

imagine

Looks like an ASW22, but the "eta-biter" is much more: highly modified, it was proof of concept, testbed and ultimate motivation to launch the Concordia project



Concordia a new supersailplane

A Transatlantik Pact to create the ultimate soaring machine

by Wolf D. Herold

Glide ratios of 75, or even 80, are not pie in the sky anymore, claims a team of pilots and aeronautical experts formed by Dick Butler. With the Concordia they intend to prove it.

What a day! the next to last one at the WGC 2008 in Luesse, Germany. At the morning briefing we've found on our task sheets a 568km multi-lateral AST around Berlin. "Gotta really move.." we're all thinking—not just because of the points, but also because of an approaching line of thunderstorms that couldn't care less about the exaggerated optimism of the met-man. And move we do, until—east of the River Oder, deep in Polish territory—we fall into the largest blue hole that I have ever encountered. At a snail's pace—and altitude—I round the last turn point and tiptoe back across the

border. Now I sit under the only cloud that's left over all of Brandenburg, a lifeless wisp that marks the exhaust of a big power station near Cottbus. It's my last hope to getting lifted to final glide altitude. A meager 200fpm is all that I can extract, despite empty tanks, and the milky haze I see in the direction of our goal tells me and anyone else who cares to know: this is our last lift, our last chance! I've gained slowly on the Eta that earlier joined my thermal about 300 feet below. Would 1 lb/ft² really make a difference in this weak, bumpy lift? Right around 4800 ft my thermal finally decides to quit. Final glide, it whispers. Final departure, it should have warned. Even in the best case I'm about 200 ft too low to reach Luesse, now at a distance of about 125 km. Looks like I will have to fire up the turbo about 10km short of the finish line. I move the flap lever to the zero notch and head out on course. Patience and concentration are needed to keep the airspeed at precisely its optimal value, and to

sese whatever slight assistance the evening atmosphere can offer. What happens seventy-five minutes later could only have been foreseen by the most pessimistic of my competitors: I float at barely 20 feet across the fence of the airfield in Luesse, the only one to complete the task. What a fantastic final glide! Fantastic, at 80:1? Yes, but only a fantasy? Who knows! There is a team of three highly motivated enthusiasts with first rate competence who view this dream as a challenge. To beat the Eta, the 'most open' of all Open Class ships, is a very concrete goal, to come up with the best possible soaring machine is an altogether different endeavour. Richard Butler, Gerhard Waibel and Loek Boermans are the "Three Musketeers" who have set the goal of applying state of the art aerodynamic knowledge in conjunction with proven construction techniques to building that glider which could push the limits of performance to new levels, despite all the compromises required to conform to the



Dick's homebase Falcon Field, with his "skunkworks" right off the runway

class definitions of the IGC. Many an eyebrow will be raised about such bold an undertaking. Remember: it took more than 10 years after Nimbus 4 and ASW22BL had reached maturity until the Eta, unconstrained by class definitions and -limitations, invoking „... uncompromising use of the most modern design methods, materials and manufacturing tools, to achieve the highest possible increase in sailplane performance...“ demonstrated what was technically feasible in the late 90's and finally threatened the aging kings of the Open Class. And now, only five years later, somebody is claiming that just by applying the latest aerodynamics one can cook up something new? Isn't that a bit too, say, "enthusiastic"? Well relax, my friends. Once ,VW' ('Vinzenz' Waibel) and ,DB' (Dick Butler) get together and team up with the best airfoil kitchen around, more than airy soufflés are bound to emerge. Here we have acclaimed design reputation and proven tuning talent sounding the call to action.

The charge was lead by Dick Butler. It was more than simply succumbing to the temptations of old habits, more than the zealous ambition of a serious racing pilot, which drove him to use his brand new ASW22BL to breed the alpha male of the Open

Class. It was, above all, the Eta, representing the greatest challenge and providing irresistible motivation. The successes of his extensive modifications proved that he was on a promising track, and with the ensuing gain in selfconfidence he admitted his intentions to nibble at the Eta's lead. When Hans Werner Grosse learned about the performance of the ASW22 DB, it is rumored, he acknowledged „Eta-biter“ as the nickname of the competitor with a sly grin on his face. Dick expected, that his comprehensive tuning would yield an improvement of the L/D of roughly 10% through the range of best glide to about 90 knots. Test flights, carried out with utmost attention to detail, so typical of his approach, brought a big smile to his face and after the two victories in the 2003 and 2004 US-Nationals his competitors conceded admiringly that he had trimmed his '22 to be the best climbing and cruising ship in the Open Class. No one, who has ever tried to chase DB on a long cruise or final glide could have doubts about the measured glide ratio of 65:1. The question, however, remained: what had Dick actually done? Everybody understood that this leap in performance was not to be achieved by a winter-long orgy with elbow grease and miracle polish, which, in any case would not

Dick Butler



"Focused, determined and committed!" Loek Boermans' characterization of Dick Butler comes without hesitation. "Enthusiastic and consequent" adds Gerhard Waibel. He has known the aeronautical engineer from Tennessee, since he showed up at the US Nationals in '74 with a stretched and "irrigated" ASW12. "Expertly modified" is the trademark of all "DB"'s, from the "12" to the big Glasflügel 604, the ASW17 and the first ASW22 for the Worlds in Hobbs '84. And, more often than not, he flew them, expertly, as well, into the top spot in many national and international contests.

After a 15 year hiatus, he staged a comeback in 1999 as pilot and, with his version of an ASW22, as tuner, as well.

Loek Boermans



Professor at the Technical University Delft, Netherlands, Director of the Low Speed Aerodynamics Laboratory, President of OSTIV, the international organization for technical and scientific aspects of soaring,... - Loek Boermans is a busy man. It was 25 years ago, when his name popped up in soaring circles. With the first ever "blown wing" on a glider (an ASW19) he demonstrated successfully the use of blowhole turbulators. Ever since he has contributed substantially to the aerodynamic design, most notably in the development of high performance airfoils, of gliders, primarily from the Schleicher factory. His name has not only become a synonym for advanced glider aerodynamics but for low speed aerodynamics in general.

have been consistent with Dick's scorn for any kind of makeshift fixes.

Searching for extra 'go', span had been his first and paramount idea – all the less surprising given his tremendous experience with wing extensions. All of his tuning masterpieces since the ASW12 had to stretch their wings. He reactivated an exchange with Gerhard Waibel dating back to his ingenious transformation of an ASW17 into a formidable 23m competitor, to investigate the structural limits of the '22 spar. A span of 28m appeared to be possible. However, reports by his German counterparts experimenting with super long wings on the '22 and '25's, had not been all that enthusiastic: the gain in performance came at least partially at the cost of handling qualities, a compromise Dick was not willing to accept.

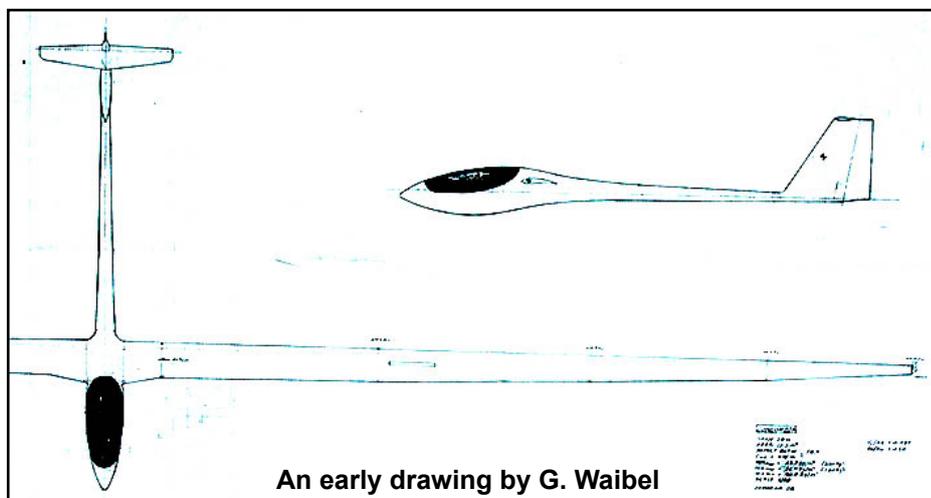
A more radical approach was called for, one, that would keep him busy for several years and lead to the best ASW22 of all time. Dick conceived a program with the strategy of going all out in performance enhancement while minimizing any detrimental effects on handling. Here's an example: there was a definite need for more rudder, since even above average leg muscle was not sufficient to force the 28m wings efficiently into the core of a strong thermal. Dick built a new, 10cm taller vertical stabilizer and rudder, using the more modern airfoil of the '24 empennage, and stretched the fuselage by 30cm.

Now the elevator was way overpowered, so he replaced it with the smaller, lighter and lower drag elevator of the ASH26.

With this strategy he compiled a comprehensive list of modifications. It included the complete aerodynamical overhaul of the wing with an altered planform, improved lower contour of the HQ17 airfoil, wing extensions with larger span, new airfoil and winglets, the stretched fuselage with new tail surfaces and retractable tailwheel, the beef-up of the entire structure to accommodate a gross weight increased to 850kg and on and on...

The result of his five year program: see above. When Dick showed up at the 2003 Nationals with his Super-22, everybody recognized the unmistakable silhouette of the ASW, but was somehow baffled by its inexplicably different looks and -above all- by its superior performance. On one hand, the unchallenged victory in Cordele one year later confirmed that the outstanding performance was not achieved in only one particularly smooth and successful test flight, it was there when required to win a contest. On the other hand, it posed the nagging question of how close to the big ship – to the Eta - he had come, of how much additional effort it would take to beat the longest wings around.

target L/D above 70, widest possible range of wing loading, realistically between 8 and 12.4 lbs/ft². The distribution of tasks was equally quick: Gerhard Waibel was responsible for conceptual layout and design; Loek Boermans and his student Johannes Dillinger of Delft University would contribute the latest from the magic pot in aerodynamics, and Dick himself was to take care of project management, construction of various components, final assembly and flight testing. To convert motivation as swiftly as possible into action an ambitious timetable was set: to challenge the Eta at the World Championships 2008 in Germany. This necessitated an approach, which the team had agreed on for yet another reason: to prove to the IGC and the soaring world that construction of the queen (to be) of the Open Class was pos-



An early drawing by G. Waibel

The big challenge

It only took a couple of back-of-the-envelope calculations before excited emails crisscrossed the Atlantic between Dick, Gerhard Waibel and Loek Boermans. The 20m-Antares, presently the most modern glider, claimed an L/D of around 55. What, then, could be expected from a state of the art 28m wing, when an - admittedly thorough - modification of a 20 year old design already delivered an L/D of 65 ? Despite all reservations against such simple extrapolations: optimism was in the air – and justifiably so.

Once more Dick had caught fire. It surely wasn't too difficult to cajole his Eta-biter team members into making the logical next step, the ultimate step. The goal was set quickly:

sible despite a financial commitment noticeably smaller than that of the competition, and hence the use of established construction techniques and existing components wherever feasible.

Since Dick had established a close working relationship with Schleicher long time ago, it came as no surprise that „AS“ became involved in the project. Naturally, they were interested in following closely the development of a novel prototype, on the other hand they had crucial know how in construction techniques to offer and possibly even some ready-to-use components. It became clear immediately that the front part of the ASW27-fuselage with its superior crash resistant and aerodynamically efficient cockpit would provide an

excellent starting point for fuselage construction. Only a few modifications in structure and gear assembly were necessary to accommodate the higher gross weight. Early on the team had decided to go for 850kg/1890lbs maximum weight, which set the stage to play with several parameters and evaluate resulting configurations. A maximum wing loading of 12.4 lbs/ft² together with a gross weight of 1890lbs yields a wing area of roughly 150 sq.feet, which, given a span of almost 92 feet, resulted in an aspect ratio of 56 – perfectly in line with the requirement to optimize profile and induced drag.

Now, these numbers are easily calculated and quickly written down, but to grasp their meaning fully we should give our imagination a little time to catch up: after all, in the Open Class we're used to wing loadings near 9.7lbs/ft² and aspect ratios around 42! Even the Eta value of 51.3 sounds rather exotic.

At the low end of the weight scale the desired minimum wing loading of 8.3 lbs/ft² presents yet another challenge as the empty weight including pilot comes out to be only 1220lbs. Consequently, light weight construction is an absolute must. Carbon pushrods to actuate flaps and other control surfaces are mandatory, as are high tensile strength fibers in a diagonal lay up to achieve the necessary torsional and bending stiffness with minimum weight. Balsa instead of hardcore foam is

used in load carrying parts of the structure.



Closely tied to the requirement of minimal weight is the problem of center of gravity location. Large span Open Class gliders are often tail-heavy, since an adequate rudder efficiency calls for a long tail boom to get sufficient lever arm. To avoid trim weights in the nose, the tail, including empennage, needs to be kept as light as possible. The use of the small, light weight and low drag horizontal tail of the ASW27 was the logical solution. This finalized the layout of the fuselage, and Dick began to construct the rear part to be fitted to the ASW27 front section. The contour aft of the root rib is less radically tailored for minimum wetted surface, which helps to improve critical flow conditions in this area and makes room for a small sustainer engine. Alternatively an additional ballast tank can be fitted there to use the maximum range of wing loading. When Dick took the first photos of the new fuselage shape less than nine months had passed since the official launch of the pro-



Gerhard Waibel



If you are an active glider pilot you must have come across Gerhard somewhere. While he gave a talk to a large audience, explained aerodynamics to a few over a glass of beer, joked about his flight at a contest, most likely, however, when he worked on one of the AS-“W” planes in his office at Schleichers in Poppenhausen. For 39 years Gerhard has pushed the frontiers in soaring performance. Now he is defining retirement in a new way: to use all his experience in his largest (by span) project yet - the Concordia

Johannes Dillinger



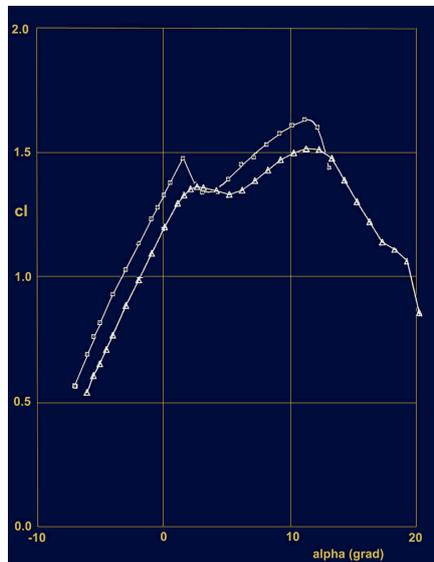
It was a photo-shoot which lured Jojo away from his computer: first flight of the ASW-28-18. Under the guidance of Prof. Loek Boermans he had designed the layout of the 18m wing configuration. Now they wanted him to be there for the occasion. A prof at the Polytechnical Inst. in Aachen had spotted his talent and recommended him to the colleagues in Delft. There he not only helped to integrate the ideas of Boermans/Butler/Waibel into a feasible design, he also added a number of innovative ideas in airfoil tuning and aeroelastic tailoring

ject. The vision had taken on shape much sooner than expected – a very encouraging start indeed.

Right from the beginning, the team of Butler, Boermans and Waibel was well aware that the bulk of development work would have to be devoted to wing design and airfoil optimization. Using a momentum rake Dick had carefully measured the airfoils of the old '22 and the much younger '27 in flight and compared the results. The progress made came as quite a shock, and he vehemently voted to adopt the '27 airfoil.

But then Loek Boermans pointed out - equally vehemently – that he and his aerodynamic wizards at Delft had advanced the state of their art substantially since the 15m racer had taken to the air (for the first time) almost ten years ago. New ideas were already incorporated in the Antares airfoil and, more recently, Loek Boermans' student, Johannes Dillinger, had found a novel way to reduce drag at high angles of attack.

Dick, however, considered the pressure distribution of Johannes' new airfoil to be rather unusual and was afraid that it would suffer from temporary flow separation on the flaps, particularly in turbulent thermals. Such flow separation would cause the separation-point on the upper wing surface to move forward disturbing the flow; and by dragging along its separation bubble it would reduce the achievable lift. But Johannes' approach had addressed precisely that problem. After days of fiddling with complicated computer code he had succeeded in tailoring the flow regime in such a way, that laminar transition and turbulent separation move forward simultaneously as the angle of attack increases. The ensuing loss of lift in the rear section of the airfoil is thus compensated by a corresponding gain in lift in the front part. With this trick he was able to avoid the dreaded dip in the plot of lift coefficient versus angle of attack and achieved an almost horizontal section.



Jojo's successful flow massage

From experience Loek Boermans had developed a healthy skepticism about the validity of seductively optimistic computer simulations: he wanted to see Johannes' results confirmed by tests in the wind tunnel. When he finally checked the clean data of the measurements he was extremely pleased and convinced Dick in no time that substantial progress had indeed been made.

Although the basic airfoil had been chosen it still needed lots of detailed refinement to optimize its characteristics for certain areas along the wing span. One spot of particular interest was the section close to the fuselage wing juncture. Here a trapezoidal piece was inserted to span the transition between the wing root rib on the fuselage and the wing with its narrow(er) chord. To place this part in an aerodynamically efficient way in a flow pattern generated mostly by the fuselage, a twist of 2.5 degrees was applied. The flaps will also be twisted by 4 degrees along the first meter of span. Loek Boermans had also performed basic research' in the wind tunnel to develop a wing root fairing, which eliminated a wedge-shaped area of high drag, caused by boundary layer flow separation. Careful management of the boundary layer along the lower surface of the wing, either by blow turbulators or zig zag tape, was crucial to achieving a laminar flow of around 95% chord, extending across the flap hinge line.

As far as winglets are concerned inflight experience of Dick and theoretical considerations are still somewhat at odds. On the one hand it was obvious that winglets would perfectly fit the overelliptical lift distribution and the relatively wide chord at the wing tip, and minimize the effect of low Reynolds numbers in slow circling flight. On the other hand, Dick had occasionally felt light turbulence while climbing in thermals, interpreted this as separation in the winglet area and had decided to fly the eta-biter conventionally tipped. In any case, the proper winglets have been incorporated into the wing design and can be used according to taste, mood or conviction. After all the fine tuning had been applied, one counts not less than 13 slightly different airfoils which define the wing contour at the relevant positions.



Winglet, nouveau

Occasional glimpses at the polar served as a loose form of quality control of the design work. They caused neither paralyzing frustration nor desperately hectic rush: „A glide ratio of 80 is out of reach, but we'll very likely get more than 70 “ is all the team would concede. Considering that the ever so popular glide ratio represents the performance at only one point on the polar, at only one speed, it alone can not adequately describe the capabilities of the new glider. It is the high wing loading which will provide the extra „go“ in the range from intermediate to high speeds and fuel the optimism that there is a veritable Eta opponent in the making. Up to this point comparison with the Eta was the only means of giving this project an identifiable profile: a proper name was missing sorely. Obvious adaptations of „Eta-biter“ wouldn't do; the common goal and

the enthusiastic and productive collaboration across borders, even oceans, inspired Dick Butler et al. to use „Concordia“. They choose this name also to recall – with a nostalgic-romantic touch – that it had been given once to an aircraft in similar spirit, but had been left without bearer since supersonic air travel ended.

To make sure that the name Concordia will be generating a fresh dose of excitement at the 2008 World Championships in Germany the team is working full power in various sectors. In Delft Loek Boermans and Johannes Dillinger are continuing to optimize the aerodynamic design,

Gerhard Waibel in Germany is finalizing the layout of the controls and shaving off unnecessary weight from the structure and Dick Butler in the US is working on the fuselage and investigating the feasibility of using a computerized milling machine to fabricate the wing molds.

There's lots of excitement and suspense in the team's offices and shops as well: will they succeed in achieving these ambitious goals, in realizing their vision? The fact that they had managed to blend numerous novel ideas, at least in the computer, to a coherent design,

which fulfills most of their requirements is certainly a very encouraging sign. After all, Dick Butler, Gerhard Waibel and Loek Boermans proved more than once, that they have plenty of experience in transforming digital prediction into operational hardware. If they pull it off again, three years down the road the pilot of the Concordia will be raving not only about marvelous final glides.

