying the flaps was hardly ever necessary.



7405
Front fuselage
from ASW 19 moulds
Metres
0
1
2
3
Mass empty 270 kg
In flight 340 kg, ballasted max 470 kg
Wing area 10.56 sq m, flaps extended 13.2 sq m
Aspect ratio 21.3, flaps extended 17.0
Wing loading 33.2 - 44.5 kg/sq m flaps retracted
26.5 - 35.6 kg/sq m flaps extended
1000
800
Horizontal tail
from SH - Janus
moulds
2700
Root profile
HQ - 144 - 39 W3
15000
640
Guides and rollers
Wortmann flap retracted
Plain flaps
and ailerons
Carbon fibre-plastic
structure
Guides and rollers
Flap shaped to
avoid binding, seals
at extreme positions
Wortmann flap extended
Plain flaps
and ailerons
Wortmann flap mechanism
Profile
HQ - 144 - 39 W3
20
40
60
80
100
Calibrated airspeed – (kts)
Flaps
extended
L/D Max 41
Sink rate – knots
1
2
3
4
5
6
7
Flaps
retracted
Braunschweig SB - 11
M/S 34 - 27.2 kg/sq m
MASS 359 kg
Stich
Tip profile
HQ - 144 - 39 W3
400
320
SB - 11
1978
Drawn by Martin Simons 2003 ©

The SB - 11, a valuable experiment, proved a point. Variable geometry, with its complexities and special wings, did not yield great advantages. Simpler, less expensive 15 metre sailplanes could do just as well in competition. There was very little further development in this direction.

SB - 13 'Arcus'

The SB - 12 of 1980 was a straightforward Standard Class sailplane used mainly to investigate the effects of pneumatic turbulators. What, in 1982, should Akaflieg Braunschweig attempt now? A major improvement in performance could come only from something radical. There was fierce debate among the students, some of whom wished to continue work on variable geometry, refining the Wortmann flapped wing profiles of the SB - 11 and adjusting the design to suit European soaring conditions.

Others proposed a tailless project. This, they believed, would be scientifically more interesting. There had been no new 'flying wing' competition sailplane for more than thirty years. A tailless sailplane ought to be less expensive to build, having fewer components and using less material than the SB - 11. The tailless layout seemed to offer worthwhile gains. The students made their decision. Financial support was forthcoming from official sources.

There was much more to do than had been realised at first. After first selecting a simple swept back wing plan, a one-third scale radio controlled flying model was built. Its behaviour was not what had been expected. The centre of gravity position was very critical. Balanced too far aft, the model would stall and spin at the least opportunity. Recovery control action often instantly produced another spin in the other direction. With the centre of gravity forward, there was a puzzling short period longitudinal instability or 'pecking'. In slightly gusty air the model would suddenly pitch sharply nose up and down without warning, too quickly for the pilot to respond. If attempts were made to stop the pecking it was very easy for the pilot to make the situation worse, causing increasingly violent 'pilot induced oscillations' (PIO).

At moderate flight speeds the model fluttered dangerously.

A complete re-thinking of the design was undertaken. The flutter problem, after profound computer analysis, required the wing plan form to be changed The straight sweep back was altered to a curved form. A special, high grade, carbon fibre was used to stiffen the main spar, which was itself curved and positioned within the wing chord to achieve a self-damping effect. The critical flutter speed was thereby raised to more than 270 km/h, which was acceptable. Calculation of the combined bending and torsional loads in the curved spar was extremely difficult. A test piece of the wing structure was built and proved on a test rig.

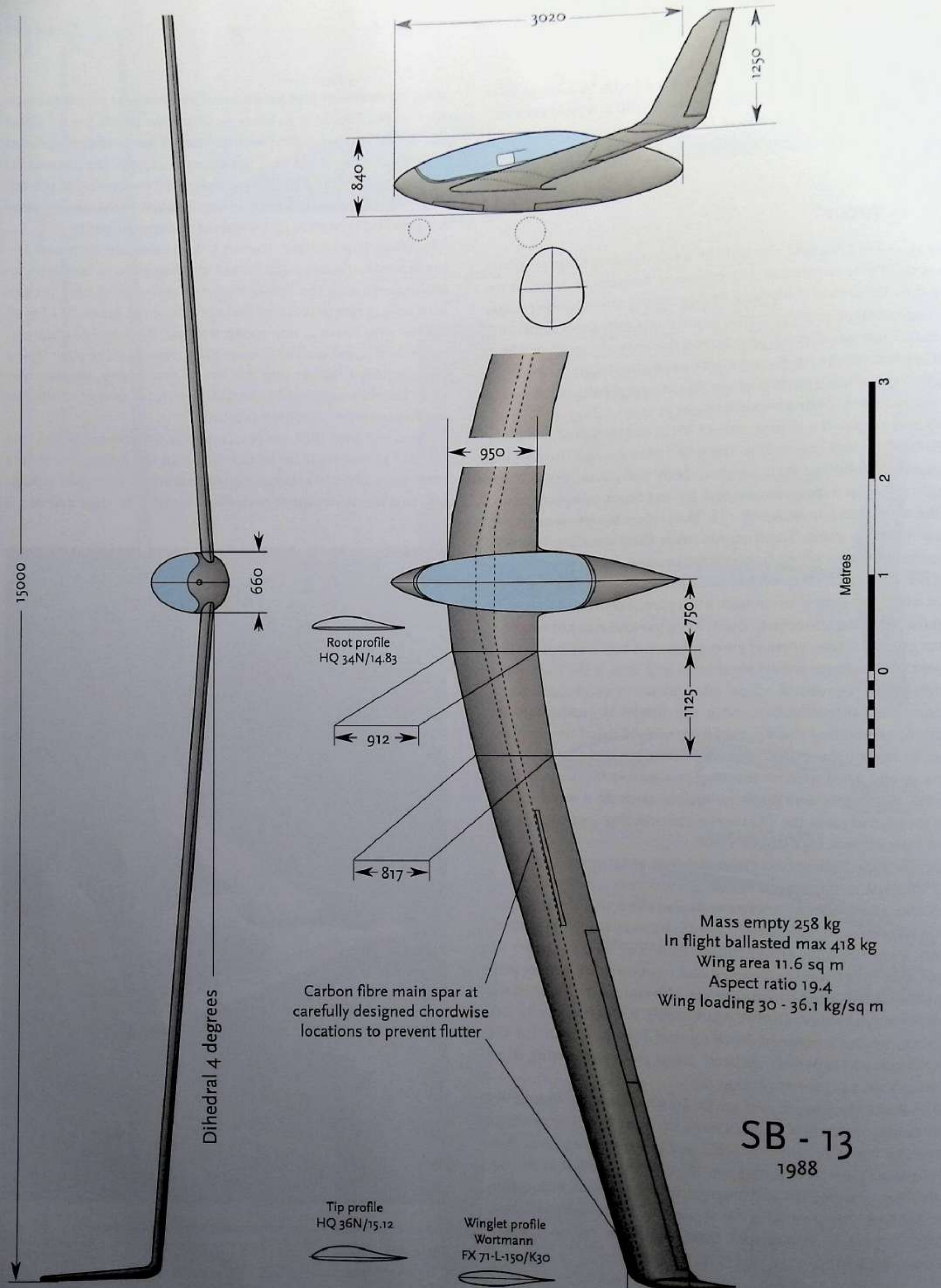
Karl-Heinz Horstmann and Armin Quast designed a completely new family of strongly reflexed wing sections with low pitching moments. These retained as much laminar boundary layer flow as possible. They were tested in flight on the DFVLR Janus aircraft. They achieved lift and drag figures comparable with orthodox profiles. The profiles were also tested with artificial 'bug' contamination to ensure that there would be no unexpected changes in flight.

Many other design problems arose. The main spar passed through the cockpit. Should it go above or below the pilot's knees? Below was the answer. Raising the nose for take off and landing threatened to bring the swept back wing tips onto the ground. The main wheel must raise the central nacelle far enough off the ground to prevent this. A nose wheel was also necessary. Stability in the yawing sense was provided by vertical tip winglets of symmetrical profile.

In actual construction, the wing skins were laid up in the prepared female moulds ready for the spar flanges to be laid in them. For impregnating the brittle high-modulus carbon fibre rovings with resin, a special machine had to be designed. Teams of 12 to 15 people were needed, one group working the impregnation machine, one laying out the rovings to a precise plan, another laying the assembled flanges into the wing. Once begun, progress was rapid but there remained to be done a series of tests of oscillation resonance on the completed sailplane.

It was not until 1988, six years after the project was started, that the SB - 13 was ready for its first flight. In the subsequent testing there remained still many unpleasant surprises. The undercarriage required re-positioning to keep the rear of the fuselage nacelle off

An unusual attempt to advance sailplane design: tailless SB 13 "Arcus" (Photo Jochen Ewald)



3020
1250
840
950
15000
660
750
Root profile
HQ 34N/14.83
1125
912
817
Metres
0
1
2
3
Mass empty 258 kg
In flight ballasted max 418 kg
Wing area 11.6 sq m
Aspect ratio 19.4
Wing loading 30 - 36.1 kg/sq m
Carbon fibre main spar at
carefully designed chordwise
locations to prevent flutter
Dihedral 4 degrees
SB - 13
1988
Tip profile
HQ 36N/15.12
Winglet profile
Wortmann
FX 71-L-150/K30
600
Drawn by Martin Simons 2003 ©

the ground. On tow, the downwash behind the tug aircraft could produce large nose-down forces; the tips of the glider being out of the downwash and lifting strongly, the centre section fully immersed in it. The spinning behaviour with centre of gravity aft was as it had been with the model, corrective action producing a reversed spin. The awkward and potentially dangerous 'pecking' behaviour at the forward centre of gravity trim, recurred. Five years after the first flights, this phenomenon was still not fully understood or preventable. Various devices were tried, including boundary layer fences, which improved the handling. The performance in test glides was comparable with orthodox Standard Class sailplanes of the period, but it was not markedly superior. The tricky handling mitigated against general acceptance of the type.

In parallel with the design and testing of the SB - 13, members of the Akaflieg also began work on a rescue parachute system which would, in an extreme emergency, bring the entire sailplane, pilot and all, safely to the ground. Successful demonstrations were done with the original radio-controlled model. This encouraged the group to continue with tests of a complete SB - 13 fuselage nacelle and, finally, with the entire sailplane. Deployment of the parachute is not, however, the end of such a rescue. The sailplane under the open canopy can swing to and fro and rotate dangerously. The final landing can be very heavy, with consequent injury to the pilot. This pioneering work has continued and the prospect for a rescue equipment of this kind for all sailplanes, is likely to be realised.

There was now an eighteen metre contest class. Work began on the SB 14.

Darmstadt

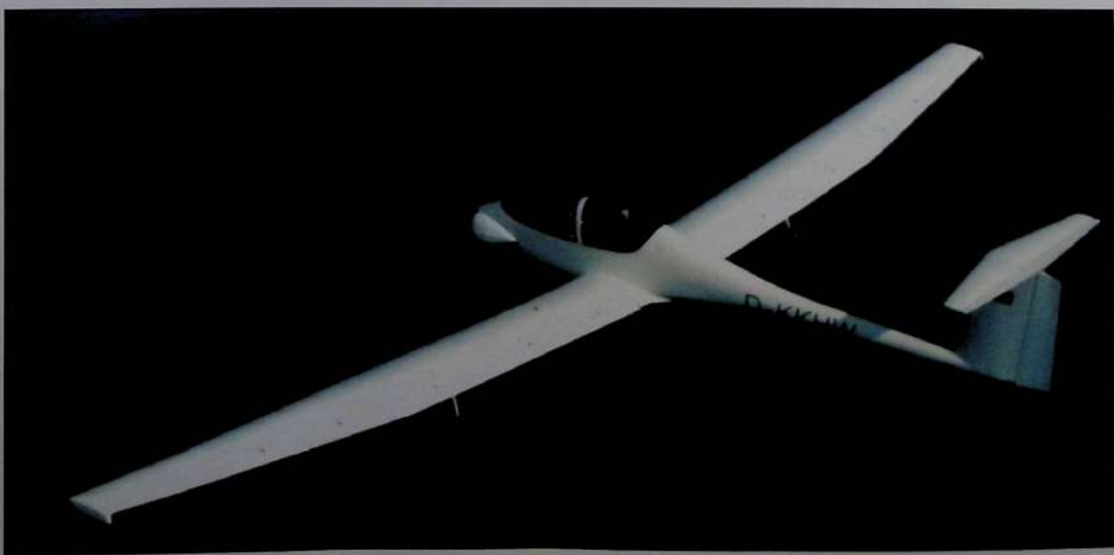
Akaflieg Darmstadt had been at the forefront of sailplane development since the beginning. The D - 36 of 1964 was the first 'super orchid' of the glass-plastic era.

D 37

With the D - 37 'Artemis', the group led by Wilhelm Dirks, investigated the self-launching sailplane, choosing a wing span of 18 metres. Trials of a new type of wing structure, based on honeycomb plastic ribs and a two-component plastic foam, seemed satisfactory in test models but failed under load when built to full size. A return was made to the now-established system of glass fibre rovings for spars with GRP sandwich skins. A fully retractable Wankel motor of 18 hp was mounted behind the cockpit. The D - 37 was flown in 1969, the pilot Wilhelm Dirks himself. The engine proved unsatisfactory and, after trials, was removed and the compartment sealed up. The D 37 thereafter became a good 18 metre sailplane. Dirks continued working to produce, in 1972, the Standard Class D - 38. He took this design with him when, with Gerhard Glaser, he founded the new firm, Glaser-Dirks GmbH.[22] In 2000, like the D - 37, the D - 38 remained in service with the Akaflieg. Next from Darmstadt came the D - 39, which had a 50 kW Limbach motor mounted in the nose, a low wing, and a good soaring performance with the motor off. This too remained in use with the Akaflieg.

D 40

The next Darmstadt experiment was an exercise in variable geometry. Discussion and preliminary studies began in 1980. An outline of the design was published in 1981. The Darmstadt group were well aware of the difficulties encountered by the British Sigma project. The München Akaflieg had also built their Mü 27 two seater, which flew well but, rather like the Sigma, was enormously complicated and heavy.[23] Like the SB - 11 in which Reichmann had won the World Championships in 1978, the D 40 was to be a fifteen metre class sailplane but the method of changing the geometry was quite different. It became known as the 'penknife' wing. The wing extension folded in and out to change the wing plan from a double tapered shape with narrow wing root, to a more triangular, straight tapered form with greater area at the wing root. The hinge point for



An innovation in Sailplane design, the Darmstadt Motorglider D 39 with 50hp Limbach engine. Note the outriggers under the wings which permitted taxiing and take off without assistance. (Photo Jochen Ewald)

22 – See DG 100, p. 100
23 – See p. 52

Darmstadt D 40: Its 15 meter "penknife" wing area could change geometry, wing area and camber. Here it is shown with flaps fully retracted. (Photo Jochen Ewald)

the extension was just inboard of the ailerons. At the root, ingenious guides and rollers allowed the wing to emerge from its sheath to the required extent, increasing both the area and camber. At the extreme root, the wing profile when extended was the Wortmann FX 67 - VG - 170/36, similar to that designed for the Sigma.

When the flap was extended, the increased camber at the wing root created an aerodynamic twist (washout) in the wing, of 12 degrees. The intention was to preserve, as far as possible, a nearly elliptical lift distribution to minimise vortex drag, while ensuring that the ailerons, beyond the flap pivot, remained always fully effective. With the flaps retracted the washout also disappeared so there was no penalty at high airspeeds.

Early experience when flying the D - 40 showed that it was not easy to manage in the air and the ailerons were not sufficiently effective. The students, most of whom were not highly experienced as pilots, had little success with it but at one IDAFLIEG meeting, Helmut Reichmann flew it and showed that it was capable of out-performing all the other sailplanes in weak thermal conditions. This encouraged the Akaflieg to do some further work. With modified ailerons and winglets, it became docile and proved itself fully.

Despite this, the idea of the penknife wing was not taken further, and neither was there any great development of variable geometry sailplanes. Some further discussion of this follows in the article, below, about the Stuttgart Akaflieg's FS - 29.

D 41

The D - 41 two seater was intended to demonstrate that a sailplane with a side-by-side seating arrangement could be made to perform just as well as the more usual tandem seating layout. It had a wing span of 20 metres and aspect ratio 28.6.

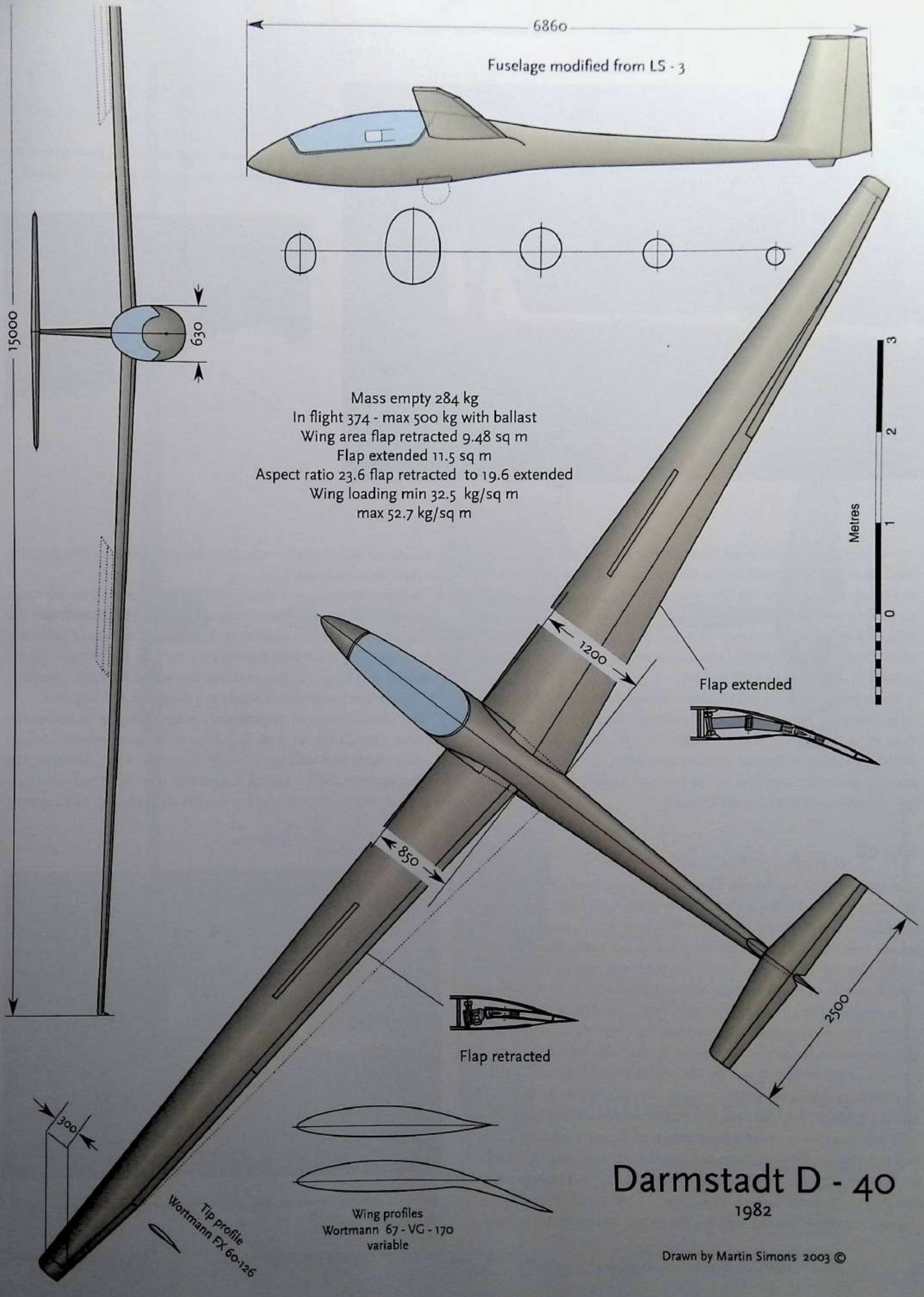
The argument for tandem seating is that the narrow fuselage creates less parasitic drag and causes minimal interference with the flow of air over and under the wing root. It brings with it some other difficulties, especially restricted vision from the rear seat. These problems are overcome as far as possible by sweeping the wing forward. The side-by-side arrangement requires a wide fuselage but, with reclining seats, the total frontal area of such a fuselage is not very much more than the tandem layout. The British Slingsby T - 49 and the Italian Caproni A - 21 used this layout, as did the Australian ES - 65 Platypus. For an instructor and student to converse in flight, the wide fuselage may be preferred. To fly such an aircraft solo requires ballast to compensate for the missing pilot.

On completion in 1993 the D - 41 proved very successful and was very popular. Sadly, during a training exercise with an aborted launch, it stalled and span, killing both pilots. It was not rebuilt. At the turn of the century, the D - 43 two seater, a smaller version of the D - 41 intended for training, was under construction.

(Thanks to Bernd Ewald for help with this article.)

München

The Munich Akaflieg began working in 1970 on a large, two seat variable geometry sailplane, the Mü 27. It was nine years before it made its first flight. The span was 22 metres and the all-up flying weight 900 kg. Half of this was the wing. The wing had an alumini-



Darmstadt D - 40

1982

Drawn by Martin Simons 2003 ©

Left and Below: D-41 High performance doubleseater with side-by side arrangement of seats (Photos Jochen Ewald)

um alloy main spar and large flaps, with the same Wortmann wing profiles as had been used on the British Sigma. The skins were GRP sandwich; fuselage and tail also were GRP. The flaps were driven by an electric motor. The wing area could be increased by 35% and the wing loading varied between 33.4 and 51.1 sq m. Large air brakes were fitted to aid landing and there was a tail drag parachute housed in the bottom of the rudder.

Many problems were encountered during construction but these were overcome and the sailplane was flown without problems, other than sheer complexity, size and weight. In a parallel development, in Switzerland Albert Neukom designed and built the AN - 66C, a large variable geometry sailplane which flew successfully in 1973. He did not persist with it after the early flights.

Mü 28

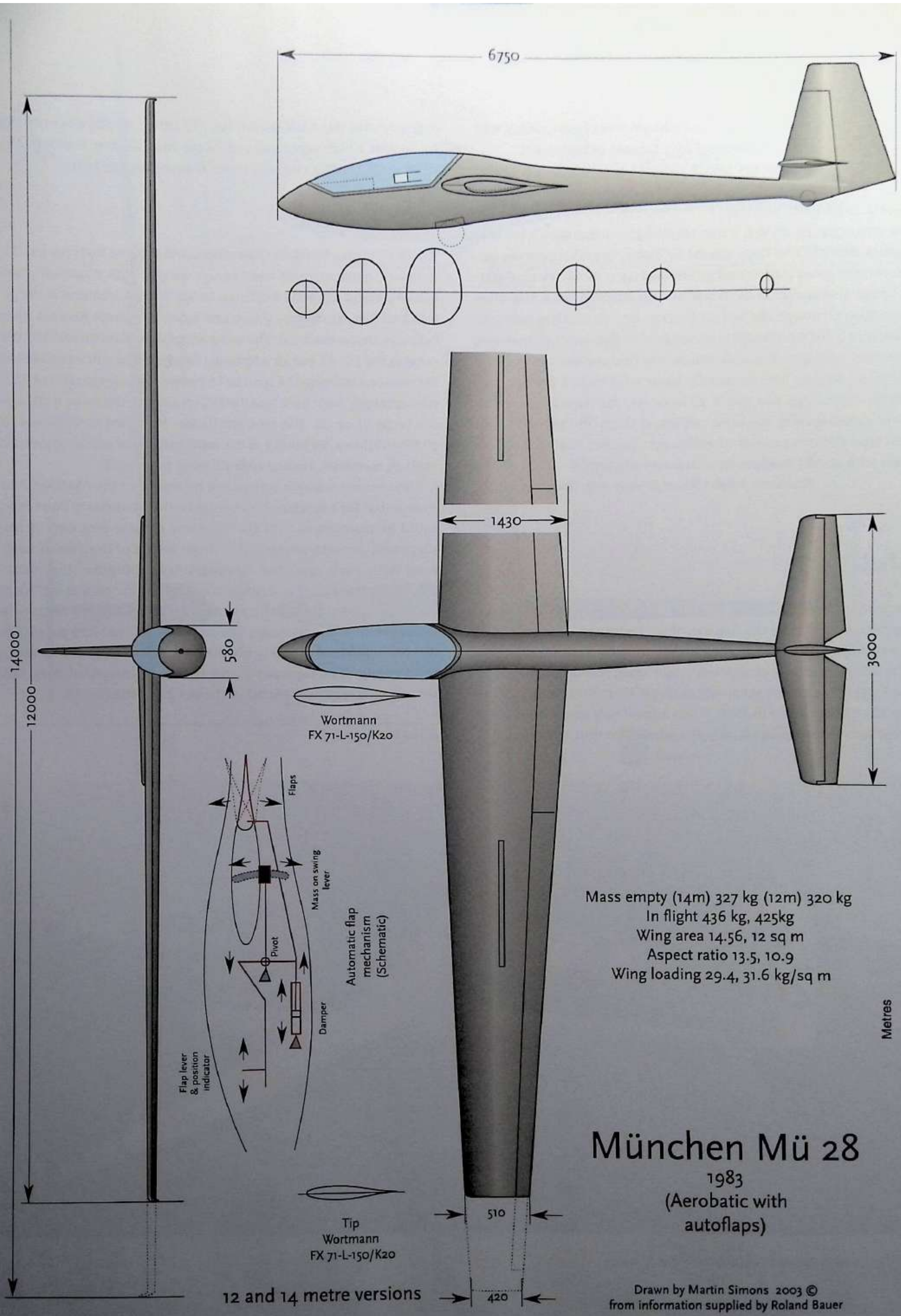
Perhaps the Munich students, after their long and hard effort with the Mü 27, felt the need to tackle a smaller project. The Mü 28 was a 12 (alternatively 14) metres span, aerobatic sailplane. It might have attracted little attention had it not been for the automatic flap system.

The fuselage except for the tail section, was laid up in the borrowed moulds of the Glasflügel Mosquito, but with considerable reinforcement. The elevators were similarly copied from the Scheibe SFH 34. The rudder was a carbon-fibre foam plastic structure with ribs covered in fabric to save weight. It was fully mass balanced to reduce the likelihood of flutter. The undercarriage required special care because it had to lock securely in the retracted position under high 'g' loads. The wing, with a symmetrical profile and zero dihedral, was an entirely new Akaflieg design in standard GRP materials and techniques. Carbon fibres were used for the ailerons and flaps to increase stiffness. The Mü 28 was stressed for positive and negative 10 g loads and a maximum airspeed of 380 km/h, though such a speed was never needed even for aerobatics. Flutter tests were carried out up to 500 km/h without problems emerging. The autoflap worked well and reliably.

The flaps themselves experience a certain moment, which tends to move them up or down according to the speed. In aerobatics the 'g' force also varies constantly. By arranging a system of pushrods and a swinging lever with a weight on the end, the balance can be adjusted to achieve the required flap movement for each speed and 'g'. To prevent unwanted oscillations a damper is also required.

The combination of symmetrical wing profile with automatic camber change makes it much easier to perform negative loops, Cuban eights and rolling circles. By means of a simple brake, the swinging lever can be locked. Control of the flaps then reverts to the pilot, which is preferred for take off and landing. The autoflap

The Mü 28 was an aerobatic sailplane with an ingenious system of automatic flap. (Photo Roland Bauer)


6750
14000
12000
580
1430
3000
510
420
Wortmann
FX 71-L-150/K20
Flaps
Mass on swing lever
Pivot
Damper
Flap lever & position indicator
Automatic flap mechanism (Schematic)
Tip
Wortmann
FX 71-L-150/K20
12 and 14 metre versions
Mass empty (14m) 327 kg (12m) 320 kg
In flight 436 kg, 425kg
Wing area 14.56, 12 sq m
Aspect ratio 13.5, 10.9
Wing loading 29.4, 31.6 kg/sq m
Metres
0
1
2
3
München Mü 28
1983
(Aerobatic with
autoflaps)
Drawn by Martin Simons 2003 ©
from information supplied by Roland Bauer

is also locked for tail slides, to allow the pilot to choose which way to recover from the slide, pitching over forward or backwards.

The 14 metre wing of the Mü 28 proved less satisfactory for aerobatics and it could not compete in cross country flying with specialised, larger-span, sailplanes.

In cross-country flying, when climbing in a thermal, a low airspeed is required and flaps should be down. In glides between upcurrents the speed is increased greatly and flaps should be up slightly. When sinking air is encountered the airspeed must rise even more, to get through the bad air quickly, and flaps raised more. In practice, a pilot who fusses constantly with flap settings becomes distracted from the main task which is to find the best air to fly in. The pilots who do best are usually those who make a few approximations with flaps and speed. If, however, the flaps adjust themselves automatically, the pilot can forget them and remain confident that there is no loss of efficiency. Further trials have been made with an LS - 3 sailplane, with promising results.

Thanks to Roland Bauer for help with the above article.

Stuttgart

The first glass-plastic sailplane, the FS - 24 Phönix of 1957 was developed nominally under the auspices of the Stuttgart Akaflieg.[24] The FS - 23 Hidalgo had been proposed earlier, in 1955. Various other projects delayed its realisation. Work began again with a completely revised GRP design using the newly available Wortmann wing profiles. The FS - 23 flew at last in 1966. It was a small sailplane with strongly swept forward wing and V tail. The wheel was non-retracting. The only air brake was a tail parachute. The flying weight was only 190 kg. Despite a high aspect ratio of 24 the wing loading was only 27.1 kg/sq m. The Hidalgo was destroyed in an accident in 1971.

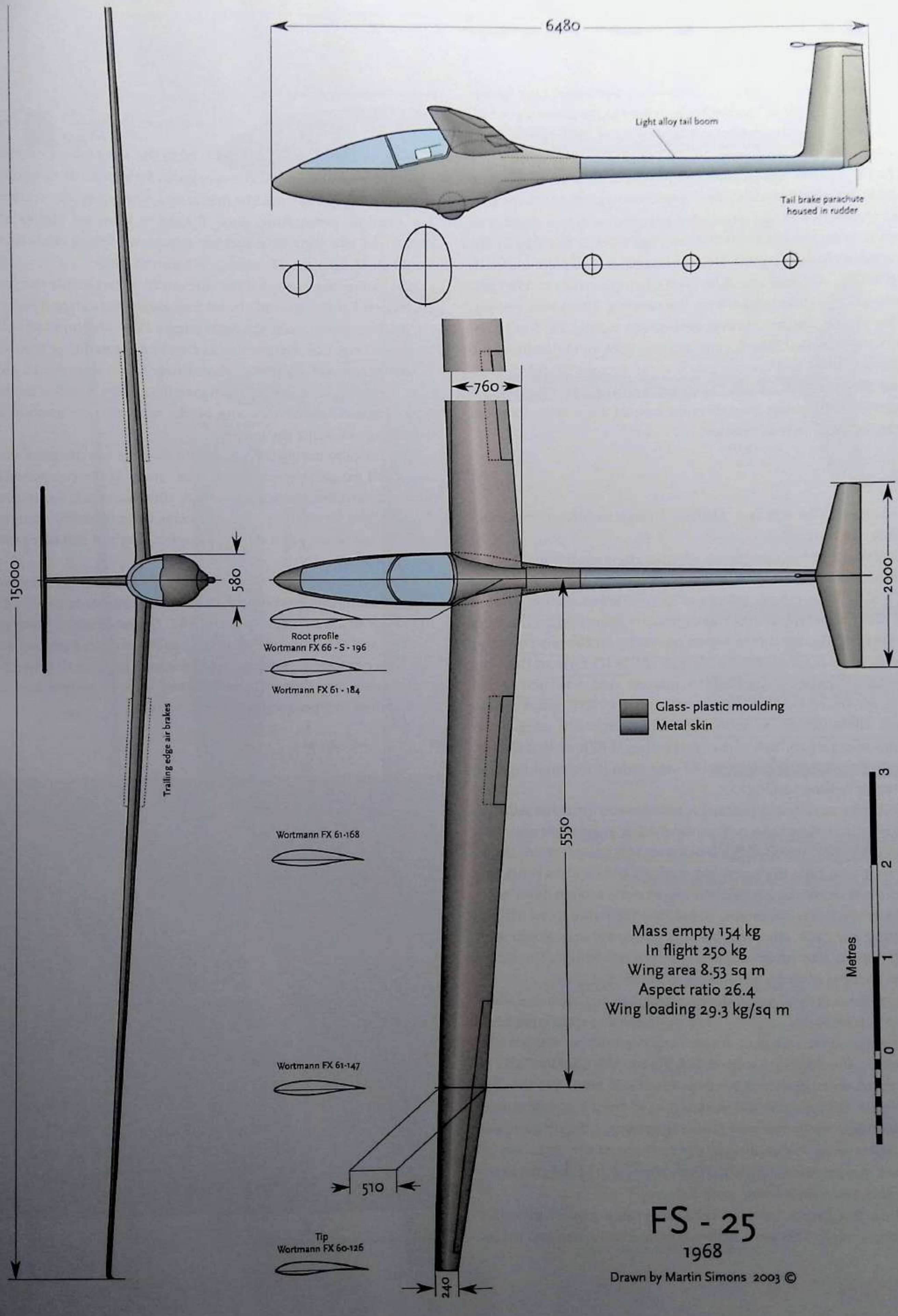
FS - 25 'Cuervo'

The FS - 25 was a Standard Class sailplane developed from the FS - 23. As before, much care was taken to save weight. With a light sailplane a large proportion of the total mass in flight is concentrated at the pilot's seat. For satisfactory vision and balance, a swept forward wing becomes almost essential. The outer wings were aerodynamically the same as the FS - 23 but an additional one metre length was added at the root end to bring the span to 15 metres. The aspect ratio of 26.4 was extremely high for a Standard Class aircraft, the more usual figure being 21 or 22. The root profile was increased in thickness to 19.6% to allow a deepening of the main spar in the region of greatest bending moments. Trailing edge airbrakes were fitted.

Wind tunnel research carried out by several of the Akafliegs had shown that for a fuselage a low drag, laminar boundary layer flow could be maintained over the nose and cockpit area only if the shape was correctly computed without breaks of line. Eventually, even with such care, the boundary layer becomes turbulent. Once this transition to turbulence occurs, the 'scrubbing' skin friction can be substantially reduced if the fuselage contracts to a tail boom of small diameter. The flow around the wing root is always complex and it is easy for the contraction to be too sudden, resulting in flow separation and serious increases of drag. All these points were considered in the design of the FS - 25.

24 – See Volume 2

The FS 25 Cuervo, a Standard Class sailplane ahead of its time



6480
Light alloy tail boom
Tail brake parachute housed in rudder
760
15000
580
2000
Root profile
Wortmann FX 66 - S - 196
Wortmann FX 61 - 184
Trailing edge air brakes
Glass- plastic moulding
Metal skin
5550
Wortmann FX 61-168
Mass empty 154 kg
In flight 250 kg
Wing area 8.53 sq m
Aspect ratio 26.4
Wing loading 29.3 kg/sq m
Metres
0
1
2
3
Wortmann FX 61-147
510
Tip
Wortmann FX 60-126
240
FS - 25
1968
Drawn by Martin Simons 2003 ©

The central structure of the fuselage was a light steel tube framework with a GRP shell. The tail boom bolted to the frame was a fabricated light alloy tube, with a tall vertical fin to carry the small, all moving T tailplane which required an external mass balance.

The FS - 25 flew first in 1968 and proved to have best glide ratio of 38.5. It showed itself to be exceptionally good for soaring in weak thermals, and was often able to continue across country in conditions that grounded heavier and fast types. It was used by the up-coming champion pilot, Helmut Reichmann, to place fourth in the German National Standard Class Championships in 1969 and remained in regular service with the Akaflieg. There were two significant faults. The trailing edge brakes were inadequate. A tail parachute was installed. The cockpit was too tight and uncomfortable for many pilots and anyone much above average height or girth could not get into it.

Almost all sailplanes from this time onward adopted the 'pod and boom' or 'club' style of fuselage.

FS - 29

With the FS - 29 sailplane Akaflieg Stuttgart ventured into completely new territory.

To gain height in upcurrents, whether these are thermals, waves or even slope lift, requires a light wing loading and a high aspect ratio wing, large in span relative to its area. When soaring, most of the drag, often about 70% of the total, is generated by the wing tip vortices. Increasing the aspect ratio is by far the most effective way of reducing this. Details such as the exact form of the wing plan, the shape of the tips themselves and whether or not winglets are added, are matters of comparatively minor importance. Generalising, to double the aspect ratio of a wing, other things being equal, halves the vortex drag. It follows that for efficiency in soaring, a large span-to-area ratio is required together with a light wing loading.

Climbing rapidly in a thermal is not of much use if the sailplane cannot glide fast and at a sufficiently shallow angle to get across the gap to reach the next lift. For penetrating still or sinking air, the pilot must trim for a high airspeed, perhaps two or three times that used when climbing. For this, the aspect ratio, though never negligible, is much less important. To increase the flying speed without spoiling the glide, the wing loading, weight for area, needs to be high. This is why most sailplanes carry water ballast. The ballast slows the rates of climb but aids the inter-thermal glides.

From these general principles and complete mathematical analyses, it can be shown that the ideal cross-country sailplane should have wings of variable span. All previous experiments with variable geometry, the AFH - 4, the BJ - 2 & 3, Sigma, AN - 66, Mü 27, D - 40 etc, relied on large extensible flaps of various kinds but the span was fixed. The fundamental weakness of all these was that extending the flaps, while reducing the wing loading, actually decreased the aspect ratio. Vortex drag as a proportion of the total, was increased, not decreased, when the flaps were out. The benefits of the changing area were thereby much reduced.

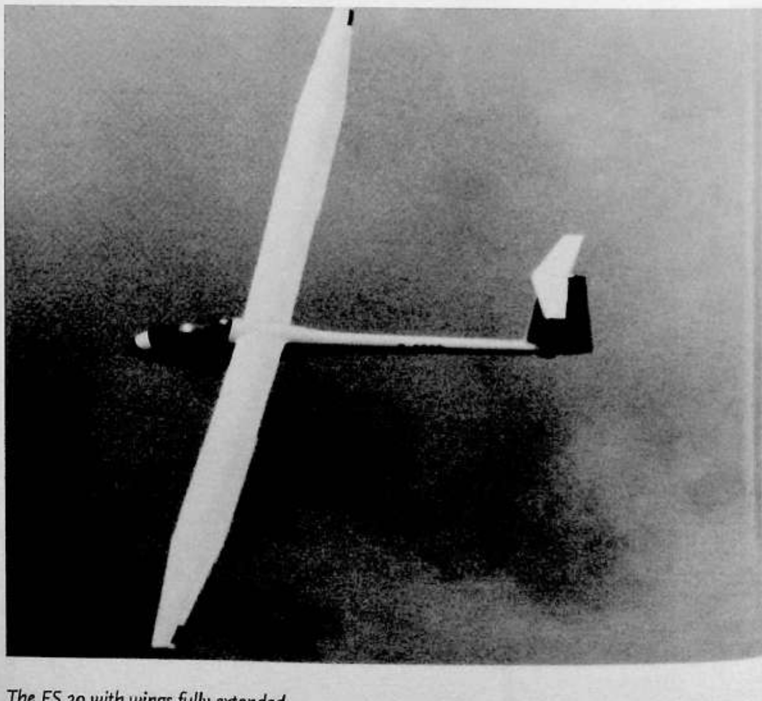
Akaflieg Stuttgart decided, in 1972, to develop a sailplane with a telescopic wing. This would allow both the wing area and the aspect ratio to be changed in flight. With the wing fully extended, soaring performance would be very good. Retracted, the wing loading and profile drag would be minimised, producing an excellent, fast, shallow, penetrating, glide. A span of nineteen metres was chosen for the wing at maximum extension. When retracted it would be 13.3 metres. The change of area was 145%.

A second photograph of the FS-25

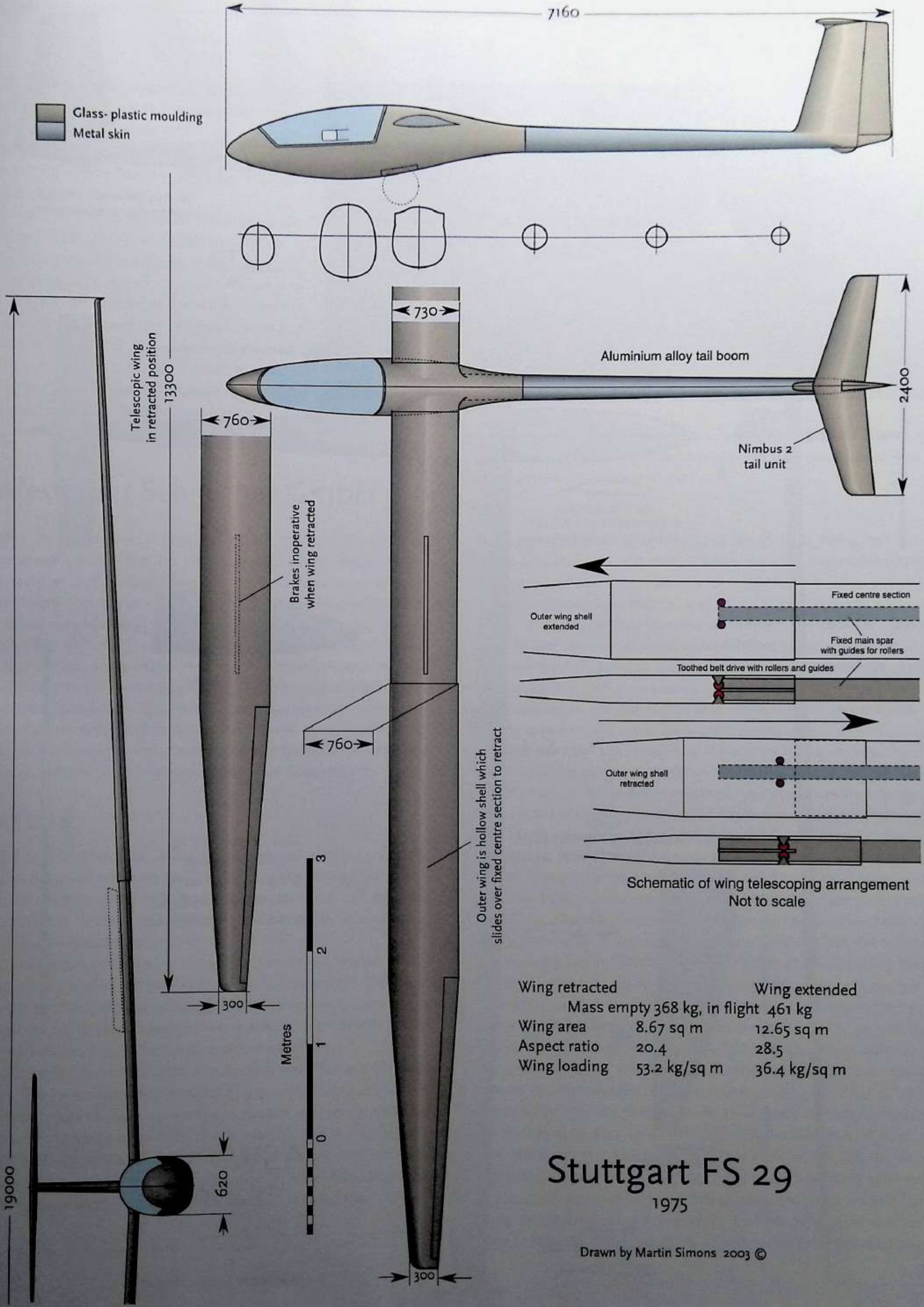
First studies assumed that the tips would retract inside the centre section but this proved almost impossible to arrange. The better solution was to make the outer wing a shell which would slide in or out over the slightly thinner and narrower inner section. Extensive use was made of carbon fibre. A stub spar would provide the necessary bending resistance for the shell. Roller guides with toothed belt drives would be the most reliable method of extending or folding the telescope.

This difficulty having been solved the fuselage was designed with the aid of extensive wind tunnel tests. Many of the components were adapted from the Schempp Hirth Nimbus, which was in production. The forward part of the fuselage was a shell moulding of GRP, the tail boom, as on the FS - 25, was a light and stiff fabricated tube of light alloy.

A vast amount of work, in design and construction, was completed in an astonishingly short time and the first flights of the FS - 29 took place in 1975. They were successful. Operating loads when retracting and extending the wing in flight were quite high but not altogether excessive. Handling was otherwise good in all respects. Performance tests showed the anticipated gains in performance at both ends of the speed scale were fully achieved.



The FS 29 with wings fully extended

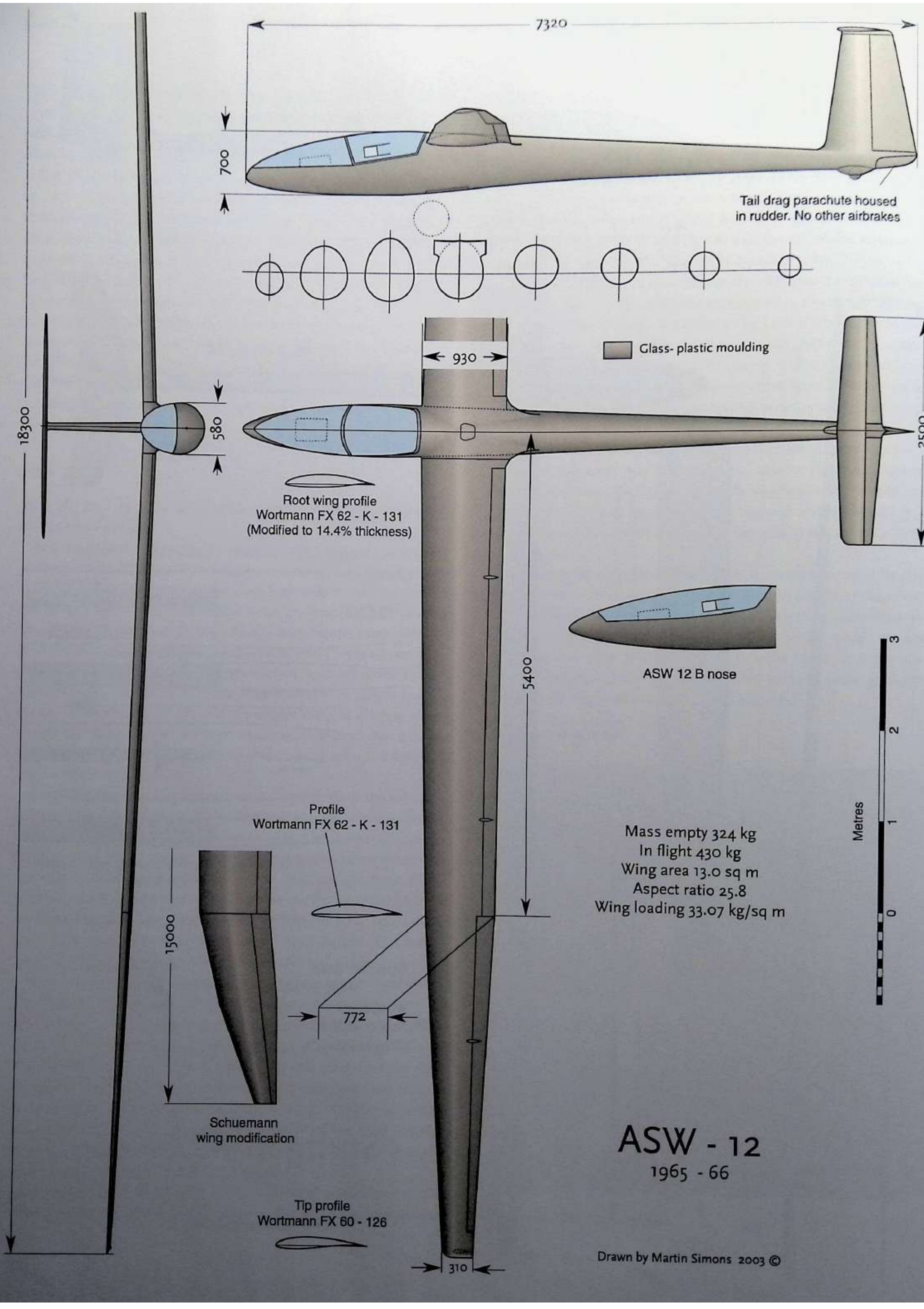


	Wing retracted	Wing extended
Mass empty 368 kg, in flight		461 kg
Wing area	8.67 sq m	12.65 sq m
Aspect ratio	20.4	28.5
Wing loading	53.2 kg/sq m	36.4 kg/sq m

Stuttgart FS 29

1975

Drawn by Martin Simons 2003 ©


7320
700
Tail drag parachute housed in rudder. No other airbrakes
930
Glass- plastic moulding
18300
580
2500
Root wing profile
Wortmann FX 62 - K - 131
(Modified to 14.4% thickness)
ASW 12 B nose
5400
3
2
1
0
Metres
Profile
Wortmann FX 62 - K - 131
Mass empty 324 kg
In flight 430 kg
Wing area 13.0 sq m
Aspect ratio 25.8
Wing loading 33.07 kg/sq m
15000
772
Schuemann wing modification
ASW - 12
1965 - 66
Tip profile
Wortmann FX 60 - 126
310
Drawn by Martin Simons 2003 ©

The students were vindicated. Years of operations and further test flying followed without serious difficulty. Even when, on one occasion, one of the outer wings refused to retract as the other one did, the sailplane remained controllable.

There had never been any intention to develop the FS - 29 into a production sailplane. It was complex and expensive, requiring careful maintenance in service. It could never lend itself to regular club use or operations under the pressures of competition. As Reichmann had said of the SB - 11, in practice the pilot had enough to do in flight without the added complication of repeatedly changing the wing setting for each different flight situation.

Supreme in the air, winning numerous national and world records, launching the ASW 12 was straightforward but if the brake parachute did not work, landing was a serious problem. (Photo Adolph Wilsch)

Alexander Schleicher GmbH

Alexander Schleicher in1925 was already building gliders in Poppenhausen, near Fulda. The village lies in the valley under the western slopes of the Wasserkuppe in the Rhön Mountains of central Germany. This is where soaring as a sport truly began, with the first gliding competition in 1920. The first sailplane Schleicher built had been the Hols der Teufel; a wooden, open-framed, fabric covered slope soaring lightweight. He had achieved his 'C' soaring badge with this. In 1927 serial production of gliders and sailplanes started and the Alexander Schleicher Company has operated continuously at the same site ever since. Schleicher himself, born in 1901, died in 1968, barely a week after the first flight of the ASW - 15. The Company continues under the control of his surviving family.

ASW 12

Gerhard Waibel, one of the four Darmstadt Akaflieg members who designed and built the D - 36 and flew it to win the German National Championships in 1964, joined the firm of Alexander Schleicher in 1965. His first task was the design of a new Open Class sailplane for production.

The experience he had with the D - 36 was not wasted. The AS 12 bore obvious resemblance to its forerunner.[25] Wortmann wing profiles were adopted again. The wing was greater in span and the fuselage re-shaped to create a more comfortable cockpit, with reclining seat. The T tail layout was retained.

Construction was supervised by Edgar Kramer, Schleicher's son in law and an experienced test pilot and master craftsman. With his advice, some changes were made in the interests of simplicity and catering to likely customers. The fuselage for these sailplanes was not laid up in a female mould. The sandwich skin was built up in layers on a wooden form and subsequently smoothed. This procedure was satisfactory for the initial small production run.

25 – The letters stand for Alexander Schleicher, designer Waibel.

During the design of the D - 36 one of the students, Friess, had dedicated himself to the air brakes. These presented many difficulties and complications. They created structural discontinuities required special care in locking them closed within the flexible wing. They could cause leakage and protrusions spoiling the boundary layer flow. Waibel resolved to avoid such problems entirely. The only air brake on the ASW 12 was a drag parachute, housed in the bottom of the rudder. The flaps were intended only for making changes to the wing camber in normal flight. They could not be lowered sufficiently to make them useful for landing approaches.

When the ASW 12 appeared on the market it was the best Open Class sailplane available. There was an initial rush of orders. The trouble was, as some pilots reported, the drag parachute sometimes failed to deploy. This, when it happened, was extremely serious. When a sailplane is near the ground, there is a strong restriction on the formation of the wing tip vortices. Just when the pilot wishes to touch down, the drag is reduced greatly by this ground effect and the glide is extended markedly. If the brake parachute failed the ASW 12 floated far, far beyond the intended touch down point and, all too often, hit something solid at the end of the available space. To avoid this, wise pilots adopted a safety first policy. They would approach for landing with ample height, perhaps 400 feet. If the parachute opened correctly, it was very effective and the landing would proceed normally. If the parachute failed, the glide ratio was so good that enough height remained for a second careful circuit. The 'float' before touch down could still be disconcertingly lengthy. It was possible to sideslip, presenting the fuselage to the airflow at an angle and thus creating additional drag. This could be done with the rudder hard over in one direction with the ailerons keeping the wings almost level, crabbing towards the landing spot until the last possible moment. It was, however, easy to precipitate a ground loop by grounding a wing tip. As soon as the main wheel touched the ground or a fraction before, the flaps would be moved to the fully reflexed position. This cut the lift and the sailplane then stayed firmly down. The wheel brake was then required to shorten the roll. Not all pilots were able to achieve this kind of landing.

As a way of avoiding the trouble, some ASW 12s were fitted with a second parachute, housed in a compartment under fuselage behind the main landing wheel. If one parachute failed, the other might work.

Despite the general feeling that the ASW 12 was not for the ordinary customer, it was outstanding in the air. At the World Championships at Marfa, Texas, in 1970, George Moffatt won the Open Class in the prototype Nimbus. Second was Hans Werner Grosse in his ASW 12 and there were four more in the top ten places. There followed a whole series of new National and International records. In 1969 Wally Scott in the USA broke the World Goal Flight record with 973 km, which was again broken by H W Grosse with 1032 km. Scott set a new figure for the out and return flight with 859 km. In 1970 Ben Greene set the World Distance record at 1153 km and two years later Hans Werner Grosse flew his ASW 12 to a new figure of 1460.8 km from his home field at Lübeck to the coast of France near Biarritz. More outstanding flights and contest wins followed, notably when Scott won the first transcontinental 'Smirnoff Derby' across the USA in 1972.

Having acquired a reputation for being difficult, only fifteen of the ASW 12 were produced, ten of these going to the USA. Production ended at Poppenhausen in 1970. By this time there were rivals of comparable or slightly better performance on the market, without the awkwardness of the unreliable braking parachute. Under the liberal legislation applied to experimental aircraft in the USA, two of the ASW 12s had spans extended to 20 metres and became known as the ASW 12B.

Wil Schuemann, an imaginative and inventive American engineer-pilot, carried out a series of experiments with his ASW 12. He had previously done a great deal of work on his Glasflügel H - 301 Libelle, improving the best glide ratio to 40. In 1978, wishing now to compete in the Fifteen Metre Class, he cut the wing tips off his ASW 12. (This entailed a reduction in the aspect ratio.)

He was disappointed to find the climbing performance suffered so much that he could not keep up with other competing sailplanes. He tried various devices to improve the situation. Winglets of differing heights helped but he was far from satisfied. After a series of careful tests with wool tufts on the wings, he became convinced that there were hitherto unsuspected separation bubbles and cross flows in the boundary layer.

He designed new swept back wing tips. There was an immediate improvement. Thus was born what became known as the Schuemann planform, in which the trailing edge of the wing is straight and the leading edge tapered back, to yield a more or less crescent shape. The results influenced sailplane design for many years afterwards.

ASK - 13

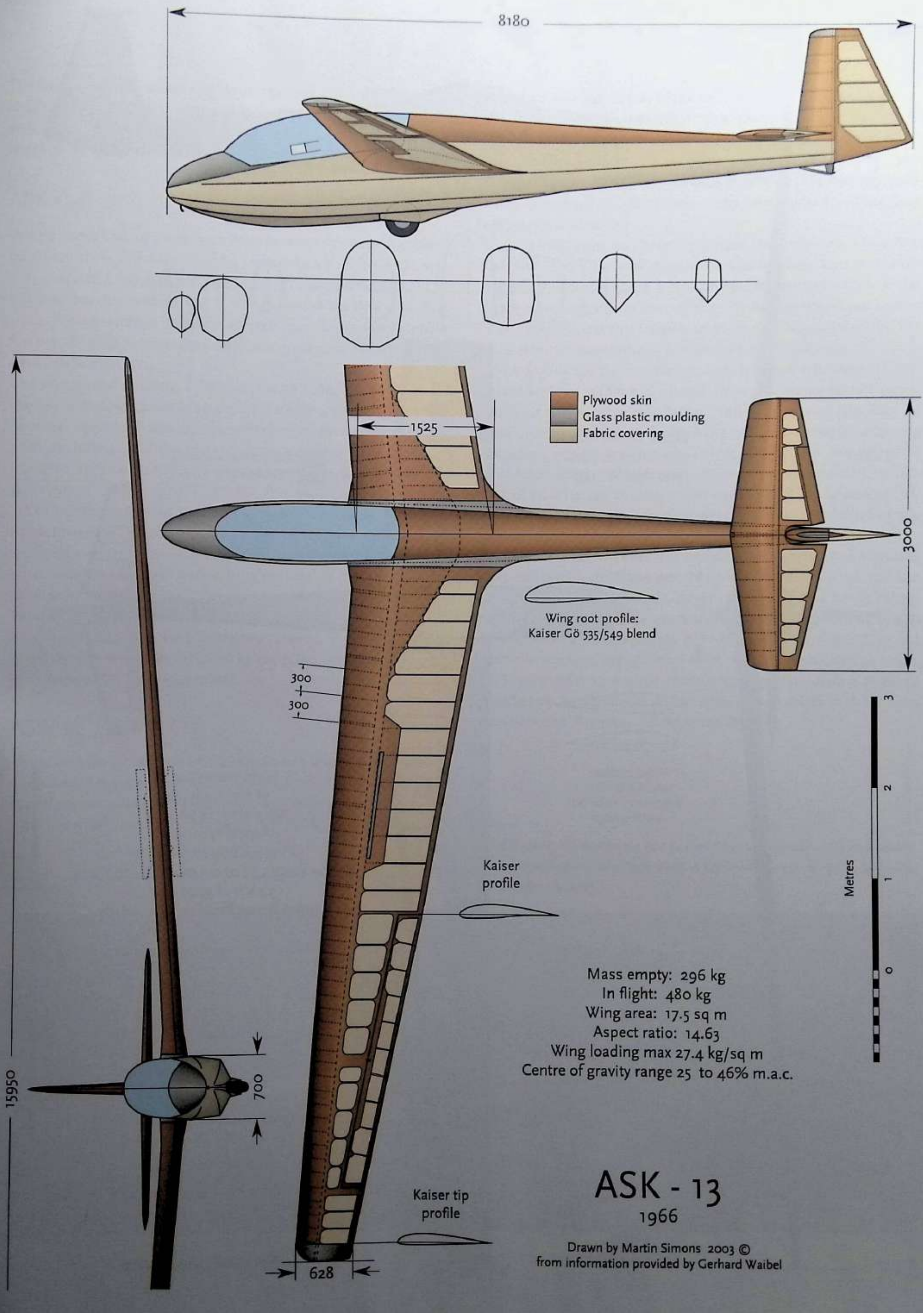
Rudolf Kaiser had worked as chief designer for Schleicher since the time of the highly successful Ka - 6, leading to the Ka - 6E which continued in production until 1972. The Ka - 7 two seater had also proved very popular. More than 500 examples were built in the home factory and under licence in several other countries. The Ka - 7 was less than ideal for training. The rear cockpit was not very comfortable and the high wing restricted the instructor's vision.

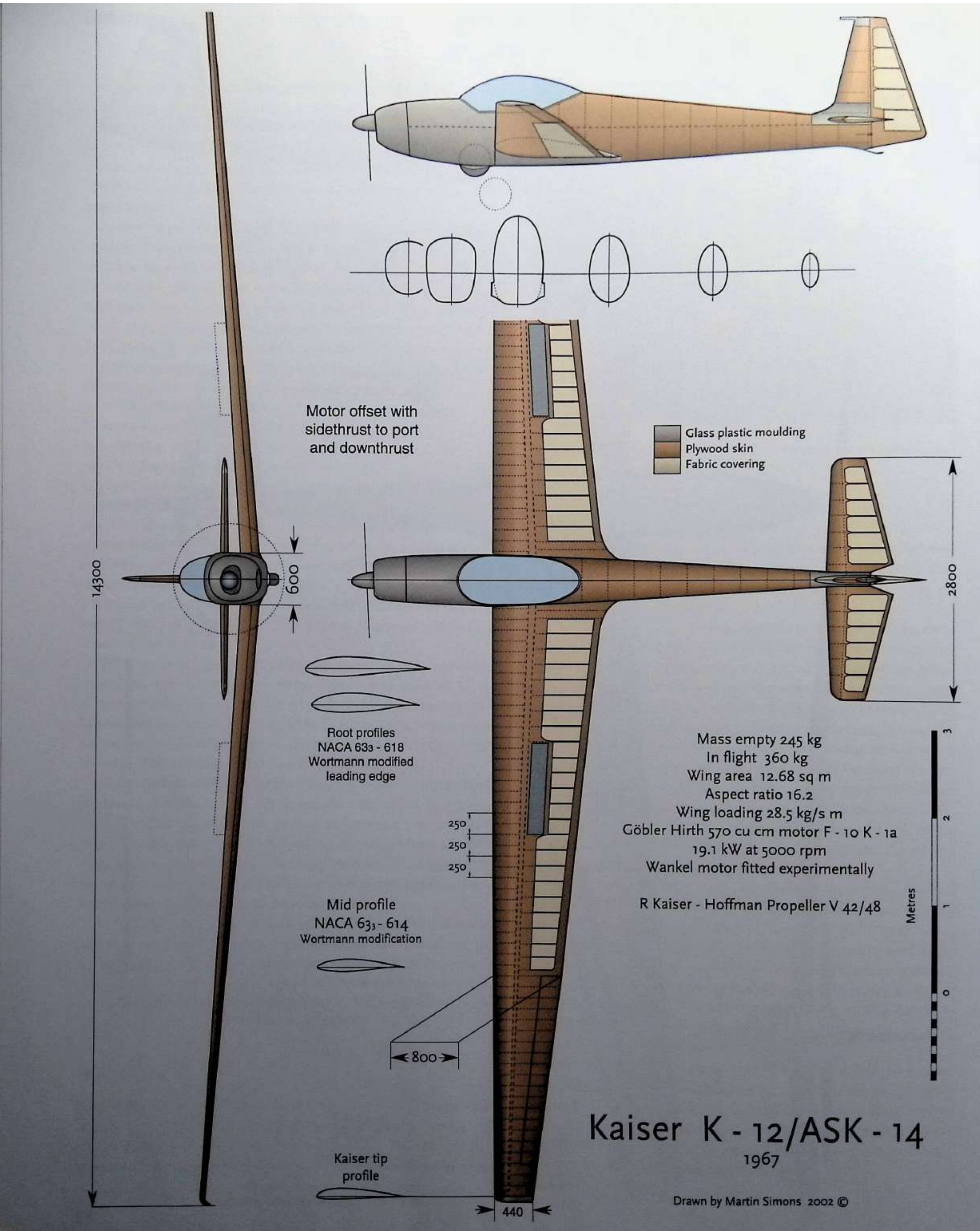
Rudolf Kaiser's ASK 13 became well known all over the world. It was recognised as having all the desirable qualities for a trainer.

It was decided to improve these faults by mounting the wing lower on the fuselage with a large, optically perfect transparent canopy covering both cockpits. The instructor's view was then excellent. Attention was given to the seats, and more use was made of GRP mouldings for wing tips, the fuselage nose and turtle decking aft of the cockpits. The main landing wheel was sprung. There were no other very significant innovations but slight improvements to the wing aerodynamics were made, without going to the expense of using laminar flow profiles and the necessary special skins. With wooden wings and tail surfaces and a steel tube frame fuselage covered with fabric, the ASK - 13, or as most people knew it, the Ka - 13, was attractive to look at, robust and, most importantly, handled well and safely in flight. The performance was slightly better than the Ka - 7.

The prototype flew in 1966 and production began almost at once. The Ka - 13 became one of most popular training two-seaters in the world. More than 580 had been built by 1977. An important development was when sixty were imported by the Centrair Company for sale to clubs in France. There were no two-seaters immediately available from French factories. Previously there had been a policy of tariff and subsidy protection but the crisis forced a change and the French market became open to German manufacturers.

Even when GRP two seater trainers became available, there were many instructors and clubs who continued to use the Ka - 13. After Schleicher ceased, there was some limited production under licence at Oerlinghausen, in association with the very large gliding school there. The Lasham Gliding Centre in England also continued using the Ka - 13 until after the end of the century.


8180
Plywood skin
Glass plastic moulding
Fabric covering
1525
3000
Wing root profile:
Kaiser Gö 535/549 blend
300
300
Kaiser
profile
Metres
0
1
2
3
15950
700
Mass empty: 296 kg
In flight: 480 kg
Wing area: 17.5 sq m
Aspect ratio: 14.63
Wing loading max 27.4 kg/sq m
Centre of gravity range 25 to 46% m.a.c.
Kaiser tip
profile
628
ASK - 13
1966
Drawn by Martin Simons 2003 ©
from information provided by Gerhard Waibel


14300
Motor offset with sidethrust to port and downthrust
600
Glass plastic moulding
Plywood skin
Fabric covering
2800
Root profiles
NACA 633 - 618
Wortmann modified leading edge
Mass empty 245 kg
In flight 360 kg
Wing area 12.68 sq m
Aspect ratio 16.2
Wing loading 28.5 kg/s m
Göbler Hirth 570 cu cm motor F - 10 K - 1a
19.1 kW at 5000 rpm
Wankel motor fitted experimentally
R Kaiser - Hoffman Propeller V 42/48
250
250
250
Mid profile
NACA 633 - 614
Wortmann modification
Metres
3
2
1
0
800
Kaiser K - 12/ASK - 14
1967
Kaiser tip profile
440
Drawn by Martin Simons 2002 ©

The Ka - 13 was well able to fly across country. On April 25th 1972 Siegfried Baumgartl and Walter Schewe flew 714 km from Dinslaken to their goal at Angers, a world record. It was on this day also that Werner Gross in the ASW 12, broke the solo distance record.

ASK - 14

Rudolf Kaiser had for some years been developing motor sailplanes based on his highly successful Ka - 6 and Ka - 8. The Ka - 11 was very successful and led soon to the Ka - 12. Schleicher decided to put this into production and it was re-named the ASK - 14. The wing, fuselage and tail unit were adapted from the Ka - 6E sailplane but the wing was low mounted and there was a semi-retracting one-wheel undercarriage.
The motor was mounted in the nose with a slight side thrust to the left, and downthrust. A Hoffman feathering propeller of 1.3m diameter was fitted. Several different types of motor were used in trials, including a Wankel rotary, but the main production version was the570 cc Göbler Hirth F10 A1 1a which yielded 19.1 kW at 5000 rpm.

The prototype flew in 1967 and attracted favourable attention. In motor glider competitions the ASK - 14 achieved excellent results. Its performance as a sailplane was not comparable with what could be achieved with a fully retractable power unit. The Scheibe SF 27M[26] won the 1970 contest. But the simplicity and reliability of the ASK - 14 and its ease of operation ensured it would be a success. By 1972, when production ceased, 65 had been built, many for export. It was followed by the ASK - 16, which had two seats in side by side arrangement.

ASW 15

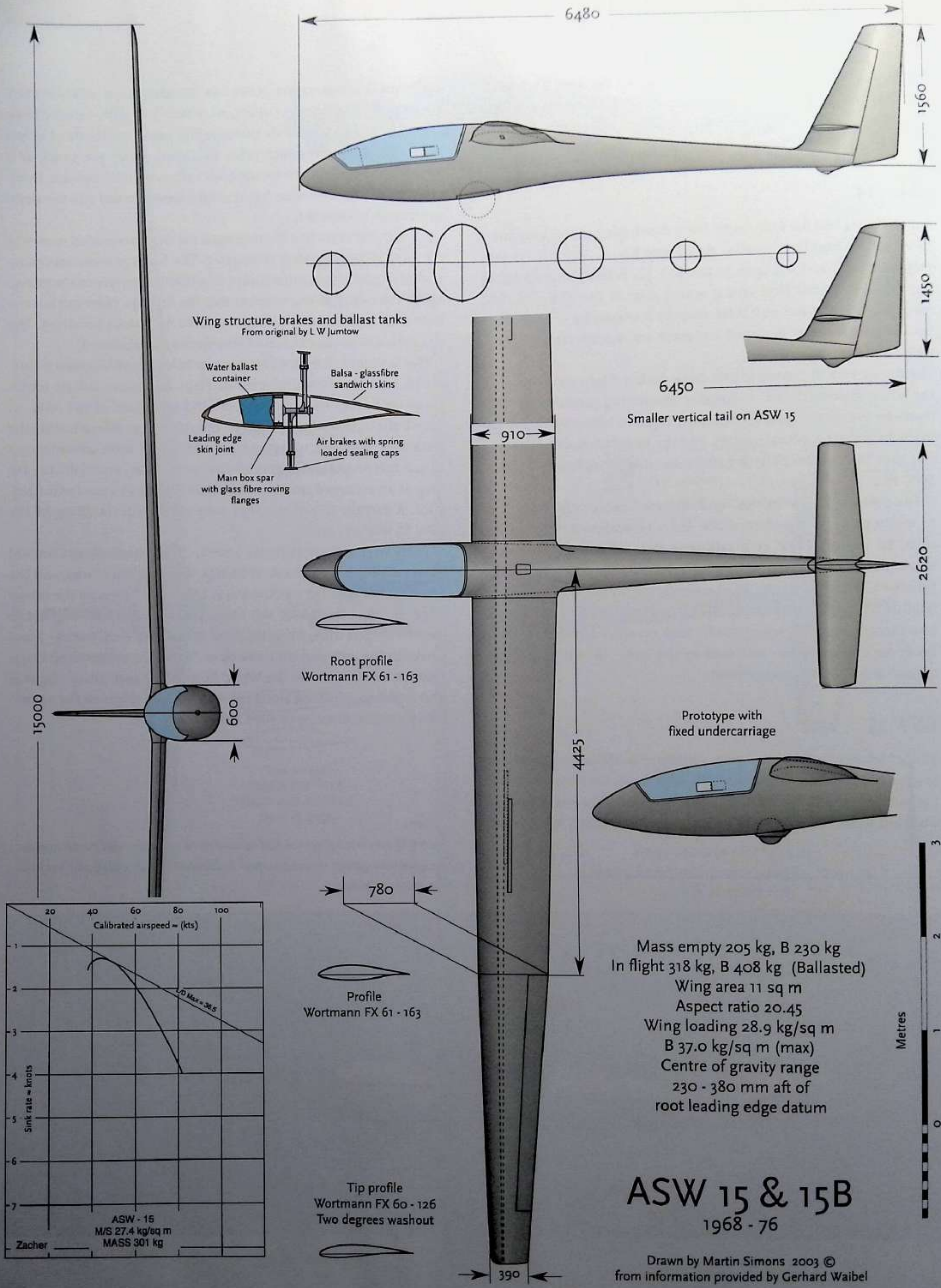
The Schleicher factory was in the middle of a revolution, changing to glass-fibre reinforced plastics. The work force, drawn mostly from the villages around the Wasserkuppe, was skilled in aircraft woodwork but would be required to learn new skills. Partly for this reason, some fuselage frames of the new Standard Class sailplane coming from Waibel's design office, were wooden, although the basic structure was in GRP. This occasionally gave trouble since it was possible for the glasscloth skins to distort under the shock of a heavy landing, and then spring back without visible damage. Internally, however, a wooden frame might have cracked and the damage remain undetected.
Once this difficulty had been recognised, the few wooden frames in the ASW 15 fuselage were eliminated. The fuselage skins were sandwiches of glass cloth with filling of a plastic honeycomb material. At the time, Waibel was worried that the fuselage came out heavier than expected, but this turned out to be no serious handicap. The wing skins were sandwiches of glasscloth and balsawood.

The Standard Class specification at this time disallowed refinements such as retracting wheels, flaps and water ballast tanks. Large air brakes were mandatory. 183 examples of the ASW 15 were built to these rules. In 1970 the rules were relaxed, allowing retracting wheels and ballast. The ASW 15B took advantage of this. A few additional improvements were made, especially the fitting of an enlarged landing wheel and changes to the rudder balance. A further 270 of the type were produced. Handling of the ASW 15 was very good.

There were already available several other outstanding Standard Class sailplanes, the Standard Libelle, the Standard Cirrus, and the LS - 1. In terms of sales alone, the St Libelle far outpaced the others although its performance was not as good and the handling not so easy. In contest wins, while the ASW 15 did very well, the LS - 1 and Cirrus in the long run achieved more. The most outstanding single flight in an ASW 15 was the World Record 'out and return' flight of Karl Striedeck, running along the Appalachian ridges in the eastern USA for a total distance of 1098 km in 1972.

26 – See p. 140

Below:
Rudolf Kaiser's motorglider, the ASK 14, used Ka 6E wings mounted low on a newly designed fuselage with retractable wheel. A Göbler-Hirth engine of 19.1 kw was fitted. (Photo Peter Selinger)



Mass empty 205 kg, B 230 kg
In flight 318 kg, B 408 kg (Ballasted)
Wing area 11 sq m
Aspect ratio 20.45
Wing loading 28.9 kg/sq m
B 37.0 kg/sq m (max)
Centre of gravity range
230 - 380 mm aft of
root leading edge datum

ASW 15 & 15B

1968 - 76

Drawn by Martin Simons 2003 ©
from information provided by Gerhard Waibel

ASW 15, a graceful shape on the ground as well as in the air

Left Pilots's seat and harness

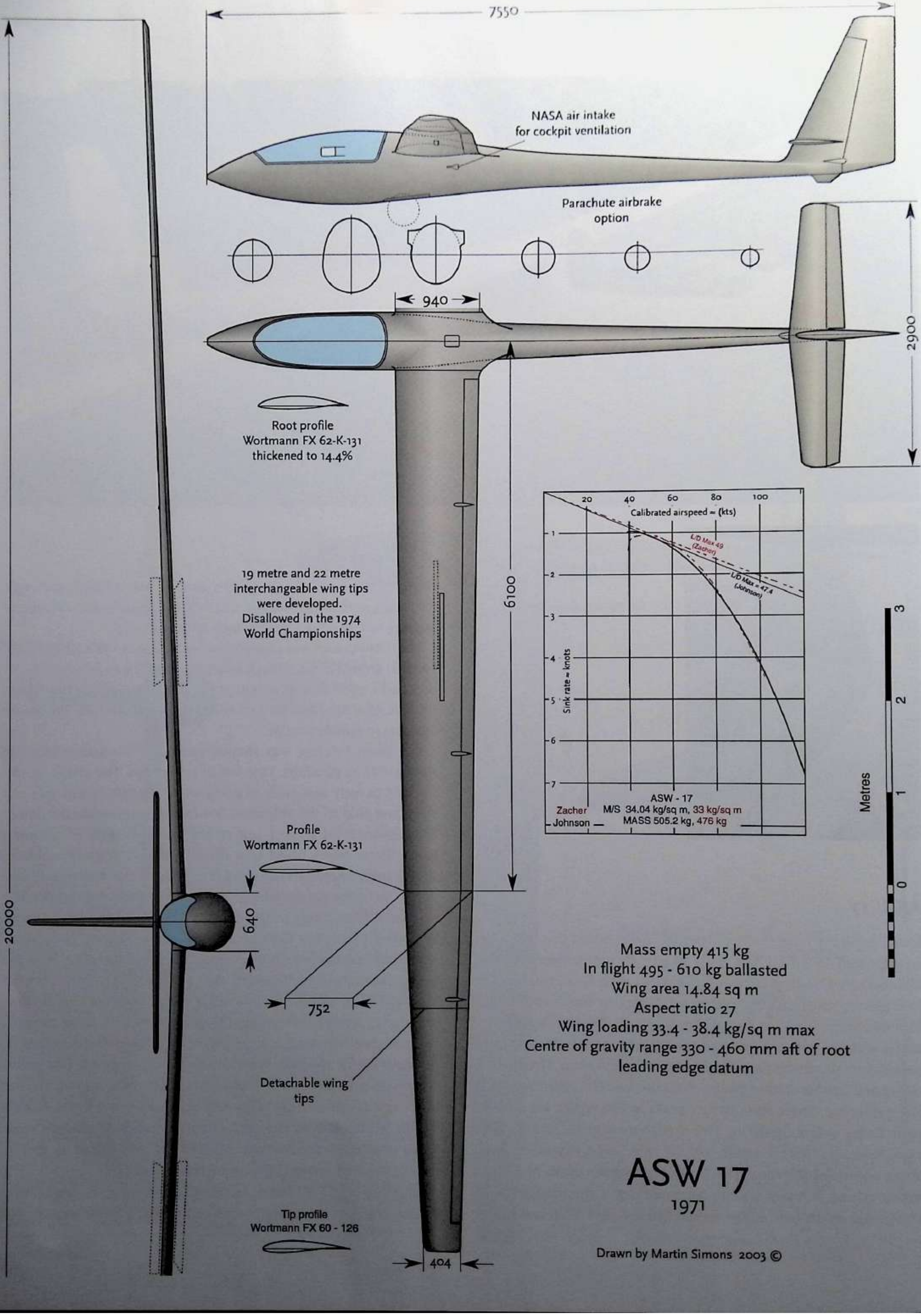
ASW 17

Initial publicity from the manufacturer describeded the ASW 17 as an improved ASW 12. It was really an entirely new design. The span was increased to 20 metres and the wing, with flaps, was built in four pieces, which made rigging and de-rigging much easier. This idea was taken from the Braunschweig SB - 9. For the sake of simplicity and strength, the flap and aileron drive horns were large and required small bubble shaped fairings above the wing. This feature was characteristic of later Waibel designs also. The additional drag was negligible. There were ballast tanks in the wings, for a maximum flying weight of 610 kg. This time there were air brakes of the usual Schempp Hirth vertical 'parallel ruler' type, extending both above and below the wing. These could be supplemented by a braking parachute, housed in a compartment under the fuselage belly rather than in the base of the rudder like the ASW 12. It was much easier to get the ASW 17 onto the ground after a flight, although the wings were rather flexible and drooped dangerously during the landing run, making a ground loop rather too easy.

The T tail layout was changed to one similar to that of the ASW 15. This arrangement, though not quite so efficient aerodynamically, saved a good deal of weight at the tail. The fuselage skins were like the ASW 15, glasscloth and honeycomb sandwich. The lay-up now was in female moulds.

The front fuselage was shaped carefully to preserve laminar flow as far as possible. This led to criticisms. The shape of the cockpit canopy was such that the view directly ahead was not good and that to the sides and downwards somewhat restricted. This counted for a good deal in the crowded skies of competitions. There was a blind spot directly ahead, preventing pilots seeing sailplanes marking good thermals in the distance. Other details were the positioning of the control levers. Everything was on the left-hand side of the cockpit, the wheel retracting lever, the wheel brake, the flap handle, and the air brakes. Dick Johnson remarked that the pilot needed three hands when landing. George Moffat wrote: "Landing the '17 requires that one fly with the right hand and do the following things with the left: (1) lower gear, (2) select landing flap, (3) operate the dive brake normally. In touchdown the pilot: (a) promptly releases the dive brakes, (b) reaches for the flap lever to select full negative flap to increase aileron effectiveness and ward off the threatened ground loop, and (c) drops flap lever and reaches for the brake handle which is attached to the end of eight inches of springy wire. Small wonder that in Australia Hans Werner got mixed up and retracted the gear instead of applying the brake!"

Initial flights in 1971 were successful and production began, continuing until 1976, reaching a total of 55. Performance tests showed



Mass empty 415 kg
In flight 495 - 610 kg ballasted
Wing area 14.84 sq m
Aspect ratio 27
Wing loading 33.4 - 38.4 kg/sq m max
Centre of gravity range 330 - 460 mm aft of root
leading edge datum

ASW 17
1971

Above: The ASW 17 used by Hans Werner Grosse to break records, was still flying in Australia in 1994.

Left: Underwing ventilation intake of the ASW 17

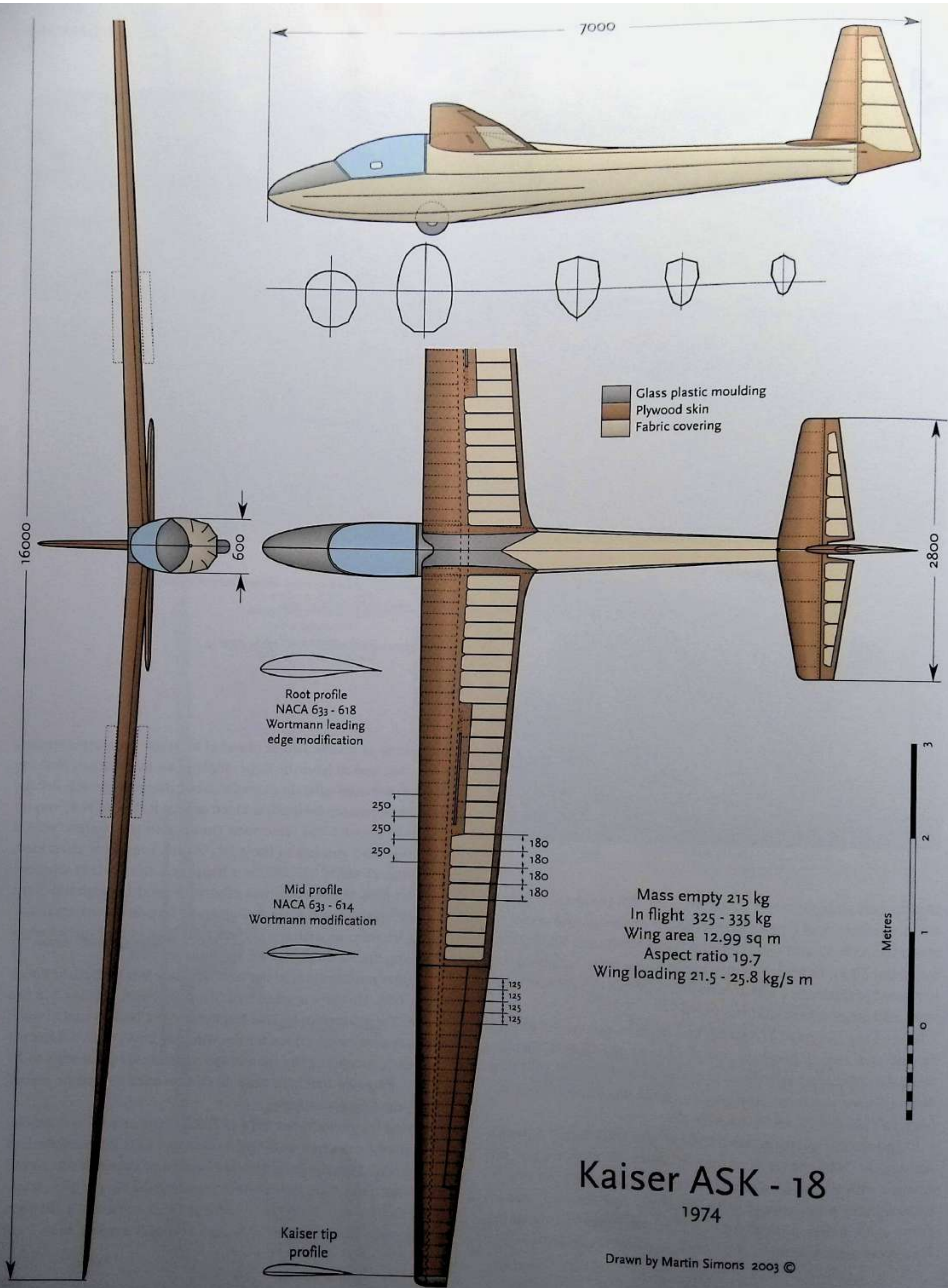
that the best glide ratio was about 48 - 49:1. For the keenest contest pilots, the choice of Open Class sailplane at this period rested between the ASW 17 and the Schempp Hirth Nimbus 2. The Nimbus was about 50 kg lighter. When wing loadings were equalised, the low speed performance was almost identical but the ASW 17 had a small advantage at high gliding speeds.

Before long the ASW 17 established itself as one of the greatest contest and record breaking sailplanes. At the World Championships in 1972 Matt Wiittanen of Finland placed 3rd, In 1974 Hans Werner Grosse was third, and George Lee of Britain won first place twice, in 1976 and 78, all in the ASW 17.

An interesting question was raised at the 1974 World Championships, at Waikerie in S Australia. Hans Werner Grosse had arranged with Waibel for a modified version of the ASW 17, with interchangeable outer wings. With the short tips the span was reduced to 19 metres, which would suit strong thermal conditions. For days of weak thermals, the long tips could be fitted to extend the span to 21 metres. Grosse intended to choose the wing according to the day, and so have the right sailplane for the weather. Nothing in the Open Class rules disallowed this but after considerable debate, the Championship Stewards decided against it. The ASW 17 was required to fly with the same wing throughout the contest. Which wing was used was left to the pilot. Grosse, somewhat chagrined, chose the 21 metre tips and, as it happened, the weather after two difficult days at the start, was otherwise good throughout. Hans Werner later believed Klaus Holighaus had made the better choice, flying his Nimbus with the shorter wing. The idea of interchangeable wing tips for sailplanes was to be revived later.

Another modification to the basic airframe was by Richard Butler in the USA. He had hoped to fly a Schempp Hirth Nimbus 3 in the World Championships in 1981 but it could not be delivered in time. He built new root sections for the wings of an ASW 17, 1.5 metres long each, extending the span of the resulting six-piece wing to 23 metres. Finished barely in time, in this un-tried aircraft he placed 7th in the Championships.

During the period from 1974 to 1982, flying usually in Australia, H W Grosse set a new goal flight record of 1231 km, completed a record 1063 km triangular distance flight and exceeded this record later with 1306.9km, flew a world record speed for a 750 km triangle at 144 km/h, a 1000 km triangle at 145.3 km/h and a 1250 km triangle at 133.2 km/h. In 1976 Karl Striedeck made a 1634.7 km



7000
16000
600
2800
Glass plastic moulding
Plywood skin
Fabric covering
Root profile
NACA 633 - 618
Wortmann leading
edge modification
250
250
250
180
180
180
180
Mid profile
NACA 633 - 614
Wortmann modification
125
125
125
125
Kaiser tip
profile
Metres
0
1
2
3
Mass empty 215 kg
In flight 325 - 335 kg
Wing area 12.99 sq m
Aspect ratio 19.7
Wing loading 21.5 - 25.8 kg/s m
Kaiser ASK - 18
1974
Drawn by Martin Simons 2003 ©

out and return flight along the Appalachians, this being specially notable in the USA because it was the first sailplane flight ever to exceed 1000 miles. A problem with his turning point photograph prevented this being recognised as a formal international record.

ASK - 18

The 'Club Class' was launched in Germany in 1968 and Rudolf Kaiser was aiming at this with his ASK - 18. At a time when most sailplanes were being built in reinforced plastics, there was still some interest in traditional materials. Many clubs had yet to learn about maintenance and repair of plastic structures. Pilots at an intermediate stage of experience, who had very probably learned to fly in the ASK - 13 and made early solo flights in the Ka - 8, were usually ready for something with better performance for cross-country flying and competition experience. They might not, however, be prepared for the new generation of GRP contest sailplanes. These would pick up airspeed rapidly if not carefully flown. Inexperienced pilots could easily find themselves approaching to land much too fast and so prolonging their landing run dangerously.

The ASK - 18 was a direct descendent of the highly successful Ka - 6 and Ka - 8 series. The wing was essentially that of the Ka - 6E, with the span extended to 16 metres. Kaiser had his own ideas about suitable profiles for wing tips, and designed one especially for this aircraft. The fuselage was framed in steel tubing and covered with fabric except for the front fuselage decking, fairings and wing tips. The result was an elegant sailplane with many attractive features. It handled very well and safely but it was not expected that it would dominate the market in the way earlier Kaiser designs had done.

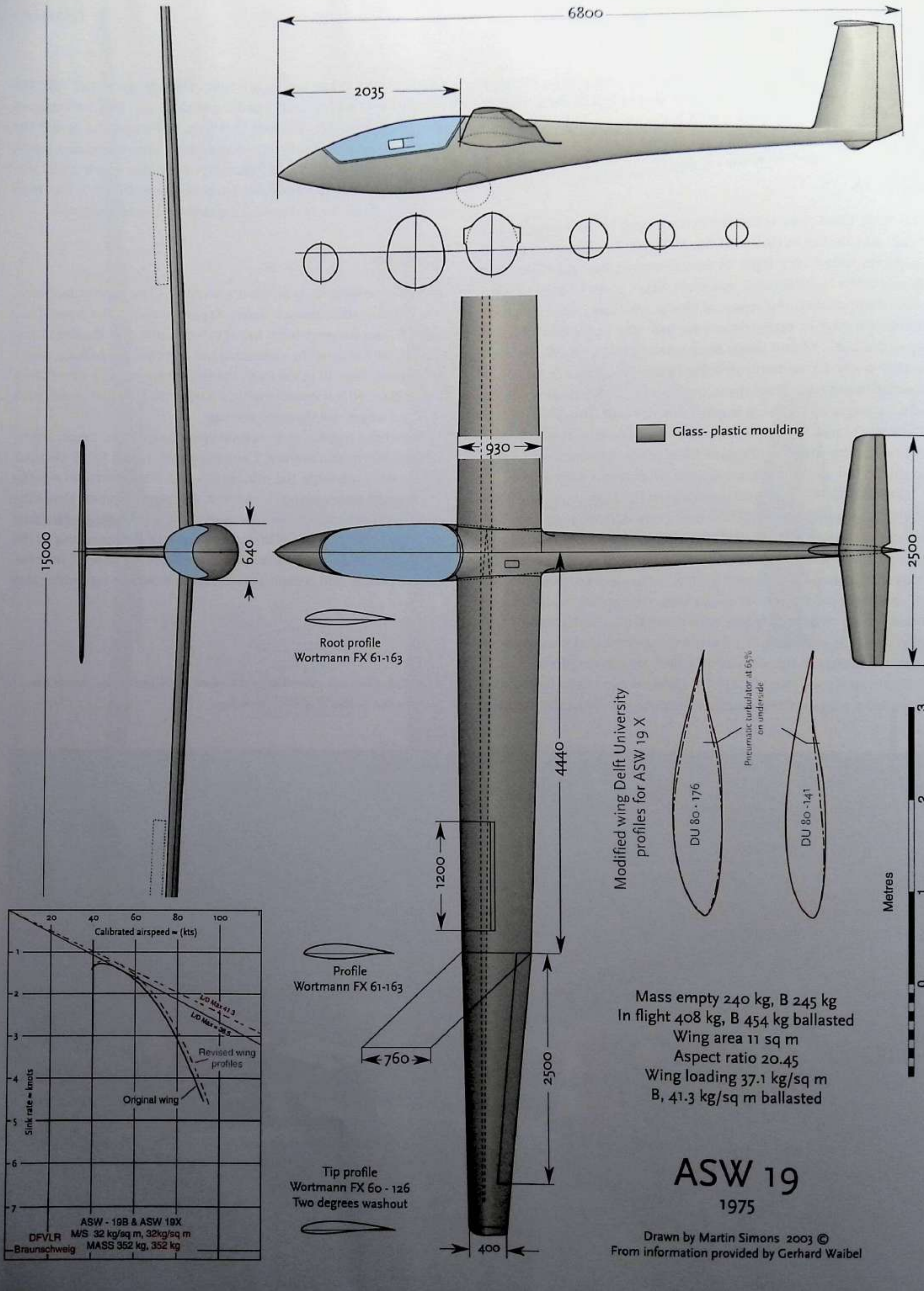
In several senses, the ASK - 18 fell between two stools. It was never intended for Open Class contests. It could not fly in the Standard Class because it had too large a span. One was produced with the wings truncated but this idea did not catch on. The performance was good, especially in weak thermals, but could not match the new generation of plastic sailplanes coming onto the market, and it was not particularly cheap. After the first flights in late 1974, production began and continued fairly slowly until 1977. The total reached only 47, or 48 counting the solitary 15 metre example.

ASW 19

By 1975 the ASW 15, Schleicher's Standard Class contest sailplane, was considered somewhat dated. Experience with the Open Class ASW 17 encouraged Waibel to begin work on a new Standard Class design, with almost the same wing but an improved fuselage and T tail layout. Also, in mind from the beginning was the new fifteen metre class, which would require a wing with flaps but could, with minor changes, use the same fuselage.

Waibel had come to distrust some more recent wind tunnel test results on Wortmann profiles. These suggested that an FX 18.4% thick profile was superior to the thinner 61 - 163. He preferred to rely the older results which, he was convinced, were more accurate. Hence the wing of the new design was almost identical to the ASW 15. The chief difference was that the air brakes now were on the upper side of the wing only. The fuselage was similar in profile to the ASW 17, with improved canopy and cockpit layout. The honeycomb sandwich skins

An ASK 18 at a vintage glider meeting at Camphill in England in 1997. Behind is an old Kirby Kite, painted in wartime camouflage.



ASW 19

1975

Drawn by Martin Simons 2003 ©
From information provided by Gerhard Waibel

were abandoned, the fuselage now being a multi-layered shell of glass-cloth with a minimum number of internal cross frames and stiffeners.

First flights were made by Edgar Kramer in November 1975. Handling was exceptionally good and the cockpit was comfortable and convenient. Performance measurements carried out in 1976 by the independent DFVLR group and confirmed by the Dallas group led by Dick Johnson, showed that best glide was 38:1, a hitherto unequalled figure for the Standard Class. Waibel was confident that the new sailplane was a world beater. His judgment was confirmed when the relatively youthful Dutch pilot, Baar Selen, won the Standard Class World Championship at Chateauroux in 1978. Subsequently the ASW 19 achieved more successes, especially two feminine records in 1980, by Doris Grove who flew 1010 km distance and Cornelia Yoder a few weeks later with a goal flight of 1025 km. Both these flights were made along the Appalachian ridges. A total of 425 of the ASW 19 was built. In 1986 a 'Club' version with fixed undercarriage and other simplifying features was offered, but seems to have aroused little interest. Production ceased in that year.

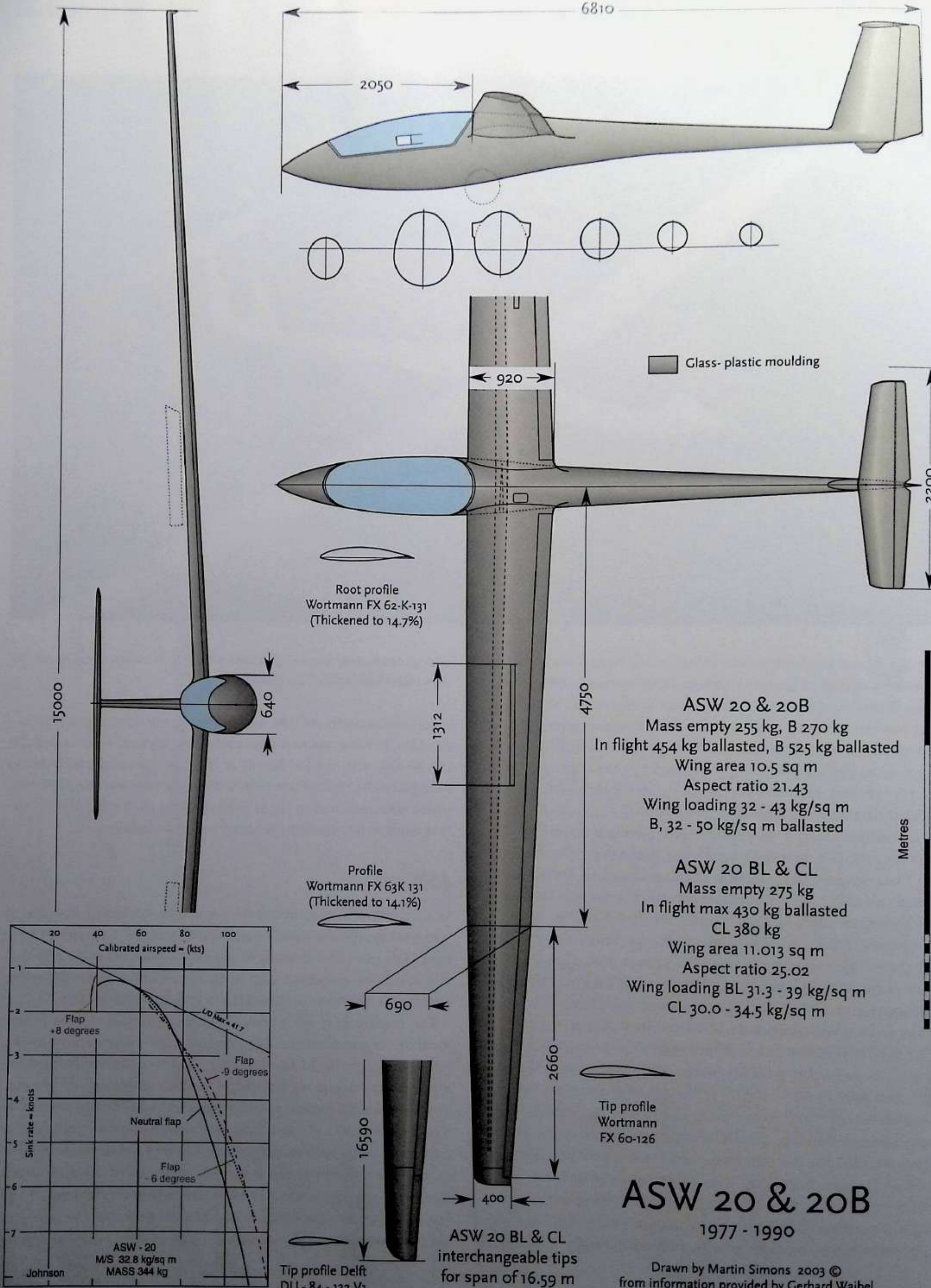
The ASW 19 provided an excellent test vehicle for new ideas coming from the university research groups. The Braunschweig Akaflieg fitted their ASW 19 with winglets of various types and sizes, investigating their effects and endeavoring to discover the best size and shape. Some preliminary conclusions were published in the OSTIV papers for 1983. At the same time the Delft University research group under Loek Boermans, were experimenting with the wing profiles of the ASW 19. In the first instance a section of the outer wing was modified by building up the contours with filler material to produce a newly computed profile, with several types of turbulator at critical positions. The results were so encouraging that an entire ASW 19 wing was modified to the new section, now named the DU 80-176, with the DU 80-141 at the tips. Pneumatic turbulators were placed at appropriate points. The outcome was the ASW 19X, which was measured in flight to have a best glide ratio of 41:1, the best result so far achieved for a Standard Class sailplane.

ASW 19. Outstanding Standard Class sailplane of 1975. This example is flying over the River Murray near Waikerie in S Australia.

ASW 20

Much controversy surrounded the decision to establish a new class of competition sailplane based on a fifteen metre span. The original Standard Class rules had encouraged the development of some very fine sailplanes. However, some, such as the Foka 4 and the Siren Edelweiss, were far removed from the concept of a simple club sailplane.

The requirement for a non-retractable wheeled undercarriage must be observed but nothing prevented the designer burying the wheel so deeply in the fuselage belly that it could hardly function as an undercarriage at all, except on the smoothest of ground. There was a good argument for relaxing this rule. To fit a retractable wheel would not only save drag, but would allow the sailplane to cope more easily with rough ground. Landing speeds would be lower, because a more tail down attitude would be possible for touch down. The fuselage underside would be further off the ground and less liable to damage. Pilots would have to remember to raise and lower the wheel but this was easy enough to incorporate in regular



ASW 20 & 20B

Mass empty 255 kg, B 270 kg
In flight 454 kg ballasted, B 525 kg ballasted
Wing area 10.5 sq m
Aspect ratio 21.43
Wing loading 32 - 43 kg/sq m
B, 32 - 50 kg/sq m ballasted

ASW 20 BL & CL

Mass empty 275 kg
In flight max 430 kg ballasted
CL 380 kg
Wing area 11.013 sq m
Aspect ratio 25.02
Wing loading BL 31.3 - 39 kg/sq m
CL 30.0 - 34.5 kg/sq m

ASW 20 & 20B

1977 - 1990

Drawn by Martin Simons 2003 ©
from information provided by Gerhard Waibel

cockpit drills. The additional complication and cost of retracting the wheel would not be very great.

The old specification also required air brakes capable of limiting the airspeed in a vertical dive. This was because pilots when cloud flying sometimes lost control. The airspeed would increase rapidly and structural failure was likely. In such an emergency the brakes could be deployed to limit the speed to a figure below the 'red line'. Brakes of sufficient size were extremely difficult to design. At the same time there was pressure, mainly from America, to allow ninety-degree trailing edge flaps for landing. Easy to design and cheap to build, these were very effective in controlling the landing approach and reduced the touch down speed. However, they could not be deployed at high airspeeds and would be useless in a cloud flying emergency. European designers had never taken the speed limiting brake rule very seriously. Vertical diving tests were not usually done, either by the manufacturers or by the OSTIV design prize judging panel. Cloud flying was normally disallowed in competitions anyway and in most countries altogether illegal.

Water ballast was also forbidden. This led to anomalies. Nothing prevented a pilot carrying an extra load in the form of lead weights, or steel bars inside the wings. This had been done with the Edelweiss of 1962. Such ballast could not be jettisoned in flight. But on a day of strong thermals the pilot could choose to fly throughout with high wing loading. The ballast would be put in before taking off. On a weak day it was omitted. This did not infringe the letter of the law but it ran contrary to the intentions of the Standard Class. Changes were undoubtedly necessary. The first attempt to improve the specification produced results that were quite different from what was intended. In 1974 the sailplane that won the World Championships at Waikerie, was fully in accordance with the revised rule but was far from suitable for club use.[27] The CIVV delegates were forced to think again.

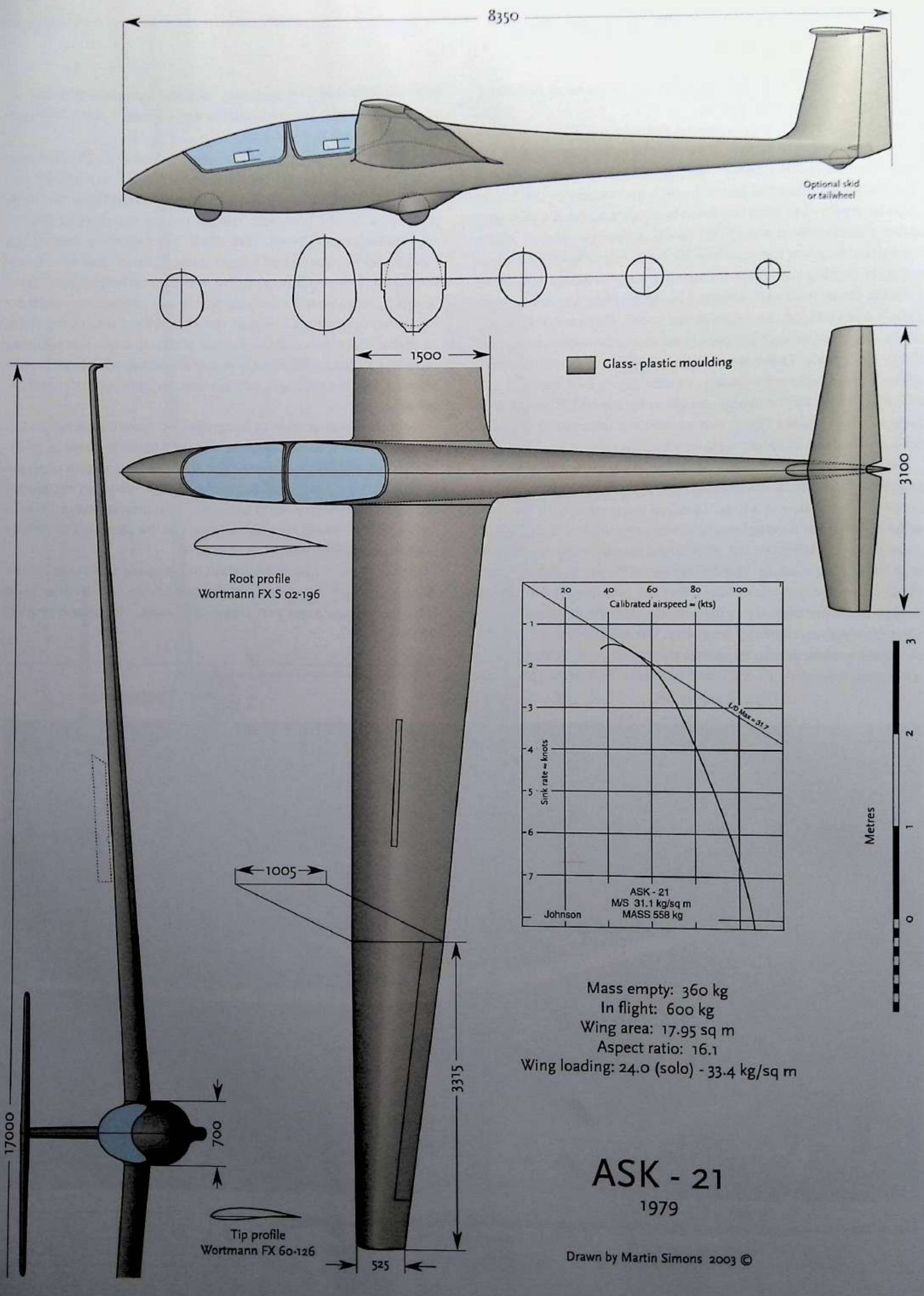
In March 1975 an entirely new class was created. The first proposal had been for a span limitation of seventeen or eighteen metres, without other restrictions. This type of sailplane had been well proved in the past, with such aircraft as the original SH Cirrus, the Glasflügel Kestrel, ASW 17 etc. Many of these were still in service and the nucleus of a new Championship Class already existed. The final decision, however, was for a 'Fifteen Metre Class'. In effect, this allowed a designer to use any performance enhancing devices possible, so long as the wing span did not exceed the 15 metre limit. Meanwhile, the old Standard Class was retained in modified form. Water ballast and retracting wheels were now allowed, but the rule against flaps and variable geometry was reinstated.

From the point of view of designers and manufacturers, the Fifteen Metre Class, as now defined, was welcomed. It would be possible easily to adapt the fuselage and perhaps the tail unit of a successful Standard Class aircraft. Fitted with new wings, an entrant for the 15 metre category could be created. Minimal alterations would be needed to existing moulds and many of the controls and fittings could be used, with obvious economies.

Gerhard Waibel had no hesitation in designing new wings for the ASW 19 fuselage. He was neither the first nor the last designer to do this. The outcome was particularly fortunate. The prototype ASW 20 flew in 1977.

27– See the discussion of the LS - 2 sailplane, p. 127.

ASW 20 Works No. 20289, built in 1980, here flown by its owner Jürgen Koch in the French Alps. (Photo Claus-Dieter Zink)


8350
Optional skid
or tailwheel
1500
Glass- plastic moulding
3100
Root profile
Wortmann FX S 02-196
20
40
60
80
100
Calibrated airspeed – (kts)
Sink rate – knots
L/D Max = 31.7
ASK - 21
M/S 31.1 kg/sq m
MASS 558 kg
Johnson
Metres
1005
3315
17000
700
Tip profile
Wortmann FX 60-126
525
Mass empty: 360 kg
In flight: 600 kg
Wing area: 17.95 sq m
Aspect ratio: 16.1
Wing loading: 24.0 (solo) - 33.4 kg/sq m
ASK - 21
1979
Drawn by Martin Simons 2003 ©

In structural and aerodynamic terms there were few very surprising features. The Wortmann wing profiles were already well known, but Waibel chose a root section of only 14.7% thickness. The ASW 20 was notable for the flexibility of its wings. They bent up a good deal under load, but were proved amply strong enough. For normal flight the ailerons and flaps were coupled so that lowering or raising the flaps caused the ailerons to change also, while retaining their normal function. The flap could be lowered to 55 degrees for landing, the ailerons then being slightly raised to ensure good lateral control during the ground run. The landing flap was coupled with the elevator trim so that lowering the flap did not produce any sharp pitching tendency. There were Schempp Hirth brakes on the upper wing surface. Handling in the air was very good, the cockpit was well designed and comfortable, the controls well laid out and easy to reach. With the option of water ballast out or in, the wing loading could be varied between 32 and 43 kg/sq m, and when the ASW 20B was produced, up to 50kg/sq m.

It was recognised from the beginning that the ASW 20 was an outstanding sailplane. Dick Johnson measured the best glide ratio at 41.2 and expressed himself astonished. The type remained in the forefront of competition flying for many years. In the 1978 World Championships, in which the unrestricted 15 metre class was allowed for the first time, the variable geometry SB - 11 took first place. But second, third, fourth, sixth and seventh places were taken by the ASW 20 in a field of 32. In the 1981 Championships the ASW 20 placed first and second and there were 7 of the type in the top ten. The ASW 20 continued to compete at World Championship level until 1995. By this time it was considered out of date but could still give a very good account of itself when flown by an expert contest pilot. In lesser competitions and National Championships it remained a contender for years more.

Further developments, winglets, wing tip extensions to allow a choice of span, followed. In its many variants the ASW 20 remained in production until 1990. A total of 765 were built at Poppenhausen and another 140 under licence in France by the Centrair Company. The grand total, over 900, was more than any other GRP sailplane at that time.

ASK - 21

When Schleicher recognised the need to offer a two seat trainer to replace the ASK - 13, Rudolf Kaiser's first suggestion was for a steel tube framed, fabric-covered fuselage with tandem seats, with GRP moulded fairing only for the front end. The wings and tail unit would be in plastic.

The factory by now was set up to produce plastic sailplanes and a mixed structure could not be easily accommodated. It was no longer true to say that the steel tube structure would be cheaper and easier to build than GRP. The ASK - 21, when it finally left the drawing board, was completely moulded, like the trainers already coming from other manufacturers. This was Kaiser's first venture into plastics but he was more than ready and able to learn the techniques required. The prototype flew in 1979 and production began. By the year 2002, a total of more than 750 had been produced, with no sign of early cessation.

When Dick Johnston examined the example offered for testing by his group in Texas, he remarked that it was "obviously of outstandingly good design." He found the instructor's cockpit slightly cramped for tall pilots, but the all round view from both seats was good and the sailplane handled easily with no vices. The ASK - 21 was stressed for simple aerobatics. The measured performance was considered quite adequate for a trainer, but Johnson anticipated some further improvement would result from improved sealing of the wing root.

ASW 22

When carbon-fibre-reinforced plastics became readily available, sailplane designers were anxious to take full advantage of these materials. Aramid (Kevlar) fibres also were found to be useful. These were light but tough and resilient (used for body armour). New aerofoil sections coming from Braunschweig and Delft Universities, with pneumatic turbulators, promised substantial gains in performance.

ASK 21 operating from an usual strip, a frozen lake in Sweden. (Photo Thorsten Fridlizius)

Theoretical studies showed that providing the wing span of a sailplane could be extended, variable wing geometry had no advantage in terms of cross-country performance, compared with simple camber flaps. The way ahead for the Open Class lay towards large spans and ever higher aspect ratios. Carbon fibre allowed such extensions. From the manufacturer's viewpoint, a few metres of extra wing did not add greatly to the costs of production, whereas the complex and heavy mechanism required to change the wing area in flight was very expensive. It required very careful maintenance in service. Leading pilots confirmed that the workload in competition racing was in any case too great for variable area wings to be used to full advantage. The only remaining doubts were whether sailplanes with much more than 20 metres span would prove easy and safe to fly, and how much trouble they would be on the ground, handling, rigging and de-rigging, crew sizes, and cost. George Moffat at the World Championships in Texas in 1970 had difficulties with the Nimbus 1. Nevertheless, he had won. The Glasflügel 604, also of 22 metres, had proved satisfactory. These were before carbon fibre.

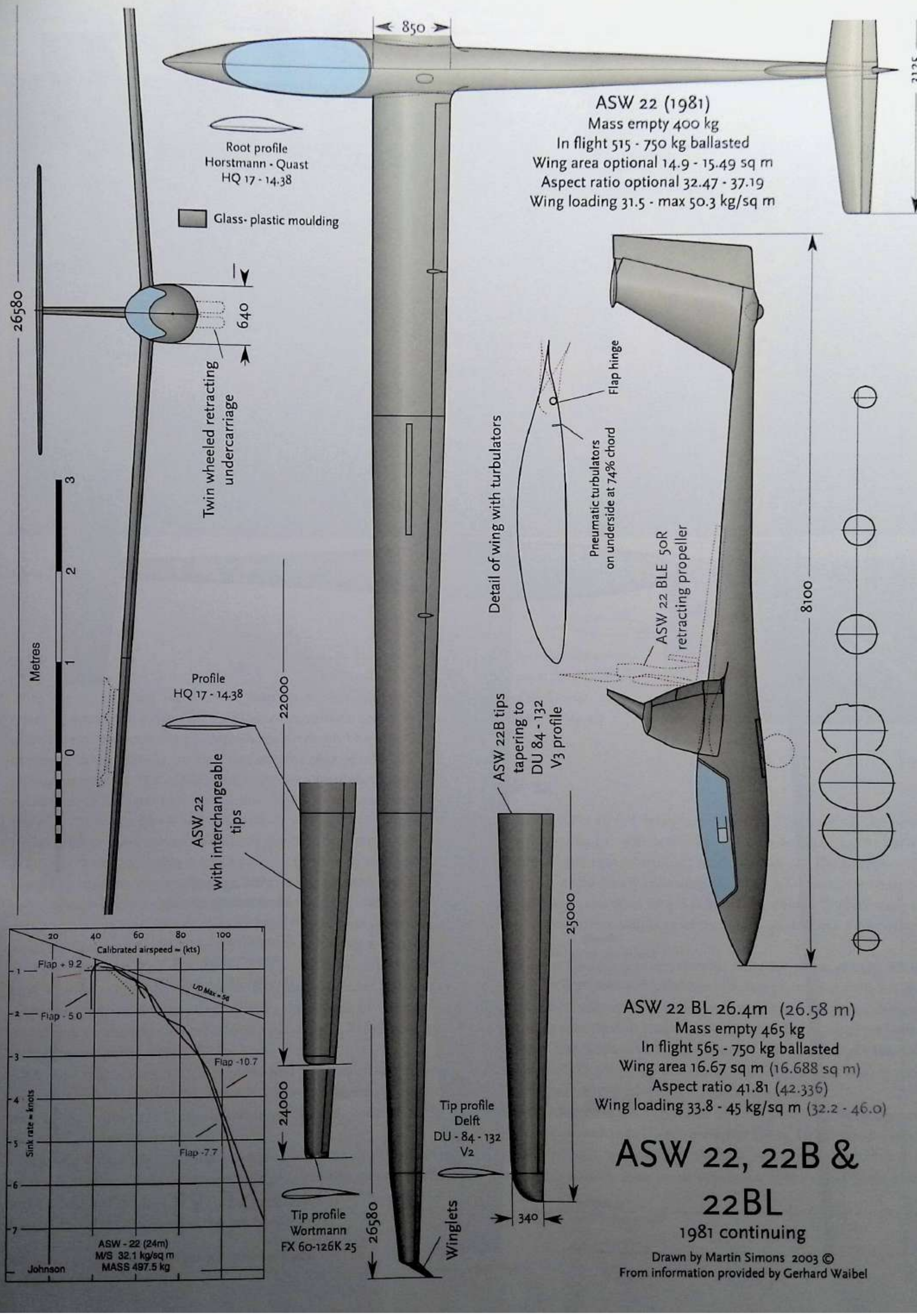
The Schleicher Company announced late in 1979 that a new Open Class sailplane was under development. The best glide ratio would be at least 55:1. Extensive use was to be made of carbon and Kevlar. The new sailplane would be available with interchangeable wing tips allowing the span to be either 22 or 24 metres.

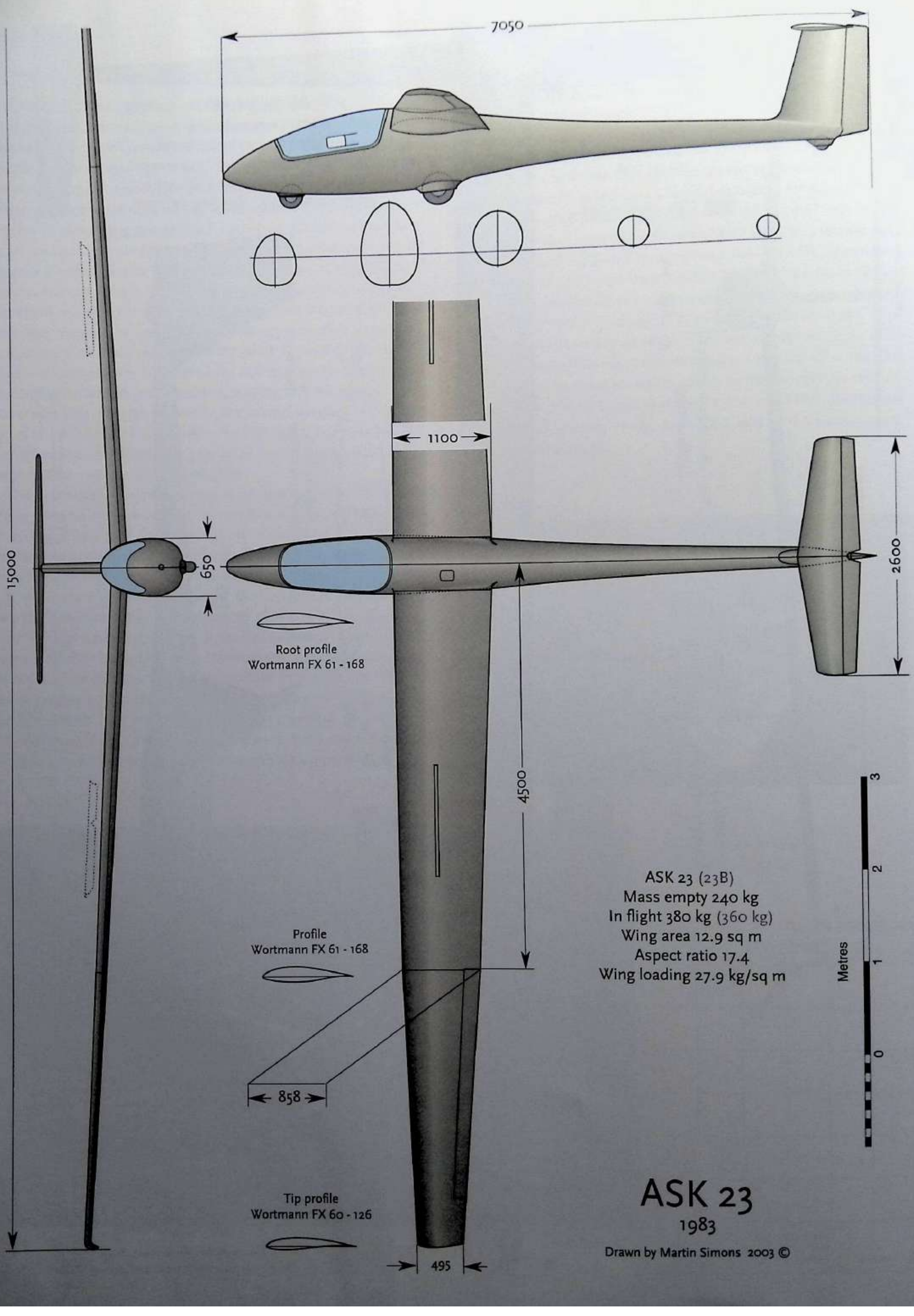
It was hoped to have a prototype for George Lee to fly in the World Championships at Paderborn in 1981 but despite great efforts it could not be completed in time. (Lee flew a Nimbus 3 and became World Champion for the third time.) It was not until four weeks after the Championship that the ASW 22 made its first flight. Handling was acceptable. On the ground rigging was simplified as far as possible. Each wing was in four main sections so each part was relatively light. In addition there were the interchangeable wing tips, so six pieces in all. For transport by road the longest unit was the fuselage, 8.1 metres. Performance tests flights showed that the ASW 22 had achieved what was expected. The best glide ratio was better than 56:1, with further improvements coming later from the addition of even longer wing tip extensions to 26.58 metres, and winglets. In World Championships the chief rival at this time was the Nimbus 3, which was accepted as having virtually the same performance. The Nimbus dominated in 1983 and 85, but in 1987 Ingo Renner won his fourth title with Marc Schroeder second, both in ASW 22s. In 1989 Jean Claud Lopitaux flew his ASW 22 to victory by a narrow margin over Ingo Renner in a Nimbus. Hans Werner Grosse used his ASW 22 to establish yet another world speed record in Australia, a 750 km triangle at 158.4 km/h in January 1985.

Large Open Class sailplanes were, and are, costly and never could be expected to sell in very large numbers. A total of 47 of the ASW 22 and its B & BL versions was reached. In the longer run, the self-launching BE and BLE, still available in the year 2000, and further developments leading to the ASW 22-2 and ASH 25 two-seaters, were equally significant.

Above: ASH 22 with winglets (Photo Manfred Münch)

Left: ASW 22. Jürgen Baumgartl north of Serres Airfield, the home base of Klaus Ohlmann (Photo Claus-Dieter Zink)


850
3125
ASW 22 (1981)
Mass empty 400 kg
In flight 515 - 750 kg ballasted
Wing area optional 14.9 - 15.49 sq m
Aspect ratio optional 32.47 - 37.19
Wing loading 31.5 - max 50.3 kg/sq m
Root profile
Horstmann - Quast
HQ 17 - 14.38
Glass- plastic moulding
26580
640
Twin wheeled retracting undercarriage
Metres
0
1
2
3
Detail of wing with turbulators
Flap hinge
Pneumatic turbulators on underside at 74% chord
ASW 22 BLE 50R retracting propeller
8100
Profile
HQ 17 - 14.38
22000
ASW 22 with interchangeable tips
ASW 22B tips tapering to DU 84 - 132 V3 profile
25000
24000
Tip profile
Wortmann
FX 60-126K 25
26580
Winglets
Tip profile
Delft
DU - 84 - 132
V2
340
Calibrated airspeed ≈ (kts)
20
40
60
80
100
Sink rate ≈ knots
1
2
3
4
5
6
7
Flap + 9.2
Flap - 5.0
L/D Max = 56
Flap -10.7
Flap -7.7
ASW - 22 (24m)
M/S 32.1 kg/sq m
MASS 497.5 kg
Johnson
ASW 22 BL 26.4m (26.58 m)
Mass empty 465 kg
In flight 565 - 750 kg ballasted
Wing area 16.67 sq m (16.688 sq m)
Aspect ratio 41.81 (42.336)
Wing loading 33.8 - 45 kg/sq m (32.2 - 46.0)
ASW 22, 22B &
22BL
1981 continuing
Drawn by Martin Simons 2003 ©
From information provided by Gerhard Waibel



7050
1100
2600
15000
650
4500
858
495
Root profile
Wortmann FX 61 - 168
Profile
Wortmann FX 61 - 168
Tip profile
Wortmann FX 60 - 126
ASK 23 (23B)
Mass empty 240 kg
In flight 380 kg (360 kg)
Wing area 12.9 sq m
Aspect ratio 17.4
Wing loading 27.9 kg/sq m
Metres
0
1
2
3
ASK 23
1983
Drawn by Martin Simons 2003 ©

Above: The ASK 23 derived from its two seat forerunner, the ASK 21. (Photo Jochen Ewald)

Right: The cockpit layout makes it very easy to change from two seater to single seater. (Photo Manfred Münch)

ASK 23

With the widespread adoption of plastic two seat sailplanes for training, there was a need for a single seater suitable for early solo pilots. Rudolf Kaiser set out to fill this requirement. The ASK 23 was matched to the ASK 21, so that the student pilot would find the transition natural. The ASK 23 was, in Kaiser's own words, the GRP equivalent of his earlier Ka - 8, standing in the same relationship to the ASK - 21 as the Ka - 8 had to the Ka - 7 and ASK - 13. There was no attempt to make the cross-country performance outstandingly good but it was desirable for the pilot to be able to soar readily. Handling must be safe and predictable and the aircraft must be capable of withstanding the occasional heavy landing without damage. There was a non-retracting main wheel and a nose wheel, with a tail skid or tail wheel option. Special care was taken to make the cockpit adaptable. The seat and rudder pedals were adjustable so that even an unusually tall pilot would have ample leg and headroom. In the first instance, a very high cockpit load of 140 kg was permitted, catering for those seriously overweight. This figure was later reduced for the ASW 23B.

The first flights were in October 1983 and favourable pilot reports were published in early 1984. The ASK - 23 was welcomed and sales were brisk. A number of very similar trainers soon appeared on the market at competitive prices.

This was Kaiser's last sailplane design. He retired in 1985. Sadly, he did not enjoy a long retirement. His physical and mental health broke down and he died in 1991, in Poppenhausen, at the age of 69. He was mourned throughout the world of soaring.

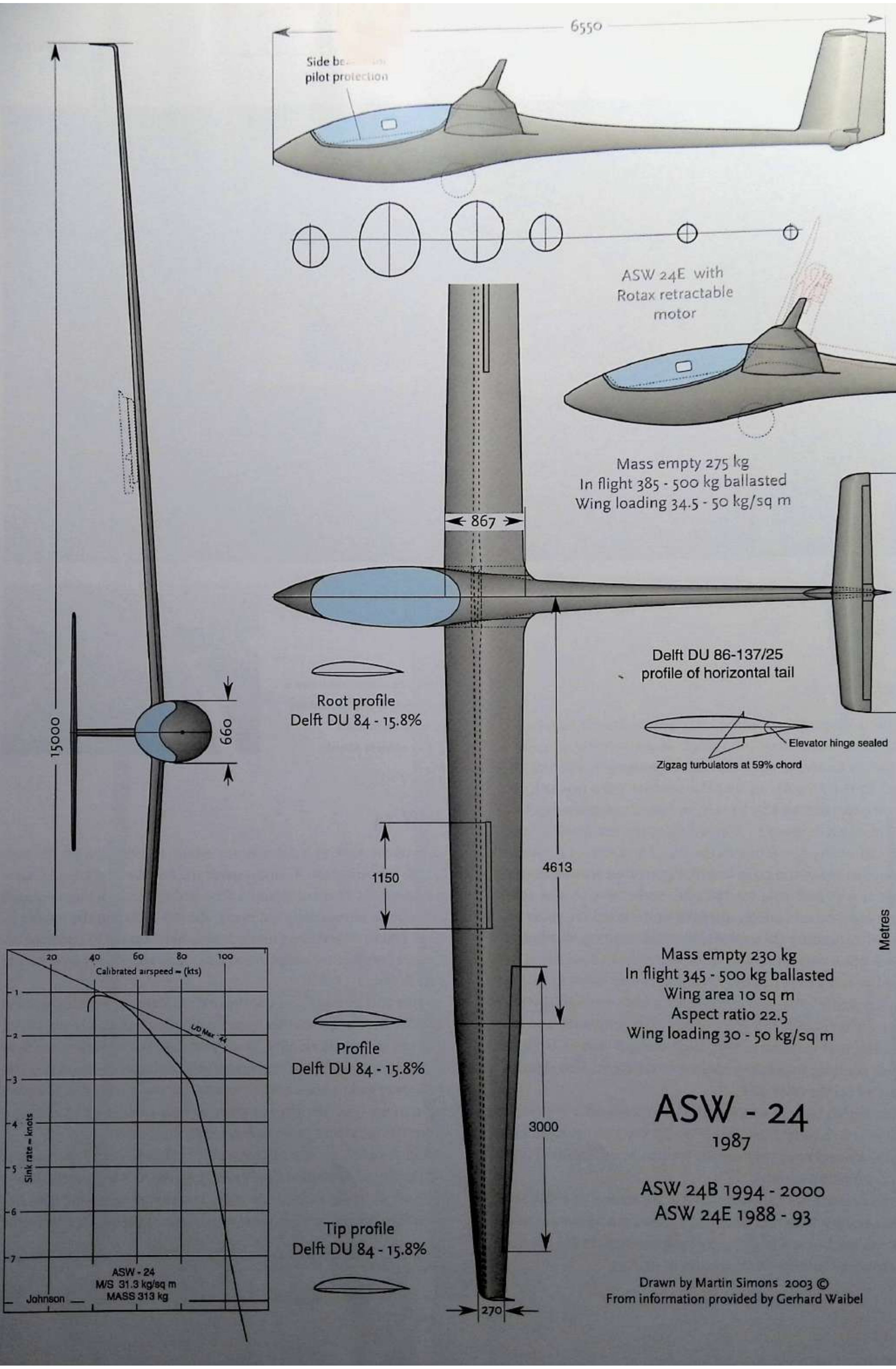
ASW 24

Sales of the ASW 19 fell drastically when, in 1980 and 81, the new Lemke Schneider LS - 4 almost swept the board at the World Championships.[28] Other outstanding Standard Class sailplanes appeared in the years immediately following, the DG - 300 and the Schempp-Hirth Discus. It was clear that if Schleichers wanted to continue offering a competitive sailplane in this class, an entirely new design was necessary.

In the first instance an experimental sailplane, misleadingly called the ASW 24, was flown, chiefly to investigate pneumatic turbulators. This was essentially an ASW 20 without flaps but with the underside of the wing modified in shape and with turbulators installed. After the factory had finished with this aircraft it was exported in 1985 and flown in the USA. There it was found to have a best glide of 41:1, providing the turbulator holes were carefully cleaned out.

Waibel called for the assistance of Professor Loek Boermans of the Faculty of Aerospace Engineering in Delft. The Delft laboratories had, in 1966, begun a lengthy research programme into low speed aerodynamics. Here there were some of the world's best wind

28 – See p. 131


6550
ASW 24E with
Rotax retractable
motor
Mass empty 275 kg
In flight 385 - 500 kg ballasted
Wing loading 34.5 - 50 kg/sq m
867
2550
Delft DU 86-137/25
profile of horizontal tail
Elevator hinge sealed
Zigzag turbulators at 59% chord
15000
660
Root profile
Delft DU 84 - 15.8%
1150
4613
Metres
0
1
2
3
Mass empty 230 kg
In flight 345 - 500 kg ballasted
Wing area 10 sq m
Aspect ratio 22.5
Wing loading 30 - 50 kg/sq m
Profile
Delft DU 84 - 15.8%
3000
ASW - 24
1987
ASW 24B 1994 - 2000
ASW 24E 1988 - 93
Tip profile
Delft DU 84 - 15.8%
270
Drawn by Martin Simons 2003 ©
From information provided by Gerhard Waibel
Calibrated airspeed – (kts)
20
40
60
80
100
Sink rate – knots
1
2
3
4
5
6
7
L/D Max 44
ASW - 24
M/S 31.3 kg/sq m
MASS 313 kg
Johnson

Waibel's design of 1980 for the Standard Class, the ASW 24. Special attention was given to the cockpit strength and pilot protection in bad landings. (Photos Manfred Münch)

tunnels and research facilities, with ample computing machinery and expertise readily available. The revised wing used on the ASW 19X and the 'Special' ASW 24, originated here and the Delft group collaborated successfully with the Braunschweig study group and the German DFVLR.

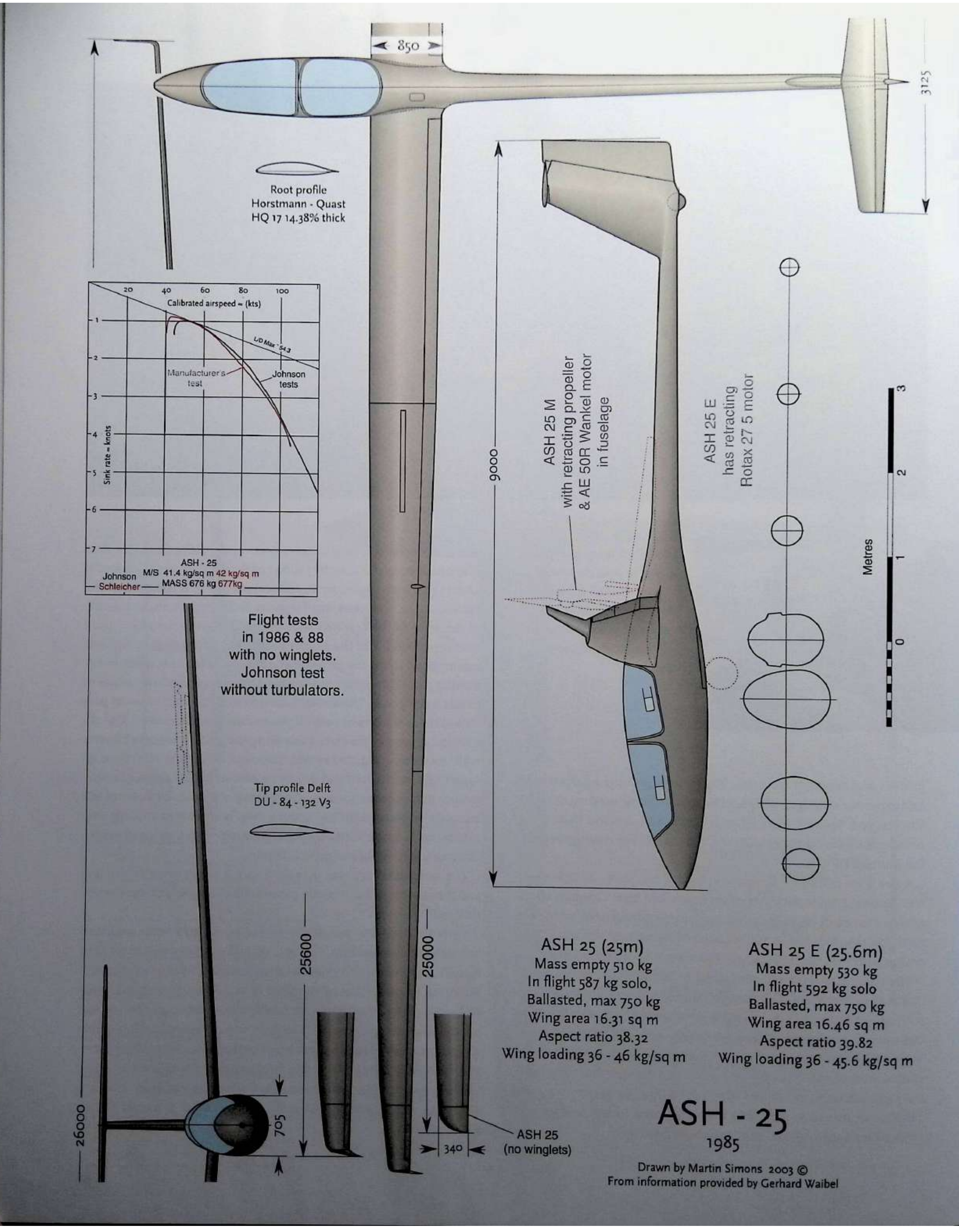
A new 15% thick profile was adopted for the ASW - 24. Special attention was given to preserving low drag when insect remains contaminated the surface. Rather than pneumatic turbulators, which can easily become blocked in service, simple zigzag tape was used at the critical points on the underside of the wing, and on the tail unit.

The wing planform was subjected to full analysis by advanced computing methods. The final choice of a double tapered form with aspect ratio of 22.5, emerged from these computations. Serious studies were made of fuselage shape, eight different forms being tested before the final choice was made, with a well-marked contraction of the cross section aft of the cockpit, but very carefully calculated to avoid any flow separation. By contracting the fuselage in this way, the surface area exposed to the airflow was reduced with consequent savings in skin friction.

'Panel' methods were used to develop the wing-fuselage junction. Panel methods involve a lengthy process of iteration. A computer model of the surface of the aircraft, or relevant parts of it, is constructed and marked out in numerous small separate surface segments. In the case of the ASW 24, 3000 panels were plotted, covering the whole front fuselage and much of the adjacent wing. Beginning with some basic assumptions about the pressure and flow, one panel is taken as the starting point. The effect this segment has on the flow over adjacent panels is computed. These results are fed out to the next adjacent panels and these to the next until all panels have been calculated. The calculation returns to the start, comparing the initially assumed figures with the newly computed results. There is a difference. The initial assumptions are replaced and the entire process begins again. After numerous iterations the same result appears at start and finish. From this an image of the total airflow, and the drag, is discovered and improvements can be made to run the iteration again with a changed model. Obviously a powerful computer is required.

The horizontal tail was designed with a slight reversed camber and turbulators in front of the control hinge line, as also on the vertical tail.

From these wholly aerodynamic results, the structural engineering remained to be done. Gerhard Waibel was responsible for this. As well as the usual and essential basic stressing, Waibel gave careful attention to protection of the pilot in accidents. Strong, high side rails were built into the front fuselage but although the cockpit canopy was relatively small, the view was excellent in all possible directions and the seating was very comfortable. When Dick Johnson tested the aircraft in Texas, he described the canopy latching and emergency jettisoning system as the best he had seen. Waibel's efforts to improve safety were recognised with a special OSTIV award in 1993.



850
3125
Root profile
Horstmann - Quast
HQ 17 14.38% thick
Calibrated airspeed – (kts)
20
40
60
80
100
L/D Max ~ 54.3
Manufacturer's test
Johnson tests
Sink rate – knots
1
2
3
4
5
6
7
ASH - 25
Johnson M/S 41.4 kg/sq m 42 kg/sq m
Schleicher MASS 676 kg 677kg
Flight tests
in 1986 & 88
with no winglets.
Johnson test
without turbulators.
ASH 25 M
with retracting propeller
& AE 50R Wankel motor
in fuselage
ASH 25 E
has retracting
Rotax 27 5 motor
9000
Metres
0
1
2
3
Tip profile Delft
DU - 84 - 132 V3
25600
25000
26000
705
340
ASH 25
(no winglets)
ASH 25 (25m)
Mass empty 510 kg
In flight 587 kg solo,
Ballasted, max 750 kg
Wing area 16.31 sq m
Aspect ratio 38.32
Wing loading 36 - 46 kg/sq m
ASH 25 E (25.6m)
Mass empty 530 kg
In flight 592 kg solo
Ballasted, max 750 kg
Wing area 16.46 sq m
Aspect ratio 39.82
Wing loading 36 - 45.6 kg/sq m
ASH - 25
1985
Drawn by Martin Simons 2003 ©
From information provided by Gerhard Waibel

Waibel made the first flights of the new sailplane himself in December 1987. Performance tests gave the ASW 24, with winglets, a best glide ratio of 44:1. Only a few years previously, the ASW 19 had been thought exceptional with 38.5:1.

The ASW 24 was not the only Standard Class sailplane with this kind of performance. All other designers had applied the same principles and achieved similar results. In terms of performance, handling and cost, a whole new generation of Standard Class sailplanes had developed. Schleicher's new product had no very clear advantage over the others. The Standard Class now was equaling and surpassing the performance of the older unrestricted fifteen metre sailplanes, many of which were still in service and flying in competitions. On those occasions when Standard and Fifteen metre tasks were the same, it quite often turned out that the winning Standard Class times were as good, or even better than the unrestricted 'fifteens'. Which sailplane a leading pilot chose to fly depended very much on matters of detail and taste. The only major international win by an ASW 24 was by Sarah Steinberg in the 2001 Women's Championships.

Further minor improvements led to the ASW 24B. It was also now more or less essential for any new sailplane type to be made available with self-launching ability. The ASW 24E with a retractable power unit was produced in 1988 and it was now possible to adapt almost any sailplane to take a Fischer 'TOP' motor. This, in a well shaped housing, could be bolted onto the fuselage behind the cockpit. The additional drag with the propeller tucked away was not very serious.

In production, a total of 221 of the ASW 24 and 218 of the 'B' model was reached by 1994. With 58 of the self-launching E and eight equipped with the TOP motor, the total reached 505.

Above: High performance two seater ASH 25 in flight

Middle: The Self-launching version ASH 25E with retracting propeller

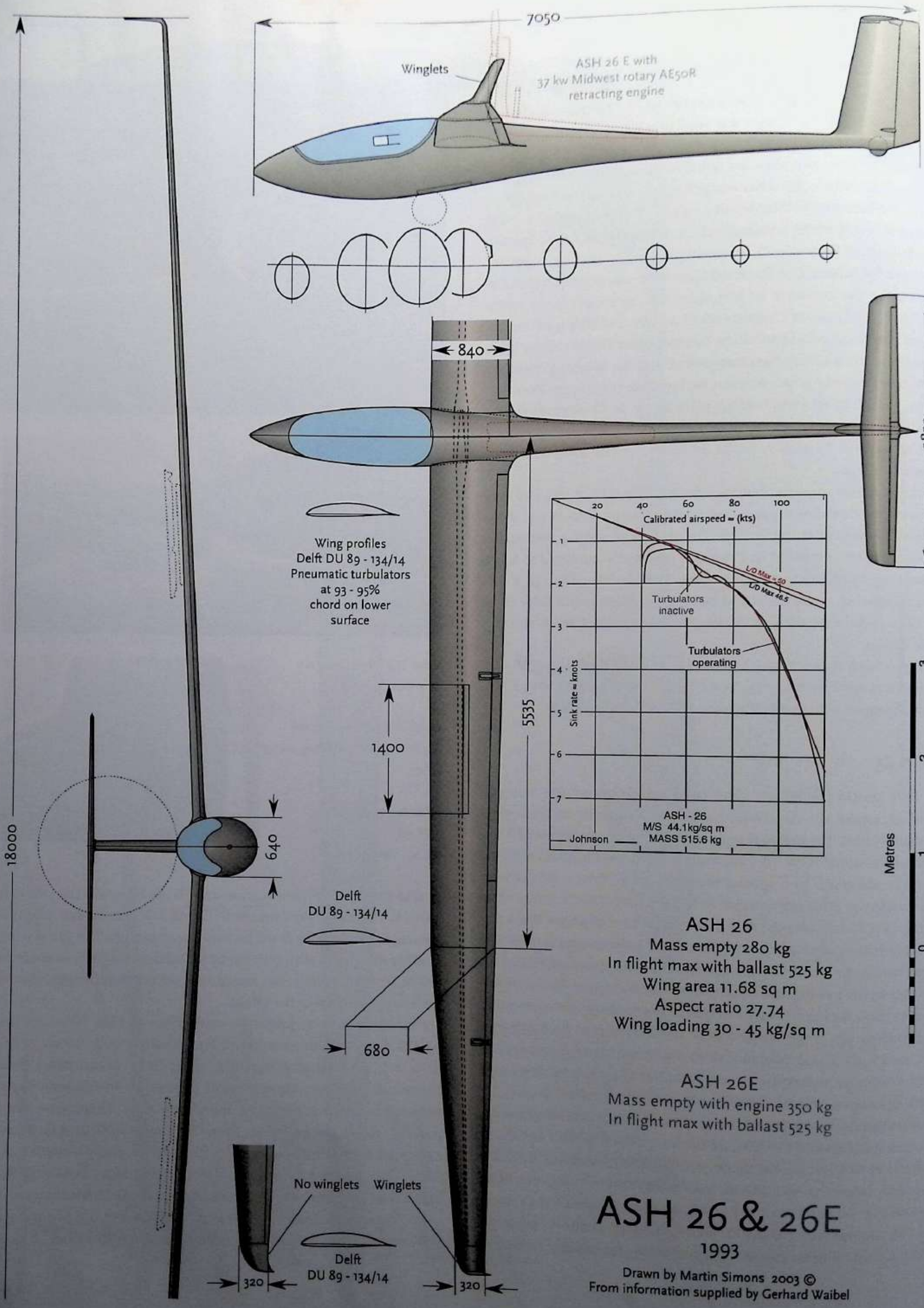
Right: Rear cockpit of the ASH 25E (Photos Manfred Münch)

ASH 25

In 1981 Martin Heide, who had been a member of the Stuttgart Akaflieg, joined the Alexander Schleicher Company to work with Gerhard Waibel. His first major project was the development of a two seat version of the ASW 22, which was named the AS 22-2. Only one of these was built, to a special requirement of Erwin Müller who planned to use it for attempts on World Records. The 24 metre wing of the ASW 22 was adapted with some significant changes. The wing tips, interchangeable on the original, were built integrally with the wing, saving the weight of fittings and reducing the moments of inertia about the yawing and rolling axes. The main spar was strengthened to allow for the increased weight of the fuselage and extra pilot. The fuselage was largely copied from the most recent Stuttgart project, the FS - 31. The slender tail boom made from carbon and Aramid fibre reinforced material, was very light but stiff. The front cockpit and the canopies were adapted directly from the ASK 21.

Müller's aircraft was successful and aroused much interest. In comparative trials against the ASW 22 flown by Hans Werner Grosse, it was found to have almost equal performance. Another 'one off' sailplane, called the ASH 25 MB, with a retracting engine, was built privately by Walter Binder, with help from the Schleicher Company. This too was very successful. Binder was a specialist on powered and self launching sailplanes. The Company was already planning to take the development further and Heide designed the two seat ASH 25. The wings were similar to the AS 2-22 but various simplifications were made to assist factory construction. The same wing profiles were used, with pneumatic turbulators on the underside of the inner wing panels, but zigzag tape on the outer wings, placed underneath at 68% of the chord.

First flights of the prototype were made in May 1986 and the ASH25 proved to be everything Heide had hoped. When, some time later, Dick Johnson reported on the Dallas performance tests, the results were very close to those claimed by the manufacturer, which was not true of many other sailplanes. There were some puzzling results, nonetheless. Johnson made profile drag measurements both with and without the turbulators, and on one test replaced the pneumatic system with dimpled tape. Doubling the amount of air blown through the pneumatic turbulators was also tried. So far as his tests could determine there was little consistent difference in the drag, with or without the turbulators. If any-



ASH 26

Mass empty 280 kg
In flight max with ballast 525 kg
Wing area 11.68 sq m
Aspect ratio 27.74
Wing loading 30 - 45 kg/sq m

ASH 26E

Mass empty with engine 350 kg
In flight max with ballast 525 kg

ASH 26 & 26E

1993

Drawn by Martin Simons 2003 ©
From information supplied by Gerhard Waibel

thing, Johnson remarked, they sometimes appeared to cause an increase in drag at high airspeeds. There was still something to be learned about turbulators, their placement on the wing, and their effects at different angles of attack and flap settings. There was no question that the ASH 25 had an outstandingly good performance, whatever further refinements might be possible. Winglets were fitted later and these became almost standard.

In the Southern Hemisphere summer of December- January 1987 - 8, Hans Werner Grosse again visited Australia, taking the prototype ASW 25 to Alice Springs. With his co-pilot Hans - Heinrich Kohlmeyer (of the 1979 SB - 10 record flights) and on one occasion, his son Werner, he broke seven World two-seater records. The following year, again from Alice Springs, now with his wife Karin as co-pilot, he took four more. In 1990 three more records were broken, two from the Grosse's new base at Newman in Western Australia and one from Lübeck, their home, to La Mure in France. With the motor glider ASH 25E, Grosse continued through the seasons 1990 - 93, setting yet more record figures from Newman and Lübeck. Hans Werner Grosse, in his lifetime of soaring, broke 48 World Records, nearly all of them in Schleicher sailplanes. The record he set in 1987 with Kohlmeyer, 143.46 km/h for the 1250 km triangle, still stands at the time of writing.

ASH 26

As Open Class wingspans increased to 20, then 22 and by 1985, 25 and 26 metres, the need for something intermediate between the 'fifteens' and these monsters became more pressing. Apart from any other considerations, the cost of competing in the unrestricted class escalated with the spans. The numbers of entrants in Open Class World Championships declined. In 1976, there were 39 Open Class contenders. In 1983 there were nineteen, in 1995 fifteen.[29] The idea of an eighteen metre competition class for sailplanes had been mooted many years before and had been informally recognised in some national and minor regional Championships. Nothing had been arranged internationally yet.

With the ASH 26, Schleicher decided to produce an 18 metre sailplane to satisfy the growing demand for this size of aircraft. It was recognised that more and more orders were being placed for self-launching sailplanes. Martin Heide therefore designed the ASH - 26 to take a power unit. There would be no need to produce two different models, as had been usual before. The 'pure' sailplane could be bought but if, subsequently, the owner wanted to install a motor, everything would be ready. A new type of engine had become available, the liquid-cooled Norton Midwest Wankel Rotary. This promised less weight, less noise and much less vibration than usual. The larger wing would be able to carry the extra weight of the engine easily and, with liquid cooling, extended cruising flights under power would be possible.

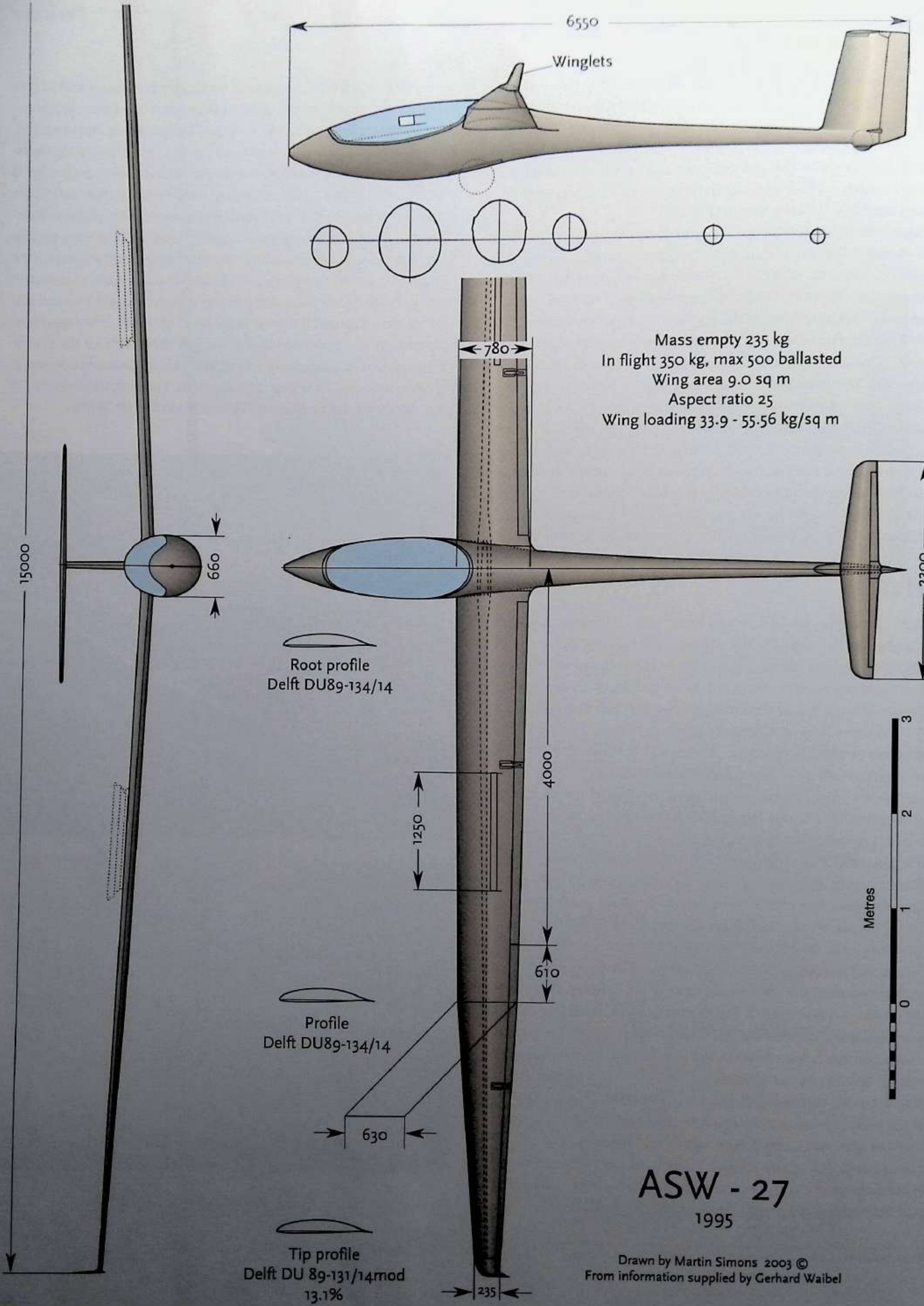
All the lessons learned with the ASW 24 were applied. The many differences were not immediately apparent. The cockpit of the '24 had been good, that of the '26 was better, with the same safety features for pilot protection. The fuselage was entirely of carbon and aramid fibre-reinforced plastic. The undercarriage raised the belly of the fuselage higher off the ground for greater protection and to give slightly more clearance for the longer wings. The engine, when fitted, was buried entirely in the fuselage. Under power, the propeller, driven by a toothed belt, emerged on a pylon with the cooling radiator. The motor itself remained entirely within. This saved a good deal of weight and drag compared with those motor sailplanes where the entire engine, air cooled, had to be raised into the airflow.

For the wing, Loek Boermans in Delft designed new flapped profiles, with pneumatic turbulators. The holes required for this were 0.6 mm diameter at 8 mm spacing, blowing at about 2 cubic centimetres of air per second. An interesting observation in the wind tunnel was that, at low airspeeds, with the turbulators shut off, flow separation occurred on the underside of the wing at about 93% of the chord. This produced an audible whistling. With the turbulators operating, this was cured and no whistle was apparent. The drag was reduced. At high speeds, the turbulators had little effect either on or off.

Above: ASH 26 about 18 km east of Aosta (Photo Claus-Dieter Zink)

Below: ASH 26 fuselage and root section

29 – This decline did not continue but at the time, 1993, there was little sign of any recovery.


6550
Winglets
Mass empty 235 kg
In flight 350 kg, max 500 ballasted
Wing area 9.0 sq m
Aspect ratio 25
Wing loading 33.9 - 55.56 kg/sq m
780
15000
660
2300
Root profile
Delft DU89-134/14
4000
1250
610
Profile
Delft DU89-134/14
630
Tip profile
Delft DU 89-131/14mod
13.1%
235
3
2
1
0
Metres
ASW - 27
1995
Drawn by Martin Simons 2003 ©
From information supplied by Gerhard Waibel

Early pilot reports were favourable and at the time of writing, the ASH 26 and 26E (the motorised version) are still available from production. The contest record is good, with wins and high placing in several National Championships in the 18 metre class. Mark Schroeder won the German Nationals in 1994. It was not until 1997 that the International Gliding Commission recognised the 18 metre class for World Championships, in both the motorised and un-motorised categories. At the first international championships for the new class, the Italian pilot Ricardo Brigliadori took second place in his ASH 26E. By this time the Schleicher Company had produced 110 of the ASH 26 and by 2002 the figure exceeded 200. More than 90% of these were fitted with motors.

ASW 27

Since the outstandingly successful ASW 20, first flown in 1977, Schleichers had produce no contender in the unrestricted fifteen metre class. Gerhard Waibel believed by 1995 that enough had been learned to enable significant improvements, with best glide ratios of 50:1 definitely possible and all-round improvements in high speed performance.

The fuselage design followed the lines already established by the ASW 24 and ASH 26, but the '27 was intended primarily as a sailplane without self-launching facility. There were to be no compromises with the performance. In co-operation with the University of Aachen, tests of a fuselage in crashing situations, somewhat similar in principle to tests of cars, were carried out. After being raised to some specific height by a crane the test fuselage was dropped to the ground and the damage carefully assessed from the point of view of likely injuries to the pilot. Some important lessons were learned from this and incorporated in the new cockpit design. Waibel also considered the possibility of using a rescue parachute system, which would be housed in the fuselage behind the cockpit, to be deployed after a mid-air collision or other desperate emergency, to bring the entire sailplane safely down.

The wing, in CRP, used new profiles designed by Boermans, as for the ASH 26. A great deal of work was also done on the wing tips. Waibel himself designed a set of winglets 0.27 metres high, which were offered as standard equipment. However, Mark Maughmer, Professor of Aeronautics at Pennsylvania State University produced a 'shark fin' curved form 0.4 metres high, and while attached to the Delft Laboratories, the English pilot and postgraduate student Afandi Darlington developed winglets 0.45 metres high.[30] Darlington showed that his high winglets could reduce total drag at the airspeed for best glide ratio by about 3.4%. Careful design was necessary and proper allowance was made for the additional loads on the wing. At high airspeeds the drag benefit disappeared. To special order, any of the three types of winglet could be fitted to the ASW 27 which was then termed the ASW 27B. The first flights were made in

Above: The Instrument panel is raised with the canopy for easy access. (Photo Manfred Münch)

Left: ASW 27. Schleicher's new offering for the 15 Metre Class (Photo Manfred Münch)

30 – Afandi Darlington was a member of the British International Team for the 2001 World Club Class Championships and placed 4th. He led a team working for Airbus on the design of winglets for the ASXX 550.

April 1995 and full certification followed in 1997. The new sailplane was well received and went into production.

In the 1999 World Championships at Bayreuth, Steve Raimond placed third and Justin Wills 6th in their ASW 27s. Their chief opponents were flying the SH Ventus 2. By August 2002, Schleicher's production of the ASW 27 and 27B reached 192.

Above: ASW 28 - 18 (Photo Jochen Ewald)

Left: Cockpit layout of the ASW 28 (Photo Manfred Münch)

ASW 28

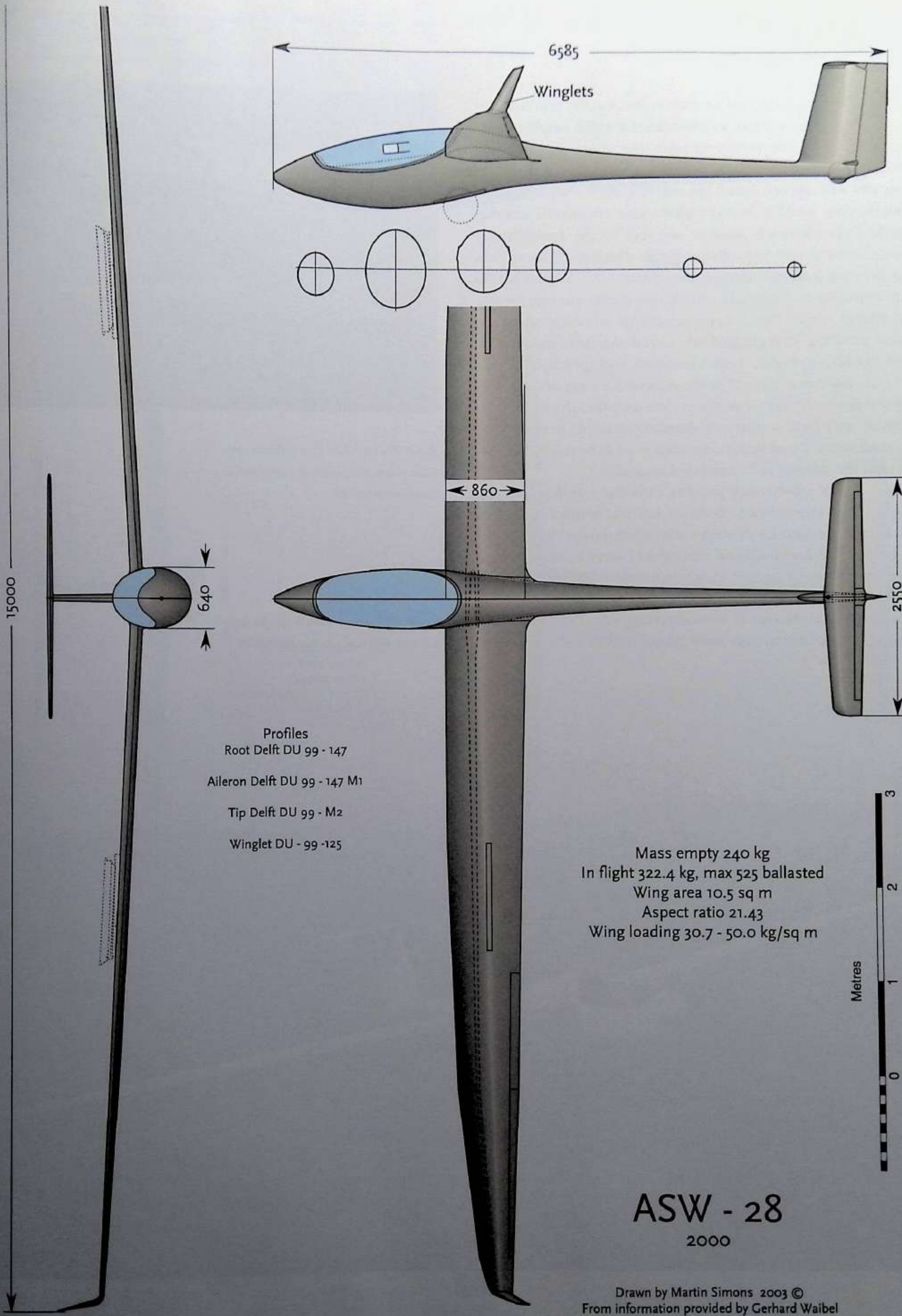
The ASW 28, Schleicher's new entry to the Standard Class, used almost the same fuselage as the ASW 24, but the wing was entirely new with profiles developed at Delft, and long winglets of the Darlington type. Hansjörg Streifeneder's Company built the prototype wings under subcontract. This greatly shortened the time between the planning and the first flights in May 2000. The ASW 28 therefore only just comes within the scope of this volume. By August 2002 sixty had been sold. A version with interchangeable 15 and 18 metre wing tips has been developed by Schleicher's new engineer, Michael Greiner, who joined the firm in anticipation of Gerhard Waibel's retirement in August 2003. The ASW 28 18 wing was in four sections, the inner section 5.25 metres long with lightweight tip panels respectively 2.25 and 3.75 metres long.

Burkhardt Grob Flugzeugbau GmbH

The firm of Burkhardt Grob, which had originally been involved in making machinery for automobile production, became involved in sailplane manufacture when it contracted with Schempp - Hirth to built the Standard Cirrus under licence. Burkhardt Grob himself was a glider and power pilot. Two hundred of the St Cirrus were built at the factory at Mindelheim-Mattsies airfield, between 1971 and 75. In 1974 Grob decided to continue independently, using the newly acquired expertise in composite materials. Advised by Professor Richard Eppler, rather than trying at once to compete for the contest sailplane market, they resolved to produce, at very competitive prices, sailplanes for clubs. At the same time Grob developed the outstandingly successful G - 109 motor glider series. After 1996 the Company's interests shifted wholly to light powered aircraft and glider production ceased.

G - 102 Astir CS and G - 102 Club

The Astir CS was the first glider to be offered by the Grob factory. It was intended as a safe, simple and strong Standard Class sailplane for clubs and private owners. The aerodynamic design and wing profiles were developed by Richard Eppler. Compared with other



ASW - 28

2000

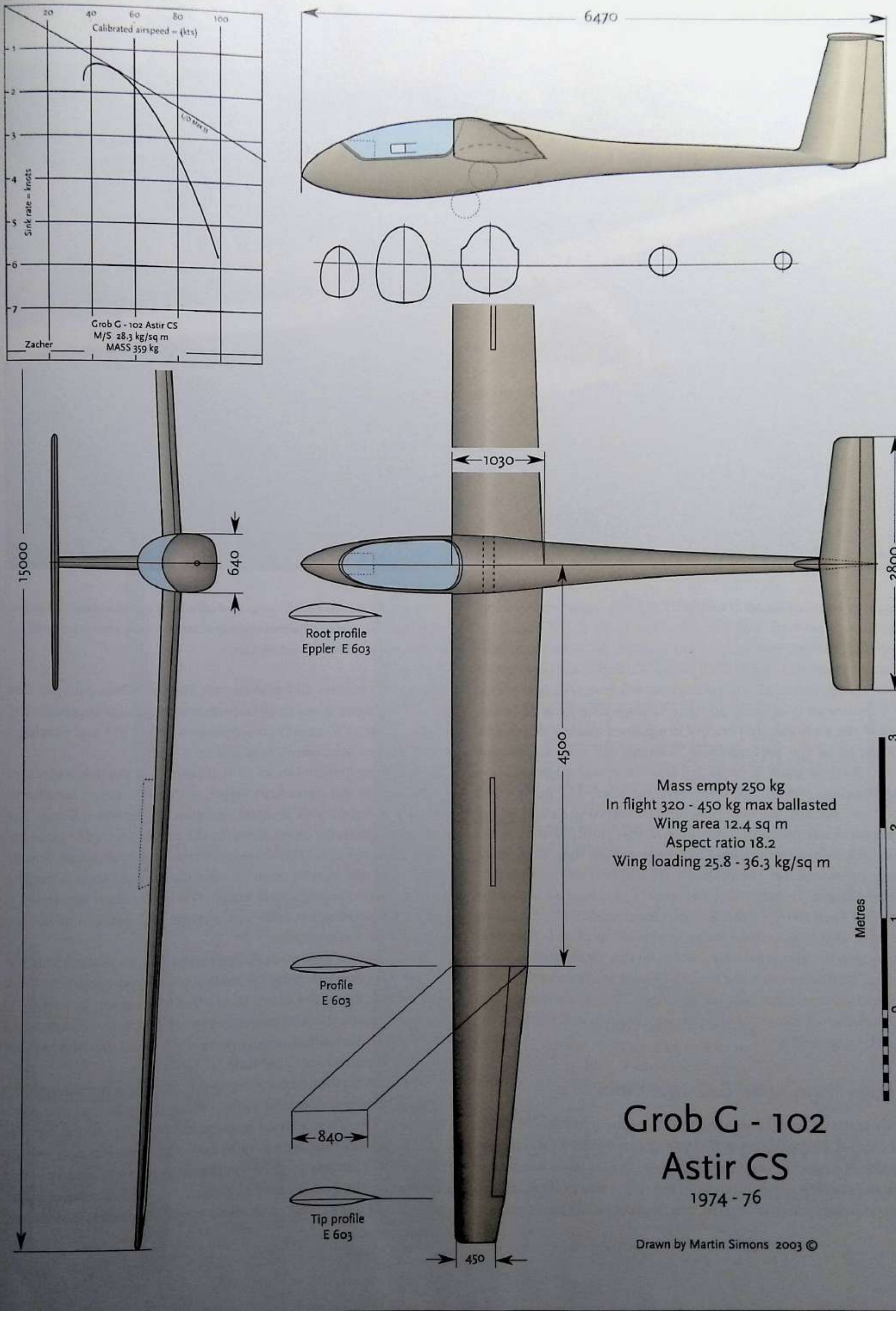
Drawn by Martin Simons 2003 ©
From information provided by Gerhard Waibel

sailplanes of its class the aspect ratio was low, but the resulting low wing loading was considered an advantage for a club sailplane, likely to be flown by inexperienced early-solo pilots. Nevertheless, there was provision for 90 kg of water ballast. The cockpit was roomy and well laid out. Inside the rear fuselage was a strong vertical reinforcing member. In early production aircraft the internal main fuselage frame was wooden and very strong. Subsequently this was replaced with light alloy castings, which could sometimes crack in heavy landings. Many of the control bell cranks were also light alloy castings. The undercarriage, retractable, was well sprung, with a large wheel. There was a removable tail dolly wheel for ground handling. This plugged into a vertical hole in the fuselage below the fin. (In flight, if left uncovered, the open hole made a loud flute-like noise. It could be silenced with a piece of tape.) Rigging was especially easy. The wings were joined to the fuselage by means of 'snap lock' connectors, the pins remaining in their housings at all times. There were no separate bolts to be mislaid or lost. However, the controls were connected manually.

The Astir CS proved very popular with clubs and production continued for several years. A total of 536 was reached in 1977, at which time the Astir CS 77 with a slimmer fuselage but the same wing was announced. Of this variant 227 were built. The 'Astir Jeans' of the same year had a cockpit lining in blue denim and a fixed undercarriage. It was advertised for the Club Class at a low price. The 'Standard Astir II' with retracting wheel and 'Club Astir II' with fixed undercarriage were introduced in 1979. The same

Above: The later Astir Club IIIB with new fuselage and cockpit, which some pilots found uncomfortable

Below: First version of the successful Astir CS, here shown in a factory photograph



20
40
60
80
100
Calibrated airspeed = (kts)
Sink rate = knots
Grob G - 102 Astir CS
M/S 28.3 kg/sq m
MASS 359 kg
Zacher
6470
1030
640
15000
2800
4500
Root profile
Eppler E 603
Profile
E 603
840
Tip profile
E 603
450
Mass empty 250 kg
In flight 320 - 450 kg max ballasted
Wing area 12.4 sq m
Aspect ratio 18.2
Wing loading 25.8 - 36.3 kg/sq m
Metres
Grob G - 102
Astir CS
1974 - 76
Drawn by Martin Simons 2003 ©

wing was retained for all. The Grob Club IIIB was a final development for pilots who had trained in the Grob G 103 Twin. The Club IIIB variant was fully tested in 1983 by Dick Johnsons's group in Texas and earned high praise. An important point which probably applied to all the Astir series, was that sealing the wing roots, where air could pass from the fuselage into the wings, to escape at the air brakes and control hinge lines, made a measurable difference to the performance. Without the sealing, Johnson found the best glide to be 31.5:1 and the measured polar curve was irregular. When the seals were installed, the polar curve smoothed out and the best glide ratio improved to 33.2:1. An unexpected result noted by Johnson was that in turbulent air, the Club IIIB he was testing had less wing profile drag than when flown in smooth air. The probable explanation was produced by Dieter Althaus. He tested the Eppler 603 profile, used on all the Astir and Twin series, in the Stuttgart wind tunnel. The profile responded well to turbulator strips at 65% of the chord. There was evidently a laminar separation bubble on the 'clean' profile. Probably on a turbulent day, the boundary layer made an early transition and no separation bubbles developed. Tripped by the turbulator in the wind tunnel, separation was avoided and the drag decreased by about 5%.

G 103 - 'Twin Astir' & G 102 'Club'

While plastic sailplanes were beginning to dominate the club solo and competition scene, most pilots still learned to fly in aircraft like the ASK 13 and other wooden two-seaters. The SH Janus was a high performance GRP competition sailplane. There was nothing in production suitable for training the new generations of pilots prepar-

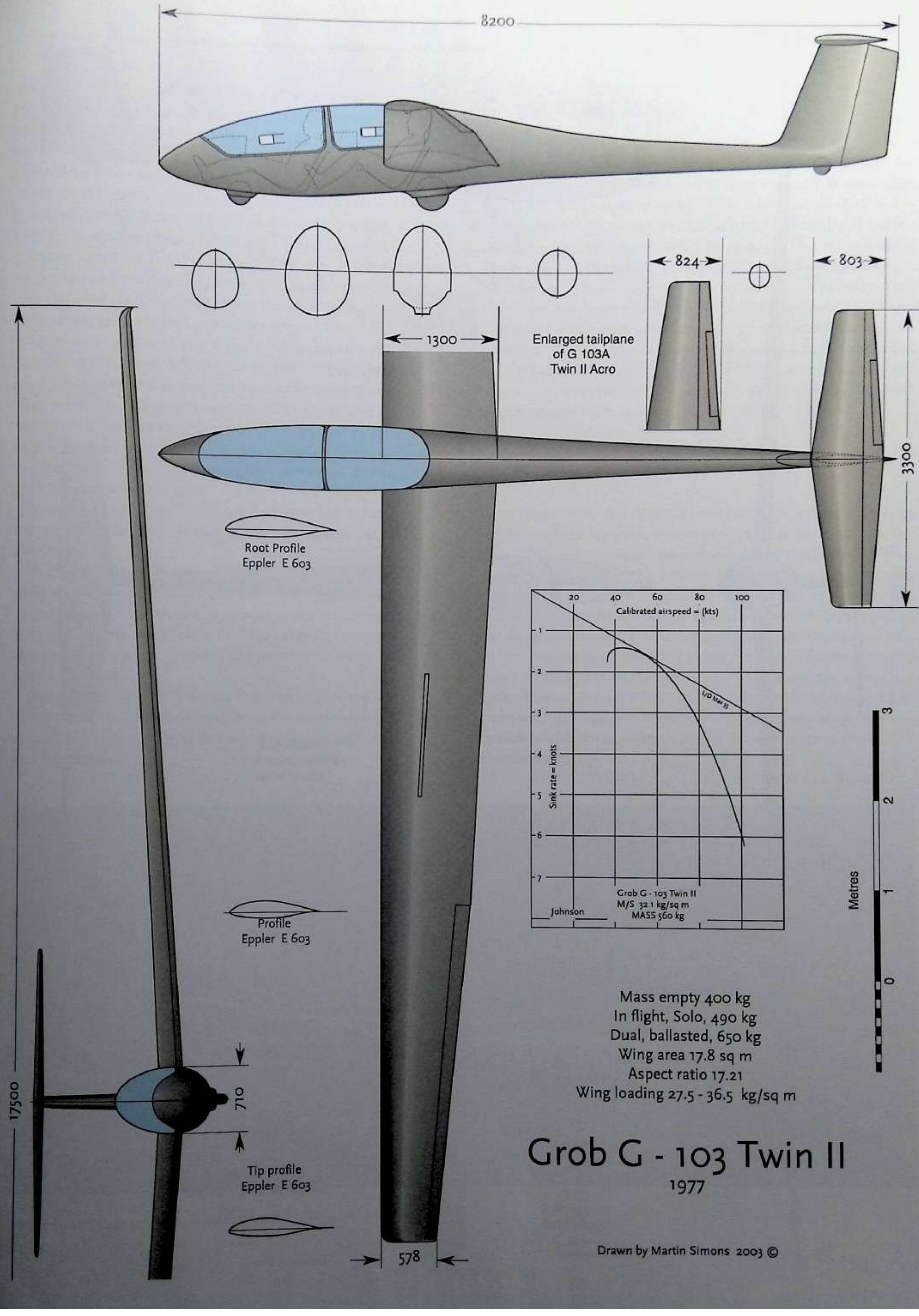
Grob Twin 2 fitted with small forewings to de-stabilise the aircraft and enable it to spin for instructional purposes. The forewings may be removed easily when not required. Photo taken at the Adelaide Soaring Club.

ing for the modern GRP solo aircraft. The Grob Twin Astir was first to fill this need. It was in all respects matched to the successful single seat Astir CS, already in production since 1974 and proving a great success as an early solo sailplane.

The prototype flew late in 1976. It resembled the solo Astir in all respects but was necessarily larger, with two seats in tandem in roomy cockpits, with separate canopies. There was a T tail. The wing was markedly swept forward. The profiles were the same Eppler 603 as the solo Astir. There was a retracting main wheel directly under the rear seat. To retract it necessitated a different retracting mechanism from the single seater. When the wheel was raised it was simultaneously rotated into a horizontal position to lie flat. This system was patented.

Some changes were made during production, including reduction of the wing sweep to bring the leading edge to right angles with the centre line. An option with a fixed wheel was chosen by some customers because the retraction mechanism was rather complex and in any case, for training, hardly necessary. Sales of the Twin reached 311 in a comparatively short time.

The Twin II retained the wing of the Twin Astir but the ailerons were lengthened to extend to the wing tip, improving their effectiveness. There was a slight consequential change to the taper at this point. The fuselage was quite new. The front was narrower by 16 cm and 4 cm less deep. Part of this reduction was made possible by using a fixed wheel located behind the loaded balance point, with a nose wheel. This made room for the rear seat to be set lower

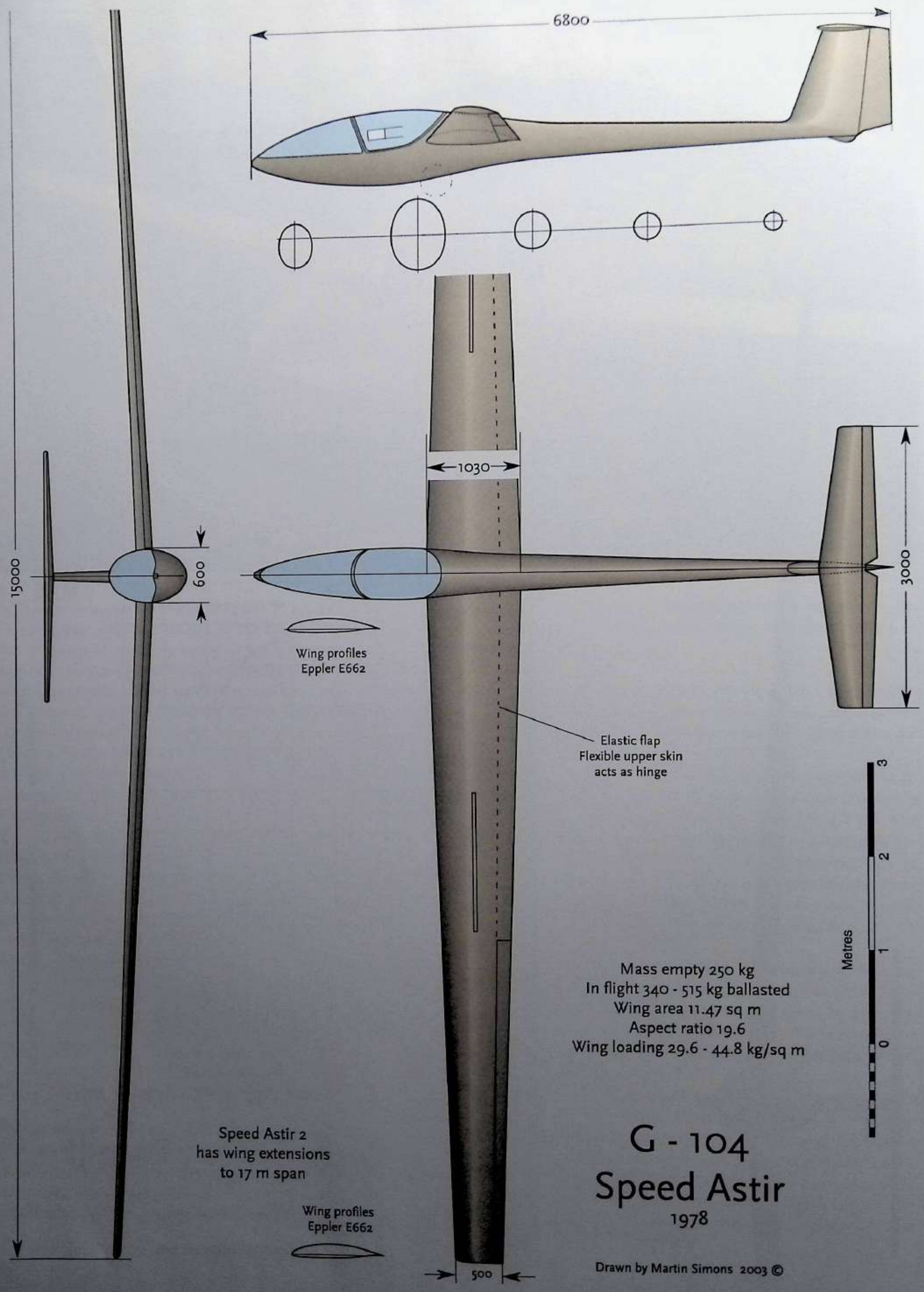


Mass empty 400 kg
In flight, Solo, 490 kg
Dual, ballasted, 650 kg
Wing area 17.8 sq m
Aspect ratio 17.21
Wing loading 27.5 - 36.5 kg/sq m

Grob G - 103 Twin II

1977

Drawn by Martin Simons 2003 ©


6800
15000
600
1030
3000
Wing profiles
Eppler E662
Elastic flap
Flexible upper skin
acts as hinge
3
2
1
0
Metres
Mass empty 250 kg
In flight 340 - 515 kg ballasted
Wing area 11.47 sq m
Aspect ratio 19.6
Wing loading 29.6 - 44.8 kg/sq m
Speed Astir 2
has wing extensions
to 17 m span
Wing profiles
Eppler E662
G - 104
Speed Astir
1978
500
Drawn by Martin Simons 2003 ©

and the height of the canopy reduced without loss of head room. The tailplane was slightly larger, with a thinner profile and fixed stabiliser and elevator. The height of the vertical tail was reduced slightly with a small increase in chord.

The Twin II was highly successful and became one of the most common two-seaters in the world. A strengthened version, the G - 103 Acro, was produced. The British Air cadet training scheme bought 100 of these, re-naming the type 'Viking T Mark 1'.

Almost 550 of the Twin II were built altogether. It was not only a successful trainer but quite capable of good cross country flights. Tom Knauff broke the two-seat World Out and return record with a 1000.9 km flight along the Appalachian ridges in the USA, in a Twin.

Simple aerobatics were also possible, but a curious feature of the Twin II was that it was very difficult to spin. This was regarded as a good safety feature but some instructors believed it essential to teach pupils what a true spin was like and how to recover from it. To cater for this, Grob produced optional, and detachable, canard stub wings which could be mounted on the nose ahead of the front seat. With these in place the Twin could be persuaded to enter a full spin. Recovery was quite easy.

Tested in America, the Twin II proved a glide ratio of 35:1, which was virtually the same as that of the Astir CS, but at a slightly greater airspeed.

In 1986 the Twin III Acro entered production. This had a new wing with Horstmann/Quast profiles and a crescent shaped plan. This was further developed to provide a self-launching version. Fifty of these were built but in 1996 the Grob Company decided to abandon sailplane production and concentrated future efforts on powered aircraft.

Hundreds of the Twin II remain in service, a good club two seater which leads the student naturally to the single seater. There is enough cross-country flying potential for training pilots in club level competitions.

G - 104 'Speed Astir'

The Speed Astir, flown in 1978, was Grob's attempt to produce a competitive sailplane in the Fifteen Metre class. For it, Richard Eppler designed a new wing profile which incorporated an elastic flap, that is, a flap which relied on a flexible upper skin to allow movement instead of the usual metal hinging with the inevitable sudden changes of shape and probable air leakage. The Braunschweig Akaflieg SB - 9 had a similar arrangement, as did the Polish Jantar 2. The fuselage and tail differed only in detail from the Astir Standard. After some two dozen had been built, in 1997 the Speed Astir II was introduced with carbon fibre main spar and a slimmer fuselage derived from the DG - 100. Later the Speed Astir IIB had a lengthened cockpit and an extended span version with 17 metre wings was also offered. In competitions the Speed Astir failed to make any great impression and production ceased after 107 had been built.

ETA

Many years ago, the English designer and manufacturer of sailplanes, Fred Slingsby, remarked, "There is no substitute for span." This was true then and remains so. No substitute has been found for span. The ETA project began when six well-known sailplane pilots, Bruno Gantenbrink, Hans Werner Grosse, Jan Krüger, Hartmut Lodes, Umberto Manticato, and Erwin Müller met and decided to combine financial resources to develop the world's best cross-country sailplane. The Greek letter ETA symbolises efficiency so this was to be the name. After preliminary discussions the design bureau Flugtechnik & Leichtbau, headed by Dr Reiner Kickert in Braunschweig, was established. Studies began at once, in co-operation with the Institute of Design Aerodynamics of the DLR in Braunschweig.

Burkhard Grob's design for the new 15 Meter Class, the "Speed Astir" (Photo Peter Selinger)

ETA: The world largest sailplane making its first flight at Cochstedt in Germany (Photo Gerhard Marzinzik)

Extensive computer work guided the general layout and size of the aircraft. It was assumed that much of the distance in cross country flying would be covered by 'dolphin soaring', gliding straight at high speed most of the time, pulling up to fly slowly and gain height without circling in areas of weak lift. Circling would be done in selected large and strong thermals. To circle in weak thermals wastes time, but when a strong upcurrent is found, circling to climb rapidly remains important. The inter-thermal glide airspeed can be much greater and a higher average speed results. Dolphin soaring, then, is regarded as a means of crossing the distance between strong thermals as efficiently as possible.

By the end of 1997 the basic design was settled. The Eta was to be a two seater with self-launching ability. New wing and tail profiles were designed by Horstmann & Quast, and wind tunnel tested. The wing span, greater than any previous sailplane, was to be 30.9 metres and the aspect ratio 51.33, figures never reached before. (Kronfeld's unsuccessful, wooden, Austria of 1931 had been 30 metres span, aspect ratio 25.7.[31]) The mean wing chord was about the same as that of many existing 15 metre sailplanes but with twice the lateral extension. In more recent times, only the SB - 10 had approached this span, with the 29 metre wing tips fitted. The maximum take off mass would be about 920 kg, wing loading variable between 37.4 and 51.3 kg/sq m.

The wing was in six sections, with winglets. To improve aileron control, a slight 'chord skip' was introduced. This ensured that the wing tips would not stall in a turn, even though there was to be no wing twist or washout. The small penalty in vortex drag, caused by the departure from the ideal elliptical lift distribution, was considered unimportant and would be negligible at high airspeeds.

Construction was carried out by subcontractors, who kept in close touch throughout. The fuselage, wing spar flanges and final assembly were carried out by Walter Binder Flugmotorenbau, at Ostheim /Rhön. The wing was built at Schmidt & Schatz, of Rosswälden, and the controls by Wolf-Hirth GmbH at Kirchheim Teck

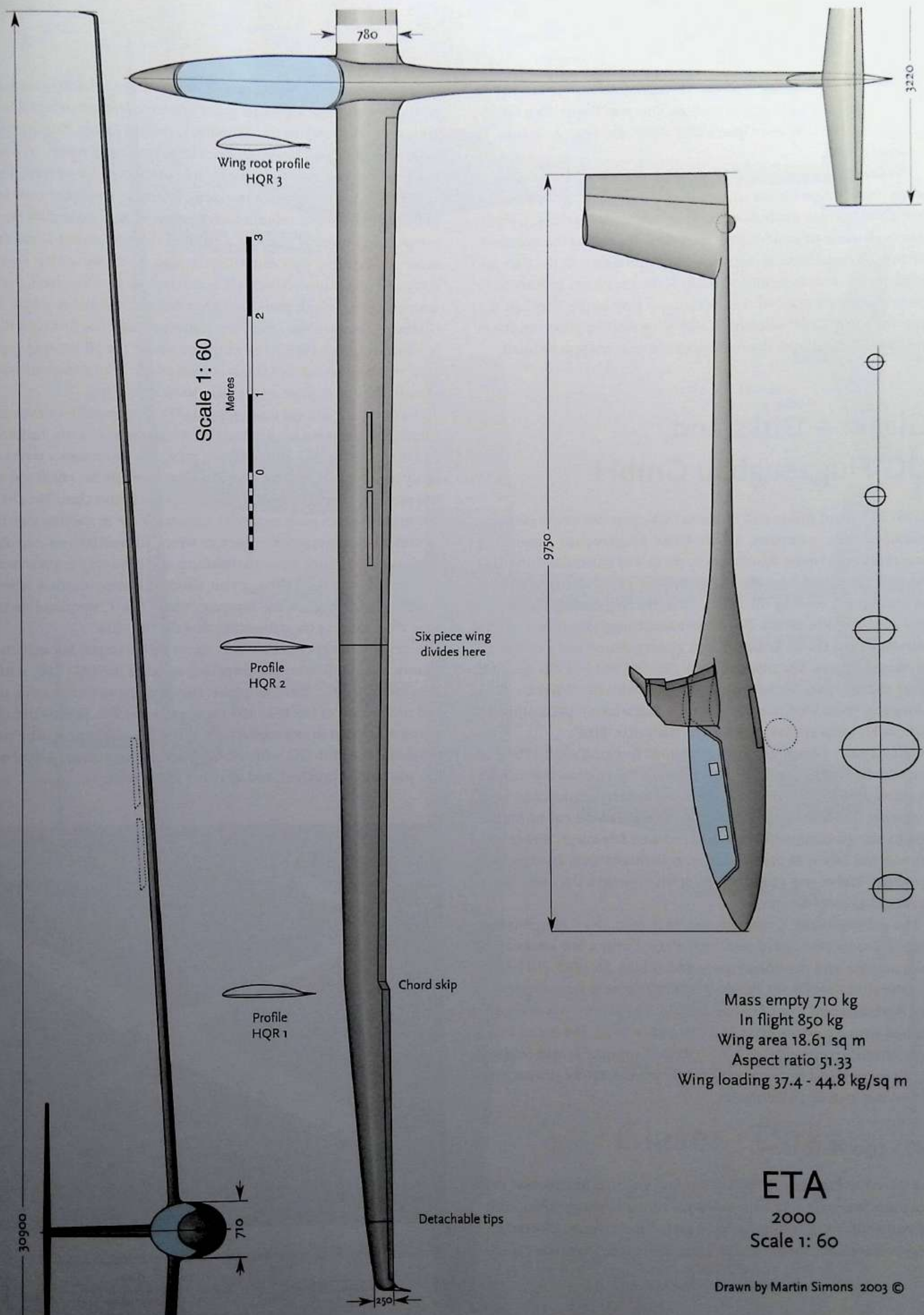
The main spar flanges were made from pre-impregnated high tensile carbon fibres. For the wing skins, to increase torsional stiffness, high-modulus carbon fibre fabric laid diagonally would be necessary, despite the cost. The necessary milled moulds for wing, fuselage and tail were prepared. Segments of the proposed structure were made and tested for loading and fatigue life. By mid 1999, a complete wing segment, 11 metres long, was tested to destruction. Before failure it bent into the shape of a quarter circle.

In July 2000 the prototype was completed and submitted to ground vibration tests. The first flight was successfully carried out on July 31st at Cochstedt near Magdeburg. After some minor adjustments Hans Werner Grosse, a prime mover of the project, took delivery of the first Eta. He flew it immediately and expressed himself delighted. By late 2003 he had flown the Eta for a total more than 600 hours and had completed many cross country flights, including two 1000 km triangles within Germany.

As to be expected with such an extraordinary venture, there have been difficulties. The prototype fuselage was heavier than expected. The entire tail and tail boom of Hans Werner Gross's Eta have been replaced with a lighter, and somewhat smaller, unit from an ASW 22. This, at the time of writing, has been flown and has been found very satisfactory. Later models were made lighter.

Another Eta, however, has been unfortunate. While undergoing tests to satisfy the rigid rules of the German Airworthiness Authority, Walter Binder, as test pilot, attempted to force the Eta into a spin. It would not spin, but rolled violently over, semi inverted, to enter a spiral dive. The speed built up very quickly, well beyond the calculated limit. Application of rudder to bring it out of the spiral caused the tail to twist off. Binder and his co-pilot were able to get out of the cockpit in time to use their parachutes. Clearly, to fly such an aircraft requires a great deal of care and extreme manoeuvres, including spins, and spiral dives, are not to be attempted.

31 – See Volume 1



Mass empty 710 kg
In flight 850 kg
Wing area 18.61 sq m
Aspect ratio 51.33
Wing loading 37.4 - 44.8 kg/sq m

ETA

2000

Scale 1: 60

Drawn by Martin Simons 2003 ©

A total of six of the Eta, including the one destroyed, had been built and flown by the time of publication. One was flown, by a Polish pilot, in the 2003 World Open Class Championships at Leszno. It placed second.

The cost being so great, currently in the region of Eu 800,000, it seems unlikely that the Eta will ever be produced in large numbers or that it will become a common site at ordinary gliding clubs. It represents a pinnacle of achievement reached at the end of the twentieth century. It remains to be seen what the outcome will be. New absolute world records seem very likely. If the Eta proves in practice to be outstandingly good in competitions, it may in the long run not help the 'Open Class' sailplane. If only a few wealthy pilots can afford to compete at this level, the number of entries is likely to be small.

Glaser – Dirks and DG Flugzeugbau GmbH

In 1973 Gerhard Glaser and Wilhelm Dirks founded a new sailplane manufacturing company, Glaser-Dirks Flugzeugbau GmbH, at Bruchsal about twelve kilometers north east of Karlsruhe. Dirks had recently graduated from the Darmstadt Technical University where he had been a leading member of the Akaflieg during the design and construction of the D - 37 self-launching sailplane and the Standard Class D - 38. Glaser, a keen glider pilot, owned a civil engineering business. The new company did well and in 1978, needing more factory space, an alliance was formed with the Slovenian Elan Company (near Bled in what was then Yugoslavia). DG Sailplanes built in Slovenia are distinguished by the suffix 'Elan'.

The Glaser - Dirks Company continued in being until 1996 but ran into financial troubles, partly because the engines ordered for the new, self-launching DG 800B, about to enter production, were no longer available. A replacement power unit could not be found. The bankrupt Company was bought by Karl Friedriech Weber and his wife Eva Marie, in partnership with Gerhard Wolff, an expert accountant. Weber was a sailplane pilot who owned a DG - 400. Dirks remained as chief designer.

The reinvigorated Company was re-named DG - Flugzeugbau GmbH. Production at Bruchsal began again only a few weeks after the purchase and continued there and at Elan. In 1999, DG began the ambitious project of building an entirely new, large factory in Bruchsal, adjacent to an existing airfield. The factory was officially opened with a ceremony on 31st December 2000. The association with Slovenia continued. In 2003, DG took over the Lemke-Schneider Company and became responsible for the future production and servicing of all LS Sailplanes.

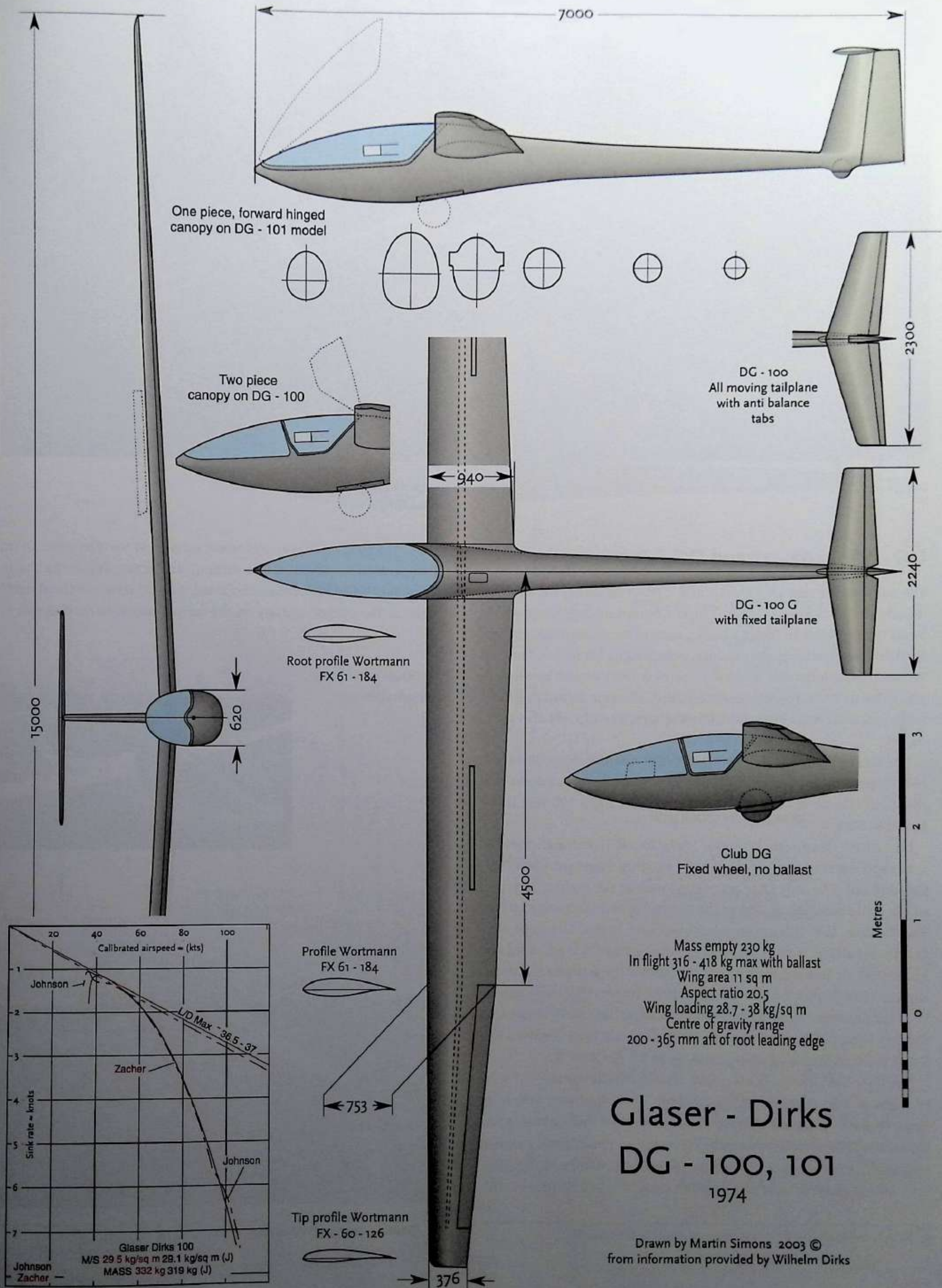
DG - 100 & 101

The DG - 100 first flew in 1974. The wing skins, as by now was the usual practice, were GRP with sandwich filling of plastic foam, with the main spar in resin-impregnated glass-fibre rovings. Wortmann wing profiles, also normal at this time, were used. There was capacity for 100kg of water ballast, which, the Company claimed, exceeded the ballast capacity of all other contemporary Standard Class sailplanes. The fuselage was a monocoque shell except for points of highly concentrated loads. An extra large retracting wheel, to keep the fuselage well off the ground, was offered as an option. The cockpit canopy was deep at the sides, giving an excellent view for the pilot. The control column was operated with a fore and aft horizontal hand motion through a parallel linkage, rather then the more usual control stick hinged at the base. This reduced the possibility of a pilot-induced-oscillation in rough air or when taking off, bouncing over rough ground. (Other designers, notably Hänle of Glasflügel, adopted the same idea, Hänle probably the first with the H - 401 Kestrel of 1968.) The tailplane was of the all-moving type with anti-balance tab but this was replaced by a tailplane with elevator in later production of the DG - 100G and - 101G.

The Company did not claim that the D-G 100 would be a contest-winning sailplane but emphasised that it was strong and safe, handled well in the air and was competitive in price. The performance was certainly superior to that of the Glasflügel Standard Libelle, which was at this time the most numerous type of sailplane in this class. The DG - 100 handled much more easily and was notable for its stability together with unusually responsive ailerons which allowed it to roll rapidly into and out of turns when thermalling. It proved very popular and did after all win the 1974 Austrian National Championships when flown by Harro Wodl. At the European 'Club Class' Championships in June 1982, many of the competitors flew the DG - 100.

It was intended to produce only about 100 examples because the factory was simultaneously preparing to build the DG - 200, a fifteen metre 'unrestricted' sailplane. However, more orders came in and production of the DG - 100 Elan began in 1979. Several minor changes resulted in the appearance of the DG - 100 and - 101 Elan series and the Club DG, which had a fixed undercarriage. A total of 105 was built at Bruchsal, and a further 221 at Elan.

The DG-100 prototype flying near its home base. (Factory photo)



Mass empty 230 kg
In flight 316 - 418 kg max with ballast
Wing area 11 sq m
Aspect ratio 20.5
Wing loading 28.7 - 38 kg/sq m
Centre of gravity range
200 - 365 mm aft of root leading edge

Glaser - Dirks
DG - 100, 101
1974

Drawn by Martin Simons 2003 ©
from information provided by Wilhelm Dirks

DG-400: Fritz Klein wave soaring south of Monterosa. The first cloud over the Po river plains is visible on the right. (Photo Claus-Dieter Zink)

DG - 200, 202 - 17 and DG - 400

The announcement in 1975 by the CIVV (Commission Internationale du Vol a Voile) that in World Championships there would be an unrestricted 15 metre Class of competition sailplane, encouraged all manufacturers to produce new designs for this.[32] The first World Championships in which the new class would be allowed was to be in 1978. For the Standard Class, the rule forbidding flaps was reinstated, and a new 'Club Class' championship was also introduced.

The Glaser - Dirks Company decided immediately to develop a new fifteen metre design. Limited factory space determined that this could be done only if production of the DG - 100 was transferred to Elan.

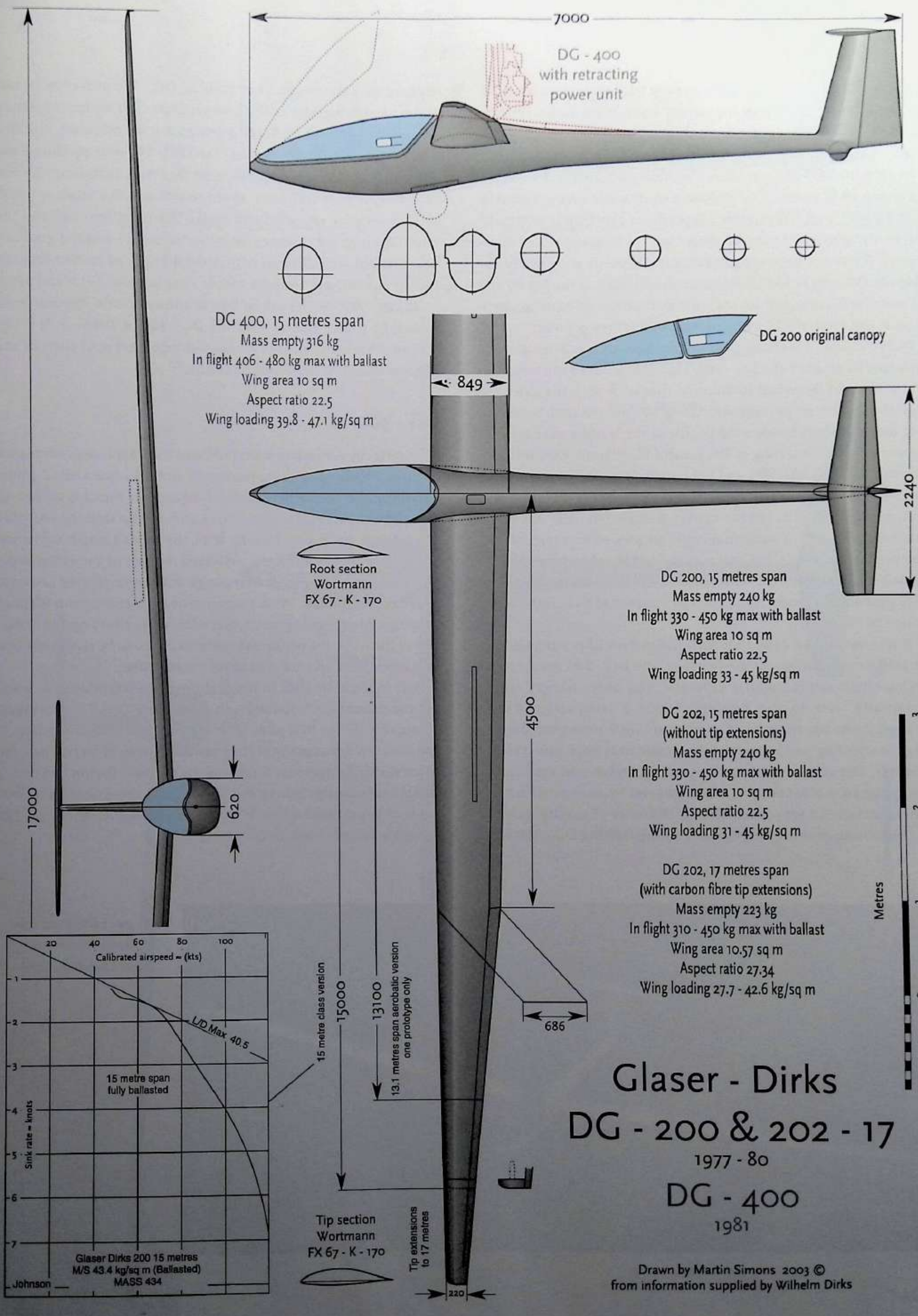
Like other designers, Wilhelm Dirks found it a straightforward matter to develop new wings for the existing Standard Class fuselage and tail. The only changes needed were at the point of junction of wing and fuselage, to accept the flapped Wortmann wing profile. This profile, 17% thick, extended from root to tip. The flaps were continued all the way to the fuselage where there was a sliding seal to prevent air leakage from the underside of the wing to the upper surface. The prototype flew in April 1977, by which time competitors had produced their own 15 metre designs. Several of these used thinner wing profiles, 15% in the cases of the SH Mini Nimbus, LS - 3 and the Glasflügel Mosquito, and 14,7% for the ASW 20.

The DG - 200, like its predecessor, was especially notable for safety features and comfort of the cockpit. Dick Johnson, when he came to test it at Caddo Mills in Texas, remarked that he had never flown a sailplane that was more comfortable. The control column operated with the same type of parallelogram linkage as the DG - 100. This popular feature was retained on future DG sailplanes. The flaps, trimmer, air brakes and wheel retraction handles were all on the left side, but there was no difficulty selecting and using them. The wheel brake handle was mounted, bicycle style, on the control column. The cockpit canopy on the early production models was in

The DG-202 17 metre span with carbon fibre spar

DG-100 at Tocumwal NSW Australia

32 – For some brief discussion of this decision see the article about the ASW - 20, p. 73.


7000
DG - 400
with retracting
power unit
DG 400, 15 metres span
Mass empty 316 kg
In flight 406 - 480 kg max with ballast
Wing area 10 sq m
Aspect ratio 22.5
Wing loading 39.8 - 47.1 kg/sq m
DG 200 original canopy
849
2240
Root section
Wortmann
FX 67 - K - 170
DG 200, 15 metres span
Mass empty 240 kg
In flight 330 - 450 kg max with ballast
Wing area 10 sq m
Aspect ratio 22.5
Wing loading 33 - 45 kg/sq m
DG 202, 15 metres span
(without tip extensions)
Mass empty 240 kg
In flight 330 - 450 kg max with ballast
Wing area 10 sq m
Aspect ratio 22.5
Wing loading 31 - 45 kg/sq m
DG 202, 17 metres span
(with carbon fibre tip extensions)
Mass empty 223 kg
In flight 310 - 450 kg max with ballast
Wing area 10.57 sq m
Aspect ratio 27.34
Wing loading 27.7 - 42.6 kg/sq m
4500
17000
620
686
Metres
0
1
2
3
20
40
60
80
100
Calibrated airspeed ~ (kts)
Sink rate ~ knots
-1
-2
-3
-4
-5
-6
-7
L/D Max 40.5
15 metre span
fully ballasted
Glaser Dirks 200 15 metres
M/S 43.4 kg/sq m (Ballasted)
MASS 434
Johnson
15 metre class version
15000
13100
13.1 metres span aerobatic version
one prototype only
Tip section
Wortmann
FX 67 - K - 170
Tip extensions
to 17 metres
220
Glaser - Dirks
DG - 200 & 202 - 17
1977 - 80
DG - 400
1981
Drawn by Martin Simons 2003 ©
from information supplied by Wilhelm Dirks

two pieces, the front section permanently built and sealed onto the fuselage. Later, to eliminate the canopy hoop frame which restricted the pilot's view slightly, a single-piece canopy, hinged at the front, was produced. This could be fitted retrospectively if required.

In 1978 the DG - 200 was offered with the option of tip extensions for a span of 17 metres. This yielded a worthwhile improvement in performance, especially at low airspeeds for climbing in thermals, but for competitions in the 15 metre class the long tips would be removed. It was not to be expected that the 17 metre wing would enable the DG 200/17 to compete successfully against the big 20 and 22 metre sailplanes, but for the pilot not concerned with competitions at this level, the 17 metre option became very popular.

In 1980 Glaser - Dirks decided to introduce carbon fibre into the structure to produce the DG - 200/17C. This reduced the weight of the wings and increased stiffness so that even with the extended tips, the maximum permitted airspeed was not reduced. Some minor modifications to the wing profile at the leading edge and improvements to the sealing of the control hinge lines, were incorporated in the DG - 202/17C, and the range of flap angles was also increased. More water ballast capacity was provided.

As an experiment to test the market, a single DG - 200 'Acroracer' was produced with a wing that could shortened to a span of 13.1 metres, for aerobatics. For ordinary soaring the short tips could be replaced by extensions to the full 15 metres. The type did not go into production. Production of all the varieties of DG - 200 reached a total of 192.

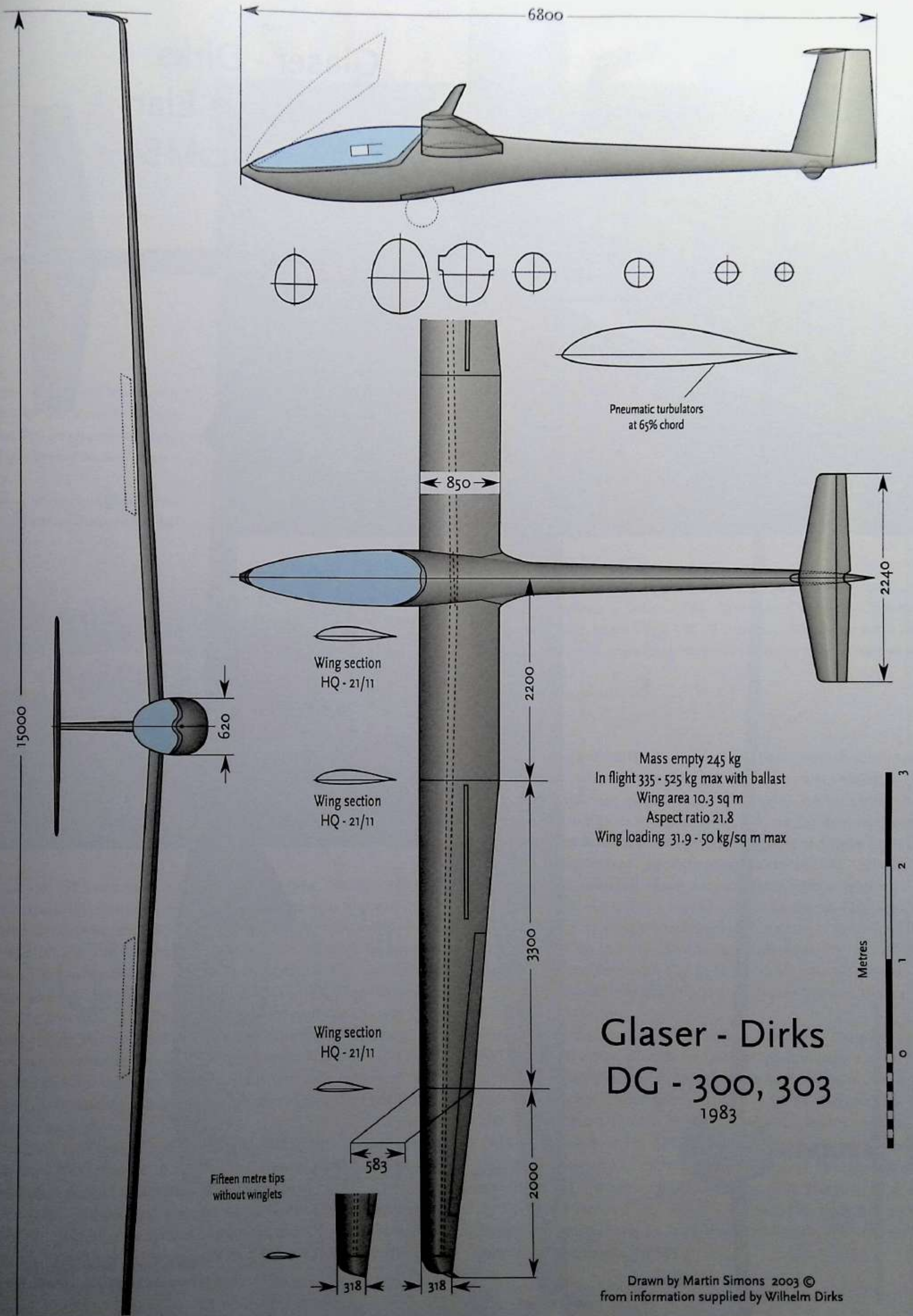
It was recognised early that with the carbon fibre wing and relatively small changes to the fuselage, the DG - 200 would make an excellent self-launching sailplane. The only changes visible externally were to the fuselage, where a compartment with hinged doors was required. Controls and instruments for deploying, controlling and retracting the power unit were added in the cockpit. The motor, mounted low on the pylon and driving the propeller by a toothed belt, was deployed by an electric motor. There was only a very small change of centre of gravity location on extending or retracting the unit so the existing DG - 200 wing required no adjustment. The resulting DG - 400 proved to be one of the most successful of the new generation of motor sailplanes. The engine was a 43 hp Rotax driving a tractor propeller. The first flight, by Walter Binder, was in May 1981. 290 were produced and numerous records were broken with this type, including the 500 km triangle 'pure sailplane' speed record at 170.6 km/h in 1988, with the engine retracted and sealed down. In New Zealand the World Records for distance by motor sailplane and the goal distance record were broken with 1039.8 km, and in Namibia the 100km and 300 km triangle speeds were broken, 191.9 and 176.9 km/h, in 1987. No less than five feminine World Records were broken by Ingrid Köhler with the DG - 400 in 1988 - 9. It is significant that more of this motorised type were sold than of the original DG - 200 from which it came.

DG - 300

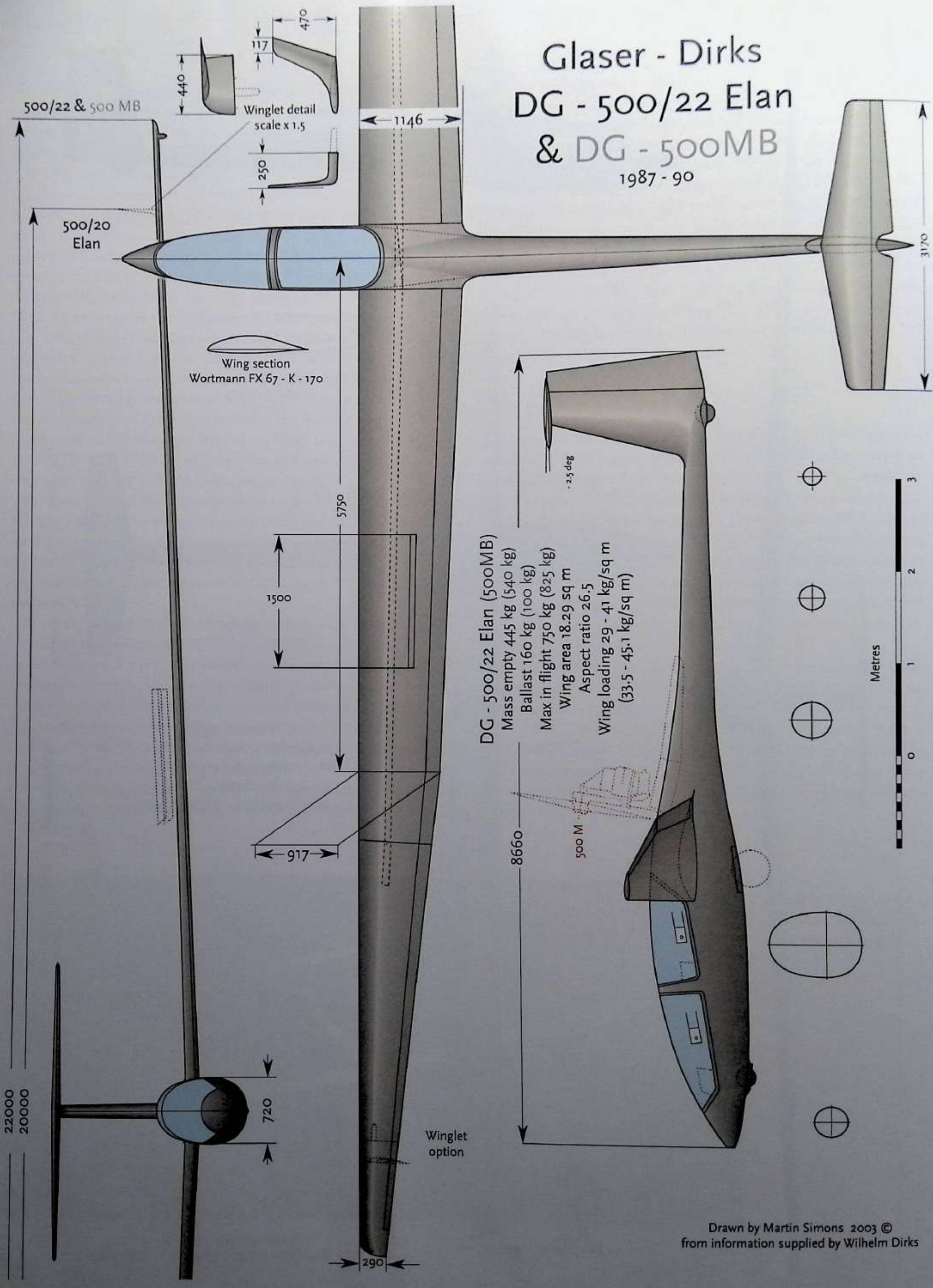
Discoveries by aerodynamicists indicated that sailplane performance could be improved by using pneumatic turbulators at critical points on wings and tails where laminar separation bubbles tended to form. The DG - 300 Standard Class sailplane replaced the DG -100. The fuselage was changed hardly at all, the over-all length shortened by 200 mm, retaining all the well-liked features of the earlier type. The wing was a completely new design with triple tapered plan and winglets as an option. With a new profile from Horstmann & Quast at Braunschweig, and turbulators at 65% of the chord on the underside of the wing, the performance was expected to be noticeably better. Carbon fibre was not used in the construction.

Tests in flight by Dick Johnson showed the importance of keeping the pneumatic turbulators in good condition. First measurements showed the best glide several points less than advertised. It was discovered that many of the pneumatic blow holes had become blocked, possibly because some over-enthusiastic person had used a compound when polishing the wings. In all there were about 900 holes of 0.6 mm diameter. When all these were cleaned out, the best glide achieved was 42:1.

DG-300: Erich Spiertz a few km north of Rieti in Italy (Photo Claus-Dieter Zink)



6800
Pneumatic turbulators
at 65% chord
850
2240
Wing section
HQ - 21/11
2200
15000
620
Wing section
HQ - 21/11
Mass empty 245 kg
In flight 335 - 525 kg max with ballast
Wing area 10.3 sq m
Aspect ratio 21.8
Wing loading 31.9 - 50 kg/sq m max
3
2
1
0
Metres
3300
Wing section
HQ - 21/11
Glaser - Dirks
DG - 300, 303
1983
583
Fifteen metre tips
without winglets
2000
318
318
Drawn by Martin Simons 2003 ©
from information supplied by Wilhelm Dirks



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from information supplied by Wilhelm Dirks

Right: DG-500: Peter Teutsch and a Passenger over Terminillo Mountain near Rieti, the geographical centre of Italy (Photo Claus-Dieter Zink)

Below: DG-500 front fuselage showing the non retractable front wheel.

Flown in 1983 and entering production in 1984, the DG - 300 and later the DG - 303 Elan with winglets and several important improvements to the cockpit safety features, was very successful.

The 1983 World Championships were dominated to an extraordinary extent by the LS - 4 and 4A sailplanes. In the top 16 there were 13 LS 4s and three pre-production DG - 300s. Three days were won by the DG - 300. There was no doubt that the DG was fully competitive, but the pilots could not maintain the necessary consistency to take the Championship. Markku Kuittenen (Finland) led the field for two days but slipped down to 14th at the end, Baar Selen (Netherlands) was more consistent and placed seventh without any daily wins.

In 1985 the dominant aircraft was the SH Discus, but once again the DG - 300 appeared in the top ten. George Moffat flew one to third place in the US Nationals in the same year.

The DG - 303 was still competing in World Championships in 1995. A specially strengthened version, the DG - 300 Elan Acro was also produced. This was stressed for the full aerobatic routine, even with the full fifteen metre wing span. It was first flown in 1992 and 28 were built. A DG - 300 Elan Club and Club Acro were developed. More than 490 of the DG - 300 series were sold and at the time of writing the type remains in production at the Elan factory.

DG - 500

The prototype DG - 500 two seater, with flaps, flew first in March 1987 and was joined soon by the self-launching DG - 500M, with a Rotax 535 retracting motor. These were intended for Open Class competitions and cross-country flying. During the next few years a series followed from both the parent company and from Elan; the DG - 500/20, 20 metres span with winglets and the DG - 500/22, 22 metres span, no winglets. Both were available with or without motors. There followed in 1989 the DG - 500 Elan trainer, fully aerobatic with no flaps or winglets and fixed undercarriage. Then came the DG - 500/20 Elan and DG - 500/22 Elan. Subsequently the DG -505 Elan Orion was offered with 17.2 or 18 metre wing tip extensions.

All these aircraft were constructed partly or wholly in carbon-fibre reinforced plastic.

By the time these impressive two-seaters appeared, there were several competitive types already on the market. Production at the DG factories was fairly slow with two-year waiting lists. Sales were comparatively modest. Twenty-one of the DG - 500M, fifteen of the DG 500 Elan Trainer and nine of the DG - 500/22 Elan were sold. In 1994 there followed the DG - 505 Elan Orion which had interchangeable tips for 17.2 metres fully aerobatic, or 18 metre span for training, or 20 metres for cross country flying. The total of all DG 500 versions reached 186. A DG - 500 in 1995, with one flight, broke the world records for both absolute altitude of 11,570 metres and for gain of height, 10,545 m.

DG 600

Almost contemporaneously with the DG - 500 in 1987, the Company was working on the DG - 600 for the Fifteen Metre Class, but with optional tip extensions to 17 or 18 metres, and a self-launching DG - 600M version to fly late in 1989. The fuselage shape was slightly improved and the wings were entirely new, using flapped profiles designed by the Braunschweig aerodynamicists, Horstmann & Quast. The profiles chosen for the DG - 600 were very much thinner than those of the DG - 200 series, only 12%, with zigzag turbulators on both upper and lower surfaces, at 68% and 82% of the chord respectively, except for the tip extensions. In plan, the wings were tapered in two stages, with the trailing edge straight. The aspect ratio was slightly less than that of the DG - 200.

The prototype flew in 1987 only four weeks after the DG - 500, and was found entirely satisfactory although the handling was not quite so easy as the previous DG products had been.

When the first examples of the new type arrived at Caddo Mills in Texas, Dick Johnson carried through a long series of flight tests, with and without the long tips, and made drag probe measurements at several points to examine the role of the turbulators. It was concluded that the factory had placed these correctly. Moving them, either forwards or backwards, tended to increase the drag. The omission of turbulators from the tip extensions was evidently correct too, as the smaller chord in these areas of the wing altered the Reynolds numbers and probably changed the character of the laminar separation zone.

In flight the DG - 600 did not exhibit the docile character of the earlier DG aircraft, although the performance was outstanding when flown by an experienced pilot. Extending the wings to 17 metres with winglets improved the handling considerably but the DG - 600 did not achieve all that had been hoped for.

There was a factory fire in 1992 when only 112 had been built. The fire damaged the vital moulds so seriously that production stopped at this time.

DG - 800

The DG - 700 was a project that never left the drawing board. The DG 800 was at first planned as an improved version of the DG - 600, with new wing profiles coming from the Delft University group under Professor Loek Boermans. These promised more docile handling than the thin HQ profiles of the DG - 600. The same fuselage and tail unit were used and provision was made for a self-launching power unit and for both 18 and 15 metre span interchangeable tips and winglets.

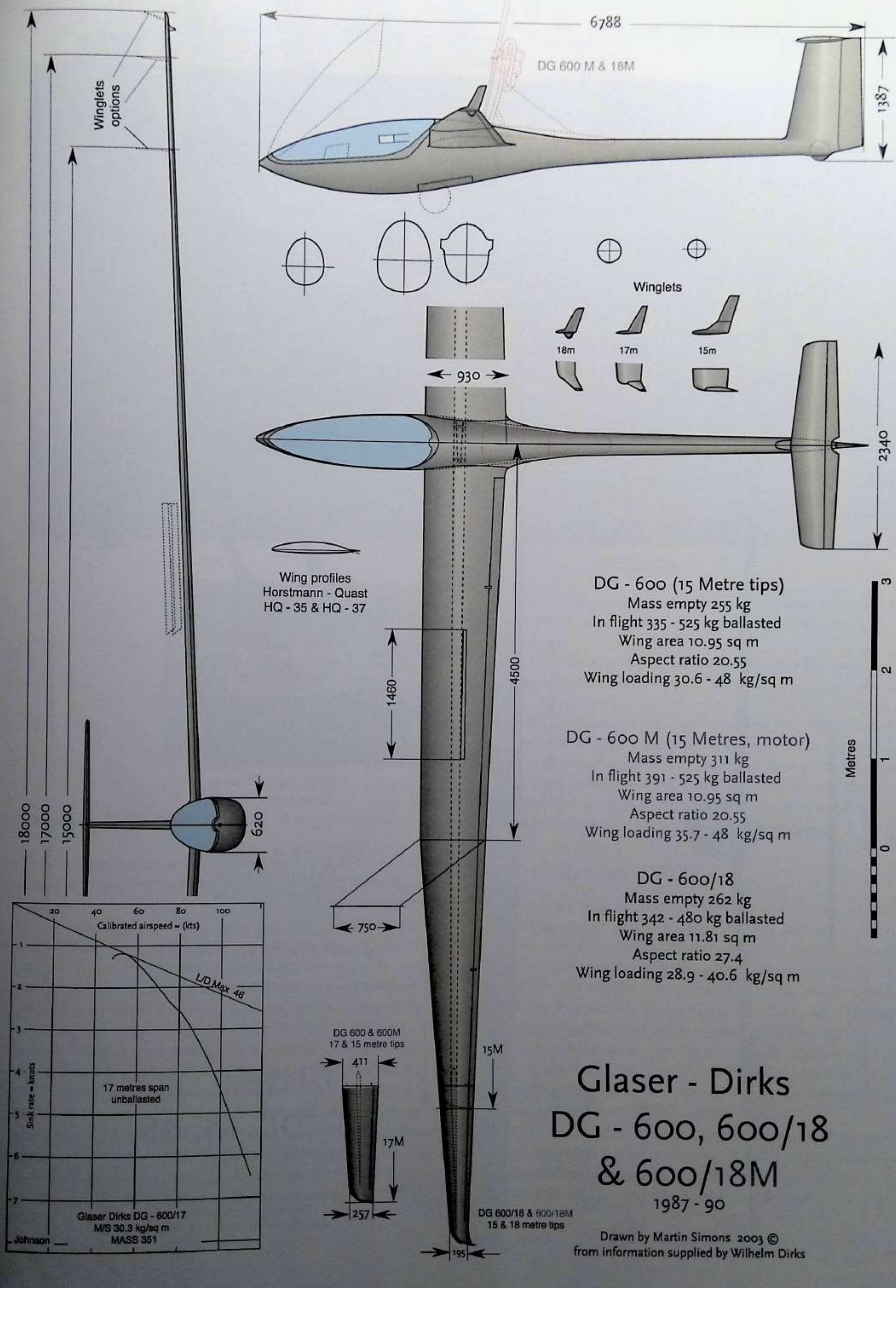
The prototype flew in May 1993 and two of the 'pure' sailplane version, DG - 800S, were completed in time to fly in the 1993 15 metre World Championships in Sweden. The first five DG - 800A were already flying with Rotax motors when the Rotax Company decided not to produce more engines for self-launching sailplanes. Glaser Dirks re-designed the power compartment to take the English two-stroke Midwest 50 motor, but this also ceased production. After building another five aircraft, Glaser Dirks could not deliver more of the DG - 800B. This precipitated the crisis leading to bankruptcy in 1996.

After the Webers and Gerhard Wolff took over and re-named the Company, the new Solo 2625 motor became available and, after many early teething problems, could be used. The DG - 800B resumed production after an interval of a few weeks. Further improvements, the most visible externally being an enlarged vertical tail surface, resulted in the DG - 808 which entered production after the year 2000.

An interesting innovation in the interests of pilot safety was the optional rescue system, named NOAH. After a mid-air collision or major structural failure, the pilot is sometimes unable to get out of the glider cockpit to use the parachute. The NOAH is an inflatable cushion, like a large air bag, which, in such an emergency, pushes the pilot up and out of the seat.

At the time of writing, the DG - 800 and - 808 remain in production and have established a very good record in 15 and 18 metre Class championships.

Only one DG-600 competed in the World Championships, St Auban, in 1997. The pilot finished about half way down the 15 metre list.



DG - 600 (15 Metre tips)
Mass empty 255 kg
In flight 335 - 525 kg ballasted
Wing area 10.95 sq m
Aspect ratio 20.55
Wing loading 30.6 - 48 kg/sq m

DG - 600 M (15 Metres, motor)
Mass empty 311 kg
In flight 391 - 525 kg ballasted
Wing area 10.95 sq m
Aspect ratio 20.55
Wing loading 35.7 - 48 kg/sq m

DG - 600/18
Mass empty 262 kg
In flight 342 - 480 kg ballasted
Wing area 11.81 sq m
Aspect ratio 27.4
Wing loading 28.9 - 40.6 kg/sq m

Glaser - Dirks DG - 600, 600/18 & 600/18M

1987 - 90

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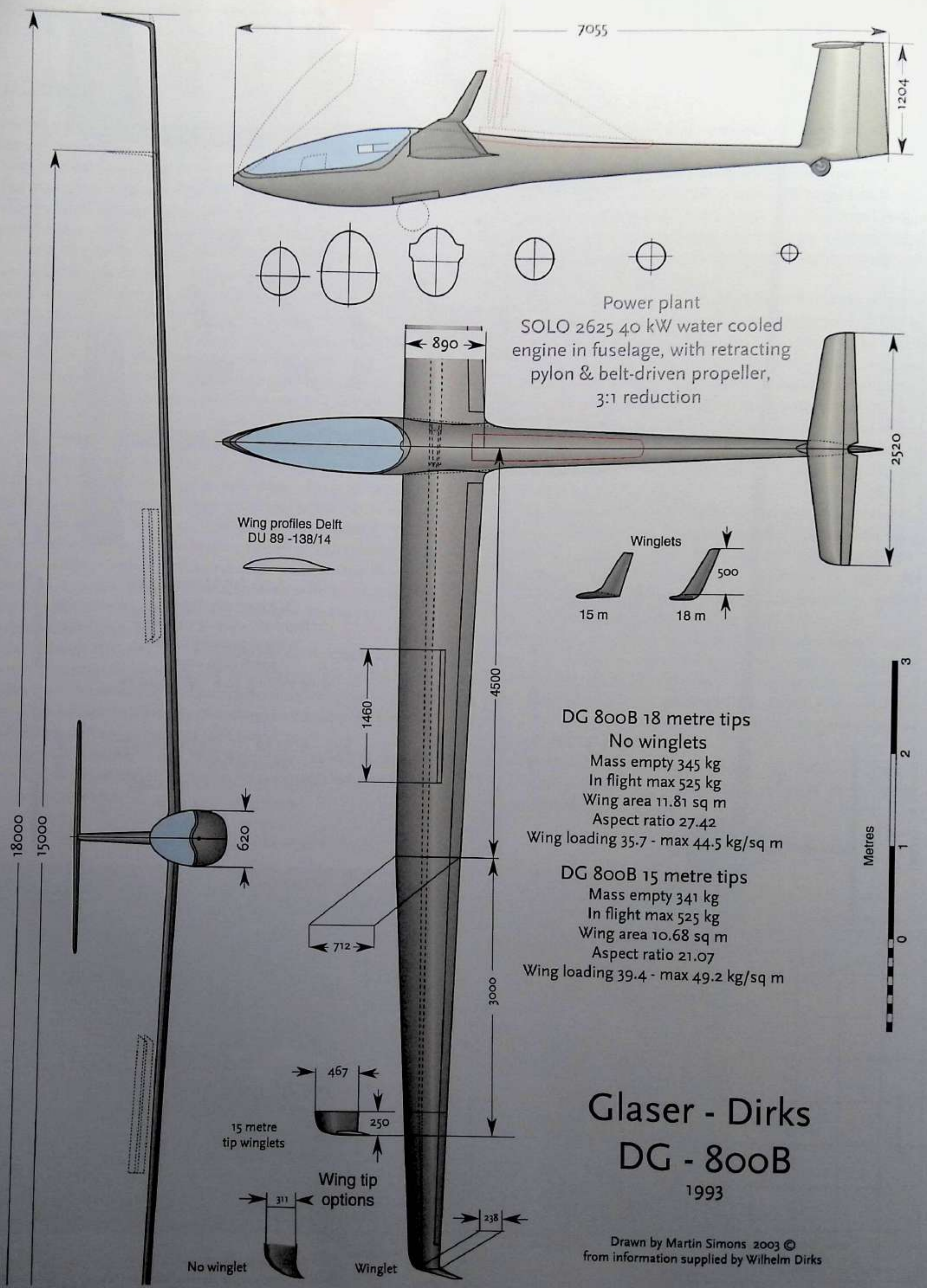

7055
1204
Power plant
SOLO 2625 40 kW water cooled engine in fuselage, with retracting pylon & belt-driven propeller, 3:1 reduction
890
2520
Wing profiles Delft DU 89 -138/14
Winglets
500
15 m
18 m
4500
1460
18000
15000
620
712
3000
467
250
15 metre tip winglets
Wing tip options
311
238
No winglet
Winglet
Metres
0
1
2
3
DG 800B 18 metre tips
No winglets
Mass empty 345 kg
In flight max 525 kg
Wing area 11.81 sq m
Aspect ratio 27.42
Wing loading 35.7 - max 44.5 kg/sq m
DG 800B 15 metre tips
Mass empty 341 kg
In flight max 525 kg
Wing area 10.68 sq m
Aspect ratio 21.07
Wing loading 39.4 - max 49.2 kg/sq m
Glaser - Dirks
DG - 800B
1993
Drawn by Martin Simons 2003 ©
from information supplied by Wilhelm Dirks

Above: DG-800 in the wave systems south of Mont Blanc. The view is to SW with the main summit of Ecrin directly under the cockpit. (Photo Claus-Dieter Zink)

Left: DG-800 at Omarama New Zealand during the 1995 World Championships. Gerard Lherm, the French pilot, placed fifth.

Glasflügel

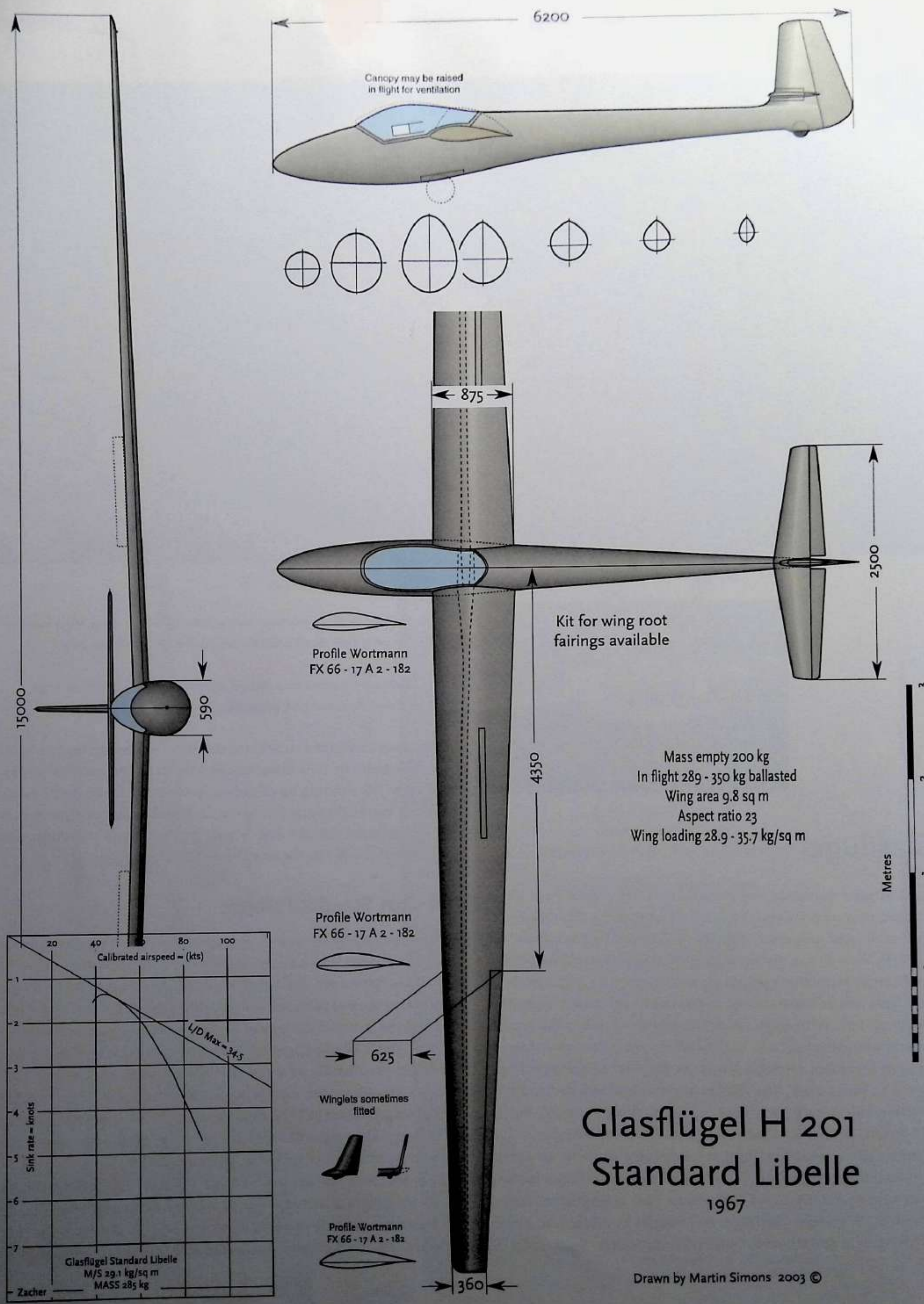
The Glasflügel company was founded by Eugen and Ursula Hänle who had been chiefly concerned with producing GRP blades for fans, rotors, and propellers but who built their first sailplane, the H - 30, in their home, flying it in 1962. They entered the field of professional sailplane manufacture with the H - 301 Libelle of 1964. This was an outstanding success and continued in production until 1969. With flaps, retracting wheel and tail braking parachute; it was excluded from the Standard Class Championships. It was later regarded, retrospectively, as the first of the new unrestricted 15 metre class. The Hänles afterwards developed and produced a series of sailplanes and the Company flourished, but in 1975 Eugen Hänle was killed in a powered plane accident.

Schempp Hirth and Glasflügel subsequently came to an agreement enabling production to continue at the Glasflügel factory under supervision by Klaus Holighaus. This arrangement lasted only until 1979 when Glasflügel was bought by a Brazilian group with long term ambitions to build GRP car bodies. Production of sailplanes continued in Schlattstal for some time but no car bodies were built. In 1981 disagreements between the shareholders resulted in the winding up of the company and closure of the factory. The HpH Company in the Czech Republic rescued the last of the Glasflügel designs and began production of a modernised Glasflügel H - 304 in the late 1990's.

H - 201 Standard Libelle

The Standard Libelle made its first flights in 1967. It was very similar in general appearance to the famous H - 301 but with a different wing, no flaps and a fixed undercarriage. The Schempp -Hirth type air brakes opened both above and below the wing. When the CIVV altered the Standard Class rules to allow retracting wheels and water ballast, the St Libelle was quickly adapted to the change and many of the first production were retrospectively modified. The H - 201B with large air brakes on the upper side only and slightly larger tailplane, appeared in 1971. In place of the balsa wood filling for the sandwich skins of the wing, plastic foam was used, which was more resistant to changes of humidity and temperature.

The St Libelle had many advantages for clubs and private owners. It was available at a good price. It was light and easily handled on the ground, capable of being rigged or de-rigged by two or three people. The cockpit was comfortable for the pilot of average or


6200
Canopy may be raised
in flight for ventilation
875
2500
Kit for wing root
fairings available
Profile Wortmann
FX 66 - 17 A 2 - 182
15000
590
4350
Mass empty 200 kg
In flight 289 - 350 kg ballasted
Wing area 9.8 sq m
Aspect ratio 23
Wing loading 28.9 - 35.7 kg/sq m
Metres
0
1
2
3
Profile Wortmann
FX 66 - 17 A 2 - 182
625
Winglets sometimes
fitted
Profile Wortmann
FX 66 - 17 A 2 - 182
360
Calibrated airspeed – (kts)
20
40
60
80
100
Sink rate – knots
-1
-2
-3
-4
-5
-6
-7
L/D Max = 34.5
Glasflügel Standard Libelle
M/S 29.1 kg/sq m
MASS 285 kg
Zacher
Glasflügel H 201
Standard Libelle
1967
Drawn by Martin Simons 2003 ©

John Neracher in his Libelle in the Bernese Oberland some km east of his home base at Saanen (Photo Claus-Dieter Zink)

slightly more than average size, with good view all round, and an excellent ventilation system, especially useful in hot, sunny climates. The cockpit canopy could be raised slightly in flight to admit air at the front. There was doubtless some extra drag when the canopy was opened in this way but the cool pilot was likely to fly more accurately.

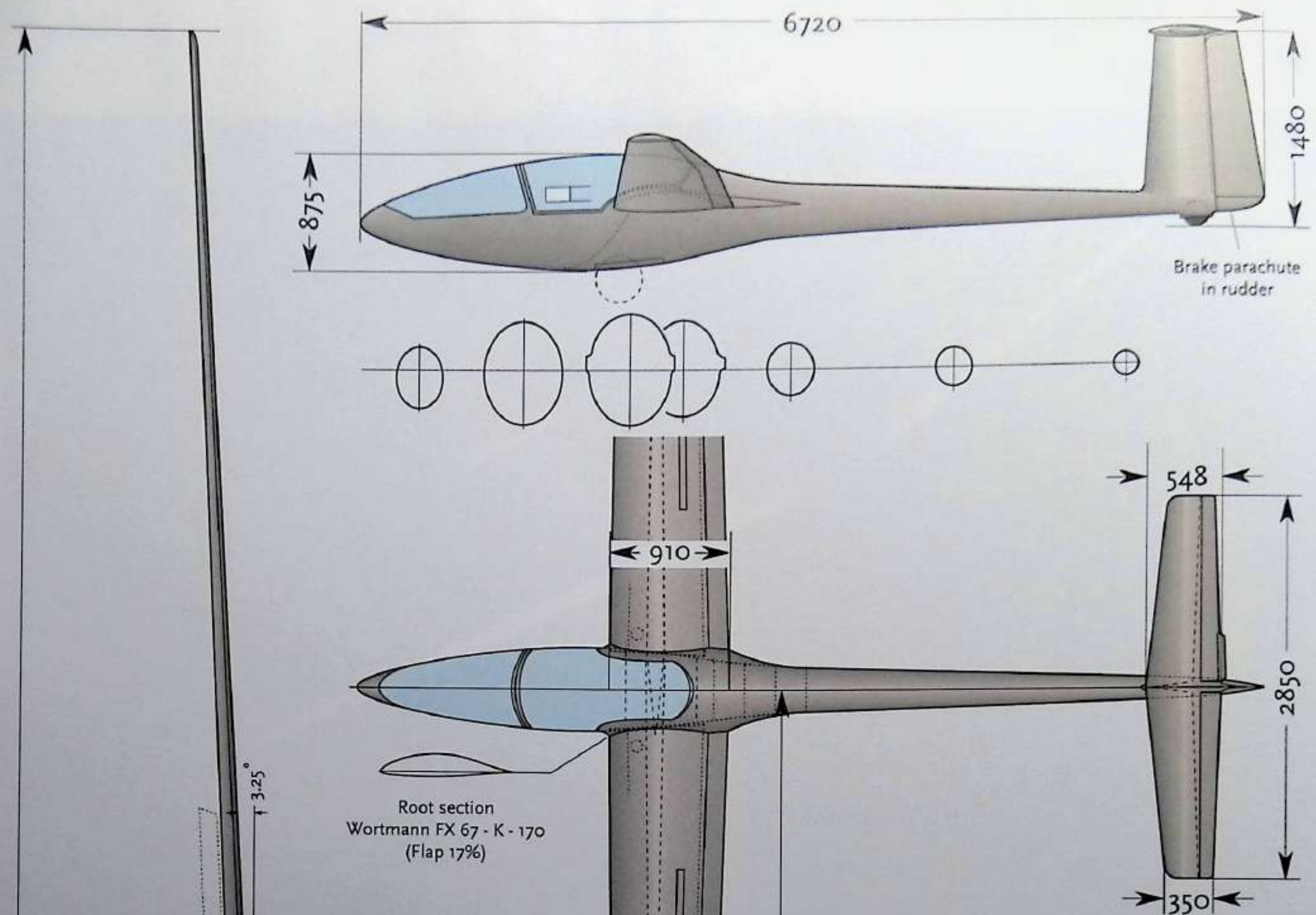
The H - 201B was an immediate success on the market. For several years it numerically dominated the club scene but the Libelle never won any of the major Championships. It was often claimed that the performance in competitions was not as good as the rival products such as the Standard Cirrus and LS - 1. In its defence the aerodynamicist Richard Butler argued that the polar curve was at least as good as the rival aircraft if the wing loadings were the same. Despite this, flight test results indicated the best glide about 34:1 and the rivals were one or two points at least better. The H - 201 was not entirely easy to fly accurately. When attempting to roll quickly into or out of a turn the rudder was not powerful enough to correct the adverse yaw. To fly tidily without skid or slip required constant care. Production ceased in 1974 but Hänle continued to develop new versions. The Libelle H - 202, - 203 and - 204 all flew but did not go into production. These led directly to the later development of the Club Libelle, Hornet and Mosquito.

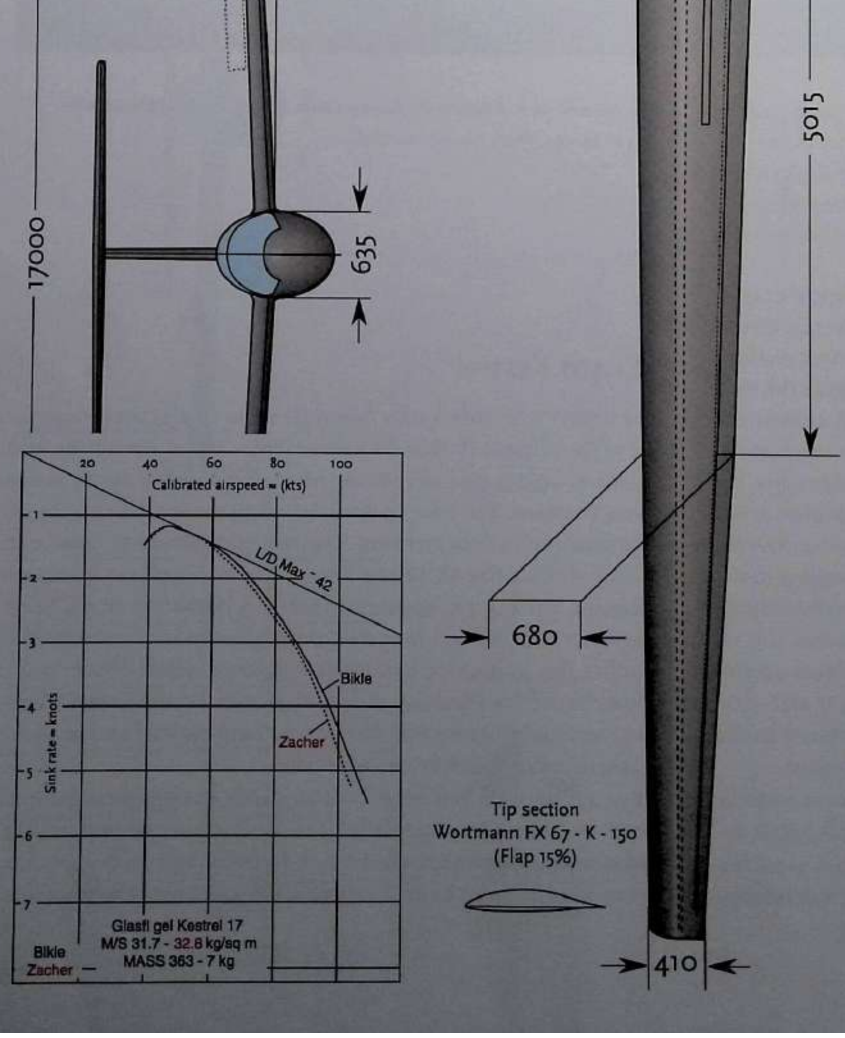
In more recent years wing tip extension kits have become available for the St Libelle allowing it to fly with 17 metres span. Winglets are also often fitted. More extensive modifications that yield some improvements in performance include the addition of wing root fairings.

H - 401 Kestrel

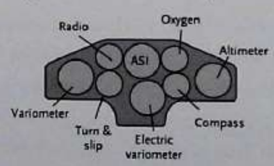
The Kestrel was intended by Eugen Hänle to be a 17 metre successor to the original H - 301, 15 metre Libelle. When it made its first flights in 1968 it was, next to the AS 12 and possibly the 18 metre Swiss Diamant, the best Open Class sailplane available, though this situation did not last long. The best glide ratio was measured at 42:1. Unlike the AS 12 the Kestrel had adequate air brakes of Schempp Hirth type, opening above and below the wing. They were later changed to top surface only. There was a very effective landing flap and, in case of dire necessity, a reliable brake parachute. Unlike the Diamant, the pilot's seating position was moderately reclined and very comfortable, rather than flat on the back. All these points found favour with pilots.

For a pilot who had been used to flying the previous generations of Open Class sailplanes the Kestrel cockpit was full of levers and knobs which must be understood and used correctly. There were of course the standard main controls. The stick was





Typical instrument panel



Mass empty 272 kg
Ballast 50 kg
In flight 363 - 400 kg
Wing area 11.58 sq m
Aspect ratio 25
Wing loading 31.3 - 34.5 kg/sq m

Glasflügel H 401 Kestrel

1968

Drawn by Martin Simons 2003 ©

Kestrel hired from Klaus Ohlmann west of Guillaume Southern France (Photo Claus-Dieter Zink)

on a parallel fore and aft linkage making it less likely that the pilot would jerk the elevator in rough air or when taking off. Hänle was apparently the first to introduce this on a sailplane. The trimmer was a highly convenient small knob on the stick. A single press with a finger tip set the trim and held it until the pilot pressed again at a new elevator position. There was the usual tow release knob, airbrake handle, undercarriage retraction handle and wheel brake. The rudder pedals were adjustable – another handle. There was a lever for the camber flaps, which could be set at five different positions. In addition there was a special lever which lowered the flaps by 40 degrees for landing. A handle could be pulled to deploy the braking parachute. The water ballast release valve was rather awkwardly placed behind the pilot's head. There were two small hand pumps to inflate the seat cushion under the knees, the seat back was adjustable in flight with another handle, there were cockpit canopy jettison handles, and all the usual switches and dials on the instrument panel, now itself a complicated affair with electric variometers, and multi channel radio. Oxygen breathing apparatus might be added.

Once all the features were comprehended, the Kestrel was very easy to fly, had no vices, and performed well. Some reservations were expressed by influential American pilots who found the Kestrel did not climb as well as expected. It was suspected that the fuselage contraction behind the cockpit had been overdone slightly. The total number of Kestrels built by Glasflügel was a relatively modest 129.

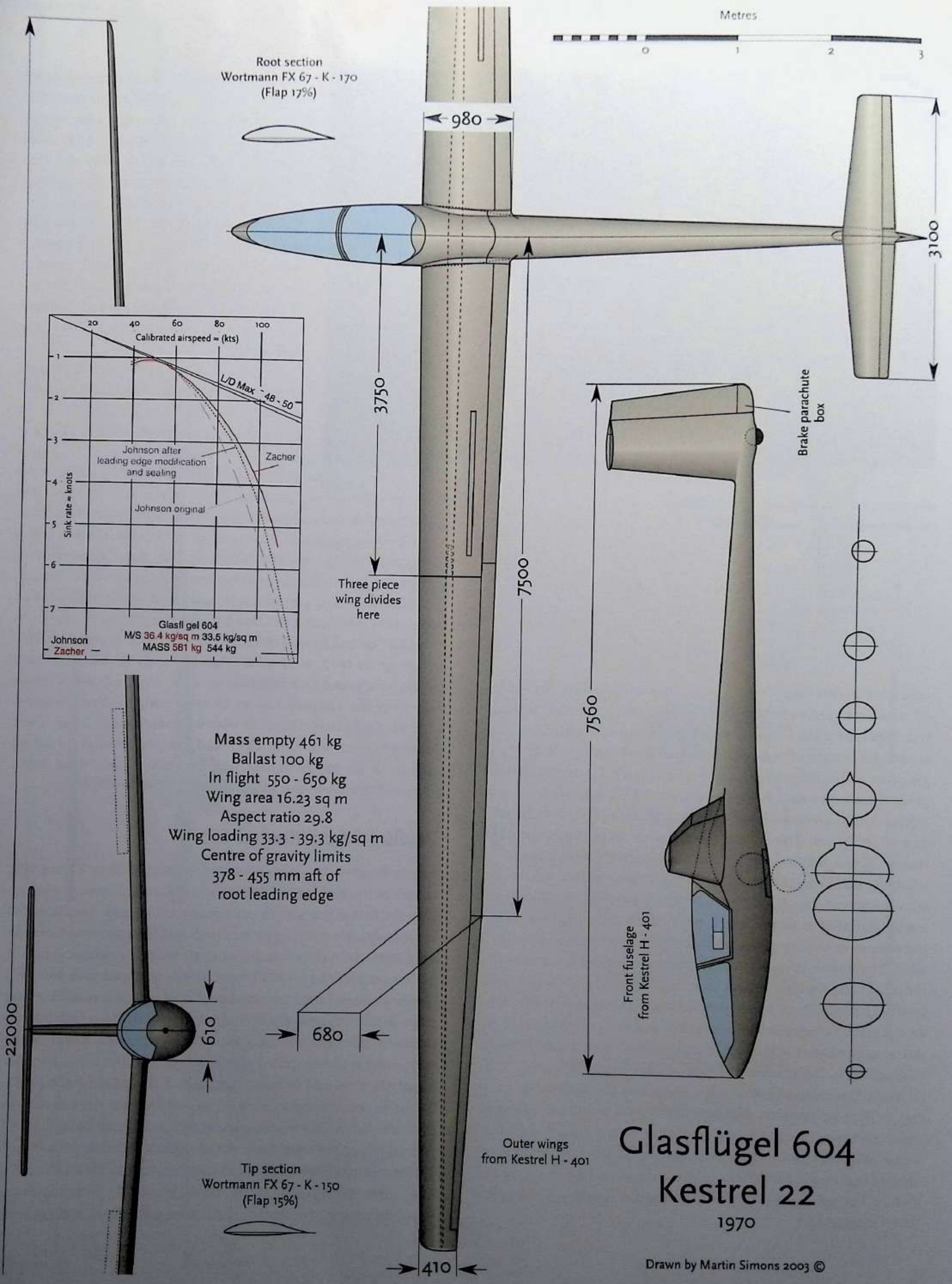
In major competitions the Kestrel soon came up against the ASW 12 and some of the new very large span sailplanes, one of these, the 22 metre Glasflügel 604, came from the same factory. In 1970 the first Schempp-Hirth Nimbus also with a span of 22 metres, won the World Championships, flown by George Moffat. ASW 12s flown by Hans Werner Grosse and Michel Mercier were second and third. Fourth came a Kestrel 19 flown by George Burton. This aircraft was a standard Kestrel from Glasflügel but with a metre extension spliced into each wing.

Burton was newly appointed Managing Director of Slingsbys, the English manufacturer. He negotiated with Hänle to build the Kestrel under licence. The first one built in England flew in 1970. Flight tests were carried out with wool tufts on the centre section and fuselage. These indicated that there was indeed some airflow separation at low speeds. With help from Professor Wortmann and Dieter Althaus in Stuttgart University, a redesigned fairing over the centre section did a good deal to smooth the flow. Slingsbys went on to build more of the Kestrel 19. These achieved considerable success in competitions and broke many National and some International records, most notably the Out and Return distance flown in New Zealand by Dick Georgeson in 1972, 1001.4 km. This was the first time 1000 km had been exceeded by a sailplane on a pre-declared course. More than 90 of the Slingsby Kestrel 19 were sold, but the Company made no profit from them. In World Championships the larger sailplanes were still dominant and, in an attempt to break through, a 22 metre Kestrel was developed. Two were built. These, unfortunately had little success.

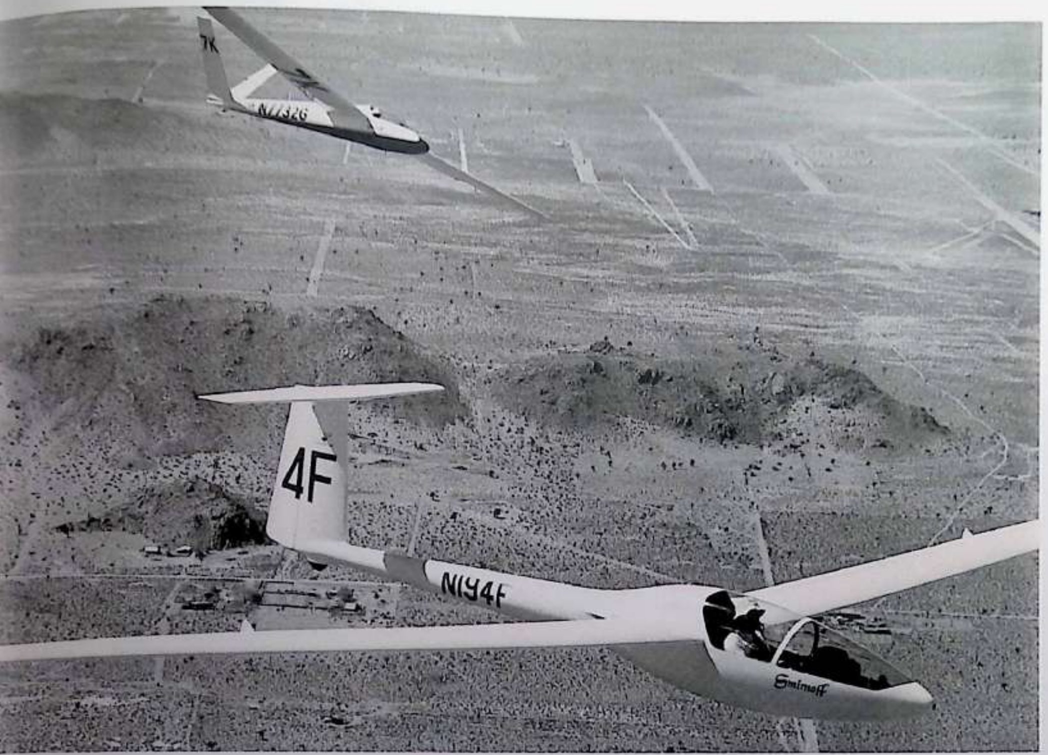
Glasflügel 604 'Kestrel 22'

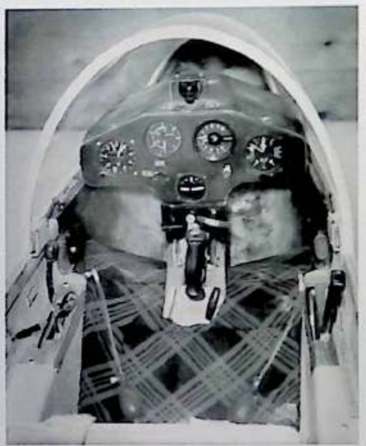
The Glasflügel 604, sometimes called the Kestrel 22 or Kestrel 604, was one of the first GRP sailplanes with 22 metres span. It was certainly the first of this size to enter production. Hänle had intended the prototype as a test aircraft for a proposed large two seater but the single seater seemed promising enough to justify production as it was. It resembled the H - 401 Kestrel in general appearance, but with a longer fuselage, larger tail unit and longer wing it was really a new design, highly impressive in both size and weight. Water ballast tanks were provided to take 100 kg. With a three-piece wing, handling the heavy centre section required a large, strong crew, but a special trailer system was produced to make rigging and de-rigging much easier. Like the Kestrel, the ailerons were coupled with the flaps to change the camber across the whole span. As well as large air brakes on the upper surface of the wing, there was an optional tail drag parachute.

The prototype was ready for Walter Neubert to fly in the 1970 World Championships at Marfa, Texas. He did fly there but had a very unfortunate experience on the first day, which was an 'area



Metres
0
1
2
3
Root section
Wortmann FX 67 - K - 170
(Flap 17%)
980
3100
3750
Brake parachute box
Calibrated airspeed = (kts)
20
40
60
80
100
L/D Max ~ 48 - 50
Johnson after leading edge modification and sealing
Zacher
Johnson original
Sink rate = knots
1
2
3
4
5
6
7
Glasfl gel 604
M/S 36.4 kg/sq m 33.5 kg/sq m
MASS 581 kg 544 kg
Johnson
Zacher
Three piece wing divides here
7500
7560
Mass empty 461 kg
Ballast 100 kg
In flight 550 - 650 kg
Wing area 16.23 sq m
Aspect ratio 29.8
Wing loading 33.3 - 39.3 kg/sq m
Centre of gravity limits
378 - 455 mm aft of
root leading edge
Front fuselage from Kestrel H - 401
22000
610
680
Outer wings from Kestrel H - 401
Tip section
Wortmann FX 67 - K - 150
(Flap 15%)
410
Glasflügel 604
Kestrel 22
1970
Drawn by Martin Simons 2003 ©





Above: Ken Briegleb flying the Kestrel 17 before the transcontinental Smirnoff Derby. The other sailplane is the SHK flown by Dan Pierson

Right above: Ingenious Hänle rigging system here shown with the Kestrel 17. The water ballast tap is behind the pilot's head.

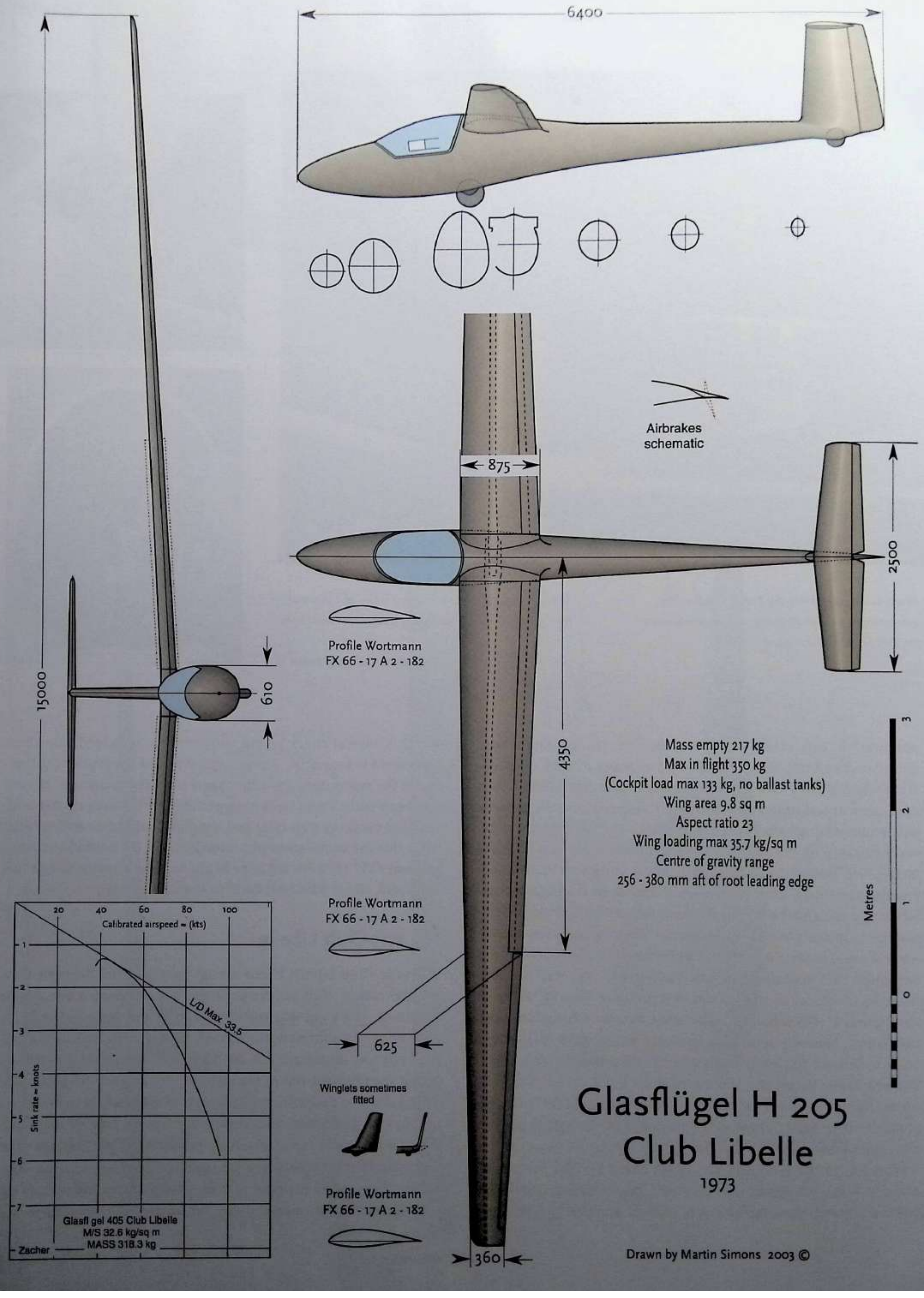
Right below: Cockpit of Kestrel 17

distance' or 'cats cradle' task. Six remote turning points were nominated and the pilots had to visit as many as they could, in any sequence they chose, to accumulate distance points. They were more or less obliged to continue flying late into the evening and land near dusk after a final glide from the last thermal. Neubert's distance of 483 km was third best for the day by a few kilometres. He landed in failing light at an isolated ranch which proved to be totally deserted. He spent the night sleeping uncomfortably in the glider cockpit. His crew found him next day but he and the sailplane got back to Marfa too late to achieve any worthwhile score. Losing a day at the beginning of a Championship is enough to ruin anyone's chances. Neubert did very well to climb the score sheet, day by day, to end in sixth place. George Moffat in the Nimbus 1, which had the same span, became Champion. After the contest Neubert remained in Texas to do more flying and broke the World 100 km triangle record with a speed of 155 km/h. Two years later he set the 300 km triangle record at 153 km/h in Africa. Hänle put the H - 604 into production. In the 1974 Championships Bert Zegels, the Belgian pilot, flew an H - 604 to second place but Moffat, now in a Nimbus 2, won again.

When, in 1977, an H - 604 was flight tested by Dick Johnsons' group in Texas, the results were excellent, but at high airspeeds the 604 did less well than the 20 metre ASW 17 and the 20.3 m Nimbus 2. A careful check of the wing profiles indicated that there were some inaccuracies. These may have been the result of shrinkage of the resins during the four years since this particular aircraft had been built. These faults were rectified by building up the leading edge contours with filler and templates, and some re-finishing. After this the H - 604 was improved but still fell behind the Nimbus and ASW 17 in the high speed glides. After the first dozen had been sold, Hänle withdrew the type from production.

H - 205 Club Libelle

With the Club Libelle Hänle aimed to satisfy the demand for a simple, robust club sailplane of good performance but docile handling. The wing was aerodynamically the same as the St Libelle and the performance not much inferior. The area of the vertical tail was increased. A T tail improved the pitch stability by taking the tailplane out of the wake of the wing, at the same time decreasing the probability of damage when landing in tall grass or crops. To give more clearance for the tips on take off and landing, the wing was raised to a high position on the fuselage. The Schempp-Hirth air brakes were replaced by large trailing edge brakes. These were highly effective, though some instructors expressed reservations about them. When deployed they increased



Glasflügel H 205 Club Libelle

1973

Mass empty 217 kg
Max in flight 350 kg
(Cockpit load max 133 kg, no ballast tanks)
Wing area 9.8 sq m
Aspect ratio 23
Wing loading max 35.7 kg/sq m
Centre of gravity range
256 - 380 mm aft of root leading edge

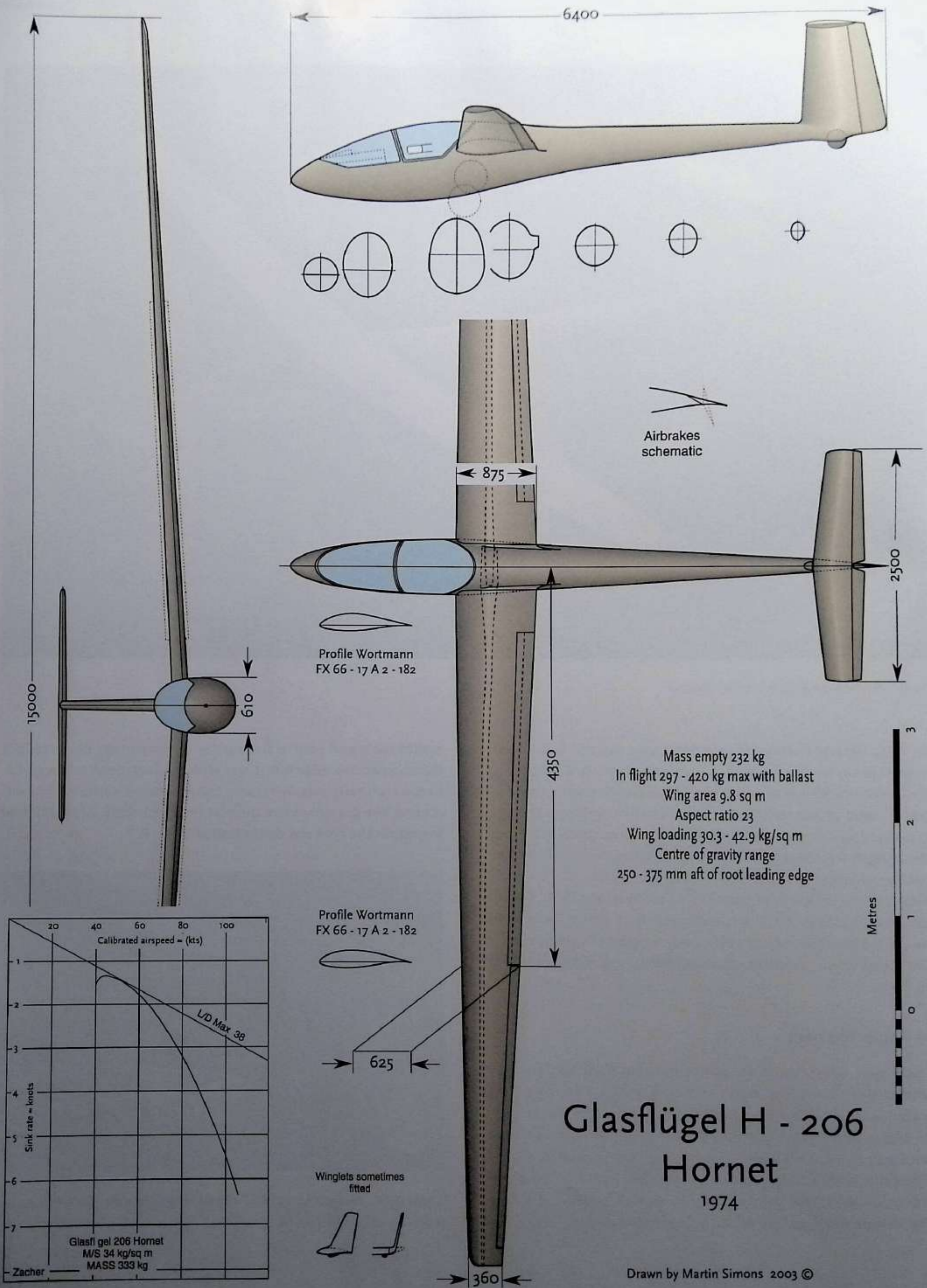
H 205 Club Libelle showing the airbrakes deployed

the wing lift and lowered the stalling speed slightly. If an inexperienced pilot, fearing an undershoot, closed the brakes suddenly there was a sudden loss of lift and instead of extending the glide, height could be lost suddenly. This had to be emphasised before a first flight in the type. A non retracting main wheel was fitted. The cockpit was enlarged to suit a greater range of pilots. Production began after the first flight in 1973 and a total of 171 was produced before production ended in 1976. Research by R. E Baker, reported to OSTIV in 1995, indicated that zigzag turbulators placed at 55% of the chord could improve the performance of the Club Libelle and, possibly, other sailplanes using the same wing profiles.

H - 206 Hornet

The Hornet, a Standard Class competition sailplane, and the Club Libelle, were developed more or less together. The wing, with brakes, and tail unit were identical but the Hornet was stressed for higher maximum flight speeds and equipped with water ballast tanks to hold 60 litres. The fuselage was improved aerodynamically with a fully contoured canopy and the wing was mounted lower. The landing wheel was retractable. The first flights were in December 1974. In service the Hornet, which was comfortable and easy to fly, was thought by many pilots to lack the competitive edge but it was widely recognised as a well-behaved club sailplane. A version incorporating carbon fibre was offered but did not revive interest in the aircraft. After 112 had been built the type was discontinued in 1979.

H 206 Hornet Standard Class sailplane with the same wing as the Club Libelle but an improved fuselage with retracting wheel



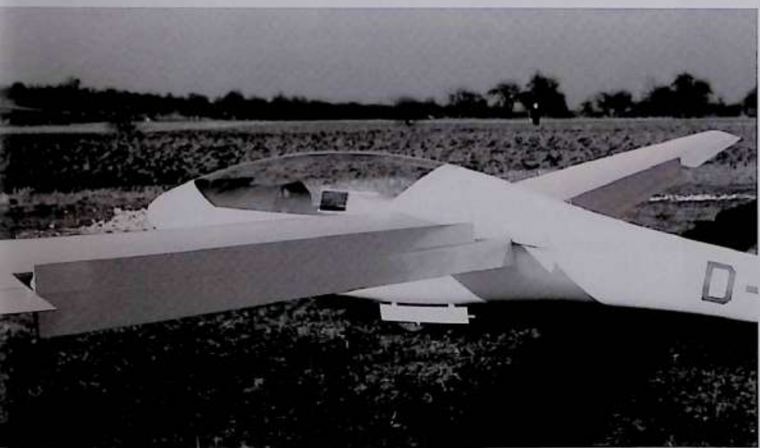
Mass empty 232 kg
In flight 297 - 420 kg max with ballast
Wing area 9.8 sq m
Aspect ratio 23
Wing loading 30.3 - 42.9 kg/sq m
Centre of gravity range
250 - 375 mm aft of root leading edge

Glasflügel H - 206 Hornet

1974

Drawn by Martin Simons 2003 ©

Above: *The H 303 Mosquito prototype (Photo Peter Selinger)*

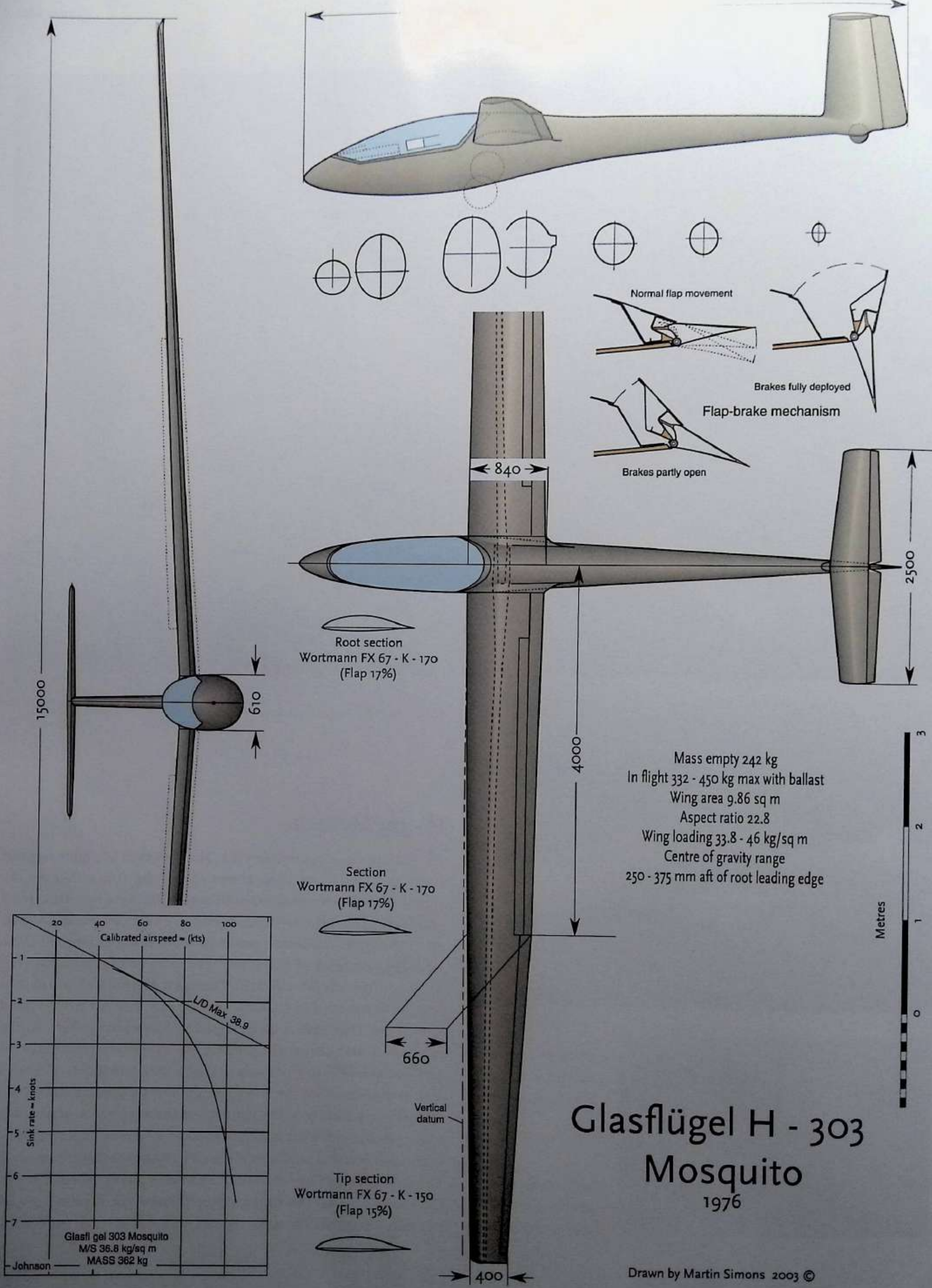


Middle: Mosquito showing the combined flap airbrakes

Below: Mosquito cockpit. Note the parallel action control column.

H - 303 Mosquito

Eugen Hänle died in October 1975. The prototype Mosquito was not flown until February 1976. It was one of the first sailplanes designed for the new unrestricted fifteen metre class, and attracted a good deal of attention. A notable feature, much welcomed, was that all the controls connected automatically during rigging, so there was little possibility of a pilot taking off with something adrift. The main control column operated through a parallel linkage, so that the elevator moved in response to a directly forward and aft hand movement. This made it much less likely that a pilot-induce-oscillation could arise during sharp up or down motions during take off and landing, or with gust loads in flight. Other designers adopted a similar systems. (See the DG - 100, above.) In appearance the H - 303 was very similar to the Hornet but the wing was entirely new, using the current Wortmann profiles designed for flaps. The Mosquito also incorporated a new type of combined flap-airbrake. In normal flight the flaps moved as required to change the camber for different airspeeds. The ailerons were linked to the flaps so the camber changed across the whole span as the flap lever in the cockpit



Mass empty 242 kg
In flight 332 - 450 kg max with ballast
Wing area 9.86 sq m
Aspect ratio 22.8
Wing loading 33.8 - 46 kg/sq m
Centre of gravity range
250 - 375 mm aft of root leading edge

Glasflügel H - 303 Mosquito

1976

Drawn by Martin Simons 2003 ©

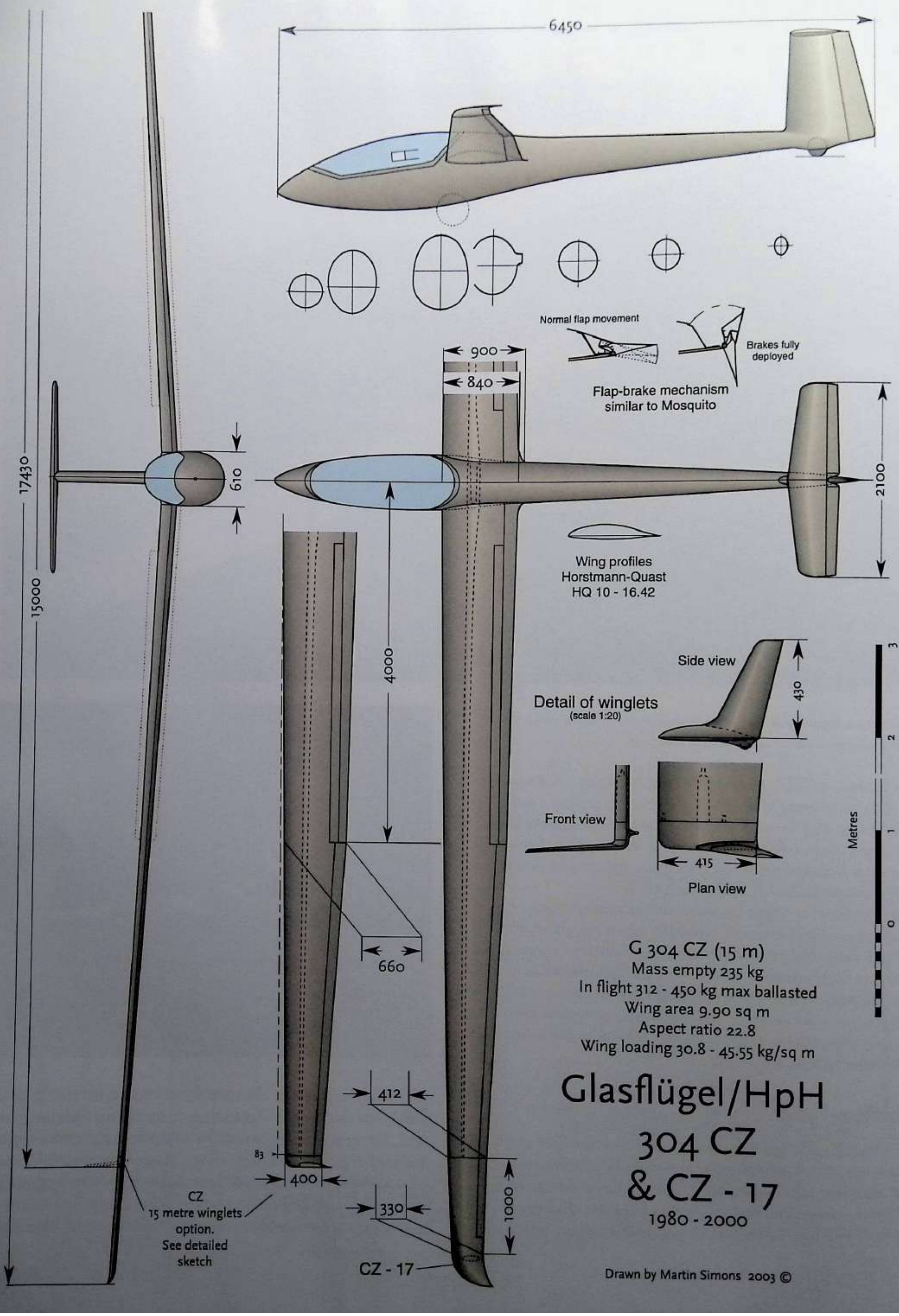
Glasflügel 304, Eugen Hänle's design of 1980 (above) and its late successor HPH 304 (right), still in production in 2004 (Photo Jochen Ewald)

was moved. When preparing to land, the flaps and airbrakes, hinged on the same axis, opened together to present a very large drag surface. The ailerons were not moved by the airbrake lever, so full lateral control was retained. This proved a highly effective system and was copied on other Schempp-Hirth designs, notably the Mini Nimbus, Nimbus 2C and Ventus A & B.

When tested in flight in Texas, the Mosquito seemed to lack something in performance, especially when compared with the ASW 20. Even after considerable work had been done to smooth the wings, in Dick Johnsons' words "The Mosquito was found to be generally well-made and indeed pleasant to fly; however it lacks the performance edge necessary to make it fully competitive in major contests, especially at high airspeeds." Mosquito production was ended after 202 had been built.

Glasflügel 304

The Glasflügel 304 was intended to replace the Mosquito in the fifteen metre class. It was designed by Martin Hansen who remained with Glasflügel after Hänle's death. Except for new wing profiles, developed by Horstmann & Quast, it resembled the Mosquito closely. About 60 were built before the original production run ended. After the political changes in 1989, and the foundation of the Czech Republic, the sailplane manufacturing industry there became privatised. The newly established enterprise HpH established a co-operative relationship with Schempp-Hirth. All rights and tooling for the H - 304 were acquired and production began again, with a significant saving in price for international buyers. There was an encouraging response and sales were brisk. At the time of writing the H - 304 CZ is in



G 304 CZ (15 m)
Mass empty 235 kg
In flight 312 - 450 kg max ballasted
Wing area 9.90 sq m
Aspect ratio 22.8
Wing loading 30.8 - 45.55 kg/sq m

Glasflügel/HpH 304 CZ & CZ - 17

1980 - 2000

Drawn by Martin Simons 2003 ©

production, over 60 having been sold, with options such as winglets and 17.43 metre tip extensions.

Flight tests of the H - 304 CZ at Caddo Mills showed that, after some work to improve sealing of the wing roots, brakes and hinge lines, the performance was very good with a best glide ratio about 45:1, with the 17.43 metre tips.

A new Standard Class version, the H - 304C 'Wasp' is also now available. This has no flaps, a more cambered wing profile, and simple Schempp-Hirth air brakes instead of trailing edge brakes.

Rolladen Schneider

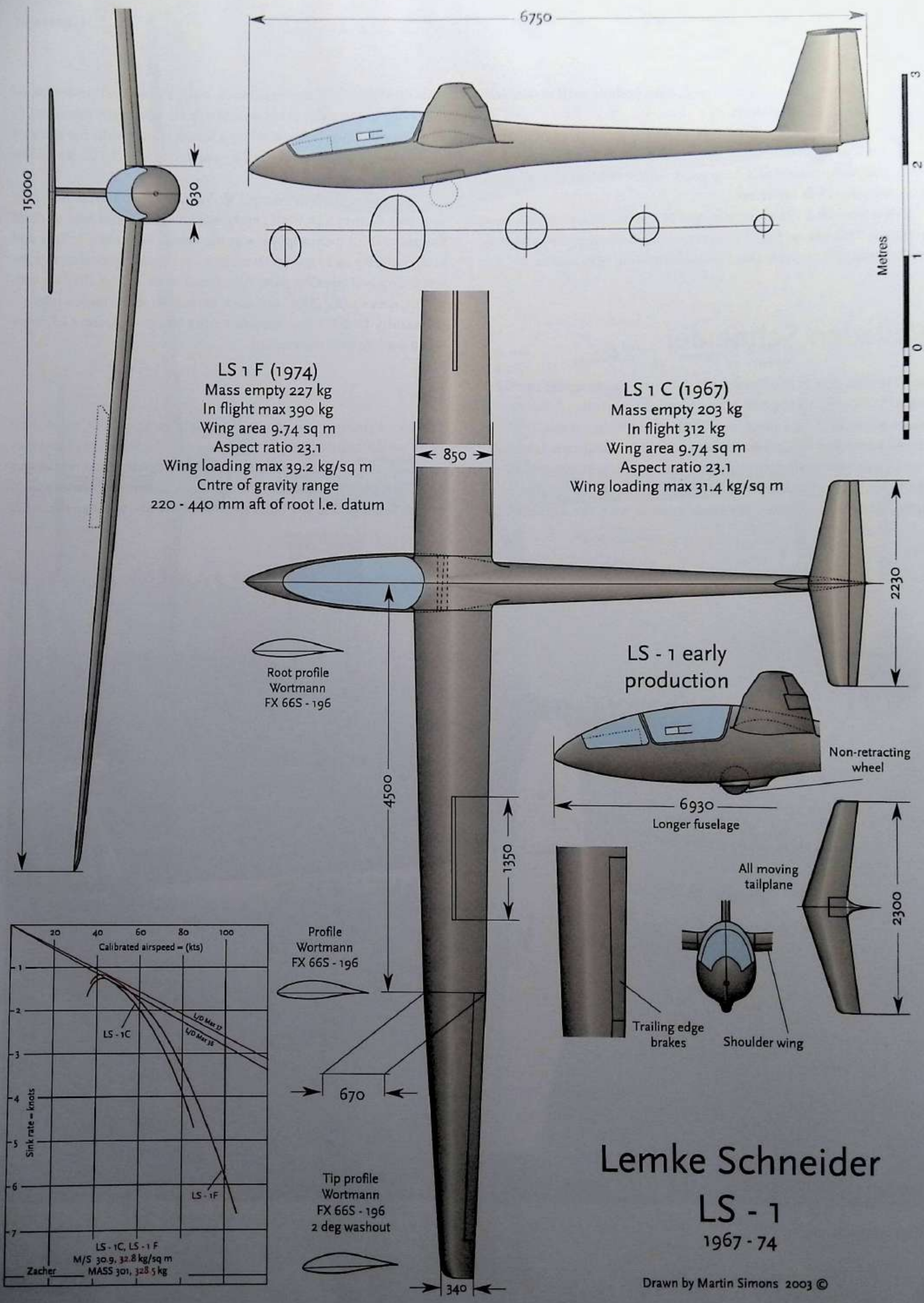
Wolf Lemke, one of the Darmstadt students who designed the original D - 36, on leaving the University joined Walter Schneider, a well-known sailplane pilot, and his brother Willi, in the firm Rolladen Schneider at Egelsbach near Frankfurt. Rolladen Schneider was a business making rolling doors and shutters. Walter was an enthusiastic sailplane pilot who, with fellow club members, had built some wooden sailplanes. He made contact with the Akaflieg and, with their approval and assistance, built the second prototype of the D - 36 in the cellar at his own home. He also nearly destroyed it, and himself, when he took off on a winch launch with the elevator disconnected. He saved himself by parachute and the D - 36V2 was repairable.

After this it seemed natural to Schneider to establish a new sailplane factory and Wolf Lemke was invited to join him as chief designer. Their first sailplane was the Lemke Schneider 1. This and later products up to the LS - 8 made a very great reputation in contest flying and the Company flourished until, in the difficult economic times after 2001, Rolladen Schneider were forced into receivership. In 2003 the manufacturing and brand name LS, were taken over by DG Flugzeugbau.

LS - 1

The LS - 1 prototype made its first flight in May 1967, piloted by Wolf Lemke, the designer. It conformed to the Standard Class rules then in force, having a non-retracting undercarriage and no flaps or provision for water ballast. The wing was mounted shoulder high on the fuselage and the tailplane was of the all-moving type, with

LS 1 at Lovettsville, Virginia, USA


6750
15000
630
Metres
0
1
2
3
LS 1 F (1974)
Mass empty 227 kg
In flight max 390 kg
Wing area 9.74 sq m
Aspect ratio 23.1
Wing loading max 39.2 kg/sq m
Cntre of gravity range
220 - 440 mm aft of root l.e. datum
850
LS 1 C (1967)
Mass empty 203 kg
In flight 312 kg
Wing area 9.74 sq m
Aspect ratio 23.1
Wing loading max 31.4 kg/sq m
2230
Root profile
Wortmann
FX 66S - 196
LS - 1 early
production
Non-retracting
wheel
4500
6930
Longer fuselage
1350
All moving
tailplane
2300
20
40
60
80
100
Calibrated airspeed = (kts)
Sink rate = knots
1
2
3
4
5
6
7
LS - 1C
L/D Max 37
L/D Max 36
LS - 1F
LS - 1C, LS - 1 F
M/S 30.9, 32.8 kg/sq m
MASS 301, 328.5 kg
Zacher
Profile
Wortmann
FX 66S - 196
670
Trailing edge
brakes
Shoulder wing
Tip profile
Wortmann
FX 66S - 196
2 deg washout
340
Lemke Schneider
LS - 1
1967 - 74
Drawn by Martin Simons 2003 ©

sweep back. Trailing edge air brakes were mounted just inboard of the ailerons. The cockpit canopy was in two sections, the front portion fixed to the fuselage. After test flying, production began and sixteen were built before the design was revised. The LS - 1A had Schempp-Hirth brakes on both sides of the wing. Only two pre-production prototypes were built before the LS - 1B followed with the brakes on the upper side only. After five more like this the LS 1C with an increased rudder area appeared in 1968. After 1970 retracting undercarriages were allowed and 146 of the LS - 1C were built. The LS - 1D of 1971 had provision for water ballast and a fixed tailplane with elevator.

At the German National Championships in 1968 Helmut Reichmann flew an LS - 1 and won, which assured him a place in the German International team for the 1970 World Championships at Marfa in Texas. This, too, he won in an LS -1. It was not surprising after these successes that orders came in to Rolladen Schneider for more sailplanes than their small workforce could cope with. 47 of the D model were built but it was not until the LS - 1F that the factory was able to meet demand within a reasonable time. More were built in the years 1973 - 76 than in the preceding seven years. The LS - 1F of 1974 had the wing mounted lower on the fuselage, a one-piece cockpit canopy hinged at the front, and a tailplane with hinged elevator. There was capacity for 90 kg of water ballast. Flight tests showed that the F model had a measurable performance advantage over the earlier versions. 226 were built and many were exported.

All the LS - 1 series handled well and were competitive with other Standard Class sailplanes of the period. A total of 444 were built, including several experimental types. Another experiment was the LSD Ornith, of 1972 a two seat version of the LS - 1 with swept forward wings of span 18 metres, and two seats in tandem. The rudder was enlarged. It flew successfully and set records in South Africa but did not go into production.

LS - 2

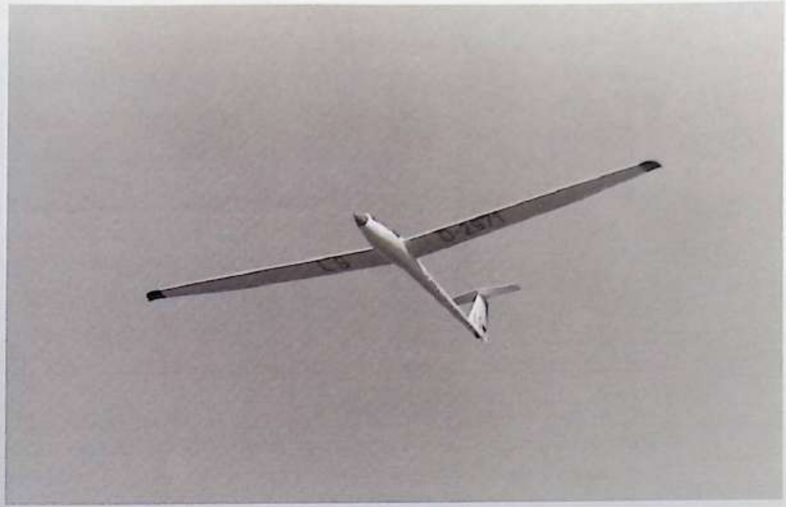
The LS - 2 was designed and built as a result of the CIVV decision, in 1969, to change the rules for the Standard Class contests. Having observed the LS - 2 in the World Championships in 1974, the CIVV changed its collective mind again.

The Standard Class specification was originally intended to encourage the development of simple, 15 metre span, inexpensive sailplanes, easy to fly, operate, maintain and repair but with good performance. Flaps, variable geometry, retracting wheels, water ballast and other complications were forbidden. Airbrakes which would limit the airspeed in a vertical dive to the maximum permitted 'red line' speed were required. The sailplane which best represented the original intention was probably the Kaiser Ka 6 of 1958 but in the years following, designers and manufacturers aiming to win the Standard Class World Championships, produced sailplanes in which practicalities were sacrificed to performance.

Water ballast was not allowed but a sailplane could still be equipped to take heavy weights in the wings when the pilot chose. On a good soaring day the heavy sailplane has an advantage in cross-country flying and racing. The solid ballast could not be jettisoned if conditions deteriorated. The extra load increased the speed at touch down, increasing the risks of an accident if landing in a small field, but pilots were prepared to take on the extra load if it was likely to improve their chances of winning. On days that were expected to be difficult the weights would be removed before take off.

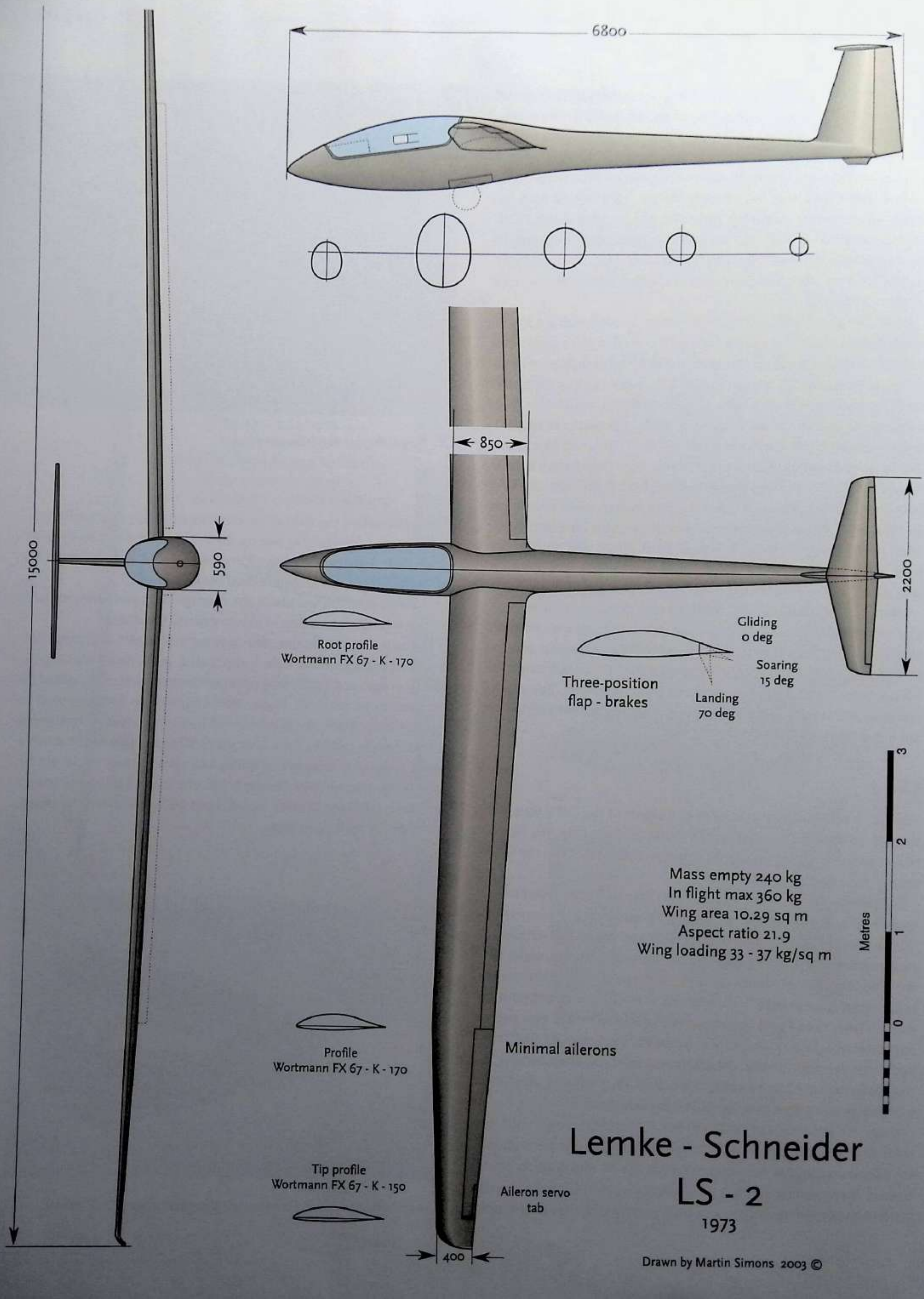
Wheels almost buried inside the fuselage, to reduce drag, were legal but were almost useless as aids to ground handling.

The rule about airbrakes was in some senses self-defeating. Airbrakes of sufficient size were complicated, quite heavy and expensive to design and build, and could be dangerous if mishandled by inexperienced pilots in flight. Few designers in fact troubled to comply fully. The vertical dive speed limit was never officially enforced. Simple camber flaps, lowered to 90 degrees for landing, were much simpler to design and build, and cheap. They could not be used if the airspeed was already high. The idea of using the brakes to save a sailplane already out of control, for instance in cloud, could not be applied to flaps.



LS 2 flying in the 1974 World Championships

Helmut Reichmann shelters from the sun in the cockpit of the LS 2 at Waikerie


6800
850
590
15000
2200
Root profile
Wortmann FX 67 - K - 170
Gliding
0 deg
Soaring
15 deg
Landing
70 deg
Three-position
flap - brakes
Mass empty 240 kg
In flight max 360 kg
Wing area 10.29 sq m
Aspect ratio 21.9
Wing loading 33 - 37 kg/sq m
Metres
0
1
2
3
Profile
Wortmann FX 67 - K - 170
Minimal ailerons
Tip profile
Wortmann FX 67 - K - 150
Aileron servo
tab
400
Lemke - Schneider
LS - 2
1973
Drawn by Martin Simons 2003 ©

There were good reasons in 1970 for making some rule changes. Retracting undercarriages were permitted, since the cost was not very great and a wheel that raised the fuselage well clear of the ground was more practical than one sunk far into the belly.

The chief controversy arose because of the rule about flaps. After much debate the specification was relaxed. The vertical dive speed limit requirement was removed, since cloud flying was not permitted in competitions anyway. Simple flaps which could be used as brakes were admitted, but they must not be coupled with the ailerons. This was expected to limit their use to improve the sailplane's performance.

For camber flaps to be most effective they should extend across the whole span. If the camber of the wing is changed to suit different flight speeds, it should change from tip to tip. In the Open Class, ailerons and flaps are usually coupled to achieve this. The ailerons droop or rise with the flaps, while retaining their lateral control function. The new Standard Class rule made the space occupied by ailerons on the trailing edge of the wing unavailable for the flaps. Typically, ailerons are about half the semi-span in length. Moving the flaps up or down without coupling would, with normal long ailerons, actually tend to increase the drag because vortices would arise at the outer ends of the flaps.

However, ailerons need not be so long. By reducing them to the bare minimum required for lateral control, the flaps could be extended much more towards the tips than the rule makers had envisaged. There would still be some drag penalty but it would be minimised.

Wolf Lemke designed the LS - 2 deliberately with small, wide chord ailerons and very long flaps. The flaps could be lowered to 70 degrees and they were very effective as landing aids, so no other brakes were required. For flying at the various airspeeds required in cross-country racing, most of the wing could have the camber adjusted. The LS - 2 would have a performance advantage but it conformed to the new rules.

The fuselage and tail unit of the LS - 2, which first flew in March 1973, were similar to the LS - 1F. The wing, with its flaps and small ailerons, was swept forward three degrees to assist the balance. Test flying established that the aircraft performed well. It was controllable, though not pleasant or easy. Because the ailerons were broad, after test flying small servo tabs were fitted to lighten the loads on the control column.

The pilot chosen to fly at the 1974 World Championships, at Waikerie in South Australia, was Helmut Reichmann, who hoped to regain the title he had won in the LS - 1 in Texas, but had lost in 1972 in Yugoslavia.

Reichmann did win the Waikerie Championships, but only by the narrowest of margins over Ingo Renner, the Australian, who was flying a completely orthodox Standard Cirrus. The difference in scores after eleven days was 29 points in a total of 9325. In third place was the Polish pilot, Franciszek Kepka, in a Standard Jantar, only 59 points behind the winner. Evidently the LS - 2 in practice was not vastly superior in performance. All three pilots were outstandingly good. All three had won on some days and so had several of the other leading pilots. Any really noticeable difference in performance between the sailplanes should have been more apparent in the results. The point was made all the more forcefully because Renner had been in first place until, on the last day, the airbrakes of his Cirrus would not lock closed properly. Rectifying them took hours and was not wholly successful. He was forced to take off late and fly cautiously. Subsequently Reichmann agreed that the LS - 2 was far from satisfactory, being tricky to take off and land, and not manoeuvreable enough in thermals to climb well. Only the one was ever built. It remains in the hands of its designer, Wolf Lemke.

The CIVV changed the rules again.

LS - 3

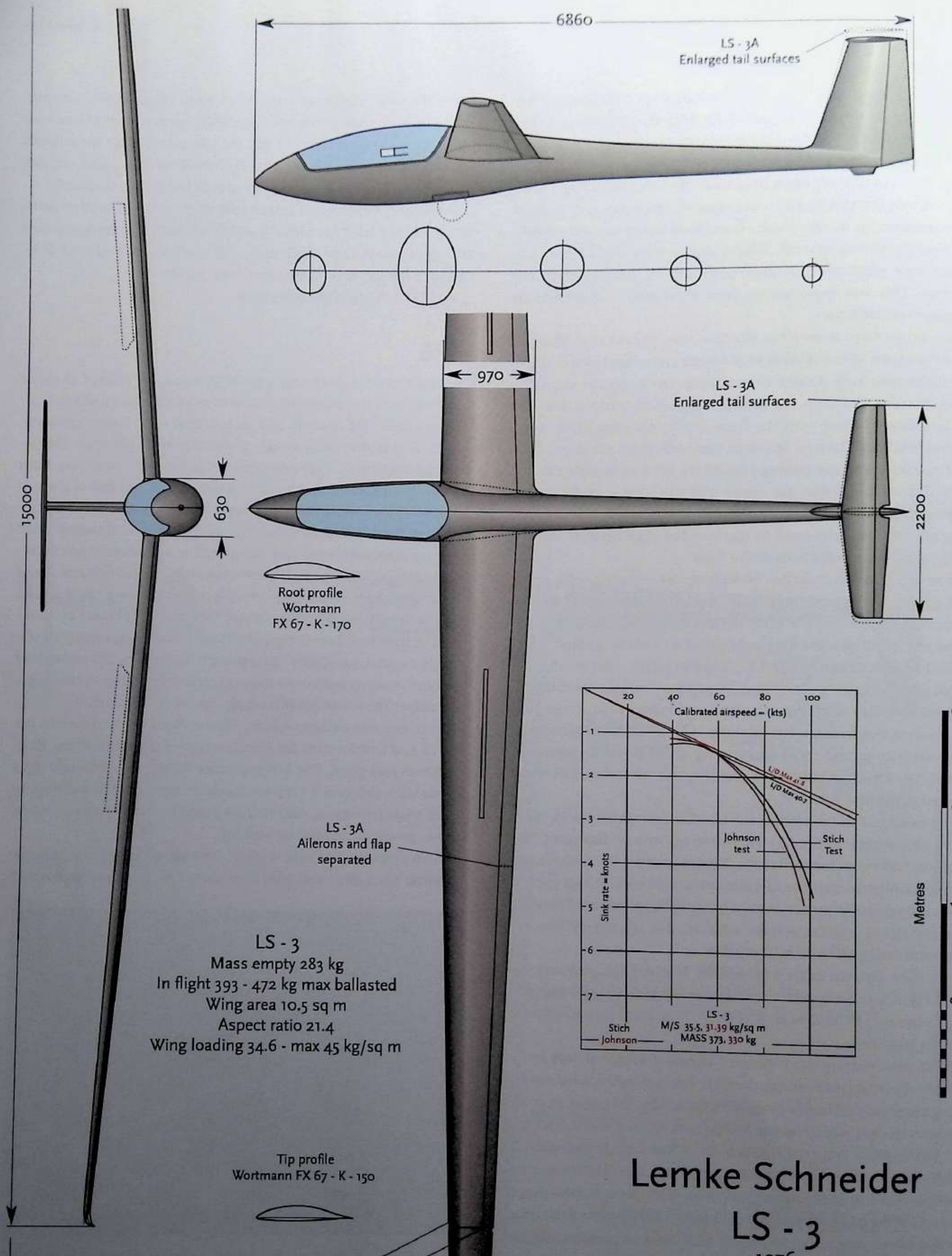
The result of the rule change after 1974, was a new class of 15 metre sailplanes with no restrictions.[33] Lemke was more than ready to enter this new field. The fuselage and tail unit of the LS - 3 were similar to the LS 1F, adapted easily to take new wings with full span aileron-flaps or 'flaperons'. There was one hinged surface extending from root to tip on each wing. The drive was from the root end of the surfaces, so all the mechanism was housed in the fuselage. This was simpler than that needed for coupling separate surfaces. However, since the long 'flaperons' were somewhat flexible in torsion, it was necessary to mass balance them by attaching 20 kg of lead in strips ahead of the hinge line. Schempp-Hirth type air brakes were fitted on the upper side only, as by now was usual. Deploying the brakes also lowered the flaps to reduce the speed of touch down. The wing plan was straight tapered, somewhat unfashionable because most sailplanes of this time were tapered in two stages to come more closely to the elliptical shape. The losses, in vortex drag, were relatively small.

There was also ballast capacity. The cockpit was wider than the LS - 1F and comfortable for a wide range of different pilots. Handling was very good. The full-span ailerons were surprisingly light on the stick and gave a very good rate of roll even when drooping at the 10 degree down, thermalling position. There was no lack of aileron power during the take off roll.

When measured in flight, the LS - 3 proved to have a best glide ratio better then 40:1, and with flaps raised an excellent high speed

Klaus Rademacher flying his LS-3 over Aletschhorn in the Bernese Alps. (Photo Claus-Dieter Zink)

33 – See ASW 20, p. 73



LS - 3
Mass empty 283 kg
In flight 393 - 472 kg max ballasted
Wing area 10.5 sq m
Aspect ratio 21.4
Wing loading 34.6 - max 45 kg/sq m

Lemke Schneider
LS - 3
1976

Drawn by Martin Simons 2003 ©

With a more orthodox arrangement of flaps and ailerons, the LS 3A was considerably lighter than the earlier version. The vertical tail area was also increased.

glide. In Texas, it was found that any leakage through the small gaps at the root ends of the flaperons, should be sealed. This resulted in a noticeable improvement in the low speed performance.

The only substantial criticisms of the LS - 3, from such experienced pilots as George Moffat, were that it was heavy and, in competition with other Fifteen Metre Class sailplanes, did not climb so well in weak lift. About 150 of the LS - 3 were produced before the LS 3A was introduced in 1978. This was substantially lighter, partly achieved by removing the mass balances and returning to the orthodox arrangement of ailerons and separate flaps. The area of the vertical tail was slightly increased.

The LS - 3/17 was introduced in 1979. This had interchangeable wing tips allowing the span to be extended to 17 metres span, offering a worthwhile improvement in performance. Two versions were available, one with the same wing spar as the fifteen metre LS 3A. This, with the long tips installed, was not permitted to carry water ballast. The alternative version had a stronger spar, which increased the weight when flying at 15 metres, but was able to carry ballast with the long tips. The best glide with the long tips was measured at 43:1. When flown with the shorter tips in Texas, the LS3/17 had a slightly better performance than the LS - 3A measured by the same Caddo Mills group previously. The explanation is that two sailplanes, even from the same moulds, may nevertheless differ slightly.

In major competitions the LS - 3 and 3A came up against the outstanding ASW 20 and never achieved the kind of results that had been hoped for. A total of 358 of all versions was produced.

LS - 4

If the LS - 3 was something of a disappointment in terms of contest results, the LS - 4 was an astonishing success. Wolf Lemke and Walter Schneider were greatly impressed by some of the results emerging from the American Standard Class championships.

In the USA it was permitted for pilots entering the Standard Class National Championships to fly any 15 metre span sailplane, providing the flaps were locked in the neutral position throughout. Time and again the Championships were won by pilots flying Fifteen Metre sailplanes in this way. They were outperforming the specialist Standard Class aircraft. In both the 1979 and 1980 US St Class Nationals, the top places were taken by 'locked flap' Fifteen Metre types. Dave Culpepper became the US Champion in 1979 flying an LS - 3.[34]

It seemed clear that some aerodynamic lessons could be learned from this. The first important decision was to use a new wing profile which, without having flaps, would embody all the lessons learned from the development of profiles for the Fifteen metre Class. The sections chosen came from Wortmann at Stuttgart, where special attention was being paid to profiles less affected by insect contamination, and capable of a wide speed range without camber variations. The profile at the root was 16.2% thick but tapered to a much thinner 13.3% at the tips. Other improvements included a revised wing plan and cockpit layout, but essentially the same fuselage and tail unit as the earlier LS series.

34 – He was second in the scores to the Englishman, Justin Wills, not eligible for the National title. Wills too was flying a fifteen metre aircraft with flaps locked, the Mosquito.

LS 4 over the southern French Alps, still snow covered in summer (Photo Claus-Dieter Zink)

LS 4 cockpit canopy open

The LS - 4 flew in 1980 and test measurements gave it a glide ratio of better than 40:1, with a performance curve previously unknown for Standard Class gliders. It entered the market with relatively little advanced publicity. Nonetheless, demand was high from the first. At the World Championship at Paderborn in Germany in May-June 1980, of 27 entrants, sixteen of the LS - 4 were entered. Seven of them finished at the top of the list. In the 1982 US Nationals the LS - 4 took the top two places and in 1983 the top four. No doubt these almost unprecedented results prompted many pilots to equip themselves with the LS - 4, or its successor the LS - 4A, for the next World Championships. The LS - 4A was different from the LS - 4 in detail. Instead of one large ballast bag in each wing, the 4A had two, allowing a higher maximum flying weight of 525 as against 472 kg and a wing loading of 50 kg/sq m.

At the 1983 Championships at Hobbs, New Mexico, of the top 25 at the end of twelve days, 21 were LS - 4s including the top six. Dominance of this kind had never been seen before. It was especially important that the LS - 4, capable of such results over two years in major international competitions, had docile handling characteristics, was robust, and could be flown even by relatively inexperienced pilots. The only sailplane that seemed to offer any challenge was the very new DG - 300, with its pneumatic turbulators.

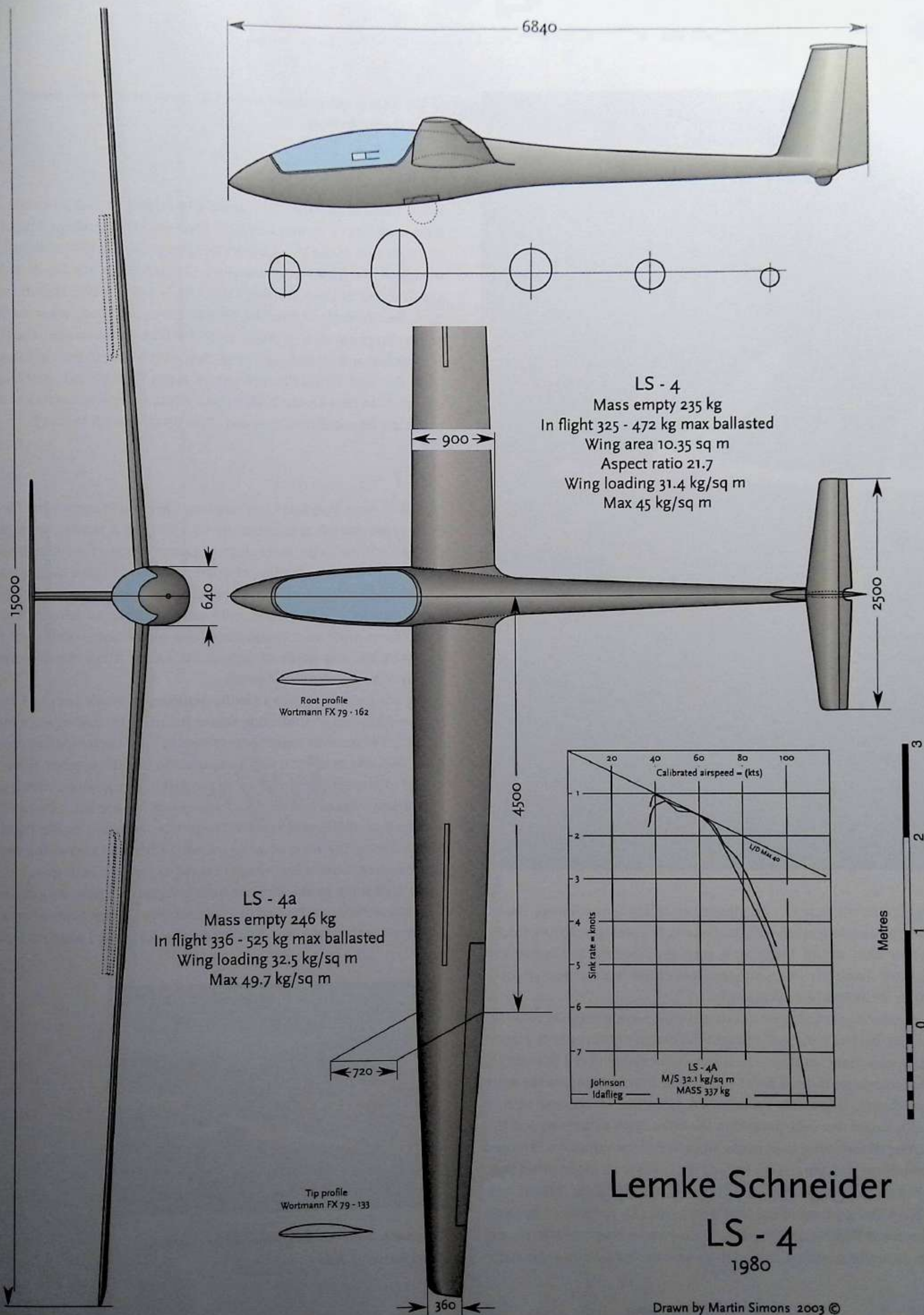
The rival manufactures were given furiously to think. By the next World Championships, in 1985 at Rieti in Italy, the LS - 4 was no longer at the top.

When the Rolladen Schneider Company was finally taken over by DG in 2003, it was mentioned that while the LS - 4A remained nominally in production, only a dozen had been built in the previous two years. However, winglets for retrospective fitting to the LS - 4 were offered.

The LS - 5 was a large, 22 metre span two seater which flew in 1986 but did not enter production.

LS - 6

Having, with the LS - 4, met the challenge of the Standard Class, Rolladen Schneider offered a competitor in the Fifteen Metre Class, the LS - 6. This had a carbon fibre main wing spar with GRP skins. The new Wortmann wing profiles were considerably thinner, than those of the LS - 3, 13.2%, and less than the rival sailplanes from other de-



Lemke Schneider LS - 4

1980

Drawn by Martin Simons 2003 ©

LS 6C - 17.5 m in 1991, production number 6245, flying near Lidköping in Sweden. (Photo Thorsten Fridlizius)

signers. As with the LS - 3a, ailerons and flaps were coupled. Toward the tips, Lemke worked with Wortmann to develop a slightly thicker profile that would blend well with the ailerons and retain safe stalling character. The wing plan was of the double tapered form, closer to the ideal elliptical shape.

The fuselage was smaller in external cross section than the LS 3. The cockpit, despite some well-thought-out design of the controls, was described as 'tight' but once in it was comfortable. A tall pilot might need to remove the seat panel and put the headrest back on the main cross frame. To provide greater pilot protection in the case of accidents, Kevlar was incorporated in the skins. Both jettisoning and filling the water ballast bags in the wing, was done through a hole and connecting plumbing in the belly of the fuselage aft of the wheel well.

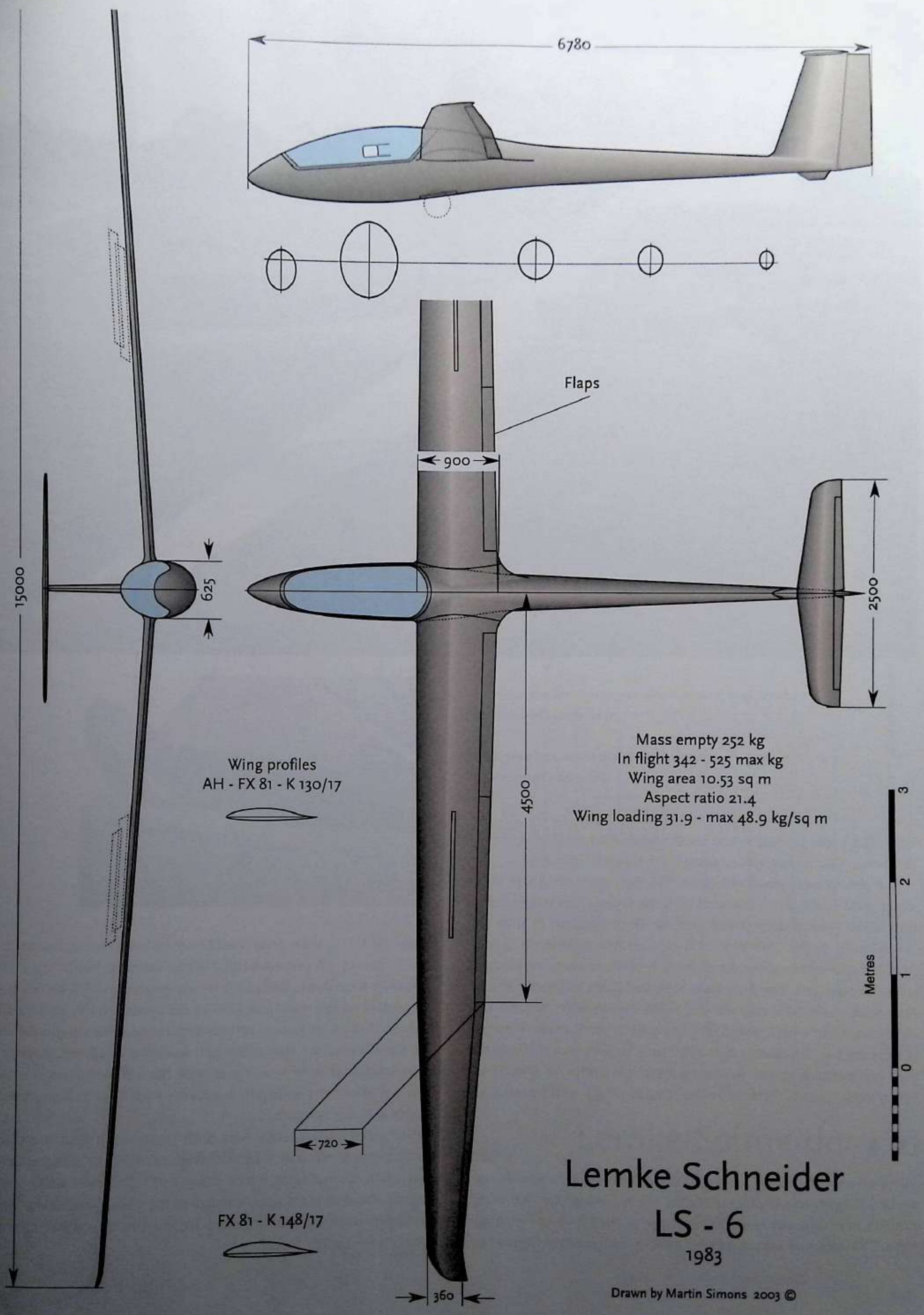
Testing time came at the 1985 World Championships, held at Rieti in Italy. Doug Jacobs of the USA won in his LS - 6, followed by Simo Kuusisto of Finland, also in an LS - 6. There were thee others in the top ten. As Jacobs remarked, if a sailplane wins the World title, there is not much more to be asked for. Lemke and Schneider had produced a quite outstanding contest sailplane, their success deserving comparison with that of the LS - 4 a few years previously. In 1987 at Benalla the LS - 6 flown by Brian Spreckley of England won, the LS - 6 took also 2nd, 3rd, 5th, 8th and 9th, 11th, 12th & 13th. In 1991 the Champion, Brad Edwards of Australia, flew an LS - 6, with 2nd, 3rd and 4th places also going to LS - 6 pilots. In 1993 at Börlange in Sweden, the LS - 6 took first and second places and there were twelve in the top twenty. In the 1995 World Championships Justin Wills placed second at Omarama in New Zealand. After these outstanding results, the LS - 6 was at last displaced from the head of the lists by the SH Ventus 2.

LS - 7

The LS -7 was a Standard Class sailplane intended to replace the LS - 4. In appearance it resembled the LS - 6, using a similar fuselage and tail unit but with three degrees greater angle of incidence on the wing to improve landing characteristics and to give the pilot a better view on the approach. Attention was given to improving the airflow around the wing roots, with carefully designed fairings. The cockpit was made to accommodate large pilots more comfortably. Extensive use was made of carbon and Kevlar fibre, the ailerons wholly of Kevlar-reinforced plastic.

The wing was new with a profile designed by Wolfe Lemke. This wing section had an underside almost flat near the trailing edge instead of the common slight concave cusp of most contemporary profiles. This was in effect a slight modification of the camber. It was hoped to prevent the formation of any laminar separation bubbles. It evidently worked and the LS - 7 was one of the few new sailplanes of its period without turbulators. The profile was tested first in flight by modifying the wing of an LS - 4 with filler and measuring the performance. Results encouraged Lemke to proceed with the LS - 7 wing. After some production had been completed, a new winglet design was worked out. Instead of a fairly abrupt change from wing to nearly vertical winglet, the later production LS - 7 had winglets that

LS 6 flown by Berger Bulukin of Norway at the 1997 World Championships, St. Auban



6780
Flaps
900
625
15000
2500
4500
720
360
Wing profiles
AH - FX 81 - K 130/17
FX 81 - K 148/17
Mass empty 252 kg
In flight 342 - 525 max kg
Wing area 10.53 sq m
Aspect ratio 21.4
Wing loading 31.9 - max 48.9 kg/sq m
Metres
0
1
2
3
Lemke Schneider
LS - 6
1983
Drawn by Martin Simons 2003 ©

LS 7 at Gawler, South Australia, competing in the year 2000 Club Class World Championships

Cockpit of an LS 7 from the Netherlands, at the Gawler World Club Class Championships.

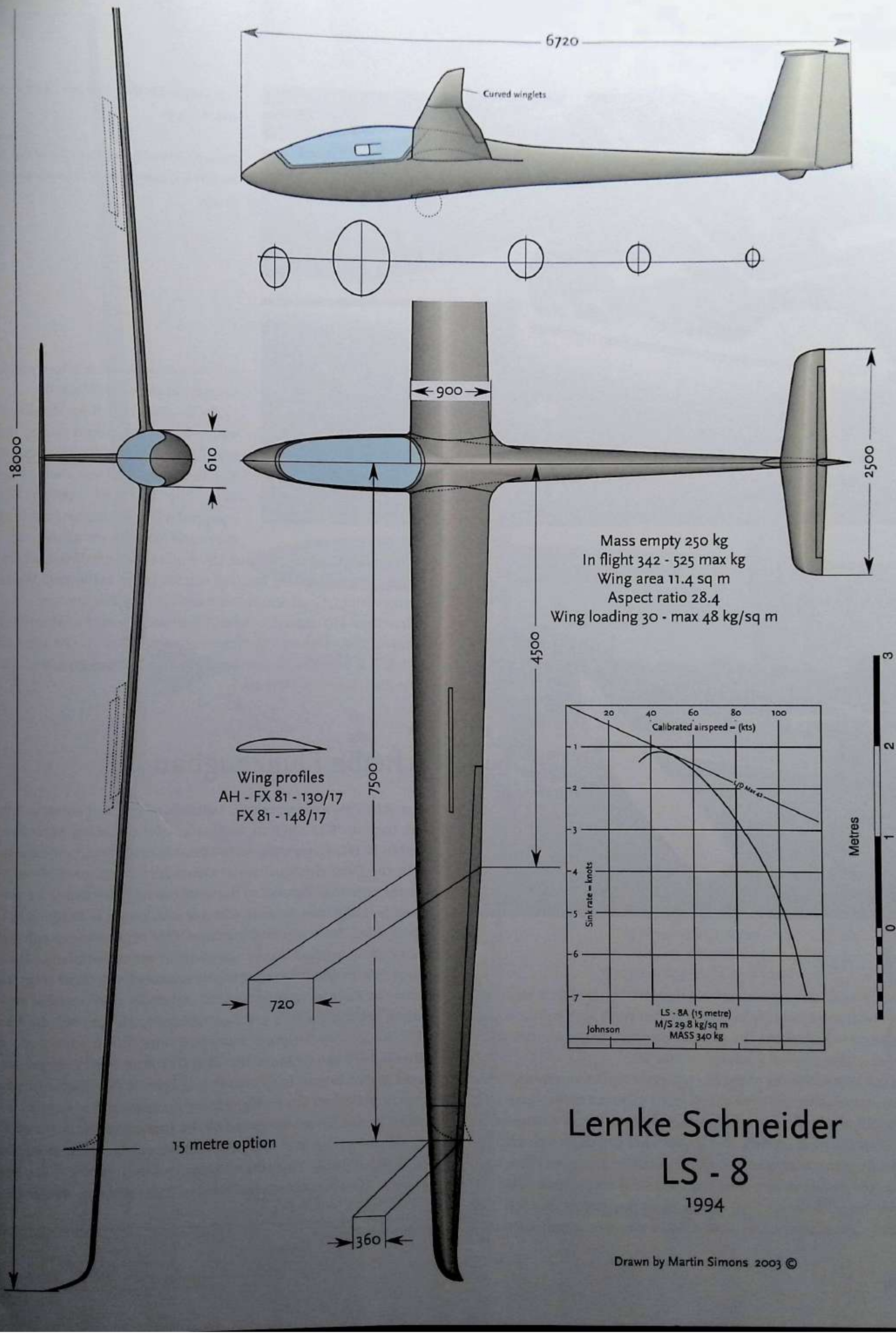
curved upwards gradually. The result was another small gain in performance. This feature was retained on the later LS sailplanes.

The results were good all round. The best glide ratio was measured at 42:1, a figure associated with the Open Class sailplanes of only a few years before. The LS - 7 was in production in time for several to fly in the 1989 World Championships at Bayreuth in Austria. The outstanding results of the LS - 4 some years previously, were not repeated. The dominant Standard Class sailplanes at this time were the SH Discus, the DG - 300, Polish SZD - 55 and the ASW - 24, all of which were close to equal in performance. Nevertheless the LS - 7 took 4th, 5th and 7th . The type was still considered competitive at the following Championships at Uvalde in Texas, 1991. The LS - 7 flown by the Finnish pilot J Sorri placed 5th.

LS - 8

In appearance the LS - 8, a new Standard Class aircraft, was almost an LS - 6, with the characteristic LS curved winglets. The wing profiles were virtually the same as those of the LS - 6 but with no flaps. This idea had been tested by making comparative flights between the LS - 6, with flaps fixed in neutral and sealed, against an LS - 7. The LS - 6 proved better. When detailed boundary layer flow tests were done, laminar flow was proved to 65% on the upper surface of the wing and 80% of the chord on the underside, with normal transitions to turbulence and no separation bubbles. The significance was that at low and moderate airspeeds, Standard Class sailplanes now were equal with the fifteen metre class of only a year or two previously. Sailplanes with flaps had an advantage only at high airspeeds.

Four water ballast tanks were built integrally within the wing leading edge D box structure, and when full carried 180 kg weight, equivalent to two extra pilots. Since the full ballast tanks were slightly ahead of the normal balance point, a small trimming tank in the fin was fitted, enabling the pilot to adjust the centre of gravity to suit the cockpit load.



Lemke Schneider

LS - 8

1994

Drawn by Martin Simons 2003 ©

Left: Doug Jacobs of the USA with LS 8A at St. Auban in 1997

Below: LS 8 flown by Brian Spreckley of England at the Omamara World Championships in 1995

The cockpit was well laid out and comfortable. Handling was excellent with good stability in all planes but good response for rolling into and out of turns. The ailerons provided ample control at low speed during the initial roll before take off.

Dick Johnson wrote of the LS - 8 that the workmanship and finish were outstanding and even after a year's exposure to the Texan summer, there was virtually no shrinkage of the resins or change in the form of the wing profiles. The largest wave-like departure from the smooth profile measured was .08 mm and the average was about half this. The measured best glide ratio was 42:1, with a remarkably flat polar curve. At an airspeed of 105 knots, the rate of sink was 3.86 knots, a glide ratio of 27:1. Such a figure would once have been considered wonderful for a fifteen metre sailplane at its best glide speed.

The LS - 8-18/LS8 - B was developed with wing tip extensions raising the span to 18 metres if the pilot chose. The best glide ratio was then about 48:1. The LS - 8T version was equipped with a retractable Solo 2350 motor and propeller was offered.

In Standard Class contests the LS - 8 quickly established itself as a leading contender, taking 2nd, 4th and 5th places at the 1995 World Championships. Good results continued into the 21st Century.

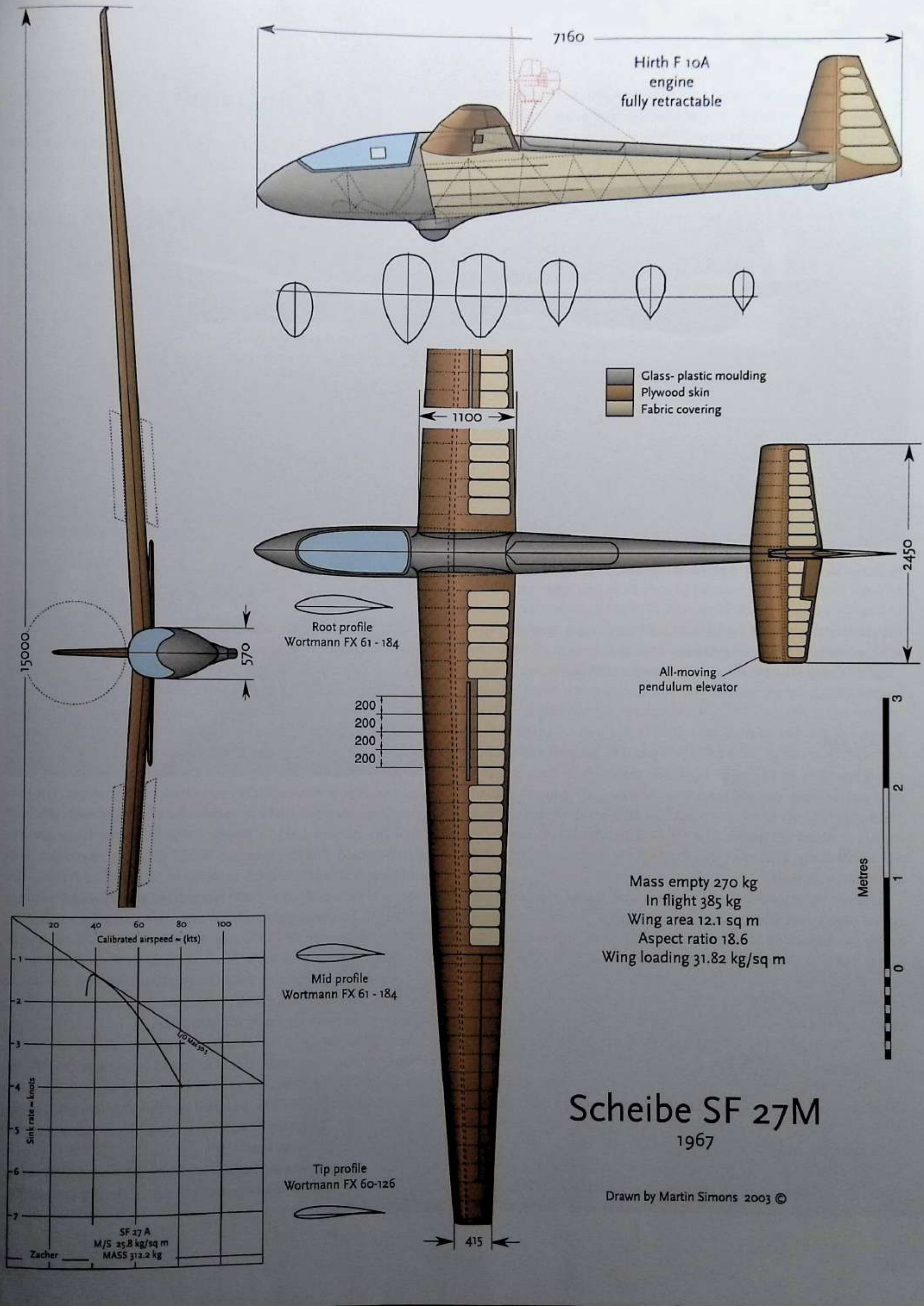
More than 450 of the LS - 8 had been sold before the takeover of Rolladen Schneider by DG Flugzeugbau in 2003. At the time of writing, it is intended to continue production of this type, possibly at the Elan factory in Slovenia.

Scheibe Flugzeugbau

Egon Scheibe's involvement in sailplane design and construction went back to 1933 when he was leader of the Akaflieg München. The Mü 10 two-seater was a record breaker in its time, now exhibited in the Deutsche Museum at Oberschleissheim near Munich. Scheibe remained devoted to the methods of construction he preferred for sailplanes: wooden wings and tailplane, with light steel-tube-framed, fabric covered fuselages. One of the earliest applications of this method was to the giant 3 - 4 seat sailplane, 'Obs', which flew in 1932.[35] From 1951 he produced sailplanes from his factory at Dachau near München, especially the Bergfalke two-seaters, the Spatz series, the Zugvogels and, his first venture into GRP, the SF - 34 'Delphin' two seater, first flown with wooden wings in 1978 and subsequently all in GRP from 1981. This was produced under licence in Germany and France. The output of new types from Dachau was prodigious and many are still in service.

Scheibe was always interested in the concept of the self-launching sailplane, the first one in which he was involved being the Mü 13M of 1936. The series continued with the SF - 24 Motorspatz, SF - 25A Motorfalke, the SF - 25B-Falke, SF - 25C & 25 E

35 – See Volume 1


7160
Hirth F 10A
engine
fully retractable
Glass- plastic moulding
Plywood skin
Fabric covering
1100
2450
15000
570
Root profile
Wortmann FX 61 - 184
All-moving
pendulum elevator
200
200
200
200
Mid profile
Wortmann FX 61 - 184
Tip profile
Wortmann FX 60-126
415
Mass empty 270 kg
In flight 385 kg
Wing area 12.1 sq m
Aspect ratio 18.6
Wing loading 31.82 kg/sq m
Metres
0
1
2
3
Calibrated airspeed ≈ (kts)
20
40
60
80
100
Sink rate ≈ knots
1
2
3
4
5
6
7
SF 27 A
M/S 25.8 kg/sq m
MASS 312.2 kg
Zacher
Scheibe SF 27M
1967
Drawn by Martin Simons 2003 ©

The first self-launching sailplane to enter factory production. Thirty-two of Egon Scheibe's SF - 27 M, in slightly different versions, were built at Dachau. (Photo Peter Selinger)

Superfalke, the SF - 28 Tandem-Falke. There was a further series of light and ultra-light aeroplanes.

Egon Scheibe died a few days before his 89th birthday in September 1997.

SF - 27M

The 'Zugvogel', or Ka - 5, of 1954, was designed by Rudolf Kaiser who at the time was working with Scheibe. After Kaiser joined Alexander Schleicher the Zugvogel was developed through several further versions at Dachau. The SF- 27, a Standard Class sailplane, was unofficially known as the 'Zugvogel V'. It flew in 1964 and about 120 were built.

Sailplane wing loadings were beginning to increase in the interests of high speed gliding between thermals. The idea of carrying ballast was becoming generally accepted. The additional weight of a power unit in a glider was no longer so important. The reason why dedicated soaring pilots did not usually buy Scheibe's Motor Spatz or Schleicher's ASK 14 was not the extra weight but the drag of the exposed power unit and propeller. This was very serious at high airspeeds. Glider plots were not prepared to accept the performance disadvantage.

If the power unit could be wholly retracted when not in use there would be no drag penalty. The Carden Baynes Scud III of 1935 and Wolf Hirth's 'Mose' Hi 20 flown in 1941 had retractable engines, but only one of each was built. The Nelson Hummingbird two-seater in the USA was powered by a 45 hp motor which retracted fully. It was successful and several were built, but there was no further production.

The SF - 27, with its light framed fabric-covered fuselage, offered an opportunity to fit a fully retractable motor and propeller. It was adapted to take a four cylinder 26 hp Hirth Solo engine on a pylon, which folded down, with the propeller, into a compartment behind the wing. The fuselage required some minor alterations to allow this, and hinged doors enclosed the power unit completely when it was not in use. The wing was strengthened and swept back slightly to adjust the balance. To raise or lower the engine, on its pylon, there was a chain drive operated by a crank in the cockpit. The motor could be started in flight by means of a hand-operated cable.

First flights were in1967. The SF - 27M was very successful. In 1968 Willibald Collée broke the World distance record for self-launching sailplanes, 539 km from Elz to Le Rabot in France. The motor was switched off at 3000 ft over the take-off field, and not used again. In the increasingly popular German motor sailplane championships, the SF - 27M won in 1970, 71 and 72, second in 1973 and won again in 1974. Many records were set, including a 724.5km distance flight by Paul Droghoff in 1974 and the World Out and Return record of 603.8 km by Kurt Hermann in 1976. In all cases the motor was used only for launching.

About 32 of the SF - 27M were built, with various minor modifications and improvements. It was followed in 1975 by the SF - 32, which had 17 metre span wings with light alloy main spars, taken from the Swiss Elfe AN - 17A designed by Albert Neukomm. The Rotax 642 motor was deployed and retracted by means of an electric motor. Only one of these was built.

The SF - 27M was the first self-launching, fully retracting motor sailplane to be built in quantity and offered on the general market. It was ahead of its time.

Schempp - Hirth GmbH

The beginnings of the Schempp - Hirth Company were in 1935 when Sportflugzeugbau Göppingen was founded. Martin Schempp and Wolf Hirth were partners and in 1938 the firm was re-named Sportflugzeugbau Schempp-Hirth. With factories in Göppingen, 50 km east of Stuttgart and at Kirchheim Teck, and Wolf Hirth's own plant at Nabern Teck, the Company continued after the Second World War. Wolf Hirth himself died in 1959, having suffered a heart attack while flying his Lo - 150 aerobatic sailplane. In 1964 Martin Schempp found a new and energetic chief designer, Klaus Holighaus, who joined the firm after graduating from Darmstadt Technical University. Holighaus had been interested in soaring since he grew up near the soaring site at Herzenheim, and had in his teens made a name for himself with a radio-controlled sailplane duration record of more than six hours.

In 1970 two members of the Akaflieg Braunschweig, Jürgen Laude and Helmut Treiber came to the Company after graduating, strengthening the technical team. In 1972 Holighaus became chief executive of the firm and from 1977, sole proprietor as well as chief designer and engineer. He was also an outstanding soaring pilot, and frequently a member of the German International Team.

Holighaus' died in an accident while flying his Nimbus 4M in the Alps in August 1994. The Company remained in the care of his wife Brigitte and sons, all of whom are keen glider pilots and who continue in control at the time of writing.

The success of the Schempp-Hirth sailplanes over the years has seen the Company often employing sub-contractors and issuing licenses to other German Companies, such as Burkhardt Grob at Mindelheim. Schempp-Hirth Sailplanes have also at various times been manufactured in Yugoslavia at Vrsac, in France by Lanaverre Industrie at Bordeaux and, in most recent times in the Czech Republic by the Orlican Company at Chocen near Prague.

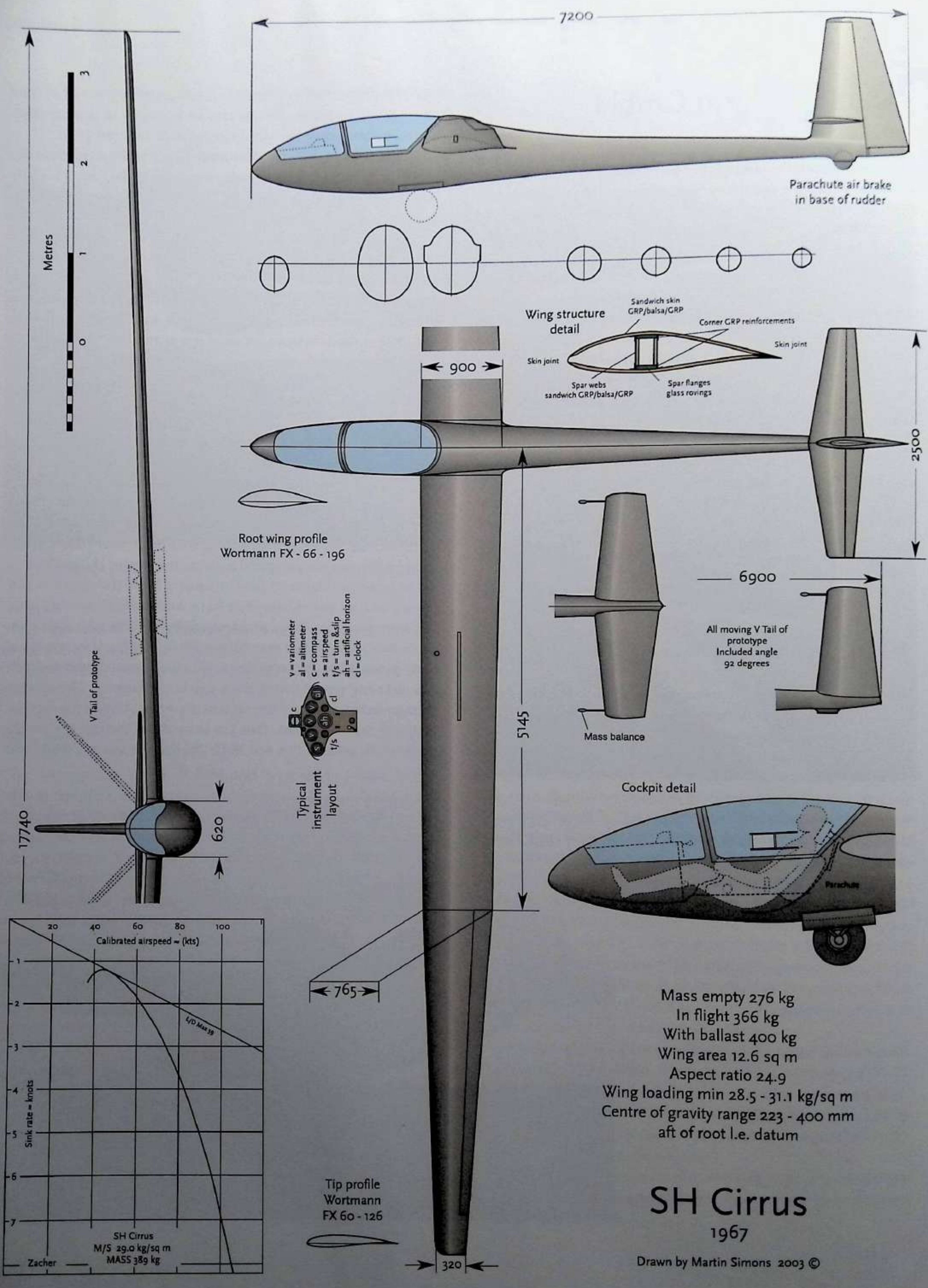
SH - Cirrus

Holighaus' association with Schempp-Hirth began when he developed the wooden SHK - 1 sailplane from the existing Standard Austria. The 17 metre SHK - 1 continued in production until 1968, by which time the Company was ready to put its first glass-plastic sailplane into production. Holighaus had experience with GRP structures since he had worked at Akaflieg Darmstadt with Waibel, Friess and Lemke when designing and building the famous D - 36 'Circe'.

The prototype Cirrus V1 flew in January 1967. The span was 17.6 metres, with an aspect ratio of 24.6 and a double-tapered wing plan. The spars were glass fibre rovings embedded in resin, with foam plastic sandwich skins rather than balsa wood filling. The foam was 'Conticell' 8 mm thick. The air brakes were of the original Schempp-Hirth 'parallel ruler' type, opening above and below the wing. The aerofoil sections were from the Wortmann series, FX 66 - 196 at the root, tapering to the FX 66 - 161. (The last three digits indicate the profile thickness in percent: 19.6 and 16.1.) The fuselage was of a shape that

Above: The prototype SH Cirrus with V tail. Holighaus began this design as part of his University degree studies.

Right: Cirrus at Tocumwal, NSW, Australia


7200
Parachute air brake
in base of rudder
Wing structure
detail
Sandwich skin
GRP/balsa/GRP
Corner GRP reinforcements
Skin joint
Skin joint
Spar webs
sandwich GRP/balsa/GRP
Spar flanges
glass rovings
900
2500
6900
Metres
Root wing profile
Wortmann FX - 66 - 196
v = variometer
al = altimeter
c = compass
s = airspeed
t/s = turn &slip
ah = artificial horizon
cl = clock
Typical
instrument
layout
All moving V Tail of
prototype
Included angle
92 degrees
Mass balance
V Tail of prototype
5145
17740
620
Cockpit detail
Parachute
765
Calibrated airspeed – (kts)
Sink rate – knots
L/D Max 39
SH Cirrus
M/S 29.0 kg/sq m
MASS 389 kg
Zacher
Tip profile
Wortmann
FX 60 - 126
320
Mass empty 276 kg
In flight 366 kg
With ballast 400 kg
Wing area 12.6 sq m
Aspect ratio 24.9
Wing loading min 28.5 - 31.1 kg/sq m
Centre of gravity range 223 - 400 mm
aft of root l.e. datum
SH Cirrus
1967
Drawn by Martin Simons 2003 ©

became characteristic of later Holighaus designs, with a roomy cockpit pod, contracting moderately to the tail boom. It was a 1.5mm thick shell of glass-fibre with stiffening rings. A strong steel tube framework was constructed to take the concentrated loads of wings, undercarriage and control fittings. This internal steel frame became a regular feature of Holighaus designs. The cockpit canopy was in two pieces, the forward section bonded to the fuselage to ensure no discontinuities or air leaks to disturb the laminar boundary layer flow over the nose. The wheel was retractable. The fuselage was 6.9 metres long over-all. On this prototype there was an all-moving V tail with mass balances, similar in form to that of the SHK.

Holighaus with the new Cirrus entered the German National Championships at Klippeneck in June 1967 and, to the astonishment of the more experienced competitors, won the Open Class, beating Klaus Hillenbrand in a Libelle H - 301 to second place. The Cirrus could hardly have had a better start, but Holighaus was not entirely satisfied and made important modifications before starting production.

The span was increased slightly to 17.74 metres and the V tail was replaced by a more orthodox cruciform arrangement, with a longer fuselage. There were tanks in the wings for 34 kg of water ballast and a parachute air brake housed in the base of the rudder. The registration number, D - 9406, was the same as that on the V - tailed prototype, but they were different aircraft. Holighaus himself flew the first production model in May 1967 at Hahnweide. The best glide ratio was measured at 39:1 by Hans Zacher's team. At the time the Cirrus was entering production there were few sailplanes of better performance in the Open Class, other than the outstanding, but difficult, ASW - 12 from Gerhard Waibel and Alexander Schleicher.

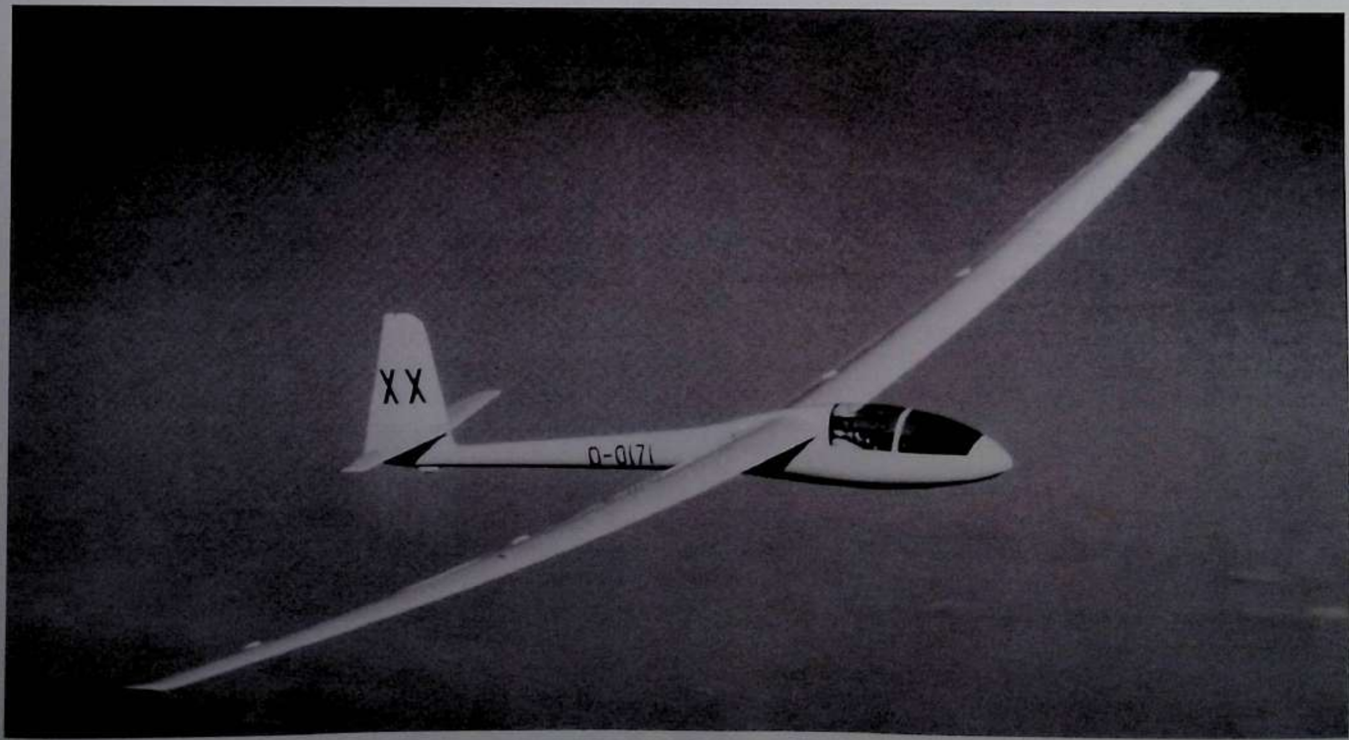
In a Cirrus the Austrian pilot Harro Wödl won the 1968 World Championships at Leszno in Poland. Not surprisingly, orders came in for more. By late 1971 the parent firm had built 107. After this, production was transferred to the Yugoslavian firm VTC (Vazduhoplovno Techniki Centar) at Vrsac, where another 63 were produced, bringing the total to 170.

Holighaus Nimbus 1

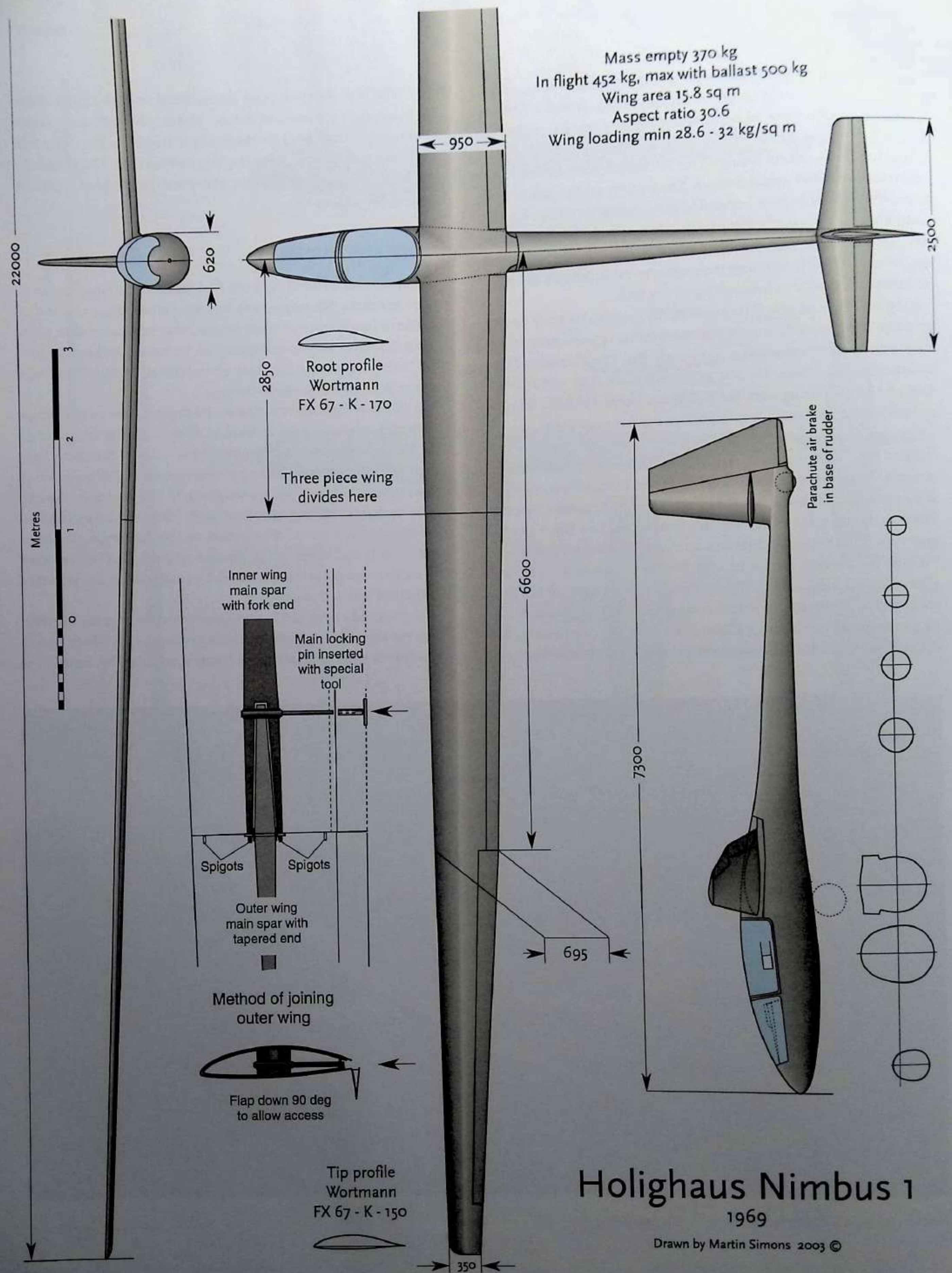
Klaus Holighaus himself built the first Nimbus in spare time, in an empty loft at the Schempp-Hirth factory. Among those who visited was the American pilot, George Moffat, who had dropped in to see Martin Schempp. He was introduced to the young designer. Brigitte, Klaus' wife, was in the next loft, giving ballet lessons. Their baby son was in a carrycot between the two.

The Nimbus fuselage was almost the same as that of the Cirrus, but with the wing moved forward to allow a greater tail moment arm. This necessitated a shortening of the cockpit. Holighaus built the Nimbus for himself and he had enough room. The wing was in three sections, the centerpiece, weighing 104 kg, had to be lowered by the crew onto the top of the fuselage. There was a new internal steel tube frame. None of the controls on this prototype connected automatically and access to the linkages when rigging was not easy. The rudder and tailplane were slightly enlarged but the layout of the tail unit was unchanged.

The wing had a span of 22 metres, exceptionally large for the time. (Only the experimental Braunschweig Akaflieg SB - 9, which flew in January 1969 three days before the Nimbus, equalled this figure.) The



Holighaus Nimbus 1 in flight (Photo A. Aldott, Archives Peter Selinger)



Holighaus Nimbus 1

1969

Drawn by Martin Simons 2003 ©

The original Nimbus at the World Championships, Marfa, 1970

profiles were from the new Wortmann FX 67 series, intended for camber flaps. Water ballast, up to 110 kg total, was carried in the wings in tanks about three metres out from the centre line. There were no air brakes. For landing the inner section of the flaps could be lowered ninety degrees, and there was a tail-braking parachute in the rudder, as with the Cirrus. The centre section of the wing was skinned with glass and balsa wood sandwich. Construction methods were otherwise similar to those now in regular use for Cirrus production. A method of joining the outer wings to the centerpiece was required. Holighaus solved this problem and patented his solution.

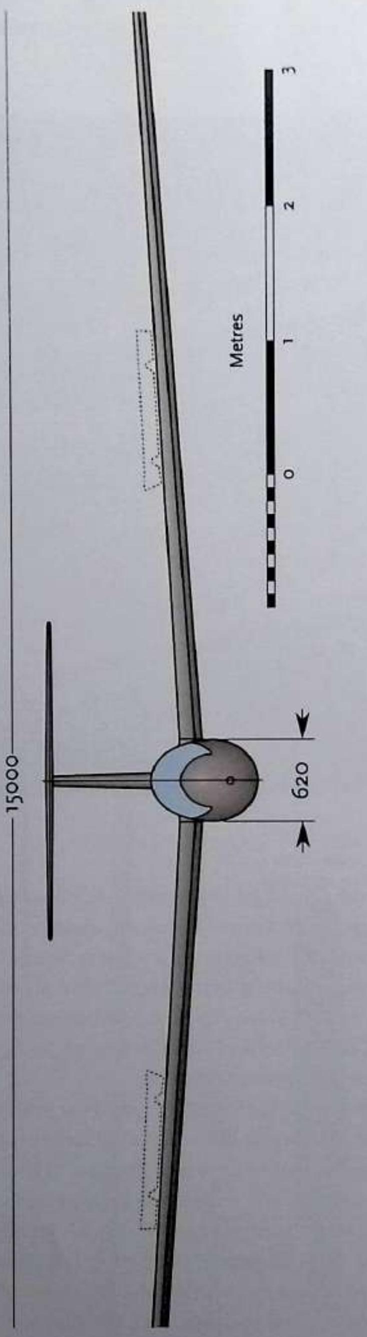
The performance in straight flight was outstanding with a best glide radio better than 50:1, but the Nimbus was not easy to handle. Adverse vortex drag caused by applying the ailerons yawed the sailplane the wrong way when starting turns, or coming out of them. Holighaus, after a few flights, fitted drag spoilers at the wing tips to help but these were not effective until full aileron was applied. At this stage they tended to 'snatch'. When circling, it was necessary to hold off bank strongly. These effects, together with the moment of inertia in the yawing plane of the very long, massive wings, made it hard to start a turn and hard to come out of it. In the hands of an experienced pilot these disadvantages could be overcome but Holighaus himself had some difficulties when landing in the early weeks after the first flight. The braking parachute was not reliable and the landing flaps by themselves were inadequate. There were several seriously overshot landings, one at least resulting in some damage.

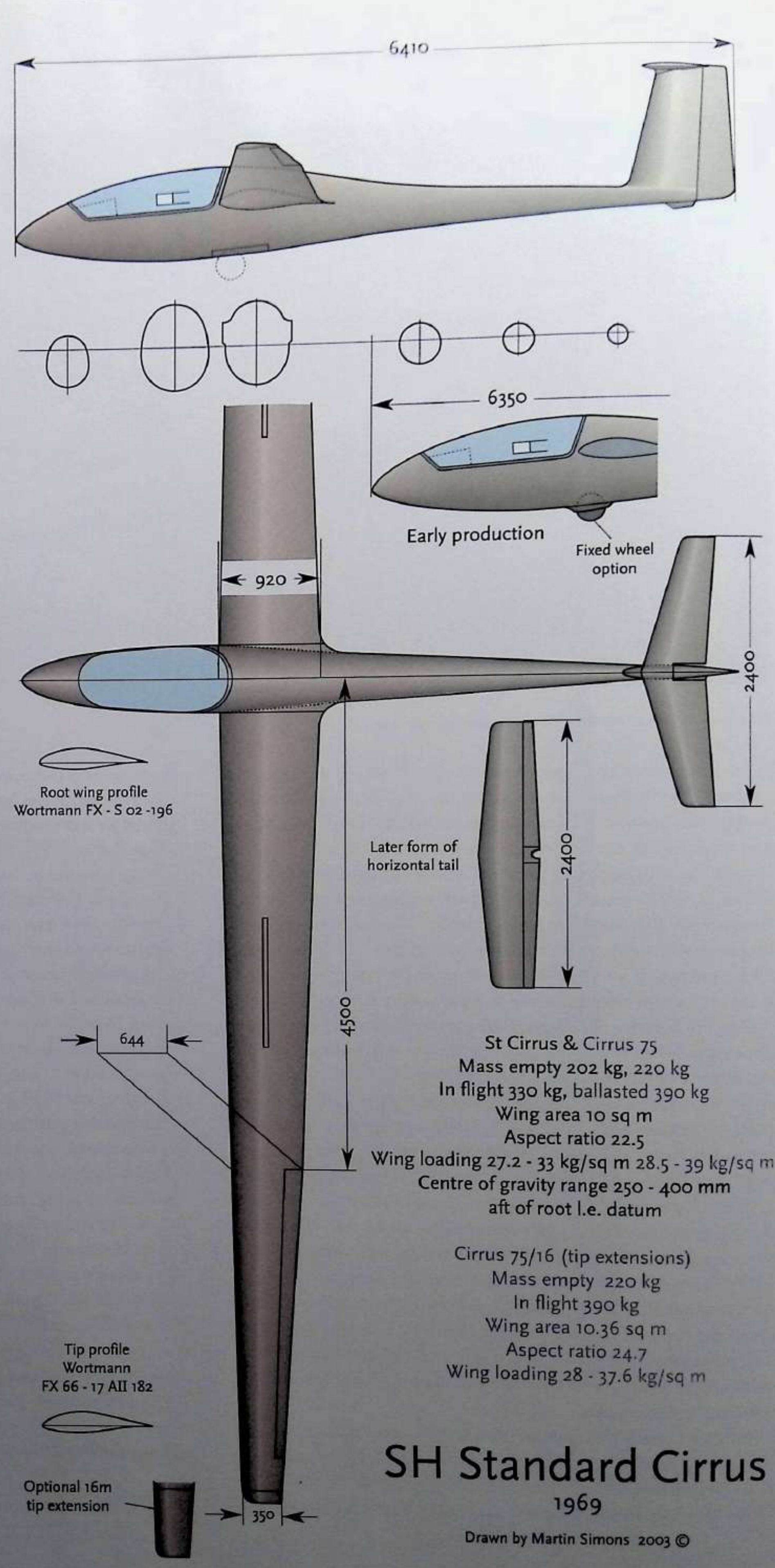
Holighaus himself was not selected for the German team to fly in the Open Class at the 1970 World Championships at Marfa in Texas. Hans Werner Grosse after trying the Nimbus, decided he would prefer his ASW - 12, which admittedly was not free from problems itself. Walter Neubert preferred the Glasflügel 604, which had flown a few months before. It was equal in span to the Nimbus but easier to manage and he was familiar with it. Holighaus offered the Nimbus to George Moffat, who accepted but a long anxious wait followed before the ship, several days late, arrived in Newark. The Nimbus was eventually released by customs authorities and taken by road to Texas, arriving only a few days before the opening ceremony.

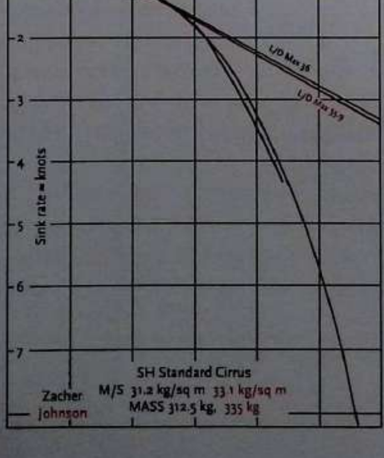
Moffat found the Nimbus more than difficult, the first problem being getting himself into the cockpit. A special modification had to be made to the rudder pedals. Once he was in, he said, "The ship seemed to prefer flying sideways. Full rudder did little or nothing for several seconds until finally the nose began to move." Trying to enter thermals: "With the pilot desperately applying full aileron and rudder, the Nimbus would sail on by in a stately manner, altering course not a millimetre. Several seconds later, the thermal being well passed, the wing would drop violently, necessitating full opposite controls." If he allowed the airspeed to rise too far, there was flutter. Having had hardly any time to practice with the monster, Moffat did badly on the first day, a 'prescribed area distance' task or 'cats cradle' in which pilots had to visit, and photograph, as many distant turning points as possible.[36] Moffat's distance was a modest 287 km. The Polish pilot Ed Makula in a 17 metre span, wooden Kobra, achieved more than 500. Moffat was 21st! He began, day by day, to improve his position.

On the fifth day, he confronted an emergency. Banking steeply to take a turning point photograph and, as usual, inadvertently sideslipping, he found himself with no warning in a spin. Holighaus had never attempted to spin his creation and had warned Moffat

36 – For Neubert's adventure on this day see under Glasflügel 604, p. 115.







St Cirrus & Cirrus 75
Mass empty 202 kg, 220 kg
In flight 330 kg, ballasted 390 kg
Wing area 10 sq m
Aspect ratio 22.5
Wing loading 27.2 - 33 kg/sq m 28.5 - 39 kg/sq m
Centre of gravity range 250 - 400 mm
aft of root l.e. datum

Cirrus 75/16 (tip extensions)
Mass empty 220 kg
In flight 390 kg
Wing area 10.36 sq m
Aspect ratio 24.7
Wing loading 28 - 37.6 kg/sq m

SH Standard Cirrus

1969

Drawn by Martin Simons 2003 ©

against it. With the altimeter unwinding rapidly, the standard recovery technique did not work. The inertia of the long wings kept the sailplane rotating against the full power of the rudder. Moffat was preparing to bale out. He then remembered hearing that Gerhard Waibel when flying the 'gummiflügel' D - 36 had managed to bring it out of a spin by rocking the stick strongly back and forth to cause the flexible wings to bend violently. Moffat did the same and it worked. He continued on task and won the day. The problem was discovered to be a jammed valve in the ballast tank of one wing. He had jettisoned ballast earlier, but about 50 kg of water remained on one side, three metres off centre. He had not noticed this asymmetry in straight flight.

By the end of the Championship Moffat and the Nimbus had won five days out of nine and he was World Champion.

After this the Nimbus returned across the Atlantic and was bought by the French Airforce. Not surprisingly, it was severely broken before very long. Holighaus, who had a great affection for his aircraft, was able, after long delays, to take the wreckage back and restore it.

SH - Standard Cirrus

The demand for Standard Class sailplanes was always greater than that for the large and costly Open Class aircraft which, by the late 'sixties, were growing larger and larger in span and price. It made excellent sense for Schempp-Hirth to give attention to the smaller and simpler competition class. A fifteen-metre version of the Cirrus was called for, and by using the same name the prestige of a World Championship winner would be attached to the new type immediately.

Holighaus began design work on the Standard Cirrus in 1968. The prototype flew in March 1969, four weeks after the first flight of his Nimbus. It won the Hahnweide competition in summer the same year, and placed second in the German National Standard Class Championships a few weeks later. Production was already under way by then and five competed at Marfa in June 1970. Tom Mix, of Canada, placed fourth. He was beaten by Helmut Reichmann in the LS - 1, and by the Polish pilots Jan Wroblweski and Francisek Kepka, both of whom were flying new, wooden, Kobra 15s.

The St Cirrus was in appearance very much like a small Cirrus but it had a T tail with an all-moving, swept back, elevator. The Wortmann wing profiles were also different, and the airbrakes opened on the upper surface of the wing only. Methods of construction followed what was now Holighaus' usual practice, a strong steel tube central frame inside a shell fuselage, with glass roving main wing spars and plastic-foam-glass sandwich skins. Changes to the Standard Class rules allowed the Cirrus to have a retracting wheel. A fixed undercarriage was offered as an option but hardly ever chosen by customers.

The St Cirrus prototype had not been entirely satisfactory in the first flight tests. The low speed handling still left something to be desired, with a tendency to drop a wing sharply at the stall. The wing washout was increased to improve this. Washout was increased further for later production series. The 'stick free' longitudinal stability was not high and the all-moving tailplane was lacking in 'feel'. (This led to a spectacular incident at Waikerie in Australia. A pilot unwisely having undone his straps while leaning forward to reach something he had dropped, with his hand off the stick, ran into sudden turbulence. The Cirrus instantly pitched over, ejecting him through the shattered canopy. He had enough presence of mind to pull his parachute ripcord and descended unhurt, to land a few yards away from the broken glider lying upside down on the ground.)

In 1972 modifications were introduced, further taming what some pilots regarded as a rather tricky aircraft. After this, the new type was very good in all respects and became very popular, not only for competition flying but for general club use. The Cirrus 75 and 78 followed, with fixed tailplanes and other refinements.

In 1977 an experiment, suggested by Burkhardt Grob, was carried out at Mindelheim. Modifying an existing St Cirrus, the wing was mounted above the fuselage on a 100mm high pylon, to discover if there was any saving in interference drag. Results were not favourable. A Cirrus with a retracting motor was also built for Helmut Reichmann to fly in the Motor Glider competitions at Burg Feuerstein in 1976. At a late stage, the St Cirrus was sometimes fitted with wing tip extensions to produce a span of 16 metres, with an improvement in the low speed performance.

Performance tests by Paul Bikle early in 1970 showed an early production St Cirrus had a best glide ratio almost exactly the same as the contemporary LS 1C and ASW 15, and slightly better than the St Libelle. At higher airspeeds, the Cirrus was measurably superior. Tests by

Standard Cirrus at Marfa, USA , flown by J.C. Wright, Contest Director (Photo A. Aldott)

Standard Cirrus with brakes partly out, over Waikerie, S Australia

Johnson and Zacher's group later confirmed the figures. How influential these results were in affecting sales is not known, but the St Cirrus became one of the most popular and successful sailplanes. Factory space at Schempp-Hirth was insufficient to meet orders, especially when the firm progressed to new types. Sub-contractors and licensees were called in. Of the 740 built up to 1979, 200 were by Grob, others had been produced in Yugoslavia and France.

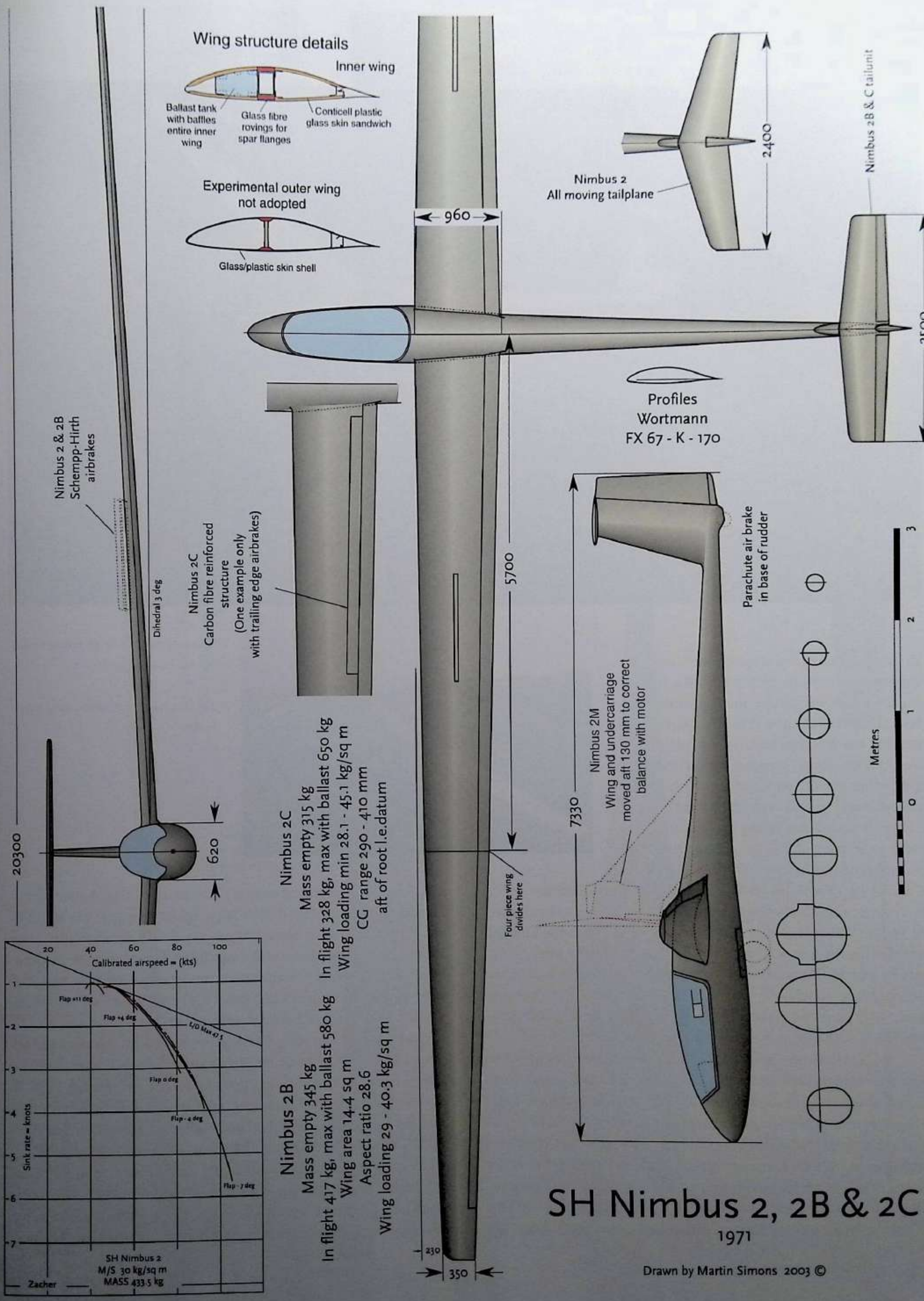
Contest results for the St Cirrus were consistently good. The St Cirrus won many National Championships and lesser contests. Yet a World Championships win was elusive. The closest it ever came was in 1974 when Ingo Renner was foiled on the very last day by a fault in his St Cirrus air brakes, which slowed him down and allowed Helmut Reichmann, in the LS - 2, to achieve a small winning margin.

SH - Nimbus 2

It was clearly not possible to put the Nimbus, as Holighaus had originally built and flown it, into production. It was necessary to design a new sailplane, using a similar wing incorporating all the lessons learned, while still aiming for the highest possible performance for Open Class competitions.

The span of the Nimbus 2 was 20.3 metres, which Holighaus reckoned would give a good enough performance without serious control problems. With flaps and large span ailerons, the wing was in four sections, with the same Wortmann profiles. The outer wings were identical to those of the Nimbus 1. To make for easier management on the ground, rigging and de-rigging, the inner wing sections were kept down to 80 kg each. One person could lift the root end. Ballast tanks to carry 150 kg of water were fitted ahead of the main spar, as close as possible to the root. The inner flaps could be depressed to 20 degrees for landing. With flaps down and the large upper surface air brakes it was not difficult to get the aircraft down, but the brake parachute (if it opened when it should) could be used if necessary to get into small fields.

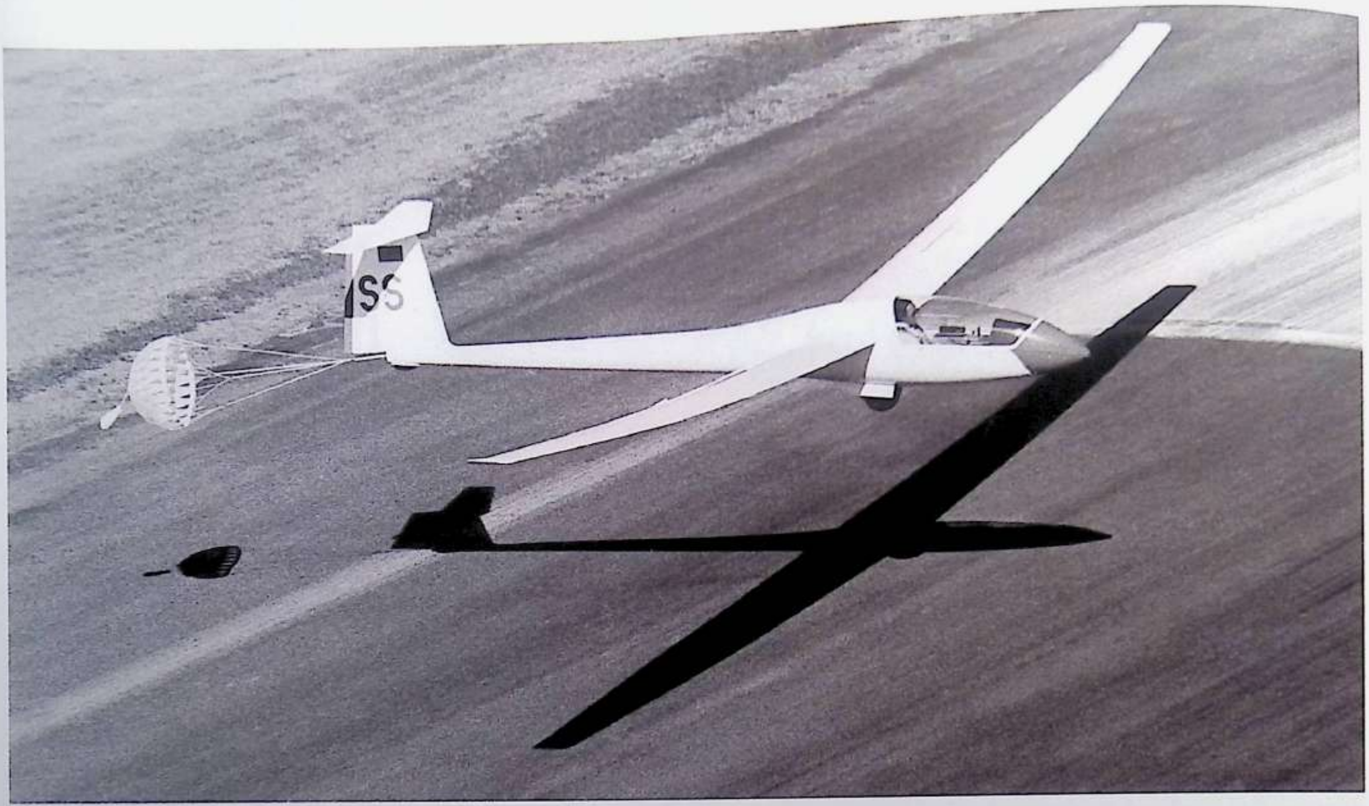
The fuselage and wing mounting owed more to the original Cirrus and Standard Cirrus than to the Nimbus 1. The cockpit was roomy and laid out very much like the Standard Cirrus with the addition of the flap control lever and a tail braking parachute handle. The same



SH Nimbus 2, 2B & 2C

1971

Drawn by Martin Simons 2003 ©



Above: Nimbus 2 with parachute brake, in New Zealand

Left: The Nimbus 2C with trailing edge brakes

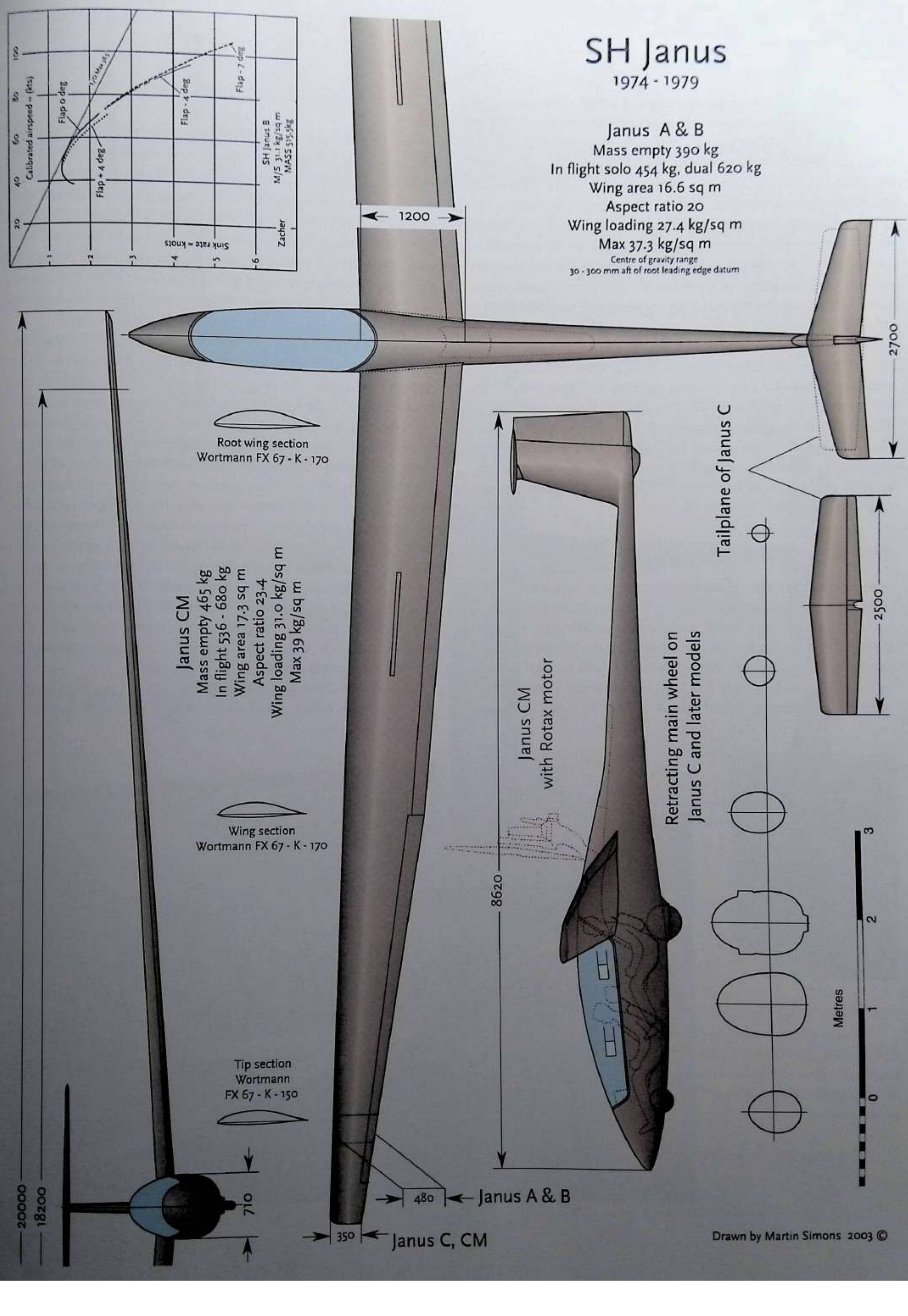
all-moving T-mounted tailplane was used as for the St Cirrus with no increase in area, but the moment arm was longer and the vertical tail area increased. Despite this, the longitudinal stability was marginal and in the yawing plane the pilot was always aware of the inertia of the long wings. Rudder power on large sailplanes is almost always less than the pilot would like.

The Nimbus 2 was flying by April 1971, entered production and became recognised as an outstanding performer. The Swedish pilot Goran Ax won with his Nimbus in the 1972 World Championships at Vrsac in Yugoslavia. There were eight Nimbus in the field of 38. In 1974 at Waikerie George Moffat in a Nimbus 2 won the Championships for the second time. In 1976 in Finland there were 7 Nimbus in the top 15 places. Holighaus himself placed fourth but George Lee in an ASW 17 won, with two Polish Jantars in close pursuit. There were other sailplanes with performance as good as the Nimbus 2, but the popularity of the type did not diminish.

As production continued improvements were introduced, often without changing the nomenclature. In 1976, ballast capacity was increased to 160 kg, the tanks extending all the way along the inner wing. The maximum permitted airspeed was raised from 220 to 250 km/h (120 to 135 knots). There was a larger rudder and improved tailplane. In 1978 for the first time carbon fibre material was introduced as an option for buyers prepared to pay more for the advantages. The Nimbus 2B followed, with a fixed tailplane and elevator replacing the all moving surface, still more ballast capacity (210 kg) and, because of improved accuracy in manufacturing, better performance. Then came the Nimbus 2C, a lighter structure in carbon fibre, the unladen mass down from 345 to 315 kg. Large trailing edge airbrakes similar to those of the Glasflügel Mosquito were incorporated in some examples and there was another increase in maximum permitted speed to 270 km/h (145kts). A total of 190 of the Nimbus 2 was reached before production ended.

Apart from contest successes, the list of records, national and international, broken by pilots flying the Nimbus 2, is impressive. They include a World Goal Distance record of 1254km (779.36 miles) in January 1978, flown in lee waves by three Nimbus pilots working as a team, in New Zealand. Holighaus himself, in his Nimbus 2C, flew the first 1000km triangle in Germany in May 1979.

The quantity of ballast commonly carried now by Open Class sailplanes, was about equal to two additional pilots. The water could be jettisoned if a pilot was struggling in poor conditions, but in practice this was not often necessary and the ballast would usual-



SH Janus
1974 - 1979
Janus A & B
Mass empty 390 kg
In flight solo 454 kg, dual 620 kg
Wing area 16.6 sq m
Aspect ratio 20
Wing loading 27.4 kg/sq m
Max 37.3 kg/sq m
Centre of gravity range
30 - 300 mm aft of root leading edge datum
Calibrated airspeed ~ (kts)
Sink rate ~ knots
Flap 0 deg
Flap + 4 deg
Flap - 4 deg
Flap - 7 deg
SH Janus B
M/S 31.1 kg/sq m
MASS 515.5kg
Zacher
1200
2700
2500
Tailplane of Janus C
Root wing section
Wortmann FX 67 - K - 170
Janus CM
Mass empty 465 kg
In flight 536 - 680 kg
Wing area 17.3 sq m
Aspect ratio 23.4
Wing loading 31.0 kg/sq m
Max 39 kg/sq m
Janus CM
with Rotax motor
Retracting main wheel on
Janus C and later models
Wing section
Wortmann FX 67 - K - 170
8620
Metres
0
1
2
3
Tip section
Wortmann
FX 67 - K - 150
20000
18200
710
480
Janus A & B
350
Janus C, CM
Drawn by Martin Simons 2003 ©

ly be released only during the last stages of a final glide and circuit for landing. It was usual to see sailplanes crossing the finish line in races with a trail or several trails of water streaming behind. They would still be draining tanks as they rolled to a standstill after landing. From the point of view of weight it was no longer difficult to adapt a sailplane to take a retractable power unit. The Nimbus 2M of 1974, with a motor and propeller mounted on a retracting pylon, was a necessary development. Jürgen Laude was chiefly responsible for the design, working with Walter Binder who was the chief expert on motor sailplanes in Germany. To adjust the balance, it was necessary to move the wing and the undercarriage back slightly, but otherwise few external alterations were necessary.

Holighaus was conscious at this time that full advantage was not being taken of the carbon fibre materials. The Nimbus 2C was, aerodynamically, no great advance on what had gone before. The wing, designed originally for GRP, was thicker than it needed to be if built with carbon. The Wortmann profiles were beginning to look old fashioned. The stage was set for something better and bigger. As a preliminary, the Nimbus 2CS flew in 1980 with wing tip extensions to give a span of 23.5 metres. With this Holighaus won the German Open Class Nationals that year.

SH - Janus

There has always been some demand for high performance two seat sailplanes, for instruction in cross-country flying and racing and also because many pilots enjoy flying in company. A project for a high performance two seater had been on Holighaus' drafting board for years before Schempp-Hirth finally decided to enter this market. The Company had built no two-seaters since the old 'side-by-side' seating Göppingen 4 or Gövier. A few had been built at Nabern in 1951 but the basic design of the Gö 4 went back to 1939.

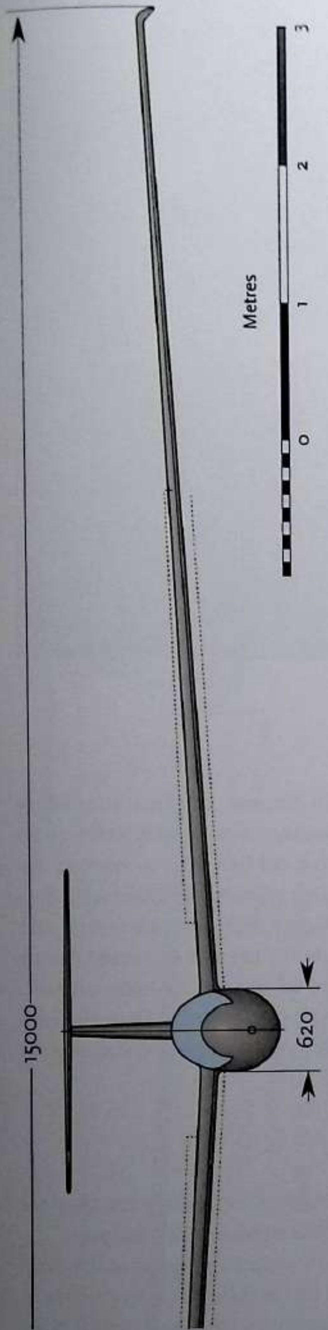
There were no major competitions for two-seaters now. The last time such a Class had been recognised in World Championships was in 1956. Nonetheless, it might still be possible for a good two-seater to challenge single-seaters. The Braunschweig Akaflieg was busy with the SB - 10, which Jürgen Laude knew all about. Wolf Lemke flew the 'one off' Ornith in 1972. But, in production, there was no two-seat sailplane in glass-fibre plastic. Holighaus and Laude were entering a new realm. Two pilots had to be accommodated in comfort with dual controls, the performance must still be good enough for serious cross country flying and racing, and the price must not be too high.

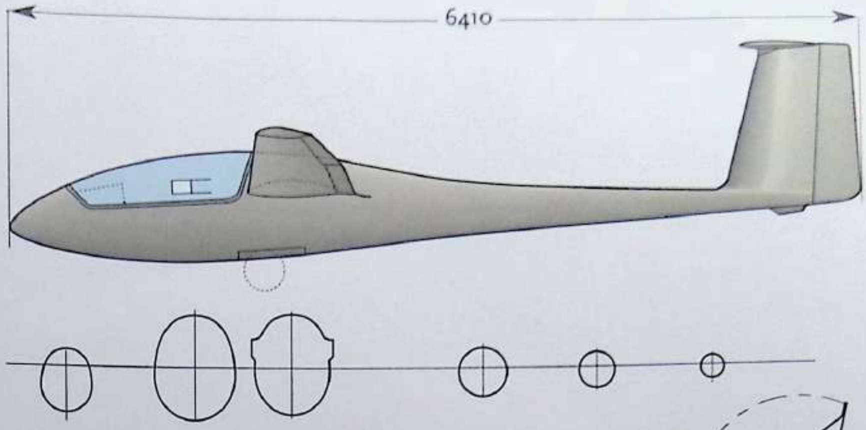
The design that emerged for the first flights in 1974 was called Janus, though not because the pilots, like the ancient god, faced in different directions. The seats were in tandem, with, as usual, the rudder pedals for the rear pilot on either side of the front seat. The fuselage thus had to be somewhat wider than for a single seater. Two seats also made it difficult to arrange the undercarriage, which was not retractable. The longitudinal position of the centre of gravity in flight would be above the rear seat. The main wheel could not be directly under this point because then the fuselage would have to be made excessively deep. With the main wheel behind the rear cockpit the nose of the glider would go down to the ground when the crew were in place. Older gliders had skids. The Janus had a nose wheel. This had many advantages. During take off it was easy to hold the sailplane straight during the slow part of the run before the airspeed was enough to give rudder control. On landing the wheel brake could be applied firmly without danger of damaging the belly by pitching tail up.

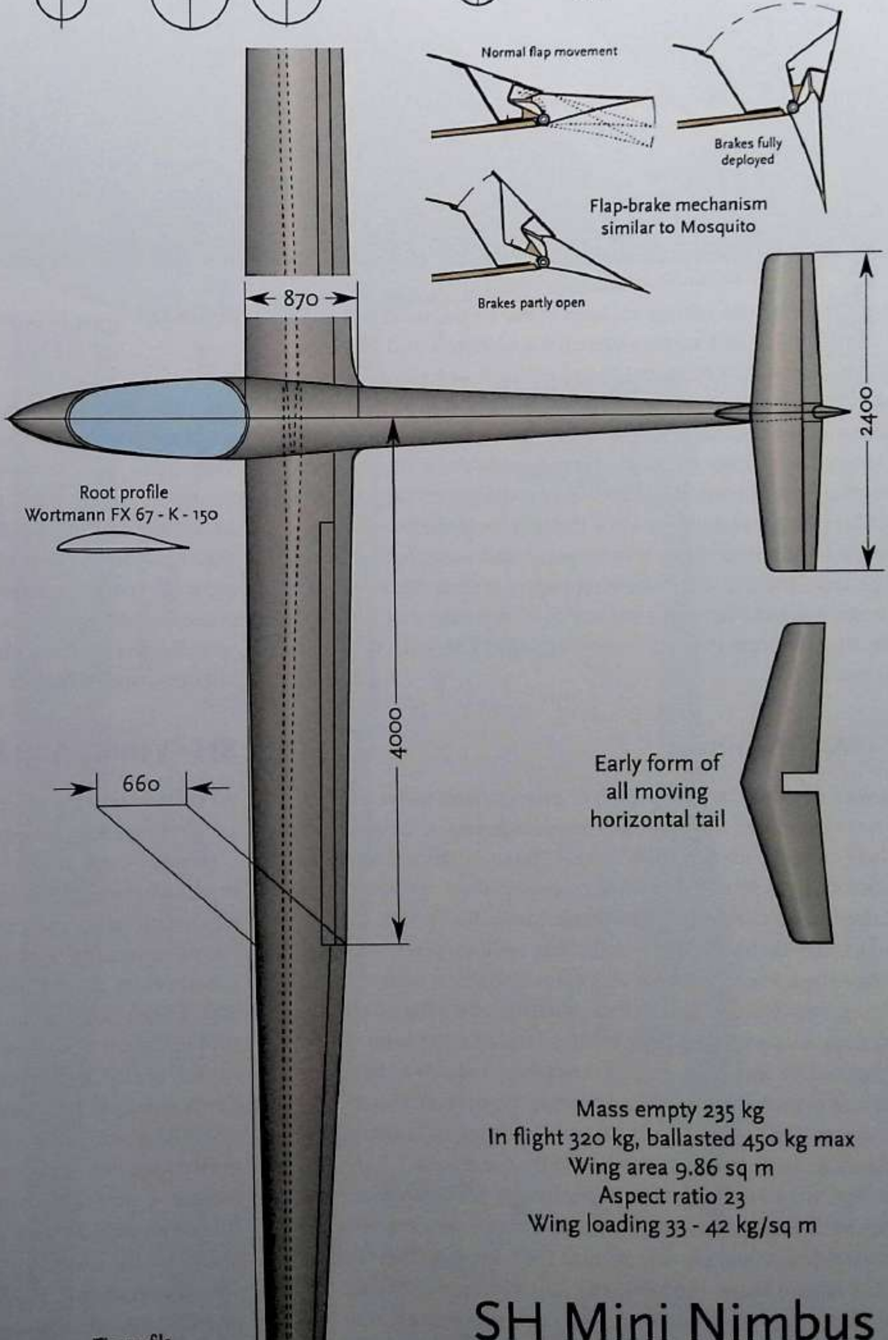
The wing, with flaps, was aerodynamically similar to the Nimbus with a reduced span and swept forward to bring the aerody-

Above: The Janus cockpit

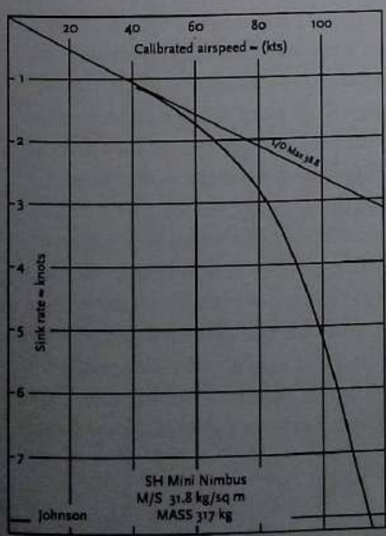
Right: The Schempp-Hirth staff assemble to celebrate completion of the 50th Janus. By 1979, 100 had been built.







Early form of all moving horizontal tail



Mass empty 235 kg
In flight 320 kg, ballasted 450 kg max
Wing area 9.86 sq m
Aspect ratio 23
Wing loading 33 - 42 kg/sq m

SH Mini Nimbus

1976

Drawn by Martin Simons 2003 ©

Mini-Nimbus showing flaps deployed

namic centre of the lifting surfaces close to the balance point. The second pilot had an excellent field of vision and the Janus could be flown solo from the front without any need for trimming ballast. The tail unit was essentially the same as the Nimbus 2 but proportionately larger.

The Janus proved very popular. The best glide ratio, slightly more than 40:1, was at least equal to the current generation of Standard Class single seaters. In 1978 Helmut Treiber flew the Janus B, with a tailplane/elevator arrangement and water ballast tanks, for the first time. In the following year a carbon-fibre wing for the Janus was offered with a reduction of the structure weight to 365kg. Finally came the self-launching Janus CM, with retracting Rotax motor.

SH - Mini-Nimbus

The announcement in March 1975 of a new fifteen-metre competition class prompted all the major manufacturers to develop new sailplanes in time for the 1978 World Championships. There were no restrictions as to variable wing geometry, flaps, ballast, brakes, retracting wheels, etc. The Glasflügel Mosquito, which had the same fuselage as the Hornet, was already well advanced when Eugen Hänle died. For a time after this Klaus Holighaus was effectively managing two Companies, Schempp-Hirth and Glasflügel. The wings of the Mosquito and the new SH - Mini-Nimbus were virtually the same. The ingenious flap-brake system, conceived by Hänle, was carried to completion by the Schempp-Hirth team and used on both aircraft. The Mosquito was ready first, flying in January 1976, the Mini-Nimbus not until September of that year.

Although they handled well, performance tests indicated that both the Mini-Nimbus and the Mosquito did not perform as well as the outstanding ASW - 20, which from 1978 for some years dominated the Fifteen Metre contest scene. The reason was chiefly that the Nimbus wing, from which the Mini-Nimbus came, was now somewhat out of date. The thinner Wortmann profiles used for the ASW 20 gave it a considerable advantage at high airspeeds.

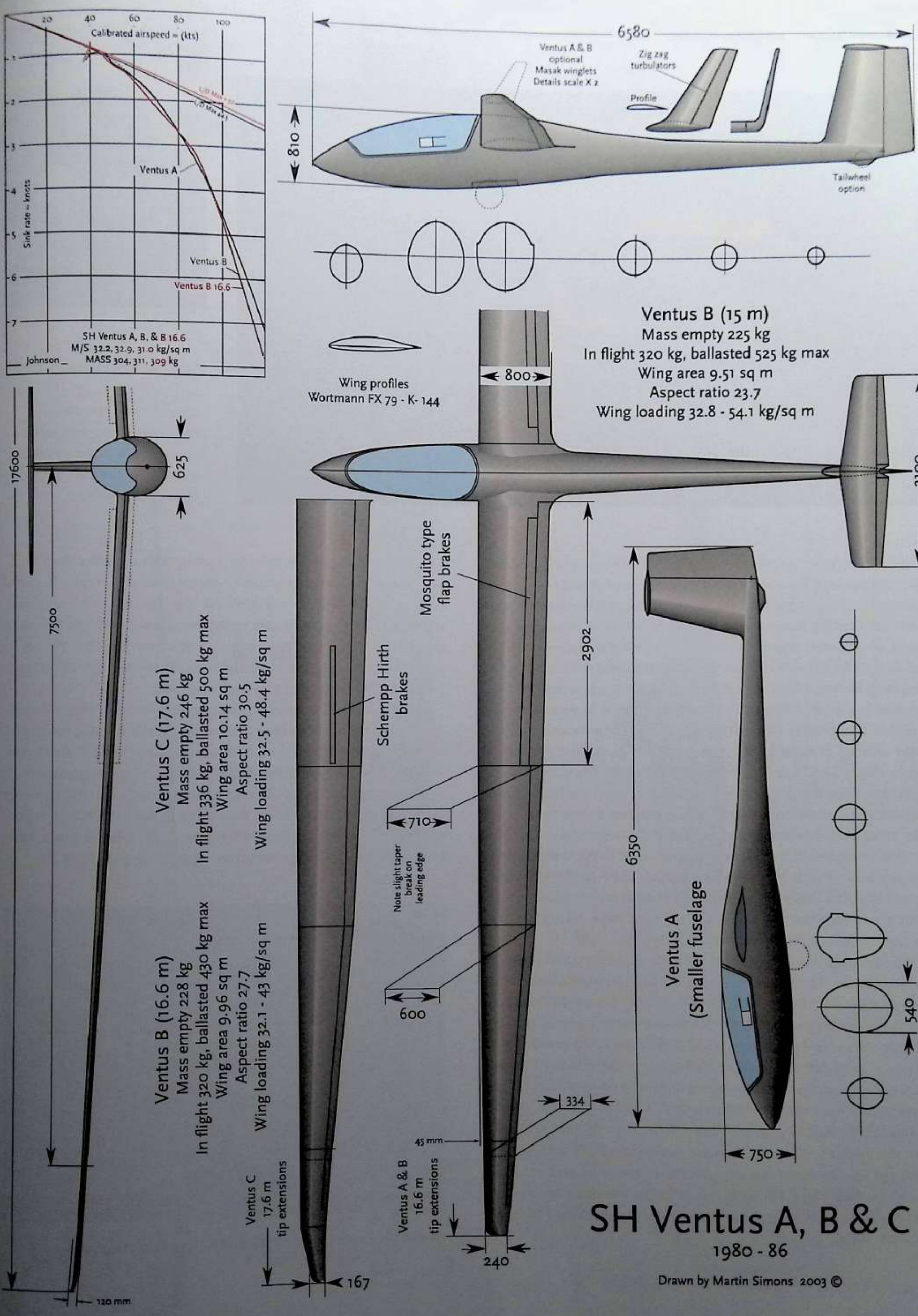
Like the large Nimbus, the Mini-Nimbus had an all-moving tailplane, which many pilots were beginning to dislike. Research by Wortmann demonstrated that such a tail had little or no drag advantage over the fixed tailplane and elevator arrangement. The Mini-Nimbus B appeared in 1979, with tailplane and elevator, and the Mini-Nimbus C, with some carbon fibre and increased ballast capacity, soon afterwards. Over 200 of all versions were ordered. Some disappointment was nevertheless felt with the Mini-Nimbus, which never achieved the kind of contest record and consequent sales that were hoped for.

SH - Ventus A, B & C

By 1980, to take the place of the Mini-Nimbus there was a need for a fully competitive Schempp-Hirth Fifteen Metre Class sailplane.

Less-expensive carbon fibre was now available. Instead of the earlier manufacturing technique, which had required a costly process of depositing carbon on tungsten filaments, the newer methods involved carbonising synthetic fibres at high temperatures. Carbon fibre was three times stiffer than glass, 60% stronger in tension, but 20% lighter. With such material, wings could be made thinner, stronger, stiffer and more accurate. The wing of the new Ventus was entirely of CRP, spars with carbon fibre rovings and skins of fine carbon woven cloth laid diagonally for improved stiffness in torsion.

Working with Wortmann and Althaus at the Stuttgart University wind tunnels, over a period of two years Klaus Holighaus developed a new wing profile, the FX 79 - K - 144. (14.4% thick compared with 17% for the old Nimbus wing.) Turbulators were placed on the undersurface to forestall the development of laminar separation bubbles. Attention was also give to the problem of insect contamination in flight. The new profile shape was less likely to pick up 'bugs', and less likely to suffer increased drag from those it did collect.



Calibrated airspeed = (kts)
20 40 60 80 100
Sink rate = knots
1 2 3 4 5 6 7
L/D Max =
L/D Max
Ventus A
Ventus B
Ventus B 16.6
SH Ventus A, B, & B 16.6
M/S 32.2, 32.9, 31.0 kg/sq m
MASS 304, 311, 309 kg
Johnson
6580
Ventus A & B optional Masak winglets Details scale X 2
Zig zag turbulators
Profile
810
Tailwheel option
Ventus B (15 m)
Mass empty 225 kg
In flight 320 kg, ballasted 525 kg max
Wing area 9.51 sq m
Aspect ratio 23.7
Wing loading 32.8 - 54.1 kg/sq m
Wing profiles
Wortmann FX 79 - K- 144
800
2100
17600
625
7500
Ventus C (17.6 m)
Mass empty 246 kg
In flight 336 kg, ballasted 500 kg max
Wing area 10.14 sq m
Aspect ratio 30.5
Wing loading 32.5 - 48.4 kg/sq m
Ventus B (16.6 m)
Mass empty 228 kg
In flight 320 kg, ballasted 430 kg max
Wing area 9.96 sq m
Aspect ratio 27.7
Wing loading 32.1 - 43 kg/sq m
Mosquito type flap brakes
Schempp Hirth brakes
2902
710
Note slight taper break on leading edge
600
6350
Ventus A (Smaller fuselage)
540
334
45 mm
750
Ventus C 17.6 m tip extensions
Ventus A & B 16.6 m tip extensions
240
167
120 mm
SH Ventus A, B & C
1980 - 86
Drawn by Martin Simons 2003 ©

Above: The Ventus Cockpit

Left: Ventus CM. Peter Dittmar, shortly before landing looks back at the impressive lenticular of Pic de Bur in French Maritime Alps. (Photo Claus-Dieter Zink)

On the principle that every possible gain in efficiency should be exploited, the wing plan adopted was triple tapered. It had been known since the nineteen-twenties, that for minimum vortex drag the spanwise lift loading across a wing should be elliptical. This shares the work evenly, area for area. Every part of the wing contributes its share of drag. So for greatest efficiency, every part should contribute its proportionate share of lift. This did not mean in practice that the wing should be a perfect ellipse in plan although a few famous aeroplanes such as the Heinkel 70 and the Spitfire, had approached this. It is very difficult to make such a truly elliptically curved wing, especially since ailerons and flap hinges have to be straight. The usual compromise has been taper. A simple straight taper, as on the LS - 3, comes fairly close to the elliptical loading, but tapering in two stages is better. Triple taper, like the Ventus, is fractionally better still.

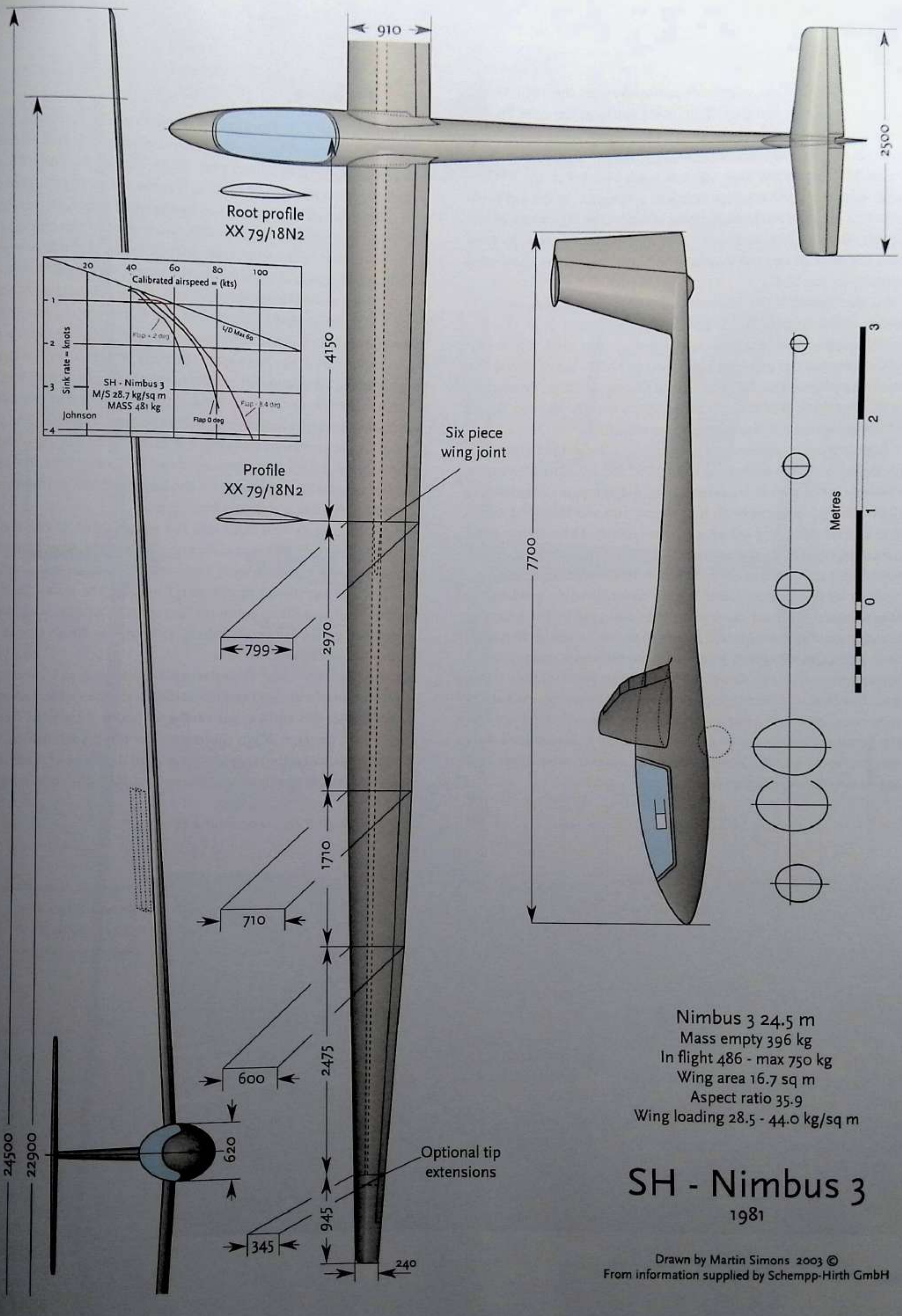
The well-proved, but rather complex flap brake system of the Mosquito and Mini-Nimbus was retained. The T tail layout was by now fully orthodox and accepted. The chief aerodynamic reason for this was to keep the tailplane out of the wing wake, allowing it to be reduced in size, creating less drag. It was made of CRP.

The fuselage was offered in two different sizes to suit larger and smaller pilots. The Ventus A, which Holighaus himself flew in prototype form early in May 1980, was shorter with a smaller cross section. The B version, flown first a few days later, had a longer and slightly fatter fuselage and weighed slightly more. In practice, slim pilots of average height had no difficulty getting into the Ventus A and found it comfortable, with a sensation of being part of the aircraft rather than sitting separately from it. Dick Johnson, slender but fairly tall, had to wear thin-soled shoes or even none at all, and put the rudder pedals fully forward. Anyone over 184 cm tall could manage only by removing most of the instrument panel to make room for their knees. For them, the B model was more appropriate. Production of both versions began almost immediately after the first test flights.

The Ventus A demonstrated a best glide ratio of better than 44:1, which was unknown for a fifteen-metre sailplane before. In comparison flights against the ASW 20, the Ventus demonstrated a slight superiority at both ends of the speed scale, better in thermals and better at high speeds, but about equal between. The Ventus B, when it came to be measured, had virtually the same performance, losing only very slightly at the higher speeds.

The Ventus A and B could be flown in two versions, fifteen metres span or, with alternative tips, 16.6 metres. Johnson tested the 16.6m Ventus at a glide ratio of 50:1. A Ventus flown by Bruno Gantenbrink won the 1980 German Fifteen metre Championships. Holighaus took a Ventus to the American National Championships in 1981 and won after nine days, with no fewer than seven of the ASW 20 in hot pursuit. Success came again in the US Nationals the following year, Ventus A and B taking the top two places, again beating the ASW 20.

Ventus C flown by Karl Rabeder of Austria at the 1995 World Championships



Nimbus 3 24.5 m
Mass empty 396 kg
In flight 486 - max 750 kg
Wing area 16.7 sq m
Aspect ratio 35.9
Wing loading 28.5 - 44.0 kg/sq m

SH - Nimbus 3
1981

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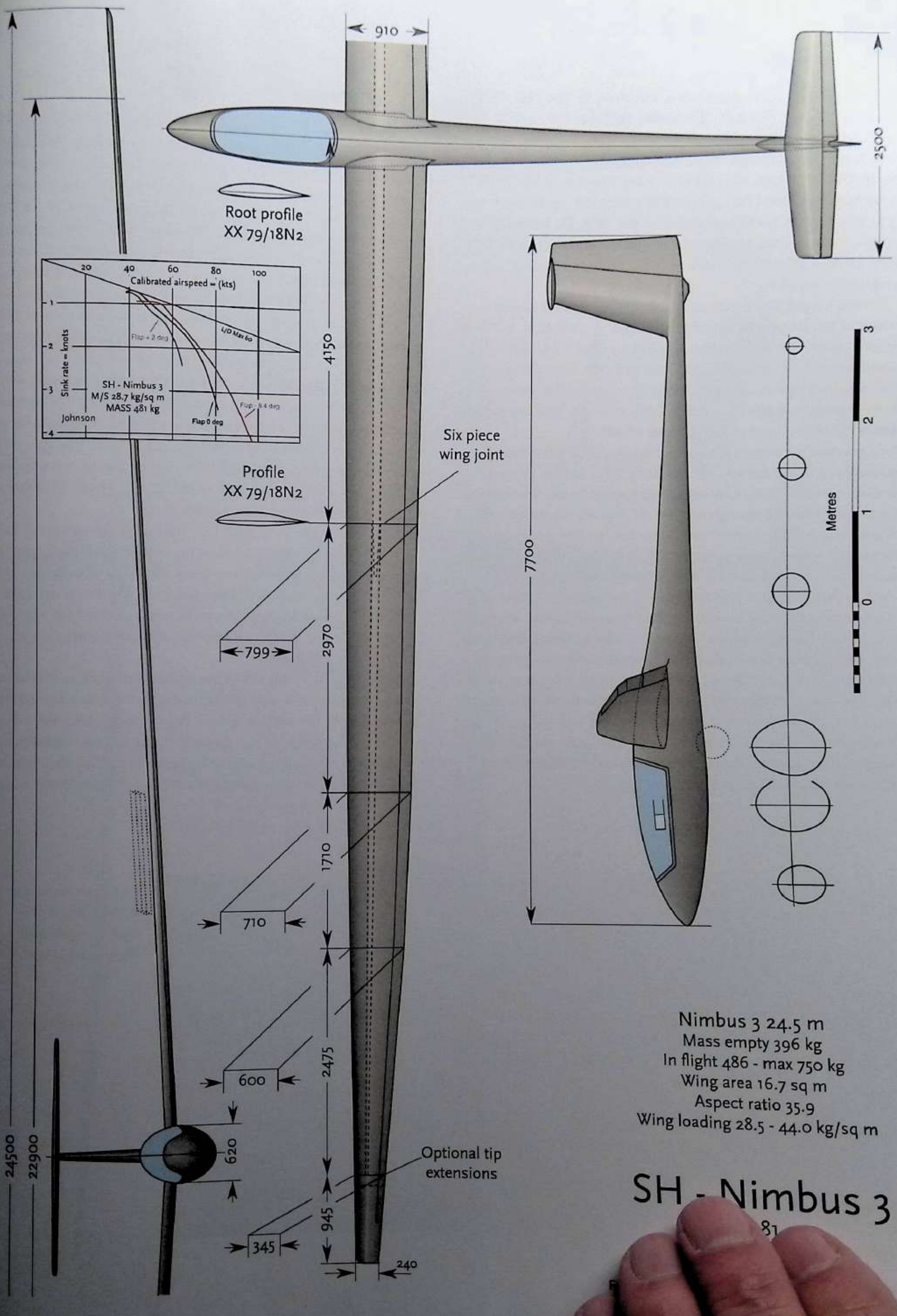


Nimbus 3 24.5 m
Mass empty 396 kg
In flight 486 - max 750 kg
Wing area 16.7 sq m
Aspect ratio 35.9
Wing loading 28.5 - 44.0 kg/sq m

SH - Nimbus 3

81

mbH

The ASW 20 was still competitive, however. In the 1981 World Championships in Germany there were thirty of the ASW 20 in a field of 42. Two Ventus B placed in the top five, but Goran Ax won with his countryman Ake Petersson second, both flying the ASW 20. In 1983 at Hobbs, New Mexico, Keith Musters of the Netherlands won the World Championship in a Ventus A. In the top twenty at this contest, there were seven of the ASW 20, twelve of the Ventus, and a solitary American Zuni in nineteenth place. By 1985 both the ASW 20 and the Ventus were beginning to meet new challenges from the LS 6.

On the Ventus C the elaborate flap brakes were abandoned in favour of the simpler Schempp-Hirth upper surface type. Gantenbrink became World Champion in a Ventus C in 1989. The Ventus C had optional tips extending the span to 17.6m, but of course this was not permitted in 15 Metre World Championships. Production of the Ventus A, B and C ended in 1994, a fifteen-year run during which 613 of the A & B models had been built.

As now was becoming commonplace, versions of the Ventus were produced with self-launching capability and a Ventus BT was also available, with a small retractable power unit capable of sustaining flight. Not powerful enough for take off, this was intended to save the pilot from landing out after a cross-country. The sustaining motor could be used to cruise home. Of the BT model 176 were produced, and about 110 of the self-launching C.

Many of the Ventus A and B were retrospectively modified to take winglets. In some cases these were designed by the American aerodynamicist Peter Masek, rather than the Schempp Hirth factory. From the cockpit in flight, without elaborate measurements it was not possible to detect a difference in performance. There was, however, a distinct improvement in aileron control at low airspeeds, especially during the early stages of a take off run. Dragging a wing tip on the ground was more easily avoided if the winglets were on. The Ventus ailerons, however, were never lacking in sensitivity, winglets or not.

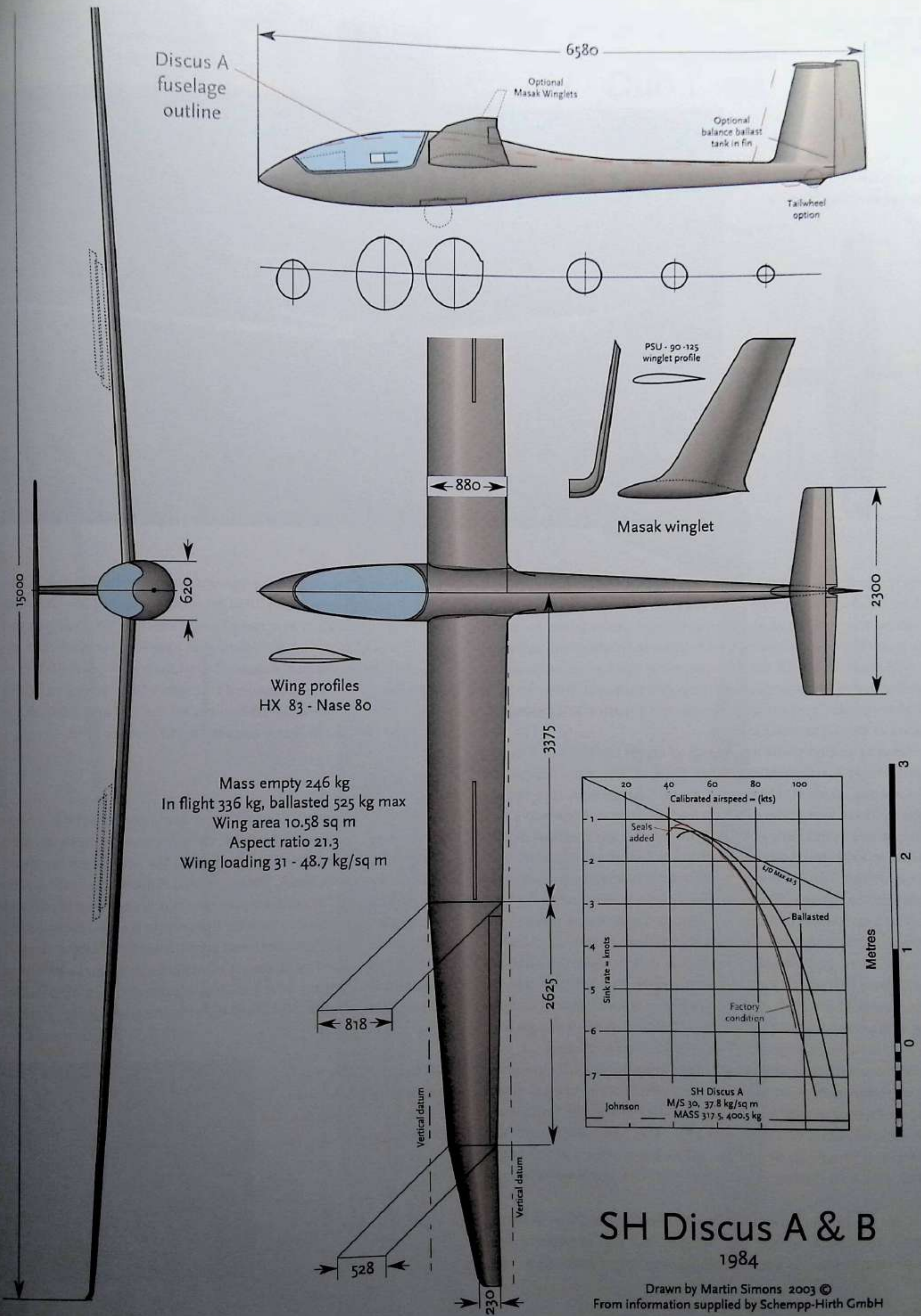
SH - Nimbus 3

New materials, new wing profiles, a new Nimbus. The Nimbus 3, first flown in February 1981 over a snow-covered airfield at Hahnweide, had alternative spans of 22.9 or 24.5 metres. The serious problems of control experienced with the original Nimbus of twelve years earlier, were solved. Part of the solution was a wing made from CRP (carbon-fibre-reinforced plastic) instead of GRP, stronger and stiffer but lighter at the outer ends of the great span. Inertia in yaw and roll were reduced. The wing was in six sections, the inner portions 4.15 metres long with the usual interlocking spar ends at the root adding to this figure when disassembled. The mass of one of these pieces was 53 kg included the air brakes and the inner segment of the wing flaps, and the strongest part of the main spar. The outer section, over 7 metres long, weighing 73 kg and very similar to the whole of a Ventus wing, plugged into the inner, with Holighaus' patent system. The extreme, detachable tips for the longer span were a little over 2 kg each. The total mass of the assembled wing was less than 260 kg. The new wing profiles, derived from those developed for the Ventus, were thinner and were fitted with turbulators on the lower surfaces of the wing, just ahead of the flap and aileron hinge lines.

Four ballast tanks were built into the wings ahead of the main spar. Two of the tanks were as close as possible to the root, two further out near the mid-semi span. The total ballast capacity amounted to 310 kg (like three extra pilots). Dumping the water took 5 minutes. With four filling points on the top surface of the wing and four jettison valves below, a Nimbus 3 crossing the finish line in a race trailed four streams.

The fuselage was longer than the earlier Nimbus 2, so increasing the tail moment arm, and the tail areas themselves were greater. The horizontal tail surface was of the orthodox type with fixed tailplane and elevator. When flown with the full tip extensions, at the extreme outer ends of the ailerons a small drag spoiler operated to aid the rudder in counteracting adverse yaw. With the short wings,

The two-seat version of the Nimbus 3, the 3D, at St Auban during the World Championship in 1997



6580
Discus A fuselage outline
Optional Masak Winglets
Optional balance ballast tank in fin
Tailwheel option
PSU - 90 -125 winglet profile
Masak winglet
880
15000
620
2300
Wing profiles
HX 83 - Nase 80
3375
2625
818
528
230
Vertical datum
Vertical datum
Mass empty 246 kg
In flight 336 kg, ballasted 525 kg max
Wing area 10.58 sq m
Aspect ratio 21.3
Wing loading 31 - 48.7 kg/sq m
Calibrated airspeed – (kts)
20
40
60
80
100
Sink rate – knots
Seals added
L/D Max 42.5
Ballasted
Factory condition
Johnson
SH Discus A
M/S 30, 37.8 kg/sq m
MASS 317.5, 400.5 kg
Metres
0
1
2
3
SH Discus A & B
1984
Drawn by Martin Simons 2003 ©
From information supplied by Schempp-Hirth GmbH

Discus flown by the well known Austrian competion pilot Wolfgang Oppelmayer, south of Hochschwab (Photo Claus-Dieter Zink)

the tip spoilers were not present. This made it slightly more difficult to fly the Nimbus with the short tips than with the long ones. Without the drag spoilers, there was not enough rudder power to enter a turn quickly, or come out of it, without some skidding and slipping.

The Nimbus 3 with the full span wing tips had an outstanding performance, with a measured best glide ratio of about 60:1. At higher speeds the short span version was superior, as expected because of the higher wing loading.

Leading contest pilots were quick to accept the Nimbus 3. In the 1981 World Championships three of them, flown by Englishman George Lee, Klaus Holighaus and Bruno Gantenbrink, took the top places. There were, however, only twelve entrants. There was a very real danger at this time of the Open Class pricing itself out of existence. In 1972 there had been 38 entrants. Now the number had been cut to a third. This did not prevent fifteen of nineteen pilots flying the Nimbus 3 in the next World Championships, in 1983 in New Mexico. Led by Ingo Renner of Australia, the top six places were taken by the Nimbus 3, the only serious challenge coming from three of the Schleicher ASW 22. In the next Internationals in Italy, 1985, the Nimbus 3 took all six first places, Renner winning again, in a field of seventeen. There were, at this time, only two sailplane types capable of competing at this level, the ASW - 22 and the Nimbus 3. Both were expensive. In 1987 in Australia Renner flew an ASW - 22 and won again.

World records were also broken. Tom Knauff of the USA in company with two other pilots in different aircraft, took the out-and-return distance record of 1647 km in 1983 and, by himself, the world triangle distance record of 1363 km in 1986. Speed triangle records also fell to the Nimbus 3, Renner with 195.3 km/h for the 100 km in 1982, J P Castel (France, in South Africa) with 169.5 km/h for 300 km, and 164.11 km/h for 500 km.

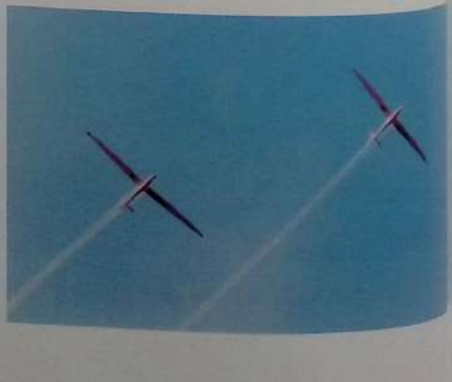
It was now expected that any new sailplane would be available with a retractable motor. The Nimbus 3M was capable of self-launching. It was less usual for an existing single seater to be converted to take two pilots. This was done by with the Nimbus 3D, in 1986. The fuselage was modified from the Janus and the wing was swept forward slightly to achieve correct balance. The rear seat was wholly ahead of the wing, ensuring an excellent view for both pilots. Self-launching and 'sustainer' versions were also available. In one of the latter, Holighaus and co-pilot R Van Tonder in South Africa broke the World Speed Records for the 750 and 1000km triangles, 147.8 and 138.1km/h respectively, in January 1988.

SH - Discus

By 1982 a new Standard Class sailplane from Schempp-Hirth was urgently needed. New 15.7% thick wing sections were devised by Horstmann & Quast, in collaboration with the wind tunnel engineer Dieter Althaus at Stuttgart. These required turbulators on the underside of the wing. The simple zigzag tape was found to be as effective as pneumatic turbulators. Carbon fibre was to be used for the main spars, but less costly glass cloth and plastic foam for the wing skins.

Studies published by Sigismund Hörner as long ago as 1951, had indicated that a wing with generally elliptical chord dimensions should have a slightly up-turned tip with the leading edge curving

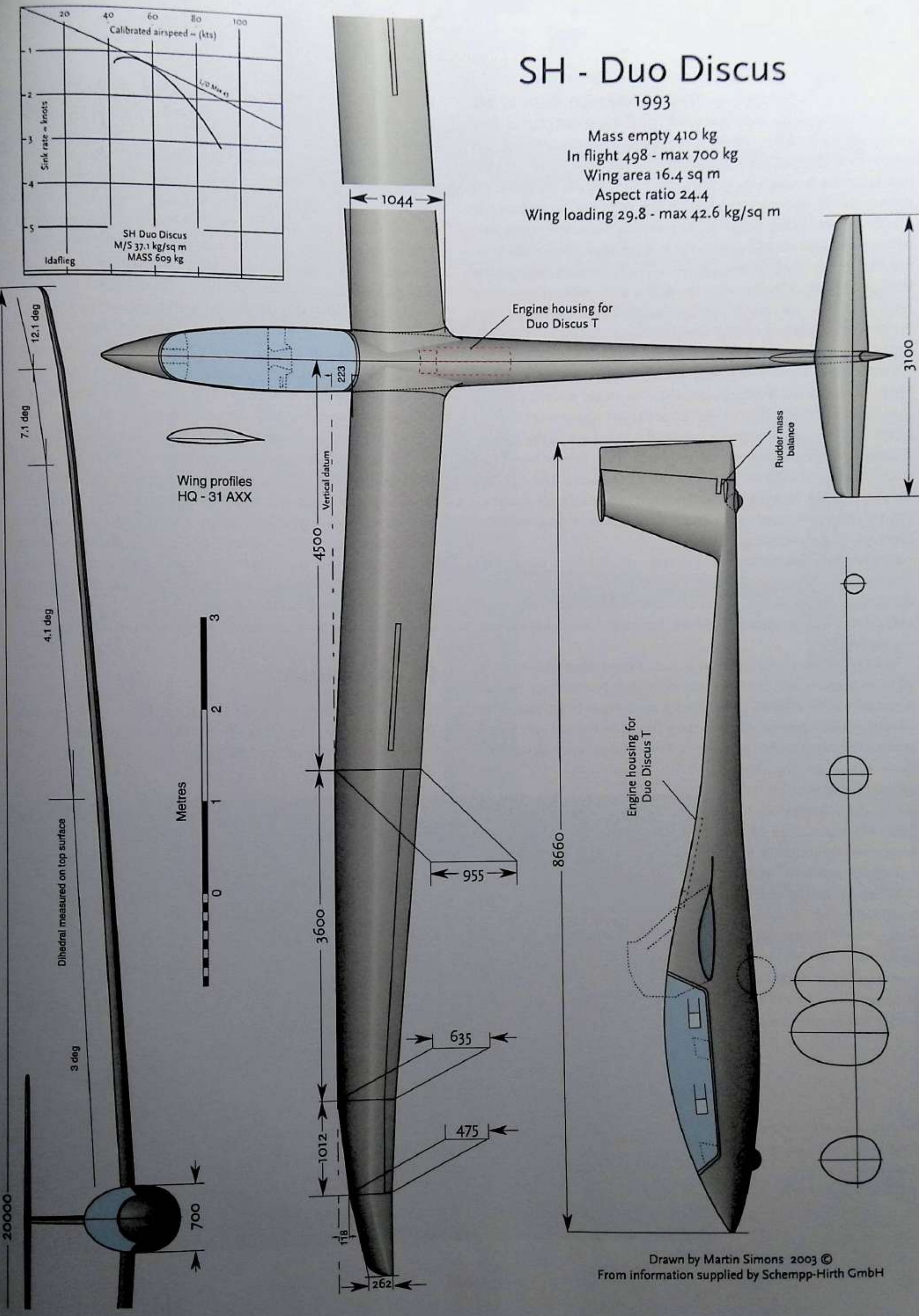
Two Discus crossing the finish line and dumping ballast together in the World Championships, Omarama 1995



SH - Duo Discus

1993

Mass empty 410 kg
In flight 498 - max 700 kg
Wing area 16.4 sq m
Aspect ratio 24.4
Wing loading 29.8 - max 42.6 kg/sq m



Drawn by Martin Simons 2003 ©
From information supplied by Schempp-Hirth GmbH

back to keep the trailing edge straight. Some experiments by Wil Scheumann with his modified ASW - 12[37] suggested that further saving of drag could be obtained by introducing a small amount of sweep back over the outer panels of the wing. The Discus was the first sailplane to adopt these ideas. In plan view the result was an approximately crescent shape. From the centre to about half the semi-span, the leading edge was at ninety degrees to the centre line, with a small amount of taper on the trailing edge. Thence the leading edge angled back in two segments. The outermost metre of the trailing edge was at ninety degrees, with a slight Hörner up-turned tip. Results were very encouraging. (The work by R T Whitcomb on tip winglets in the late nineteen seventies was known, but their value for sailplanes was not yet recognised.)

Ballast tanks capable of taking 190 kg were built into the wing. There were internal baffles to prevent unexpected sudden shifts of load in flight. The tanks were ahead of the main spar and so ahead of the normal centre of gravity. A small 6 litre tank in the fin was arranged to balance the aircraft correctly. One litre of water was added to the tail tank for each 38 litres in the wing. The tail tank water level was visible to allow adjustment before take off. Lead ballast weights for bolting into a fitting in the extreme nose were also provided for lightweight pilots.

The fuselage and tail unit were adapted directly from the Ventus. The prototype Discus used the small fuselage of the Ventus A, but in production the B fuselage was almost always preferred. All the controls, including the ballast plumbing, connected automatically during rigging

The Discus flew in April 1984 and made a good impression immediately. Its potential was demonstrated when Tom Belz won the 1985 US Standard Class Nationals in his Discus, with Klaus Holighaus in the prototype close behind. There were 4 Discus in the top seven. This marked the beginning of a decade of 'Discus dominance' in the Standard Class. In the 1985 World Championships at Rieti in Italy, Brigliadori became Champion and there were seven Discus in the top ten of 37 entrants. In the 1987 World Championships Matt Kuittinen of Finland won, in 1989 the French pilot Aboulin, in 1991 Dutchman Baar Selen, Andy Davis of Britain won in 1993, in 1995 it was Kuittinen again, all in the Discus. It was not till 1997 that the pattern changed. In that year the LS - 8 almost swept the Discus away from the top places. Yet there were still four in the top twenty.

In flight tests, the Discus had a measured best glide ratio of 42.5:1. It handled very well with no vices. A relatively inexperienced pilot could fly it. The only thing a beginner needed to watch, in common with all the modern sailplanes, was the airspeed. A small change of trim in flight produced a rapid rise in speed with very little difference in attitude. The cockpit was quiet so the sound of airflow, changing tone and volume with speed, was not very perceptible. It was easy to exceed the 'red line' airspeed without realising it. On the approach to land particularly, concentration on the intended touch down point and failure to monitor the air speed indicator, could easily lead to serious overshooting, possibly rolling off the end of the intended landing strip even with the air brakes fully open. Otherwise the Discus was safe, well mannered, and a contest winner.

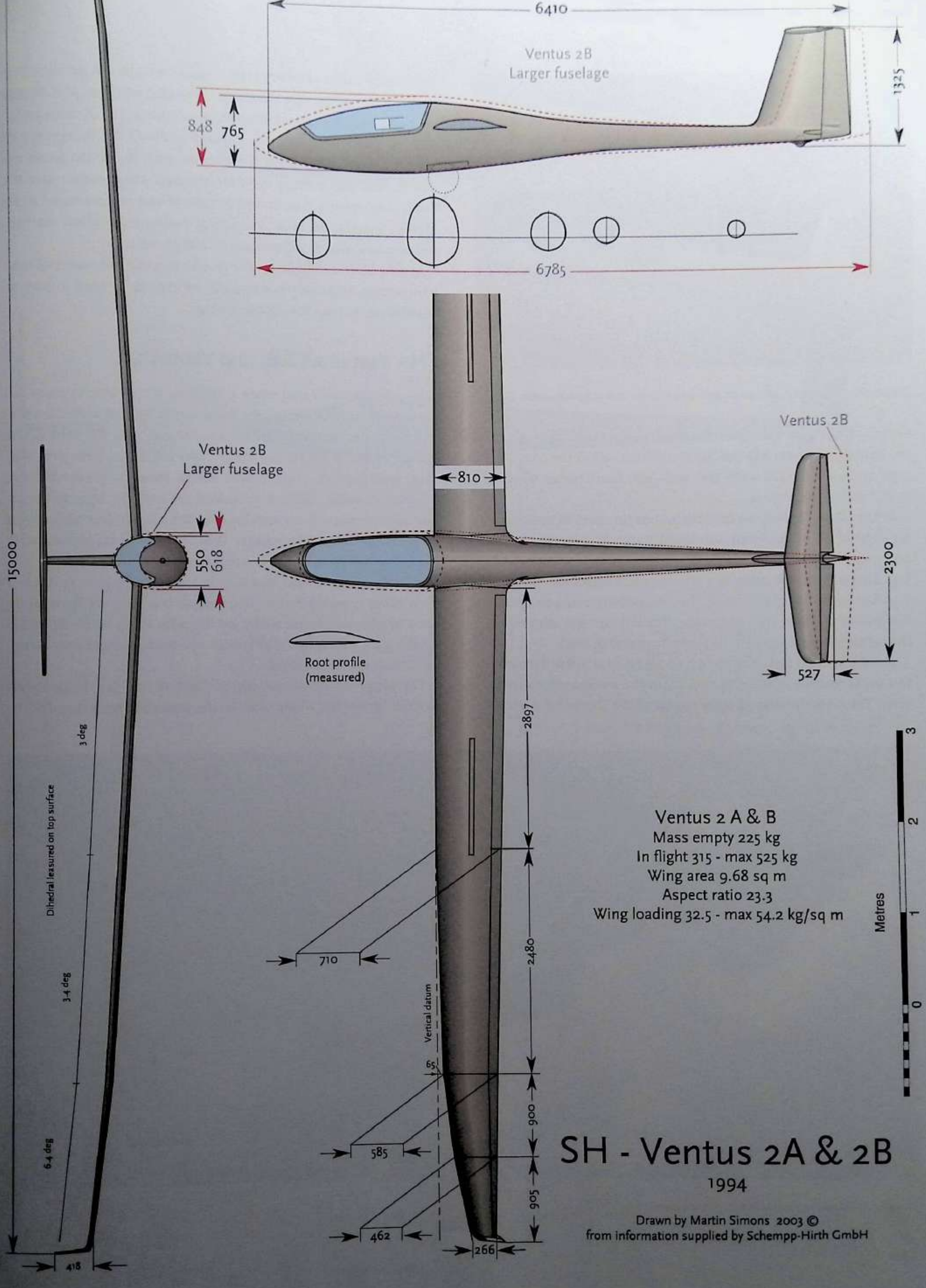
Over 850 have been built, many of them, with the suffix CS, in the Czech Republic by the Orlican Company. There was a single, short span aerobatic version which did not enter production, and a 'sustainer' motor, capable of bringing the sailplane home by air from a cross country but not capable of taking off, was also introduced. Ingo Renner, many times World Champion, remarked once to the author that if he was ever restricted to only one type of sailplane, he would choose the Discus. If he could have a Discus with winglets, that would be better still. By this time, winglets were available for the Discus, as they were for almost all sailplanes.

SH - Duo Discus

It was time for a new advanced two-seat trainer to replace the Janus. The Duo Discus was first flown in 1993 and, at the time of writing, is still in production at the Orlican factory. Several hundred have

Duo Discus north of the sea-breeze front from the Mediterranean (Photo Claus-Dieter Zink)

37 – See p. 60



SH - Ventus 2A & 2B

1994

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The prototype Duo Discus, on loan for assessement by the club at Bad Neuenahr, Germany

been built so far. It was never intended to equal the performance of the larger two-seaters like the Nimbus 3D and 4D or the ASW-25. Its chief rivals are the DG - 500 Elan and - 500 Elan Trainer, which are in the same general class.

As the name implies, the Duo-Discus was intended to be similar, as far as possible, to the vastly successful Standard Class single seater, and used the same technology. The seats were in tandem in a fuselage derived from the Janus, but now the main wheel was retractable. The fixed nose wheel remained, the drag penalty being accepted for the sake of practical club operations. The tail unit was adapted from that of the Nimbus 4, which had been flying since 1990.

The wing of 20 metres span in four pieces, was swept forward for the usual reasons of balance and to aid the second pilot's field of view. The crescent-shaped outer panels of the Discus were adopted

The combination of sweep forward and crescent tips gave the Duo Discus a very distinctive planform. The outer wing was also slightly up-swept, in accordance with new aerodynamic calculations by Eppler, indicating that not only an elliptical chord distribution but elliptical dihedral, also saved some vortex drag. Unlike the Janus, the Duo Discus had no wing flaps but the new wing profiles gave it a better performance. The best glide ratio of 44:1 was measured at the Idaflieg meeting in 1994. Extra large ballast tanks allow the two-seater to be flown at a maximum of 700 kg mass.

As now almost obligatory, the Duo Discus may be equipped with a retracting 'sustainer' power unit, which can be used to save an outlanding, but not for self-launching.

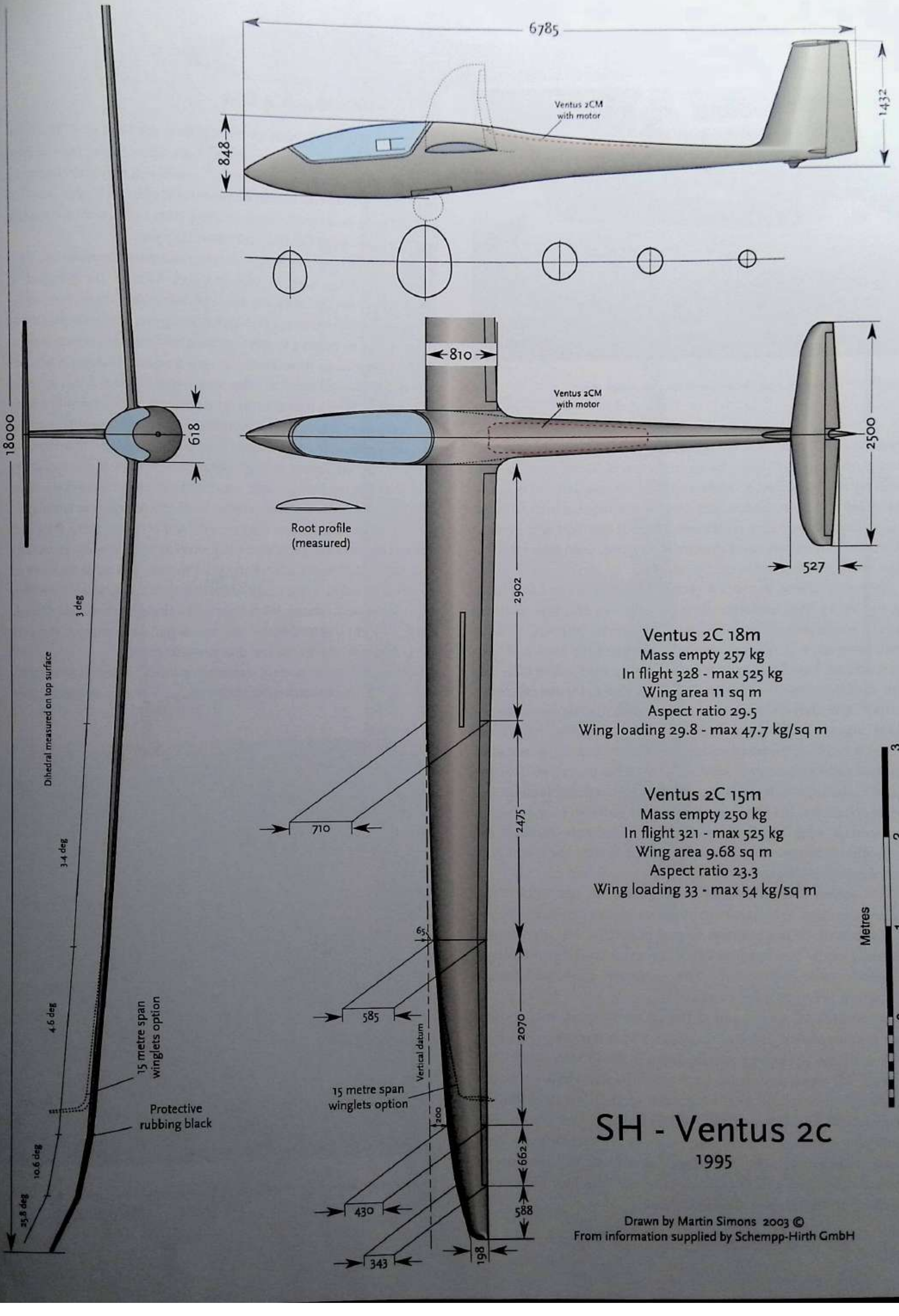
SH - Ventus 2A &B, and Ventus 2C

It is understandable that when a sailplane with a certain name has been particularly successful, the name should be used again for a new type. So it has been with the Nimbus, so it is with the Ventus. The Ventus 2A and B are Fifteen Metre Class sailplanes, with new wing plan, new profiles, flaps, ample ballast capacity, polyhedral and winglets. As before, two sizes of fuselage are available, large and small. The difference in performance between the A & B is detectable only at high speeds. Production began in 1994. The Ventus 2C, introduced in the following year, could be regarded as yet another new type.

The fuselage, whichever size it is, is a shell of carbon, Kevlar and glass fibres in epoxy resins. The cockpit area is specially strengthened to provide greater safety for the pilot in an accident, and is mostly glass and Kevlar, which does not shatter dangerously on impacts as carbon tends to do.

The wings are almost entirely of CRP and there are ballast tanks extending over the whole span, in the leading edges in front of the

Ventus 2 with polyhedral and winglets, Eric Napoleon, 1995



SH - Ventus 2c

1995

Ventus 2C 18m
Mass empty 257 kg
In flight 328 - max 525 kg
Wing area 11 sq m
Aspect ratio 29.5
Wing loading 29.8 - max 47.7 kg/sq m

Ventus 2C 15m
Mass empty 250 kg
In flight 321 - max 525 kg
Wing area 9.68 sq m
Aspect ratio 23.3
Wing loading 33 - max 54 kg/sq m

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From information supplied by Schempp-Hirth GmbH

The Ventus 2A flown by Alastair Kay, World Championships 1997

main spar. A tail balance compensation tank is necessary. The total ballast capacity is 210kg. The Ventus 2 can be flown at wing loadings up to 54 kg/sq m. Ailerons and flaps are coupled and may best be called flaperons. That is, not only do the ailerons work with the flaps, being drooped or raised together, but the flaps also move as ailerons. Lateral control is exceptionally good, even when the ballast tanks, running out to the tip, are full.

When, in 1996, a Ventus 2 was carefully tested by the Caddo Mills group led by Dick Johnson, a best glide ratio of 46:1 was obtained, which was extremely good for any fifteen metre sailplane. This figure, however, was reached only after considerable work had been carried out. It was discovered, by measuring with a drag rake, that the turbulators as fitted by the factory tended to increase the drag, rather than decreasing it. The turbulators supplied were not the usual zigzag tapes but were dimpled 'dymo' tape. Removing them entirely reduced the wing profile drag and increased the best glide by two points, though it still fell short of expectations. Further tests, including oil flow trials to detect the presence of laminar separation bubbles, led to a re-location of the turbulators and their replacement with zigzag tape. Finally, air leakage through the flap/aileron hinges was detected. It was only after these had been properly sealed that the 46:1 glide ratio was achieved.

The Ventus 2 soon realised its potential. In the 1995 World Championships, Eric Napoleon of France placed first in his Ventus 2, Justin Wills of England was second in an LS 6, but there were 5 Ventus 2 in the first ten. The list of contest achievements has continued to grow impressively with successes in World Championships in 1997, 1999, 2001 and 2003.

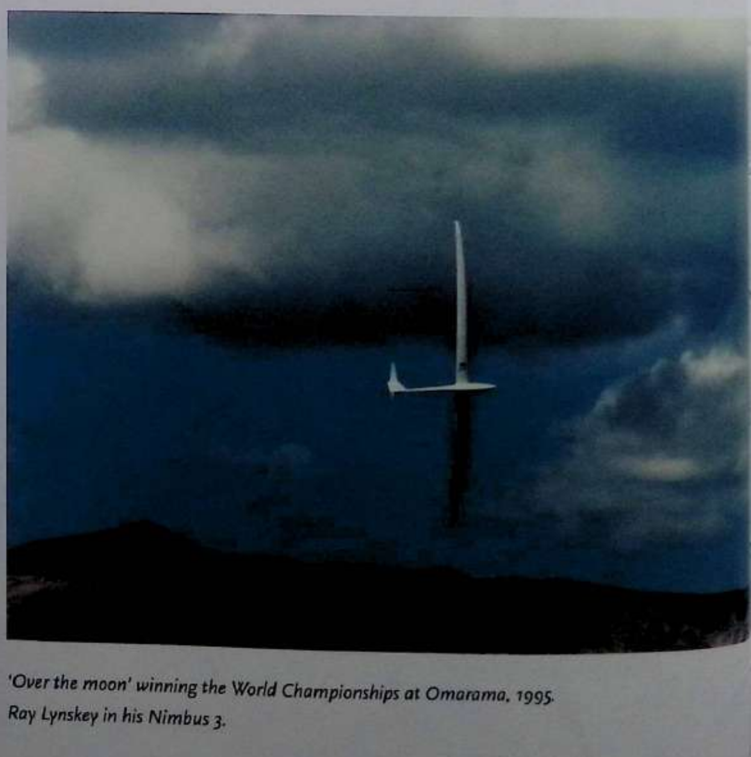
The Ventus 2C was aimed at the 18 metre span category and was provided with polyhedral wings and interchangeable tips, with winglets, so that it could be flown in the Fifteen Metre Class as well. All three top places were taken by the Ventus C at the World Championships in the Eighteen Metre Class in 2003. The Ventus 2CM is self-launching. Further improvements have been made to the Ventus 2 in the early years of the 21st Century. New winglets designed by Prof Mark D Maughmer of the University of Pennsylvania, new profiles for the tail unit from Prof Loek Boermanns at Delft, result in the Ventus 2AX.

SH - Nimbus 4 & 4 DM

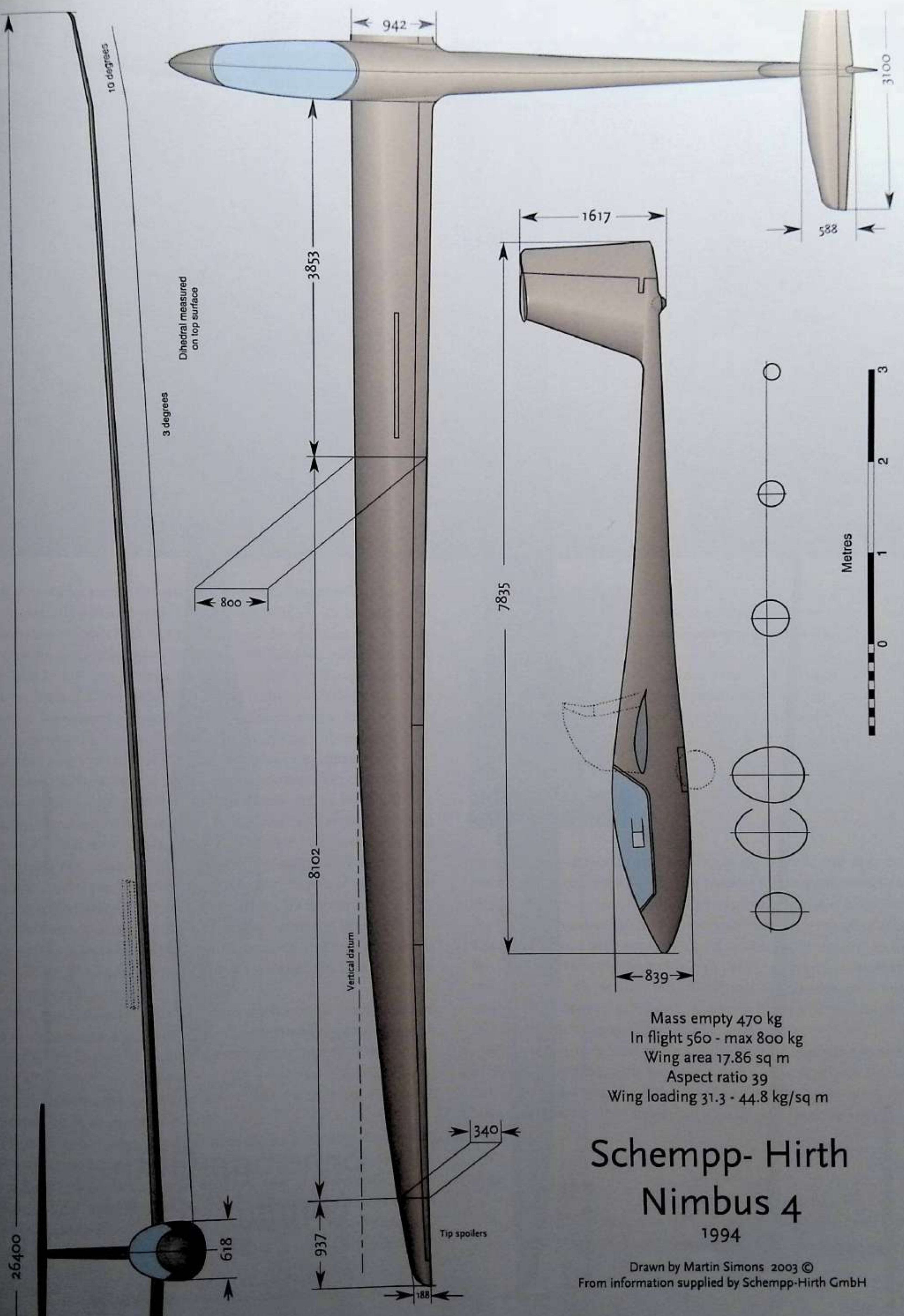
The Nimbus 4 was developed directly from the Nimbus 3. The span was increased to 26.5 metres with a multi-tapered wing plan, slightly crescent-shaped as on the Ventus 2 series, and polyhedral coming as close as possible to the theoretically best elliptical curve. Modifications were made to the wing profiles, with turbulator tape on the underside ahead of the flap and aileron hinges.

The fuselage was lengthened and the rudder area increased, to help control the large span in yaw and roll. As with the Nimbus 3, spoilerons at the tips assist the ailerons and rudder. These move up to 80 degrees at the extreme deflection, adding drag and reducing lift at the wing tip, so helping to yaw and bank in the desired senses. A standard measure is the time taken to reverse a turn at 45 degrees of bank to a similar banked turn the other way. In the Nimbus 4 this is about six seconds. When trying to centre a thermal, six seconds is a long time. In a good fifteen metre or Standard Class sailplane turn reversal may be under four seconds, and that is long enough. However, all modern sailplanes cover as much distance as possible in cross-country flight, and racing, by 'dolphin' soaring. Most of the time there is no circling in thermals so the inevitable problems of bringing large span, heavily laden wings round into smooth and efficient turns arise less often. The excellent glide ratios achieved at high speeds, especially with full ballast tanks, allows the pilot to sample a large number of thermals en route, using many of them by pulling up steeply and flying slowly straight ahead. With flaps set for the minimum rate of sink, enough height is gained in this way for the glide to continue. The area of upcurrent is left in a shallow dive to regain speed.

Finding lift is not merely a random process. There is almost always some internal structure to the air, with thermals more often



'Over the moon' winning the World Championships at Omarama, 1995. Ray Lynskey in his Nimbus 3.



Mass empty 470 kg
In flight 560 - max 800 kg
Wing area 17.86 sq m
Aspect ratio 39
Wing loading 31.3 - 44.8 kg/sq m

Schempp- Hirth Nimbus 4

1994

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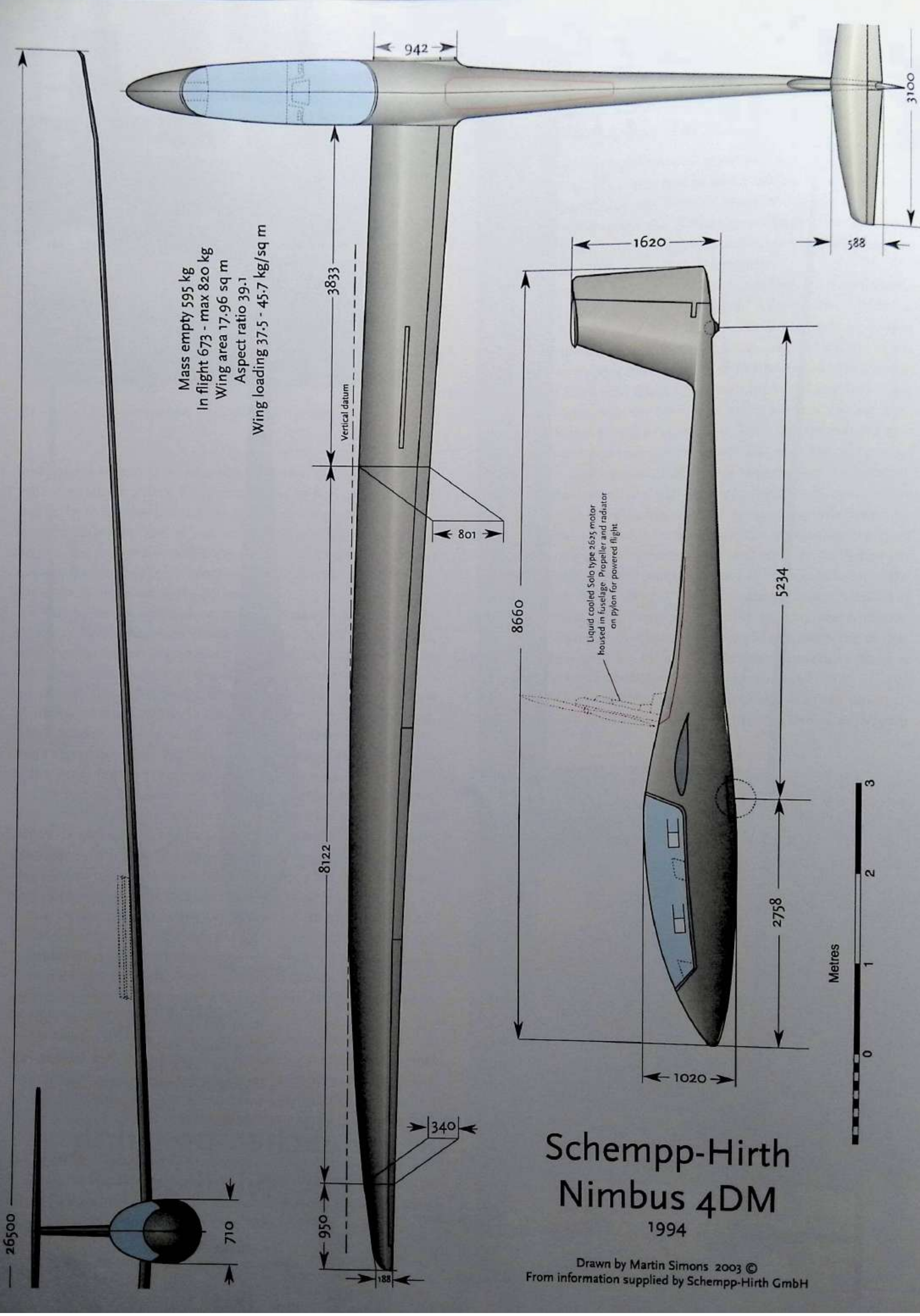

Schempp-Hirth Nimbus 4DM

1994

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than not in a pattern of some kind, which can be recognised and followed. The skilful pilot picks a route which is likely, on a given occasion, to 'run with the grain'. In good conditions it is not unusual to cover 100 km or more dolphin fashion, with little or no height loss. When a strong thermal is found, it still pays to circle in it to climb fast. The speed in the glide is then increased with a gain in the average over long distances. When circling is necessary, the enormously high aspect ratios, 38.8 in the case of the Nimbus 4, ensures that even the fully ballasted sailplane can climb well.

The Nimbus 4 wing is in six pieces constructed in carbon fibre-plastic. Each section is relatively light and can be managed by a minimum crew. The fuselage was designed for a retracting power unit. For this reason there is less reduction in cross section behind the wing than fashionable for the 'pure' sailplanes. For the same reason, space was allowed for a large battery to power the propeller pylon retraction mechanism and the starter for the motor.

The flaps, lowered for landing, and the powerful double bladed air brakes together have proved adequate. No braking parachute is necessary. The main wheel features a hydraulic disc brake which is very effective.

Like the Nimbus 3, the '4 quickly established a reputation and won an impressive series of World Championships, beginning with 1991 when Lherm, Lopitaux and Holighaus, placed third, fourth and fifth. 1993 was the year of the ASW - 22 and - 25, with Lherm fourth, but in 1995 Lynskey of New Zealand won in the Nimbus 4, pursued by three of the ASW - 22.

Following the lead of the Nimbus 3, the Nimbus 4 DM, a self-launching two seater, flew in 1994. One of the chief problems arising for all powered sailplanes has been that of noise, both for the pilot and for people on the ground. The high pitched buzzing that comes from some of the two-stroke motors used, causes strong negative reactions from residents near gliding sites. Even over open

Above: One of the pre-production Discus 2 prototypes at Lasham, UK

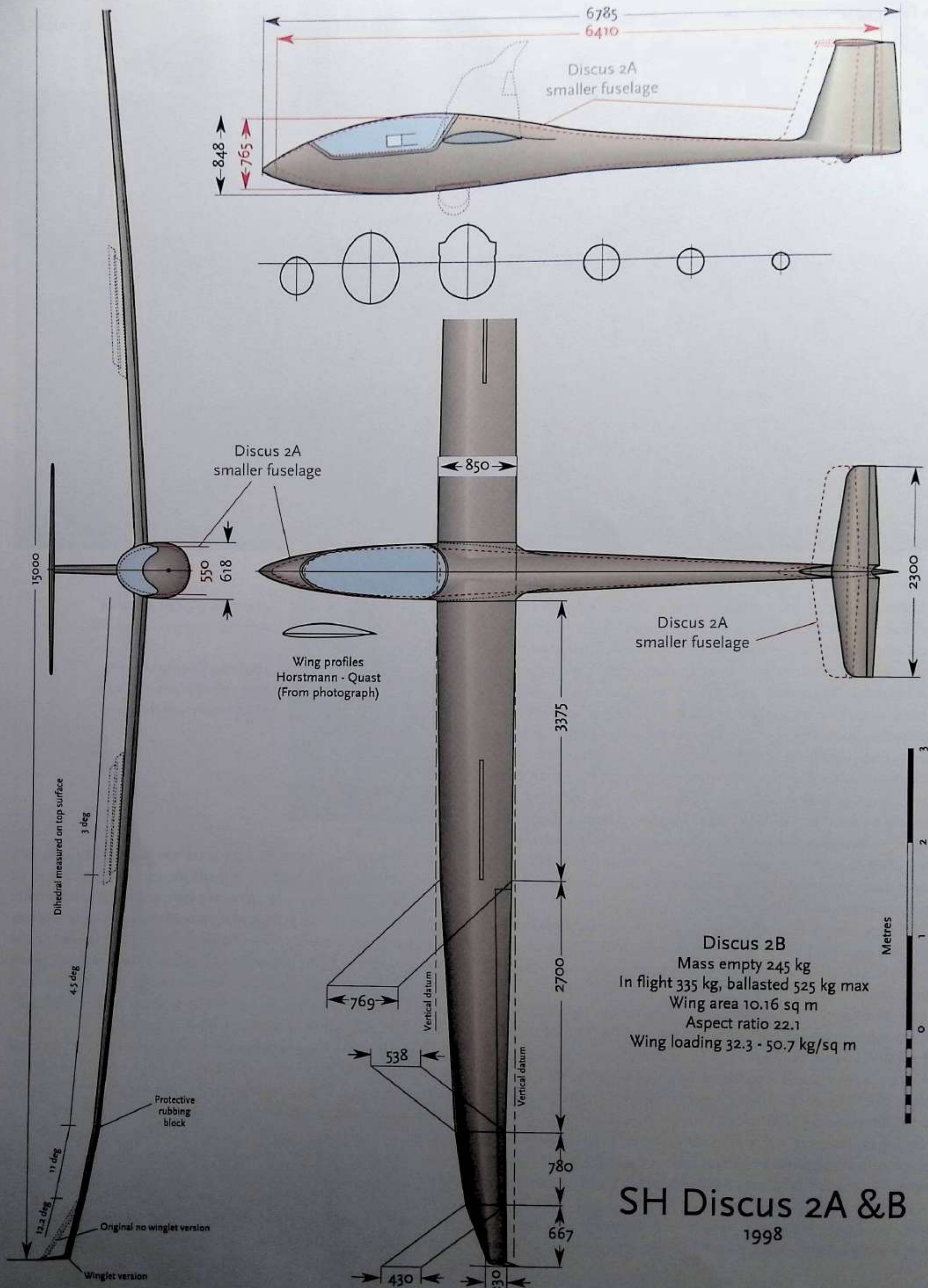
Left: Discus 2 wing tip. A rubbing block is placed to protect the wing tip from contact with the ground.

country the noise can cause fury since the sound, like that of a chain saw but coming from the sky, radiates for long distances in all directions. The irritation is more, as a rule, than that arising from the louder but lower-pitched racket coming from a tug aeroplane. The solution has been to use a liquid cooled motor buried in the fuselage, with only the propeller on a pylon, with a radiator, being extended into the airflow. The Nimbus 4DM, in common with many other powered sailplanes, has been fitted with a Solo 2625 motor and a belt-driven propeller with wide blades.

With the power off and pylon retracted, the gliding performance of the Nimbus 4DM, with two pilots on board, is very little inferior to the single seat version. The extra drag from the larger fuselage is apparent, if at all, only at very high airspeeds when parasitic drag looms large.

SH- Discus 2

The last sailplane design to emerge from Schempp-Hirth in the 20th Century, was the Discus 2 which made its first flights in April



Discus 2B
Mass empty 245 kg
In flight 335 kg, ballasted 525 kg max
Wing area 10.16 sq m
Aspect ratio 22.1
Wing loading 32.3 - 50.7 kg/sq m

SH Discus 2A &B

1998

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Siebert Sportflugzeugbau SIE 3, shown in 1977 at Klippeneck (Photo Dietmar Geistmann)

1998. The team now responsible for the technical design, under Tilo Holighaus, was headed by Helmut Treiber, with Eberhardt Schott and Joachim Krauter.

The wings in plan resemble the original Discus of 1984, but tapered in three stages and with a slightly higher aspect ratio. The wing profiles, from Horstmann & Quast of Braunschweig but tested in the Stuttgart wind tunnels, now in charge of Dr Würz, are new. The dihedral, following Eppler's theories, approaches the elliptical form with the outermost panels at about 30 degrees. When winglets are fitted, which is an option, the tip panel of the wing is at a smaller angle. The tail unit takes advantage of the latest work by Loek Boermanns on profiles for tailplanes and fins.

The ballast capacity of 190 kg gives a range of wing loading from 32.3 to 50.7 kg/sq m. The compensating tail ballast reservoir is now normal.

Crash tests, somewhat similar to those done by auto manufacturers and racing car engineers, have been done with sailplane fuselages and safety harnesses. A pioneer in the field was the English Dr Tony Segal, who began work on the problem in 1985. Further results by English, American and German researchers were reported to the OSTIV Congress in 1989. Since then many more tests have been done, some under the auspices of the German Federal Ministry of Transport. The lessons from these are incorporated in all modern sailplane designs. The fuselage of the Discus 2 is an example. As with previous types, the Discus was offered with two different fuselage sizes.

As expected, the performance and handling of the Discus 2 were excellent. Any doubts were probably removed when Andy Davis won the British Nationals in June 1998, only a few weeks after the prototype had flown. This contest, however, was flown in an atrocious week with scoring possible on only three days. The result might have been a fluke. Any doubts were dispelled at the World Championships in 1999 when Jean Marc Caillard and Andy Davis in Discus 2A placed first and second, in 2002 (South Africa) Laboulin won in Discus 2, and in 2003 at Leszno in Poland, Davis won and two other Discus 2 followed closely.

Siebert Sportflugzeugbau

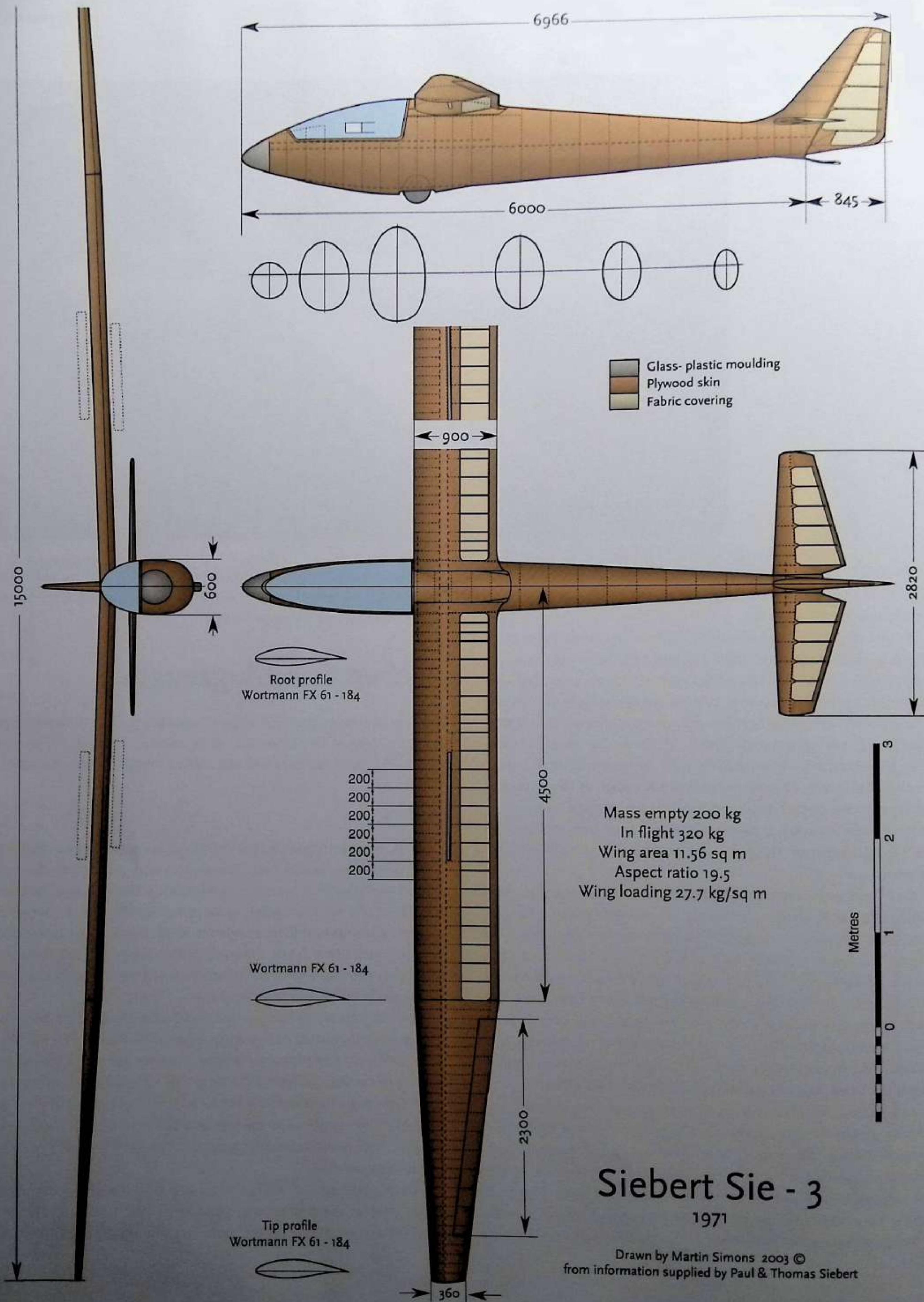
The small company of Paul Siebert, based in Münster, built under licence a total of 131 Kaiser Ka - 6CR sailplanes during the period 1960 - 70. Chief engineer with the firm was Wilhelm (Peter) Kürten.

Sie - 3

Paul Siebert, anticipating that the Ka - 6 licence-building contract with Schleicher would soon come to an end, decided to develop and manufacture an inexpensive Standard Class sailplane for club use. It would be a potential replacement for the Ka - 6. Wilhelm Kürten was responsible for the design work. It was a simple wooden aircraft with some fabric covering of the wings and tail surfaces. The wing profiles were from Wortmann and were expected to give it a better performance than the Ka - 6.

The wing planform had parallel chord with the same profile over the inner three-fifths of the wing, tapering thence to the tip. The ribs were cut from plywood. Several sheets of ply were blocked together and milled accurately to the profile with lightening holes cut out. They were then separated to be trimmed and glued in place at 200 mm spacing ahead of the spar and 400 mm behind. The simple fittings were aluminium alloy castings. The air brakes were also in aluminium alloy.

The fuselage was of normal wooden semi monocoque construction. Most of the frames were band-sawn from plywood. The tail unit followed the same general scheme as the wings. The all-moving



Siebert Sie - 3

1971

Drawn by Martin Simons 2003 ©
from information supplied by Paul & Thomas Siebert

elevator resembled that of the Ka - 6E. Special care was taken to ensure that there was ample rudder power to aid recovery from spins.

The first flight, with the aircraft in primed finish only, was by the designer Kürten in September 1968. Type approval did not come through till January 1972, after which production began. 27 Sie - 3s were manufactured during the next four years, with a few exports. Amateurs built some from kits. The performance was fully comparable with other 15 metre wooden sailplanes of the period.

15 m-Salto with winglets, the last one built (Photo Jochen Ewald)

Start + Flug

Ursula Hänle, a qualified engineer, with her husband Eugen, built the original H - 30 in their house, and flew it in 1960[38]. Together they founded the Glasflügel Company. In 1971 Ursula began her own business, Start + Flug. After several years of successful production, the development costs of a new two-seater, the 'Globetrotter', proved too much and the small company was forced into bankruptcy. A total of 93 sailplanes had been produced.

H 101 Salto

With the old H - 30 in mind, Ursula Hänle developed the H - 101 Salto, a 13.6 metre span, fully aerobatic sailplane with V tail. The wings were the same as the outer wings of the Standard Libelle, reduced in span by taking 0.7 metres from the root end. The fuselage was carefully faired to the wing root and gave the pilot some additional elbow room under the 'tear drop' shaped canopy. Trailing edge air brakes were fitted. A tail braking parachute was available as an option.

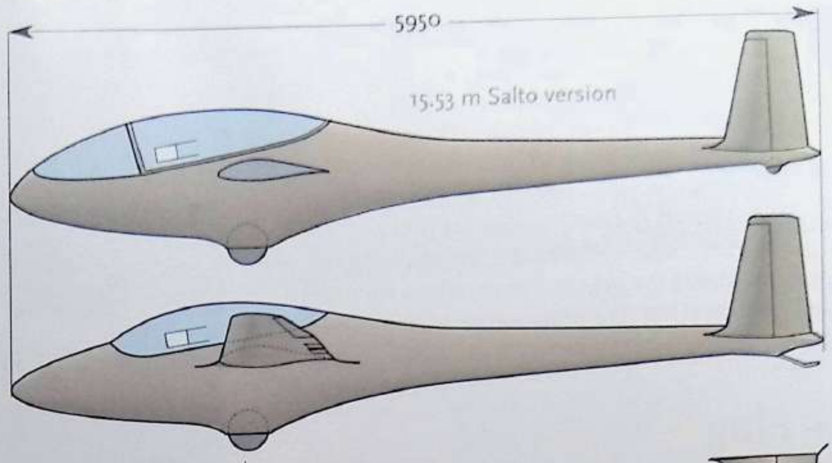
The prototype was built at Schlattstal in the Glasflügel factory and the first flight was in March 1970 at Karlsruhe. From 1971 production began in the Start + Flug works at Saulgau.

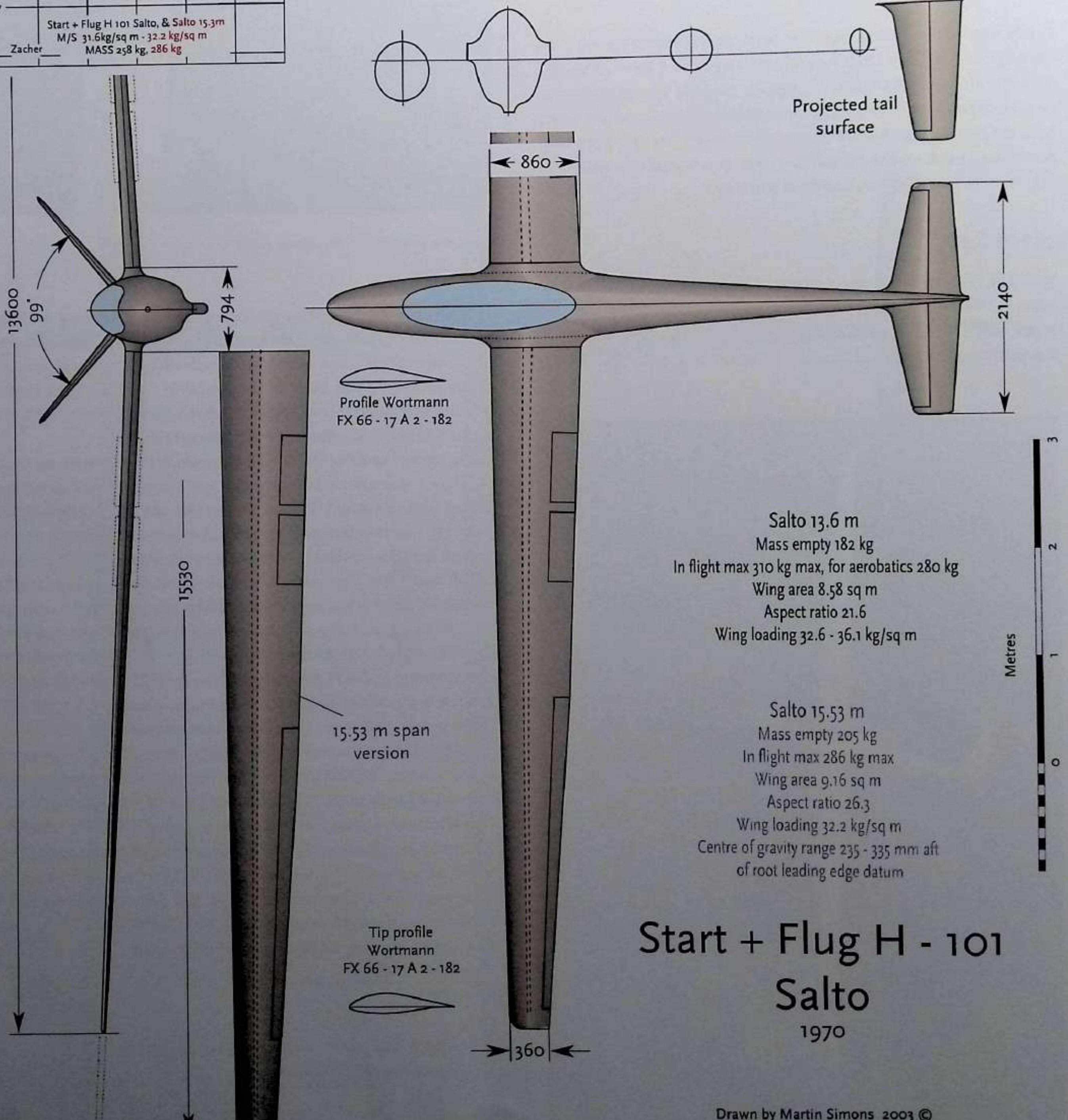
The aircraft handled well. The V tail created no problems. In a fully developed spin after a few turns the Salto began to rock gently fore and aft while rotating, but there was no sign of a flat spin developing. Recovery was easy but required the full technique. Rotation did not stop till the stick was moved forward. As an aerobatic aircraft the Salto established a fine reputation at air shows and displays. In particular the pilot Herbert Tiling developed a spectacular and beautiful routine, demonstrating on many occasions what a sailplane of this type could do. The Salto also performed quite well as a cross-country sailplane and competed in Club Class competitions. By 1973 Ursula's work force of ten was producing two or three Saltos per month, to a total of 57. Ten were exported, to the USA, Switzerland and Australia.

The production manager in the Saulgau team, Alwin Güntert, obtained a damaged Salto, extended the wing to 15.53 metres span and redesigned the fuselage to produce the Salto 15, of which eight were thereafter built. Ursula Hänle went on to design the H - 111 'Hippie', which was an ultralight glider capable of being foot-launched. Thirty-five were produced from 1974 to 1978, 15 in the form of kits for home assembly. Walter Stender designed the H - 121 'Globetrotter' two-seater with side-by-side seating. It flew in 1977 but only one was completed before the Company was closed down.

38 – See Volume 2

H - 101 Salto. Suitable for both excellent aerobatics and cross country soaring (Photo Peter Selinger)





Salto 13.6 m
Mass empty 182 kg
In flight max 310 kg max, for aerobatics 280 kg
Wing area 8.58 sq m
Aspect ratio 21.6
Wing loading 32.6 - 36.1 kg/sq m

Salto 15.53 m
Mass empty 205 kg
In flight max 286 kg max
Wing area 9.16 sq m
Aspect ratio 26.3
Wing loading 32.2 kg/sq m
Centre of gravity range 235 - 335 mm aft of root leading edge datum

Start + Flug H - 101 Salto

1970

Stemme GmbH & Co KG

Dr Reiner Stemme of Berlin was managing partner of the firm Stemme GmbH in Berlin, a newcomer in 1986 to the field of sailplane manufacture.

Stemme S - 10 'Chrysalis'

The Stemme S - 10, very expensive but still in limited production at the time of writing, is a two-seat motor sailplane of very unusual kind. The structure is a combination of glass, carbon and Kevlar fibre-reinforced plastics. The propeller is in the nose, driven by a carbon fibre shaft passing, in suitable housing, through the cockpit between the two side-by- side seats. When flying as a sailplane the propeller is folded, retracted and completely faired by the nose cone. When the engine is to be started, the nose cone is moved forward about 10 cm and locked in position. At the same time the various air and cooling intakes for the engine open. When the electric starter is engaged to spin the engine the propeller blades deploy automatically by centrifugal force, and remain out under power. (On early models the propeller had fixed pitch but variable pitch was introduced later.) When the motor is turned off the blades fold, their resting position is adjusted for the nose cone to be unlocked and pulled back to make a clean fairing. The cooling ducts also close.

When first announced the S - 10 had a wing span of 22 metres and the leading edge was unswept and straight. After early flights in 1986 the span was increased to 23 metres and the planform modified in line with current thinking about the benefits of the crescent form. The wing profiles are from Horstmann & Quast at Braunschweig, the HQ 41/14.35.

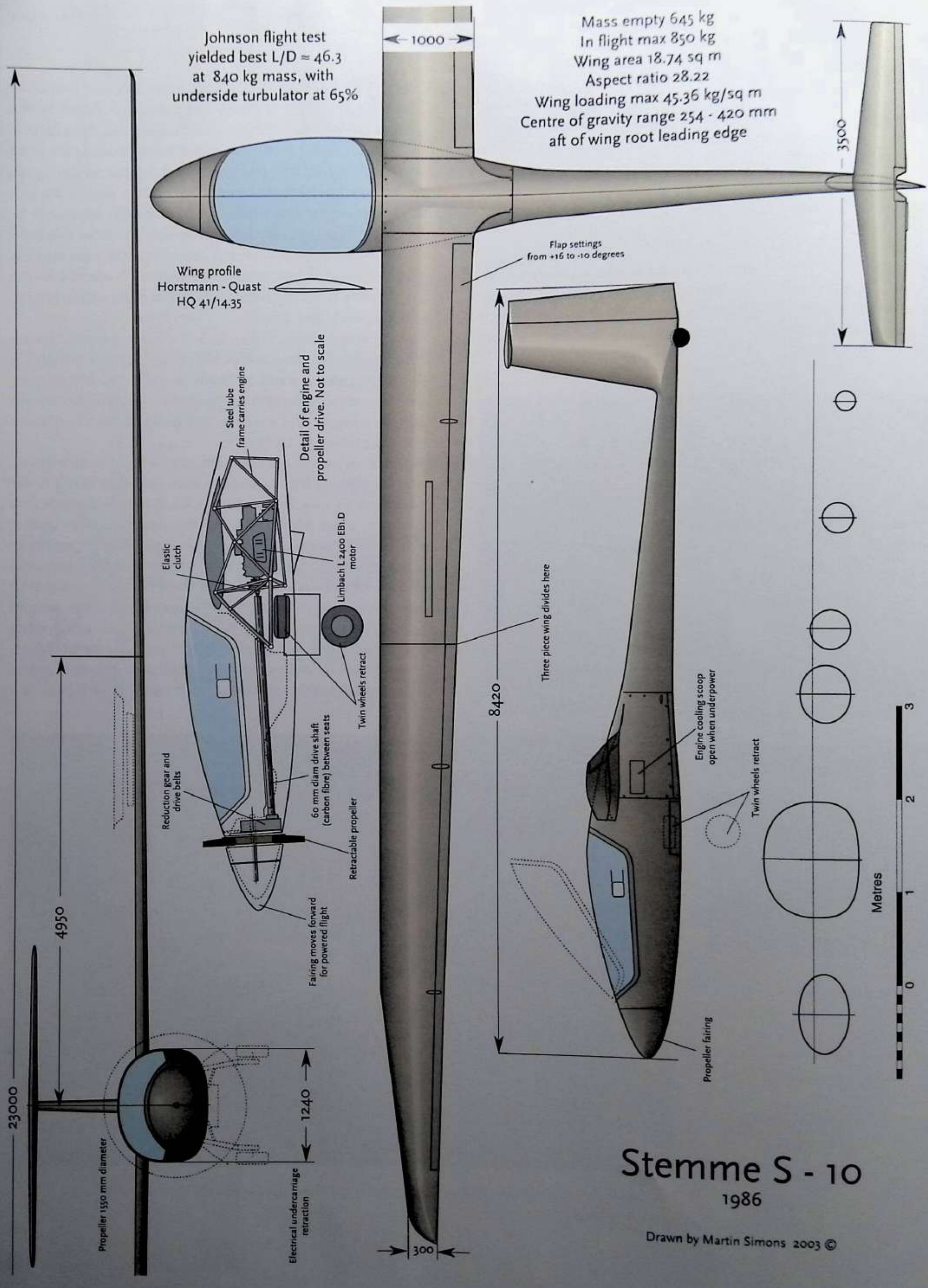
An ingenious mechanism allows the outer wing to be folded back, rather than removed entirely as with normal sailplanes. The S - 10 was not designed for road transport by trailer. It is normally kept in a hangar with wings folded. There are two retracting main landing wheels, with a tail wheel. The main wheels in the retracted position lie flat in the belly of the aircraft just behind the cockpit. On deployment they move down and outwards to give a lateral wheel base of about 1.2 metres. It is not necessary to have a crew member to hold the wing tip clear of the ground for take off. In strong cross winds caution when taxying is necessary. It is possible to touch a wing tip on the ground.

The S - 10 can be used to make long distance flights under power and has been described as a touring motor-glider. The motor is a 4

Above: The nose cone moves forward to free the propeller. The drive shaft from the engine buried in the fuselage, passes between the seats. The pilots here are Harry Schneider and Noel Roediger, at Gawler, S Australia.

Middle: The retracting twin wheel undercarriage allows independent operation at any airport

The Stemme S 10, here with only one pilot, in evening light east of Serres airfield at the end of Montagne d'Ajour. (Photo Claus-Dieter Zink)



Johnson flight test
yielded best L/D ≈ 46.3
at 840 kg mass, with
underside turbulator at 65%
1000
Mass empty 645 kg
In flight max 850 kg
Wing area 18.74 sq m
Aspect ratio 28.22
Wing loading max 45.36 kg/sq m
Centre of gravity range 254 - 420 mm
aft of wing root leading edge
3500
Flap settings
from +16 to -10 degrees
Wing profile
Horstmann - Quast
HQ 41/14.35
Detail of engine and
propeller drive. Not to scale
Steel tube
frame carries engine
Elastic
clutch
Limbach L 2400 EB1.D
motor
Twin wheels retract
Three piece wing divides here
8420
Reduction gear and
drive belts
60 mm diam drive shaft
(carbon fibre) between seats
Retractable propeller
Engine cooling scoop
open when underpower
Twin wheels retract
Fairing moves forward
for powered flight
4950
Metres
0
1
2
3
Propeller fairing
23000
1240
Propeller 1350 mm diameter
Electrical undercarriage
retraction
300
Stemme S - 10
1986
Drawn by Martin Simons 2003 ©

cylinder, 4 stroke 69kW (92.5 hp) Limbach L2400 EBI.D with single magneto ignition and twin carburettor. The fuel tanks hold 90 litres (19.8 gals). At the recommended cruising speed of 165km/h (8kts) fuel consumption is 15 litres (3.3 gals) per hour. A nominal air distance of 900 km can be flown without refuelling.

As a sailplane the S - 10 was tested by Dick Johnson at Caddo Mills in 1986. A best glide ratio of 46.3 was reported. This was with zigzag turbulators under the wing at the 65% chord position. Johnson pointed out that further sealing of air leakage needed to be done, especially around the air ducts to the motor, with a tail wheel fairing and further trials with turbulators in different locations. Probably the manufacturer's claim of a 50:1 glide ratio can be achieved if attention is given to these details. Soaring performance is excellent. Handling is very good considering the size and weight of the S - 10. The 45 degree banked turn reversal is rapid at about 4.5 seconds, the flaps and ailerons working together to yield a very good rate of roll for the 23 metre span.

The S - 10 is probably the most complex motor-sailplane ever produced, and requires care and expertise in management and maintenance. It is also very costly. It may never appear in large numbers at ordinary gliding clubs, but suits the pilot who needs to operate independently. The sailplane can be kept at an airport near home and flown under power to get clear of controlled airspace. After soaring for a few hours, the return by air to base is a matter of re-joining the general aviation traffic.

HUNGARY

The Hungarian gliding movement flourished under the communist regime. There was an energetic culture of imaginative design and manufacture of sailplanes and training gliders. The Omre OE - 01 of 1951was one of the first to use a laminar flow wing profile. The A - 08 Siraly was a highly successful wooden aircraft of 1956 and the Gobé, an all metal trainer, was built in quantity. Political upheavals and economic crises gave severe checks to the gliding movement, recovery from which has been slow.

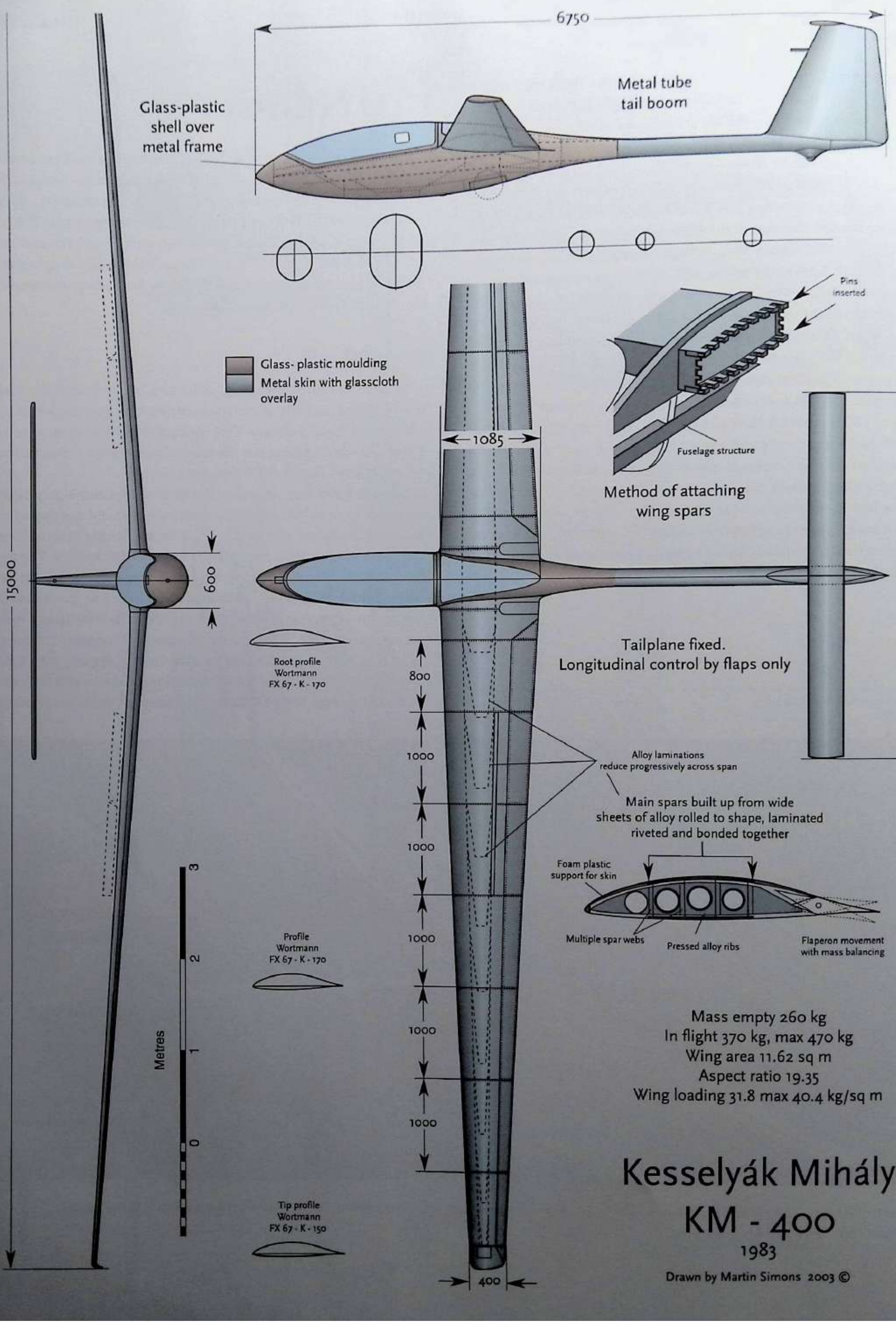
KM - 400

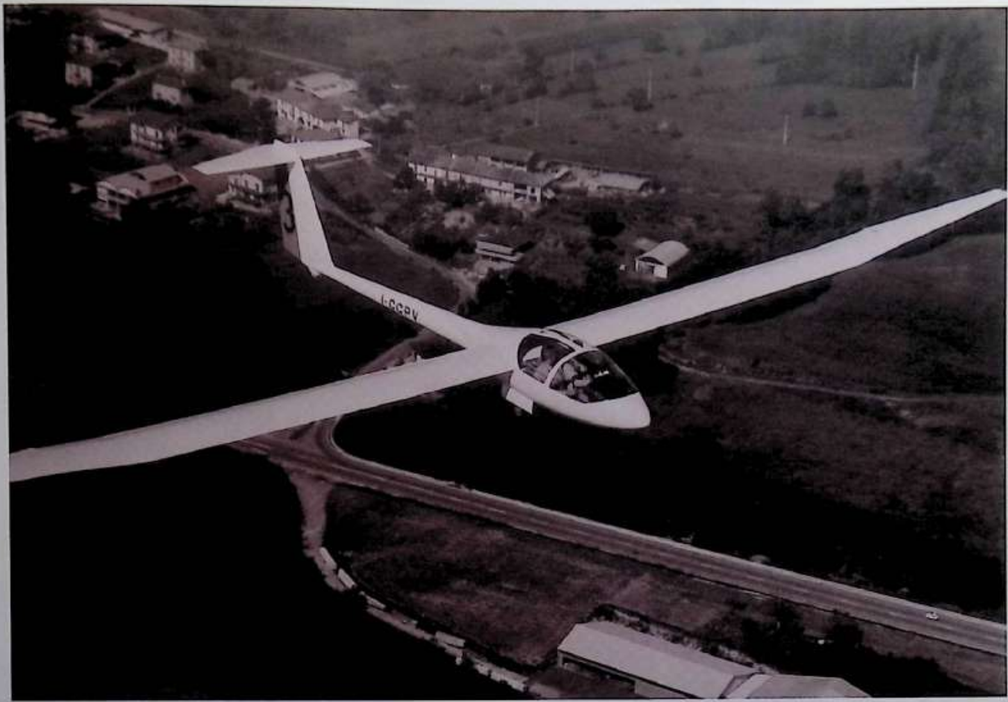
A sailplane design competition launched by the magazine Australian Gliding, in 1970, attracted entries from all over the world including two from Hungary. One by Imré Bano was joint winner with Sunderland's Moba, but the competition ended in disappointment for all and Bano's entry was never built.[39]

The other entry from Hungary was an advanced and highly original design in metal from Kesselyák Mihaly. This did not appeal to the Australian judges who were looking for something that could be built in reasonable time by amateurs with limited tooling. The design submitted for the competition, revolutionary in several respects, would have strained the facilities of most professional sailplane manufacturers. Kesselyák had previously submitted a winning design, his KM - 200, to a competition in Hungary. The most interesting feature was his longitudinal control system, which he patented. In 1975 he found financial backing and was able to begin construction of his KM - 400 in the workshops of the MÉM Airplane

39 – See under Sunderland Moba 2, p. 15

KM 400 in flight 1983. Mihaly Kesselyak's unusual sailplane design had no movable elevator, only a fixed tailplane. Longitudinal control was achieved by setting the flaps. (Photo Dr. Lázló Széll, provided by Gábór Fekecs)


6750
Glass-plastic shell over metal frame
Metal tube tail boom
Pins inserted
Glass- plastic moulding
Metal skin with glasscloth overlay
1085
Fuselage structure
Method of attaching wing spars
15000
600
3900
Root profile Wortmann FX 67 - K - 170
800
1000
1000
1000
1000
1000
Tailplane fixed.
Longitudinal control by flaps only
Alloy laminations reduce progressively across span
Main spars built up from wide sheets of alloy rolled to shape, laminated riveted and bonded together
Foam plastic support for skin
Multiple spar webs
Pressed alloy ribs
Flaperon movement with mass balancing
Profile Wortmann FX 67 - K - 170
Metres
0
1
2
3
Tip profile Wortmann FX 67 - K - 150
400
Mass empty 260 kg
In flight 370 kg, max 470 kg
Wing area 11.62 sq m
Aspect ratio 19.35
Wing loading 31.8 max 40.4 kg/sq m
Kesselyák Mihály
KM - 400
1983
Drawn by Martin Simons 2003 ©



Caproni Calif A 21 (Factory photo)

laid over the metal skin, filled and smoothed to ensure an accurate profile.

The fuselage was a light alloy structure with steel tube framing in the centre section. A steel hoop above the pilot's head acted as a crash pylon. There were alloy beams on each side to support the seat and controls. The tail boom, a length of 200 mm diameter circular section steel tubing, was bolted to the tubular frame at the front. The nose, back to about one third the length of the tail boom, was enclosed in a glass-reinforced plastic shell of good aerodynamic form. The moulded cockpit canopy was side hinged. The tail unit was all metal.

Early test flights were made in June 1983 with the tailplane temporarily arranged as an orthodox, all-moving elevator, to check the general behaviour of the sailplane. It was then modified to allow flight in either mode, elevator free, or locked. Finally in December 1983 the KM - 400 flew with the fixed tailplane, relying only on the flaps for control in pitch. These flights were successful.

Nothing further seems to have been done with the KM - 400. The KM - 400 now resides in a museum in Budapest.

Service at Nyiregyháza. The fundamental innovation was that the horizontal stabiliser was fixed rigidly with no moveable elevator. Longitudinal control was entirely by means of the wing flaps. Moving the control column back lowered the wing flaps, moving the stick forward raised them. This changed the angle of attack of the wing to the air and had the same effect as an orthodox elevator.

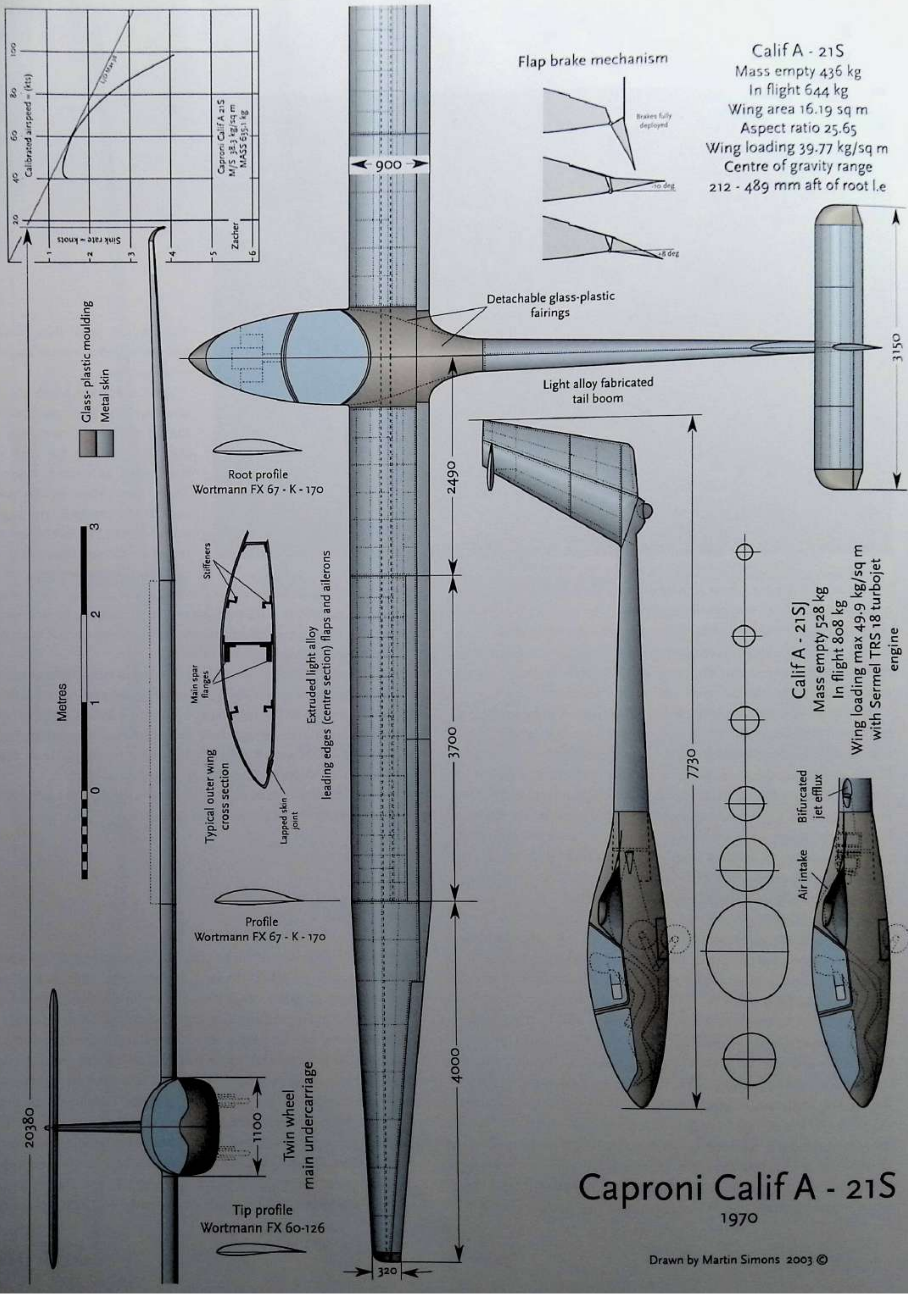
There were, Kesselyák claimed, several advantages for his system. For high-speed flight the wing camber was reduced and for low speed, increased, without the necessity for the pilot to adjust the flap setting. Changes in airspeed were achieved by changing the lift coefficient of the wing. Altering the camber of a wing also changes its pitching moment. In general, a greater camber tends to pitch the wing nose down; less camber pitches it up. Downwash on the tail from the increased wing camber with flaps down would produce a corresponding download on the tail to keep the nose up. Raising the flaps reduced the pitching moment of the wing to lessen the downwash.

The fuselage should not greatly change its attitude to the airflow at different speeds, remaining generally aligned with the flight direction. This generates less parasitic drag. As with any other flapped sailplane, the wing-twisting loads at high airspeed was reduced by raising the flaps, so the KM - 400 could be stressed for a high maximum speed.

The KM- 400 was built in light alloys. The wing was constructed of a series of overlapping plates, rolled to the required curvature conforming to the Wortmann FX 67K - 170 aerofoil section. The sheets were 0.4 mm thick, eleven laminations at the root end, reducing to two at the tip. The laminated sheets, riveted and bonded together, formed wide top and bottom spar flanges. The broad spar flanges joined a strong 'carry through' member in the fuselage, with a complicated, inter-digitating fitting. When rigging, long steel pins were inserted from the front. Pressed alloy ribs and multiple webs created a strong under frame with a light skin over the whole. A thin layer of glass cloth was

ITALY

There is a long history of successful Italian sailplane design and production, going back to the very earliest days. This continued until, as in most other countries, the dominance achieved by German and Polish manufacturers squeezed out Italian commercial producers. In the period covered by the present volume, there have been many very promising Italian designs which have progressed to prototype stage. Very few indeed have gone further. The main exception was when the Caproni Vizzola Company, one of the oldest aircraft manufacturing companies in the world, began sailplane production in 1964. After considerable successes, however, the Caproni family decided to sell the aircraft manufacturing business to the Agusta group whose interest was in helicopters. Commercial glider production ceased in 1983. Attempts



Caproni Calif A - 21S
1970

Drawn by Martin Simons 2003 ©

to revive the small industry continue. Some future development of light and ultra-light sailplanes is likely. The 12 metre span 'Silent' of 1994, designed by Mauri and Orlando, with unladen mass of 135 kg, may point to an interesting future. It has flown with self-launching capacity. Some small scale production of this type took place before the turn of the century.

The Caproni Calif A 21 at Dunstable, England, 1974, was used for advanced cross-country training.

Caproni Calif A - 21S

Designs promised by Caproni included the A - 10 Standard Class sailplane, the A - 12 for the fifteen Meter Class, and the A - 14 with 20.38 metres span. These never appeared but the Calif A -15 single seater, 22.87 metres span, all metal with a three piece wing, was put into production after 1969 and about 50 were built. The designers were Carlo Ferarrin and Livio Sonzio (hence CA-LIV). One competed at the World Championships at Vrsac in 1972, but did not do very well. Despite the large span, the A - 15 had not achieved as much as had been hoped for and made little impression outside Italy.

The Calif A - 21 made its first flight in December 1970. Externally it resembled the A - 15. It was a 20.38 metre span two-seater with the seats side-by-side in a wide and comfortable pod, with a slender tail boom, high T tail with all-moving elevator, twin-wheeled retracting undercarriage, and flap air brakes. After early test flights the tail was changed to tailplane with elevator, and the type became the Calif A - 21S, which entered production.

The wing was built in sections, all metal, with extensive use of extruded metal spars. The application of extrusions to the structure owed a great deal to the work of the Morelli Brothers who produced the M - 300 (see below). The skins were flush riveted, The profiles across the rectangular part of the wing were from the well-known Wortmann FX 67 series, tapering to the FX 60 - 126 at the tips for good stall control. The tail boom and tail unit were all metal. The front fuselage was enclosed in a shell of glass-fibre-plastic.

The performance was very good and there was no two-seater with comparable potential available at the time. The A - 21S set a number of National and International two-seater records during the early seventies. These included a 500 km triangle at 101.19 km/h, a 300 km triangle at 113 km/h, 128 km/h for the 100 km triangle, and the goal and return record, 718 km, all by Ed Makula flying as a visitor in the USA with different co-pilots, in August 1972. Ingo Renner with H Geissler broke the two-seat World Distance Record in 1975, 970 km, in Australia. At the World Championships in 1974, a Calif A - 21S was entered but did not do well, mainly because of lack of competition experience of the pilots.

All told, 53 of the A - 21S were produced. Trials were made with a small turbo jet, a Sermel TRS 18 in the A - 21, with a air intake above the fuselage behind the cockpit, and a bifurcated efflux on either side of the tail boom. The A - 21J flew in January 1979 but was not put into production.

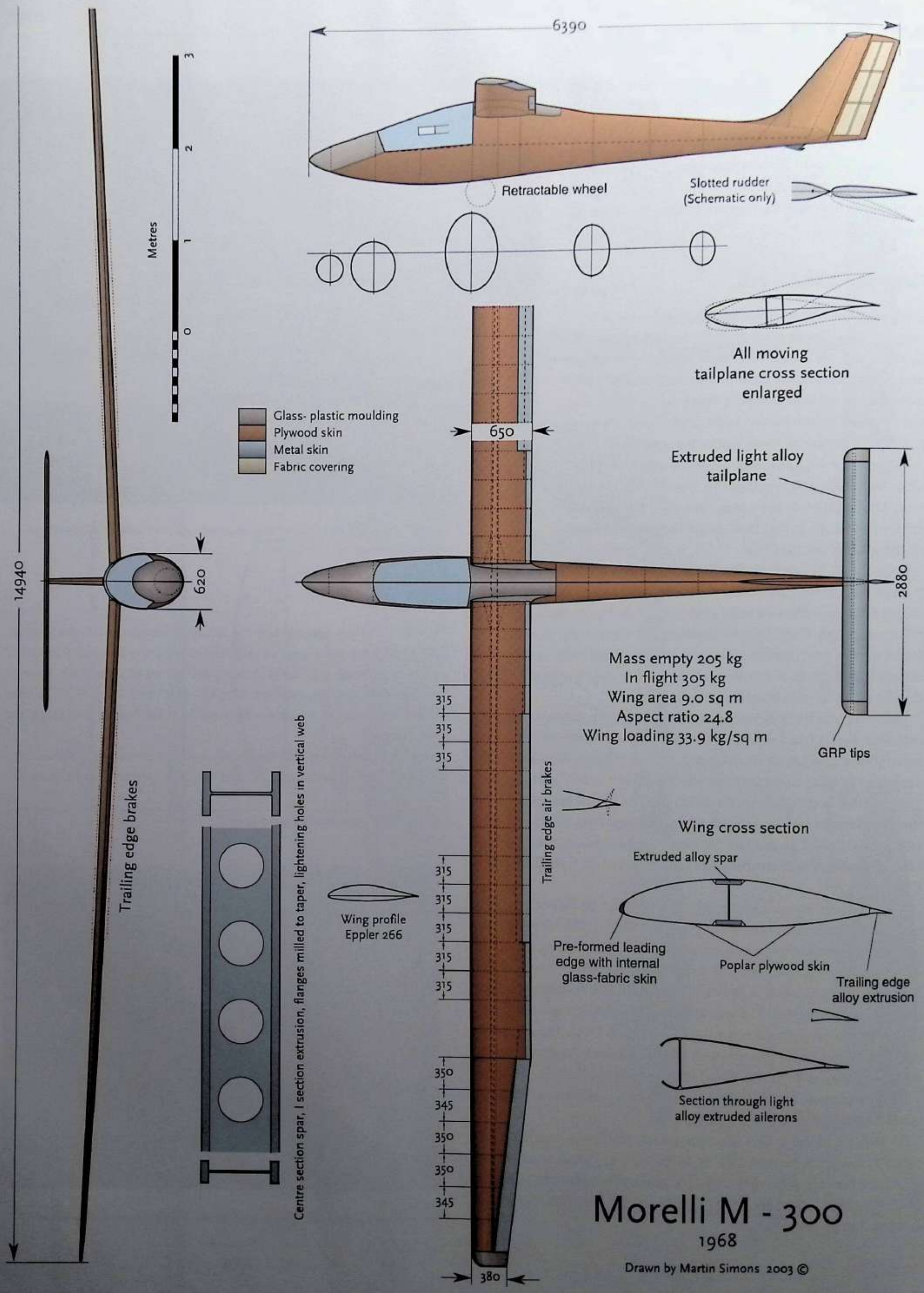
M - 300

The M - 300 was designed by the brothers Alberto and Piero Morelli, who had long experience of sailplane design, the Strale and Veltro of 1954 & 56 being especially notable and ahead of their time, though never going into production. The M - 100S and M - 200, orthodox wooden sailplanes, became very popular in the 'sixties and many are still flying.[40]

The M - 300, on which design work began in the early sixties, was highly original in concept. The Morellis hoped to demonstrate the

40 – See Volume 2 for these earlier Morelli designs

The Morelli M 300 was designed to demonstrate the effective use of alloy extrusions



Morelli M - 300
1968
Drawn by Martin Simons 2003 ©

value of extruded light alloy structures in light aircraft, especially sailplanes. It was envisaged that entire wings and other major components might be produced as extrusions. The M - 300 was partly intended as a first practical demonstration.

The main wing spar was a light alloy extrusion of I section, with lightening holes in the web. The alloy used was the common aircraft 7075 T. Only the outermost part of the spar required some machining to accommodate the taper. The entire tailplane, all moving, was an extrusion as were the ailerons and the trailing edge air brakes. Chemical etching was used to reduce the skin thickness of these units from 2mm to 0.8 or 0.5mm. Another extrusion formed the wing trailing edge. Extrusions are essentially of constant cross section. To use them effectively imposed some constraints on the aerodynamic design. The tailplane, ailerons and brakes were all rectangular in plan. The wing also was of constant chord for most of its length, with only the outermost two metres tapering. This was a good compromise with the ideal elliptical plan, with many advantages for construction despite the rather narrow, thin, and therefore highly stressed, wing root. The root fittings were of light alloy castings, Redux bonded to the spar. The wing profile was from Eppler.

The rest of the sailplane was of wooden construction, poplar plywood skins, wing ribs and fuselage frames. The wing and tail tips, the decking and fuselage nose cap ahead of the cockpit, were GRP. The slotted rudder followed the pattern originally developed for the Veltro to improve control response. The tailplane, with an inverted cambered profile, was intended to minimise drag under the usual download required for balance, and improved the 'feel' on the control column. The landing wheel was retractable.

It was planned to build four examples of the M - 300 at the Turin Polytechnic Centro di Volo a Vela. Only two were completed in 1966 but they were fully successful. The prototype, flown by the French pilot Rantet, competed in the major European International Competition, the Coupe d'Europe or Huit Jours d'Angers, at Avrille in 1969 and placed a creditable eighth in a total field of 29 in the Standard Class. Both the prototypes also flew in several Italian National Championships.

The further development of the extrusion process, to manufacture complete wings, did not take place. The prototype M - 300 was retired from use to go on permanent exhibition in the Aeronautical Museum of the Politecnico di Torino.

Thanks for help with the above article from Professors Piero and Alberto Morelli.

JAPAN

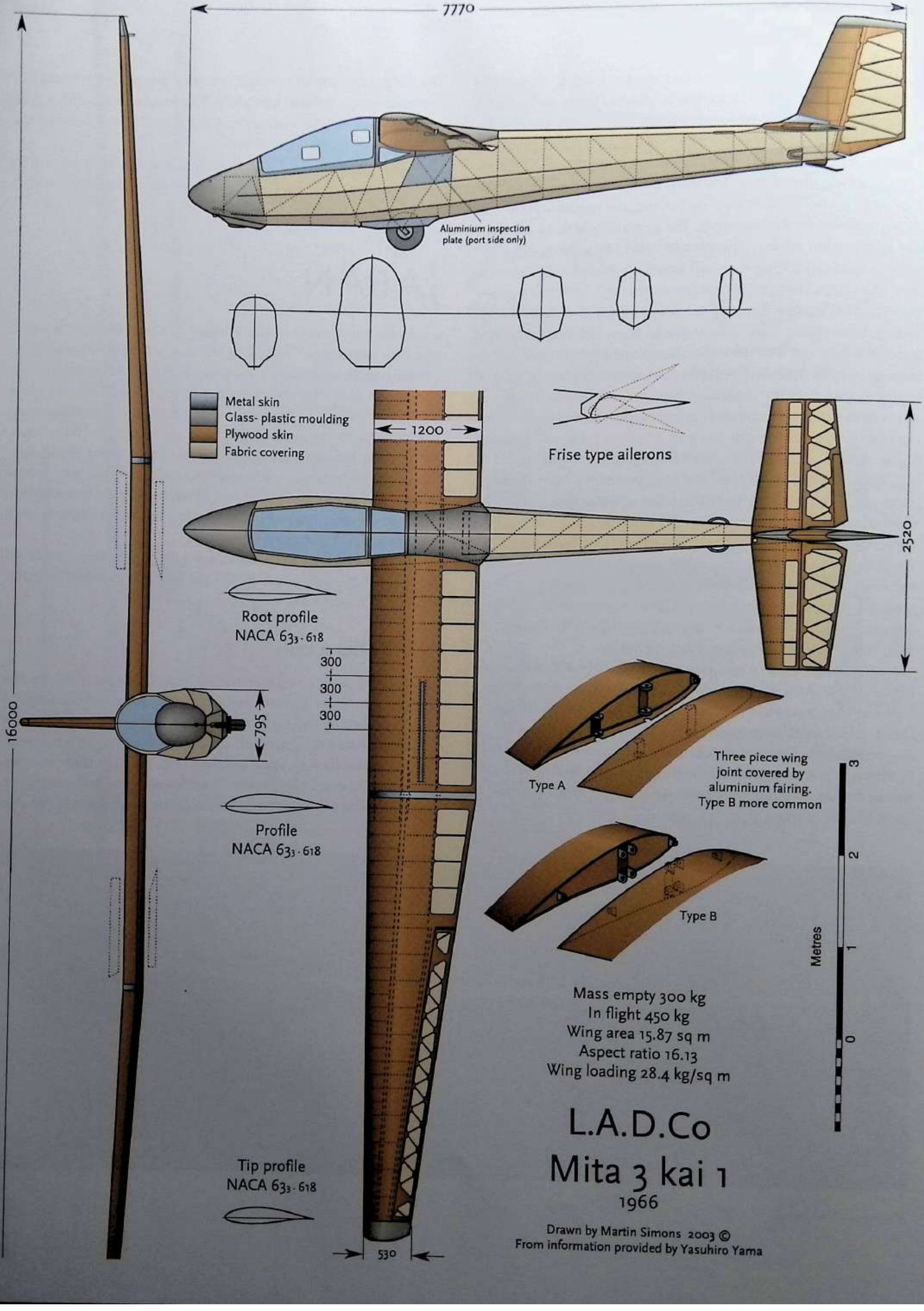
Soaring in Japan has been handicapped by the difficulties facing pilots who venture out of gliding distance of their home airfield. Landing out is hazardous. Where the country is not under intense cultivation, it is either built upon or mountainous. Gliding clubs have usually relied on imported aircraft for training and local soaring. Interest in the competitive sport revived in the late sixties. Many pilots have traveled to gain cross-country flying experience. There are, for instance, regular parties visiting soaring sites in Australia. Saburo Fujikura become well known to World Championship pilots in the seventies and Japanese pilots since have often entered the Championships to gain experience.

Except for some basic trainers, few gliders have been produced but there were some successful designs before the general adoption of composite structures.

L A D Mita 3 kai-1

The Mita 3 was a two-seat trainer first flown in 1962 by the Kirigamine Glider Manufacturing Co, but subsequently adopted and modified by the Light Aircraft Development Co (LAD). This group produced the improved version Mita 3 kai-1 which flew in 1966 and was built in some numbers. The wing, in three sections with tapered outer panels, was of orthodox wooden construction with plywood skins except for some fabric covering over the rear

The Japanese Mita 3 kai - 1


7770
Aluminium inspection plate (port side only)
Metal skin
Glass- plastic moulding
Plywood skin
Fabric covering
1200
Frise type ailerons
2520
Root profile NACA 63₃-618
300
300
300
795
16000
Profile NACA 63₃-618
Type A
Three piece wing joint covered by aluminium fairing. Type B more common
Type B
Metres
3
2
1
0
Mass empty 300 kg
In flight 450 kg
Wing area 15.87 sq m
Aspect ratio 16.13
Wing loading 28.4 kg/sq m
L.A.D.Co
Mita 3 kai 1
1966
Tip profile NACA 63₃-618
530
Drawn by Martin Simons 2003 ©
From information provided by Yasuhiro Yama

The SS 2, JA 2132 at Menuma, 1971 (Photo Shizuo Kawamori)

portion. After some were built with vertical steel pins to join the outer wings to the centre section, this was changed to a horizontal pin system. The ailerons, driven by pushrods rather than cables, were fabric covered. The profiles were from the NACA 6 digit series, comparable with those used in Europe and the USA at the time.

The fuselage was a steel tube framed structure with fabric covering. Compared with the earlier Mita 3, the cockpit was much improved and larger. The rear pilot's seat was raised high enough to give a good field of vision for the instructor over the student's head and sideways above the wing. There was a single landing wheel, not retracting. GRP mouldings were used for the nose cap and fairings, and the tips of all the flying surfaces. The tail unit was wooden framed and fabric covered. The rudder was mass balanced.

One of the Mita 3 is preserved at the Kagamigahara Air and Space Museum.

L A D SS - 2

The Japanese Aeronautical Association in 1967 was concerned that Japanese sailplane pilots had no locally-produced sailplane capable of making 300 km triangle flights. At the request of the Association, and with their financial support, the chief engineer of the L A D Company, Asahi Miyahara, designed the SS - 2, which, it was hoped, would enable pilots to achieve long cross-country flights from their home bases. It was supposed that a good sailplane would always be able to reach a suitable landing field if forced to land out.

Aerodynamically the SS - 2 was up to date with Wortmann FX profiles, an elegant wing with 17.4 metres span in three sections, and Schempp-Hirth air brakes opening above and below the wing. There was a single main box spar, with wooden ribs and plywood skin over all. Dihedral was confined to the outer panels of the wing.

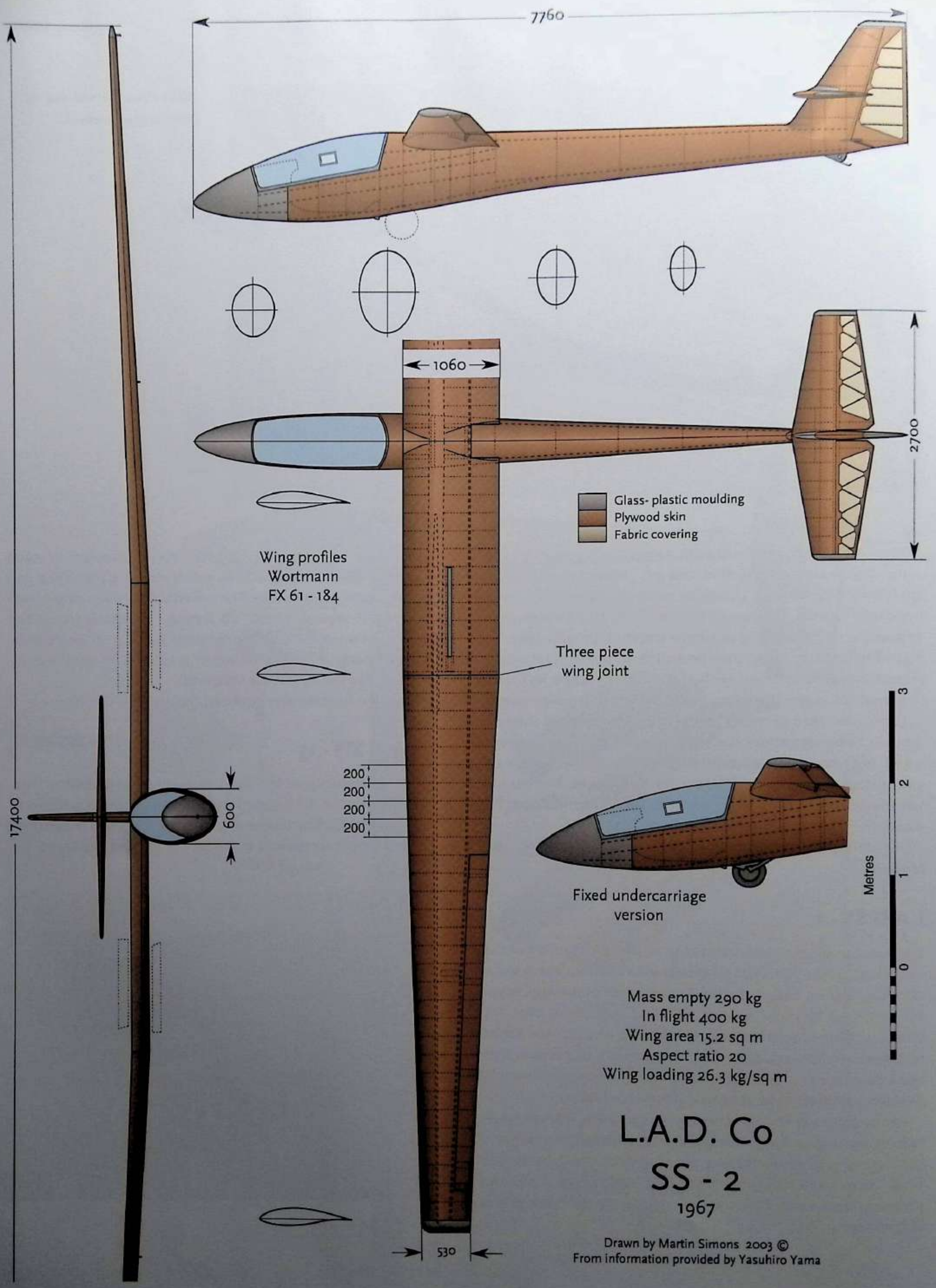
The fuselage was a normal plywood semi-monocoque of good shape, with glassfibre-plastic nose, a semi-reclining pilot's seat and moulded transparent canopy. The undercarriage was a single fixed wheel, a later version , the SS - 2B, having a retractable wheel. The tail unit was wood, the tailplane mounted part way up the fin to be clear of damage if landing on rough ground or in crops was inescapable. The rudder was mass-balanced.

A total of only three were built over the period 1969 - 70.

Takatori SH - 15

The SH - 15 was designed by Osamu Saito, chief engineer of the Yokohama Gliding Club. He designed several other sailplanes, notably the SH -16 and SH 18, which were single-sealers. Only one of each type was built, which applies also to the SH - 15 training two-seater. The

Takatori SH 15 at Menuma, 1970


7760
17400
1060
2700
600
200
200
200
200
530
Glass- plastic moulding
Plywood skin
Fabric covering
Wing profiles
Wortmann
FX 61 - 184
Three piece
wing joint
Fixed undercarriage
version
Metres
0
1
2
3
Mass empty 290 kg
In flight 400 kg
Wing area 15.2 sq m
Aspect ratio 20
Wing loading 26.3 kg/sq m
L.A.D. Co
SS - 2
1967
Drawn by Martin Simons 2003 ©
From information provided by Yasuhiro Yama

first flights were in August 1967. The aircraft was useful to the home club for training, but was not intended for much more than this.

It was a wooden aircraft except for some small GRP mouldings for the nose cap. The wing was a simple, tapered form in two sections joining on the centre line. The wing profiles were from the old, non-laminar Göttingen series and with the wing span of 15 metres, performance was not sufficient for ambitious cross-country flying in such a difficult environment for field landings.

LITHUANIA

Lithuania, along with the other Baltic Republics, was invaded by Germany in 1941, reoccupied by the Red Army in 1944 and taken into the USSR as a constituent Republic. Independence was achieved in 1991.

A State-owned aircraft factory at Prienai was established in 1969. It was at that time the only factory in the USSR manufacturing gliders, sailplanes and light aircraft. Plastic-composite sailplanes were produced from 1972. A very large new factory was built near a large airfield at Pociunai in 1984. Aerobatics and sky diving were, and still are, practiced there. There are summer camps for children to learn to fly by the old solo, primary glider method. After 1991 the factory was privatised as the AB Sportine Avaicija and continued with glider production, including the LAK 12, a 20 metre span, high performance sailplane, some of which were exported. Contacts were established with the American 'Project Genesis'[41] and twenty-seven of this unusual sailplane were built.

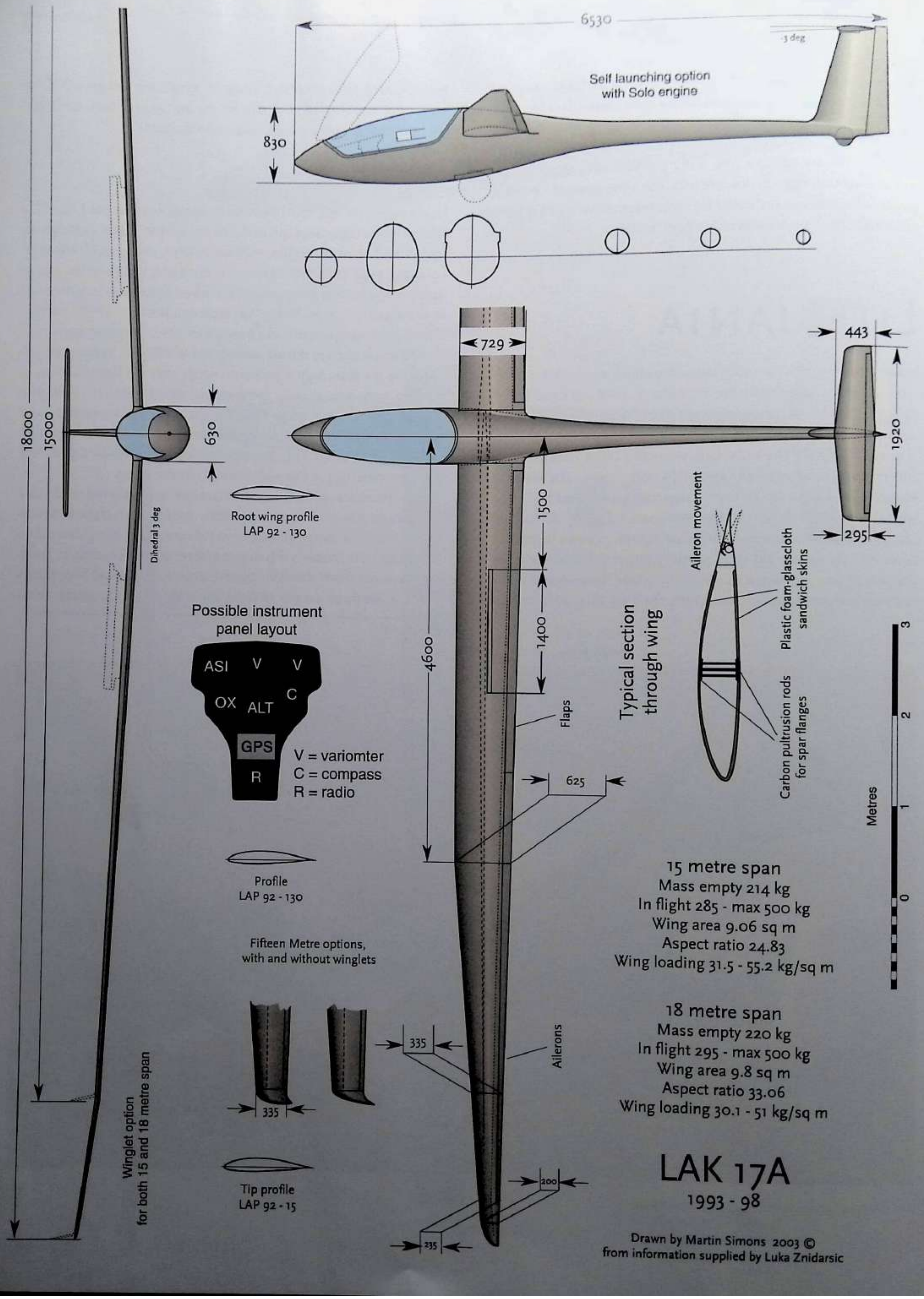
LAK 17A

In the early nineties, Sportine Aviacija began work on the LAK - 17, a fifteen metre class sailplane with unusually thin wings and high aspect ratio. The wing profiles, with turbulators, designed by Eduardas Lasaukas, were 13% thick at the root, changing to 15% at the tips to improve the stalling characteristics. Carbon fibres were incorporated in the main spar. A prototype was built and flown in 1992, entering the World Championships in Sweden in 1993. This prototype later proved unsatisfactory during subsequent test flights. Despite the carbon fibre the thin, high aspect ratio wings were too flexible. Plans to go into production were temporarily abandoned. In 1996 Jim Marske, the designer of the Genesis, was at the factory carrying out tests on 'pultruded' carbon rods for the spars. Klemas Juocas, chief designer for the Company, became interested and realised that with this new material the LAK - 17 project could be saved.

The cylindrical rods, 3 mm in diameter, are machine made in a continuous process by pulling densely packed high-quality carbon fibres, soaked in resin, through heated dies, and curing them. The advantage of this material is that the fibres are pulled straight, without the usual slight waves and uneven tensions of hand laid carbon fibres. If the fibres are not straight, some are subject to greater loads

41 – See p. 245

LAK 17A, flying in Namur, France (Photo Jochen Ewald)


6530
3 deg
Self launching option
with Solo engine
830
18000
15000
630
729
443
1920
295
1500
1400
4600
Dihedral 3 deg
Root wing profile
LAP 92 - 130
Possible instrument
panel layout
ASI
V
V
OX
ALT
C
GPS
R
V = variomter
C = compass
R = radio
Flaps
625
Typical section
through wing
Aileron movement
Plastic foam-glasscloth
sandwich skins
Carbon pultrusion rods
for spar flanges
Metres
0
1
2
3
Profile
LAP 92 - 130
Fifteen Metre options,
with and without winglets
335
335
Ailerons
Winglet option
for both 15 and 18 metre span
Tip profile
LAP 92 - 15
200
235
15 metre span
Mass empty 214 kg
In flight 285 - max 500 kg
Wing area 9.06 sq m
Aspect ratio 24.83
Wing loading 31.5 - 55.2 kg/sq m
18 metre span
Mass empty 220 kg
In flight 295 - max 500 kg
Wing area 9.8 sq m
Aspect ratio 33.06
Wing loading 30.1 - 51 kg/sq m
LAK 17A
1993 - 98
Drawn by Martin Simons 2003 ©
from information supplied by Luka Znidarsic

than others and these begin to fail while the rest of the material is not yet bearing its full load. The tensile and compressive strength of the carbon rods is much greater than the equivalent weight of hand laid fibres. Less material is needed for a given strength and stiffness.[42] The spar flanges are made by assembling the necessary numbers of rods in clusters, to be laid span-wise in the wings with resin bonding. By using the carbon in this way the main spar could be amply strong and stiff enough for the LAK - 17, and the design was developed around this concept.

The rest of the design followed what had by now become usual practice. Ballast tanks to hold 180 litres were fitted in the wing, with a tail tank to adjust the balance point, and nose ballast fittings for light pilots. The fuselage was composite in carbon, Kevlar and GRP, with retracting main wheel and tail wheel. All the controls connected up automatically when rigging. The cockpit was large, having been increased in length after the early experience.

The outcome surpassed expectations. In flight tests, the LAK 17 showed up very well against other modern Fifteen Metre Class sailplanes such as the Ventus 2. The LAK was found to be slightly under the best glide ratio of the Ventus, but superior at both the lower and the higher speed ends of the scale. In practice a pilot very seldom needs to use the best glide ratio. When soaring a lower speed is required, when gliding between thermals the airspeed is always faster than best glide. The LAK 17A was expected to prove better in competitions than some of its close rivals.

With the carbon rods it was possible, with few changes, to develop an 18 metre version with interchangeable 15 metre tips, with or without winglets. In flight tests at Caddo Mills this produced a performance comparable with the ASH - 26 in the mid speed ranges, the best glide ratio close to 50:1, slightly poorer at lower speeds but better in the faster glides.

At the time of writing the LAK 17A is in production. The total number built is more than 60. Some excellent results appeared in the 2003 World Championships and in lesser contests. What may help the Sportine Aviacilj in future is that the LAK 17A is on the market at a very competitive price. A version without flaps, the LAK 19, became available in the year 2001.

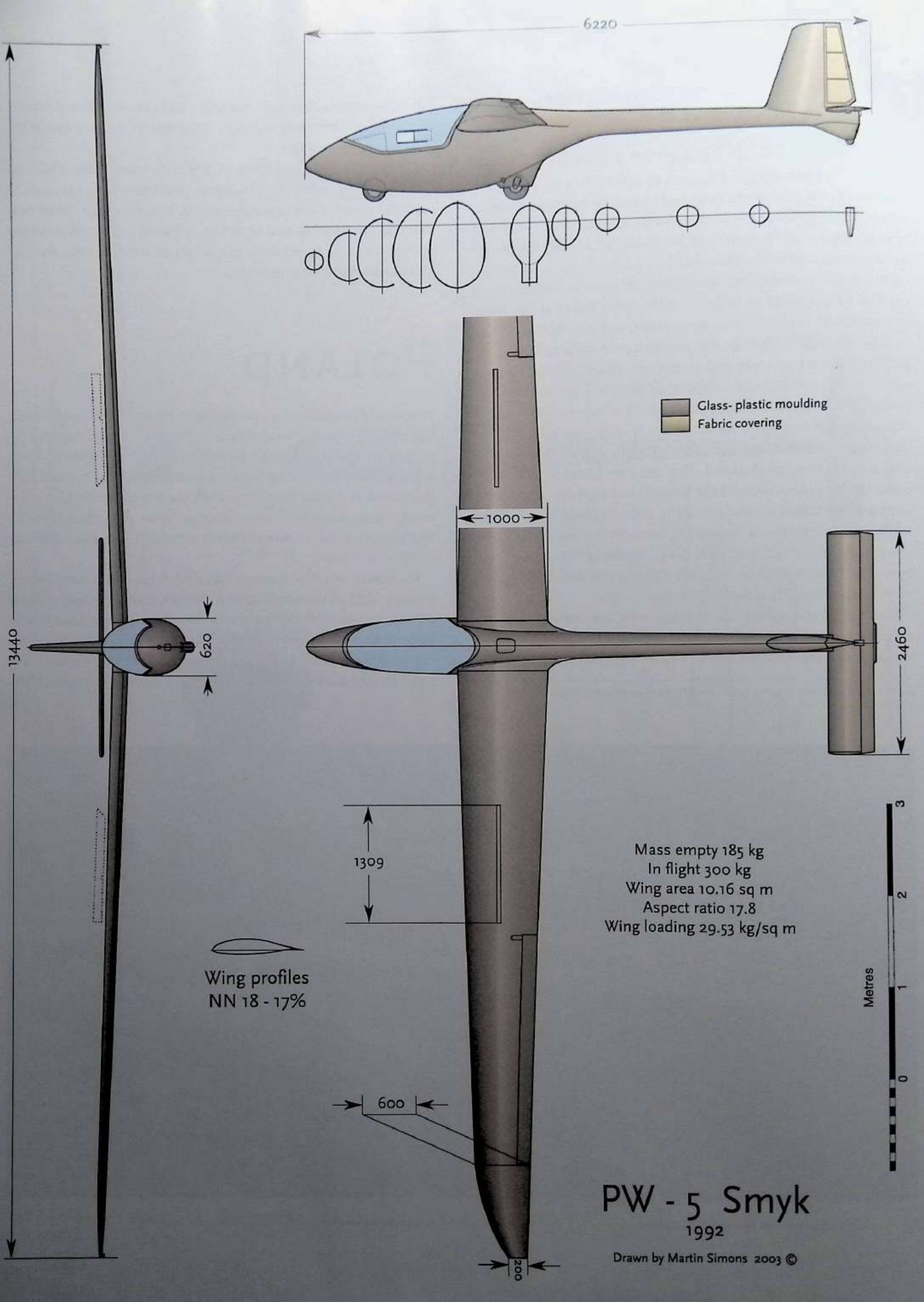
POLAND

Design and production of sailplanes in Poland flourished during the decades of state-ownership and control. Official support for gliding ensured that a considerable industry developed and was maintained. The Gliding Institute at Bielsko-Biala, became SZD (Szybowcowy Zaklad Domianowany), the Experimental Glider Institute. Regional Glider Workshops at Jezów (the old Schneider factory at Grunau) continued and production was also undertaken at other centres.

The strikes, political tensions and disturbances that transformed Polish society in the seventies and eighties, leading at last to a new constitution in 1989, caused severe disruption. Many of the former State glider factories were closed. The centre at Bielsko-Biala survived but towards the end of the century SZD ran into financial difficulties. The Company became officially bankrupt in mid 1998.

42 – More information about the carbon rods is included in the article about the Genesis and Marske Monarch, p. 243 / 245.

The PW 5 World Class Sailplane at Gawler. This example was used by Keith Willis in Australia to establish several records in the new 'World Class' category.


6220
13440
620
Glass- plastic moulding
Fabric covering
1000
2460
1309
Mass empty 185 kg
In flight 300 kg
Wing area 10.16 sq m
Aspect ratio 17.8
Wing loading 29.53 kg/sq m
Wing profiles
NN 18 - 17%
Metres
0
1
2
3
600
200
PW - 5 Smyk
1992
Drawn by Martin Simons 2003 ©

The assets were taken over by a new Company, Aviontech, but this enterprise had no intention of continuing glider production.

Arising from the old business, new independent companies started and some of the SZD sailplanes continued in production. Bielsko-Biala remains a centre of expertise in sailplane design and development. Other small sailplane manufacturing enterprises have also been established in Poland. Further developments may be expected.

Poland has also produced a great many outstanding soaring pilots and Champions, and has staged many highly successful regional, feminine, junior and club contests as well as a series of World Championships, and World Air Games, at Leszno.

PW - 5 Smyk

When it was proposed to include soaring in the Olympic Games of 1940, it was agreed that all competitors should fly identical sailplanes. After a design competition, the 'Meise' of Hans Jacobs was chosen and preparations were made for this to be built, world-wide, as the 'Olympia'. The 1940 games never took place but many Olympias were built. The original 'Standard Class' specification was drafted with this type in mind.

The American Schweizer Brothers observed yacht races and thought that competitions were fair only when everyone sailed the same kind of boat. This led them to produce the 1- 26 sailplane in 1954, for which very successful 'one design' soaring competitions were organised in the USA. Paul Schweizer at the OSTIV Congress in 1987, once again strongly advocated the adoption of an International 'One Design Class'. With strong support from Piero Morelli of Italy and others, the principle was once again taken up and resulted in the announcement in October 1989 by the CIVV (International Gliding Commission) of the FAI (Federation Aeronautique Internationale) of a design competition for a 'World Class Glider'.

Detail of the PW 5 tail unit

The main emphasis of the guidance issued to the competition entrants was on reducing the costs of the aircraft, safe handling, and performance good enough for pilots to achieve the FAI soaring badges. Air brakes rather than flaps or tail parachutes were to be installed, with a low stalling speed under 65 km/h (35kts). Rigging and de-rigging by a maximum crew of two persons was required. There was no specification as to materials of construction providing a useful service life of 20 years or 9000 flying hours could be assured. The likelihood of kit production for completion by amateur builders was also to be considered.

An international panel of 14 judges under the Chairmanship of Professor Morelli, was appointed. A short-list was prepared from the forty or so designs submitted on paper. The remaining contestants were required to produce their prototypes for flying and assessment at Oerlinghausen in Germany over a three week period during September and October 1992.

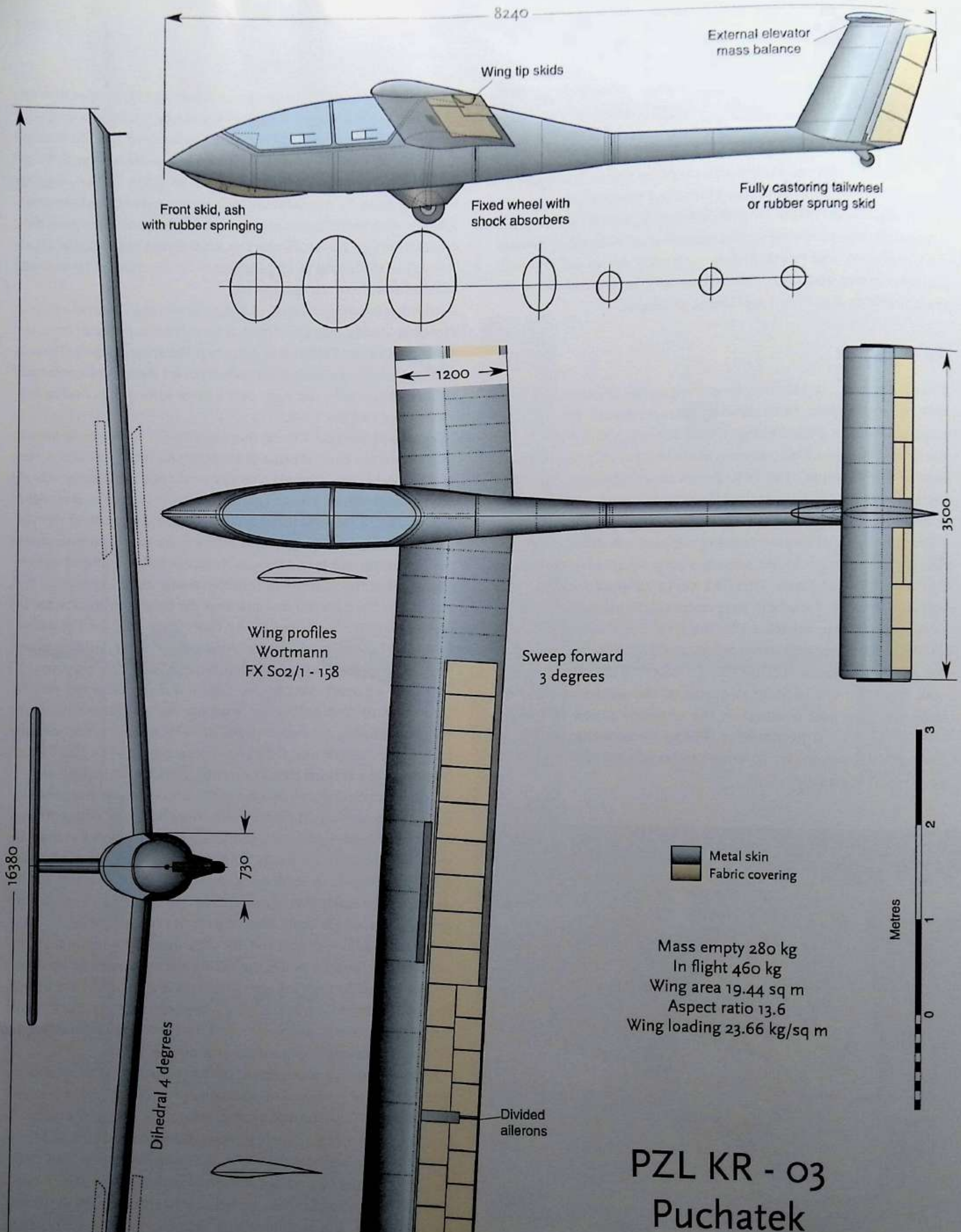
Six aircraft arrived. Of these, one, the SZD 51 - 1 Junior, was already well known as a club sailplane in service, conforming to the old, simpler Standard Class formula. Perhaps it was not sufficiently radical, nor especially cheap. Another prototype which did later enter production, the L - 33 Solo was thought to be too costly, not easy to rig with two people, and not entirely satisfactory in handling. Another of the prototypes was eliminated because it was not fully completed and unready for test flying, one was considered seriously lacking in performance and the fifth was unsafe unless the balance was corrected by adding considerable ballast in the nose. Only one, the PW - 5, remained. There were still several features which the judging panel, when announcing the final decision, required should be improved.

The PW - 5 Smyk (Urchin), all GRP, was designed at the Warsaw University of Technology by students in the University Light Sailplane Project, a group founded in 1978. Several earlier designs had been produced and flown. Two prototypes of the PW - 5 had been built at a Warsaw-based Company, DWLKK, which had experience in composite materials. One of these was used for static testing.

The wing was straight-tapered with swept-back tips, large airbrakes and a very simple system of rigging. A cost-saving item was that the spars for left and right wings were identical. The wing profile was specially designed by Professor Ostrowski at the University. It produced a high maximum lift coefficient, so ensuring a low stalling speed. It was not too badly affected by insect contamination.

The fuselage, which gave the PW - 5 its distinctive appearance, ensured good clearance under the tail for winch launching and even bungee launching from hill tops. The main landing wheel was behind the laden centre of gravity so a nose wheel was necessary. The tail unit was a simple form to save weight, and the elevator (as required by the CIVV specification) connected automatically on rigging.

Following the announcement of the competition win, manufacture of the PW - 5 was undertaken by the PZL factory at Swidnik near Lublin, (This Company was previously engaged mainly in building helicopters.) The first production example flew in March 1993. Interest was stimulated by the announcement that there would be regular 'World Aerial Games' including soaring championships for the World Class as well as other sports such as sky diving, aerobatics, and aeromodelling. Exports of the PW - 5 began in 1994. For three years about a dozen were produced each year.



PZL KR - 03 Puchatek

1985

Drawn by Martin Simons 2003 ©

The first Aerial Games were held in Turkey at Inonu during 1997. By now about 140 of the PW - 5 had been produced at Swidnik. The soaring section was won by Fridiric Hoyeau of France who already had several outstanding European and French contest wins behind him. Further World Air Game meetings followed in Poland, Spain and the Slovak Republic but sales of the Smyk slowed down considerably after this, with only about a dozen being built in 1999. Most were exported, 70 to the USA where sufficient interest existed to justify the foundation of a World Class Soaring Association with National Championships and records, as had happened before with the Schweizer 1 - 26 Association. Other countries on the whole proved less enthusiastic, with national registrations of the PW - 5 rarely reaching double figures.

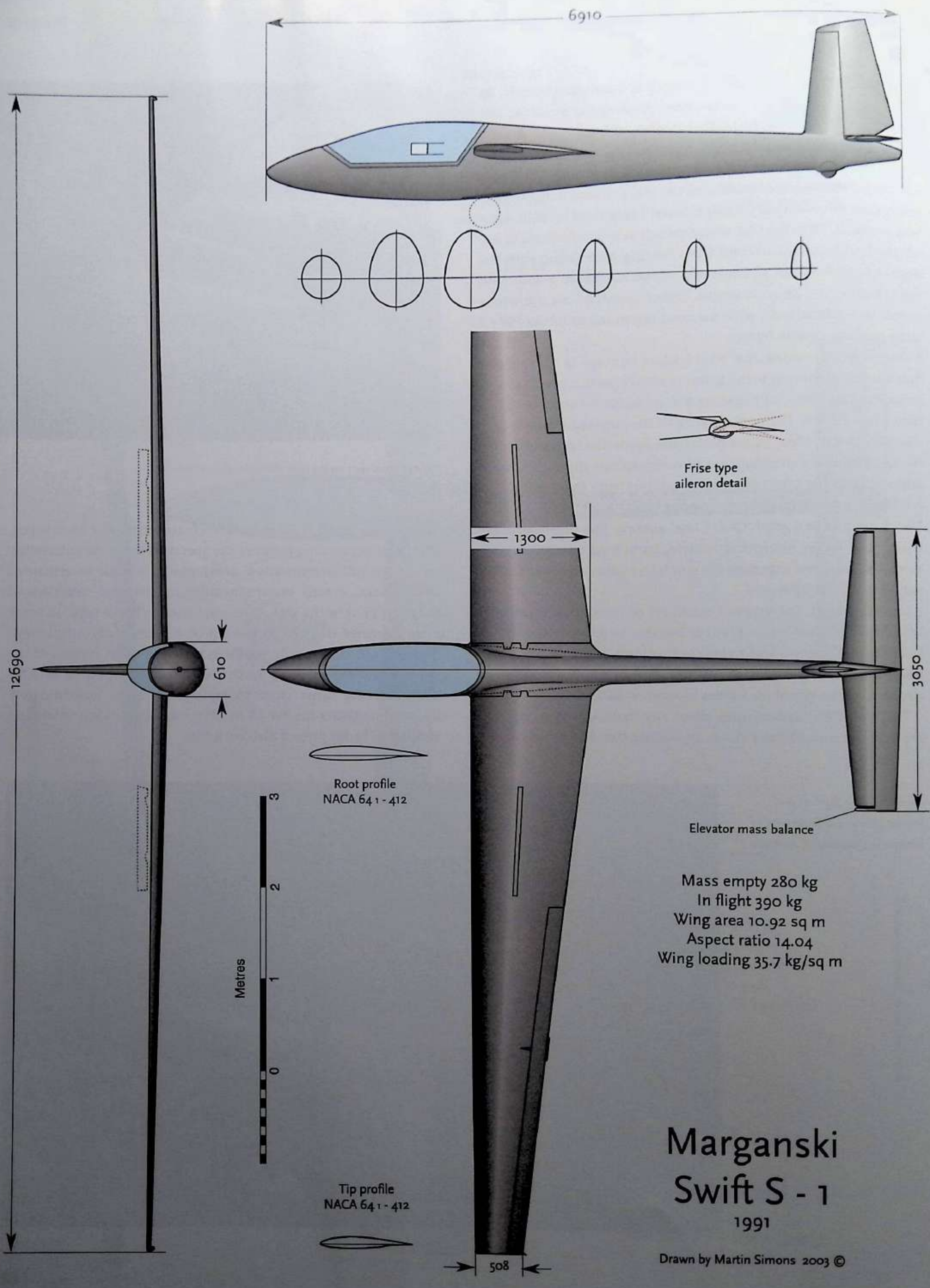
One difficulty facing the World Class concept is that despite much attention having being given to saving costs, a good secondhand Standard Class sailplane such as a Standard Cirrus costs less than a new PW - 5. The performance of the larger sailplane is considerably better. Most pilots prefer the secondhand purchase. At the same time, the proliferation of competitions for the Club and Junior Classes has taken away some interest from the World Class. It is not very much cheaper, or easier, to enter a competition with a PW - 5, than with a good 'Club Class' aircraft. The overhead costs, travel, road trailer, retrieving vehicle, launching charges, accommodation and crew expenses are much the same whatever kind of sailplane is to be flown

Undiscouraged, the original members of the design team from Warsaw established a new plant at Bielsko, to produce the PW - 5 and its promising two-seat stable companion the PW - 6, in competition with the PZL works at Swidnik. Two of the Bielsko PW - 5s competed at the World Air Games in Spain in 2001.

The World Air Games rules allow any materials to be used in the construction of the PW - 5, providing that the aerodynamic shape, wing profiles, fuselage etc, remain externally unchanged, and the wing loading is under the specified limit. An interesting but, in the final outcome, sad development was the enterprise of Oran Nicks, a well known aerodynamicist and experienced sailplane pilot in the USA. (The total energy 'Nicks tube' in some form or other is fitted to the fin of a great many sailplanes.) Nicks designed and built, partly in metal, his own version of the PW - 5 and flew it very successfully. The prospect of kits for homebuilding came close to realisation. Most unfortunately Nicks while flying his PW - 5 in 1998 was killed in an outlanding accident. The kit project died with him.

The Puchatek rests on the nose skid even when empty

The Puchatek in flight at the Boonah gliding club south west of Brisbane in Queensland, Australia



Mass empty 280 kg
In flight 390 kg
Wing area 10.92 sq m
Aspect ratio 14.04
Wing loading 35.7 kg/sq m

Marganski Swift S - 1

1991

Drawn by Martin Simons 2003 ©

PZL KR - 03 Puchatek

It was recognised in 1982 that the old wooden SZD - 9 Bocian two-seaters in Poland were in need of replacement. The Aero-Club of the People's Republic decided that, since the Bielsko-Biala centre was fully engaged in production and design of advanced trainers like the Puchacz and high performance single seat sailplanes, a new basic trainer should be designed and built at the Transport Equipment Manufacturing Centre PZL- Krosno. This factory had been involved in building wooden sailplanes some twenty years before but had since then been engaged in making sub-components for metal powered aircraft, especially landing gears and fuselage frames. There was no experience here with modern GRP sailplane design or construction. An all-metal training glider was nevertheless an attractive proposition. It would be robust, weather resistant and durable, and the techniques of light alloy construction were well understood.

Design work began in 1983 at Krosno, Jerzy Krawczyk leading the design group. After the early outlines had been prepared, aerodynamic calculations were carried out at Bielsko, and support came from several other centres for flutter and fatigue-life assessment. Structural tests of sub-components were carried out at Rzeszów University of Technology. A complete prototype was submitted to static tests at Rzeszów in May 1985 and a second was prepared for test flying in August of that year. Production began in 1987.

Puchatek in Poland is 'Winnie the Pooh', the "bear of very little brain" in the famous English books for children. The reason for this choice of name is not very clear. The KR - 03 met all the criteria specified in the original requirement. It was a safe, robust and serviceable tandem-seat training glider which, if not very beautiful, served its purpose well. The wing was of rectangular shape but swept forward. The main spar was of milled duralumin extrusions of T cross section, ribs pressed from dural with a dural-skinned forward D nose and fabric covered rear section. The fuselage followed methods usual for metal aeroplanes, with dural skin over pressed cross frames. The non-retracting landing wheel behind the laden centre of gravity, was sprung with shock absorber adapted from the Wilga tailwheel. There was a prominent skid in front and a tailwheel. The T tail was an orthodox metal structure with fabric covered elevator and rudder. The elevator had mass balance weights at the tips.

How many were built is not known but some were exported.

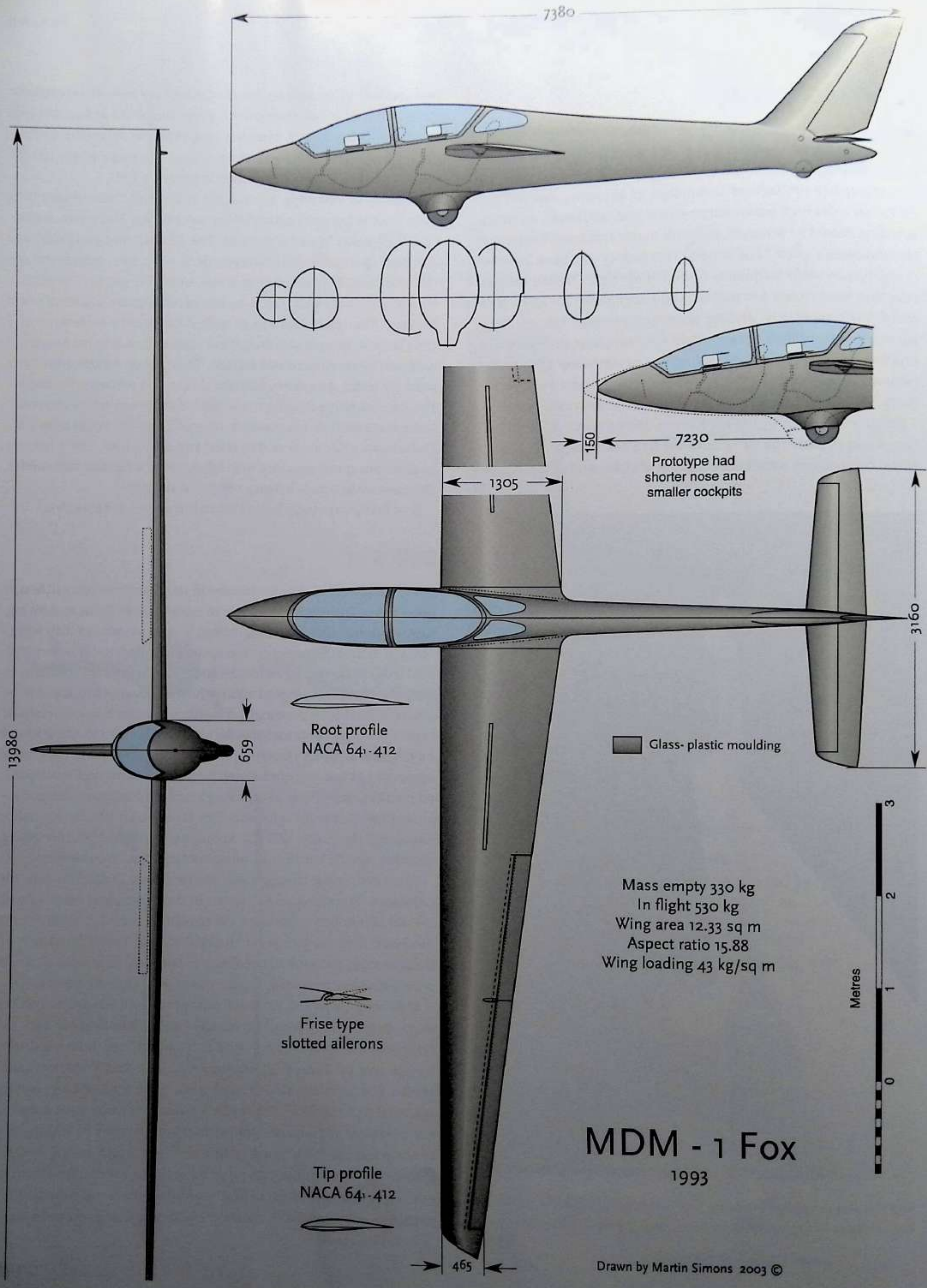
Marganski Swift demonstrating its ability to perform advanced aerobatics. The camera was mounted on the wing tip. (Photo Helmut Lindner / Bernd-Olaf Hagedorn)

Swift S - 1

There has always been some interest in sailplane aerobatics although pilots whose interest is exclusively in cross-country flying and racing, find it wasteful after struggling to gain height, to sacrifice it all with a series of extravagant, energy- consuming manoeuvres. It is nonetheless useful to know how to handle the glider in unusual attitudes, to control attitude and airspeed accurately in all circumstances, and to be able to recover from potentially dangerous situations. Some aerobatic experience is probably essential for all. There is also a steady demand for sailplane aerobatic displays at air shows and some pilots have made a speciality of this, sometimes even performing to musical accompaniment. There have been a surprising number of sailplane designs intended specifically for aerobatics. The Habicht, Lo 100, H - 101 Salto, Lunak and the Polish SZD - 21 Kobuz, are examples. (An interesting variation was the Mü 28 with automatic flaps, described above.)

There are regular competitions and Aerobatic Championships for sailplanes. The stimulus for design of the Swift came when one of the old SZD Kobuz broke up in the air, killing the pilot, at the World Aerobatic Championships at Hockenheim in 1989. Thirty-two of these wooden aircraft had been built in the early sixties and all those remaining were grounded. Replacements were urgently needed.

With some Swiss and English financial support, Edward Marganski in co-operation with Jerzy Makula, the World Champion aerobatic pilot, undertook to build a new type at his workshops in Bielsko-Biala. Design was by Tadeusz Zbos, Jerzy Cisowski and Krzysztof Krawcewicz. The Swift was all GRP, with a two piece wing of 12.69 metres span and a profile from the NACA 6 series. To ensure a good rate of roll the Friese ailerons were more than half the span in length. The fuselage was relatively short, with a small cross section and well-reclined seat beneath the one-piece transparent canopy. The canopy opened forwards, with gas strut. The landing wheel was retractable. A periscope was provided to enable the pilot to see underneath the air-


7380
7230
150
Prototype had shorter nose and smaller cockpits
1305
3160
13980
659
Root profile NACA 64₁-412
Glass- plastic moulding
3
2
1
0
Metres
Mass empty 330 kg
In flight 530 kg
Wing area 12.33 sq m
Aspect ratio 15.88
Wing loading 43 kg/sq m
Frise type slotted ailerons
MDM - 1 Fox
1993
Tip profile NACA 64₁-412
465
Drawn by Martin Simons 2003 ©

craft to assist accuracy when flying upside down or performing rolls. The tailplane was mounted below the rudder directly onto the fuselage. Fifteen metre wing extensions were allowed for, to enable the Swift to fly across country. Wave flying was also considered. Severe turbulence is often met in wave rotors, so a strong, fully aerobatic sailplane is a good aircraft to be in when such encounters are likely.

The prototype made its first flights on 6th August 1991 and production was begun in time for the Polish team to be equipped for the 1992 Aerobatic Championships at Jelena Gora a year later. The results showed that the Swift was achieving what had been hoped. The Swift was very strong, the allowable maximum airspeed being 320 km/h (≈ 173 knots) and it was stressed to plus and minus 10g. A 360 degree roll could be performed in four seconds. The first four places in the Championships were taken by pilots flying the Swift, with two others in the top ten. Makula won the Championship.

The MGM Fox two seater, an outstanding aerobatic sailplane (Photo Bernd-Olaf Hagedorn)

MDM - Fox

To develop skill in aerobatics requires expert instruction but very few two-seaters are capable of the full range of aerobatics required for competition purposes. The Fox, produced by the small Polish company founded by E Marganski, L Dunowski and J Makula (hence MDM) at Bielsko-Biala, is often regarded as a two seat version of the Swift from the same factory. It bears obvious family relationship to its immediate predecessor. The general layout and appearance are similar. This tends to conceal the amount of work necessary to produce a two seater with all the aerobatic abilities of a smaller aircraft.

The wing is 13% larger in area than the Swift, and the span greater. The wing loading with two pilots is considerably more but the Fox is frequently flown solo from the front seat. It was designed for high maximum airspeeds, stressed to +10g and -6g when flown solo and +7 and - 5 dual. The seats are in tandem, with a divided canopy. Some carbon fibre is used in the cockpit area for pilot protection in accidents. On the prototype the non-retracting landing wheel was immediately under the rear seat.

The first flights were early in July 1993 and proved satisfactory except that tall pilots found the rear cockpit extremely uncomfortable. To lower the seat a few centimetres required re-location of the wheel, and the nose was lengthened to give more leg room. There is still not very much room to spare.

In the World Aerobatic Championships at Venlo in Holland in 1993, Jerzy Makula achieved first place and in 1994, at Rieti in Italy,

Sailplanes do not usually attract commercial sponsors. They have a habit of flying out of sight! Things are rather different at public air displays (Eugen Schaal / Bernd-Olaf Hagedorn)

Pirat at Camphill, England, on a winch launch

all the Polish team of six flew the Fox. Makula yet again became Champion, the others all finished in the top fifteen. The good results continued.

A special instrument, the 'Geronimo', was devised in Bielsko-Biala to assist 'Fox' pilots during aerobatics. This is a computer which, during a flight, reminds the pilot of the planned manoeuvre to be performed next and the airspeed required for entry, analyses the kinetic and potential energy of the sailplane, and records height, airspeed, G force, and all control deflections. Subsequent analysis enables the pilot to see where mistakes were made and helps with improving future performances.

The Fox remained in production by MDM. At least 36 were produced before the end of the year 2002. The Fox has more recently been further developed to produce a new, single seat aerobatic sailplane expected to appear in future aerobatic competitions.

SZD - 30 & 30C Pirat

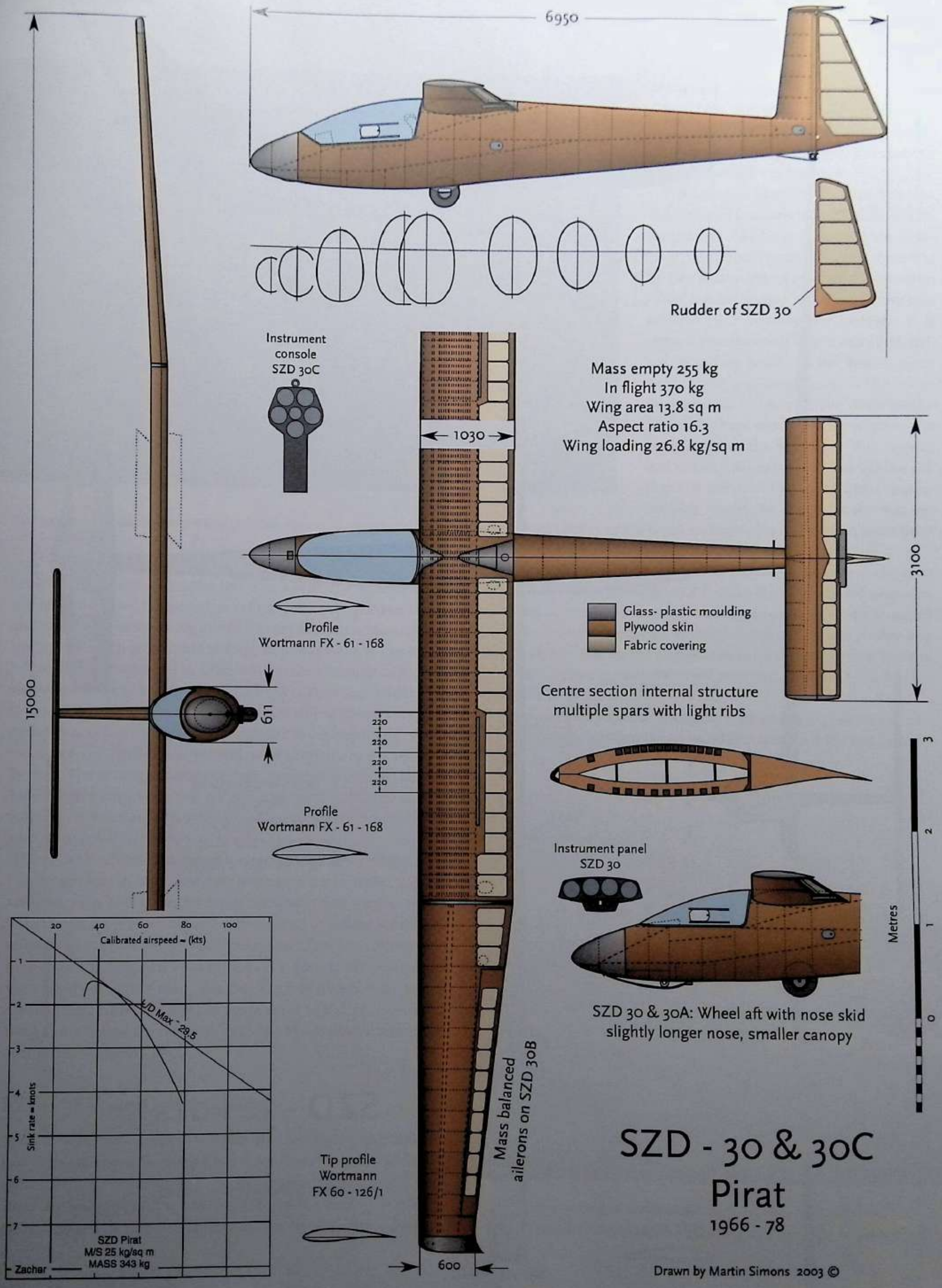
The first Pirat flew in May 1966. It was intended as an advanced trainer for early cross-country flights and elementary aerobatics. It was robust and inexpensive, built of wood with a wing in three sections. Maintenance and repair were easy. The centre section, with no dihedral, had an unusual, and very strong, structure of multiple spars supporting the plywood skin. This ensured an accurate profile to take advantage of the low drag Wortmann profile. The airbrakes opened both above and below the wing. The detachable outer panels, set at 2.5 degrees dihedral, tapered to the 60 - 126/1 section, chosen for its good stalling properties. The rear part of the wing and the ailerons were fabric covered. The fuselage was of the orthodox wooden plywood-skinned type, with a non-retracting main wheel and a nose skid. The T tail layout was adopted. The nose cap wing and tailplane tips were of GRP.

During early test flights some problems were encountered, the ailerons occasionally jamming when the wing was bending under high loads. The mass balance weight was fouling on the hinge line shrouding. After correction, the Pirat became very popular with clubs, not only in Poland but worldwide. The performance was comparable with the German Ka - 6, but handling was easier and the cockpit much more comfortable. Later improvements included a larger rudder. The Pirat C had the landing wheel further forward so that the nose skid was no longer needed. A larger cockpit canopy improved the field of view, with minor revisions in the cockpit layout and instrument panel.

Production of the Pirat began in 1967 and continued for more than ten years, a total of 813 being built up till 1979.

SZD - 32 Foka 5

The Foka 4 of 1960, which won the Open Class World Championships in 1965 against much larger sailplanes including the GRP 'gummiflügel' D - 36 'Circe', conformed to the Standard Class rules of the time. It was not seriously considered for the OSTIV Design Prize. The performance was outstandingly good and it handled well, but too little attention had been paid to the original intention of the Standard Class. It was considered far from suitable for general club use, with very low and narrow fuselage. The pilot lay almost supine with a very limited view directly ahead. On aero-tow the tug


6950
Rudder of SZD 30
Instrument console SZD 30C
Mass empty 255 kg
In flight 370 kg
Wing area 13.8 sq m
Aspect ratio 16.3
Wing loading 26.8 kg/sq m
1030
3100
15000
611
Profile Wortmann FX - 61 - 168
Glass- plastic moulding
Plywood skin
Fabric covering
Centre section internal structure multiple spars with light ribs
220
220
220
220
Profile Wortmann FX - 61 - 168
Instrument panel SZD 30
Metres
SZD 30 & 30A: Wheel aft with nose skid slightly longer nose, smaller canopy
Calibrated airspeed – (kts)
Sink rate – knots
L/D Max ~ 29.5
SZD Pirat
M/S 25 kg/sq m
MASS 343 kg
Zacher
Tip profile Wortmann FX 60 - 126/1
Mass balanced ailerons on SZD 30B
600
SZD - 30 & 30C
Pirat
1966 - 78
Drawn by Martin Simons 2003 ©

Foka 5 at the International Vintage Glider Club Rally, Achmer, Germany, 2002

could easily disappear behind the pilot's feet. The landing wheel was more than half buried in the belly to reduce drag. It was almost useless for ground handling except on very smooth surfaces. When landing on rough ground the fuselage itself was liable to damage.

The Foka 5, introduced in 1966, was a serious attempt to produce a sailplane more in keeping with the spirit of the Class. With slightly modified wing profiles, it was expected still to have a very good performance. The fuselage was completely re-designed. The cockpit was now more orthodox, larger and more adaptable to a range of pilot sizes. The seating position was only moderately reclined and the view forward quite adequate. A T tail was installed. The all moving tailplane, with an anti-balance tab and mass balance, was mounted atop a strongly swept back fin.

The Foka 5 achieved what had been hoped for it, winning the OSTIV design prize in 1968. The days when such a win meant immediate mass sales had gone, however. Standard Class contest results were moderately good but not outstanding at a time when GRP sailplanes were becoming more common. The rules themselves were changing. The new Foka proved only moderately popular and was judged out of date soon after entering production. Exports were mainly to the USSR and East Germany, some to Hungary, comparatively few to other countries. A total of 134 were built before production ceased in late 1971.

SZD - 36& -39 Cobra 15 & 17

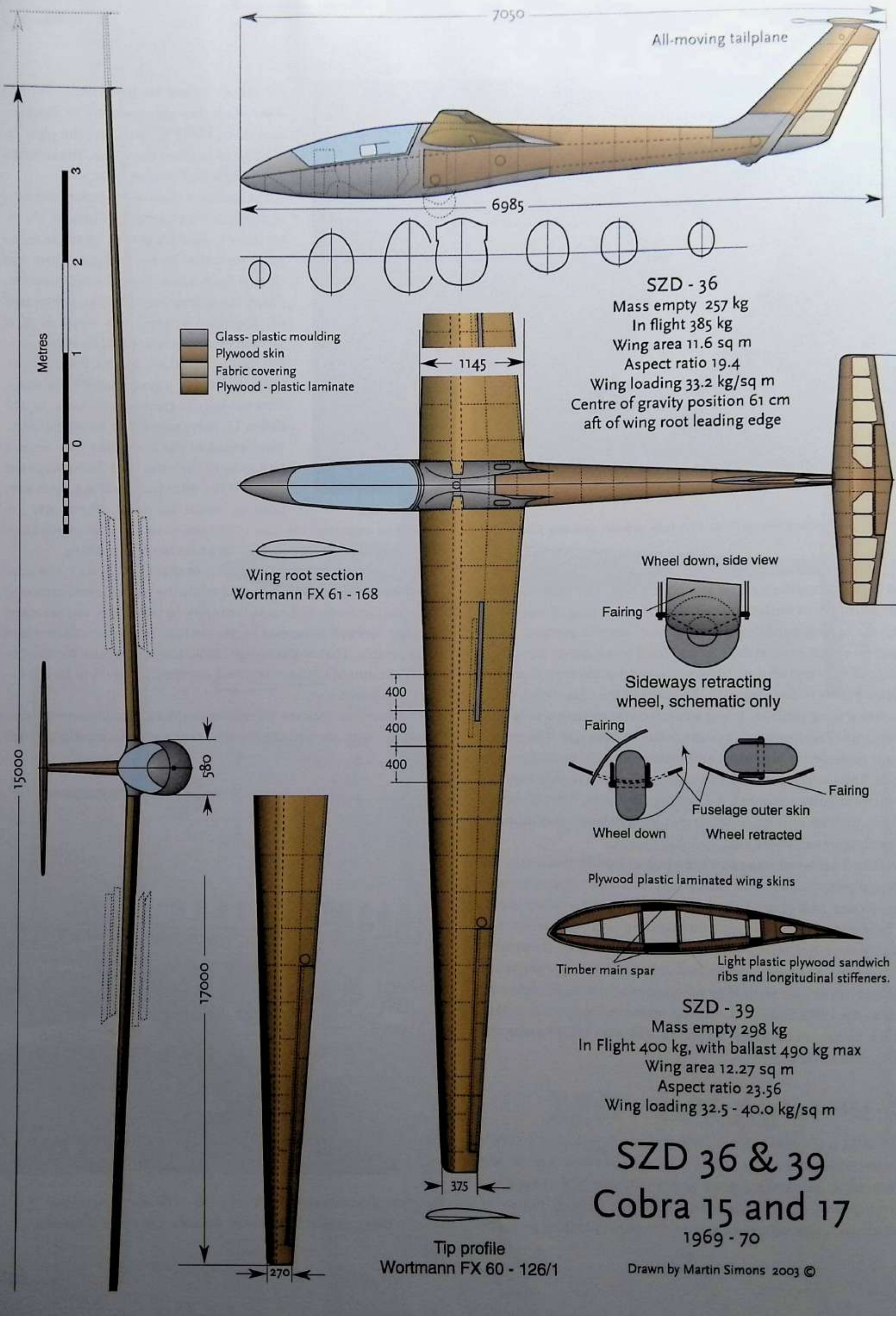
The Cobra 15 was a direct development of the Foka 5 taking advantage of the changed Standard Class rules, which allowed retracting undercarriages. There were good arguments justifying this alteration. A deployed landing wheel that lifted the fuselage some way off the ground, was safer than one in the belly. Landing and take off speeds would be lower with the tail down. Less damage was likely to the fuselage when landing, providing the pilot remembered to lower the wheel. The cost of a retracting wheel was not great.

The Standard Class specification had never forbidden the carrying of ballast. If a pilot chose to load his aircraft up to the maximum permitted by the designer, there was no rule against this. The rules did, however, forbid the jettisoning of ballast. Before take off the pilot assessed the weather. If it seemed that thermals would be strong, ballast would be taken. In the French Edelweiss, there was housing inside the wings for steel rods to increase the mass. In the Cobra 15, there were tanks for water in the wing ahead of the main spar. The aircraft had to carry the extra load throughout the flight. If the pilot had made a bad choice, nothing could be done. There was no means of emptying the tanks in flight. On a day when weak thermals were expected, no ballast was added before launching.

The fuselage was generally similar to that of the Foka 5, the nose section and fairings being in GRP while the rest followed orthodox wooden methods. The cockpit canopy, in one piece, was arranged to slide forward for access to the cockpit, which was roomy and comfortable. The undercarriage retraction mechanism for the Cobra was unusual in that the wheel retracted sideways to lie flat behind the pilot's seat.

The wing used modern Wortmann profiles and to preserve the necessary accurate contour, the plywood skin was moulded and laminat-

Sue Martin of Australia with the Kobra 15 she flew in the second International Women's Chamionships at Leszno in 1975. This was a 'One Design' competition.


7050
All-moving tailplane
6985
SZD - 36
Mass empty 257 kg
In flight 385 kg
Wing area 11.6 sq m
Aspect ratio 19.4
Wing loading 33.2 kg/sq m
Centre of gravity position 61 cm
aft of wing root leading edge
Metres
3
2
1
0
Glass- plastic moulding
Plywood skin
Fabric covering
Plywood - plastic laminate
1145
2700
Wing root section
Wortmann FX 61 - 168
Wheel down, side view
Fairing
Sideways retracting
wheel, schematic only
Fairing
Fairing
Fuselage outer skin
Wheel down
Wheel retracted
400
400
400
580
15000
17000
Plywood plastic laminated wing skins
Timber main spar
Light plastic plywood sandwich
ribs and longitudinal stiffeners.
SZD - 39
Mass empty 298 kg
In Flight 400 kg, with ballast 490 kg max
Wing area 12.27 sq m
Aspect ratio 23.56
Wing loading 32.5 - 40.0 kg/sq m
375
270
Tip profile
Wortmann FX 60 - 126/1
SZD 36 & 39
Cobra 15 and 17
1969 - 70
Drawn by Martin Simons 2003 ©

The Cobra tail unit

ed with layers of epoxy-glass cloth. Internally there was a strong, wooden main box spar. The ribs and auxiliary spar formed an accurate 'egg-box' structure to support and stiffen the skins. The ailerons, skinned with plywood, were mass balance, the hinge line beneath the wing being closed and sealed with a flexible duralumin plate. The powerful airbrakes of double-leafed type, opened both above and below the wing. Small, neatly faired wing tip wheels were provided.

The Cobra 15 flew in 1969 and entered production, replacing the Foka 5 in the SZD factory. At the 1970 World Championships in Texas Jan Wroblewski and Franciszek Kepka, using the well developed pair-flying techniques they had employed before to good effect, placed second and third in the Standard Class. Almost all their opponents, including Helmut Reichmann who took first place, were flying glass sailplanes.

293 of the Cobra 15 were built.

The SZD - 39 Cobra 17 was a special development of the Cobra 15, specifically for the Open Class World Championships of 1970. Only two were built. The span was extended to 17 metres with no other changes, except that in Open Class the ballast tanks could be emptied in flight without penalty. The prototype flew in March 1970, ten weeks after the Cobra 15. After hasty test flights it was shipped to Texas almost immediately to compete at Marfa. Flown by Ed Makula, another highly experienced former Champion pilot, it placed fifth among the glass-plastic aircraft, all of which had spans two metres or more greater. It was a surprisingly good result attributable almost entirely to the brilliant Polish pilots and their technique of co-operation and pair flying. The Cobra 17 never entered production.

SZD - 43 Orion

The Standard Class SZD- 43 Orion was never intended for production. Two special aircraft were designed and built in a considerable hurry to be ready for the World Championships of 1972. In appearance the Orion was elegant and totally modern, with T tail, retracting wheel and water ballast. The structure was a combination of plastics, metal and wood.

Since the Orion was intended only for very experienced pilots some reduction in strength was accepted. The wing was similar to that of the Cobra, the skins laminated in the mould with plywood and epoxy resin and glasscloth, but the main spar was lighter,

Jantar 1A at the Waikerie World Championships in 1974

stressed for load factor of 5.6 instead of 6. The ribs were more widely spaced. Water ballast tanks were built into the wing ahead of the spar. The front fuselage was a glassfibre shell supported on wooden longerons. The tail boom was a built up cone of light alloy and the fin also was of metal. The tailplane was a sandwich structure in plywood and glassfibre, the ailerons, rudder and elevator all in GRP. Undercarriage and retraction mechanism were the same as the Cobra. The empty mass was 262 kg, with pilot and equipment 373 kg, and with water ballast 422 kg. With an aspect ratio of 19.6 the maximum wing loading was 36.4 kg/sq m and the best glide ratio was claimed to be 40:1. The purpose was achieved. Jan Wroblewski won the Championships, pair flying as usual with Franciszek Kepka, a close second. It was Wroblewski's second World Championship. He had placed second in Texas in 1970, with Kepka as usual just behind.

SZD - 38 Jantar 1

Poland's first all GRP Sailplane, the Jantar (Amber), was designed by Adam Kurbiel, chief engineer of the SZD at Bielsko - Biala. Two prototypes were constructed. The first with span 17.5 metres flew in February 1972, the second, 19 metres, in May the same year. Both were entered in the World Championships in 1972, in Yugoslavia.

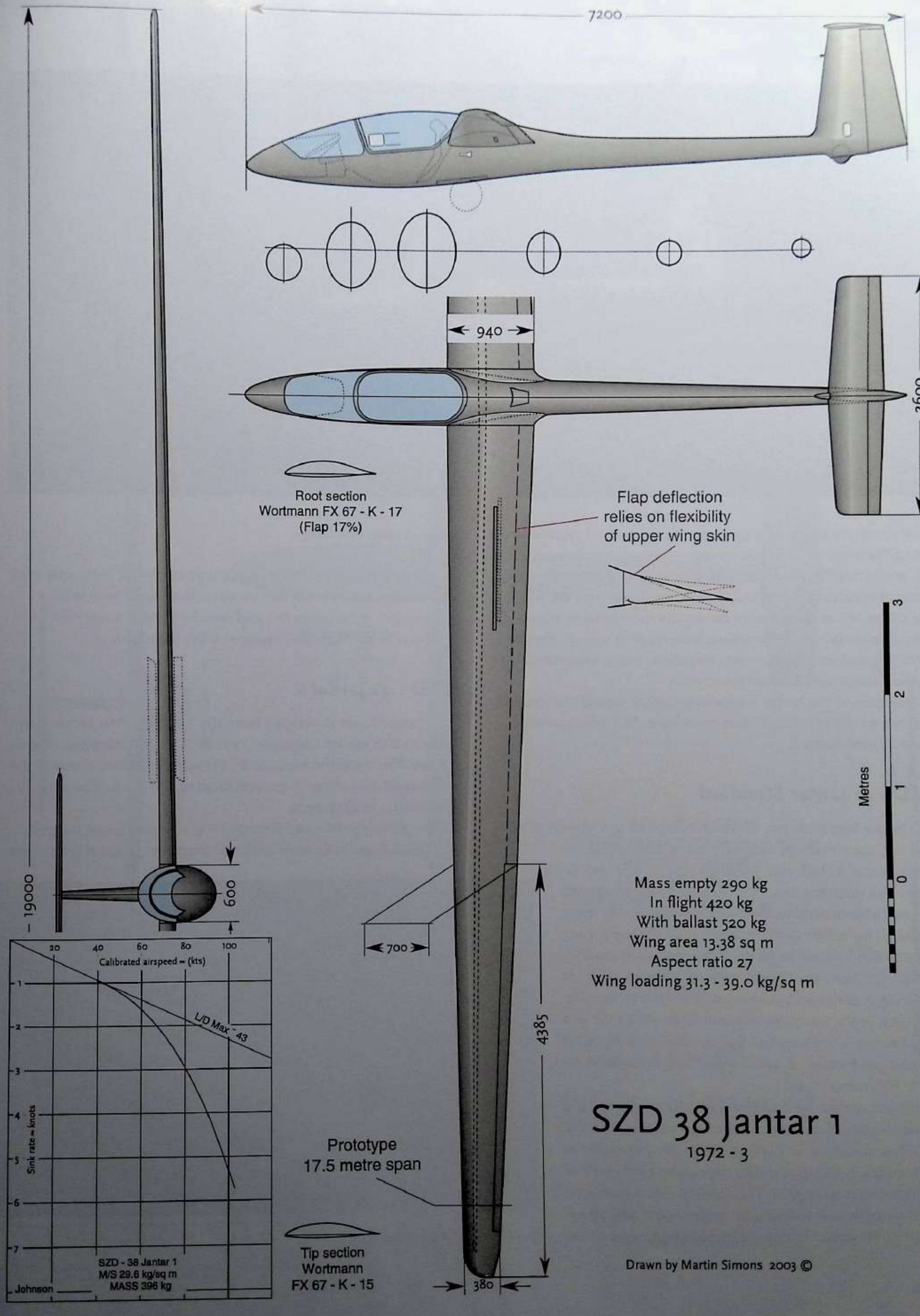
The wing profiles were from the now-widely used Wortmann 67 series. The Schempp-Hirth type air brakes opened both above and below the wing.

The most unusual and original feature of the Jantar was the elastic wing flaps. Instead of ordinary hinges, which can be a source of air leakage and flow disturbances, the upper skin of the Jantar wing was continuous to the trailing edge. The skin itself was the hinge, flexing as the flaps were altered from the cockpit. There was a carefully faired and sealed sliding joint on the underside so there was minimal change of shape at the different settings. This proved very successful although the loads for the pilot when changing the flaps, were higher than usual. In other respects the wing followed what was now normal practice, with spar flanges from glassfibre rovings and skins in Conticell - glasscloth sandwich form. Water ballast was carried ahead of the spar.

The fuselage had a steel tube frame to take concentrated loads in the centre, the rest was a glass-fibre shell. The cockpit was spacious under a two piece transparent canopy, the landing wheel retractable. The T tail layout was used, the elevator and rudder filled with foam plastic rather than the more usual sandwich skins.

In the World Championships Stanislaw Kluk in the Jantar 19 placed third and team mate Musczcynski 8th. Kluk won the cup for the best 19 metre sailplane. During the next twelve months the Jantars broke a number of Polish National records and, after some detailed improvements, plans were made for production. The Jantar 1, 19m span, flew in early August 1973 and with minor changes, two Jantar 1A were entered for the 1974 World Championships at Waikerie. The successes of the previous Championships were not repeated.

Jantar Standard 1 at Camphill, England



SZD 38 Jantar 1

1972 - 3

Mass empty 290 kg
In flight 420 kg
With ballast 520 kg
Wing area 13.38 sq m
Aspect ratio 27
Wing loading 31.3 - 39.0 kg/sq m

Drawn by Martin Simons 2003 ©

Jantar 2B (Photo Peter Selinger)

Dick Johnson's group in Texas measured the Jantar 1 and found the best glide about 43:1, which, though good, was less than expected. On measuring the wing surfaces, it was found that there were significant departures from the correct form. These were attributed to shrinkage of the epoxy resins during the months immediately following manufacture. Some efforts were made to smooth the wings, by filling and sanding to match templates, but to bring them back to the correct form involved much work.

Examples of the Jantar 1 were exported to several countries. By the beginning of 1976, 57 had been built. The type was then replaced by the Jantar 2.

SZD - 41 Jantar Standard

The Jantar Standard, two of which competed at Waikerie in 1974, had the same fuselage and tail unit as the original 19 metre Jantar 1, but with a fifteen metre wing and no flaps. The wing profiles, NN - 8, were of Polish design. The methods of construction were the same as the larger Jantars. The ballast tanks, integral with the wing, were close to the fuselage in front of the spar, with capacity for 80 kg. The first flights were in October 1973. At Waikerie, Franciszek Kepka placed third after Helmut Reichmann in the (controversial and difficult) LS - 2, and Ingo Renner in the Standard Cirrus. The Jantar Standard entered production. A total of 137 had been built by 1978, with many exports.

In flight tests at Caddo Mills, Dick Johnson found the Jantar Standard had a performance comparable with the St Cirrus, not quite so good in the climb but better at high speeds, both these results depending partly on the amount of ballast carried. The ASW 19 was slightly better than both at low and mid range speeds and about equal at 90 knots. Shrinkage of the resins was found again, which Johnson thought might be attributed to inexperience with GRP at the Wroclaw factory where the Jantars were built.

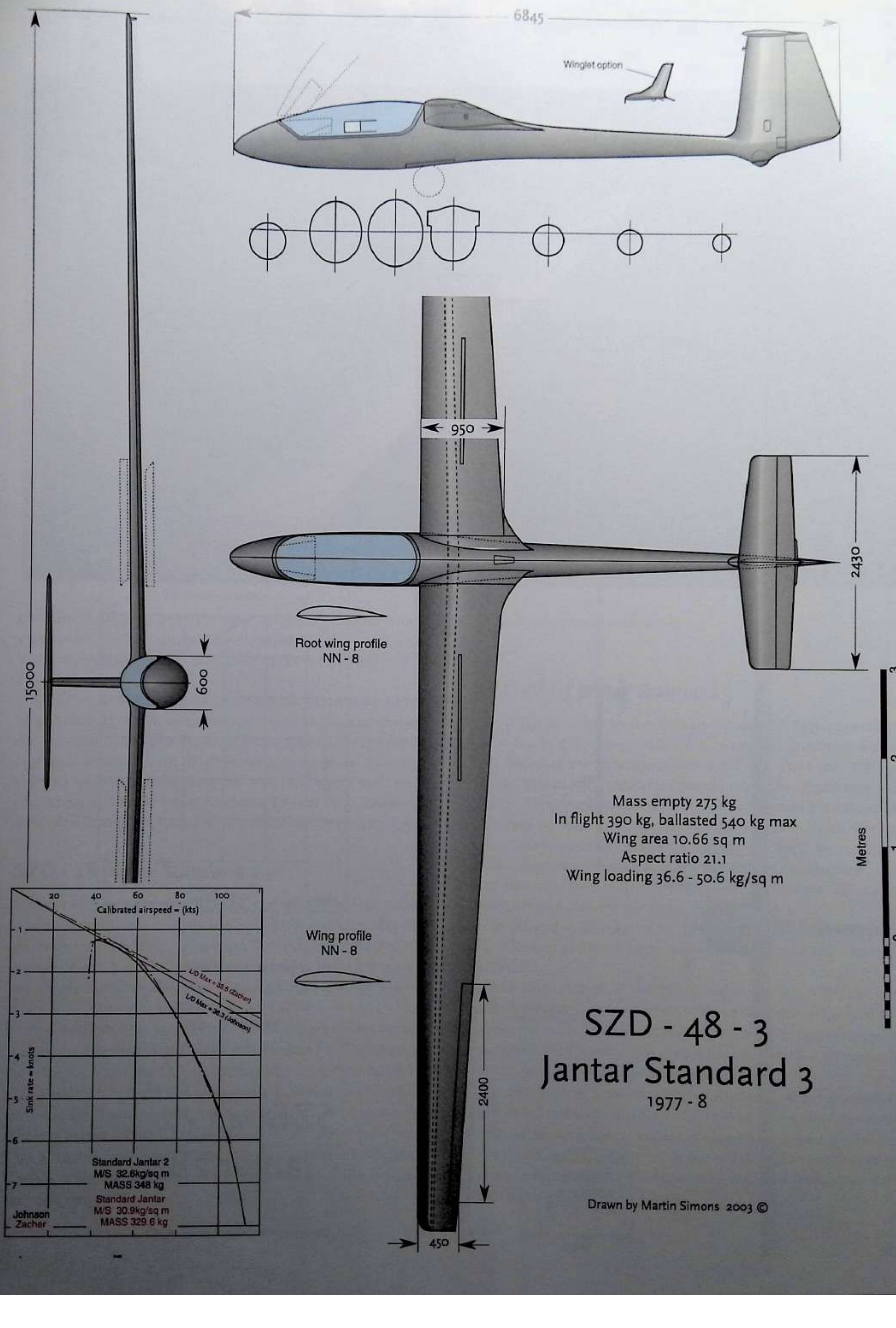
After 160 of the Jantar St 1 had been built, with many exports, in 1978 the Jantar Standard 2 replaced it in production.

SZD - 42 Jantar 2

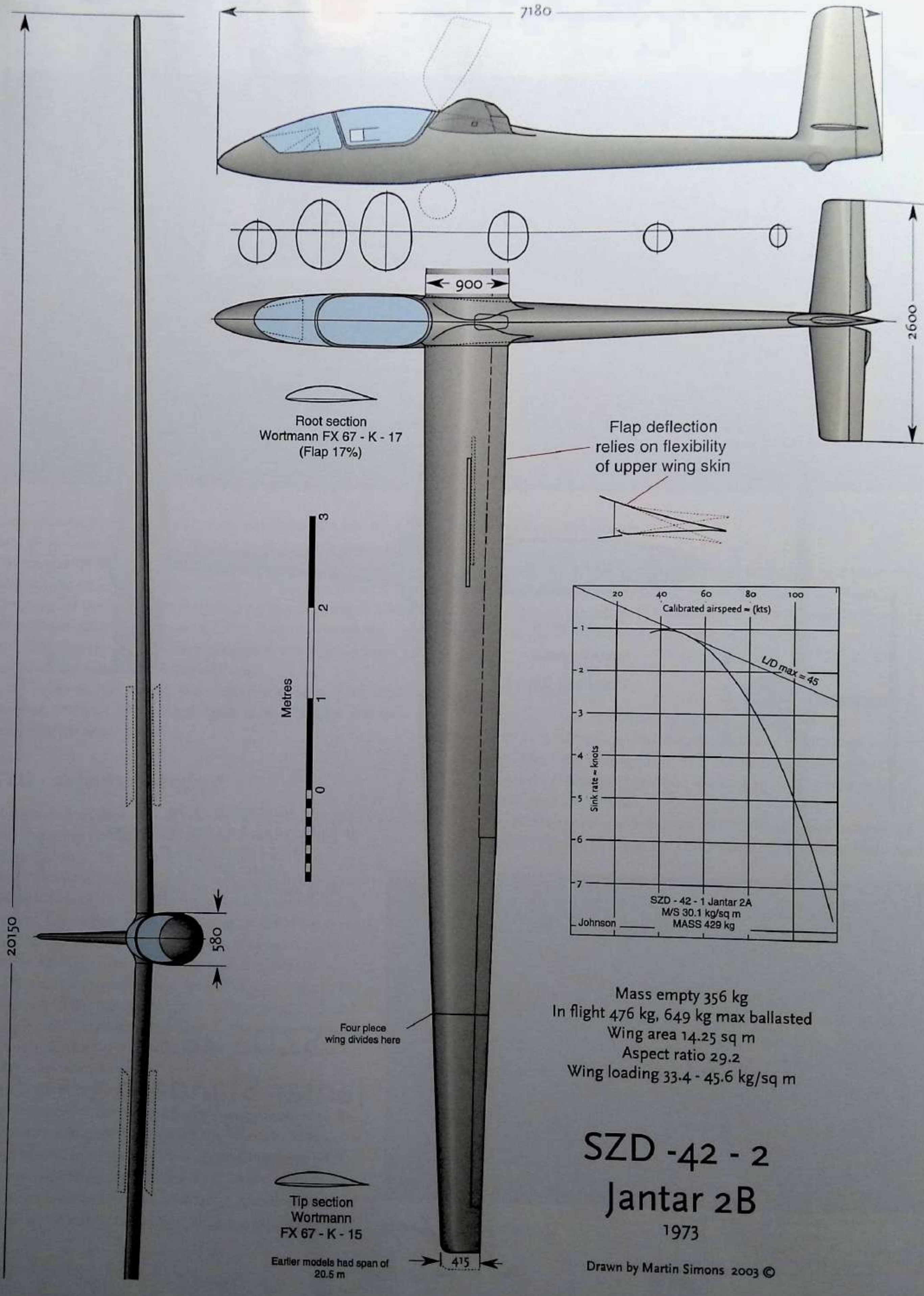
The Jantar 2 was developed from the Jantar 1, with an extended span to 20.5 metres and aspect ratio 29.2. The elastic flaps were retained. The T tail was replaced by a cruciform layout to reduce the likelihood of damage in ground looping incidents. The structure was similar in all respects.

The prototype flew in February 1976. Johnson tested the performance in flight in October 1972 and found the Jantar 2, with a best

Jantar 2A (Photo Peter Selinger)



6845
Winglet option
950
2430
15000
600
Root wing profile
NN - 8
Wing profile
NN - 8
2400
450
3
2
1
0
Metres
Mass empty 275 kg
In flight 390 kg, ballasted 540 kg max
Wing area 10.66 sq m
Aspect ratio 21.1
Wing loading 36.6 - 50.6 kg/sq m
SZD - 48 - 3
Jantar Standard 3
1977 - 8
Drawn by Martin Simons 2003 ©
20 40 60 80 100
Calibrated airspeed – (kts)
Sink rate – knots
1 2 3 4 5 6 7
L/D Max = 38.5 (Zacher)
L/D Max = 36.3 (Johnson)
Standard Jantar 2
M/S 32.6kg/sq m
MASS 348 kg
Standard Jantar
M/S 30.9kg/sq m
MASS 329.6 kg
Johnson
Zacher



Mass empty 356 kg
In flight 476 kg, 649 kg max ballasted
Wing area 14.25 sq m
Aspect ratio 29.2
Wing loading 33.4 - 45.6 kg/sq m

SZD -42 - 2
Jantar 2B
1973

Drawn by Martin Simons 2003 ©

Standard Jantar 3 (Photo Adolph Wilsch)

glide about 45:1, was generally close to the SH - Nimbus 2 then in production, perhaps slightly better at high speeds and slightly worse at low speeds. Some inaccuracy in the wing profiles was noted, as before.

23 of the Jantar 2 were built before the introduction of the Jantar 2B in March 1978. The wing was mounted 125 mm higher and the rigging angle of incidence reduced by 1.5 degrees, to align the fuselage more accurately with the airflow at high airspeeds. Water ballast capacity was increased to bring the wing loading to a maximum of 45.6 kg/sq m. A further 93 of the Jantar 2B were built, bringing the total of all Open Class Jantars to 175, including the two prototypes.

SZD - 48 Jantar Standard 2

With a new, slightly shorter fuselage, changed vertical tail areas and a swept forward wing, the Jantar Standard 2 was considerably different from its immediate predecessor. The wing was mounted 10 cm higher on the fuselage and an improved wing root fairing was fitted. Water ballast capacity was increased to 150 kg to allow a maximum wing loading of 48.8 kg/sq m.

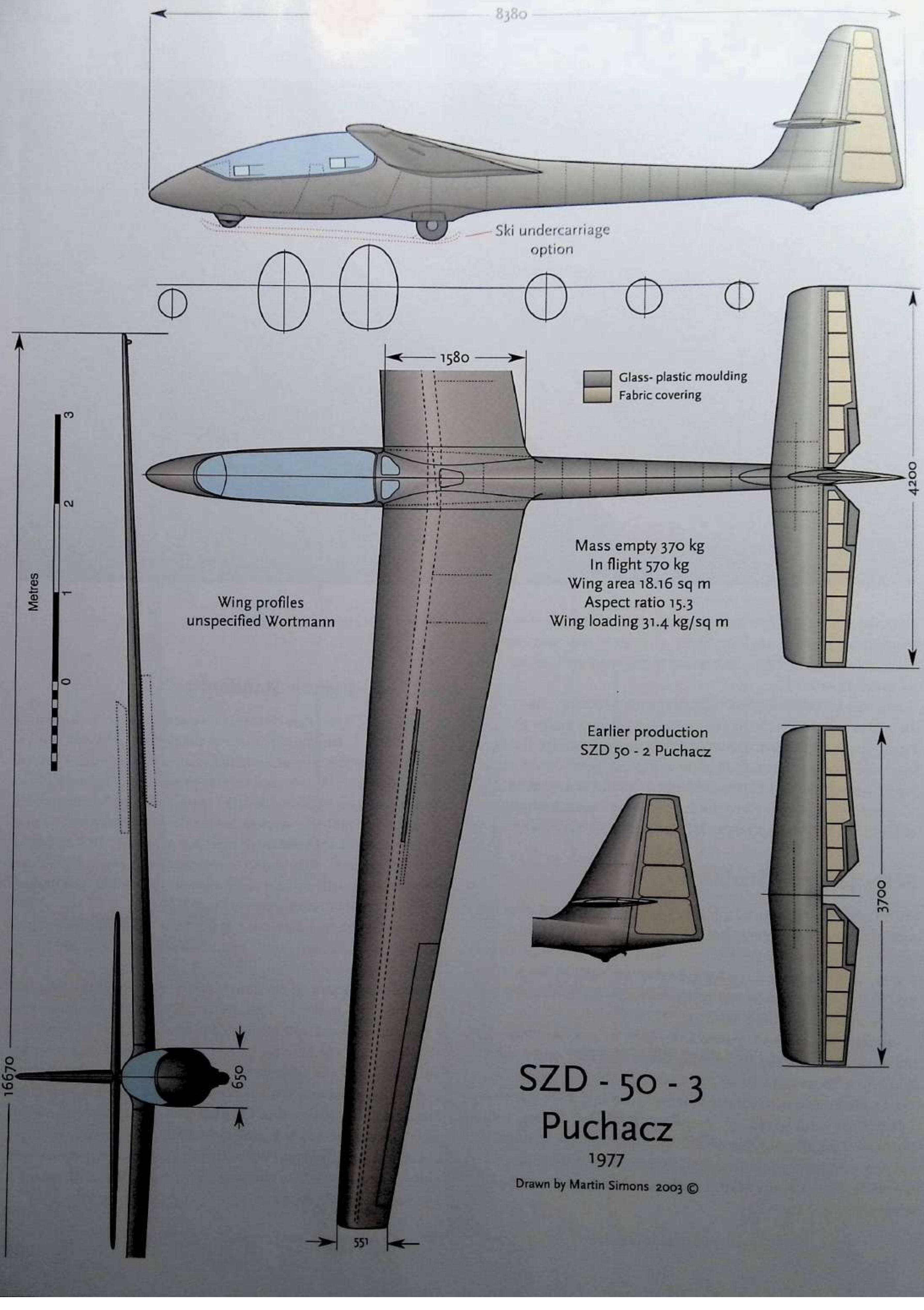
The methods of construction and the wing profiles remained the same. The first flights were in December 1977 and production began. 80 of the SZD 48 had been built by the end of 1983. The Caddo Mills flight test programme in January 1979 indicated a best glide ratio of 36.3:1. As with the earlier Jantars, resin shrinkage had affected the profile accuracy but the Jantar St 2 was approximately equal to the ASW 19 over the middle range of speeds, less good at the extreme low speed end, and marginally better above 100 knots.

SZD 48 - 3 Jantar Standard 3

The designer Wladyslaw Okarmus developed the Jantar Standard 3 from the St 2. The most noticeable change was a revised vertical tail, lowering the tailplane slightly relative to the wing. The new model flew in April 1982 and entered production. Flight tests indicated a better performance than the Jantar Standard 2. Better profile accuracy was probably responsible for the improvement. The best glide measured at the Idaflieg meetings was 40:1, 38.3 at Caddo Mills. (Apart from variations in the methods of measurement, there are always small differences between individual sailplanes.) Winglets could be retrospectively fitted to the tips.

By the end of 1983 a total of 540 of all the different marks of Jantar Standard had been built., 160 of the SZD - 41A and 380 of the SZD - 48.

The final variant of the Jantar series was the SZD - 59 Acro. This was first flown in 1991. When SZD ceased operations in 1998, the Acro was still in limited production. It is an aerobatic sailplane with the fuselage of a Jantar Standard 3. Interchangeable tips allow the span to be reduced from 15 to 13.2 metres. The full range of aerobatics is permitted with either span but the rate of roll with the smaller wing is better. The rudder has a small aerodynamic balance to reduce the loads on the pedals, and there is a dorsal fin extension. With the full span, the performance in cross- country flying is comparable with the Jantar Standard 3 and water ballast can be carried.


8380
Ski undercarriage option
1580
Glass- plastic moulding
Fabric covering
4200
Metres
3
2
1
0
Wing profiles unspecified Wortmann
Mass empty 370 kg
In flight 570 kg
Wing area 18.16 sq m
Aspect ratio 15.3
Wing loading 31.4 kg/sq m
Earlier production SZD 50 - 2 Puchacz
3700
16670
650
551
SZD - 50 - 3
Puchacz
1977
Drawn by Martin Simons 2003 ©

The Puchacz at Camphill, used for basic training by the Derbyshire and Lancashire Gliding Club

SZD - 50 Puchacz

The SZD - 50 was preceded by the SZD - 40 Halny of 1972. This was an ambitious tandem two-seater of advanced design with span 20 metres. The structure in many respects resembled that of the Orion single seater of the same year, with combined wood and GRP wing, steel tube central frame, light alloy tail boom, but GRP front fuselage and tail unit. It was regarded as an experiment and test bed for new wing profiles, and did not enter production.

Development of the SZD - 50 began in 1976 with a prototype, the so-called Dromader (Dromedary). This was modified and the SZD 50 - 2 Puchacz (Eagle Owl), flew a year later. It was a tandem two-seater intended for advanced training and cross-country flying. The wing, based on that of the Jantar Standard but with Wortmann profiles, was swept forward to ensure a good view from the rear seat, and to permit solo flying from the front without trimming ballast. It entered production in April 1979.

GRP structures now had become more or less standardised. The wing spar flanges were of glass fibre rovings, resin bonded with GRP webs. The skins were glass-plastic foam sandwich. Schempp-Hirth brakes opened above and below the wing. There were two strong plywood frames in the fuselage carrying loads from the wing attachments, undercarriage and cockpit. The cockpit canopy was in one piece, hinged at the side. It was not necessary to carry two sets of instruments since the front panel was readily visible from the rear seat. The undercarriage, with main and nose wheels, was not retractable. For operations in winter, a ski could be fitted below the wheels.

The tail unit was cruciform with the tailplane part way up the fin. Rudder and elevator were fabric covered.

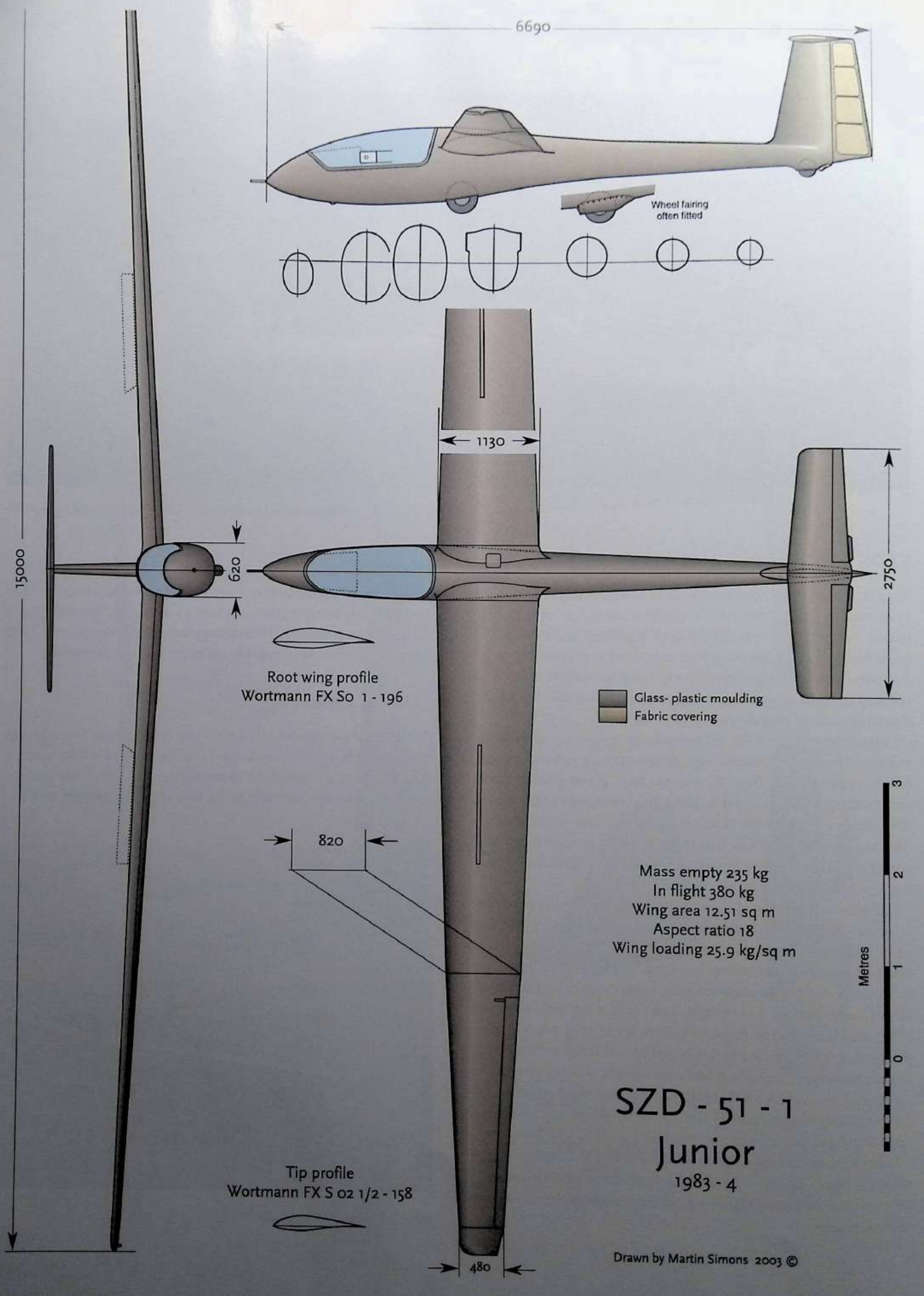
Further modifications resulted in the SZD 50 - 3. A higher vertical tail with partly balanced rudder was introduced and an enlarged tailplane was mounted higher on the fin to clear turbulence from the wing wake.

A considerable demand for this type of sailplane became evident. The Puchacz was manufactured in quantity and exported widely, finding application in many countries as a very satisfactory club two seater. Production exceeded 100 within a few years and continued until 1998, with further production, possibly under licence, very probable.

SZD - 51 Junior

The Junior was intended as a simple sailplane suitable for early solo pilots but with a performance good enough for cross-country flying and 'club class' competitions. It was required to have a low landing speed, easy and safe handling in the air and on the ground, effective

The Junior: a contender for the World Class


6690
Wheel fairing often fitted
1130
15000
620
2750
Root wing profile
Wortmann FX So 1 - 196
Glass- plastic moulding
Fabric covering
820
Mass empty 235 kg
In flight 380 kg
Wing area 12.51 sq m
Aspect ratio 18
Wing loading 25.9 kg/sq m
Metres
0
1
2
3
SZD - 51 - 1
Junior
1983 - 4
Tip profile
Wortmann FX S 02 1/2 - 158
480
Drawn by Martin Simons 2003 ©

air brakes and a cockpit suitable for a wide range of pilots. Cloud flying and simple aerobatics were permitted. A service life minimum of 3000 hours was intended, with easy maintenance and repair.

The wing followed usual practice for a GRP aircraft. The air brakes, on the top surface only, were in light alloy. The controls in the wing connected automatically when rigging, but not the elevator.

The fuselage, with T tail, was a GRP shell with internal half frames and ribs, and a steel tube central frame. The wheel was not retractable. The cockpit canopy was in one piece, side hinged. The rudder was fabric covered.

The Junior entered production in 1983 and proved popular with clubs. Derek Piggott, the very well known English instructor, wrote that it matched his idea of a good club glider, with low circling speed, light wing loading and low landing speeds. Clubs in countries where flying is possible almost every day, find the 3000 hour limitation a problem, but this is more a matter of bureaucratic regulation than engineering necessity. With good maintenance and regular inspections the service life could be safely extended.

The Junior was entered for the 'World Class' design competition in 1992. Unlike the other entrants, several of which were incomplete and untried, it had already established a good record in service. Had it not been for the PW - 5, the SZD - 51 might have been chosen as the World Class sailplane.

Many Juniors have been exported and the type was still in production when the SZD Company was dissolved. Some production under licence in Brazil has been proposed.

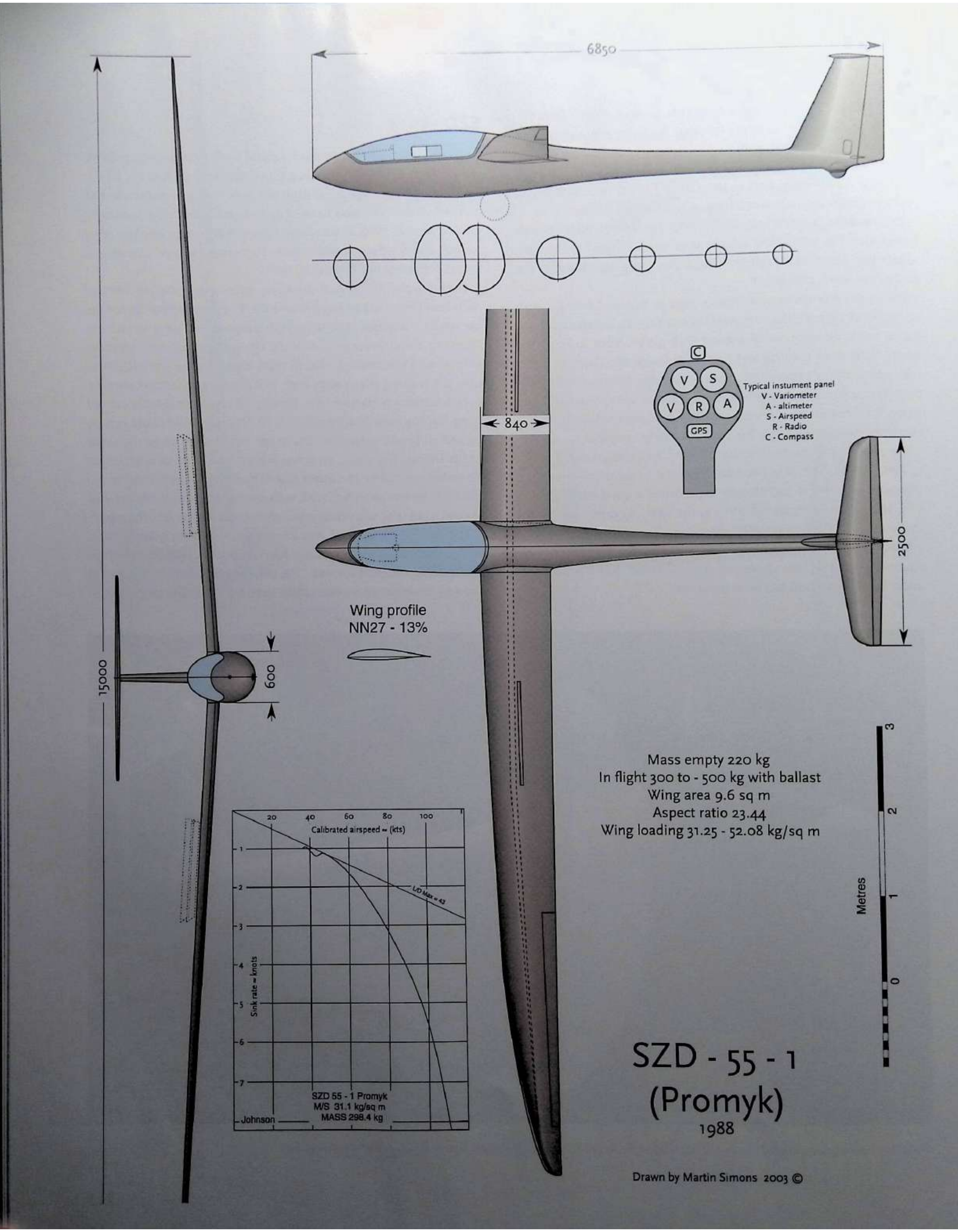
SZD - 55 - 1

By the mid 'eighties the Jantar Standard was no longer competitive with the latest German Standard Class sailplanes such as the LS - 4, DG - 300 and SH - Discus. Design of a new type was undertaken at Bielsko - Biala by a team headed by Tadeusz Labuc. The prototype flew in August 1988. It was constructed throughout of glass-reinforced plastics with no carbon fibre. The name 'Promyk' (Sunbeam) became attached unofficially by pilots.

The wing profiles, 13% in thickness, were designed at the Warsaw Technical University by Jerzy Ostrowski. They were not intended for use with turbulators. The wing plan adopted, in line with current thinking about reduction of wing tip vortex drag, was crescent shaped with the trailing edge at right angles to the aircraft centre line, the leading edge swept back and the outermost part curving back to relatively narrow tips. Usually, to construct a truly curved wing leading edge is difficult. In GRP, with carefully made female moulds, it becomes feasible. The shape was more extreme than that of the Discus. The aspect ratio was higher. The large, double- leafed air brakes opened on the upper side of the wing only. Ballast capacity of 200 kg was provided, with under-wing dumping vents. As usual now, a tail tank was arranged to allow balancing to suit the pilot.

The Fuselage, with T tail, was also shaped according to latest ideas, with contraction of the cross section behind the cockpit to reduce surface area and skin friction. The cockpit was adequate for all but the very broadest pilots who might have had difficulty getting com-

The SZD 55, Poland's very successful Standard Class challenger for the SH Discus. Note the curved taper of the wing. (Photo Jochen Ewald)


6850
840
2500
15000
600
Typical instument panel
V - Variometer
A - altimeter
S - Airspeed
R - Radio
C - Compass
C
V
S
V
R
A
GPS
Wing profile
NN27 - 13%
Mass empty 220 kg
In flight 300 to - 500 kg with ballast
Wing area 9.6 sq m
Aspect ratio 23.44
Wing loading 31.25 - 52.08 kg/sq m
Calibrated airspeed – (kts)
20
40
60
80
100
Sink rate – knots
1
2
3
4
5
6
7
L/D Max = 43
SZD 55 - 1 Promyk
M/S 31.1 kg/sq m
MASS 298.4 kg
Johnson
Metres
0
1
2
3
SZD - 55 - 1
(Promyk)
1988
Drawn by Martin Simons 2003 ©

fortably into the seat. Cockpit loads between 60 and 110 kg were permitted. For the very tall, the seat back could be removed altogether. The one-piece canopy opened forwards with a gas strut support.

The SZD - 55 handled very well and was difficult to spin, with only a very mild tendency to drop a wing at the stall. The roll, 45 degrees bank to 45 degrees the other way, was not as rapid as some other standard class sailplanes, about 4.5 seconds, but good enough. On take off, with the wing initially at a relatively high angle of attack until the tail could be brought up, the ailerons were not always sufficient to prevent a tip scraping but it could always be picked up again immediately with little danger of ground looping.

The group at Caddo Mills in Texas tested the SZD - 55 and found it had an impressive performance, both in thermalling and at high airspeeds. A best glide ratio of 43:1 established it as among the best of modern Standard Class aircraft. Johnson investigated the effect of turbulators, thinking that since most other sailplanes needed them on the underside of the wing, the SZD - 55 might improve still further if they were added. This proved to be a mistake. The wing was more efficient as it left the factory without turbulators.

At the conclusion of the test programme in December 1991, Johnson remarked that the SZD - 55 was "one of the best new sailplane designs to emerge in recent years." The example tested was number 15 off the production line. The same aircraft had, earlier in the year in the World Championships at Uvalde, New Mexico, placed second when flown by the Polish pilot Janusz Trzeciak. In 1993 at Borlänge in Sweden, an SZD - 55 flown by Tomasz Rubaj also of Poland, placed third. Other outstanding successes had been achieved before this in European competitions. Rubaj was already Junior Champion of Europe.

Most of the output of the SZD factory at this time was directed to exports. Examples of the Promyk have appeared in many countries. However, rather sadly, it was reported that of more than 100 produced, only half a dozen remained in Poland in 2002. Further production is possible.

SZD - 56 Diana

When work began on the SZD - 56, Poland had never marketed a sailplane for the 15 Metre unrestricted competition class. The designer was Bogomil Beres, a graduate of Warsaw Technical University who had worked in the SZD design office for twenty years and was closely involved in the design of the Jantar Standard, Puchacz, Junior and other projects. The new aircraft was designed to take fullest possible advantage of carbon and aramid (Kevlar) fibre-reinforced plastics, and was entirely made of these materials. This allowed the structure to be exceptionally light but very stiff and strong.

The wing was sparless, unlike every other contemporary sailplane. It was a shell of carbon fibre and plastic foam sandwich skins, with extra carbon where the stresses were greatest. All resistance to bending and twisting was in the skins. The aspect ratio, 27.57, was higher than any previous 15 metre production sailplane.[43] With the same profile as the SZD - 55, 13% thick, at the root the Diana wing was only 87 mm deep.

The SZD 56 'Diana' showing the unusually thin wing and narrow tail boom. It was claimed that this was technologically the most advanced sailplane in the world. (Photo Jerry Zieba)

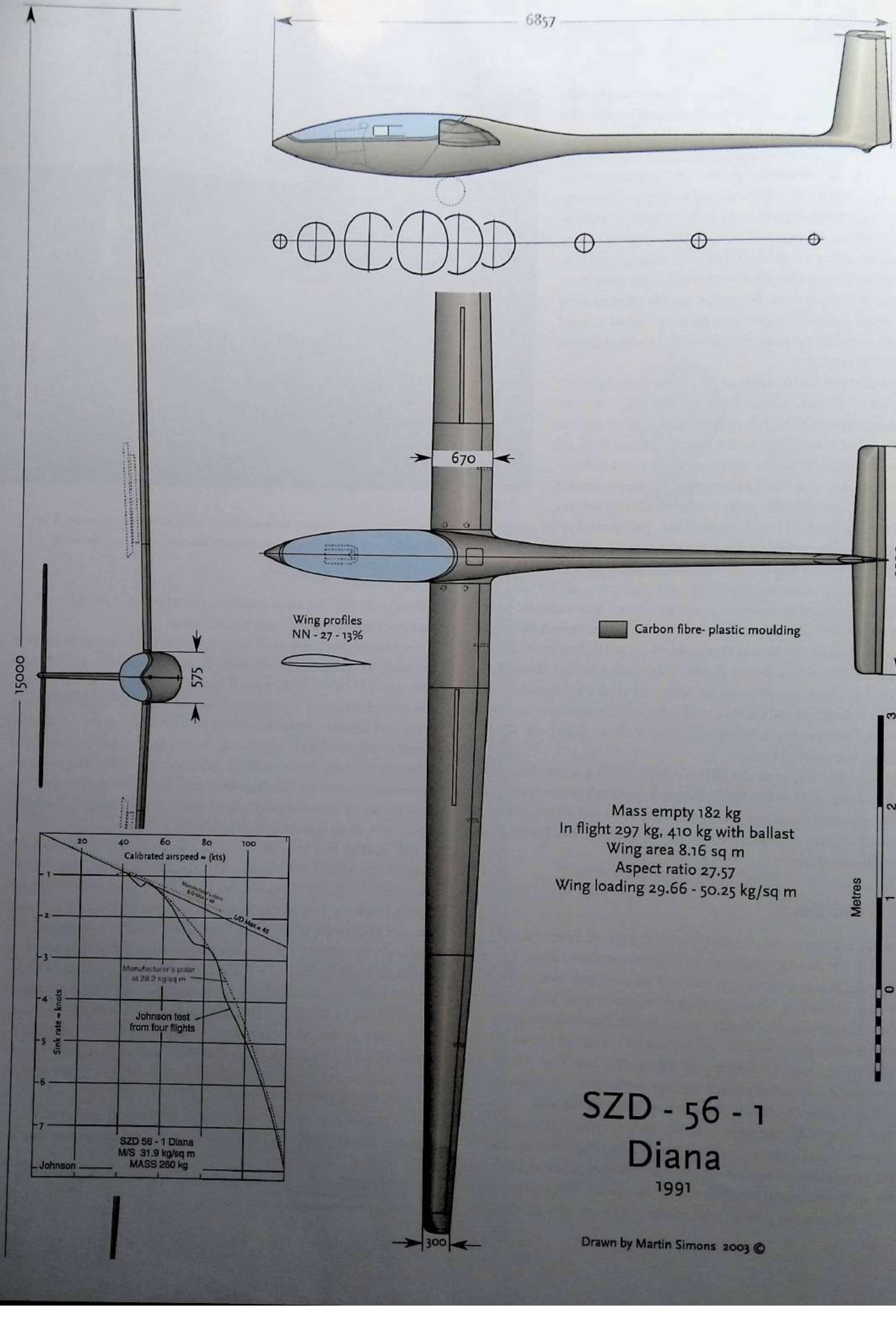
Four large integral water ballast tanks were incorporated within the shell, in each wing two tanks in front and two behind, with separate jettison valves. They were filled from the wing tips with a special funnel. As usual, a compensating tank was provided in the fin. Flaps and ailerons, coupled as 'flaperons', were hinged on the underside with careful sliding closure on the upper surface. The upper side only air brakes were specially designed to prevent dangerous reactions on opening at high speeds (many sailplanes can react violently and can slam the pilot's head through the canopy). The wing tips might, as an option, be replaced with winglets.

The fuselage was very slender with a tail boom of small diameter behind the usual contraction aft of the forward pod. The cockpit was not large but had more room than the 'type A' fuselages from Schempp-Hirth. The seating position was more reclined than usual but not as extreme as the Foka 4 or Swiss Diamant. More space was made for the pilot by the use of a side-mounted control column on the right hand cockpit wall.[44] Since there was no 'stick' in the way, the instrument console could be mounted closer to the pilot than usual so the reclined position did not put the panel out of reach. The rudder pedals and seat back were adjustable. If necessary to accommodate a pilot much more than 1.83 metres (6 ft) tall, the seat back and headrest could be removed. The one-piece canopy opened forward with a gas strut support.

The system of rigging was unique. A substantial stub spar, about 1.5 metres long, was built crosswise into the fuselage to accept the

43 – The only example known of a higher aspect ratio for a 15 metre sailplane was Dick Schreder's all metal HP - 15, which was unsuccessful with A = 33.

44 – Compare the Australian Moba 2, p. 15.



6857
670
2500
Carbon fibre- plastic moulding
Wing profiles
NN - 27 - 13%
15000
575
Calibrated airspeed – (kts)
20
40
60
80
100
L/D Max = 45
Manufacturer's polar
at 28.2 kg/sq m
Johnson test
from four flights
Sink rate – knots
SZD 56 - 1 Diana
M/S 31.9 kg/sq m
MASS 260 kg
Johnson
Mass empty 182 kg
In flight 297 kg, 410 kg with ballast
Wing area 8.16 sq m
Aspect ratio 27.57
Wing loading 29.66 - 50.25 kg/sq m
Metres
0
1
2
3
SZD - 56 - 1
Diana
1991
300
Drawn by Martin Simons 2003 ©

wings. These plugged onto the crossbar to be locked in place with a horizontal bolt. When de-rigged for road transport, the crossbeam made it impossible to put the Diana fuselage into a normal glider trailer. The wings were placed in cradles high up, tilted at an angle instead of resting vertically edge down. They then passed above the crossbar. The trailer need be no wider than the normal wheelbase.

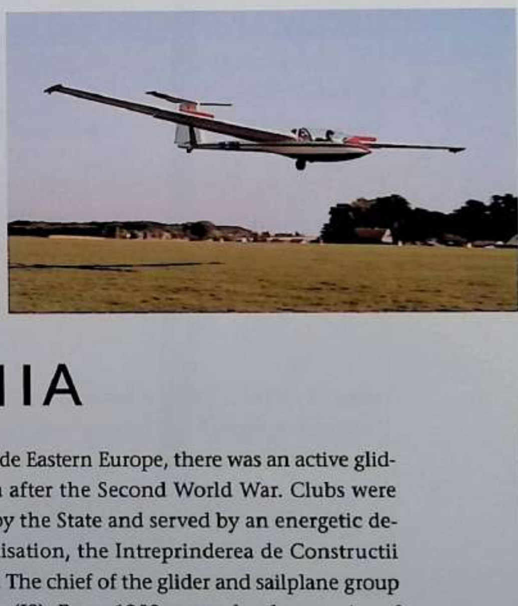
The flight tests by Johnson contained some anomalies which may have been caused by statistical scatter in collecting the data from only four flights. The manufacture's claimed curve is not very different at the peaks but is smoother, showing a best glide ratio of about 48:1, exceptional for a fifteen metre span. The finish and accuracy of the wing was described as exceptionally good. Handling was also very good, the flaperons allowing a reversal of 45 degree banked turn in 3 seconds. Early reports from the few pilots who were able to obtain one of the early production Dianas, were impressive, suggesting that it was at least equal to contemporary German Fifteen Metre Class aircraft.

The SZD - 56 has made World Record flights in the Fifteen Metre Class. In a single month, during a visit to Tocumwal in Australia during December 1998 - January 1999, the Czech pilot Hana Zejdova broke eleven feminine World Records, three of them in one flight, a 1042.55 km out-and-return which also counted also for the free distance and free out-and-return distance records. On other days she set speed records for the 300, 500 and 1000 km triangles, and other records which she herself broke later in the same month. Janusz Centka in December 2002, in the USA, flew a 15 metre World Record 1000km triangle at 144.95 km/h.

After the SZD factory closed down, rights to manufacture the sailplane were bought by its designer, Bogomil Beres, who had established his own factory in Bielsko. Production has continued slowly of what was termed "the technologically most advanced sailplane in the world". In 2003, the total had reached six, five of these being exported to the USA. The type may be built to special order. Beres, meanwhile, is reported to be working on a new model.

Above: The ICA IS 28B2 at the RAAF Club Richmond, Australia

Right; IS 28B approaching Namur airfield, France (Photo Jochen Ewald)

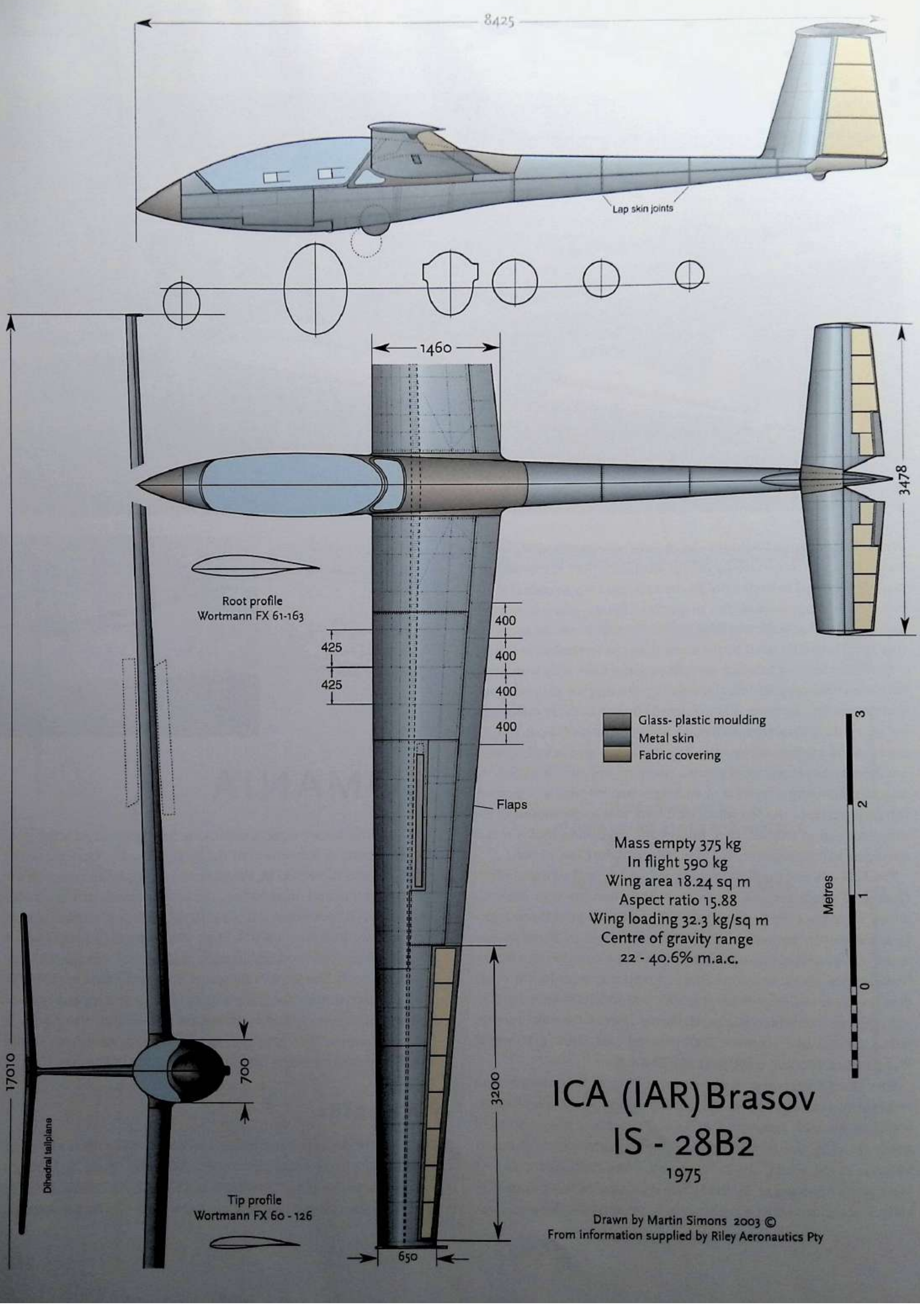


ROMANIA

Although little known outside Eastern Europe, there was an active gliding movement in Romania after the Second World War. Clubs were supported and subsidised by the State and served by an energetic design and production organisation, the Intreprinderea de Constructii Aeronautice (ICA) at Brasov. The chief of the glider and sailplane group was Professor Iosif Silemon (IS). From 1950 onwards a long series of original designs was produced. Sixteen of these were described in outline in the book, The World's Sailplanes Vol 2, published by OSTIV in 1963. Contacts outside the Eastern Block were few but a group of West German pilots participated by invitation in the Romanian National Championships in 1971. After this, successful efforts were made, by the State Enterprise for Foreign Trade, to export gliders built by the ICA.

ICA IS - 28B2

The IS - 28 began as two-seat training sailplane of 15 metres span, first flown in 1970. It was a direct development of the IS - 12 and IS - 13 which were similar in size and general appearance. It was intended to fit easily into the regular club training program and to have handling characteris-


8425
Lap skin joints
1460
3478
Root profile
Wortmann FX 61-163
425
425
400
400
400
400
Glass- plastic moulding
Metal skin
Fabric covering
Flaps
Mass empty 375 kg
In flight 590 kg
Wing area 18.24 sq m
Aspect ratio 15.88
Wing loading 32.3 kg/sq m
Centre of gravity range
22 - 40.6% m.a.c.
Metres
0
1
2
3
17010
700
3200
Dihedral tailplane
Tip profile
Wortmann FX 60 - 126
650
ICA (IAR) Brasov
IS - 28B2
1975
Drawn by Martin Simons 2003 ©
From information supplied by Riley Aeronautics Pty

tics similar to the 'early solo' single seaters. The IS - 28, with seats in tandem, had a non-retracting undercarriage of main and nose wheels. The fuselage was all-metal. The wing, wooden, was strongly tapered and swept forward with aspect ratio 12.5. There was a T tail. It was advertised to have a glide ratio of 26:1. The field of view from the rear seat was severely restricted by the wing leading edges.

The IS - 28B, which appeared in 1973, was a much more advanced aircraft with 17.01 metres span, aspect ratio of 15.8, semi-retracting wheel and an all-moving tailplane with anti-balance tab. The wing was now all-metal. The wing profiles were from the Wortmann series, but there were no flaps. This type was superseded by the IS - 28B2 which had flaps and a fixed tailplane with elevator and trim tabs.

The main wing spar was built up, the flanges of L sectioned dural with vertical webs, pressed dural ribs and a dural secondary spar. The skins, with light stringers supporting them over the forward part of the wing, were flush riveted. The ailerons, rudder and elevator were fabric covered. The air brakes were of Schempp-Hirth type opening above and below the wing. The fuselage was an all-metal monocoque with a one-piece transparent cockpit canopy, side hinged. The rear seat was now entirely forward of the wing and the field of vision excellent. The tailplane, with slight dihedral, could be folded down for de-rigging or storage. The nose cone, fairings at the wing root and other three-dimensionally curved areas were moulded in GRP.

With some further modifications suggested by importing agents in Australian and the USA, the IS - 28B2 proved to be a very practical and robust two seater with a performance quite good enough for cross country experience as well as basic training. Total production figures are not known. At least 300 were built, more than 100 were exported to the USA and 30 to Australia between 1975 and 1981.

IS 29E (Factory photo)

In Australia a careful study of the IS - 28B2 was made at the Royal Melbourne Institute of Technology, by James Ritchie, to establish a safe working life with respect to metal fatigue. Many training sailplanes in Australia are operated continuously through the year and accumulate flying hours more rapidly than in most other countries. Metal fatigue can become a serious problem. The result of Ritchie's work indicated that very substantial extensions to the nominal allowed life of the IS -28B2 would be possible, given correct maintenance and routine inspections.

Motorised versions of the IS - 28, the - 28M and - 28M2, were developed and put into production during the late seventies. The M2 had side-by side seating with a two wheel, semi-retracting undercarriage and tail wheel. The M1 had the seats in tandem with a single retractable wheel and wing tip outriggers.

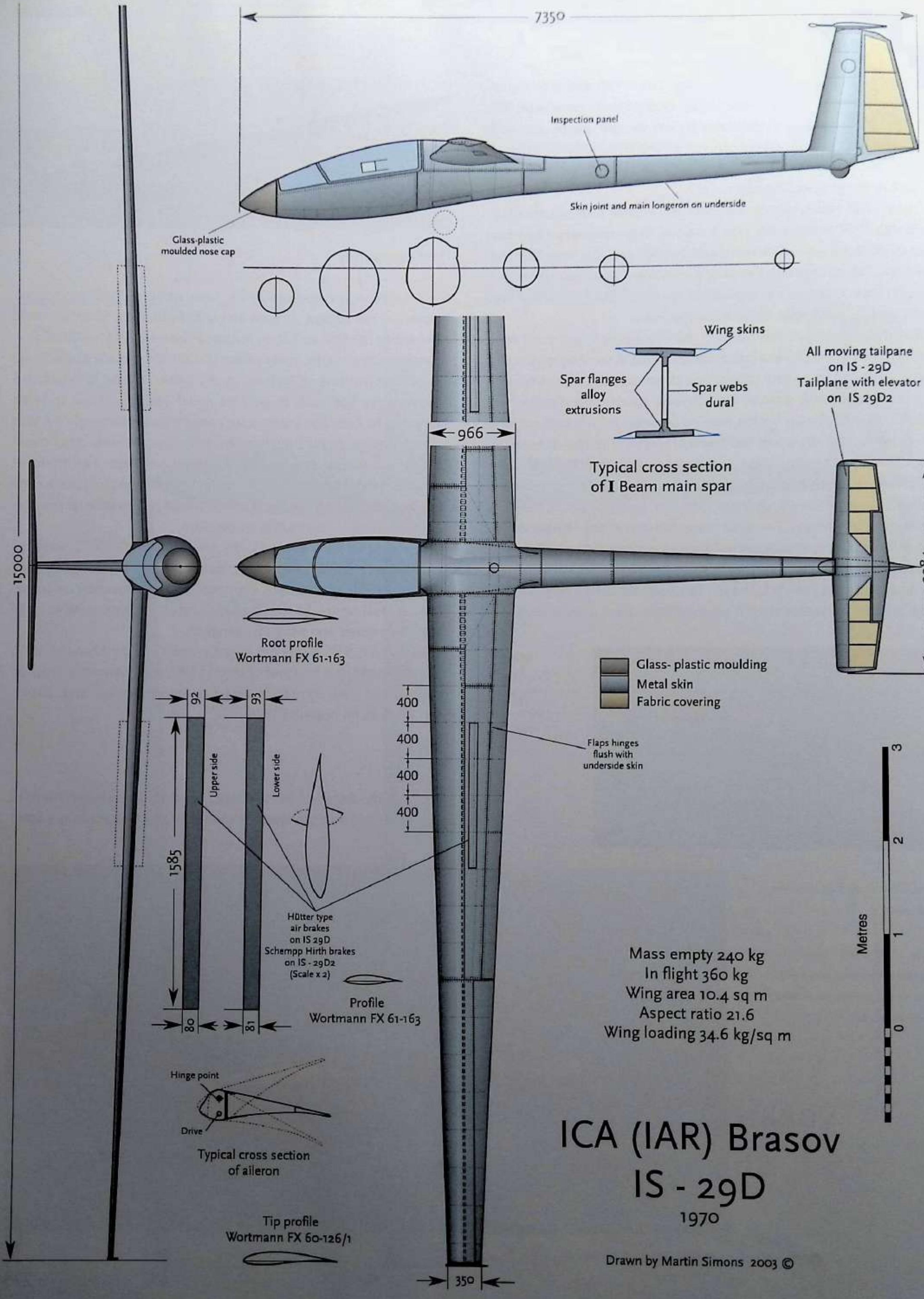
The IS - 32, which was exhibited at the Paris Air Show in 1977, was a 20 metre development of the IS 28B2, with new wing profiles, water ballast capacity, a fully retracting undercarriage, and 'flaperons'. Production began in 1978.

IS - 29

The IS - 29, designed by the same team as the earlier Silemon sailplanes, was a single seater marketed in the first place as a Stan-

Above: Detail of IS 29 tailplane and rudder

Right: IS 29, a late model with elevator & tailplane, was flying in a minor competition at Gawler, South Australia


7350
Inspection panel
Skin joint and main longeron on underside
Glass-plastic moulded nose cap
Wing skins
Spar flanges alloy extrusions
Spar webs dural
966
Typical cross section of I Beam main spar
All moving tailpane on IS - 29D
Tailplane with elevator on IS 29D2
2284
15000
Root profile Wortmann FX 61-163
Glass- plastic moulding
Metal skin
Fabric covering
92
93
400
400
400
400
Flaps hinges flush with underside skin
1585
Upper side
Lower side
Hütter type air brakes on IS 29D
Schempp Hirth brakes on IS - 29D2
(Scale x 2)
Profile Wortmann FX 61-163
80
81
Mass empty 240 kg
In flight 360 kg
Wing area 10.4 sq m
Aspect ratio 21.6
Wing loading 34.6 kg/sq m
Metres
0
1
2
3
Hinge point
Drive
Typical cross section of aileron
ICA (IAR) Brasov
IS - 29D
1970
Tip profile Wortmann FX 60-126/1
Drawn by Martin Simons 2003 ©
350

dard Class aircraft with span limited to fifteen metres, air brakes, retracting wheel but no provision for ballast. This original IS - 29 had a metal fuselage but the wings were of wood, in three parts. The centre section was of constant chord with no dihedral. The outer panels tapered, with dihedral. The IS - 29B followed, still with wooden wings. This conformed to the revised Standard Class rules as they were changed in 1969. The only air brakes were flaps which could be lowered to ninety degrees.

Nomenclature after this became somewhat complicated and confused. Later versions of the IS - 29 were all metal with tapered wings in two sections, joining in the centre. The methods of construction were similar to those of the two-seat IS - 28B. The tailplane was of the all-moving type with anti-balance tab and no dihedral. In 1975 the new unrestricted Fifteen Metre Class was introduced. The IS - 29D, which became the most popular, was first offered with Hütter type air brakes, and later, as the IS 29 - D2, with Schempp Hirth brakes, and flaps. The IS - 29D4 had provision for water ballast. These were all Fifteen Metre Class sailplanes. The IS - 29D3 had a span of 16.5 metres and non-retracting wheel. The all moving elevator was replaced with tailplane and elevator. This type was later renamed the IS - 29G. In 1971 the IS - 29E was produced with the wing span extended to 17.6 metres, flaps and ballast. Then came the E2 with span 19 metres. Later still came the IS - 29E3, and with span extended yet again to 20 metres, the E 4. All the E versions were later re-named IS - 31. The IS - 30 was a club version of the IS - 29B2, with fixed, two wheeled undercarriage and no flaps.

The complications of nomenclature should not obscure the fact that all these metal sailplanes were robust, handled and performed well in the air, although not as well as the contemporary GRP sailplanes being produced in Germany and Poland at the time. They were not chosen by the leading contest pilots but served well in clubs, commercial gliding organisations and with some private owner groups. There were exports, including about 30 to the USA and at least 16 to Australia.

SWITZERLAND

With excellent and varied soaring conditions, especially mountain flying and waves, there has always been a strong interest in gliding in Switzerland. Several companies and designers, Spalinger, Hug, the Müller Brothers, were involved with sailplane design and production before 1950. These small manufacturers ceased operations before 1960.

Swiss interest in GRP structures was manifest at the very beginning. Eugen Aeberli was closely involved with the early development of the Glasflügel Libelle H - 301. Additional inspiration came from the Swiss Federal Institute of Technology in Zurich, where Professer Rauscher was investigating the new materials. Development was also taken up by a few enthusiastic individuals. Werner Pfenninger's design, the Elfe M, had been built by Albert Neukom in 1956, after which Neukom continued almost alone.

Alpine soaring became popular among all European pilots. Gliders know nothing of frontiers. On any weekend in a good season, hundreds of sailplanes from France, Germany, Italy, Austria and everywhere else, pass over, or entirely through, Swiss air space, which becomes crowded, even dangerously so, at times. Few of the aircraft, however, are Swiss built.

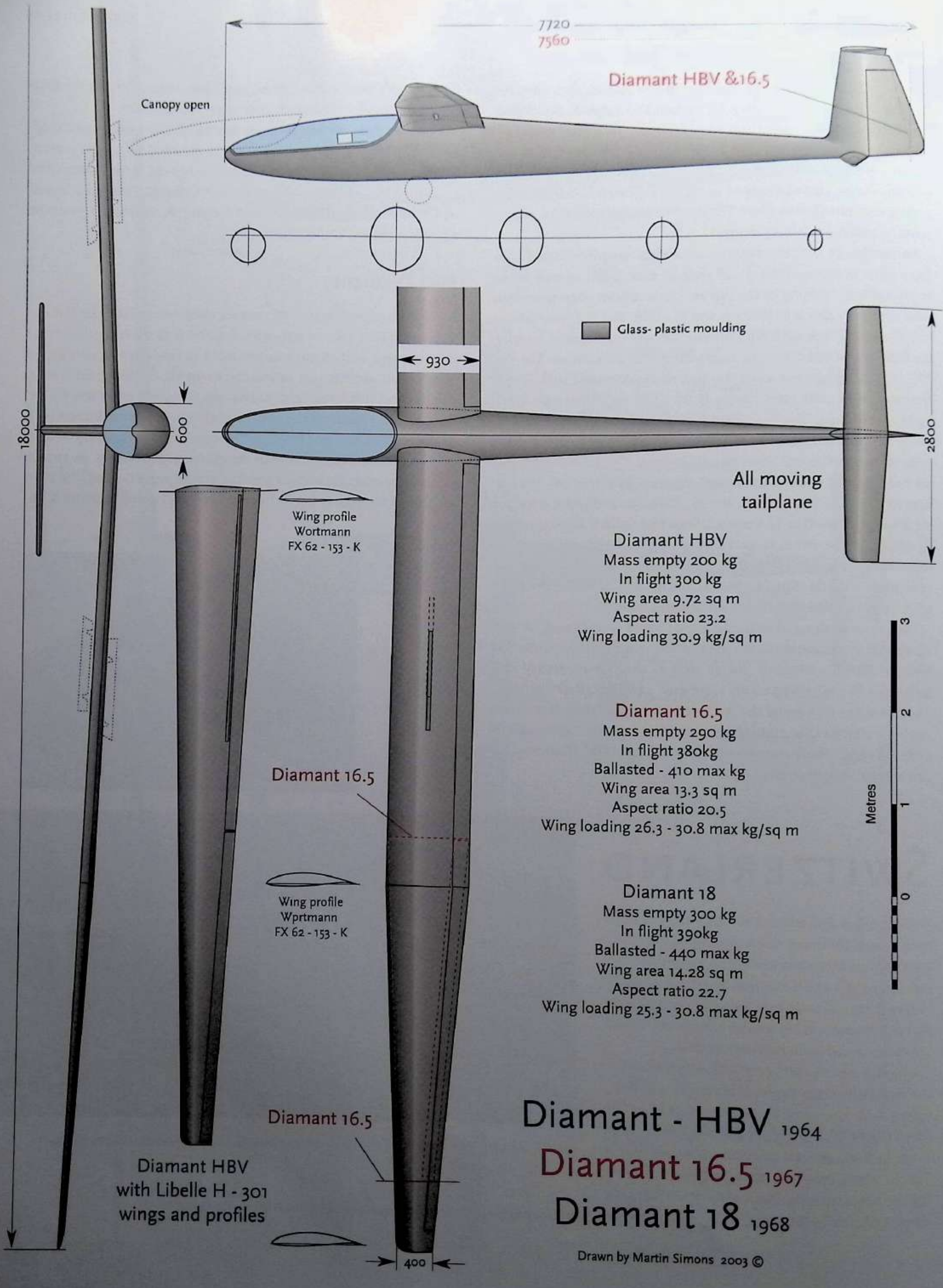
FFG Diamant

In 1962 an experimental, all moving tailplane in GRP was built in Switzerland for a Ka - 6 sailplane. Following this a completely new GRP fuselage with T tail was moulded to take the wooden Ka - 6 wings. This aircraft was called the Ka-Bi-Vo, standing for Kaiser, Bircher and von Voornfeld. Kaiser was the designer of the Ka - 6, Bircher and Voornfeld the two Swiss enthusiasts who did the bulk of the work on the new fuselage. The combination flew very well.

The special fuselage was extreme in one major respect. To reduce the cross section as much as possible to save parasitic drag, the pilot lay almost completely flat, with only a minimal raised back and head-

Above: Cockpit of the Diamant. The pilot's position was almost supine, very comfortable but visibility directly in front was not very good.

Below: Prototype Diamant in flight over snow covered coast of Lake Constance.



7720
7560
Diamant HBV &16.5
Canopy open
Glass- plastic moulding
930
18000
600
2800
All moving tailplane
Wing profile Wortmann FX 62 - 153 - K
Diamant HBV
Mass empty 200 kg
In flight 300 kg
Wing area 9.72 sq m
Aspect ratio 23.2
Wing loading 30.9 kg/sq m
Diamant 16.5
Mass empty 290 kg
In flight 380kg
Ballasted - 410 max kg
Wing area 13.3 sq m
Aspect ratio 20.5
Wing loading 26.3 - 30.8 max kg/sq m
Diamant 16.5
Wing profile Wprtmann FX 62 - 153 - K
Diamant 18
Mass empty 300 kg
In flight 390kg
Ballasted - 440 max kg
Wing area 14.28 sq m
Aspect ratio 22.7
Wing loading 25.3 - 30.8 max kg/sq m
Metres
0
1
2
3
Diamant 16.5
Diamant HBV with Libelle H - 301 wings and profiles
400
Diamant - HBV 1964
Diamant 16.5 1967
Diamant 18 1968
Drawn by Martin Simons 2003 ©

rest to allow at least some view directly ahead. To bring the control column within easy reach, it was mounted on the right hand wall of the cockpit.[45] Having proved the basic idea, Bircher and Voornfeld obtained a pair of Libelle wings from Glasflügel and married them to the new fuselage, to produce the HBV Diamant, which flew in September 1964. The H stood for Hütter, designer of the first Libelle.

Recognising that it would probably find a ready market, the design was now bought by Flug- & Fahrzeugwerka AG (FFG). Thirteen of the HBV Diamant were built during 1966 - 7, using wings imported directly from Hänle's Glasflügel factory at Schlattstall. It was one of the first GRP sailplanes to be produced in any numbers. The side-mounted control column was not continued, being replaced with an orthodox 'joystick' mounted centrally, but cranked back to make it easier to reach.

It was soon evident that the match of the small wing to a rather long and heavy fuselage was not ideal. A new set of wings, 16.5 metres span with increased area and very slightly swept forward for reasons of balance, were designed for the Diamant 16.5. This flew in 1967 and was an immediate success. The performance and handling were excellent, at least comparable with the 17.6 metre SH - Cirrus with which it was almost exactly contemporary. Forty-one were built and sold to many countries.

The all-moving elevator was very sensitive, which some pilots found difficult. The airbrakes were powerful, again, too much for some because it was easy, when landing, to lose airspeed too quickly when the brakes were opened fully. The supine position in the cockpit did not meet with widespread approval, although it was in fact very comfortable. Perhaps it was almost too comfortable. The pilot relaxed too readily and might not remain fully alert, though no-one ever actually went to sleep while flying. There was little space to spare for anything additional to the pilot. To the sides and above the view was perfect but, directly ahead, through the canopy at a very shallow angle, not very much could be seen. In this respect the Diamant was probably slightly worse than the Foka 4. On aero tow it was too easy to lose sight of the tug under the glider's nose. Despite these faults, the Diamant was impressive and successful in operations.

To improve the performance further, the span was extended to 18 metres, with an increase in the rudder area to help counter adverse drag when using the ailerons. The first flight of the 18 metre version was in 1968 and production continued until 1971, with a total of 29 built. By this time the Diamant had been surpassed in performance by such types as the H 401 Kestrel, and ASW 17. This also marked the end of commercial GRP sailplane production in Switzerland.

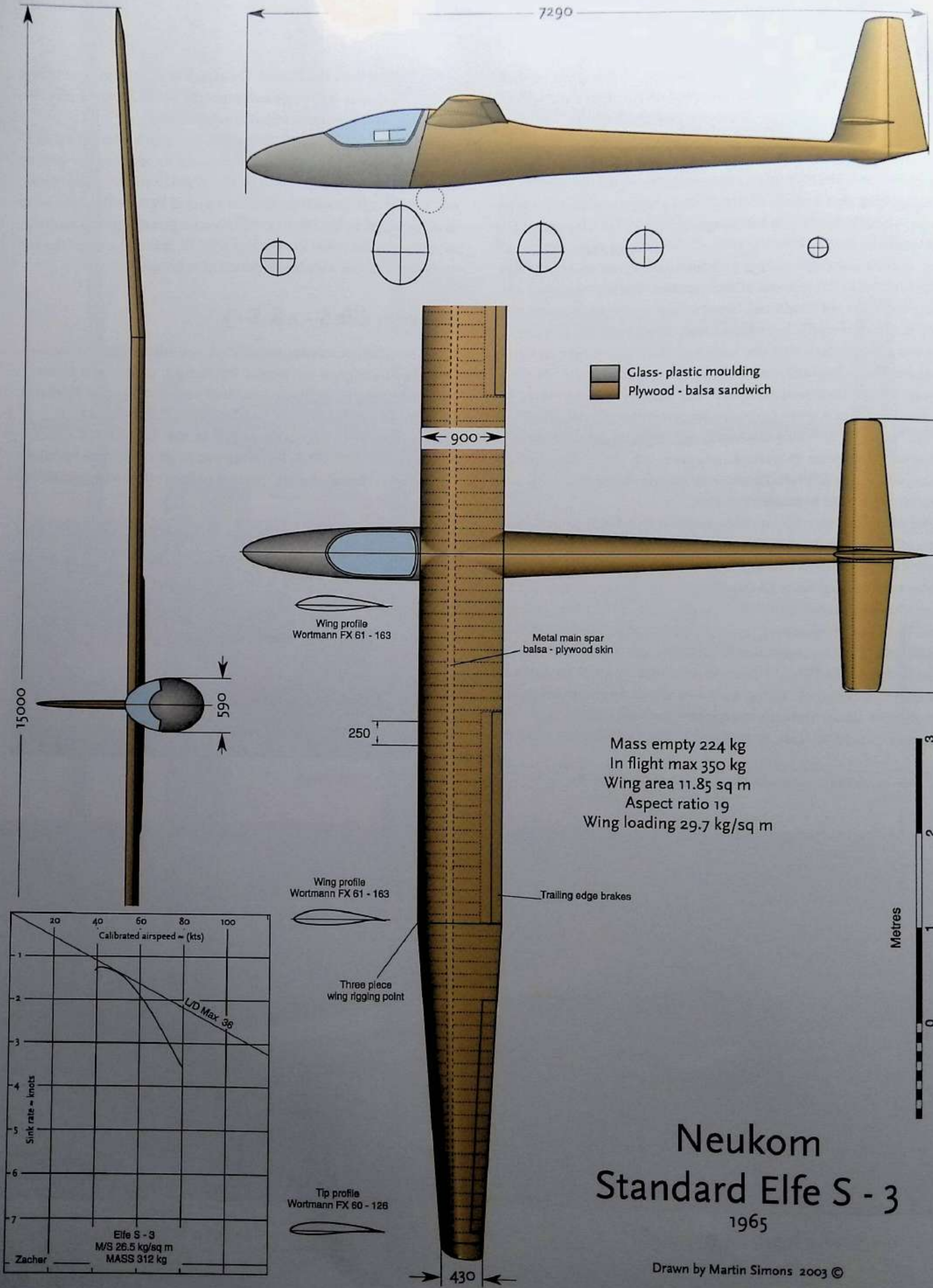
Neukom Elfe S - 2 & S - 3

Albert Neukom, by training an architect, constructed his first sailplane, the Elfe M designed by Werner Pfenninger, in his own house in 1956.[46] He went on to design and build a series of his own sailplanes, the Elfe - MN, Elfe - MNR, the Standard Elfe S, Elfe S - 2 and S - 3. Markus Ritzi flew the Standard Elfe in the 1965 World Championships, placing second. The wing was in three sections and there was a V tail. The main wing spar was of light alloy, with a sandwich

Neukom Elfe S 2 front fuselage

45 – Compare the Australian Moba 2, p. 15, the Polish SZD 56, p. 215, and the Zuni, p. 229.
46 – See Volume 2

Elfe S 2 on winch launch at Camphill, May 1977



Neukom Standard Elfe S - 3

1965

Drawn by Martin Simons 2003 ©

Above: Elfe S 4A at Challock in Kent, England, on visit from Switzerland in 2000. Flown by Lilli Grundbacher

Right Above: Elfe S 4 during assembly. The photograph shows the wing spar joint but the main pins are not yet in place and the 'hotelier' coupling for the control is not yet connected.

Right: Cockpit of the Elfe S 4

skin of plywood and balsa. The fuselage was an orthodox wooden semi-monocoque type.

In the World Championships of 1968, the American pilot Andrew J Smith won the Standard Class in an Elfe S - 3, George Moffat in another placed 4th and a third Elfe flown by Bloch of Switzerland was 6th.

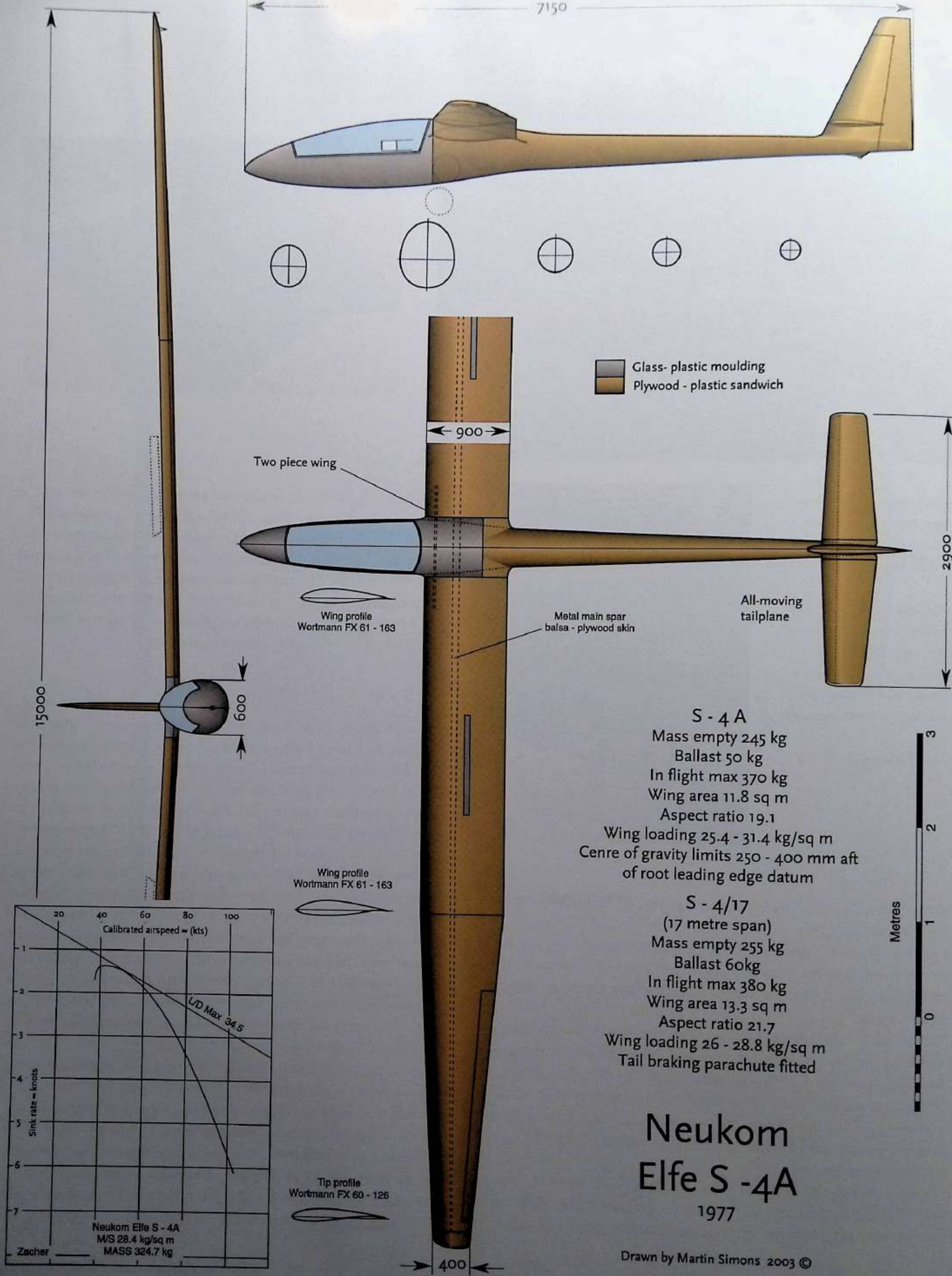
The Elfe S - 3 had wing profiles from the Wortmann FX series. The wing was derived from the Standard Elfe, with a light metal alloy main spar and a plywood-balsa sandwich skin. The fuselage had a moulded GRP shell at the front but the rear was of the usual plywood skinned type. The V tail was no longer used, having been replaced by a cruciform style with the all-moving elevator mounted part way up the fin.

Moffat commented at the time that the Elfe S - 3 seemed old fashioned among all the latest GRP sailplanes, Standard Libelles, Phoebus 15s and ASW 15s, which filled most of the other top places. Nevertheless it obviously performed very well and he believed it was equal with the 'glass ships'. (A Foka 5 flown by Ed Makula, former World Champion, placed 8th.) Moffat found the cockpit comfortable but narrow, so that anyone much wider than he was could not get into it at all. The trailing edge airbrakes were judged insufficiently effective. His other main criticism was that the Elfe was difficult to rig. The centre section weighed over 80 kg and required four bolts and three separate control connections.

Elfe S - 4

No two of Neukom's Elfes, till now, had ever been quite alike. His sailplanes had been built in the cellar of a farmhouse near his home with only one or two helpers. There was nothing like a production line. In 1972 he at last decided to establish a small factory and set up business near the airfield of Schmerlat on the outskirts of Schaffhausen. The Elfe - S4 prototype flew in 1972 and upwards of forty were constructed in the new works. The construction was, as before, mixed. The main wing spar was still from light alloys, which Neukom was sure gave the best compromise between strength, stiffness and weight. The wing skins were plywood-balsa sandwiches. These were laid up in moulds, the inner panels 1.5mm plywood with the grain laid diagonally, with 6 mm thick balsa filling. The tips were in 0.6mm plywood with 6 mm balsa. The tail unit was constructed in the same way. This structure was found to retain its accuracy for many years in service. The air brakes were of the Schempp-Hirth type.

The fuselage, with a fully contoured canopy, was a GRP balsa sandwich moulding at the front. The rear portion was, like the wings, a sandwich shell of plywood and balsa. The cockpit was large and comfortable. In later production the balsa filling for the sandwich skins was replaced by plastic foam. There were other details improvements resulting in the Elfe S - 4B. Kits were available for home builders. A 17 metre version of the Elfe S-4, called the AN - 17, was offered and there was a self-launching version, the Elfe M17, which flew in 1978.


7150
Glass- plastic moulding
Plywood - plastic sandwich
900
Two piece wing
2900
Wing profile
Wortmann FX 61 - 163
Metal main spar
balsa - plywood skin
All-moving
tailplane
15000
600
S - 4 A
Mass empty 245 kg
Ballast 50 kg
In flight max 370 kg
Wing area 11.8 sq m
Aspect ratio 19.1
Wing loading 25.4 - 31.4 kg/sq m
Cenre of gravity limits 250 - 400 mm aft
of root leading edge datum
S - 4/17
(17 metre span)
Mass empty 255 kg
Ballast 60kg
In flight max 380 kg
Wing area 13.3 sq m
Aspect ratio 21.7
Wing loading 26 - 28.8 kg/sq m
Tail braking parachute fitted
Metres
0
1
2
3
Wing profile
Wortmann FX 61 - 163
Calibrated airspeed – (kts)
20
40
60
80
100
Sink rate – knots
1
2
3
4
5
6
7
L/D Max 34.5
Neukom Elfe S - 4A
M/S 28.4 kg/sq m
MASS 324.7 kg
Zacher
Tip profile
Wortmann FX 60 - 126
400
Neukom
Elfe S -4A
1977
Drawn by Martin Simons 2003 ©

Neukom's other sailplanes included the AN - 66C, a 23 metre span variable geometry aircraft. This was built at the request of René Comte. The wing area could be increased by 20% with a large flap along the lines of the Mü 27 and Sigma. The profiles were designed by Richard Eppler. The wing was in three sections, the 6.5 metre long centre piece rectangular in plan, with tapered tips. It was flown in September 1973 but did not go into production.

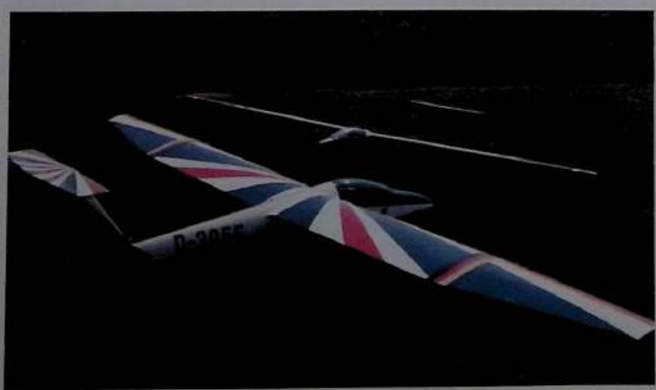
Pilatus B - 4

The firm of Rheintalwerke G Basten in St Goar had been interested in metal sailplane construction since 1960 but previous attempts to go into production had failed for various reasons. A new all-metal sailplane of 14.8 metres span was designed as a private venture by Ingo Herbst in 1966. Two prototypes were built at Basten's by Herbst with Manfred Küppers and Rudolph Reineke. The new type seemed promising and an agreement was made with a view to possible commercial production. The Pilatus Aircraft Company , after extensive market research, took over the development. With help from Herbst, the necessary work was done to obtain a Swiss type approval, and clearance for aerobatics, in 1972. Some re-design was done to simplify production, the cockpit was revised and the wing-fuselage junction improved. The span was increased slightly to 15 metres. Production began thereafter.

The Pilatus B - 4 (Basten 4) was of orthodox, all metal construction. The wing, in two pieces joining in the centre, had pressed light alloy ribs and a duralumin main spar, and metal skin. The fuselage, like that of the LET L - 13 Blanik, was built in two halves to join on the centre line with a flanged joint. The all-moving tailplane of the prototypes was replaced with a tailplane-elevator. Flush riveting was used throughout.

The B - 4 was light, robust and handled easily. It soared readily in weak thermals and slope lift. It lacked the high speed performance of contemporary GRP Standard Class sailplanes but the main function of the B - 4 was for early solo flying and first cross-country flights. It was capable of aerobatics, though not as lively as some of the more specialised sailplanes. A retractable wheel was later offered as an option.

Production at the Pilatus factory continued for six years. More than 330 had been delivered to countries all over the world when, in 1978, Pilatus decided to cease further production. All rights were sold to the Japanese Nippi-Nihon Kikoki Kabushiki Company. Only a few were built in Japan.



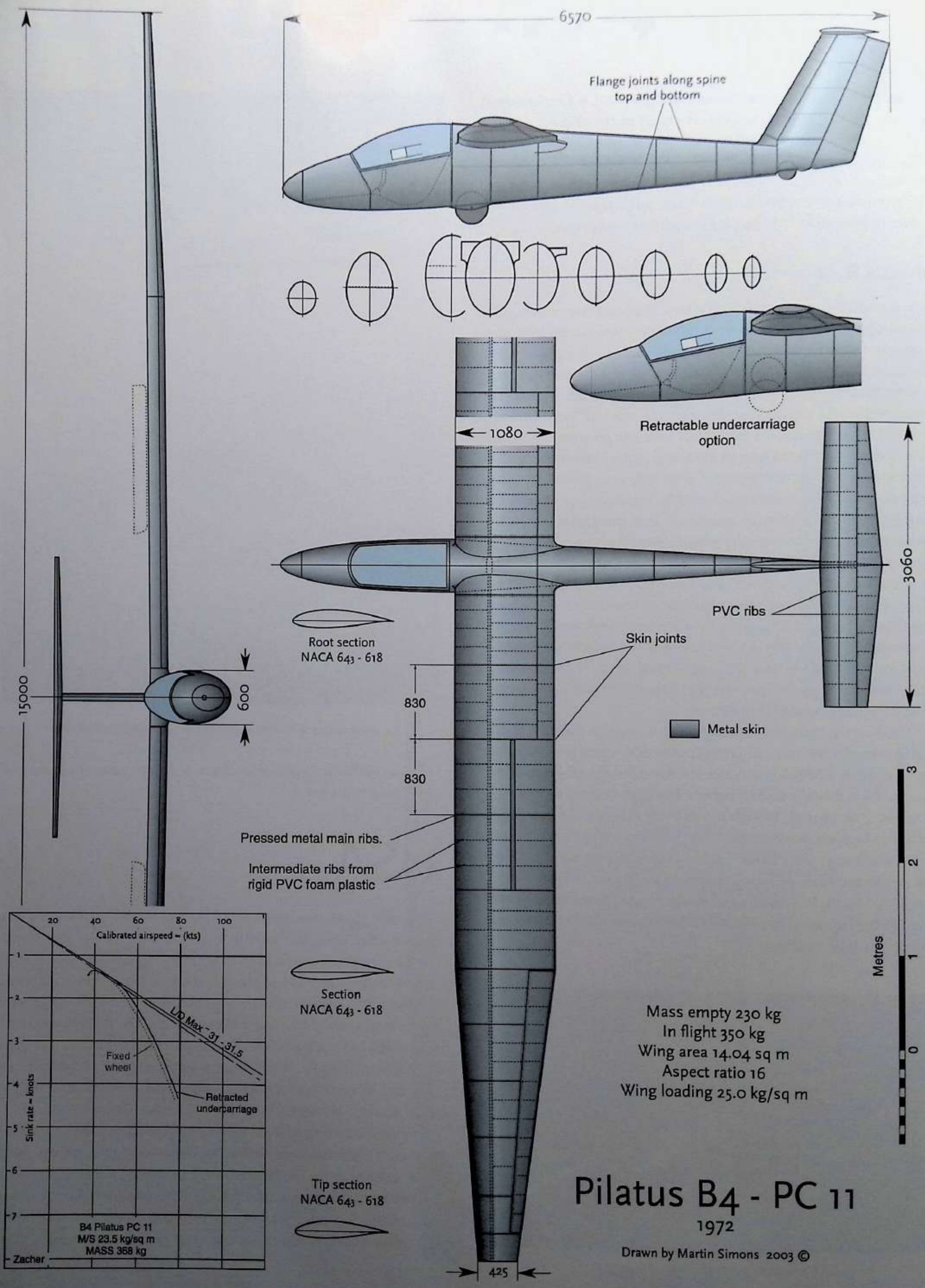
Pilatus B 4, a late version with retracting wheel (Factory photo)

Left below: Two Pilatus B 4 of an aerobatic team in attractive 'sunburst' colour scheme (Photo Bernd-Olaf Hagedorn)

USA

There was rapid development of soaring in the USA during the decades after 1965. The Soaring Society of America was a highly effective organisation and, with a successful regional structure, continued to guide and advise pilots and clubs. The SSA also managed relations with official government bodies responsible for general aviation and safety. The sport expanded rapidly. In 1975 membership of the SSA reached 10000. American pilots began to make their mark internationally. World records were repeatedly broken in the USA and World Championships were held at Marfa in Texas in 1970, Hobbs, New Mexico in 1983, and Uvalde, Texas in 1991.

Among the commercial manufacturers the largest was the Schweizer Aircraft Corporation of Elmira, NY. There were many smaller, such as the Laister Corpn, the Bryan Aircraft Company, Briegleb' Sailplane Corporation of America, and briefly, the Berkshire Manufacturing Corporation and Aero Tek Corpn. These and others struggled in the face of increasing competition from European manufacturers. They


6570
Flange joints along spine top and bottom
Retractable undercarriage option
1080
3060
PVC ribs
Skin joints
Metal skin
15000
600
830
830
Root section NACA 64₃ - 618
Pressed metal main ribs.
Intermediate ribs from rigid PVC foam plastic
Section NACA 64₃ - 618
Tip section NACA 64₃ - 618
425
Metres
3
2
1
0
Calibrated airspeed – (kts)
20
40
60
80
100
Sink rate – knots
1
2
3
4
5
6
7
L/D Max ~ 31 - 31.5
Fixed wheel
Retracted undercarriage
B4 Pilatus PC 11
M/S 23.5 kg/sq m
MASS 368 kg
Zacher
Mass empty 230 kg
In flight 350 kg
Wing area 14.04 sq m
Aspect ratio 16
Wing loading 25.0 kg/sq m
Pilatus B4 - PC 11
1972
Drawn by Martin Simons 2003 ©

were hindered by unfavourable currency exchange rates, high wages and the increasing cost of product liability insurance.

At the same time there was, as always, a very strong home-building movement. Many enthusiasts bought kits or plans, especially for the Schreder all-metal designs from Ohio and wooden types such as the Briegleb BG - 12 and 12/16, the BJ - 1B Duster and Maupin-Culver Woodstock. There were also many amateur designers taking advantage of the liberal airworthiness regulations. These allowed many sailplanes, classed as 'Experimental', to be flown with a minimum of bureaucratic interference. In a list published in 1983, there were thirty or more sailplane types of original, recent design which had been constructed at home and flown as 'one offs'. There was a very competent and active advisory and supervisory organisation, the Experimental Aircraft Association, from which expert advice was available.

Applebay Aero Tek Zuni

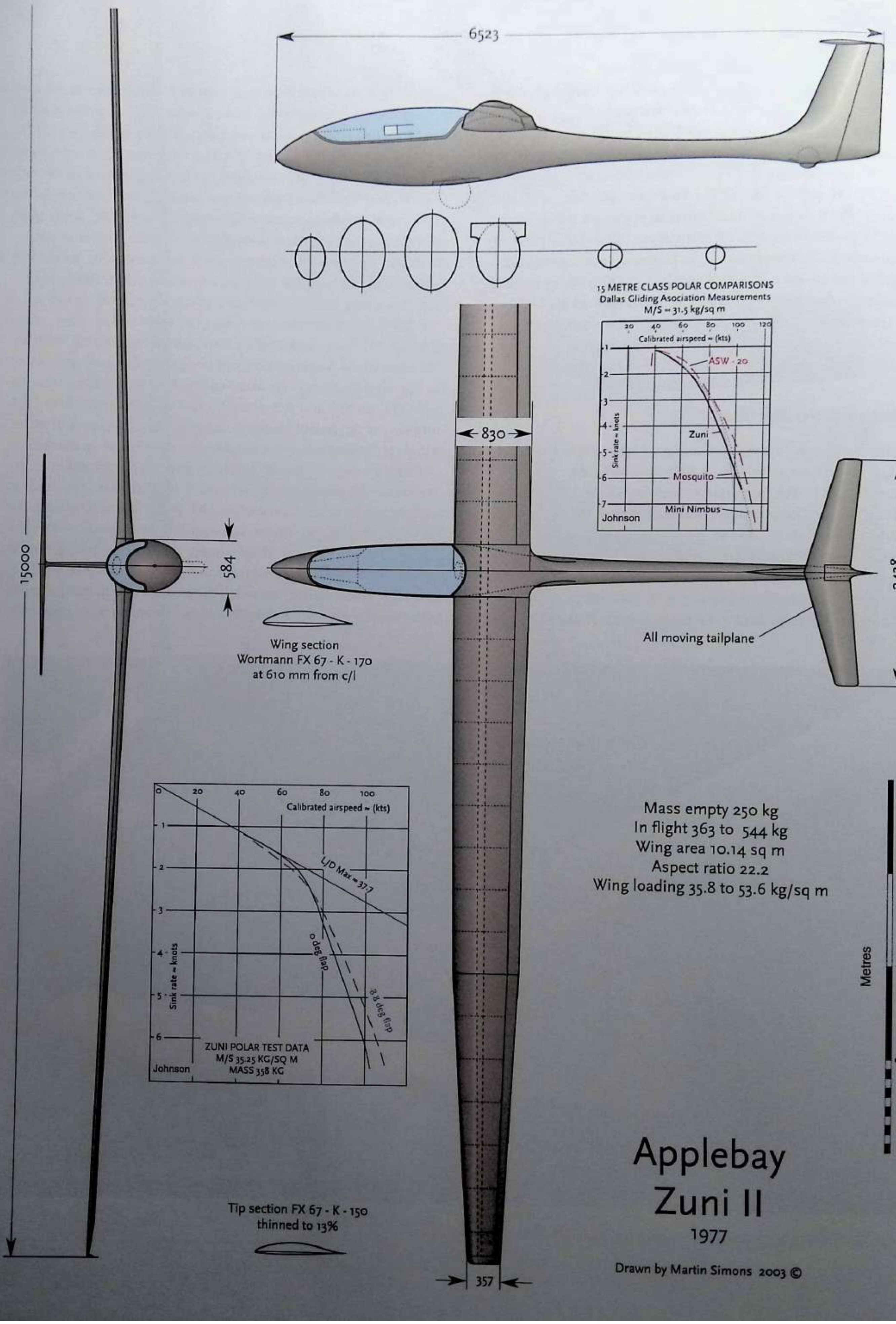
George Applebay was stimulated to design a new sailplane when the Soaring Society of America, late in 1970, announced a sailplane design competition. The organizers were concerned that leading American pilots no longer chose American aircraft for World Championship flying. George Moffat, for instance, had won the recent World Championships at Marfa, Texas, in the German Nimbus.

Prototypes of US design and construction, entered for the SSA competition, were to be presented for judging by 12th March 1972. This allowed only fourteen months for the entire process of design, building and testing. It must have been clear to Applebay that this was not long enough. He nonetheless set to work. The Mescalero, named after an Apache tribe, was an Open Class sailplane of 21.64 metres span (71 ft). The fuselage was moulded in GRP. The wing was metal with some GRP. It took four years to complete, the first flight being in January 1975. During this time Applebay was compelled to move out of his small home workshop and established AeroTek, Inc, near Albuquerque, New Mexico. He sold stock to raise capital for him to continue. By the time the Mescalero was ready the closing date for the SSA Competition was long past. No prize was ever awarded. The Mescalaro might have won, since it proved itself an excellent aircraft in service.

In 1976, Applebay planned a new, all GRP, Fifteen Metre class sailplane, the Zuni, named after a New Mexico Indian tribe. With advice from many leading pilots and designers, the work proceeded rapidly. Contributions came from Harland Ross who designed the RS-1 of 1936, the R-2 and R-3, and who had worked closely with Dick Johnson on the record breaking, laminar wing RJ-5, as well as his own record setting R-6. Other helpers were called in when needed.

The Zuni wing was double tapered in plan, with flaps, and used derivations of the well-proved Wortmann 67 series profiles. The depth at the extreme root was increased to 19% of the chord to relieve the stresses in this critical region. The wing thinned rapidly to 15% 0.9 metres outboard and continued to taper in thickness further out. At the planform taper break, the thickness ratio was 14% and at the tip only 13%. Ballast capacity up to 110 KG was provided in integral tanks in the leading edge of the wing. The flaps, lowered to 90 degrees, were

One Applebay Zuni hangs in the Smithsonian Institution Museum but others are still flying.


6523
15 METRE CLASS POLAR COMPARISONS
Dallas Gliding Asociation Measurements
M/S ≈ 31.5 kg/sq m
Calibrated airspeed ≈ (kts)
Sink rate ≈ knots
ASW - 20
Zuni
Mosquito
Mini Nimbus
Johnson
830
15000
584
2438
Wing section
Wortmann FX 67 - K - 170
at 610 mm from c/l
All moving tailplane
Calibrated airspeed ≈ (kts)
L/D Max ≈ 37.7
0 deg flap
8.8 deg flap
Sink rate ≈ knots
ZUNI POLAR TEST DATA
M/S 35.25 KG/SQ M
MASS 358 KG
Johnson
Mass empty 250 kg
In flight 363 to 544 kg
Wing area 10.14 sq m
Aspect ratio 22.2
Wing loading 35.8 to 53.6 kg/sq m
Metres
Tip section FX 67 - K - 150
thinned to 13%
357
Applebay
Zuni II
1977
Drawn by Martin Simons 2003 ©

A Zuni 2 flown by Steve Leonard over Kansas

the only air brakes. The wing was mounted high on the fuselage to minimize interference drag. 1 degree of dihedral was used. A careful flutter analysis was carried out by Carl Doherty, establishing a 'red line' speed for the Zuni wing of 147 knots indicated airspeed.

The fuselage was of very graceful, aerodynamically refined form. Aft of the cockpit it was a sandwich structure of plastic foam and GRP. This, as Applebay admitted, was somewhat heavier and more costly to produce than the usual European shell form, but more resistant to damage. The control column was mounted on the right hand fuselage wall.[47] Elevator action was provided by a horizontal slide, ailerons by wrist action. A five-strap harness was provided, made easier by the absence of a central control column. The blown canopy was completely removed for access to the cockpit. The main wheel was retractable. A smoothly faired fin supported the T tail, with all-moving elevator, which was slightly reflexed in section for improved balance in high-speed flight. The rudder was partly mass balanced.

Test flights in November 1976 proved satisfactory. There was great interest from all American soaring pilots, and Applebay was encouraged to begin regular production.

In 1977, Billy Hill, a relatively unknown young pilot, won a Regional Championship in the Zuni. In July, at the US National Fifteen Metre National Championships at Hobbs, NM, he placed a creditable 17th against a number of very experienced pilots. He won one day and was second on another. Mistakes on other days pulled his final scores down. Even so, it seemed the Zuni was at least equal to the imported European sailplanes in this contest.

For Aero Tek, however, things were not good. In May, there had been a fatal accident when a Zuni broke up in flight. The pilot, Tom Brandes, practicing for competitions, was unable to save himself by parachute. Legal action brought against Aero Tek by the estate of the pilot dealt a devastating blow to the small company. In 1978, Aero Tek was obliged to shut down.

Applebay was determined to continue to produce and develop the Zuni. He formed a new company, Applebay Sailplanes, and purchased the tooling and assets from Aero Tek. Seven more Zunis were completed and delivered in 1978. In 1978 and 1979, the Zuni was flown in National Championships. The results were good but the Zuni was still being flown only by pilots with limited competition experience.

In 1979 Dick Johnson at Caddo Mills arranged to test and measure the performance of a production Zuni. The results were something of a disappointment. Things had moved on. The reigning Fifteen Metre type was now the ASW 20, which proved superior not only to this American aircraft, but to all sailplanes of the previous generation. The Zuni, Johnson found, was outclassed, even with a best glide ratio of 37.7. It climbed well, but fell noticeably behind the imported aircraft at speeds above 70 knots. The reason for the disappointment, Johnson hinted, might be because laminar separation bubbles were forming on the wing. This needed more research.

Johnson had other criticisms. He found the side mounted control column tiring to use, especially when gusts and sudden 'g' forces pushed his arm up or down. This applied ailerons, one way or the other, when not intended. Johnson noted that the roll rate at 50 knots was adequate but not especially good; 5.0 seconds from 45 degrees bank to 45 degrees the other way with flaps set for thermalling. This was partly because the aileron control circuits seemed rather 'soft'. During inspections on the ground it was possible to move one aileron as much as six degrees either way with the other one locked. Various other discomforts in the cockpit required attention.

As a result of this and other advice, the Zuni 2 was advertised in 1980. It represented a considerable advance. The wing spar was now

47 – See Moba 2, p. 15, SZD - 56, p. 215, and Diamant, p. 221

in carbon fibre, allowing weight to be saved with improved strength and stiffness. Ballast capacity was increased to 180 kg. The aileron controls were re-designed with closer tolerances and the dihedral increased to 2 degrees to aid circling. The landing wheel was re-positioned to achieve better ground handling. The cockpit was completely re-designed and the control column relocated to the orthodox central position. The parallel action linkage introduced by Eugen Hänle in the Kestrel, was adopted. The canopy was changed to hinge forwards. Carbon control surfaces were offered as an option and the Zuni also could be fitted with winglets, as some were, retrospectively.

With all of these improvements, the fundamental aerodynamic design was not changed. To do this would have involved very costly re-tooling and new moulds for the wings. There were very few orders after 1981. The currency exchange rate made a new European glider less expensive than a new Zuni. A total of 20 Zuni and Zuni 2s had been built when production ceased altogether in 1983.

1983 was also the last year in which the Zuni competed in National Championships, continuing to score well, but not chosen by the leading pilots of the day. For International Championships, Poland had a problem at this time. There was no Polish sailplane capable of competing in the Fifteen Metre Class. To allow their team to enter in 1983, three Zuni 2s were hired. Janusz Centka placed 19th of 48 entrants in the 15 meter class. He had moved up to 6th place before a turning point photograph penalty robbed him of a daily victory. Two days later he lost all speed points by failing to cross the finish line correctly.

Poland did not produce a competitive Fifteen Metre Class sailplane until the SZD - 56 Diana of 1998.

Thanks to George Applebay and Steve Leonard for help with the above article.

Bryan Aircraft Co

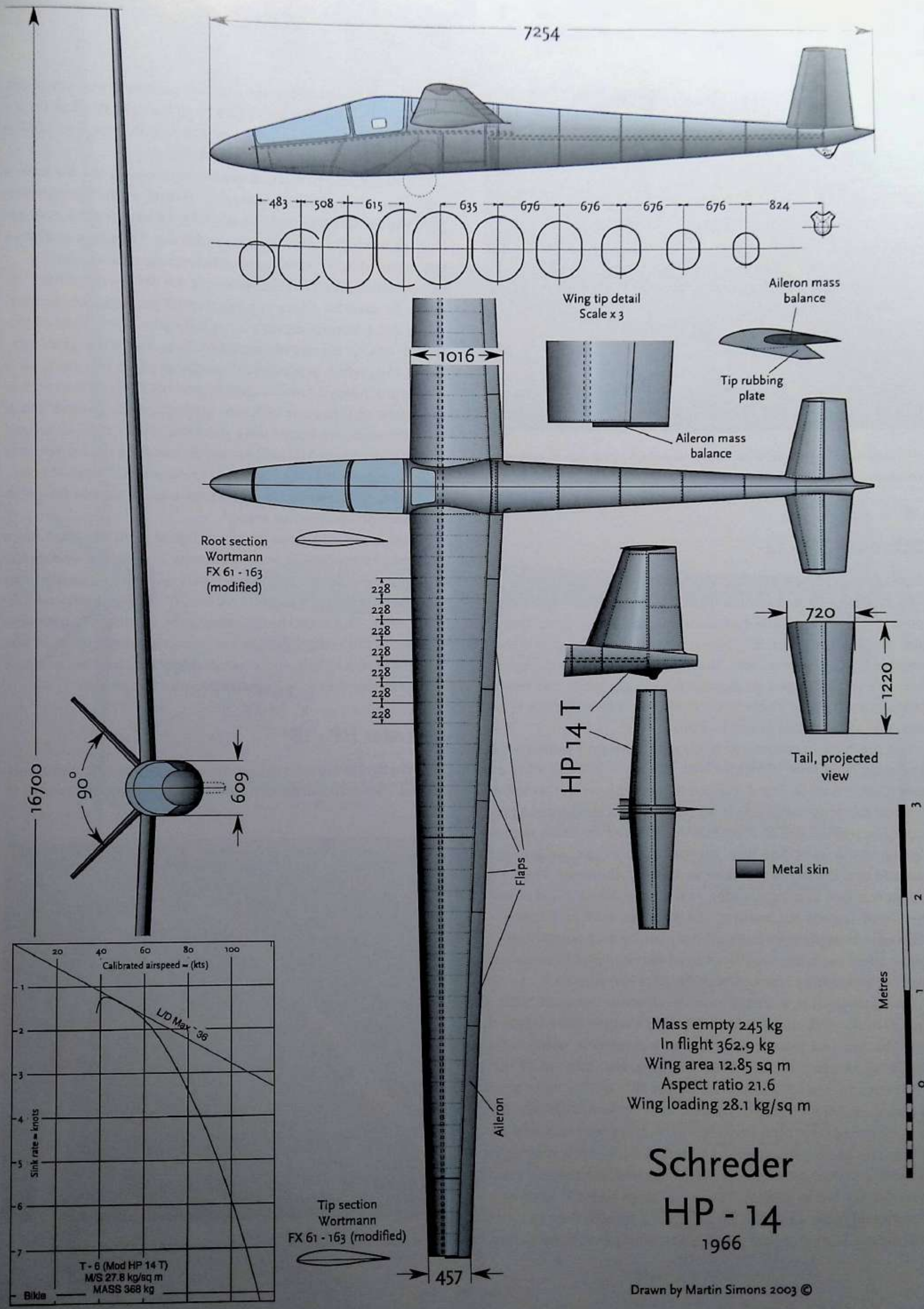
Richard E Schreder, born in 1915, graduated as an engineer in 1938 and served as a pilot in the US Navy during World War 2. Post war he built his own light aeroplane. When, in the mid 'fifties, he became interested in soaring, his first cross-country flights were made in a Bowlus Baby Albatross. He entered the US National Soaring Championships flying a Schweizer 1 - 23D and placed third.

At the US Nationals in 1957 he flew the HP - 7, an all-metal sailplane he had designed and built himself. He made a 491km distance flight, second best of the whole meeting. The following year he arrived with the HP - 8 and won the Championship, placed second the following year, and at an informal meeting in August 1959, at Odessa, Texas, he broke the World Speed Records for 100, 200 and 300 km triangles. He was chosen for the US International team for the World Championships in 1960, held at an airfield near Cologne. His HP - 9 was not quite completed so he took the HP - 8. During this meeting one day he drifted across the forbidden frontier to land on the wrong side of the 'Iron Curtain' in East Germany. Fortunately he and his sailplane were released quickly.

After this, hardly a year passed without a new sailplane from Schreder. He established his own Company, Bryan Aircraft Corporation, in Ohio, to sell plans and kits. The HP - 11 was particularly successful. With this Schreder placed third in the World Championships in Argentina in 1962. More than forty kits were sold.[48]

48 – See Vol 2

The HP - 14, seen here at Harris Hill, New York State, in 2000


7254
483
508
615
635
676
676
676
676
824
Wing tip detail
Scale x 3
Aileron mass balance
Tip rubbing plate
Aileron mass balance
1016
Root section
Wortmann
FX 61 - 163
(modified)
228
228
228
228
228
228
228
HP 14 T
720
1220
Tail, projected view
16700
90°
609
Flaps
Metal skin
Metres
0
1
2
3
Calibrated airspeed = (kts)
20
40
60
80
100
Sink rate = knots
-1
-2
-3
-4
-5
-6
-7
L/D Max - 36
T - 6 (Mod HP 14 T)
M/S 27.8 kg/sq m
MASS 368 kg
Bikle
Aileron
Tip section
Wortmann
FX 61 - 163 (modified)
457
Mass empty 245 kg
In flight 362.9 kg
Wing area 12.85 sq m
Aspect ratio 21.6
Wing loading 28.1 kg/sq m
Schreder
HP - 14
1966
Drawn by Martin Simons 2003 ©

HP - 14 cockpit. The front part of the canopy was a simple curved piece of Plexiglas. The rear section was moulded and supplied with the kit.

Schreder HP - 14

In 1966 Schreder won the US Nationals in his latest product, the HP - 14. With this he had taken a slightly different approach from his previous designs, which had been fast and likely to do best in strong conditions. The HP - 14 was more lightly loaded and had a somewhat lower aspect ratio. The argument was that soaring contests are often decided on days with weak thermals. The heavily laden aircraft, 'lead sleds' as they were termed, come down and land out, as the lighter ones continue.

The methods of construction followed Schreder's usual system. The wing spars were fabricated with flanges of 2024 T6 alloy, 6.6 mm (0.25 ins) thick, rolled to a slightly curved cross section to conform to the wing section, with vertical webs forming a strong box spar. The pressed ribs and intermediate vertical stiffeners were attached to the webs. The skin, pre-formed to fit the leading edge, was laid over the top of the framework and flush riveted. There was a light rear spar to carry the ailerons and flaps, which could be lowered to 90 degrees for landing. The wing tips were protected by a simple rubbing plate with the aileron mass balance outside this. In detail, there was some modification of the wing profile on the underside, to simplify construction of the flaps and ailerons.

The fuselage was a simple semi-monocoque structure with a canopy in two sections, the foremost being a simply curved sheet of Plexiglas, the rear piece moulded to give acceptable aerodynamic form. The main landing wheel was retractable, and there was a V tail.

Schreder marketed kits and plans for the HP - 14. The rolled strips of alloy supplied for the spar flanges had to be sawn longitudinally. As the stresses in the metal were relieved, they sprung and bowed out of line. This necessitated careful, and gentle, hammering to straighten them. The sheet alloy skins for the wings were not supplied ready formed. They had to be bent. The advice given with the kits was to lay each four metre long sheet on a clean and smooth floor and with the help of a team of several people and a stout plank, bend it along the required line by lifting the edge and pushing it with the plank. The nose radius was finally formed by all the crew standing on the plank to tighten the bend. This had to match the nose radius of the ribs. If done carefully, the result was satisfactory.

The Wortmann profiles, if exactly reproduced, should have a slight cusp or undercamber near the trailing edge. Schreder supplied the ailerons and flaps as ready-folded sheets of metal, triangular in cross section with the undersides flat. The upper and lower sheets were simply riveted together to form the trailing edges.

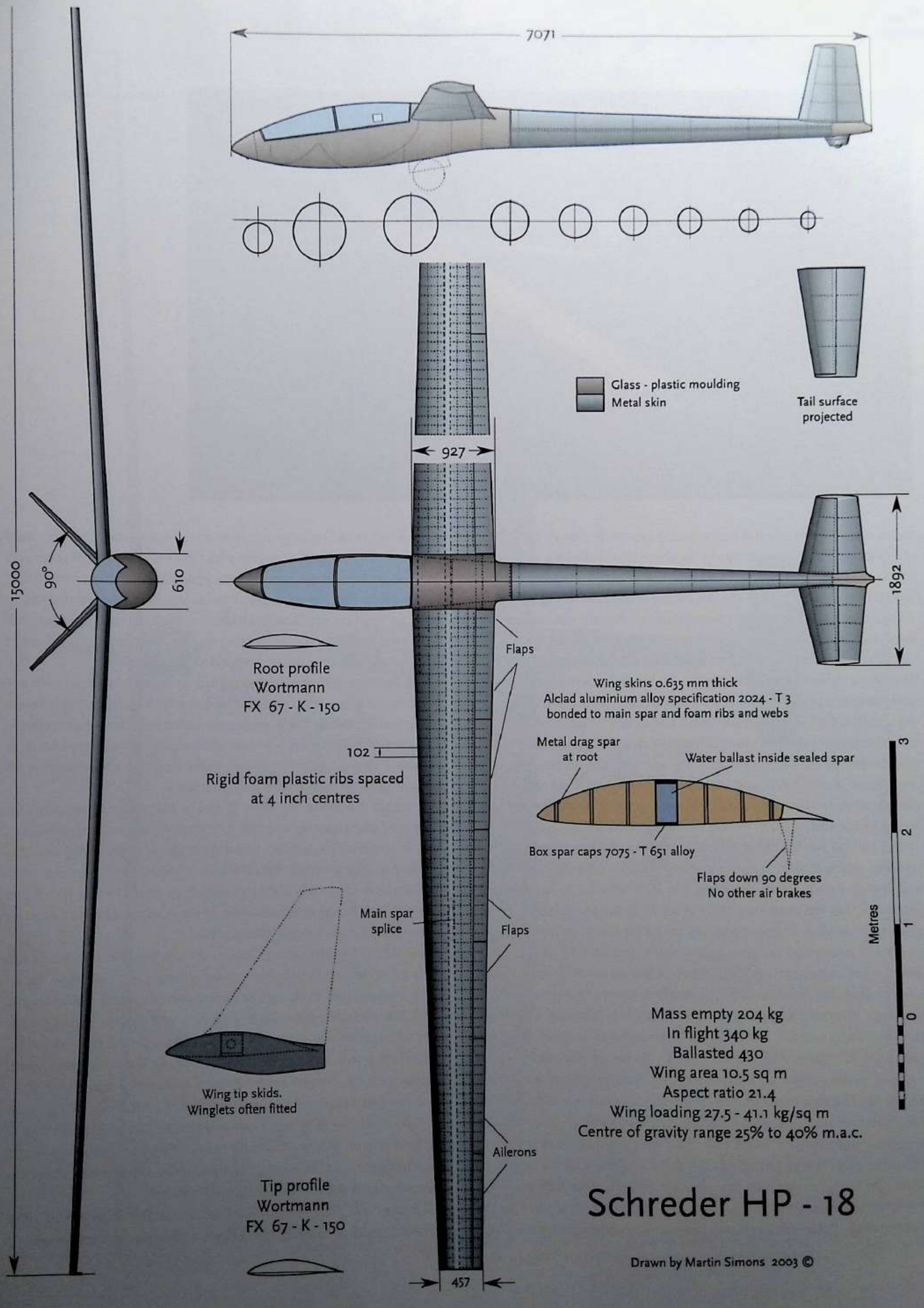
Paul Bikle built a T - Tailed version of the HP - 14, called the T - 6, which he used for a series of very careful performance measurements and comparisons with other sailplanes. These showed that the HP - 14, in his slightly modified form, had a best glide ratio about 36:1, which was not particularly good, at this time, for a sailplane of nearly 17 metres span. Imported GRP sailplanes such as the Kestrel and Diamant 16.5, were achieving 38:1 or better, and at high airspeeds the Kestrel did a good deal better at 80 knots and above. Bikle reported rather large departures from the correct wing contour, especially in the region of the main spar. "It would be unreasonable," Bikle wrote "to expect large areas of laminar flow with the degree of waviness that exists."

Production of kits from Bryan continued until 1970 and more than forty of the HP - 14 were built, some in countries outside the USA, six, for example, in Australia. An agreement was made with Slingsby Sailplanes in England for the HP 14 to be built under licence there. This ended badly. Attempts by the Slingsby Company to improve the performance by extending the wing span to 18 metres and adding a T tail, and other modifications, had bad results. A serious factory fire in 1968 effectively ended this project.

Schreder HP - 18

After the HP - 14 Schreder designed the HP - 15 which he later admitted was a failure. It had the unusually high aspect ratio of 33 with a 15

HP - 18 cockpit with instrument panel and canopy hinged in front



Schreder HP - 18

Drawn by Martin Simons 2003 ©

HP -18 with winglets

metre span. He estimated it would have a best glide ratio of 45:1. After the 1969 National Championships in which he finished a humiliating 65th, he scrapped the wings and sold the fuselage. He said later, "it would outrun anything in the sky on the straightaway, but everyone caught and passed me in the next thermal." The HP - 16, with more wing area, was successful, some twenty kits being sold, and the RS - 16, with his own initials for once incorporated in the name, followed. This was a departure in several ways. The familiar Schreder fuselage, with simple lines, was replaced by a pod and boom layout, the pod moulded in GRP while the tail boom was an aluminium tube with V tail. The wings were the same as those of the HP - 16. The kits had a high degree of pre-fabrication and, Schreder claimed, an amateur with a rivet gun, electric drill and an air compressor, would be able to put one together in about 300 hours. At least one built by an amateur was flying by the end of 1972. Twenty were built from kits.

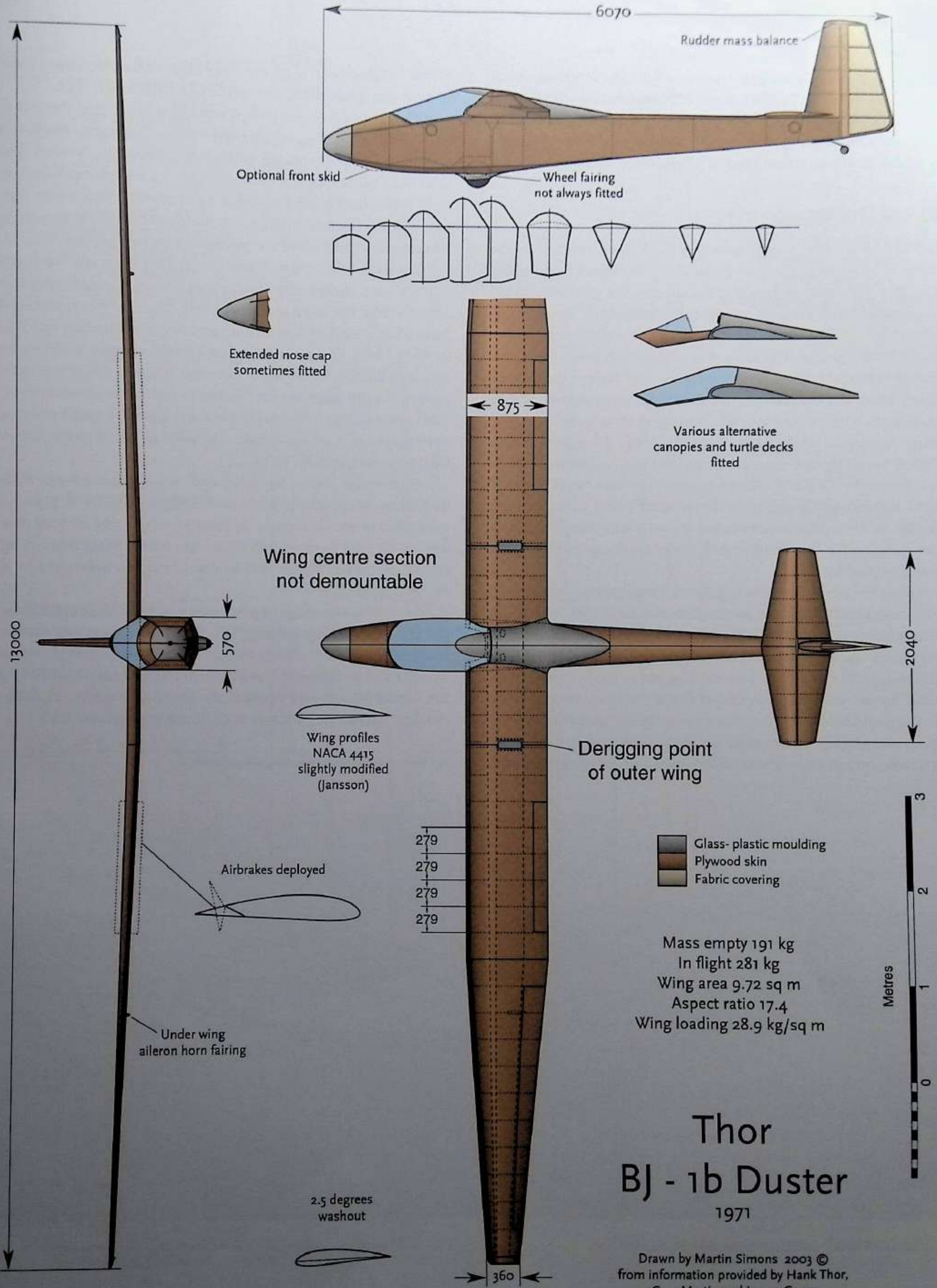
The HP - 17 was an experimental aircraft to test new German wing profiles and Schreder was not pleased with it, only the prototype ever being flown. There followed the HP - 18 which, in terms of numbers, was the most successful of all Schreder's sailplanes. It was clear by now that unless some way could be found to make metal wings as smooth and accurate as those of imported GRP aircraft, the performance would always be lacking. However carefully constructed, a riveted metal skin becomes wavy. Jack Laister had attempted to overcome this problem with his Nugget in 1971. Schreder, thinking of the amateur builder, could not use the kind of large oven required for Laister's 'Chem Weld' process. He therefore adopted a new method of wing construction, relying on 'room temperature curing' adhesives. The main spar flanges of the HP - 18 were machined from solid aluminium alloy plate, riveted to shear webs to form a box spar. This was carefully sealed and made watertight because it was to act as the ballast tank. Wing ribs were cut accurately in hard plastic foam. With the completed spar laid on trestles, web side up, the front foam ribs, spaced at 228 mm (9 ins), were glued in place with epoxy resin, all the metal surfaces having been scrupulously cleaned first. A light leading edge sub spar was glued to the ribs after they had been trued up. The assembly was then rotated 180 degrees and the rear ribs glued on, and the rear spar glued to them. A series of vertical rectangles of foam plastic were inserted between the ribs to form an 'egg box structure, which was sanded down to contour. The skins were glued to this, with care taken to ensure the fit was perfect and that no gaps or other errors spoiled the adhesion.

The fuselage was of straightforward riveted metal type, with a V tail, but the entire front was enclosed in a GRP shell, giving it an excellent aerodynamic form, with a moulded canopy in two sections. The control column on Schreder's drawings was side mounted, as on the Diamant and Zuni, but most builders chose option of mounting it centrally in the orthodox place.

Schreder described the HP - 18 in the magazine Soaring and in 1976 published a series of articles describing in considerable detail how it could be assembled. More than 110 kits were sold and distributed widely throughout the world. Many of these were completed, over fifty of the HP - 18 were said to be flying in the USA alone by 1983, and it was remarked that newly completed ones "pop out of garages with each new soaring season."

The HP - 18 flight performance was not tested until the Caddo Mills group led by Dick Johnson was able to carry out tests of a recently restored and improved example, publishing the results in July 2003. The best glide ratio, with winglets and a modified wing profile with turbulators, was measured at 40:1. Checks of wing waviness indicated that, with the very special smoothing and finishing applied to this example, the skin with no rivets was approaching the accuracy of the GRP sailplane. Recognising that the original design was in 1975 - 6, the HP - 18, if well built and finished, was certainly one of the best Fifteen Metre Class sailplanes of its time. Johnson found handling in the air satisfactory but had some reservations about the effectiveness of the V tail and the landing flaps.

Schreder was awarded the FAI Paul Tissandier Diploma in 1986, and continued producing new sailplane designs and prototypes up



Thor
BJ - 1b Duster
1971

Drawn by Martin Simons 2003 ©
from information provided by Hank Thor,
Cam Martin and James Garay

to the HP - 22. Few of the later types were built in more than one or two examples. Even in 2003, parts and drawings for the HP - 18 were still obtainable from Bob Kuykendall, who took over responsibility for Schreder's products after he retired from business. Richard Schreder, greatly mourned, died in August 2003, aged 88.

BJ - 1b Duster

The BJ - 1B 'Duster' was designed by Hank Thor. Duster was the name of the latest powerful 'Plymouth' car, which he admired. The title 'BJ' became attached because in the nineteen sixties Thor had worked with the Swedish aerodynamicist, Ben Jansson, on the BJ - 1 'Dyna Mite', a small sailplane which they built in Hank Thor's garage. The BJ - 1 was successful but had been produced without plans or documentation. Like many others at the time, Thor was concerned that the rapid development of GRP sailplanes, with rising costs, was putting soaring out of reach for many potential enthusiasts. Looking back, Thor later wrote: "What about the little guy for whom last year's glass was still far too expensive? What about the ex-model-builder (with a family) who wanted to fly and who knew what pride of authorship meant, but who would have to build a sailplane that could share the garage with the lawnmower? These are the guys the Duster was designed for."

Taking the BJ - 1 as his starting point, Thor carried out the necessary calculations and drew up the plans for the Duster, with a view to marketing the drawings. Everything was done to make construction easy. The wing was in three sections so that no part would be too long to fit in a typical suburban garage or shed. Wood, rather than metal, was the preferred material because most amateur builders and modellers had little experience of metal aircraft structures and tooling. Commercial grades of timber were used except for the most critical, highly stressed items like the wing main spar, which was laminated in spruce. Thor claimed that the Duster could be built with a sabre saw, disc sander and a 3/8th inch drill.

With all the simplifications, it was still required that the performance should be adequate for cross country flying and completion of the FAI Badge flights up to the Gold C 300 km standard. The span of 13 metres and a high aspect ratio, for a home-built aircraft, of 17.4 gave the Duster a best glide ratio of about 28:1, better than that of the Schweizer 1 - 26. A well built and finished example was subsequently flight tested and proved to have best glide of 30:1.

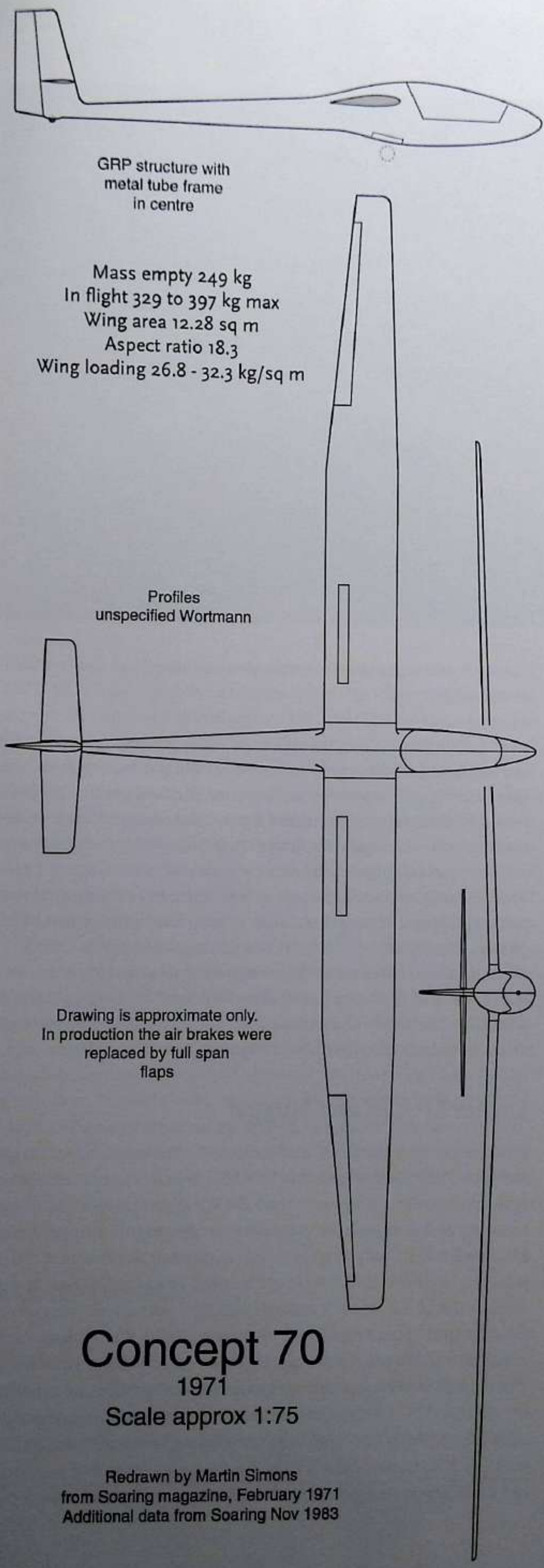
News of the BJ - 1b was released in May 1971. Soon afterwards sets of plans were offered, with instructions, at $75. It would cost about $800 to build one from scratch at home. The first Duster was built from Thor's plans by Jim Maupin and Norman Barnhart and flew in August 1971. Maupin established a small company, DSK (Duster Sailplane Kits) to market kits of materials at $1925 to registered plan holders. In the same issue of Soaring in which the advertisements first appeared, a new Standard Libelle was quoted at $5650 ex-factory in Germany. A second-hand 1 - 26 could be found in the 'Classified' advertisements for $3000.

To build from a kit, Thor estimated, would require about 800 - 900 hours. Most people took much longer, up to 1600 hours or even 3600 in one case. Some let their project lie idle for long periods. A Duster in Australia was not completed for thirty years, being started, stored and latterly sold to a new, energetic owner. It flew in the year 2000.

A total of 371 sets of Duster plans were sold and DSK provided about 169 kits before ceasing operations in 1980. 70 Dusters at least were actually built and flown. There may be others still in construction, or stored. A Duster Sailplane Association was formed and flourished for some years with its own 'fanzine', the Dust Rag. A successful 'Duster reunion' was held at Tehachapi in California in September 2001.[49]

49 – There is a web site, <http://www.classicglider.info/Duster/>.

A Duster as Jim Maupin built it, exactly according to the plans

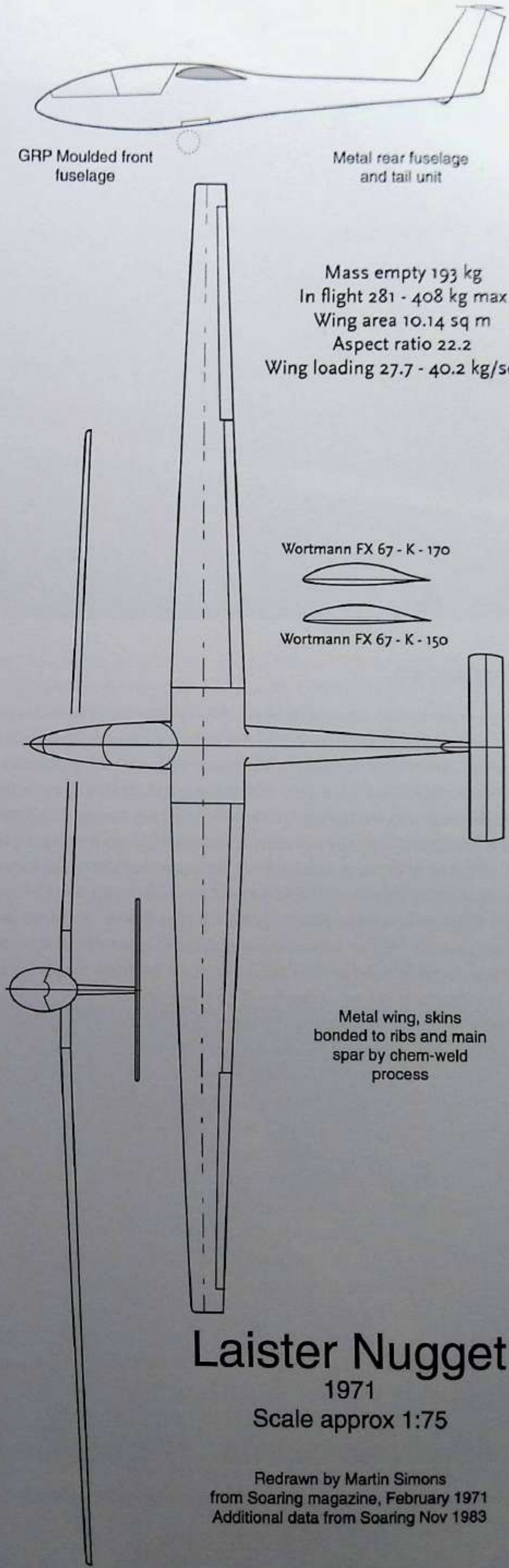


Concept 70

1971

Scale approx 1:75

Redrawn by Martin Simons
from Soaring magazine, February 1971
Additional data from Soaring Nov 1983



Laister Nugget

1971

Scale approx 1:75

Redrawn by Martin Simons
from Soaring magazine, February 1971
Additional data from Soaring Nov 1983

A Duster in Australia, completed to fly successfully after being in store part-completed for thirty years.

Concept 70

There were several attempts in the USA to break into the market for GRP sailplanes. One aircraft that did enter commercial production was the Concept 70, which, as the name suggests, was projected in 1970 and flown early in 1971. It was designed and built by Arthur Zimmerman and Wolfgang Schaer who together founded the Berkshire Manufacturing Corporation. Concept 70 was a Standard Class sailplane with an aspect ratio of 20, airbrakes, retracting wheel and an all-moving tailplane. The wing profile was from Eppler. Comparison flight trials of the prototype against the Standard Cirrus were made in April 1971. It appeared from these that, while the Concept 70 was about as good as the Cirrus in the glides, there was some airflow separation at low airspeeds when thermalling. One of the new Wortmann profiles would yield better results. In a matter of three weeks the builders changed the profile with templates and filler, to the new section, to see what happened. New comparison flights, made by pilots George Moffat and Gleb Derujinsky, yielded encouraging results. Wing moulds were made with several other important changes to the design, including replacing the air brakes with a flap brake, and the all-moving elevator with a tailplane/elevator layout. Production began and deliveries were made.

During the US National Championships at Minden, Nevada in July 1972, a Concept 70 passing through the start gate at high airspeed, suffered severe aileron flutter and disintegrated. The pilot, Jim Indrebo, was saved by parachute. For any new sailplane type to suffer a serious structural failure, not obviously caused by pilot error, does immense harm to its prospects. Analysis and publication of the reports on an accident take months to prepare. While waiting, pilots inevitably suspect that something was wrong with the aircraft. If they have placed an order, or are thinking of doing so, they often change their minds. It transpired later that the Concept 70 had been incorrectly rigged, the main wing pins not locked. Obviously this was a major contributory cause and the aircraft could not be blamed for the crew's error or the pilot's failure to check. But there had been severe aileron flutter in the first place. The bolts would probably not have shifted if the flutter had not been severe enough to shake them out. There had been some rudder flutter with this aircraft previously, requiring a damper to be fitted. Possibly some unsuspected damage had been done to the wing structure by this incident. Subsequent flutter tests and analysis seemed to exonerate the Concept 70, but this was not known until April 1973.

Production continued but there was no rush of orders, even after the report had been published. The Concept 70's future was very doubtful. The bitter end came in 1974 when Arthur Zimmerman died. Production ceased entirely. A total of 21 had been built.

Laister LP - 49 and Nugget

Jack Laister had designed and built the 'Yankee Doodle' single seater in 1938 and the two seat LK - 10 which, adopted for military glider pilot training, became the TG - 4 and was produced in large numbers and dominated the post-war, army-surplus sailplane market. Few Laister's sailplanes entered production but two that did so were the LP 46/49, and the Laister Nugget. The LP 49, flown first in 1966 as the LP 46, was a Standard Class type with metal wings, GRP fuselage and retracting wheel. The aspect ratio was 22 and Wortmann profiles were used. Paul Bikle measured the performance. The surface accuracy of the wings was far from perfect, as expected for a metal skin. A best glide ratio of 31:1 was found when imported sailplanes like the Standard Cirrus produced 35:1 and were also better at high airspeeds. Nearly fifty kits for home assembly were marketed and seven complete aircraft were produced by the factory.

Pioneer 2D, with the span extended to 15 metres

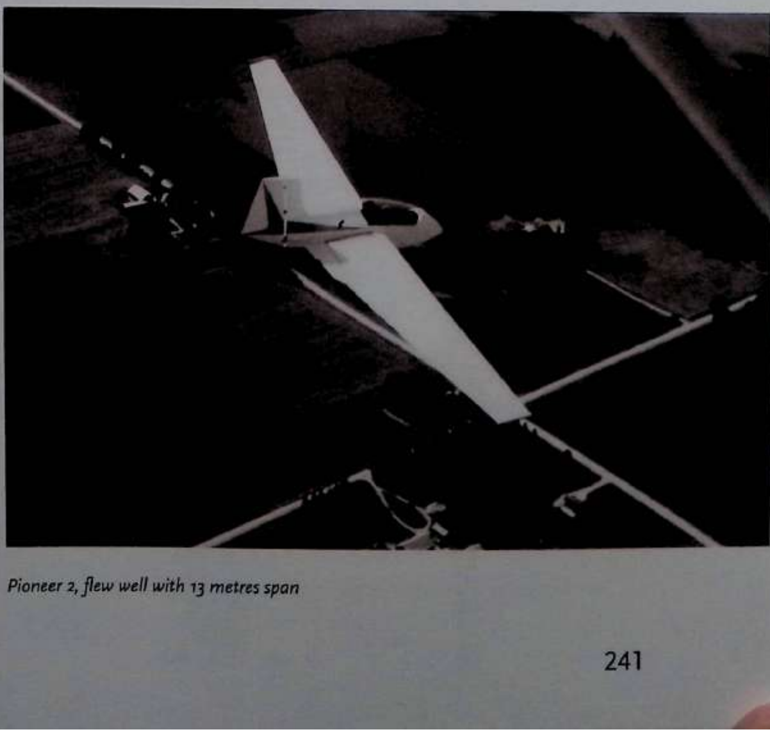
Jack and Bill Laister (Jack's son) went on to produce the Nugget in 1971. They had waited to learn what the revised Standard Class rules were to be. These were announced in 1969. The Nugget, with flap brakes now permitted, was all metal except for the front fuselage shell in GRP. The most important innovation was that the wing skins were bonded to the ribs and spars, using a process called 'Chem-Weld'. This was an effort to match the smooth and ripple-free quality of imported GRP sailplanes. After very careful cleansing of the metal surfaces, strips of adhesive, in tape form, were applied as required. The pre-formed skins were clamped in place and the entire wings baked at high temperature in a large oven. This activated the adhesive and hardened it, so preventing any possible future shifting of the joints.

Laister's base was in Los Angeles. After desperate efforts to get the prototype ready in time, it was taken by road to the site at Ephrata in Washington State, to be flown in the 1971 US Standard Class Nationals by Ross Briegleb. It arrived late for the first contest day and Briegleb damaged the aircraft seriously when landing in crops after three days. He was forced to withdraw, but spoke well of the aircraft. Unfortunately after 1974 the CIVV again changed the Standard Class rules and the Nugget no longer fitted into the competition class system.[50] Only fifteen were built. Kits were not made available for the Nugget. Laister considered the bonding process beyond the capacity of amateur constructors..

Marske Pioneer

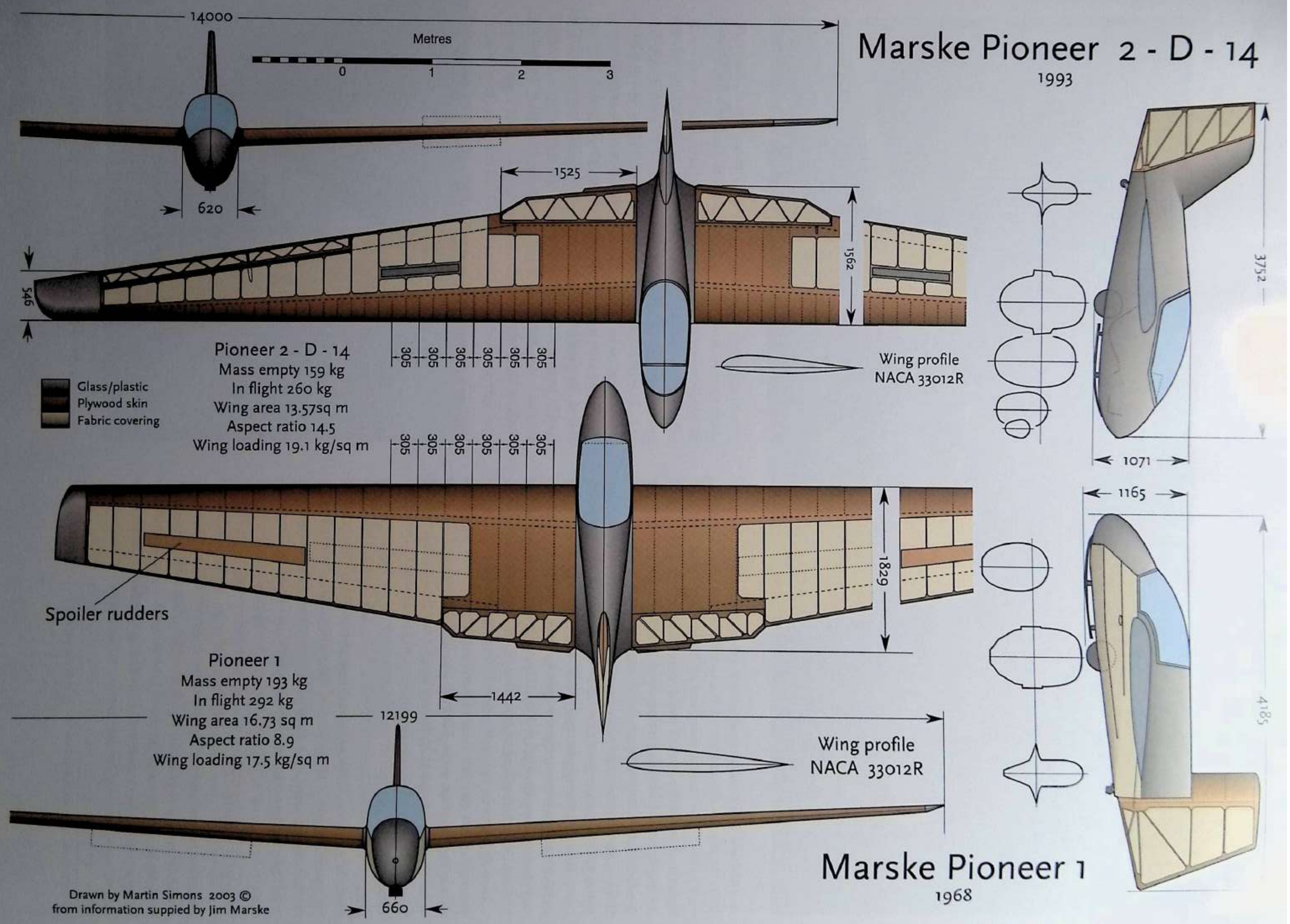
Jim Marske was a qualified aeronautical engineer with experience at the McDonnell Douglas and North American Aircraft Corporations. His interest in tailless sailplanes had been aroused in the 'fifties by the flying wings of the Frenchman, Charles Fauvel and the American Al Backstrom. Marske began with several large flying models and was impressed enough by these to build, in 1957, a 'Flying Plank' along Backstrom lines with a span of 12.2 metres (40ft). The XM - 1D flew well but exhibited too much adverse yaw in roll.

The Pioneer 1, 12.34 metres (40.5 ft.) span, which flew in 1965, was a great improvement. The general dimensions of the popular Schweizer 1 - 26 were taken as a guide, with the hope that the tailless aircraft would be equal to, or better than, the Schweizer. The same span was adopted and the weight was about the same. The wing area was determined by combining the total areas of the 1- 26 wing and tail. The profile, from the NACA 5 digit series, 33012R, was similar to that used for the 1 - 26, but as the R suffix indicates, reflexed to reduce the pitching moment to zero.



Pioneer 2, flew well with 13 metres span

50 – See the further discussion under Schweizer SGS 1 - 34 & - 35, p. 252-256



Marske Pioneer 2 - D - 14
1993
14000
Metres
0
1
2
3
620
1525
1562
546
305
305
305
305
305
305
Pioneer 2 - D - 14
Mass empty 159 kg
In flight 260 kg
Wing area 13.57sq m
Aspect ratio 14.5
Wing loading 19.1 kg/sq m
Glass/plastic
Plywood skin
Fabric covering
Wing profile
NACA 33012R
3752
1071
1165
4185
1829
Spoiler rudders
1442
Pioneer 1
Mass empty 193 kg
In flight 292 kg
Wing area 16.73 sq m
Aspect ratio 8.9
Wing loading 17.5 kg/sq m
12199
Wing profile
NACA 33012R
660
Marske Pioneer 1
1968
Drawn by Martin Simons 2003 ©
from information suppied by Jim Marske

The Monarch E. Note the tow release at the side of the nacelle, and the control cable running round the pulley and into the wing

The wing was tapered and swept forward slightly to align the leading edge at right angles to the centre line. This brought the pilot's seat, in a small streamlined nacelle with transparent canopy, forward of the main spar. The field of vision was much improved compared with the 'plank' layout. The elevator was mounted centrally on the wing trailing edge. There were no ailerons, control in roll being achieved with drag spoilers near the wing tips. There was an aerodynamically balanced rudder at the rear of the nacelle. Construction of the wing was wood with fabric covering, and GRP tips. The nacelle was a steel tube frame covered with fabric except for the rear decking and the nose cap in GRP. Twin tow hooks were mounted the sides of the nacelle just under the wing leading edge. A 'Y' bridle was used for launching by winch or aero tow.

Performance comparisons with the 1 - 26 were made by test pilot Bill Daniels over El Mirage in California in 1968. These showed that the Pioneer was able to climb in thermals with the 1 - 26, and surpassed it at high airspeeds. The tailless sailplane proved resistant to stalling and spinning. Large under-wing drag spoilers were fitted but while these were effective during the approach, in the last stages of a landing they produced floating in the ground effect making it difficult to touch down at the chosen spot.

The tip spoilers were not satisfactory for control in roll and on the Pioneer 1A, which had the span increased to 14 metres, these were placed further forward on the wing. The aerodynamic balance on the rudder was removed. The performance, especially at high airspeeds, was better and Daniels made several good flights, some in wave including a climb to 9500 metres. The roll spoilers were still unsatisfactory.

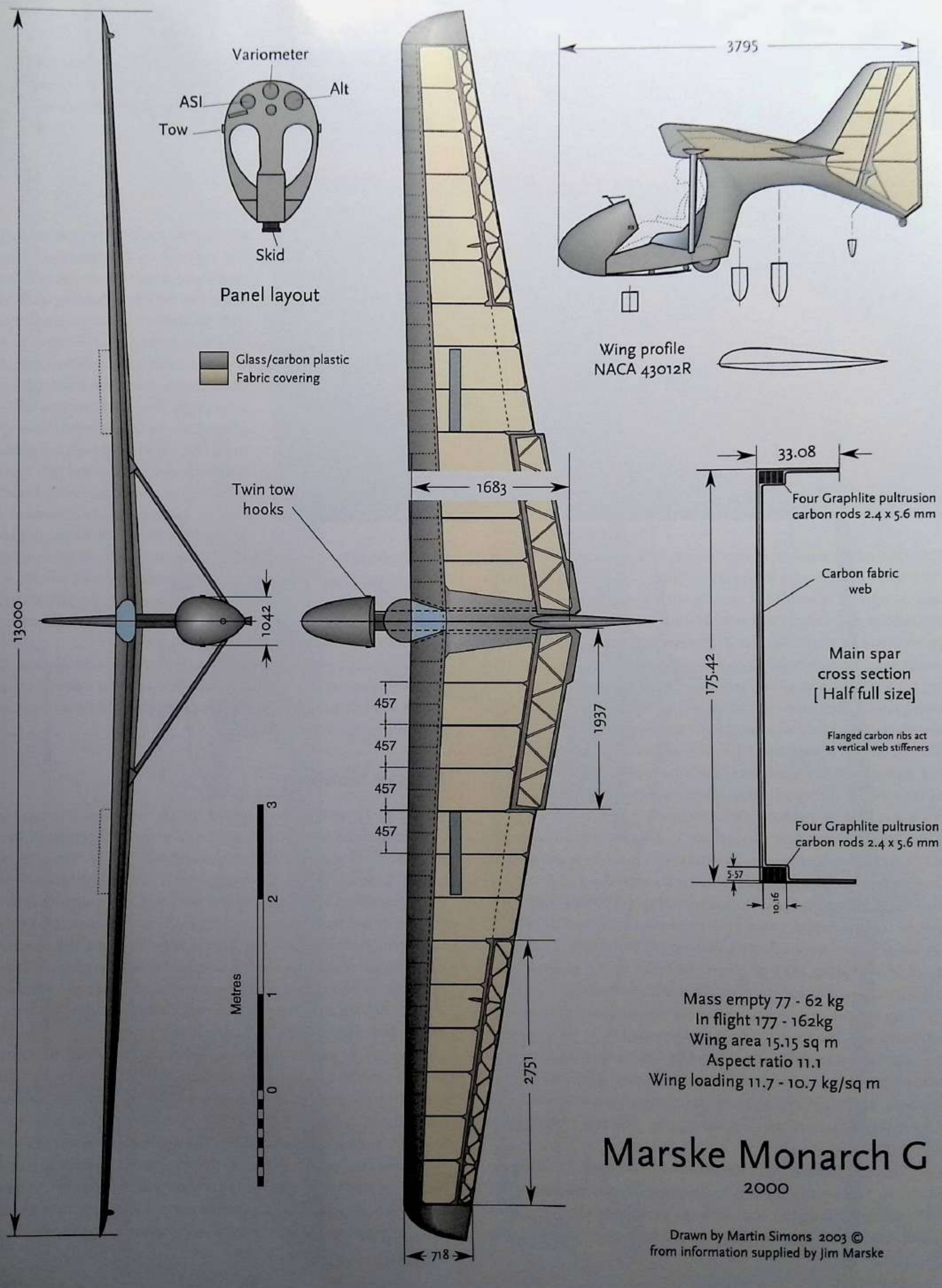
The Pioneer 2 followed, and was marketed in kit form. The span was reduced to 12.8 metres for the convenience of homebuilders with small workshops. A slightly less cambered profile was used, the NACA 23012R. The nacelle skin was a GRP moulding provided as part of the kit. The tip spoilers were eliminated and replaced by differential ailerons. Landing spoilers were now both above and below the wing. Handing qualities were satisfactory although the rate of roll was reportedly low. The amount of rudder needed to counteract the adverse aileron drag seemed excessive to some pilots. It was accepted that the Pioneer 2 was at least comparable with the 1 - 26, superior at high airspeeds. Paul Bikle remarked, these two types were 'in the same ball park'. Performances achieved clearly depended a great deal on the qualities of workmanship displayed by the builder, and this varied considerably from one aircraft to another. Later models of the Pioneer 2, the 2A and 2B, reverted to the 14 metre span. The more cambered profile, 33012R, was restored to improve low speed performance. The fin and rudder were swept back slightly and the canopy was improved.

The Pioneer 2 proved popular with homebuilders. More than 32 of the '2' were built, 25 of the A and B models and a few of the D model. A 15 metre span version was developed and flown successfully, with good results.

Marske Monarch

Marske's intention when designing the Monarch was to bridge the gap between the hang glider and the sailplane. The prototype flew in 1974. It had a span of 11.3 metres and mass 113 kg. The pilot sat on an open seat below the wing, with a streamlined nacelle in front. There was a landing skid but no wheel. The control column was suspended from above. The wing plan was similar to that of the successful Pioneer series, but with simple lift struts. There was a large vertical fin but no rudder. Control in yaw was by spoilers on the wing, operated independently by left and right rudder pedals. By pushing with both feet together they could act as drag spoilers. A single tow hook was mounted at the nose.

This airframe was extensively modified, over a period of several years, producing a series of later models. The wings were increased in span, with ailerons and elevator enlarged appropriately. The spoilers under the wing were eliminated and those on the upper surface enlarged. A landing wheel was added. The single towhook was replaced by twin hooks on either side of the nose fairing and the overhead control column was changed to a conventional, floor-mounted stick. Further modifications saw a conventional rudder fitted, a window inserted in the wing above the pilot' head, and other refinements.



Mass empty 77 - 62 kg
In flight 177 - 162kg
Wing area 15.15 sq m
Aspect ratio 11.1
Wing loading 11.7 - 10.7 kg/sq m

Marske Monarch G

2000

Drawn by Martin Simons 2003 ©
from information supplied by Jim Marske

Genesis launching (Photo Eric Raymond)

Finally, in the Monarch G, all wood and metal structure was replaced by carbon fibre reinforced plastics, including carbon pushrods for all the controls. Control hinge lines and other sources of drag were sealed and faired. The first flights were in June 2000. The Monarch was of course not a high speed, racing competition sailplane. Nor was it exactly a hang glider, since taking off by foot launch was not intended. It might be easily launched by auto tow or winch and has demonstrated that soaring in light airs is easy and enjoyable. Two have been built at the time of writing.

Project Genesis

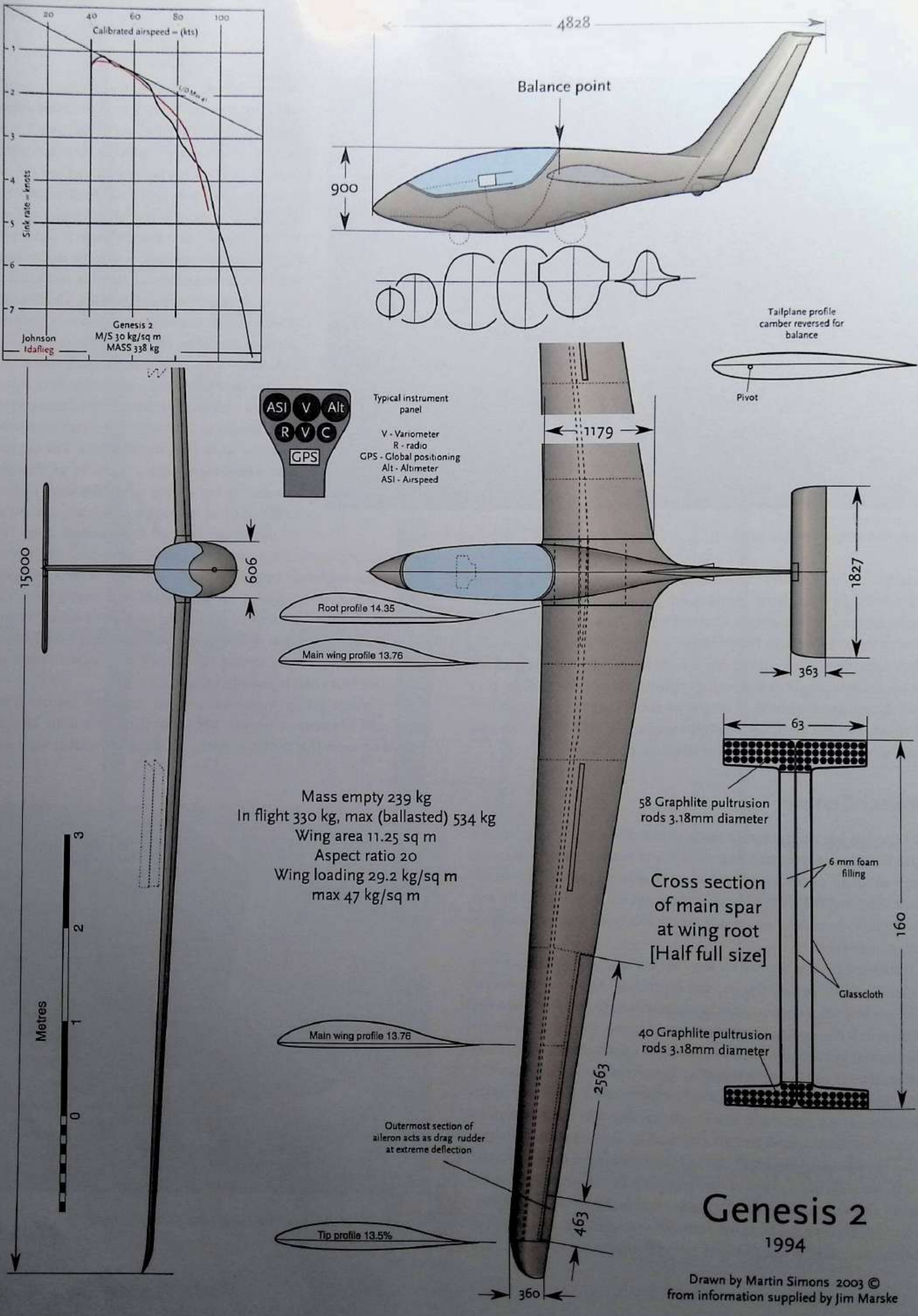
The Genesis was an attempt to make a radical advance in sailplane design. The project group felt that after thirty years or more of detailed improvements, orthodox sailplanes had reached a plateau in development. Pursuing the same lines could be expected to produce only very small gains. To make a major advance it was necessary to start again with a clean sheet.

The basic plan was devised by Jerry Mercer who was also responsible for raising the necessary finance and organising the business affairs of 'Project Genesis'. A well-qualified group assembled and an outline of a hopeful new design was presented at the Soaring Society of America's Convention in 1990. Jim Marske undertook the original aerodynamics and structural engineering. Aerofoil design work was carried out by John Roncz, an aerodynamicist who had worked on the Voyager round-the-world aeroplane, the Beech Starship and on racing yacht design. Roy Bailets, who had also worked on the Voyager, was a specialist in composite materials. Cockpit layout was developed by Robert Mudd, who was to do much of the test flying. David Treins, an FAA examiner and very experienced sailplane pilot, had general responsibility for co-ordinating the team. Extensive computer studies were made to guide all decisions. It was not quite correct to describe the Genesis as a tailless aircraft because there was a small tailplane, of the all-moving type, mounted atop a large, back-swept vertical tail surface, with rudder. The tailplane was, however, on a very short moment arm relative to the wing and was not intended to contribute to the longitudinal stability or balance. It was regarded as a trimmer to provide control in pitch but the loads it carried in flight would otherwise be negligible and its contribution to drag minimal. Stability and balance would come entirely from the wing, which had a reflexed aerofoil section and hence, a positive pitching moment. Such a profile provides its own stability, reacting to any disturbance in the longitudinal sense with a corrective force. Apart from the necessary, streamlined pod to carry the pilot, there was no fuselage and hence no drag from the usual lengthy tail boom. The tall fin, with a high aspect ratio, would be an effective stabiliser in the yawing sense. The outer section of the ailerons were arranged as drag spoilers to eliminate adverse yaw from aileron drag. The main landing wheel was retractable but a small nose-wheel was fixed.

There was sufficient interest for a prototype to be built and production plans to be made. An agreement was made with the Sportine Aviacija Company in Lithuania for further development and test work to be done with a view to manufacture there. Members of the design team visited the factory and Robert Mudd remained for four years to manage the project.

The Genesis group were well pleased with the results from flight tests of the prototype in 1994, but there was some airflow separation over the centre section. A zigzag turbulator tape was

Genesis on the ground showing its special wing - fuselage arrangement (Photo Jochen Ewald)



Calibrated airspeed – (kts)
Sink rate – knots
Genesis 2
M/S 30 kg/sq m
MASS 338 kg
Johnson
Idaflieg
4828
Balance point
900
Tailplane profile
camber reversed for
balance
Pivot
Typical instrument
panel
ASI V Alt
R V C
GPS
V - Variometer
R - radio
GPS - Global positioning
Alt - Altimeter
ASI - Airspeed
1179
15000
909
1827
363
Root profile 14.35
Main wing profile 13.76
63
58 Graphlite pultrusion
rods 3.18mm diameter
6 mm foam
filling
Mass empty 239 kg
In flight 330 kg, max (ballasted) 534 kg
Wing area 11.25 sq m
Aspect ratio 20
Wing loading 29.2 kg/sq m
max 47 kg/sq m
Cross section
of main spar
at wing root
[Half full size]
160
Glasscloth
Metres
0
1
2
3
Main wing profile 13.76
40 Graphlite pultrusion
rods 3.18mm diameter
2563
Outermost section of
aileron acts as drag rudder
at extreme deflection
463
Tip profile 13.5%
360
Genesis 2
1994
Drawn by Martin Simons 2003 ©
from information supplied by Jim Marske

Genesis in flight. Handling was reported to be entirely normal.

placed on the upper surface near the wing root. Other detailed matters needed attention.

Jim Marske also carried out test work on the materials for the spar in the Lithuanian laboratories. Marske had begun the Genesis structural design with the assumption that carbon fibre would be used for the spars, but on investigation found that while the manufacturers claimed very high tensile strengths, data on compressive strength was lacking. Test pieces of carbon in epoxy resin matrix, laid up by hand, showed very disturbing variations in both tension and compression. The difficulty was that the fibres could not be laid perfectly straight. Under load, the straighter fibres were reaching their breaking strain while the others were still not carrying full load. The prototype Genesis had been built with a hand-laid carbon spar designed with the minimum test results as the basis, with the usual safety factors applied. A spar of this kind proved under static tests to be adequate in strength and stiffness, but if the full strength of the carbon could be used there would be considerable improvements. A much lighter and stronger wing would be possible.

At this stage Marske discovered that carbon fibre rods manufactured in the USA by a highly developed 'pultrusion' process were available. These achieve the full tensile strength figures claimed for the fibre, and have a highly satisfactory compressive strength. The rods are made by machine, the fibres first being laid under equal tension to straighten them before being impregnated with resin and pulled through heated dies, and cured. The amount of resin is closely controlled. As a result, weight for weight, the rods contain a much higher proportion of carbon than the equivalent hand laid material and are very much stronger and stiffer. Marske fabricated a test spar for the Genesis. In the Sportine Aviacija laboratory this resisted loads equivalent to 10.5 g, without any sign of failure or degradation of the rods. This was the limit of the test machinery. A further test was carried out to establish that repeated loading would cause no cumulative damage. 10 000 load cycles were gone through with no difficulties.

In addition to the new spar, other changes were made. The wing washout was reduced and a new tip profile employed. The nosewheel was made retractable. The outcome was the Genesis 2, which flew in November 1998. In July 1999 an agreement was made for production to start in Lithuania and the order book was opened. Later in the year Robert Mudd took the Genesis 2 on an extensive European tour, visiting most of the well-known gliding sites and offering the Genesis 2 to over 130 pilots to fly. All reports were favourable. By December, fifteen had been delivered. Performance tests by Dick Johnson and the Idaflieg students indicated a best glide ratio of about 41:1.

One customer, who took delivery of the twelfth Genesis from production, expressed himself very pleased with it. Its handling was entirely normal and he felt that if he had not known about the unusual layout he would have thought himself to be flying a fully orthodox sailplane. Rolling from 45 degrees to 45 degrees the other way, took under four seconds, a good figure. The only idiosyncrasy mentioned was that, with the ballast tanks full, rudder power was a little lacking. Otherwise, he felt the stiff carbon spar gave rather a hard 'ride' compared with other fifteen metre span sailplanes he knew.

In the long run, pilots look at competition results before making up their mind about any new sailplane. A Genesis 2, piloted by Bill Bartell, flew in the US Standard Class National Championships in Texas in June 2000. This was the first time a G2 had entered a Championships at this level. Though inexperienced in the aircraft, Bartell won a day when everyone landed out, but he came nearest to the finish line. He was a very close second on another day. The implication was that The Genesis was at least competitive in its class.

Unfortunately, after 27 of the Genesis 2 had been completed, a breakdown of relationships between the project group and the Lithuanian Company occurred. Production stopped. Whether there will be any more, is not decided at the time of writing.

Schweizer Aircraft Corporation

The three Schweizer Brothers, Ernest, Paul and William, had been involved with gliding and soaring since the early 'thirties. As boys they designed and built a primary glider and taught themselves to fly it. They were all keen soaring pilots. Their training as aircraft engineers convinced them that the future lay with metal structures rather than wood, a conviction that never left them. They founded the Schweizer Aircraft Corporation, based near Elmira, New York State, in 1939, to design and build sailplanes. They were heavily engaged soon afterwards in producing two-seaters for the glider pilot training programme during the Second World War. When the war ended, the limited civil market was filled by surplus gliders sold cheaply by the authorities. Many of them were Schweizer's own products. The Company survived only by taking on sub-contracting work, while continuing as much as possible with sailplane design and production.[51] This situation continued over the next forty years. Sailplanes at best counted for only 20% of the Company's sales and at times the figure fell to 5%.

When the three founders of the Company were approaching retirement, they were joined by members of the next generation. Ernie Schweizer's son, Les, and Bill Schweizer's two, Stuart and Paul (Jr), now manage the Company. From 1984, they have been almost entirely engaged in building and developing helicopters. After 45 years, the Schweizer s left the sailplane business. The soaring school they founded at the Elmira-Corning County Airport, survives.

The naming and numbering system of Schweizer aircraft requires explanation. The first letter stands for Schweizer. The second may be G for glider, A for aeroplane, or occasionally X for experimental. The third letter may be P for Primary, U for Utility (a trainer) S for Sailplane, or M for motor glider. The first digit indicates the number of seats, the figures after the dash indicate the design number. Suffixes such as A, B, E, indicate modifications and later marks of the same design.

Thus, SGP 1 - 1 was the 1930 Primary glider of 1930, SA 1 - 30 was a light aeroplane. SGX 8 - 10 was a projected military troop carrying glider (never built), SGS 2 - 33 a two seat sailplane, SGS 1 - 26E the E version of the single seat sailplane, SGS 1 - 34 a single seat sailplanes, and so on.

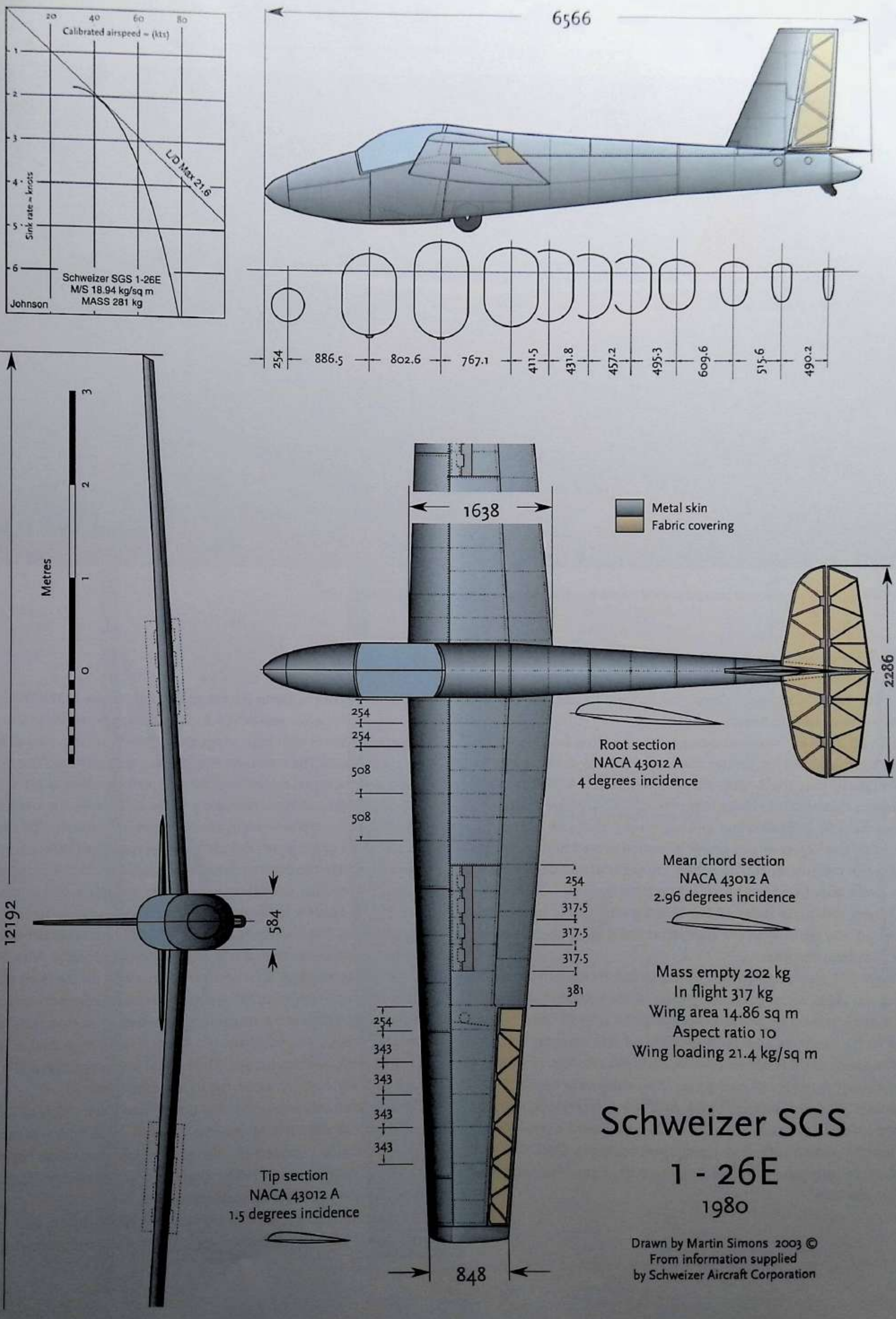
SGS 1 - 26E

The original SGS 1- 26 flew in 1954 and became the most popular sailplane in the USA. A flourishing trade in complete sailplanes and kits for home assembly was nurtured. A 1- 26 Association was formed and from 1965 on there were regular 'one design' championships. Only small modifications to the basic design were permitted. The 1 -26 passed through A, B and C marks without much visible change. Too many improvements would invalidate the 'one design' concept. New wing profiles, new materials, flaps, ballast and any other alterations that would affect performance, were ruled out. A total of 204 kits and about the same number of completed aircraft had been sold by 1965. The 'D' model was at last introduced, with improvements that would not much affect the performance, although the all-up flying mass had increased from the original 261 kg to 290.

In 1970 the 1 - 26E was introduced. The chief motivation was to reduce production costs and to modernise the appearance. The fuselage, originally almost all fabric covered, was now metal

51 – A full account of the Schweizer Company's involvement with sailplanes is contained in the book 'Sailplanes By Schweizer', by Paul Schweizer and Martin Simons, Airlife, 1998. 'Soaring with the Schweizers' by William Schweizer, Rivilo Books, 1991, is a history tracing all aspects of the Company's development.

Schweizer SGS 1- 26E in Texas 1995


Calibrated airspeed – (kts)
20
40
60
80
Sink rate – knots
1
2
3
4
5
6
L/D Max 21.6
Schweizer SGS 1-26E
M/S 18.94 kg/sq m
MASS 281 kg
Johnson
6566
254
886.5
802.6
767.1
411.5
431.8
457.2
495.3
609.6
515.6
490.2
Metres
0
1
2
3
12192
584
1638
Metal skin
Fabric covering
2286
254
254
508
508
Root section
NACA 43012 A
4 degrees incidence
Mean chord section
NACA 43012 A
2.96 degrees incidence
254
317.5
317.5
317.5
381
254
343
343
343
343
Mass empty 202 kg
In flight 317 kg
Wing area 14.86 sq m
Aspect ratio 10
Wing loading 21.4 kg/sq m
Tip section
NACA 43012 A
1.5 degrees incidence
848
Schweizer SGS
1 - 26E
1980
Drawn by Martin Simons 2003 ©
From information supplied
by Schweizer Aircraft Corporation

The Schweizer SGS 2 – 33, a most succesful two seat trainer. The photograph was taken at Harris Hill, Elmira, USA.

skinned with nose cone in GRP. The wings too were completely metal skinned. The vertical tail was swept back slightly and squared off, for stylistic reasons. Only the rudder, horizontal tail and ailerons were fabric covered.

The all up mass now was 340 kg and the wing loading, consequently, was about 6% greater than the old 1- 26 prototype. It was maintained that the 1- 26E was still compatible with the earlier marks in competition. If the higher wing loading gave a slight improvement in inter-thermal gliding speeds, this was counterbalanced by the slower rate of climb in weak thermals. But the 1 - 26E was really considerably better than the original had been, in ways not easily quantified but much appreciated by pilots. The original had been distinctly noisy to fly, because there were many small gaps and leakage around the cockpit, at the wing roots, the wheel, and doubtless elsewhere.

The 1- 26E was much quieter, better sealed everywhere, and with the metal skins, aerodynamically truer to the intended shape. The improved stiffness of the structure and the new fin and rudder, gave all the controls a better response and less 'spongy' feel. The performance cannot fail to have been improved too. How much difference it made is not easy to say. The glide ratio of the 'E' was measured at 21:6. Sales were good. Paul Schweizer wrote, with the introduction of the E version, the 1 - 26 had almost a new lease of life and 200 were built before production ceased in 1980. The total of all 1 - 26 sailplanes sold was 689, more than any other sailplane type in the USA.

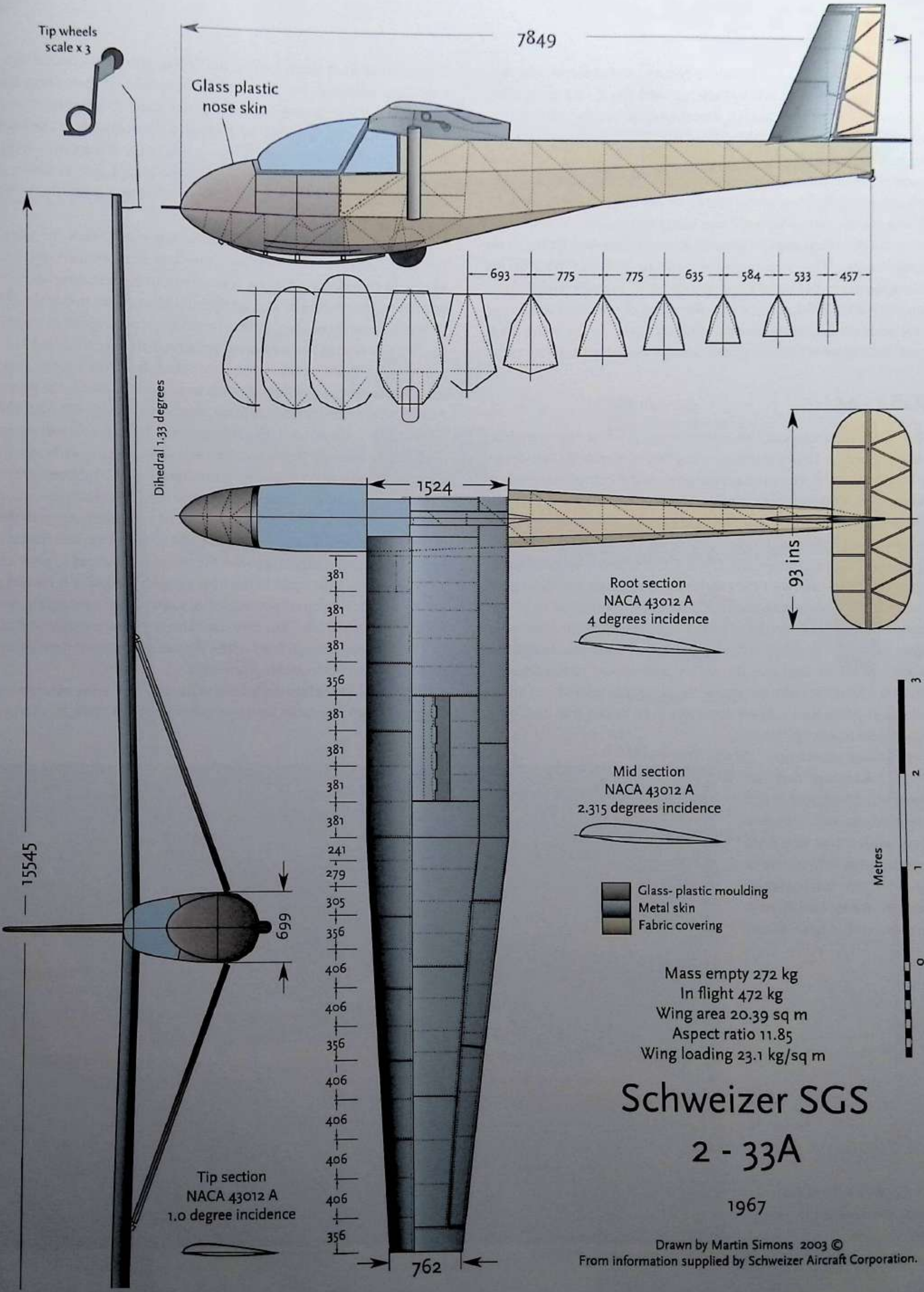
SGS 2 - 33

The mainstay of the glider pilot training programme in the USA before 1965 was the Schweizer SGS 2 - 22, an unpretentious, practical, tandem two-seater with high wings and docile handling, offered at a reasonable price. The total built was 258, some in kit form. The need for a replacement was evident and the new prototype flew in 1965.

The 2- 33 was a direct development of the 2 - 22, with the same layout and many components and other features in common. The wing, braced with a single strut, was increased in span with tapered outer panels instead of the plain rectangular plan and round tips of the earlier type. The wings and ailerons were now entirely metal skinned. Dive brakes opened on both upper and lower surfaces instead of small spoilers. The fuselage was a light steel tube frame very much as before, but deepened to make more room in the cockpits, with GRP nose covering and large blown transparent canopy for the front pilot. The instructor's view from the rear seat was still somewhat restricted by the wing. There was a single landing wheel with front skid and small tail wheel. The tailplane and elevator, steel tube framed and fabric covered, were unchanged. The vertical tail was enlarged, the fin swept back and metal skinned, the rudder fabric covered.

The performance was noticeably better than the 2 - 22. The 2 - 33 soared well in weak lift. Flown solo it could do all that was necessary for a pilot to complete the 'Silver C' badge - a duration flight of five hours, height gain of 1000 metres, and a cross country flight of 50 km, from a normal launch release height.

Production began in 1967 after full type certification, and sales were good. After 85 deliveries the 2 - 33A was produced with an


Tip wheels
scale x 3
Glass plastic
nose skin
7849
693
775
775
635
584
533
457
Dihedral 1.33 degrees
1524
93 ins
Root section
NACA 43012 A
4 degrees incidence
15545
381
381
381
356
381
381
381
381
241
279
305
356
406
406
356
406
406
406
406
356
699
762
Mid section
NACA 43012 A
2.315 degrees incidence
Glass- plastic moulding
Metal skin
Fabric covering
Metres
0
1
2
3
Mass empty 272 kg
In flight 472 kg
Wing area 20.39 sq m
Aspect ratio 11.85
Wing loading 23.1 kg/sq m
Schweizer SGS
2 - 33A
1967
Tip section
NACA 43012 A
1.0 degree incidence
Drawn by Martin Simons 2003 ©
From information supplied by Schweizer Aircraft Corporation.

aerodynamically balanced rudder to reduce control forces, and other small changes. The USAF Academy used the 2 - 33 for gliding courses and the Canadian Air Cadet League bought 55 for their youth programme. A kit was offered and a few of these were sold, but most orders came for the complete aircraft. A total of 579 was reached before production ended in 1984. The lack of orders after this was partly because of the success of the original design. The 2 - 33 was robust, rarely damaged and easily maintained. When something did go wrong, repairs were easy. Hence there was little call for replacements. The soaring movement in the USA had passed through a period of rapid expansion but this rapid growth did not continue after 1980, so very few new clubs or commercial schools were formed to absorb new training air craft. At the same time, good trainers were becoming more readily available from Europe.

SGS 1 - 34

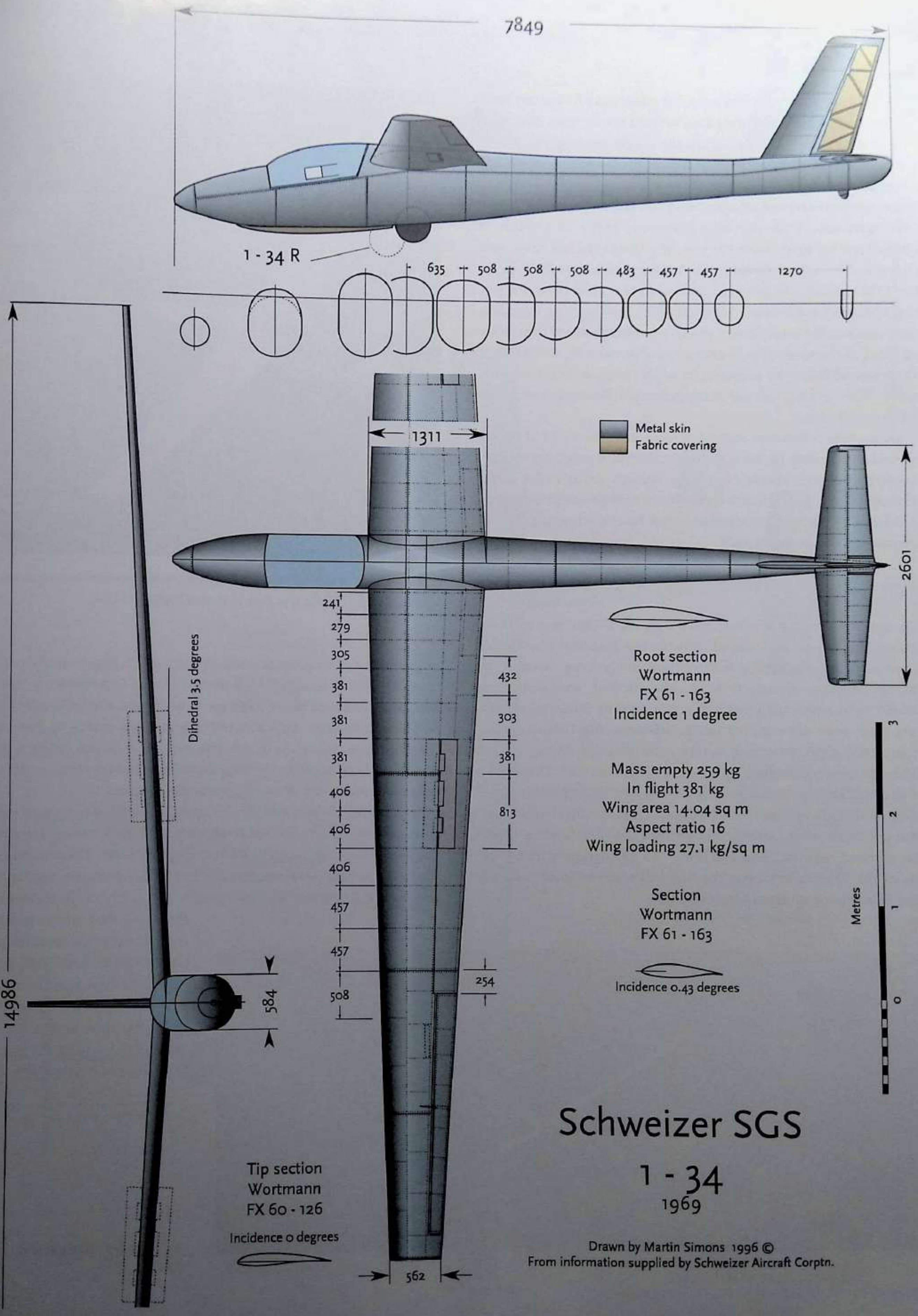
Paul, the most experienced competition pilot of the Schweizer brothers, was in 1965 a member of the OSTIV Standard Class design competition jury. The original purpose of the competition was to encourage the development of good, easily handled and practical club sailplanes. Performance was expected to be good enough for cross- country flying and racing. A World Championship in the Class was held alongside the Open Class contest, approximately every two years. Many of the entries for the design award disqualified themselves because too much had been sacrificed to performance. They might win the soaring Championships but they would never be safely operable in the ordinary club situation. In 1965, at South Cerney in England, the OSTIV award went to the Slingsby Dart 15, a wooden sailplane which the jurors considered met all the criteria. It performed well yet was likely to fit readily into club operations, suitable for pilots of fairly limited experience.

The Schweizers had not previously given very much attention to the Standard Class, which had not been regarded with enthusiasm in the USA. Its international status, however, had by now become very high. When Paul returned from South Cerney, the firm decided to produce a Standard Class sailplane. The Dart had a considerable influence on the design, but the structure, in keeping with the Schweizer tradition, was all metal. Only a few of the more attractive features of the Dart were directly adopted, especially the routing of the control rods at the sides of the cockpit rather than under the pilot's seat, enabling a small fuselage cross section to be used. In all other respects the 1 - 34 was definitely a Schweizer product.

Large dive brakes were fitted, opening above and below the wing. Dive brakes, for the Schweizers and other American designers, became a cause of considerable dismay. It was a requirement written into the Standard Class specification, that 'speed limiting' dive brakes should be fitted. These should be capable of restricting the air speed in a vertical dive to less than the maximum permitted, the so-called 'red line' speed. This was difficult to arrange but the Schweizers went to great lengths to meet the requirement. This involved aero-towing the prototype to a very considerable altitude, then diving vertically with the brakes open to check what speed was reached. In such a dive, airspeed increases to a certain figure but then remains constant. At 'terminal velocity brakes open', there is no more acceleration. The forces are in balance or equilibrium, although of course the altimeter is unwinding very rapidly. The downward force, total weight, is exactly equal to the upward force, air resistance. Since the drag of the wings and fuselage at zero angle to the airflow is small, the brakes are required to produce air resistance almost equal to the total weight. The glider is hanging on the brakes. They must not only be of sufficient area to restrain the velocity to the 'red line', but they must also be strong enough, and attached to strong enough parts of the airframe, to prevent their being torn off entirely with catastrophic results.

When Paul Schweizer visited Germany and saw some of the new Standard Class sailplanes being produced there in 1969, he discov-

SGS 1 - 34 flown by the Schweizer Soaring School operating on the airport at Elmira.



7849
1 - 34 R
635
508
508
508
483
457
457
1270
1311
Metal skin
Fabric covering
2601
14986
Dihedral 3.5 degrees
241
279
305
381
381
381
406
406
406
457
457
508
432
303
381
813
254
584
562
Root section
Wortmann
FX 61 - 163
Incidence 1 degree
Mass empty 259 kg
In flight 381 kg
Wing area 14.04 sq m
Aspect ratio 16
Wing loading 27.1 kg/sq m
Section
Wortmann
FX 61 - 163
Incidence 0.43 degrees
Metres
0
1
2
3
Tip section
Wortmann
FX 60 - 126
Incidence 0 degrees
Schweizer SGS
1 - 34
1969
Drawn by Martin Simons 1996 ©
From information supplied by Schweizer Aircraft Corptn.

ered that European designers were not attempting to comply with the regulation. They performed no vertical diving tests. Nor were they ever asked to do so as part of the OSTIV judging procedure. When the significance of this was realised in the USA, not only the Schweizers but Jack Laister[52], Richard Schreder, Gus Briegleb and others, professional and amateur, who had taken the rule seriously, were infuriated. Over the next few years, partly as a result of protests and lobbying from the USA, the Standard Class rules were changed. New rules, announced in 1969 and coming into force for the 1974 judging, did not produce desirable results, however. Further changes were urgently necessary. The final attempt to resolve the crisis was the introduction of the new Fifteen Metre Unrestricted Class, at the same time reverting to earlier rules for the Standard Class but without the full severity of the original brake requirement. There was a good deal of confusion and frustration in design offices everywhere.

Meanwhile, Schweizers continued to produce the 1 - 34. It proved popular in the role for which it was intended, a good, strong club sailplane, pleasant and safe handling, though not up to the World Championship performance levels. It did have powerful air brakes. A total of 93 was reached, the later ones having retracting wheels. Production was ended in 1979.

The Schweizer 1 - 35 was flown by Wally Scott in the trans-continental Smirnoff Derby, a multi stage race from the West Coast to the East Coast of the USA.

SGS 1 - 35

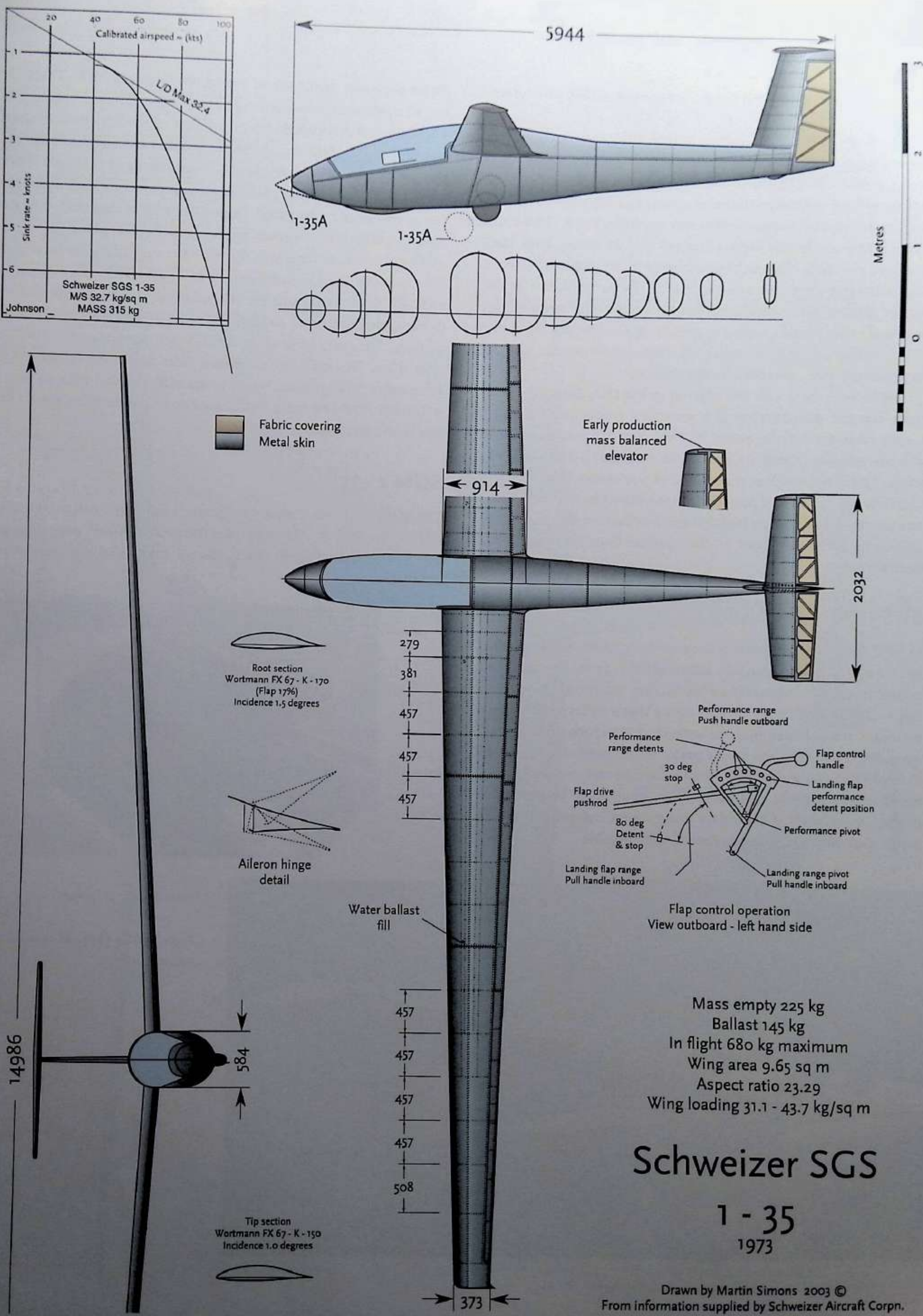
Design of the SGS 1 - 35 was started in 1972. This, as explained above, was just at the critical time for the Standard Class rules. Instead of speed-limiting brakes, flaps of the type favoured by many American designers were now allowed, providing they could be lowered sufficiently to act as landing aids, and providing they were not coupled to the ailerons. The flaps could be used for camber changing during cross country flying but the ailerons could not move up or down together with them. This was a bad rule, as was shown when the Lemke-Schneider LS - 2 arrived in 1974 and won the World Championships (see above). But the Schweizers could not know that the specification would be changed again so soon and the 1 - 35 was designed on the basis of the 1969 rules. It was the first Schweizer sailplane to have no air brakes or spoilers, only the flaps.

An ingenious and successful control mechanism was devised to operate the flaps. A quadrant with detents for the flap operating handle was provided, to allow the flaps to be moved and locked over a range of angles from fully reflexed in high speed glides, to down a few degrees for thermalling. The pilot would be guided in flight by the MacCready 'speed to fly' ring on the variometer, or by an electronic variometer which would give audible signals.

For landing, the flap handle was pulled inwards, disengaging the whole assembly from the restricting stops, and then back to operate the flaps within the range of 30 to 80 degrees down. The advantage was that the flaps could not, during the landing approach, suddenly be returned to the normal flying angle. This could cause accidents since the sudden loss of lift could find the sailplane dropping to the ground. The pilot would still have some control of the drag and the approach angle, by moving the flaps between 80 and 30 degrees, but could not raise them to

52 – See the Laister LP 49, p. 240

SGS 1 - 35 approaching to land



Mass empty 225 kg
Ballast 145 kg
In flight 680 kg maximum
Wing area 9.65 sq m
Aspect ratio 23.29
Wing loading 31.1 - 43.7 kg/sq m

Schweizer SGS 1 - 35

1973

Drawn by Martin Simons 2003 ©
From information supplied by Schweizer Aircraft Corpn.

less than 30 degrees without proper consideration first. The system worked well.

The prototype was flown successfully in 1973 and the process of getting type certification began. Production began at last in 1974 with a good backlog of orders to be filled. But at this stage the CIVV felt compelled to change the rules again. The Standard Class was once again required to have brakes, but not flaps. The 1 - 35 did not comply. The new Fifteen Metre Class had no restrictions, other than the span, but the 1 - 35 had been intended for the Standard Class, a club sailplane, never expected to match the performance of the highly refined and specialised Fifteen Metre GRP competition sailplanes now coming from Europe. As Paul Schweizer (Sr) wrote later, "Schweizer and the other US manufacturers who had designed to the 1969 specification, felt cheated."

Despite this, the 1 - 35 was popular in the USA. Later modifications saw the introduction of a retracting wheel and a slightly longer nose. Production ended in 1982 after 101 had been built. The performance, tested at Caddo Mills, indicated a best glide ratio about 32:1. This was less than some of the earlier GRP Standard Class aircraft, which had been built to the old rules. But the 1 - 35 it was robust and safe, easily handled and maintained, and met all the criteria supposedly required for the Standard Class for which it had been designed.

SGS 1- 36 'Sprite'

In 1977 Schweizers recorded the sale of their 2000th sailplane since the Company began. The SGS 1-26 had been by far the most successful in terms of sales. When production finally ended with the last 1 - 26E in 1979, it seemed necessary that a replacement should be found. It was hoped that the same kind of success would follow. A simple, cheap sailplane with a performance good enough for the FAI gold and diamond badges might become very popular and kit building was always a possibility. There might even be a new 'one design' Association. Preliminary design work indicated that a 14 metre span sailplane of reasonable cost was feasible.

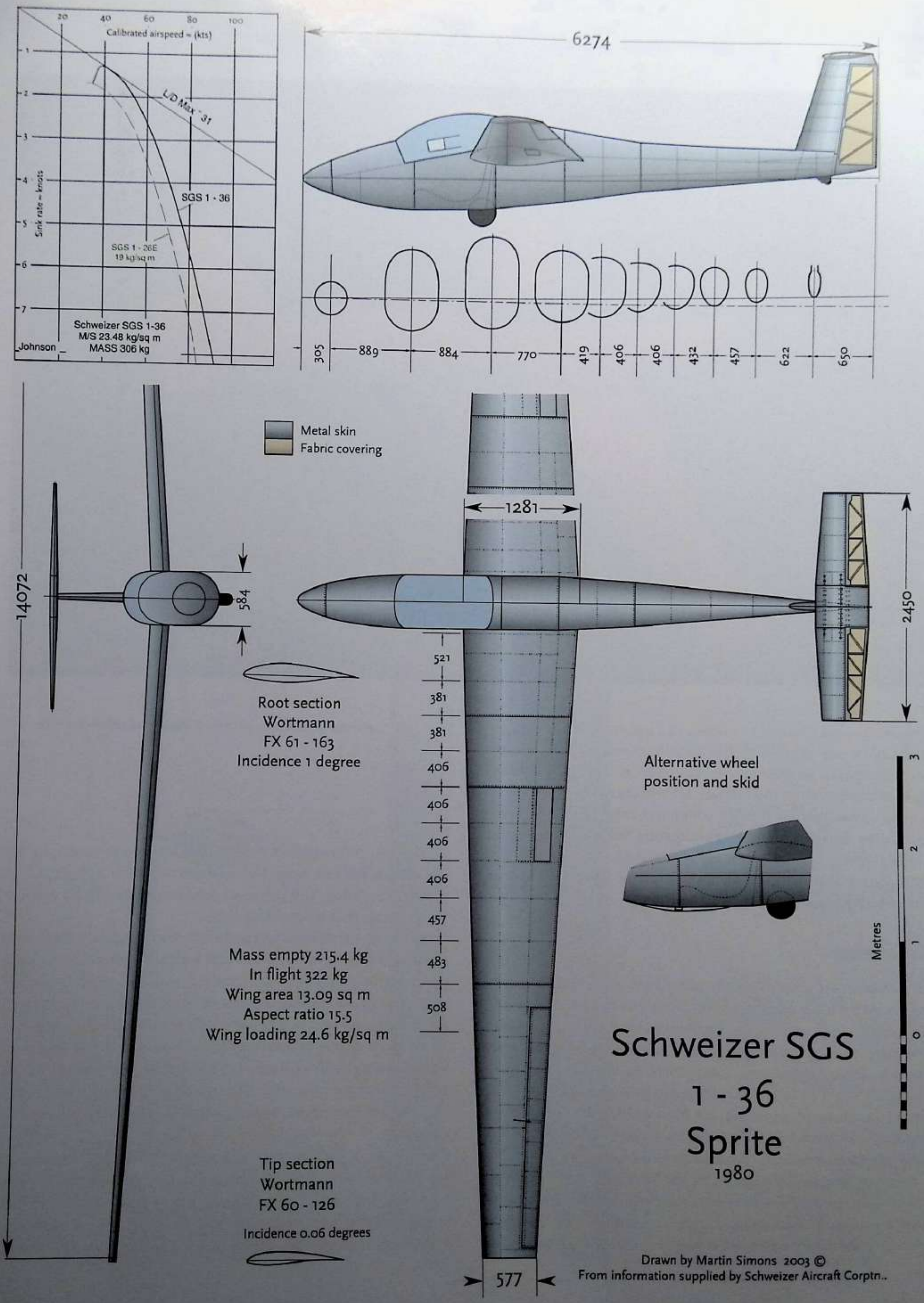
A prototype was finalised and production began in 1979. The 1- 36 was all metal except for the fabric covered elevator and rudder. The T tail layout was adopted at the insistence of the Schweizer dealers, who saw it as a stylistic requirement, rather than because the designers though it necessary. It added something to the costs. A kit, which would have many prefabricated elements for easy assembly was prepared and advertised. Orders came in as expected to begin with, but difficulties began to appear. The USA was going through a difficult economic time with interest rates very high. For buyers to borrow money and pay off loans at 15 or even 20% was extremely difficult. At the same time the US dollar was standing high relative to European currencies, so imported sailplanes were relatively inexpensive. The costs of product liability insurance rose. In 1982, a year when 96 European sailplanes were imported to the USA, Schweizers sold only six. It was reluctantly decided that no more sailplanes would be built. Production ended when 43 of the 1 - 36 had been completed.

SGM 2 - 37

The SGM 2- 37 was a motor sailplane, based on the fuselage and tail of the SGS 2 - 32 high performance two-seat sailplane of 1962, with the wings of the 1 - 36 on a new rectangular centre

Above: SGS 1 - 36 cockpit

Below: SGS 1 – 36 tied down on the Elmira airport


20
40
60
80
100
Calibrated airspeed – (kts)
1
2
3
4
5
6
7
Sink rate – knots
L/D Max – 31
SGS 1 - 36
SGS 1 - 26E
19 kg/sq m
Schweizer SGS 1-36
M/S 23.48 kg/sq m
MASS 306 kg
Johnson
6274
305
889
884
770
419
406
406
432
457
622
650
Metal skin
Fabric covering
1281
14072
584
2450
521
381
381
406
406
406
406
457
483
508
577
Root section
Wortmann
FX 61 - 163
Incidence 1 degree
Alternative wheel
position and skid
Mass empty 215.4 kg
In flight 322 kg
Wing area 13.09 sq m
Aspect ratio 15.5
Wing loading 24.6 kg/sq m
Tip section
Wortmann
FX 60 - 126
Incidence 0.06 degrees
Metres
0
1
2
3
Schweizer SGS
1 - 36
Sprite
1980
Drawn by Martin Simons 2003 ©
From information supplied by Schweizer Aircraft Corptn..

The SGM 2-37M motor sailplane, after which the Schweizers ceased sailplane production

section. The span was 18.13 metres. The motor was a Lycoming 0-235-L2C. It was adopted by the Air Force Academy, who bought eight to operate at their base in Colorado, at a height above sea level of 5000 ft. From this aircraft, Schweizers went on to develop a quiet surveillance aeroplane which was used by the US Coastguards for interdiction of drug smuggling boats off the coast of Florida. It was further developed into the SA 2-37A, which was 19.5 metres span and full of electronic and other surveillance equipment for military and policing duties.

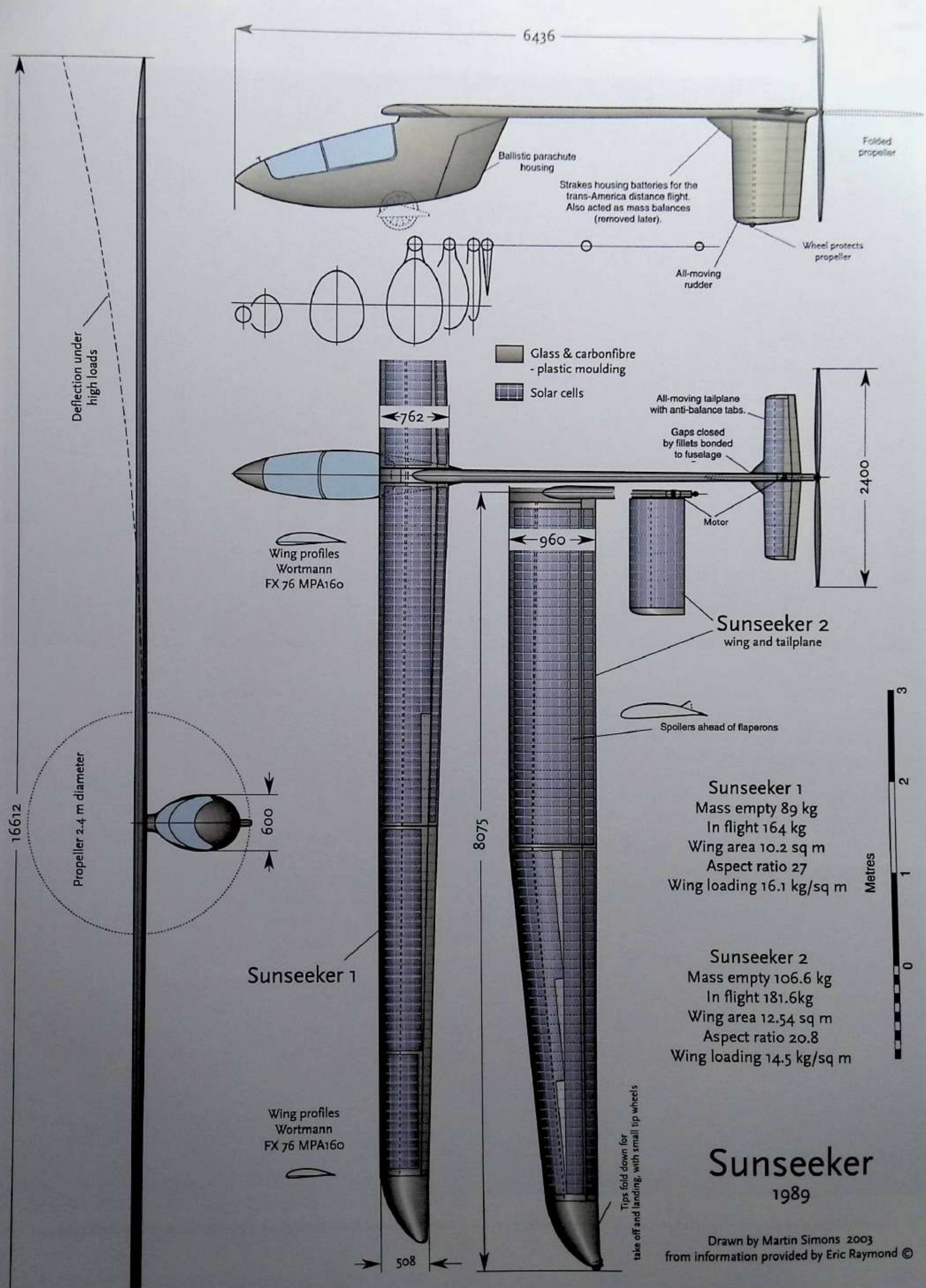
Sunseeker

All sailplanes are powered by the sun, which is responsible on the large scale for the planetary weather, atmospheric temperature gradients and winds, and, on the small scale, for thermals. It seems a small step, intellectually, to imagine a sailplane that can use solar power to drive a motor and launch itself. To make the same step practically is not so easy. The MacCready Solar Challenger of 1982 was a solar-powered aeroplane, not intended for soaring with the motor off. Eric Raymond's Sunseeker was to be a soaring aircraft capable of taking off with its own solar powered motor.

Raymond was greatly inspired by the Musculair II, the muscle-powered aircraft designed by Gunther Rochelt that won the Kramer prize for speed round a pylon course. This flew in 1985 and Raymond was able to fly it himself. It had a cantilever wing stressed to 3g, weighed 24 kg and required only 250 watts to fly at an airspeed of 56 km/h. Rochelt developed methods of building a light, sandwich-skinned wing. This preserved good enough profile accuracy to use a laminar flow Wortmann profile.

Following the lessons learned from the Musculair, Raymond calculated that with 800 watts and a structure mass of 50 kg, a self-launching sailplane was feasible. It would need to have a best glide ratio of 30:1, a very low rate of sink, and should be stressed for a maximum airspeed of 160 km/h or 100 km/h in rough air. The highest degree of aerodynamic refinement would be necessary, low drag profiles, a streamlined and fully enclosed cockpit and minimal parasitic drag. The power must be sufficient to enable take off from short, unpaved airstrips, carrying a pilot with a parachute.

Sunseeker 1, with span of 17.5 metres and aspect ratio 28 was built and flown in 1989. The wing was in four sections. The first tests were done with it as a sailplane with a 74 kg pilot. After this, powered flights were made with two battery-driven motors of the type used in model aeroplanes, driving a propeller at 600 rpm



Sunseeker

1989

Drawn by Martin Simons 2003
from information provided by Eric Raymond ©

Sunseeker in its element: bright sunlight and air

through a reduction gearing. Power required for take off was between 1600 and 1880 watts.

The photo-voltaic array and motor was then installed, the entire wing and tailplane being covered with solar cells. These were of the thin-film, amorphous type on a polymer substrate. Their efficiency was inherently very low but they were light, conformed easily to the aerofoil section, and were weather resistant. The motor was a 2 kg,

The Sunseeker wing and tailplane totally covered with photo-voltaic solar cells

frameless, three-phase motor with cooling vanes, with a reduction belt drive to the propeller in the extreme tail. The empty mass increased to 89 kg and the glide ratio reduced to about 25 - 30:1. Batteries, charged from the solar panels were still needed. With power 2.2 kw, take off and slow climb was possible, level flight required 1.3 - 1.7 kw. With the motor off and the propeller folded, soaring was possible in light thermals.

Further work and refinement continued over several years. A series of flights across the USA was accomplished to demonstrate the aircraft and its success. Sunseeker 2 had new wings of greater area and smaller aspect ratio. 1152 cells were used, yielding a nominal 144V. The output was up to 1800 watts, more than enough for sustained level flight. Take off and climb still relied on nickel cadmium batteries carried in the wings. Replacement of these with Lithium batteries and a larger motor is seen as the next step, and more efficient solar cells are expected.

Raymond anticipates that it will be possible soon to take off under an overcast sky and climb under power through the clouds, to reach a region of constant sunlight and remain airborne indefinitely.

Woodstock

Jim Maupin, a schoolteacher in Los Angles, in his spare time had been working for the DSK company, producing kits for the BJ - 1B Duster homebuilt sailplane (see above). As interest in the kits began to wane he decided to design his own sailplane with the primary aim of getting it into the air at the minimum possible cost. This implied some sacrifice of performance but this was of little concern. At an early stage he approached the aerodynamicist Irv Culver, who produced the wing design, using his own profiles, and advised on all the aerodynamic aspects. Maupin called in further help with detailed planning and drawings. Barry McGarraugh spent most of the summer of 1978 with a drawing board in Maupin's garage, and he made the metal parts and fittings.

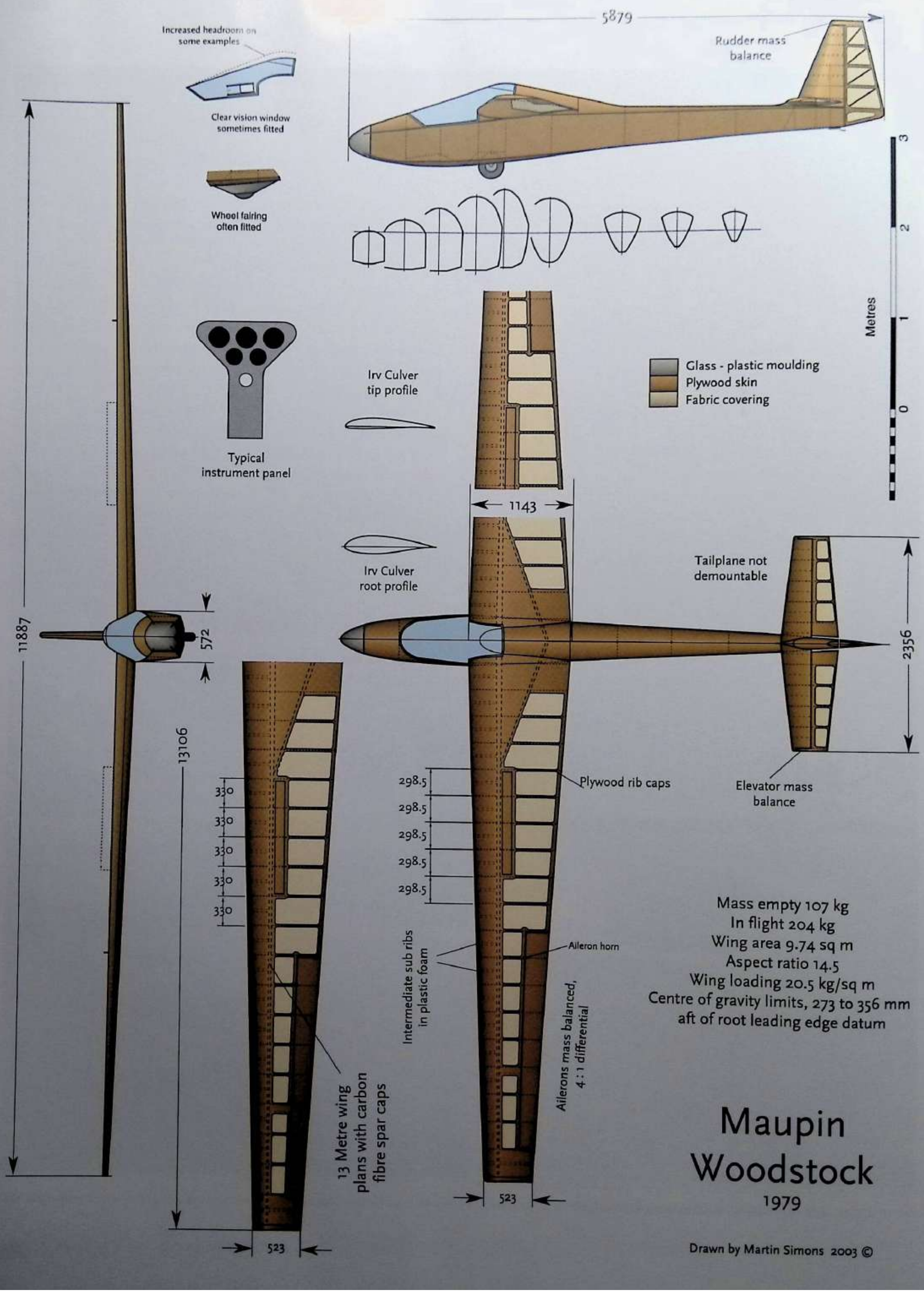
The general layout of the Woodstock resembled that of the Duster, but the span was smaller and the aspect ratio lower, with a simple tapered wing in two sections, joining in the centre. The main spar was of the box type near the wing root, changing to a [section towards the tips. Douglas Fir was used for the spar flanges, being cheaper and stronger than spruce, though somewhat heavier. The leading edge was skinned with plywood to provide torsional stiffness. Birch instead of the more costly mahogany ply was specified. The wing ribs were sawn from marine plywood, with intermediate foam plastic ribs in the leading edge to give additional support to the skin. The fuselage was very simple, covered entirely with plywood and changing aft of the wing to an oblate triangular cross section which gave extra stiffness and less weight, compared with a four sided box. All metal fittings were made from aircraft quality materials, expensive but worthwhile in terms of guaranteed security and strength.

The wing of the prototype, when completed, was proof loaded. Bags of sand were distributed on the wing to simulate the maximum air loads. There was no sign of failure.

In flight the Woodstock achieved all that had been expected. It was light, turned tightly and climbed well in weak thermals, and in the glide was slightly better than the Schweizer 1 - 26. Plans were offered and the DSK Company marketed kits as they had for the Duster. A thirteen metre version was also made available, with a spruce spar replacing the Douglas Fir, for pilots who sought a slightly better performance.

In 1984 the Woodstock won a design award from the Sailplane Homebuilders Association. Maupin continued advertising his plans until 1987. More than 350 sets of drawing were sold and some kits were made available, as for the Duster, through the DSK Company. As usual with homebuilding, comparatively few actual sailplanes were completed. In 2002 twenty-three Woodstocks, including one recently completed in Australia, and one in Brazil, were known to be still registered.

This Woodstock was built in Australia by James Garay with a slightly enlarged canopy. It is now flown at Vintage Glider Rallies.



Mass empty 107 kg
In flight 204 kg
Wing area 9.74 sq m
Aspect ratio 14.5
Wing loading 20.5 kg/sq m
Centre of gravity limits, 273 to 356 mm aft of root leading edge datum

Maupin Woodstock

1979

Drawn by Martin Simons 2003 ©

APPENDICES

How a High-Performance Sailplane is Manufactured

THE ARTICLE BELOW WAS WRITTEN BY FRIEDEL WEBER OF DG FLUGZEUGBAU AND IS REPRODUCED WITH HIS PERMISSION (PHOTOS DG FLUGZEUGBAU)

Wing Construction

A wing is built from the outside in. For that we use four large moulds per sailplane, the right and left wing upper surfaces and lower surfaces. When a new wing is started the work of the lacquerer begins at 6 AM, when, after a release agent is applied, the first of four UP gelcoats is sprayed in, not too thinly. This, the first thing into the mould, later becomes the outermost layer. Unfortunately we have to use polyester lacquer, because a PU lacquer, while it would better combine with the epoxy applied later, would also form droplets on the release agent just like the water in a car wash.

At 7 AM, when the wing workers arrive, the lacquer is partly dried and quite tacky. Epoxy is then rolled onto this surface and a thin fibre glass layer applied and pressed into the epoxy. The main function of this thin layer is to prevent the structure of the following layers showing through the wing surface. Some manufacturers used to skip this part of the process, but after a few years a fine diamond shaped structure becomes visible. That we do not want. After rolling, the thin fibreglass layer becomes almost invisible because it is saturated with epoxy. The bond between lacquer and fibres is "wet on wet" so that the lacquer can never peel off. At worst you could get hairline cracks due to rapid and extreme temperature changes during wave flying.

Next a layer of carbon fibre fabric is put in, which accounts for most of the strength of the wing surface. The direction of the car-

Stored wings awaiting rough edges to be cleaned up, before assembling with fuselages

Upper and lower wing skins lying side by side in their moulds.

Before upper and lower skins are joined, control rods, ballast tanks, etc. have to be built in

bon fibre is diagonal for greater torsional strength. This fabric is very expensive and requires a heavy use of epoxy, about 250 grams per square meter. A wing of 11 sq m contains about 46 sq m. carbon fibre at Eu 35.00 per sq m. In addition we need 11.5 kg of epoxy. The material alone costs about Eu 1,800.00. PVC foam about 6 mm thickness, carefully cut and shaped in plates, is next put on the wet outer layer of the carbon fibre fabric. The foam forms the filling of the sandwich construction and is carefully prepared, tapered towards the rear, with cut-outs for the dive brake boxes etc. The foam is perforated with a needle roller to better absorb the epoxy. This prevents delamination.

A bed is machined for the spar cap The spar caps, which must be able to absorb the extremely high tension and compression forces due to the bending of the wings, have been pre-manufactured with the help of a small tooling machine from hundreds of carbon fibre rovings in a special mould. The quality requirement for the spars is very, very high. A single air bubble can condemn a spar cap. To make sure that it is not inadvertently used again, the quality controller takes his diamond saw and cuts it in half. A lot of labor and material has gone to waste, but fortunately this is a rare occurrence. The foam core is then fixed, the spar cap put on it, and the inner carbon fibre fabric is laid in, - again diagonally, so that after curing a stable, pressure resistant sandwich is formed. This is followed by a layer of peel ply with a perforated foil pre-epoxied together with the inner carbon fibre fabric. Foil and peel ply are throw-away parts which are later removed, giving the inner wing surface a rough surface, which makes the glue for the inner parts adhere better. Now an absorbent cloth is applied to soak up any extra epoxy and to make the removal of air easier. A plastic foil is taped to the mould to cover everything. A few plastic pipe stubs are put in and sealed with Plastilin (playdough). These are used to suck out the air so that the vacuum forces the entire construction evenly against the mould. At the same time the mould is heated with water so that the wing can cure overnight.

It is now time to go home. Breakfast and lunch breaks on these days are not dictated by the clock, but must wait until certain processes are complete. There can be no interruption of the process.

Moulds for wings and fuselages in the new DG factory at Bruchsal

After moulding there is still a lot of work to do. Finishing the surfaces and fitting canopies requires hours of sanding by hand.

When I was "new" I had an interesting experience: I watched a foreman cut the previously mentioned carbon fibre fabric off a roll apparently without a pattern or tape measure. He then put it into the mould, where it protruded considerably over the edges. This struck me as irregular, using guesswork as a measurement. I was about to go over to ask him to be more careful with material that costs Eu 35.00 per square meter, when he took a roller and began to press the material into the mould. This caused the protruding material to shrink progressively towards the middle, especially in the nose. The protruding material disappeared one centimeter at time. I was astonished to see that about 10 minutes later the protruding excess had just about disappeared, leaving only about 2 cm of excess material. I went up to him and said: "Unbelievable, how you worked the material. Ten minutes ago I was going to reprimand you for wasting expensive material, but now it fits properly." He said: "Mr. Weber, I have been doing this for 25 years."

The next morning the absorbent cloth and the perforated foil are removed. The fittings for the wing tip extensions, if ordered, are built in. The two spar caps per wing half are stiffened by a shear web, which is similar to the double-T-bars used in steel construction. The finished spar extends from the wing tip to the wing root and into the inner spar end - in a 18 m wing about 9.30 m long altogether. The web is quite massive, so it can withstand the shear forces. At the main pin, for instance, the bushings into which the main pin is inserted must withstand forces up to 14.5 tons!

The finished shear web is put into the upper wing shell and epoxied to the spar cap. For wings with tip extensions, the receptacle for the outer spar is set in. The spar cap of course ends at the parting. There is an extra spar for the wing tip itself.

As mentioned before, we manufacture the spar caps separately and glue them into a 3 mm deep cut out in the foam core. There is another method. You can lay the rovings for the spar cap "wet-on-wet" on the outer layer, and you will get a spar about 6 mm deeper than we do. Because of the greater depth, material can be saved, because a deeper spar has a static advantage in bending. In very thin profiles, such as the DG-600, one cannot achieve the required stiffness otherwise. This method is also less expensive. The disadvantage is that after a few months the outline of the spar becomes visible on the upper wing surface. Take a look at various sailplane types, and in some cases you will be able to see the spar outline on the wing surface. That is why we opted for the more expensive but better method of gluing the spar cap into the foam core and fixing it with the inner fabric.

Now we begin with the installation of the controls by gluing in the bases for the control rods and support links. Measure, mark and glue - not like that, we don't! All installations are placed exactly by jigs which are fixed with guide pins to the mould. Other small fittings such as root ribs, receptacles for the rudder hinges etc. are also glued in. Our single seaters have about 250 different small parts of glass fibre or carbon fibre and for each one there is a drawing and a special mould.

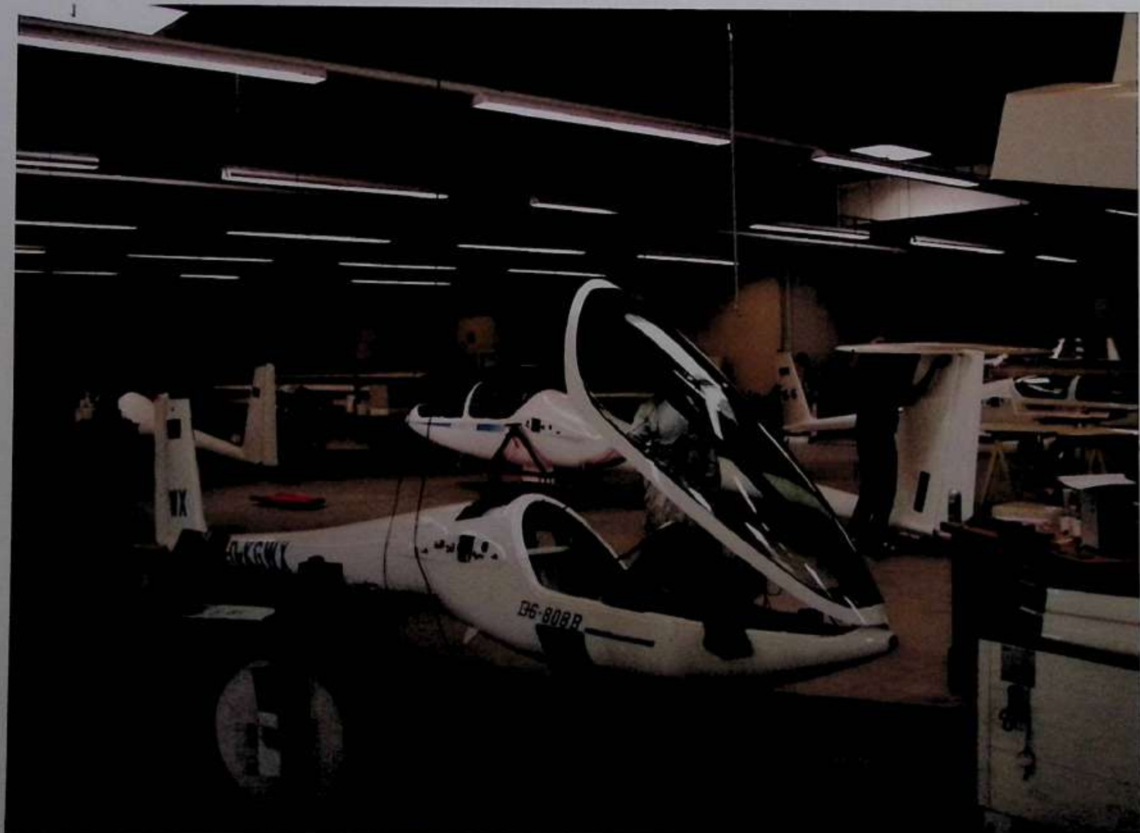
After curing, in the morning of the third day the control rods are installed. These installations take about two days. In the morning of the fourth day the preparations are made for gluing the wing halves together. This is a very critical step. During operation the bonding areas carry high loads, but after closing the wing they become inaccessible forever. Therefore these "blind bonds", as they are called, must be carefully prepared and executed with great precision. To achieve this, we developed a simple but very reliable procedure: Small strips of Plastilin are applied to all areas where the upper and lower wing halves will come in contact. These are special areas on the leading and trailing edge, the spars and ribs. Adhesive tape protects the bonding surfaces from grease contamination by the play dough. When the upper and lower moulds are put together, the play dough is compressed and reflects a very accurate image of the bonding gap. A similar technique is used for the spars: A series of cloth pins are inserted into the foam of the shear web. These pins are then pushed in when the moulds are closed, providing an accurate measure of the bonding gap. After re-seperating the moulds, our quality controller inspects the visualized thickness of the bonding gap, which has to stay within very tight tolerances to guarantee a long-term reliable bonding. Before permanently closing the wing, the quality controller checks all elements which will become inaccessible. Each individual nut of the control linkage is verified, secured, marked and signed off on a detailed checklist.

Our workers call the glue to close the wing "Mumpe". It is a mixture of epoxy resin and cotton flakes, which gives it a consistency like pastry dough. After all bonding areas have been thoroughly cleaned and roughed, the mumpe is applied with a squeeze bag, similar to a cake icer. The thickness of the mumpe layer reflects exactly the gap height as previously measured with the play dough or cloth pins, plus an additional two millimeters. The long experience of our workers shows in the art they create, with squeeze bag and wooden spatulas, of optimally trapezoid-shaped mumpe layers. The right area, exact thickness and correct processing of the bonding layer is crucial for long-term reliability. Any attempt to save weight or cost here would compromise reliability and safety. The lower wing half is put onto the upper half, adjusted exactly to the guide pins, and then compressed with many vice clamps. Both halves must fit exactly in all places, or the profile will not be correct. The force of the vice clamps squeezes the excess epoxy mixture out between the wing halves.

The glued wing is tempered overnight at 35 degrees Celsius. The next morning the wing is taken out of the mould, often with a loud crack, using a crane. In the sanding room the excess epoxy is removed. After the moulds have been cleaned and waxed, the whole process starts over again.

The Fuselage

The construction of the fuselage is roughly similar to the wing. The foam sandwich method is not used, except for the carbon fibre fabric. To achieve optimal pilot safety in a potential crash, in the DG - 808B two layers of Kevlar are used between the carbon layers. This material is difficult to work with but does not splinter into sharp edges like carbon fibre. In addition the reinforcements for the safety cockpit are glued in. Fuselage construction is faster than wing construction. But the many installations of small fit-



The final assembly department. Hundreds of parts, metres of cable, instruments and more are built in here.

Large rotating frames help with turning fuselages over.

Eu 40.00 per hour, and it takes a lot of training and experience before a worker can get good results at this level. If no polyurethane painting is wanted, the glider does not receive a complete spraying with paint. Only the glue joints, certain areas like fuselage and wing fairings and the canopy frame, need filling and spraying. After that it's sanding, sanding, sanding, by hand! All attempts to introduce machines for this work have produced very unsatisfactory results. Large rotary sanders could be used, but who wants to see the resulting circular patterns on his wings? We use wet sanding paper with decreasing grit. Some manufacturers stop at 600 grit, we keep going to 800 and 1000 and much water. The people in the finish section work in rubber boots. Drainage channels are built into the floor. It's a tough job, but the end result produces much satisfaction.

tings is quite complicated. Seat pan, landing gear, engine bay walls, bulkheads, lift pin tubes, ribs and shear webs in the fin, pitot and static ports with hoses, antenna, control system - all have to be installed and tested before the fuselage halves are glued together.

First Assembly

In the next stage the preliminary assembly takes place. The leading and trailing edges of the wings are trimmed, the control surfaces (flaperons) are cut out and fitted and the spar ends receive their outside glassfibre layers. The wings are put on the drilling jig so that the exact V shape for the drilling of the holes for the main pin bushings can be ascertained. The complete controls are installed in the fuselage, the canopy frame epoxied, the canopy glued on and the canopy locks installed. The tailplane and rudder are fitted, the engine doors installed, the wiring set installed, etc. The sailplane is assembled for the first time, all controls are adjusted and a quality control inspection takes place. Now the rough assembly is completed. Three workers take one week per sailplane.

Finish

Next is the finishing, and here one can either invest a lot of work or keep things quite simple, depending on what quality is desired. We calculate that a good finish takes about 240 hours of work at

Final Assembly

The new Final Assembly Hall At this stage there should not be any more epoxy work. We don't want to mar the finish with epoxy stained hands. The cockpit installations will be done including the many electric connections for the instruments and the automatic engine control. The complete motor unit, pre assembled in another workshop and test run on the test stand, is installed. The engine is tested after installation, carburettor adjustments, weight and balance are checked. The wings are assembled and the seals for the flaperons put in. All the required Mylar seals are taped on. Installation of the instruments, as ordered by the customer, sometimes causes unexpected problems.

If everything works properly the final inspection by the quality controller takes place. This takes about 8 hours. The telephone is switched off and no disturbance is tolerated. All the assemblies on the test list are checked, and all functions that can be checked on the ground are performed.

Test Flight

Finally the sailplane must demonstrate in test flight that everything works properly. A pre-determined program is flown and every phase checked off on the list, and the appropriate values noted. Sometimes certain adjustments have to be made and re-tested. Then the sailplane is really FINISHED. Of course we still need certification and licensing by the airworthiness authorities. So the customer can't fly the finished sailplane for a few days.

Translated by Albin Schreiter, Edited by Martin Simons

The Internet

Extensive use of the Internet has been made in preparing this volume. Most of the surviving sailplane manufacturers and their agents have web pages which can be found easily by searching the Internet with a browser. This is often an excellent way of making direct contact with persons responsible for the aircraft, individual pilots or other experts.

In addition there are many other web pages, often established by gliding and soaring associations, magazine publishers, and other interested groups or enthusiastic individuals such as model makers who have made many valuable contributions in this area. Scale model enthusiasts are sometimes a better source of accurate information than the manufacturers themselves who are, presumably, busy building the aircraft rather than designing web pages.

Unfortunately, not all the information published on the net can be relied on totally. Mistakes are made, web pages become out of date and are not regularly serviced. Occasionally items seem to be totally fabricated. A little caution and cross-checking is always advisable.

The drawings

Drawings in this volume have been prepared using Adobe Illustrator Version 8, on a Macintosh G - 4 computer. With a few exceptions the scale is 1:50. The exceptions are those sailplanes with wing spans too large to fit into one page, and a few small sketch plans included for their interest but without full details.

Acknowledgments

As before, many people have helped with information and criticism. They are listed below and on the drawings. The author and publisher are profoundly grateful.

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The Author

Martin Simons has been involved in gliding for more than fifty years. With the Gold C badge and two diamonds (missed the height badge by a few hundred feet), he has flown about one hundred different types of sailplane, including thirty two of those described in this volume, in ten different countries.

English by birth he lives in Adelaide, South Australia, with dual citizenship. In addition to the previous two volumes 'Sailplanes', (1920 – 1945, & 1945 – 1965) his earlier books include 'Slingsby Sailplanes', on the British glider manufacturing company, and he collaborated with Paul Schweizer to produce 'Sailplanes by Schweizer', about the leading American manufacturer. He is also a keen model sailplane designer, builder and flier. He wrote 'Model Aircraft Aerodynamics', the only work of its kind in the English language, now in its fourth edition, and a number of other books and a great many articles, not all of them about aviation.

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INDEX OF NAMES

ERRATA AND NOTES RELATING TO THE FIRST TWO VOLUMES

Vol. 1 (First printing)

Weltensegler

The Photograph on Page 13 is not the Weltensegler in the form it was flown, and crashed, by Leusch.

Several tailless sailplanes were built by the Weltensegler firm. This photograph (and others) probably shows an earlier Weltensegler aircaft. The 'Feldberg', 16 metres span, was flown by Peshkces near Baden in 1920. This is briefly described with photographs in the book by Werner von Langsdorff (1923, see bibliography). It was evidently brought to the Wasserkuppe in 1921 but not flown. The picture shows a rudimentary horizontal tailplane. The aircraft flown by Leusch was a new design completed just before the fatal flight.

Another tailless Weltensegler, named 'Baden - Baden - Stolz' , was briefly test flown by Fritz Stamer at the Wasserkuppe in 1922. It had 15 metres span, the pilot housed in a nacelle with shoulder wing mounting.

Peyret Tandem

The Pelzner Tandem struts in the drawing on Page 23 are shown larger in chord than the photographs indicate. It seems the intended streamlined struts shown on the constructors drawings were replaced by round tubes.

Wien

The Wien wing was built in two sections, not three as stated on page 62. See also the reference to the Wien wing on Page 187.

Minimoa

Studies of theSchempp-Hirth Minimoa original workshop plans suggest that the wing root profile differs from that stated in German references, Göttingen 681. Comparison of the true Gö 681 plotted from ordinates shows that the profile was probably thinned down from 16.8% to 15%, while retaining the identical camber. A further very slight modification apparently introduced slight undercamber perceptible on the completed aircraft. Such alterations to profiles were commonplace at the time the Minimoa was designed. The same applies to several other sailplane types of the period.

Darmstadt D - 30

The span given on the drawing is wrong. It should be 20000 mm

Vol. 2

Ross R - 3

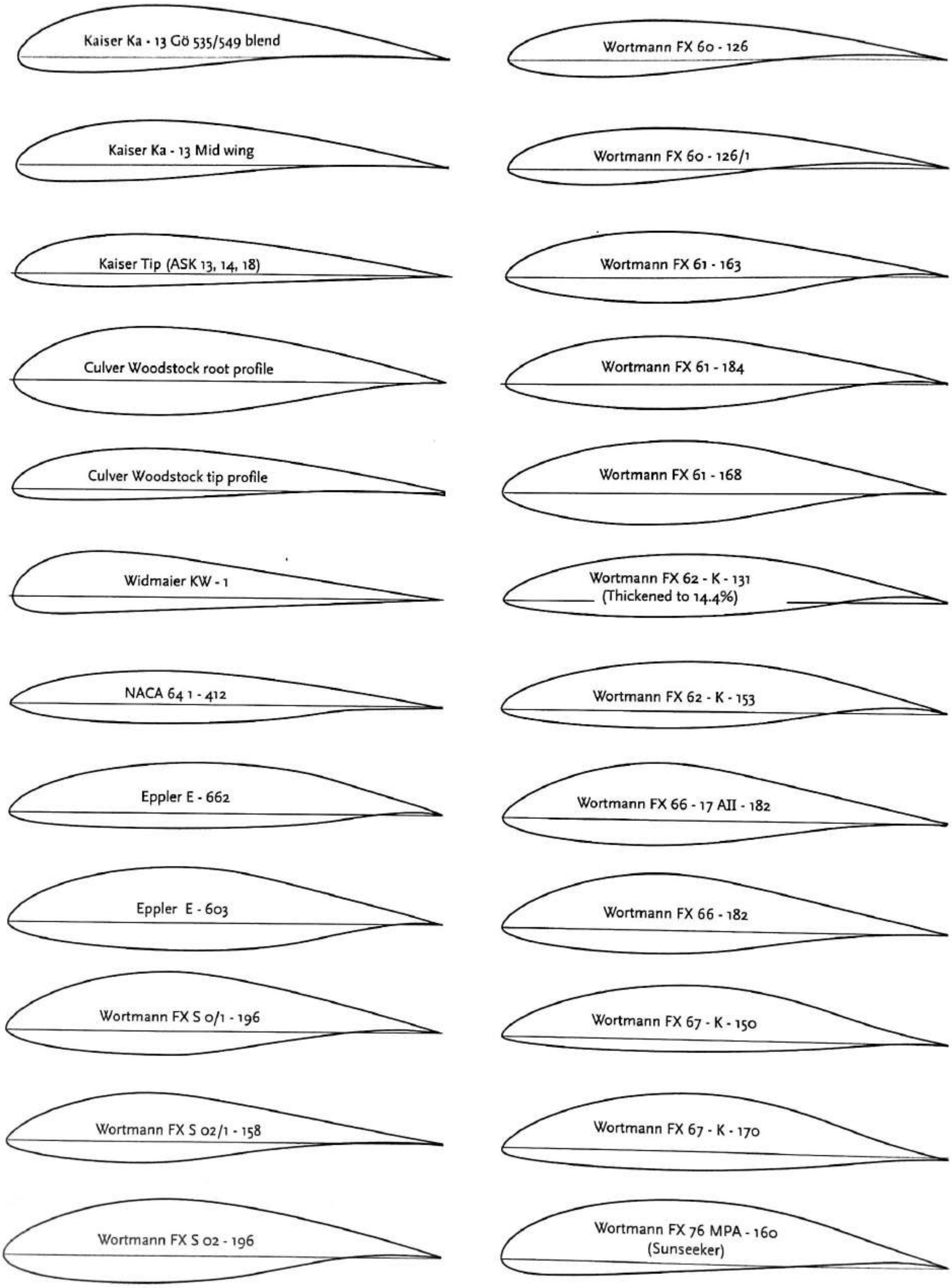
Page 144.
Two examples of the Ross R - 3 were built in Australia. Both were destroyed fairly soon after completion in fatal accidents. One span in during an otherwise apparently normal flight, Killing the owner, Dr G A M Haydon. The other was involved in a flutter incident which resulted in loss of control. The Gliding Federation of Australia thereafter withdrew all permits to fly for the type.

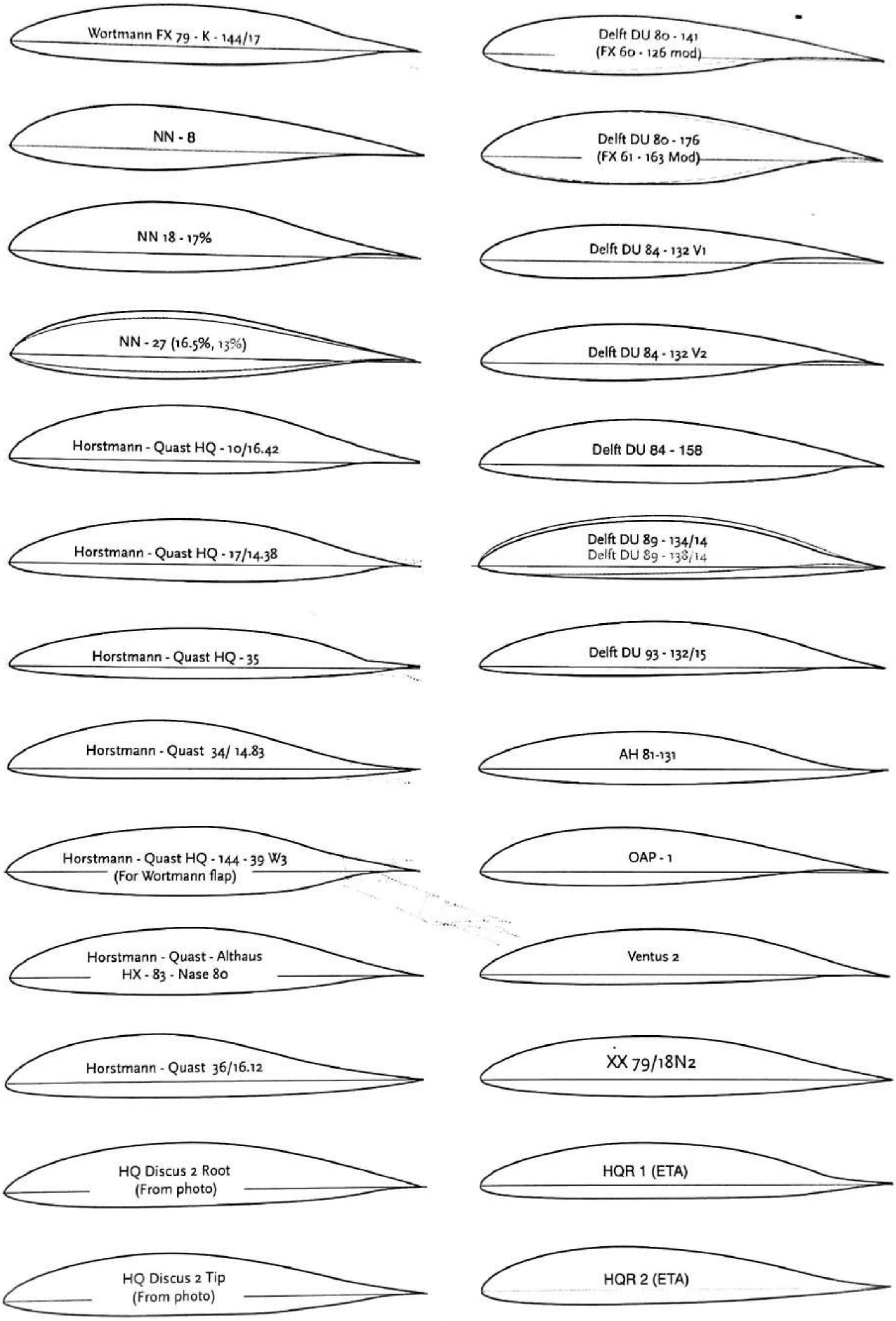
Ka - 6E

The drawing of the Ka 6E (p 171) shows the wrong wingspan. It should be 15000 mm.

Wing profiles
1965 - 2000

(Profiles shown in the previous volume , Sailplanes 1945 - 65, are not all reproduced here




Wortmann FX 79 - K - 144/17
Delft DU 80 - 141 (FX 60 - 126 mod)
NN - 8
Delft DU 80 - 176 (FX 61 - 163 Mod)
NN 18 - 17%
Delft DU 84 - 132 V1
NN - 27 (16.5%, 13%)
Delft DU 84 - 132 V2
Horstmann - Quast HQ - 10/16.42
Delft DU 84 - 158
Horstmann - Quast HQ - 17/14.38
Delft DU 89 - 134/14
Delft DU 89 - 138/14
Horstmann - Quast HQ - 35
Delft DU 93 - 132/15
Horstmann - Quast 34/ 14.83
AH 81-131
Horstmann - Quast HQ - 144 - 39 W3 (For Wortmann flap)
OAP - 1
Horstmann - Quast - Althaus HX - 83 - Nase 80
Ventus 2
Horstmann - Quast 36/16.12
XX 79/18N2
HQ Discus 2 Root (From photo)
HQR 1 (ETA)
HQ Discus 2 Tip (From photo)
HQR 2 (ETA)

The third of the series, 'Sailplanes' brings the story to the end of the 20th Century. Plastic structures became orthodox. Glass was supplemented with carbon and aramid fibres as reinforcing materials. The improved strength and accuracy of structures allowed advantage to be taken of new wing profiles. Retracting motors became more acceptable.

Pilots, modellers and aviation enthusiasts will find descriptions, pictures and excellent scale drawings showing most successfully designs, and some not so successful such as tailless and variable geometry sailplanes, and some less expensive from the flourishing homebuilding scene in the USA and Australia.

Champion pilots have showed how the new aircraft should be exploited. Records for distance and speeds around closed circuits were broken time and again by some of these outstanding sailplanes. Many of them are still available and it is useful to have this background information.

A glimpse of the future?

One example of a true solar-powered, self-launching sailplane is shown on this back cover. A fuller description is within.

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