Development of the Microlift Glider

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Introduction

At its annual meeting on February 28th, 2004, the FAI International Gliding Commission, IGC, took an important decision. Upon a proposal from OSTIV (the International Scientific and Technical Organisation for Soaring Flight), the following definition of a so called MICROLIFT GLIDER was adopted for inclusion in the FAI Sporting Code, Section 3, Gliding. The definition has just come into effect on October 1st, 2004:

> MICROLIFT GLIDER a glider with a maximum takeoff mass not exceeding 220 kg and a maximum wing loading not exceeding 18 kg/m2.

The following note is added:

> These gliders are intended for utilizing very weak atmospheric lift conditions, hardly usable for conventional sailplanes.

This is a preliminary step for the creation of a new FAI Class (in addition to the existing ones: Open, 18metre, 15metre, Standard, World, Club, Ultralight). When World records will be acknowledged by FAI for this new Class, and eventually World and/or Continental Championships, under specific FAI Rules, will be organized [1].

Diagram 1, taken from reference [1], illustrates the relative domains of the Microlift glider, just introduced in the FAI Sporting Code, and the already existent (since several years) Ultralight glider. Both have the same max-mass limitation (Wmax) but a different max. wing loading (Wmax/S). The relative position of those we call "conventional" sailplanes is also roughly indicated in Diagram 1.

Whereas "conventional" sailplanes are mainly designed for cross-country flight, i.e., for speed and distance, using the well known atmospheric phenomena as thermals, ridge or slope effects, cold fronts, waves, the "microlift" glider is designed for the exploitation of air motions within the atmospheric boundary layer, having nothing to do with the boundary layer of the aerodynamicists. For the meteorologists the atmospheric boundary layer is a layer of air from ground to a limited height of the order of a few hundred metre, where transient convective processes preceding and following the big convection, familiar to "conventional" glider pilots, takes place [2] [3].

In typical conditions, weak air motions occur with vertical components which the conventional sailplane is unable to exploit. On the other hand, a special sailplane, designed for very low rate of sink and very small circling radius, may be able to exploit these feeble air motions for sustained flight and even for climbing [4]. This is the Microlift Glider.

It should be made clear that compliance with mass and wing loading limits is enough for a glider to be officially considered a "microlift glider". However, it may occur that such a glider is unable to exploit microlift efficiently. In fact, it is very important that some flying characteristics and qualities are possessed in addition. Here the skill and experience of the designer play a decisive role.

The number of existing Microlift gliders worldwide is very small. They are not produced in a completed form, although some initiatives in this direction seem to be on the way (the Lighthawk of Danny Howell, in Southern California). The best known of all, the Carbon Dragon (Figs. 1, 2, 3, 4) designed by Jim Maupin and Irv Culver, a few of which are actually flying, are all homebuilt upon a set of drawings which can be purchased. Reliable data on the number of existing completed Carbon Dragon are not available, but certainly they are a small percentage (not more than 10% of the number of sets of drawings sold - about 400).

Figure 5 shows the American Woodstock, another successful design by Jim Maupin. It is interesting to note that Gary Osoba was able to use microlift with this glider in successful record flights, although its empty mass is considerably higher than with the Carbon Dragon.

Figures 6 and 7 relate to the German ULF-1, about 30 of which have been homebuilt upon a set of drawings available for purchase. Here the performance is less than with other types in order to keep simplicity and cost at a lower level. Microlift flights are not reported upon.

Figures 8 and 9 illustrate the Swiss Archaeopteryx, [6], chief designer Roger Ruppert, which combines a wing span of 13 metre with an astonishing empty mass of 45 kg, including a rocket recovery parachute. Microlift exploitation is claimed to be possible but no evidence is provided so far.

These are just examples, more is coming from France, Ireland, Ukraine…and where else?

Due to the very low empty mass required, homebuilding requires a few thousands man hours of very skilled craftsmanship and expensive materials. Therefore the Microlift glider is not a cheap machine, it is rather a very expensive machine and as such it would probably remain if produced in small numbers and made available on the market.

The FAI philosophy for Classes

One objection to the creation of a Microlift Glider Class is the small number of existing Microlift gliders worldwide. However, is there any philosophy in the creation of glider classes by FAI through its specialized Commission, the IGC?

In other words, are there clear cut criteria which differentiate one Class from the others?

Annex 1 to this paper gives a brief history of the FAI glider classes, from which it can be understood that no clear cut criteria differentiate one FAI Class from the other. In some cases, without any explicit statement in the Sporting Code, a Class takes into account the cross country performance in terms of distance and speed in typical conditions of thermal convection, through the limitation of the wing span and the glider variable geometry. This is the case with the Open, 18-metre, 15-metre classes. In other cases the cost of the glider and the ease of operation are also taken into account as for the Standard Class and the Ultralight.

With the World Class the pilots compete in equal conditions, flying the same glider type at the same total mass. Moreover, a relatively cheap World Class glider is available for the promotion of gliding worldwide.

The Club Class allows gliders belonging to different classes but no more competitive therein to compete at world level.

What about the not yet established Microlift Class?

Here, in addition to the capacity of exploiting the big thermal convection, as the conventional sailplanes do, the capacity of exploiting "microlift", which conventional sailplanes are unable to do, is the discriminating factor. The FAI definition recalled at the beginning of this paper is intended to promote this capacity. Therefore, world records or competition tasks of this Class should demonstrate the ability of sustained flight within the boundary layer, i.e., at very low altitude [2]. The lower the flight altitude the higher the scoring! [5]

This makes clear that the creation of the FAI Microlift Class, through the expected, and hoped for proliferation of Microlift gliders, opens the way to an extension of the soarable atmospheric domain. The attempt to attain such an ambitious goal is well worth the tentatively introduction of this new class.

Microlift: reality or fake?

Most probably microlift soaring has been experienced more or less consciously by hang glider pilots flying high performance hang gliders. But, who knows? The case of Gary Osoba [4] is an exceptional one, that of an experienced glider and hang glider pilot at the same time.

No clear cut definition is available neither from pilots nor from meteorologists. All we know is the description of weak, unsteady air motions with vertical components, taking place in the atmospheric boundary layer, typically early in the morning and/or late in the afternoon, i.e., before or after the big convection takes place in the upper atmosphere, which conventional sailplanes – but Microlift sailplanes as well - are able to exploit. [2] [3]

The literature about what we call microlift is so scarce and sparse - that appealing to glider pilots in particular – that even a pilot of great experience and reputation may not believe in its existence, at least in the form useable for soaring flight.

As a matter of fact, it must be acknowledged that very little documentation on microlift flights is available. Gary Osoba's and some other pilots' flights, however, using the Carbon Dragon and other light gliders (the Woodstock, for instance) have been widely witnessed over the years.

As reported by Osoba, the exploitation of microlift often requires dynamic soaring techniques which are not familiar to pilots of conventional sailplanes. Here a problem arises: how to teach pilots? Is a two-seater microlift sailplane feasible? This is dubious because of the mass and wing loading limitations. A flight simulator would probably do, but what about the cost?

Pilots who beautifully homebuilt their Carbon Dragon admitted that they fly it as a conventional sailplane, which in many cases is an ineffective means to extract energy from microlift.

Basic design characteristics of a Microlift sailplane

As implied by the definition, essential characteristics are a low rate of sink and a small circling radius. Therefore a low takeoff mass and a low wing loading are required. Not enough, however. A high maximum lift coefficient (CLmax) of the wing, obtainable by the choice of the wing airfoils and the adoption of wing flaps, is beneficial in this respect, because it allows the same rate of sink and circling radius with higher values of the glider mass and of the wing loading, therefore improving the penetration, a precious characteristic in headwind conditions.

A high CLmax, however, must be accompanied by irreproachable stalling characteristics in straight and circling flight. What we call "microlift" is a kind of turbulent unsteady motion. The necessity to search for the transient lift components of it, often requires to manoeuvre the glider promptly in pitch, roll and yaw to the limits of the envelope. The time of response needs to be considerably smaller than on conventional sailplanes.

The stall of the wing must not be accompanied by any appreciable loss of altitude and lack of lateral/directional control.

Due to the typical low altitude flight the outlanding must be possible and safe on small patches of land at the lowest possible speed. Powerful airbrakes are necessary.

A very attractive peculiarity of the Microlift glider is the variety of possible launching methods: aero-tow, winch launching, auto-tow, bungee launching, foot-launching, roll-down launching. The availability of the related necessary equipment and accessories should be assured since the design stage.

A perspective of development of microlift soaring

The acceptance by FAI of the Microlift glider definition upon the OSTIV proposal is a big and a small step forward. A big step because it appears as the official recognition at international level of a new form of soaring flight in a perspective of its development. A small step because the FAI decision is based more on verbal and written unofficial reports than on objective documentation.

What is the evidence we possess?

(a) Witness of low altitude flights mainly made by the American pilot Gary Osoba in a period of over 20 years, over American territory, mainly Southern California.

(b) Availability of a few light gliders, mainly the Carbon Dragon, designed by the American engineers Jim Maupin and Ilv Culver, intended as a foot-launchable high performance hang-glider, but resulting similar to a conventional sailplane of 13.6 m wing span, except for the very low empty mass of 68 kg and a wing loading of approx.12 kg/m2 (with a 90kg pilot on board).

(c) Scientific papers by meteorologists Wally Wallington (1983) and researchers of the German Institute for the Physics of the Atmosphere (1985), describing convective air motions within the atmospheric boundary layer. Wallington's paper [2] predicts the exploitation of these motions when suitable light sailplanes will be available.

(d) Many articles on microlift gliders and on microlift soaring published on soaring magazines worldwide, most of them in recent years.

It is not much, but probably enough to convince glider pilots that microlift soaring is not a fake!

Further steps forward

To speed up the process of development of the Microlift glider, and Microlift soaring thereby, several initiatives could be undertaken.

Documentation

To collect and publish reports and documents on glider and hang-glider flights allegedly exploiting microlift. This material should be verified and classified on the basis of criteria to be worked out by meteorologists. OSTIV could play a key role on the promotion and organization of this initiative. An OSTIV Working Group of experts could be designated.

Connection with hang-gliding

The connection could be made through the FAI Hang-gliding Commission to verify if there is an interest of experienced hang-glider pilots and experts to join the OSTIV Working Group and contribute to the advancement of knowledge in this area.

Promotion of video recordings

Such videos could be shot by small video-cameras installed onboard a microlift sailplane, showing instrument readings and external references during stretches of flights with evidence of microlift exploitation. If made available to interested groups at a reasonable price these videos would probably be a powerful means "to stimulate interest and support with many more people and inspire more pilots and designers" (quoted from [5]).

A link with Paul MacCready

Such a kink should be established during this research activity in order to benefit from his unique competence and experience in this area, as pilot, designer, meteorologist. At one time he expressed a belief that, if a sailplane having 0.30 m/s rate of sink were available, sustained soaring flight would be possible any place, any time! As probably known by everybody in the gliding world, his vision of an extended domain for soaring flight is a long standing one.

Conclusion

A pessimistic view: no pilot was able to achieve in the years what Gary Osoba described in his articles and reports (see for instance [4]). Osoba is such an outstanding pilot that no one of the many who tried was able to emulate him. No video recording or equivalent documentation of Osoba's flights was ever made available to pilots interested to try and learn. The negative attitude of estimated pilots discouraged further attempts. The effort to transfer the knowledge was not adequate. The prediction of competent meteorologists was disregarded. The initiative to conquer a new domain for soaring flight was clearly unsuccessful.

An optimistic view could lead us to imagine that in a reasonable number of years some hundreds of Microlift gliders fly in different countries worldwide. Their pilots know how to exploit microlift covering distances at respectable speed without exceeding (for long stretches at least) a few hundred metres altitude. When the big thermal convection develops they need not rely on microlift, if any, they can enjoy flying higher in the same way conventional sailplanes do. When the air would not support any more, they experience successful outlandings, so easy at 30 km/h! If some headwind is there they can perform a quasi vertical approach, helicopter-wise! This kind of performance suggests a different task philosophy. An example: a low altitude limitation over the contest terrain would be introduced, exceeding it would entail penalties. The challenge is to stay up as long as possible to the preset altitude limit; or to cover the maximum distance in a given time without exceeding the preset altitude, or being penalized for this. (see [5] for more). Moreover, this type of performance could make competition tasks appealing to the public (see [1] and [5]). Wishful thinking? I hope not!

References

[1] Piero Morelli, Why Microlift Soaring?, XXVII OSTIV Congress, July 2003, Leszno, Poland.

[2] C.E. Wallington, Potential Exploration and Use of Miniscale Lift Patterns – OSTIV Publication XVII, 1983.

[3] Anne M. Jochum, The Vertical Structure of the Convective Boundary Layer from Motorglider Measurements, XX OSTIV Congress, August 1985, Rieti, Italy.

[4] Gary Osoba, Toward a 20 Hour Work-Week – Sailplane Builder, July 1995. Gary Osoba, More on Microlift Techniques – Sailplane Builder, July 1995.

[5] Eric de Boer, Some Additional Remarks Concerning Microlift Soaring, XXVII OSTIV Congress, July 2003, Leszno, Poland.

[6] Archaeopteryx, Swiss ultralight sailplane, Internet: http://www.zhwin.ch/archaeopteryx

ANNEX 1

A brief history of FAI glider classes

If we look at the history of gliding and of IGC in the post-WW2 period, and in particular at the World Gliding Championships in the years 1948 to 2003, we find no Class definition at the start (1948 Switzerland, 1950 Sweden), i.e., all competitors flew in the same unlimited, therefore undefined Class.

In 1952 (Spain), 1954 (England), 1956 (France) a Two-seater Class competed in addition to the Single-seater Class. The reason for this? Not known to me. The second person on board could be an additional pilot, or simply an additional mass, or a navigator or whatever. A plausible reason for the introduction of this class could be the existence of a number of high performance two-seaters which would be given a chance to be used for high level competition. But, if this was the case, couldn't it be achieved simply allowing only one person (the pilot) on board of the two-seater glider?

In 1958 (Poland) a big change occurred, the introduction of a new Class, the Standard Class, grouping gliders complying with specifications laid down by OSTIV: wing span not exceeding 15 metre, no flaps, no retractable landing gear, no expendable ballast, cloud flying permitted, no radio transceiver on board. The objective was a cheap and safe glider, in order to counteract the tendency to sophisticated and expensive gliders. The Two-seater Class was abolished. The gliders not complying with the Standard Class specifications were grouped in the so-called Open Class.

These two classes, Open and Standard were the only two in existence as championship classes in 1960 (Germany), 1963 (Argentina), 1965 (England), 1968 (Poland), 1970 (USA), 1972 (Yugoslavia), 1974 (Australia), 1976 (Finland).

In 1978 (France) a new so-called 15 metre Class was added. The only limitation for the gliders of this class is the wing span which must not exceed 15 m.

To understand the reason for this change it is necessary to appreciate the evolution of the Standard Class (re-named 15-metre Restricted Class) after the initial objective of a cheap and safe glider.

Under the pressure of manufacturers and pilots (mainly from Germany), the retractable landing gear was allowed, then the prohibition of expendable ballast was withdrawn. Only the span limit and the prohibition of flaps were maintained (IGC 1975). Practically the only difference between the Standard and the new 15 metre Class concerns the prohibition of flaps on Standard gliders. Is this enough to justify the existence of a new class? It is not, may be the answer. However, this is the situation since 1978 (France). Pilots seem to be comfortable with this solution. At least the devaluation of existing Standard gliders is avoided.

The World championships were announced and held for the three classes in 1978 (France), 1981 (Germany), 1983 (USA), 1985 (Italy), 1987 (Australia), 1989 (Austria), 1991 (USA), 1993 (Sweden), 1995 (New Zealand), 1997 (France), 1999 (Germany), 2001 (South Africa), 2003 (Poland). The next one has been decided already for 2006 in Sweden.

The growing experience with the 15 metre class showed that a considerable improvement of performance at relatively low cost could be obtained by adding wing tips, each 3 metre spanwise, to the 15 metre wing, thus increasing the wing span to 18 metre.

A new 18 metre Class was introduced in 1998. The first World Championship for this class was held in 2001 (Spain), another following in 2003 (Poland). No records are acknowledged for this class.

The difference between the 15 metre Class and the 18 metre Class is only the wing span. One can see that a new concept has been adopted to create a new class. For consistency one could think of a class structure simply based on the wing span, thus having, for instance: 12m Class, 15 metre Class, 18 metre Class, 21 metre Class, 24 metre Class, going on or stopping here for operational reasons!

This is not the IGC choice.

The opportunity of introducing a one-design class and, at the same time promoting the availability of a simple, safe, low-cost glider contributing to the expansion of gliding worldwide, was recognized by IGC in 1988, when the process of creating a so-called World Class was started.

The 1st World Championship of the new World Class was announced in 1994 and held in Turkey in 1997, as the gliding event of the 1st FAI World Air Games, organized in Turkey in 1997.

Therefore, since 1998 the number of classes having World Championships became six, with the related events concerning the World Class held in 1997 (Turkey), 1999 (Poland), 2001 (Spain), 2003 (Slovakia), and the next one decided already for France in 2006.

In consideration of the declared objectives, the creation of the World Class is fully justified (one-design, expansion of gliding). Who would disagree?

But, there is more. For many years, the proposal to create a new class in order to give owners of gliders no more competitive (this occurs in a few years time!) a chance to compete at high level has been discussed. Finally, a so-called Club Class was introduced, grouping gliders of not too different performance, tentatively equalized by handicap factors.

Initially, only continental championships were allowed for the Club Class but in 2000 (Australia) the first World Championship was held, followed by 2002 (Germany) and 2004 (Norway). No records are acknowledged for this class. Another result was welcome: the possibility to compete at world level using obsolete gliders, added commercial value to the used gliders.

Is this a properly defined FAI Class? This is doubtful, if one thinks that handicap factors are an artificial and approximate way for compensating performance differences, and also that marketing should not be an influential factor in these matters.

With the World Class and the Club Class added to the Open, 18 metre, 15 metre, and Standard, the FAI Classes for which World Championships are run have become six.

Since 1997 another FAI Class exists, the Ultralight Class, for which world records are acknowledged but no world championship has been held so far. The Ultralight glider is defined as follows: A glider with a maximum takeoff mass not exceeding 220 kg. The reason for this class is that several successful designs complying with this definition exist. Their performance is remarkable and their cost is relatively low.

There is now a chance that the Microlift glider evolves into a Class. This requires world records and/or world championships being called for and being held.

Figure 2 The Carbon Dragon (below)

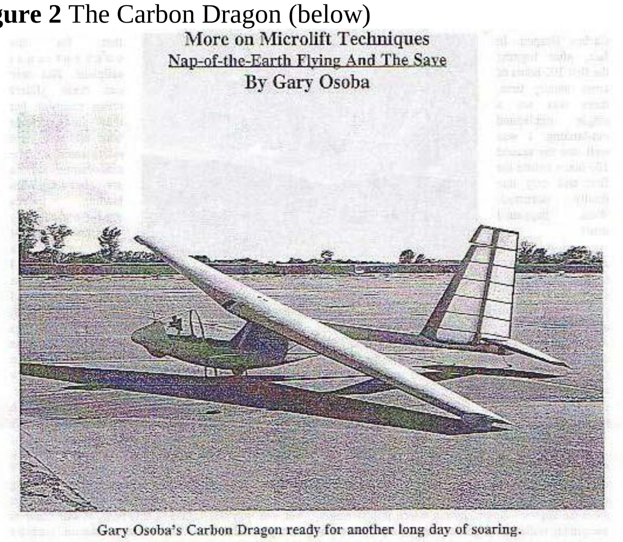
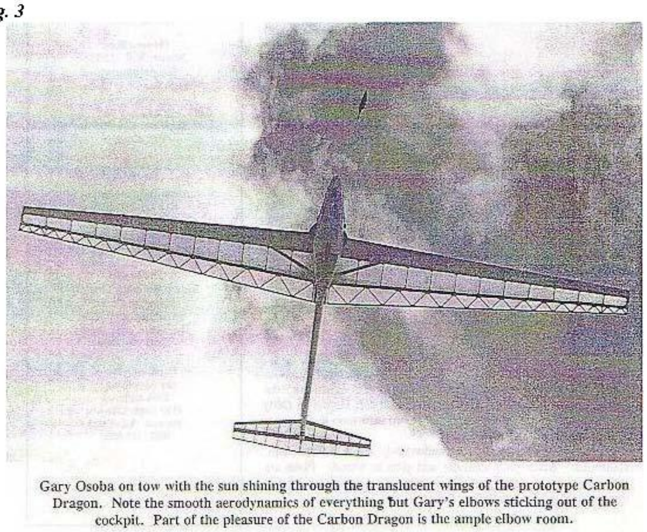


Fig. 3



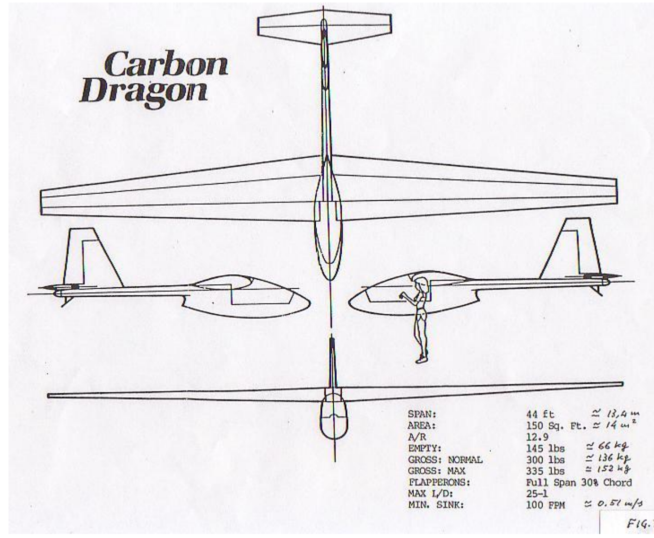


Figure 1 The Carbon Dragon schematic

Figure 4 The Carbon Dragon on tow

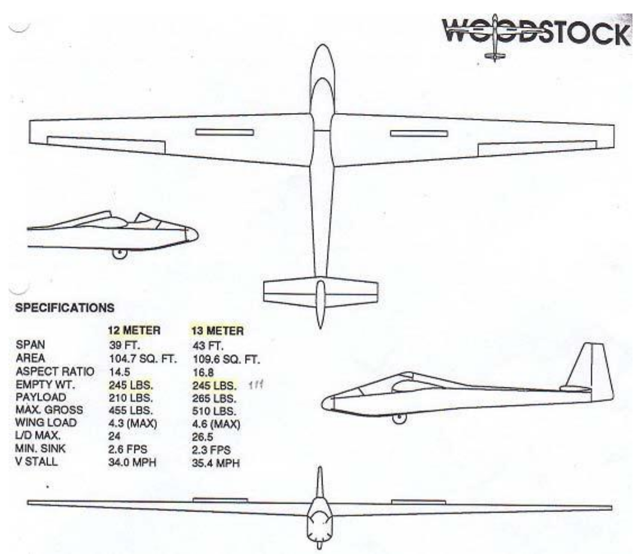


Figure 5 Schematic of the Woodstock

Fig. 6

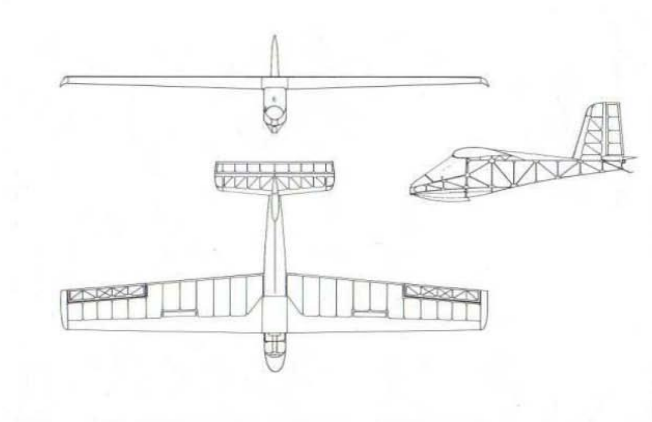


Fig. 7

ULF-1	
Wing span	11 m
Wing area	14 m^2
Empty mass	60 kg
Max. take off mass	150 kg
Max. wing loading	10.7 kg/m^2
Max. limit load factors	+ 6 / - 4g
Vmin	32 km/h
Vmax	80 km/h
Vsink	0.8 m/s
Max. L/D	17

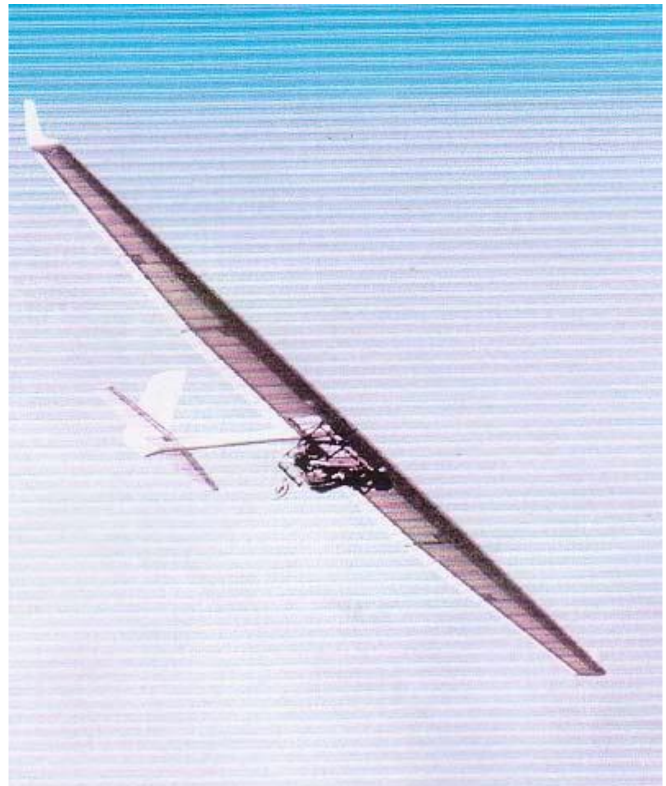


Figure 8 The Swiss Archaeopteryx

ARCHAEOPTERYX	
Wing span	13 m
Empty mass	40 kg
Rocket-chute and harness	5 kg
Take off mass	110 – 145 kg
Max. wing loading	10.3 kg/m^2
Vmin (at TOW 135 kg)	29 km/h
Vmax	140 km/h
Vsink	0.6 m/s
Max. L/D	28
Max limit load factors	+ 4.4 / 2.2g

Figure 9 The Swiss Archaeopteryx details

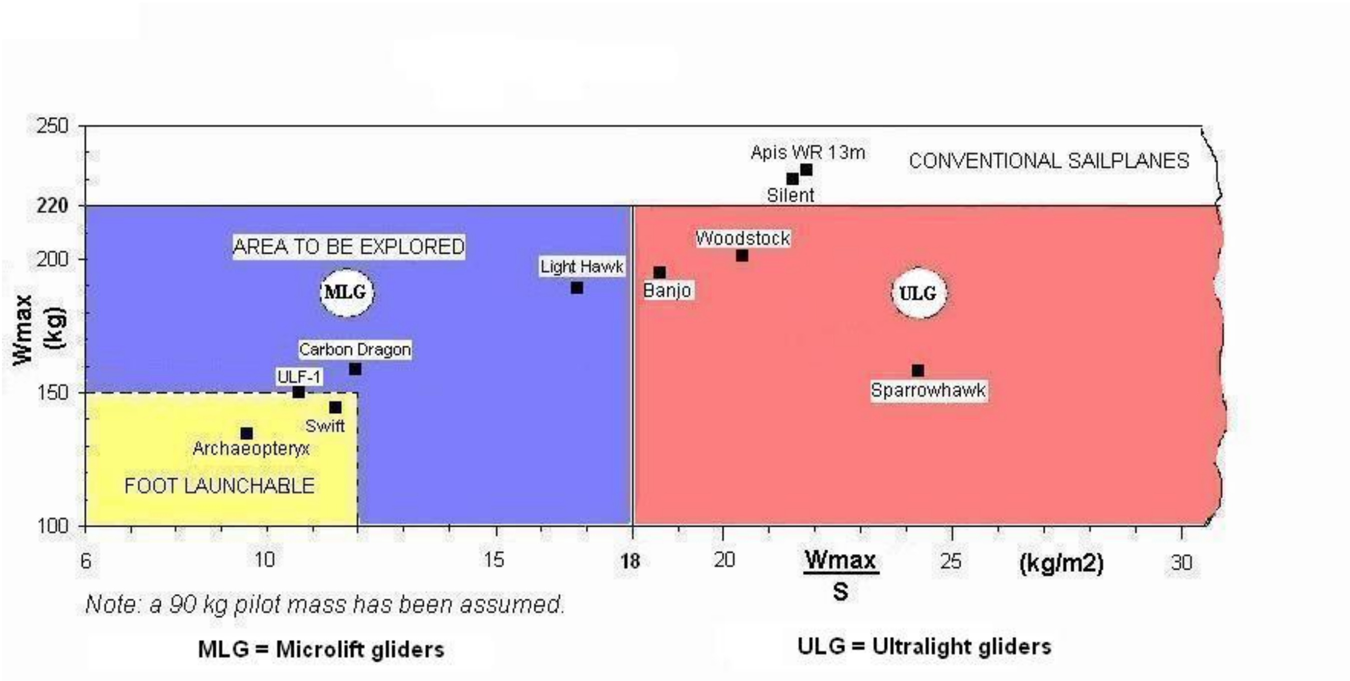


Diagram 1 Domain of the microlift glider