Development and Progress of Standard Class Sailplanes

by Boris Cijan and B. S. Shenstone

I. Introduction

National contests and international competitions assist the development of sailplanes. Although in the case of most present-day contests there are consistent disciplines and most of the contests are carried out over level ground, we still do not know a great deal about the structure of meteorological sources of energy typical of any of the Continents. If, however, several contests, particularly World Championshis, were to be flown under wave conditions, the design of sailplanes would develop in a way most suitable for such conditions. For different conditions, such as for thermal upcurrents, the development direction would be different. As a result, what is sometimes regarded as an optimum design today is actually a compromise solution, balanced between experience (data on former contests and weather conditions) and the state of the art (design and scientific knowledge). Sailplane designers, most of whom are also sailplane pilots, attempt to improve the performance and flying qualities step by step in newer designs in an effort to give a better semblance of reality to the probability calculations which have to be worked out during contests. One talks about various "proper" initial assumptions about the operations, but they are so often defeated by widely varying weather conditions, even during a single contest day. One needs a sailplane that can cope with the "critical upcurrent" because these critical weather conditions are often decisive in the outcome of a contest. In fact, it is often the case that the contest winner is the one who uses the best tactics rather than the one who is flying the best sailplane.

One tries to develop high performance machines to improve performance, not only to improve gliding angle at higher speeds but to retain a low sinking speed in order to operate safer and faster in marginal weather conditions. But such aircraft are so expensive that they cannot be built in quantity and so cannot become generally available. Without a sharp eye on the economics of sailplane manufacture, no such general availability is possible. The tendency in several countries is to build sailplanes at saleable prices and with acceptable performance. Such sailplanes, varying in dimensions, are designed to suit typical weather conditions in different countries, and may develop into local standards. In this connection, one thinks of some successful small-span types such as "Screamin Wiener" oı "Rigid Midget" suitable for stable mid-continent thermal conditions and the larger span West European types based one unstable and rapidly varying weather. It is of interest to note a tendency in some countries toward the use of typical "National Standard" sailplanes in contests so that pilots can all have equipment at the same technical level.

The above remarks and motives are even more important for World Championships. Very expensive machines are built, having extraordinary performance (usually only in straight flight) in order to gain some prestige for the nations represented by them. This approach, not to mention disappointments with some such "Hot-House Plants", does not lead to a general expansion of the sport. Therefore, the CVSM of the FAI, after a great deal of hard thinking decided to make an experiment to see whether some indirect guidance in the direction of economical development for the future could be achieved. The CVSM has not tried to standardize on one design or monotype as was intended for the 1940 Olympic Games, as it is too early for such a development. Instead, the CVSM has created two classes in the World Championships with the introduction of a clearly defined specification for a class called the "Standard Class". The Open Class is literally open: Tailless, Experimentals, "Hot-House Plants", take your choice.

Olympic Sailplane Design Competition — 1938

Fig. 1

Type Country		ORLIK Poland	S-18 Switzerland	FVA-13 Germany	B-8 Germany	DFS-MEISE Germany	Mü-17 Germany	AL-3 Italy	PELLICANO Italy
Span	m	15	13,4	15	15	15	15	15	15
Length	m	6,3	6,0	6,95	7,1	6,7	7,6	6,85	6,6
Wing Area	m²	14,8	13,36	14,5	15,6	15	13,33	14	14,7
Aspect Ratio		15,2	13,45	15,5	14,4	15	16,87	16	15,3
Wing Weight	kg	100	82	64	80	96	96	90	88
Fuselage Weight	kg	58	42	45	60	64	47	40	—
Tail Weight	kg	10	7	11	10		8,5	10	—
Structure Weight	kg	168	131	120	150	160	151,5	140	160
Load	kg	95	80	95	95	95	95	95	95
All-up-Weight	kg	263	211	215	245	255	246,5	235	255
Structure Weight / All-up-Weight		0.638	0.625	0.558	0.61	0.625	0.612	0.595	0.625
Wing Weight / Wing Area	kg/m²	6.75	6.15	4.4	5.12	6.4	7.2	6.42	6
Wing Loading	kg/m²	17,8	15,8	14,8	15,7	17,0	18,5	16,8	17,3
Wing Sections				Gö 535 Gö 535 M 3	Gö 549 Gö 535 Gö 535	Gö 549 Gö 676	Special		
Best Gliding Angle		25		20	23	25	26		

NOTE: All competition flights to be flown at 255 kg or more, there being therefore no advantage in structure weight less than 160 kg.

In the following parts of this paper the basic ideas on the subject of sailplanes classification, both in the past and at present, are discussed. In addition, the development and progress of Standard Class sailpanes are discribed.

II. The Olympic Sailplane

More than thirty years ago, M. Schrenk (1) wrote an ISTUS Paper on sailplane classification and suggested the span as a criterion for the sinking speed. Schrenk's suggestion is still of interest in indicating the state of sailplane development at the time, and was as follows:

Unlimited Class

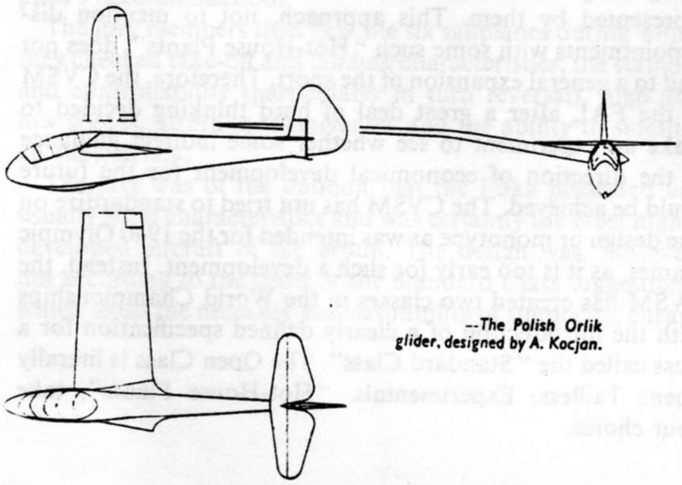
Average sinking speed 0.50 m/sec
Average gliding angle 1:25

16-metre Class

Average sinking speed 0.65 m/sec
Average gliding angle 1:21

12-metre Class

Average sinking speed 0.90 m/sec
Average gliding angle 1:17



—The Polish Orlik glider, designed by A. Kocjan.

Fig. 2

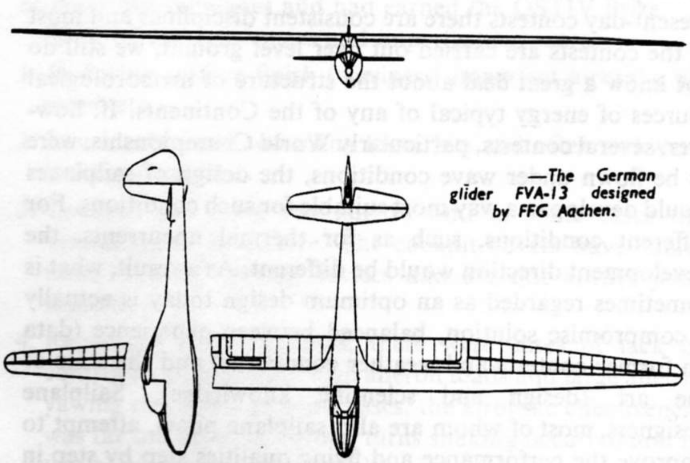
According to Schrenk, these span classifications should result in:

1. Equal basic requirements for constructor and pilot
2. Pressure to exhaust every possibility for improving aerodynamics and structures
3. Straightforward comparison of the ability of the constructor and the skill of the pilot.
4. Development of sailplanes which would be easily handled, manoeuverable, and easy to house.
5. Thereby broadening the basis of and furthering the spread of the sport of gliding.

From this we can see how sound were the ideas put forward by Schrenk and how some of them are valid even today.

In 1938 ISTUS (Internationale Studienkommission für den Segelflug), the forerunner of OSTIV, on the occasion of the scientific congress in Bern (Switzerland) drew up technical requirements at the request of the FAI for a standard sailplane, the so-called "Olympic Sailplane". This was intended for the 1940 Olympic Games. This was the general specification:

Span	15 m
Max. Empty Weight	160 kg
Load	95 kg
Max. Gross Weight*	255 kg + 3% tolerance
Fuselage Beam at Cockpit . . .	600 mm
Permitted Materials	Steel, plywood, pine and spruce
Undercarriage	Skid, but no wheel
Max. Terminal Diving Speed with Airbrakes	200 km/h.



—The German glider FVA-13 designed by FFG Aachen.

Fig. 3

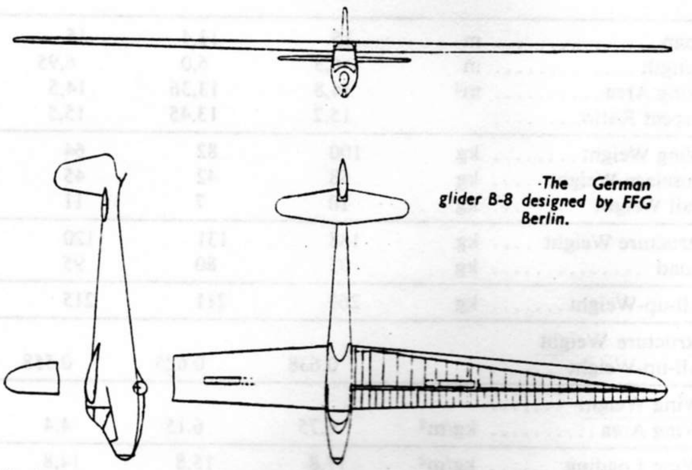
An interesting requirement was that for buoyancy after ditching; this requirement stated that the glider should stay afloat "for some thime", because in Japan (the first intended location for the Games) and in Finland (the location chosen later) there are large water areas.

The strength requirements for the Olympic Sailplane were in summary as follows:

	case A	case B	case C	case D	gust cases
Proof Factor . . .	5	5	1	2.75	
Safety Factor. . .	2	2	—	2	2
Lift Coefficient . . .	1.5	—	—	−0.4	
Dynamic Pressure (safe) kg/m²	—	140	—	—	
Speed kph	—	—	220¹	—	100²
Gust Speed m/s . .	—	—	—	—	±10 Gust efficiency η = 0.7

Max. permitted wing twist 4°

²Safe towing speed



—The German glider B-8 designed by FFG Berlin.

Fig. 4

There were further cases such as for ailerons, landing airbrakes (DFS Rhoenbussard type), empennage, towing, control system loading, etc. It is worth mentioning that these

*255 kg was also a minimum so that no advantage could be gained by refinements resulting in a reduced Empty Weight.

requirements were more formidable than the German BVS at the time, which for Case A required a proof factor of only 4 as an example. The undercarriage wheel was not permitted because of the small Japanese fields. One may also note the following points from the designs put forward:

1. Low wing loading (14.8 to 18.5 kg/sq.m)
2. Ratio $\frac{\text{Wing Weight}}{\text{Wing Area}}$ 4.4 to 7.2 kg/sq.m
3. Best gliding angle about 25

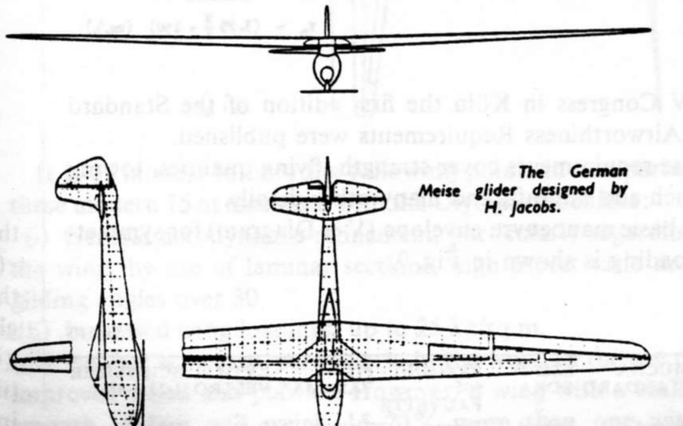
Fig. 1 shows information on the prototypes built in 1938 to these requirements. There were 4 German, 2 Italian and one Polish (2).

Fig. 2 to 8 show the general arrangement of these sailplanes*.

In 1939 near Rome an international jury of five experts decided which of these seven was to be adopted as the Olympic sailplane. They chose the DFS Meise, but, as we know, to no effect, for neither in Japan nor in Finland, nor anywhere else in the world have sailplanes ever competed in an Olympiad.

III. The Standard Class

After the second World War, gliding emerged again in Europe and the USA. World Championships were flown under the aegis of the FAI, new records were made and broken and new sailplanes developed. New technical developments kept pace with the increasing competition between pilots. At the same time, to replace ISTUS, the pre-war German-controlled organization, OSTIV was founded to encourage development and spread scientific and technical knowledge on gliding. OSTIV is independent, controlled by no country. The result, of course, is that OSTIV is poorer than ISTUS was in the late thirties. Freedom may well be worth some poverty.



The German Meise glider designed by H. Jacobs.

Fig. 5

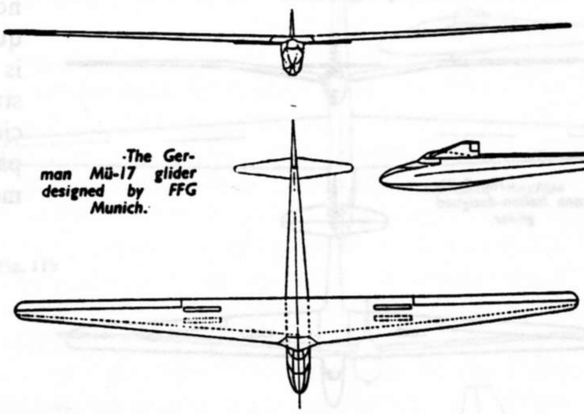
Since then, OSTIV has published six volumes of papers and two volumes of "The World's Sailplanes".

Whatever the results of a contest may be, it should be remembered that among the new developments there will have been many first-rate machines, but the financial burden of such development is often very heavy. In order to enable such development to be on a more economical basis, the CVSM has established this new class for the World Championship, the Standard Class.

When one views the progress of sailplanes in general, apart from classification, there are a number of factors to be noted if one is to obtain a clear appreciation of this new idea of classification.

*Except the S-18 for which no sketch is available

The sailplane designer, especially in regard to aerodynamics, can only advance slowly step by step and the results of theoretical and applied research can only be used gradually. The endless fight to reduce drag results in the use of very low drag



The German Mü-17 glider designed by FFG Munich.

Fig. 6

wing sections – so-called laminar sections. Gliding angles of the order of 40 have been attained by a number of sailplanes. The efforts of the constructor go far beyond the limits of an economically bearable result and a high performance creation diverges widely from what could be considered economically practicable. When the epithet "Super" has been used for such machines, it must really refer only to the cost, for nobody uses it when high performance has been attained by simple means.

The CVSM in co-operation with OSTIV studied the problem of the expensive machine with some care and came to the following conclusion:

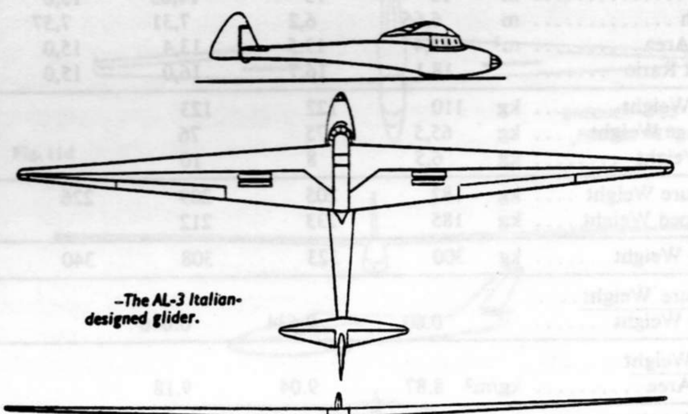
For future World Championships there will be two classes:

(i) Open class, for any sailplane without limitation.

(ii) Standard Class, for sailplanes fulfilling certain known requirements.

These Standard Sailplanes were to be developed within the framework of an FAI specification (St. Yan 1956).

(i) Standard Sailplanes must have a good performance, be easily handled, be manoeuvrable and simply constructed so that they can assist in furthering and extending the sport of gliding.



The AL-3 Italian-designed glider.

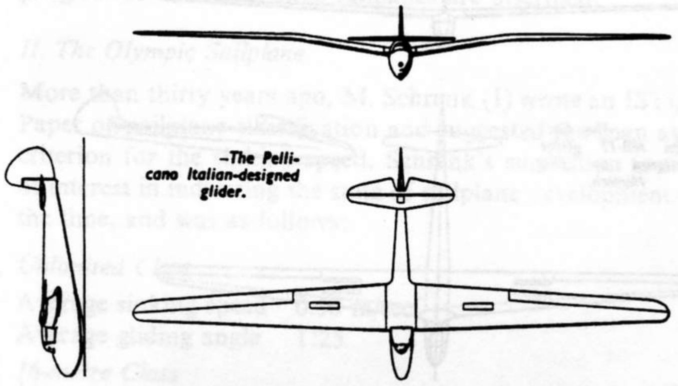
Fig. 7

(ii) Span not to be more than 15 m. (Same as the old Olympic requirements.)

(iii) The wing should be constructed as simply as possible. No flaps or other mechanical means for altering the wing camber to be allowed. No jettisonable ballast allowed. Ailerons to be simple and not used to increase lift.

(iv) No radio (but now being reconsidered).

(v) To be suitable for cloud flying.



–The Pellicano Italian-designed glider.

Fig. 8

(vi) Other points are the following recommendations:

(a) Sailplanes must be cheap and use cheap materials.

(b) They must be easy to handle on the ground, easy to repair, and easy to assemble and transport.

(c) There is to be a fixed wheel and wheelbrake.

However, there is no requirement for minimum fuselage width or seating position for the pilot. The real limitation is thus only the span and not in addition an empty weight as for the Olympic Specification (max. 160 kg).

In 1958 in Leszno, Poland, for the first time the Standard Class appeared actively in a World Championship. It was a great success. Today there are a large number of Standard Class designs which fulfil the ideas intended and are suitable for distance, wave, cloud and limited aerobatics flying and which can be used in local and world contests and club flying.

IV. Present Position and Outlook for the Further Development of Standard Sailplanes

The CVSM FAI Standard Sailplane Specification demands no special airworthiness requirements for strength, flying qualities, etc. and a valid National Airworthiness Certificate is enough for entry to a World Championship. OSTIV has studied this problem of airworthiness for this class and decided it would be a good thing to devise a suitable requirement, particularly of use to those countries which have no requirements of their own. In June 1960 on the occasion of the

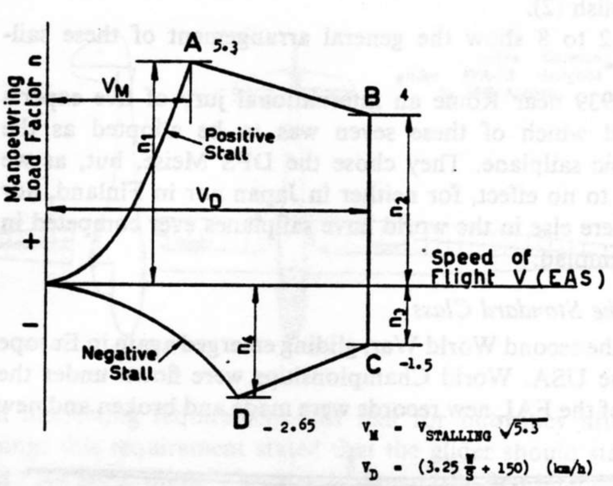


Fig. 9

OSTIV Congress in Köln the first edition of the Standard Class Airworthiness Requirements were published.

These requirements cover strength, flying qualities, towing by winch and aircraft, and many other details.

The basic manoeuvre envelope (V-n Diagram) for symmetrical loading is shown in Fig. 9.

Standard-Class Sailplanes

Fig. 10

Type		KA-6	STANDARD AUSTRIA	SKYLARK 2	OLYMPIA-EON MARK 4/15	MUCHA STANDARD	SZD-24 FOKA	BREGUET 905 FAUVETTE	PIK-16 VASAMA*	CVT-2 VELTRO	SCHWEIZER 1-23 H-15
Country		Germany	Austria	Gt. Britain	Gt. Britain	Poland	Poland	France	Finland	Italy	USA
First Flight		1955	1960	1955	1958	1958	1960	1958	1961	1954	1960
Span	m	15	15	14,63	15,0	14,98	15,0	15,0	15,0	15,0	15
Length	m	6,66	6,2	7,31	7,57	7,0	7,0	6,22	5,97	6,9	6.34
Wing Area	m²	12,4	13,5	13,4	15,0	12,75	12,16	11,25	11,7	12,5	14.9
Aspect Ratio		18,1	16,7	16,0	15,0	17,65	18,5	20	19,2	18,0	15,12
Wing Weight	kg	110	122	123		112	128	78	105	111	
Fuselage Weight	kg	65,5	75	76		96	89	65	50	59	
Tail Weight	kg	6,5	8	10		11	8	12	11	6	
Structure Weight	kg	182	205	209	226	219	225	155	166	176	215
Equipped Weight	kg	185	233	212		240		192	171	181	254
All-up Weight	kg	300	323	308	340	350	312	275	230/281	266	340
Structure Weight ... / All-up Weight		0.60	0.634	0.646		0.625	0.73	0.563	0.59	0,66	0,632
Wing Weight / Wing Area	kg/m²	8.87	9.04	9.18		8.77	10.52	6,93	8.97	8.88	
Wing Loading	kg/m²	24.2	24.0	23.0	22.6	27.4	25.7	24,5	24.0	21.3	22.8
Wing Sections		63–618 Jouk 12%	65_2–415	63_3–620 4415	64_3–618 644 421M	Gö–549 M12	63–618 4415	63 420 63 613	FX–05–188 $63_2$615	$64_2$515 $64^2$512	43 012A 23 009
Best Gliding Angle ...		31,5	34.0	30	33	27,8	34	30	34,5	35	29,2
Prize		Ostiv Prize 1958	Ostiv Prize 1960						Ostiv Prize 1963		World Altitude Record
World Championships Winner		Köln/Junin 1960/1963				Leszno 1958					

*Original butterfly tail model

The minimum safety factors are 1.0 and 1.5 for proof and ultimate loads respectively. However, it is for National Authorities to decide whether a quality factor should be taken into account to cater for variable material quality. Such a factor of 15% for wood would mean that the ultimate static loading would require a safety factor of about 1.725

Recent Standard Class developments show remarkable advances. Fig. 10 shows only a few well-known types which are in series production, and on Fig. 11 are shown general arrangement drawings of:

OSTIV Prize Winners

Ka6BR
Standard Austria
Vasama

Mucha Standard
Foka
Fauvette
Schweizer 1-23H-15

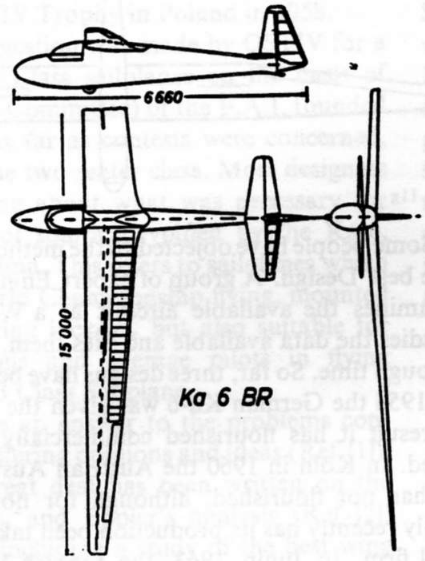


Fig. 11a

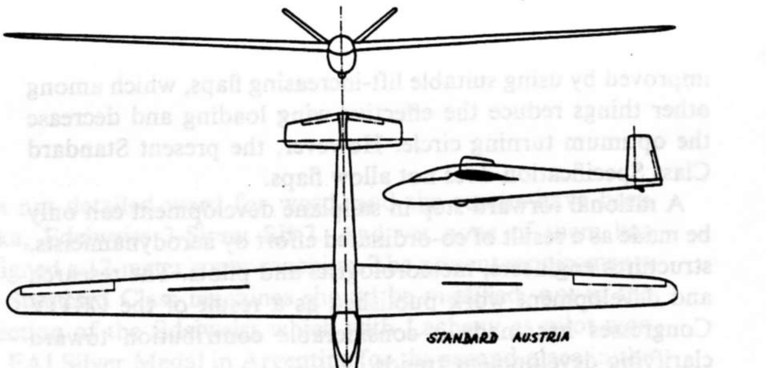


Fig. 11b

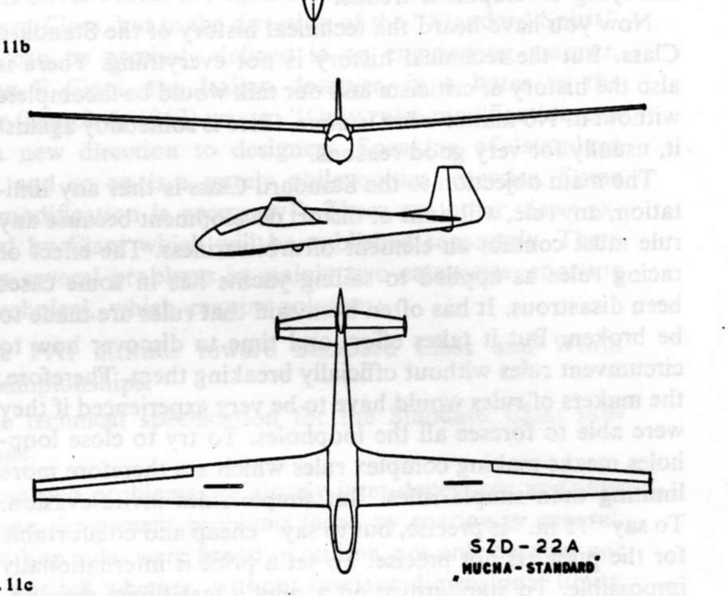


Fig. 11c

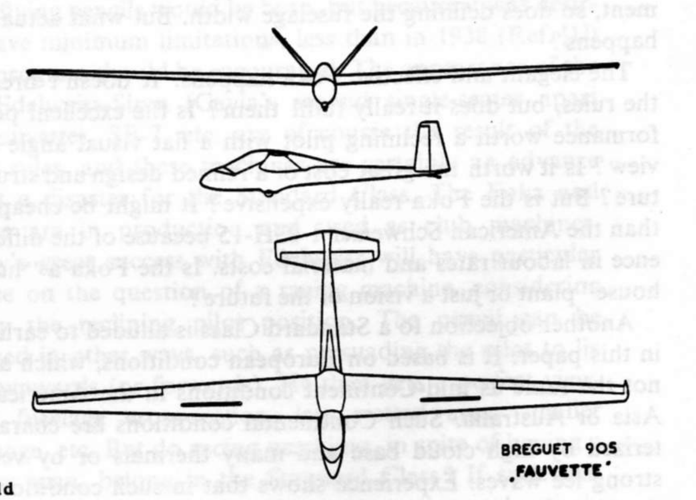


Fig. 11d

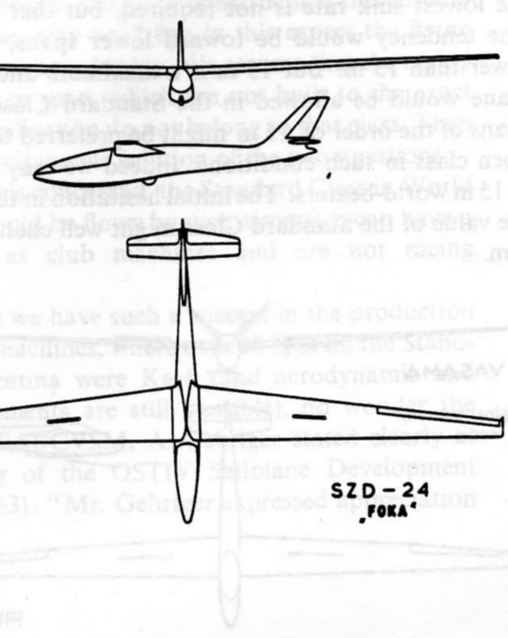


Fig. 11e

It is of interest to note the following points in comparing these modern 15 m machines with the Olympic machines:

(i) General aerodynamic refinement, particularly regarding the wing, by use of laminar sections, high aspect ratio and gliding angles over 30.

(ii) Increased wing loadings, up to 25 kg/sq.m.

(iii) Refined structure, particularly in the wing, in the use of improved wood and plastics. However, a wing with a really smooth surface will weigh 15–20% more than one with normal ribs and wing section for the same load factor.

The specific wing weight, which in the Meise was 6.4 kg/sq.m, is for the Ka-6 8.9, and for the Foka 10.5. The use of modern high strength glue (metal to wood) and mixed construction is particularly to be noted in the French Fauvette (Breguet 905) which has an empty weight of only 148 kg (Meise 160 kg) and an aspect ratio of 20. This has been achieved in spite of the above-mentioned inherent tendency for modern wings to be heavier.

(iv) Better Flying Qualities, particularly in circling flight. If one has chosen to limit the span, as was first done 25 years ago and now once again, purely to lower the selling price, we find other advantages. Experience shows that in practical operation, circling flight takes up about half the total time of any distance flight, and that smaller span machines are much more manoeuvrable than those with large spans. As far as performance goes, even a 12 m sailplane can compete successfully in the Standard Class (3). Eppler has shown that the cruising speed does not vary very much with variation of span.

(v) The increase in wing loading between the Meise (17 kg/sq.m) and the present value of about 25 kg/sq.m for 15 m sailplanes is a result of European weather experience. The soaring efficiency of future sailplanes can be further improved by using suitable lift-increasing flaps, which among other things reduce the effective wing loading and decrease the optimum turning circle. However, the present Standard Class Specification does not allow flaps.

A rational forward step in sailplane development can only be made as a result of co-ordinated effort by aerodynamicists, structures engineers, meteorologists and pilots. The research and development work published as a result of the OSTIV Congresses has made a considerable contribution toward clarifying development trends.

Now you have heard the technical history of the Standard Class. But the technical history is not everything. There is also the history of criticism and our talk would be incomplete without it. No matter what is done, there is somebody against it, usually for very good reasons.

The main objection to the Standard Class is that any limitation, any rule, will limit or distort development because any rule must contain an element of arbitrariness. The effect of racing rules as applied to sailing yachts has in some cases been disastrous. It has often been said that rules are made to be broken. But it takes effort and time to discover how to circumvent rules without officially breaking them. Therefore, the makers of rules would have to be very experienced if they were able to foresee all the loopholes. To try to close loopholes means making complex rules which are therefore more limiting than simple rules. But simple rules invite evasion. To say "15 m." is precise, but to say "cheap and comfortable for the pilot" is not precise. To set a price is internationally impossible. To standardize on a pilot's seat limits development, so does defining the fuselage width. But what actually happens?

The elegant and effective Foka happens. It doesn't break the rules, but does it really fulfil them? Is the excellent performance worth a reclining pilot with a flat visual angle of view? Is it worth the great cost of a refined design and structure? But is the Foka really expensive? It might be cheaper than the American Schweizer 1-23H-15 because of the difference in labour rates and material costs. Is the Foka a "hothouse" plant or just a vision of the future?

Another objection to a Standard Class is alluded to earlier in this paper. It is based on European conditions, which are not the same as mid-Continent conditions in the Americas, Asia or Australia. Such Continental conditions are characterized by high cloud base and many thermals or by very strong lee waves. Experience shows that in such conditions, the lowest sink rate is not required, but that speed counts. The tendency would be toward lower spans, perhaps even lower than 15 m. But 15 m is a maximum and a 12 m sailplane would be allowed in the Standard Class. So perhaps spans of the order of 15 m might be preferred to the big-span open class in such conditions. Indeed we may look forward to 15 m world-beaters. The initial hesitation in the USA about the value of the Standard Class might well change to enthusiasm.

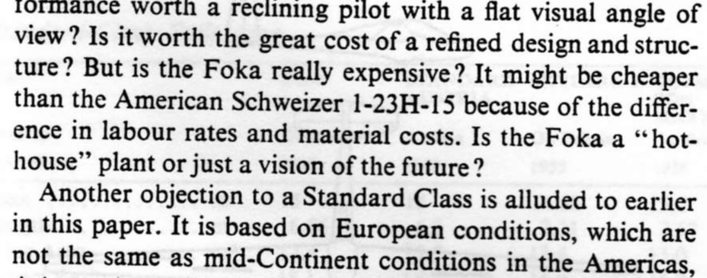


Fig. 11i

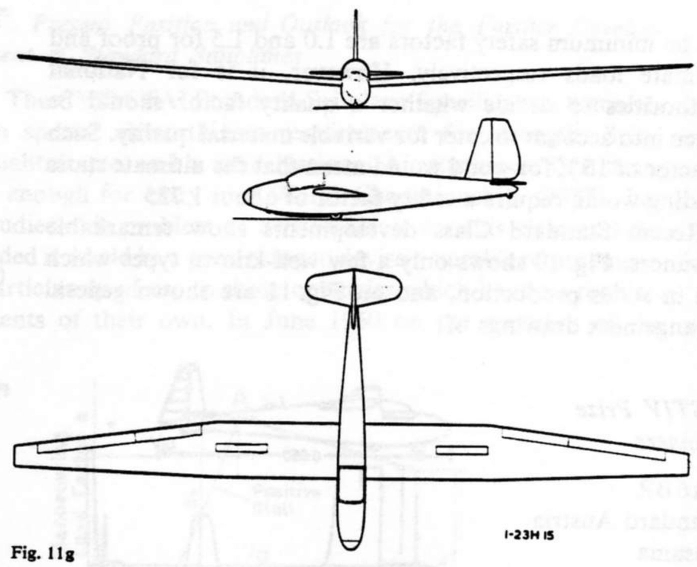


Fig. 11g

Some people have objected to the methods used for choosing the best Design. A group of expert Engineer-Designer-Pilots examines the available aircraft at a World Championship, studies the data available and flies them. There is never quite enough time. So far, three designs have been chosen. In Leszno in 1958 the German Ka-6 was given the OSTIV Prize and as a result it has flourished commercially and is now widely used. In Köln in 1960 the Austrian Austria was chosen, but it has not flourished, although for non-technical reasons. Only recently has its production been taken up by a commercial firm. In Junin, 1963, the Finnish Vasama received the Prize. Some say that only production aircraft should get the OSTIV Prize. But should the prize be given to an aircraft which is no longer new?

Others say that the Standard Class should be one-design or monotype. Just to leave it at that would mean design stagnation. To change the monotype every five or six years would be a problem. A monotype could not be the manufacturing monopoly of one firm. The issue of manufacturing licenses all around the world and the up-dating of drawings would be very laborious and expensive. One of the present authors has elsewhere put forward some suggestions for a non-stagnating monotype, and (4) should be read in this connection. Pierre Bonneau has also made interesting suggestions in (5).

If the Standard Class becomes very popular, will the Open Class disappear? As we get closer to the ultimate possibilities of design refinement, the costs of improvement will become even higher and there may well be fewer Open Class contestants. Might there be too few? This is unlikely but the question is open.

There are many other questions such as these, and we are very willing to discuss any that may occur to you.

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