

Manpowered aircraft

by B. S. Shenstone, B.O.A.C., London Airport

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This is the fourth lecture on manpowered aircraft to be presented to ISTUS or OSTIV, the first being by Silva in 1938 (7th ISTUS-Mitteilung), the second by Nonweiler in 1958 (OSTIV Publication V) and the third by the present author at Cologne in 1960 at the VIII Congress, but this was not published. These earlier lectures dealt mainly with the possibilities and probabilities of success in achieving manpowered flight, with references to the efforts made in Germany and Italy in the Nineteen-thirties.

Although it is now possible to report some real measure of recent achievement, such achievement owes much to the earlier pre-war efforts, so it is only fair to remind you of this background.

I have arbitrarily decided to limit my remarks to attempts on manpowered flight which have been based on proper scientific information. This means that I must omit almost all the attempts, because most of them have been entirely individualistic and non-scientific and showing in many cases extremely small engineering ability. For those who would like to look at all endeavours which have been made for very many years past on this problem, I would refer them to the book which was published in 1936 and entitled "Flug durch Muskelkraft" (Ref. 1).

One of the earliest attempts by an engineer to construct a muscle-powered aircraft was that by Alexander Lippisch in 1929 when he designed for Dr. Brustmann a flapping wing machine which was based on estimates of man power supplied by Dr. Brustmann. Lippisch soon found that the information that Dr. Brustmann had gathered was faulty and that man certainly could not produce as much power as Brustmann had estimated. (Ref. 2.)

Haessler and Villinger, who designed a machine in 1934 called the "Muffi" and flew it in 1936 (Figures 1 and 2), also used Brustmann's information and found in the same way that their aircraft had insufficient power to win the prize offered by the Polytechnische Gesellschaft at Frankfurt for a flight of 1 km around two pylons 500 m apart. It was indeed this prize offered in 1933 which assisted the development of manpowered aircraft in Germany in the years shortly before the Second World War, but unfortunately the prize was never won, but you may say it was nearly won. Haessler and Villinger did receive a special prize for the efforts they made.

They made several officially observed flights of about 200 m in August 1935 and one flight of 400 m and later, with another pilot, achieved a distance of 720 m in 1937 (Table I.).

It was unfortunate that Oskar Ursinus did not start his Muskelflug-Institut at Frankfurt earlier. If he had founded it earlier, his information would have been available in time for the contest mentioned above. Here I think I should refer to the six reports of the Muskelflug-Institut published in Flugsport (Ref. 3) which were mostly written by Gropp who did the work in the laboratory and tried all possible methods of getting power out of a man, including all practicable attitudes. As it turned out, the pedalling motion

was apparently the best and slightly better than rowing and some other methods. The limitations of Gropp's results lie in the fact that they did not extend beyond the first couple of minutes of exertion, and therefore did not extend as far as the true cruising power conditions. Fortunately more recent work by Wilkie and Nonweiler has extended the range up to about one hour.

The only pre-war aircraft of any consequence which was able to take advantage of the Ursinus/Gropp information was the Bossi/Bonomi "Pedaliante" aircraft which first flew about 1936 (Fig. 3 and 4). This was designed in general by Mr. Enea Bossi, an Italian who after designing seaplanes and propellers during the first World War, emigrated to America where he became an American citizen and where he still resides (Ref. 4 and 5). He found himself in Europe at work for the Budd Company and collaborated with Vittorio Bonomi in producing this aircraft which was a single-seater of 17 m (55.7 ft) span operated by one man driving two propellers oppositely rotating. In spite of its large size and rather heavy weight, this machine is said by Bossi to have taken off by the unaided power of the pilot, Emilio Casco. However, this has been denied by Silva and Rovesti. The longest flight (December 1936), which was the result of a bungee launch, was about 900 m in length and it involved two 90° turns. This machine was described in some detail by Silva in his 1938 paper before ISTUS. Table II shows some of the flights made by Casco.

The Bossi-Bonomi aircraft suffered from political difficulties, because Mr. Bonomi was an Anti-Fascist and Mr. Bossi was an American citizen, and as a result their aircraft was not allowed to enter an Italian competition for manpowered flight in 1937. There were, however, no other contestants and there has been no official record and no possibility of obtaining it. Mr. Bonomi arranged for a Press demonstration of the aircraft which was very successful.

1. Haessler-Villinger 3-view

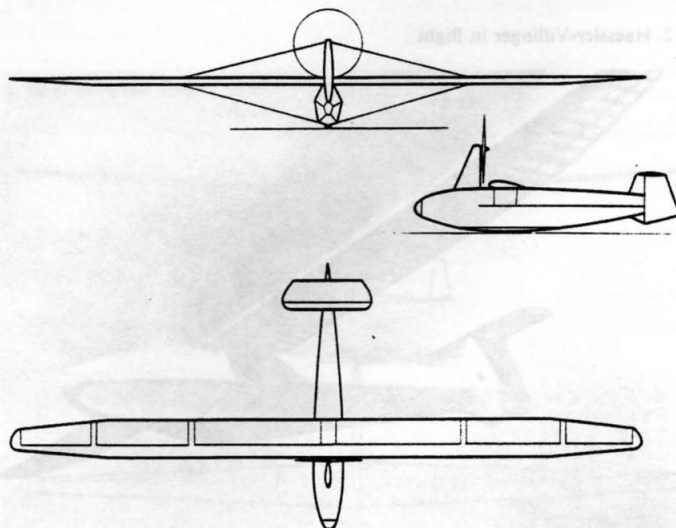


Table I
Flights made by Haessler-Villinger «Mufi»

(a) With Duennebeil as Pilot

Date	Time	Distance		Dur. sec.	Height		Remarks
		m	feet		m	feet	
29. 8. 1935	11.10	120	394	17	1	3	Slight damage
29. 8. 1935	18.22	195	635	20	1	3	
29. 8. 1935	18.43	177	580	18½	1	3	
30. 8. 1935	07.45	235	770	24	1	3	Stall, damage to fuselage nose
30. 8. 1935	08.14	150	490	14	—	—	
31. 8. 1935	17.55	220	720	21	4-5	12-16	
31. 8. 1935	18.44	204	667	20	4-5	12-16	

(b) With Hofmann as Pilot

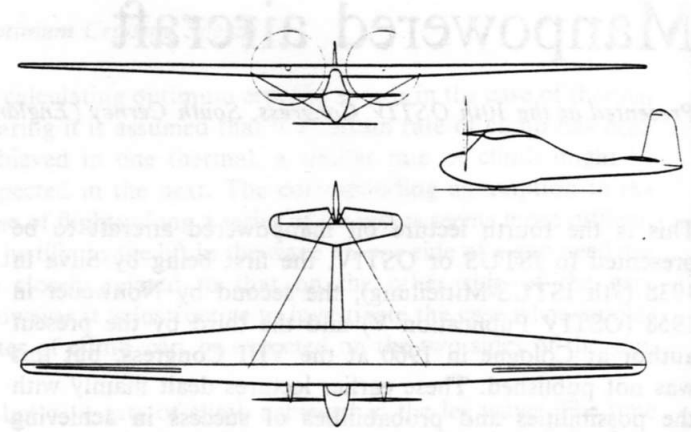
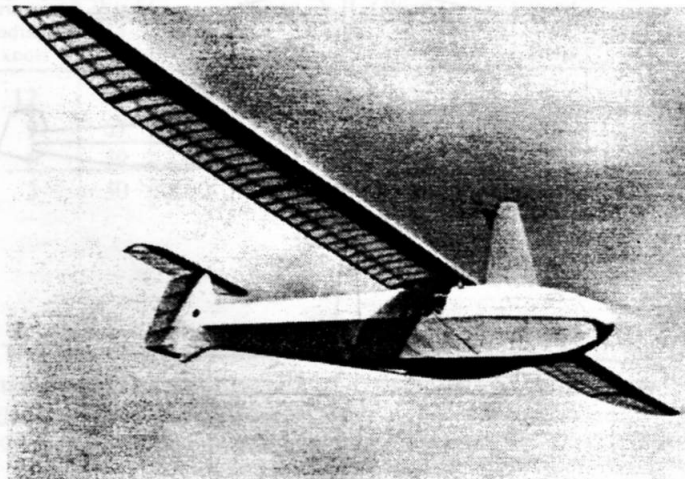
Date	Distance		Duration seconds	Speed	
	metres	feet		km/hr	mph
21. 11. 1936	435	1,420	—	—	—
1937	610	2,000	60	37	23
4. 7. 1937	720	2,360	72	35	22

although I have not seen the attested record. Mr. Enea Bossi informed me at a meeting in New York in 1960 that this may exist somewhere in the papers of the late Vittorio Bonomi.

Since World War II very little activity of any description was noted until 1948 when my former colleague, Brian Worley, wrote a review of the Haessler-Villinger and the Bossi-Bonomi aircraft (Ref. 6). Possibly the next publication was a paper by the present author read before the Low Speed Aerodynamics Research Association in London and also before the Canadian Aeronautical Institute on the subject of "The problem of the very light-weight, highly-efficient aeroplane" (Ref. 7). As a result of the delivery of this paper, it was discovered that Professor T. R. F. Nonweiler at the College of Aeronautics at Cranfield in England was already giving consideration to the problem of man-powered flight and this mutual interest encouraged both of us.

I would particularly like to call the attention of interested people to a later paper by Nonweiler with the title of "The Man-Powered Aircraft: A Design Study" (Ref. 8), which contains much useful technical detail and data and a good scientific approach.

2. Haessler-Villinger in flight



3. Bossi-Bonomi 3-view

It then became known that Emiel Hartman, a South African sculptor living in London, was very interested in producing a flapping wing manpowered aircraft and that Dan Perkins at Cardington was building an inflated wing, propeller-driven manpowered aircraft. Neither of these has successfully flown by manpower.

Somehow several people interested in various aspects of manpowered flight found themselves discussing it. As a result, on 10 January 1957 a Manpowered Aircraft Committee was formed at the College of Aeronautics, Cranfield, England, and the original members were:

H. B. Irving (Chairman)

Dr. J. R. Brown, London School of Hygiene and Tropical Medicine

Robert Graham, Microcell Ltd.

Thurstan James, Editor "The Aeroplane"

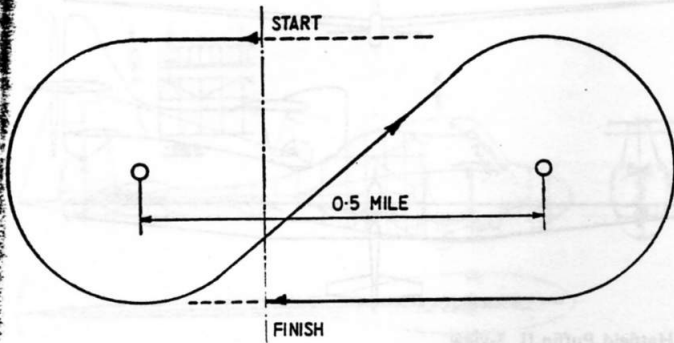
Professor T. R. F. Nonweiler, Queen's University of Belfast

A. Newell, College of Aeronautics

B. S. Shenstone, Chief Engineer, British European Airways

4. Bossi-Bonomi in flight





5. Kremer figure 8 course

Since then, the following are now or have been members of the Committee:

- J. M. Gray
- C. H. Latimer Needham
- Professor G. M. Lilley
- D. G. A. Rendel
- Dr. D. R. Wilkie
- Peter Scott
- R. P. Itter
- S. Scott-Hall
- W. C. Holloway
- R. Graves.

This Committee was formed in vacuo and had no backing or authority outside its own members. The first effort of the Committee was to try to make information available to any interested person who might like to develop a manpowered aircraft. A number of articles were written and contact was made with Haessler, Villinger and Bossi, who all supplied information additional to that available in print.

It was decided to encourage young designers to produce experimental aircraft and to enable this to be done, the Committee became associated with the Royal Aeronautical Society, and a Manpowered Aircraft Group was formed for the purpose of financially assisting promising designs. It was assumed that no financially sound organization would attempt such an unpromising project.

While money was being collected by the members of the Group, an industrialist, Mr. Henry Kremer, in November 1959 came forward apparently out of a blue sky with an offer of £5,000 for the first manpowered aircraft flight around a "Figure of 8" course based on two markers, one half-mile apart (Fig. 5) (Appendix A). The fund for assisting designers and manufacturers finally reached £5,000 so that there was initially a total of £10,000 available for assistance and for the prize.

The Royal Aeronautical Society then publicized the fact of these funds being available and specified that anybody

who wished to be assisted financially would have to put forward certain technical information (details attached in Appendix B) so that the value of his design could be judged by the Manpowered Aircraft Committee. Six projects were put forward—all fixed-wings and propeller-driven. The two initially most promising designs were those put forward by the Southampton Manpowered Aircraft Group and the Hatfield Manpowered Aircraft Group, both for single-seaters driven by single pusher propellers. Later the Southend side-by-side two-seater aircraft was assisted and finally the Woodford Manpowered Aircraft was also given assistance. At the present time, the Southampton, Hatfield and Southend aircraft have been completed, but the Woodford aircraft is still incomplete.

The first flight of the Southampton aircraft was on 9 November 1961 (Fig. 6 and 7) and the Hatfield Puffin I first flew on 16 November 1961 (Fig. 8 and 9 show the Mark II version). Both these flights were made without storage of energy and with the unaided strength of the pilots. Thus one of the major controversies was ended. It was clear that a pilot, as long as the landing wheel could be driven, could take off under his own power and fly for a reasonable distance. Full credit for this feature must be given to Bossi who incorporated it in his *Pedaliante* in 1936 (Fig. 10).

The Southend machine (Fig. 11) is the only two-seater which has been completed. However, owing to mechanical difficulties with the drive, it has not yet flown.

The second problem that these aircraft solved was the argument and discussion on the achievable structure weights. As a result of the development of structural and aerodynamic techniques it was possible to build light-weight cantilever wings over 80 ft (24.4 m) in span, the resulting aircraft having empty weights no greater than that of an average girl friend or the early Haessler-Villinger aircraft of much shorter span.

The weights achieved indicate two things: firstly, that surprisingly low weights are possible, and secondly, that one must come to the conclusion that sailplanes are excessively heavy. This may be considered unimportant to glider people and indeed in many cases high sailplane weight does not matter because weight does not affect the gliding angle although it does affect the sinking speed.

In the case of manpowered aircraft, the important thing is the power required so that the weight is one of the essential items which must be reduced to the utmost.

6. Southampton 3-view

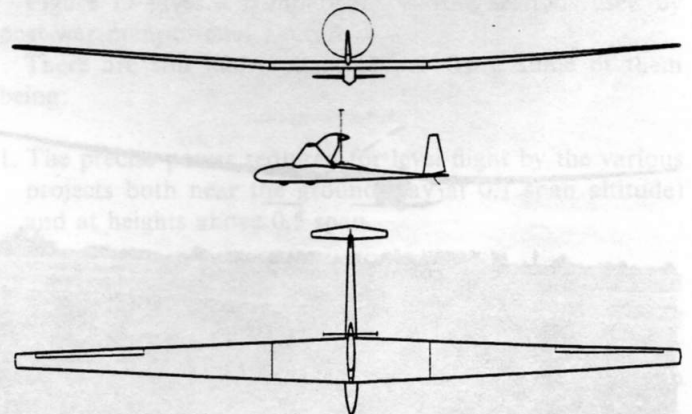


Table II
Flights made by Bossi-Bonomi «Pedaliante» (1936 and 1937)

metres	Distance		Time		Speed	
	feet		seconds		mph	km/hr
900	2,950		71		28.3	45.5
750	2,450		53		31.5	51
500	1,640		47		24	39
860	2,820		74		26	42

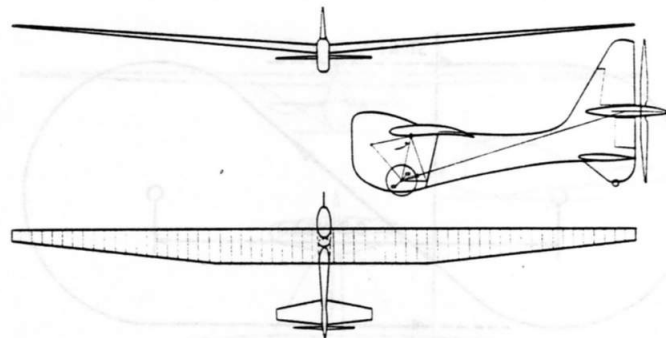
Figures 12 and 13 indicate the differences between the sailplane weights and manpowered aircraft weights. You may well ask how the load factors compare between these two kinds of aircraft. The likelihood is that the ultimate load factor for the manpowered aircraft is of the order of 5, but for the sailplane a likely average figure is 8. On the other hand, the manpowered aircraft is operated at a very much lower speed, at lower altitudes, and therefore with much less severe gust loading. However, it will be seen that even if you double or treble the wing weight, it would still be lower than the weight for the average sailplane. I feel that this achievement should encourage sailplane designers to look again at their weights, because weight is certainly of vital importance under, for instance, marginal thermal conditions, although, as we all know, high weight is often valuable in attempts at high-speed circuits.

Another point was made quite clear, namely, that mainly as a result of the work of Oskar Ursinus, Nonweiler and Wilkie (Ref. 9), the cruising power available from a man is known to be of the order of $\frac{1}{2}$ H.P. The theoretical power required for the best of the manpowered aircraft to date is of the order of 0.4 H.P.

The longest flight accomplished by the unaided efforts of the pilot, including the take-off, was by John Wimpenny in the Hatfield Puffin on 2 May 1962, a distance of 910 m in a straight line. By chance this flight was witnessed by representatives of thirteen nations (the IATA Technical Committee). This flight indicates that an aircraft that requires about 0.5 horsepower for flight close to the ground has already been built.

Experience with the Southampton manpowered aircraft, under the pilotage of Derek Piggott, indicated that certain mechanical improvements could be made and such improvements have been made over the last couple of years by the London Manpowered Aircraft Group under the direction of Alan Lassièrè. Unfortunately this aircraft crashed on November 12, 1965, and is not being rebuilt.

The Hatfield manpowered aircraft suffered a landing accident in 1963 which destroyed the wing but did no other serious damage either to aircraft or pilot. The Hatfield Group has taken full advantage of this opportunity of redesigning their wing, increasing the span from 84 ft (25.6 m) to 93 ft (28.3 m). The structure has been basically modified and changed from the classical D-nose type wing to a two-spar



8. Hatfield Puffin II, 3-view

wing with suitable diagonal bracing between the spars to supply the requisite torsional rigidity. The ribs are passed over the spars and the entire external covering is in transparent Melinex which produces a perfectly smooth surface, and which, owing to the very close spacing of the nose ribs, results in a very true surface.

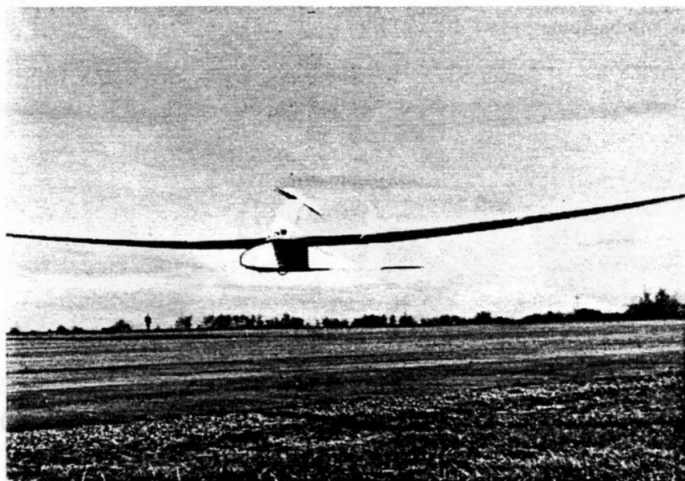
At the same time, the Hatfield Group was fortunate in being offered a specially designed wing section by Dr. F. X. Wortmann. This wing has been completed and the revised aircraft, Puffin II, flew on August 27, 1965.

It will be of interest to know that, apart from the Southampton aircraft (which was built essentially of spruce with a certain amount of balsa), the other three aircraft have been built almost entirely of balsa wood except for the wing spars, which are of spruce. Carefully chosen balsa has been shown so far to be lighter and more usable than any form of plastic so far available in a form which can be economically used on prototypes.

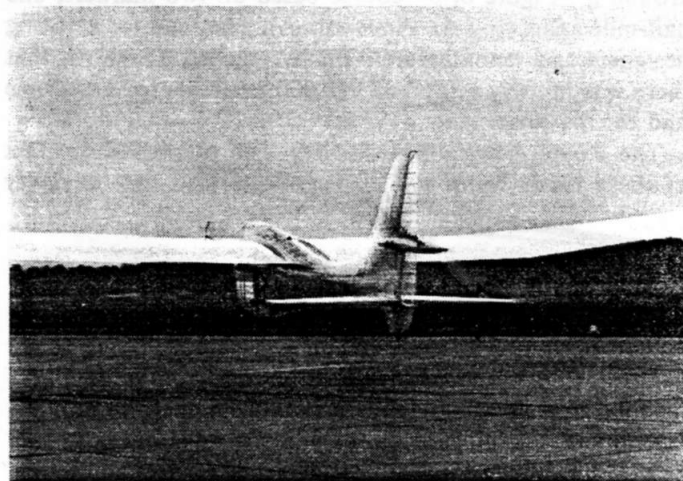
On the other hand, the Manpowered Aircraft Group in Ottawa considers that the fuselage might with advantage be constructed from thin gauge light alloy tube which is now available; for example, only 0.4 mm thick for a diameter of 4 cm or 0.6 mm for a diameter of 7.5 cm. These thicknesses are such that these tubes are difficult to attach to each other by normal means, and the Ottawa Group has devised a method of using fibre-glass cords impregnated with suitable plastic.

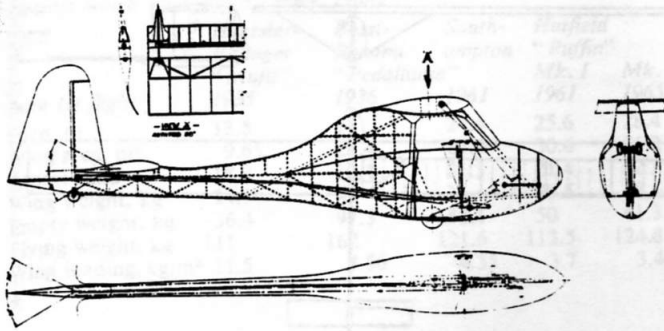
As far as drives are concerned, the Hatfield Group aircraft uses gearing only and no chains. The Southampton machine used chain and belt, whereas the Woodford and

7. Southampton in flight

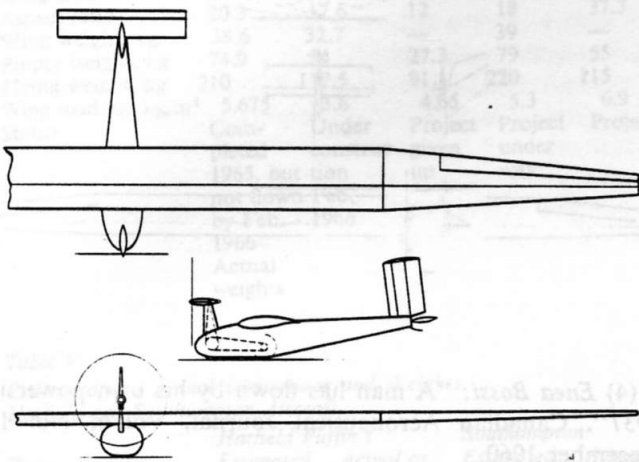


9. Hatfield Puffin II in flight

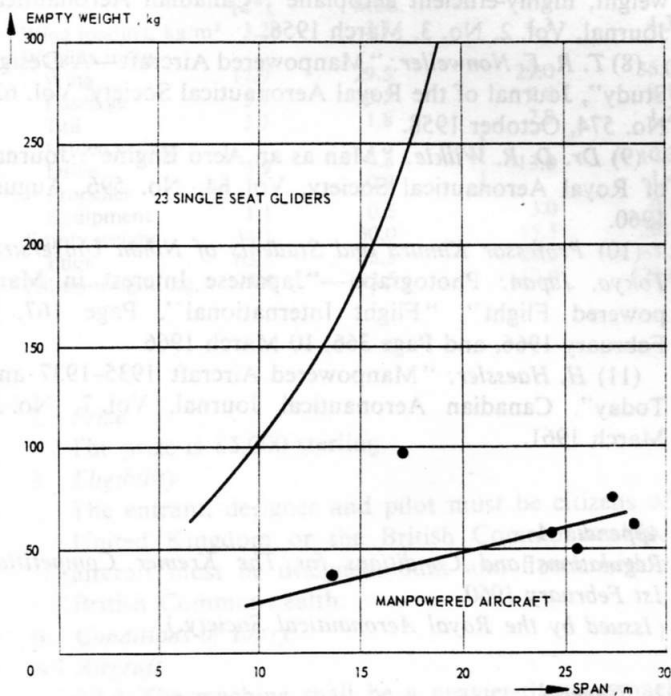




10. Bossi-Bonomi fuselage showing wheel-drive



11. Southend 3-view



12. Empty weight vs. span—Left to right: Haessler-Villinger, Bossi-Bonomi, Southampton, Hatfield I, Southend, Hatfield II

Southend machines use chains only. An alternative to gears has been developed by W. Czerwinski in Ottawa by using a clever arrangement of double universals with low friction bearings, as illustrated in Fig. 14.

Although this paper is essentially a report on the present position of manpowered aircraft development in the United Kingdom, I must not exclude significant developments in other parts of the world.

I have already mentioned that Alexander Lippisch, designer of well-known pre-war sailplanes such as "Professor", "Wien", and "Fafnir", designed a flapping wing manpowered aircraft in 1929 and has kept an interest in this subject. In Cedar Rapids, Iowa, U.S.A., he formed a Group to design and build a very light-weight manpowered aircraft (Fig. 15). This was to have a span of 15.2 m (50 ft) and a wing area of 19.5 m² (208 sq.ft) and was expected to achieve an empty weight of only 60 lb (27 kg). The design shows a braced wing, and control would be on lines similar to that used on the Haessler-Villinger machine, in that the entire wing to be rotated about the spar to give roll when rotated oppositely and pitch when rotated in the same direction. Lippisch has unfortunately not been able to complete this interesting project.

The Canadian Aeronautics and Space Institute has formed a Manpowered Flight Section. They have produced a bicycle ergometer and have made a wing structural specimen and are now working, under Czerwinski, on the detailed design, which is a braced tandem two-seater of 90 ft (27.4 m) span (Fig. 16).

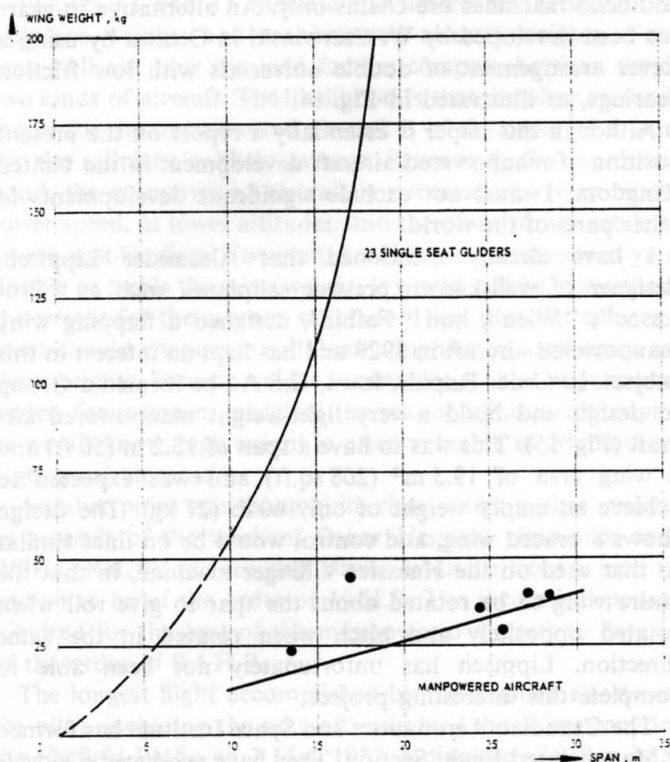
We have recently seen a photo of a Japanese manpowered aircraft developed by Professor Kimura of Nihon University, which features a propeller aft of the tail, as in the Hatfield aircraft, but in other ways it may be rather different. The only data available at time of writing are: This machine first took to the air on 27 February 1966, flying about 10 m at a height of 3 m. Span is 23 m, length 5.9 m and empty weight 50 kg (Reference 10).

Precise data are always useful to designers so I give some in Tables III, IV, and V. Table III gives basic measured data on manpowered aircraft which have flown. Table IV shows similar estimated data on certain manpowered aircraft which have not yet flown, including an interesting project by Haessler which in essence updates the Haessler-Villinger "Mufli" of 1935, by increasing span and adding a driven wheel (Ref. 11). Table V compares calculated and measured weights for the Southampton and Hatfield aircraft as originally flown. It is of interest to note that the Southampton group had never designed an aeroplane before, and the Hatfield group had wide design experience.

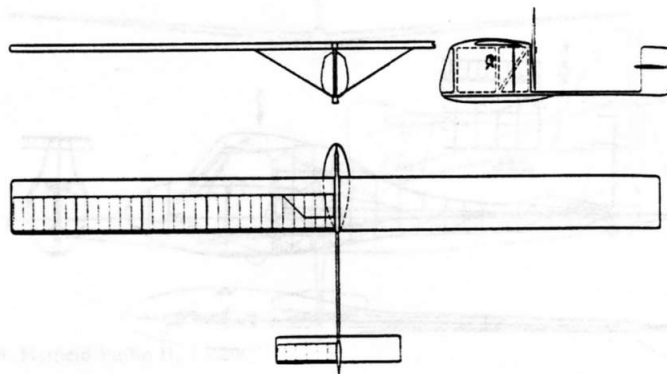
Figure 17 gives a comparison of wing sections used by post-war manpowered aircraft.

There are still many unsolved problems, some of them being:

1. The precise power required for level flight by the various projects both near the ground (say at 0.1 span altitude) and at heights above 0.5 span.
2. The degree of laminar boundary layer conditions achieved in flight on the wing. This problem is not only one of wing section and surface roughness, but of Reynolds Number near the wing tips where, with shorter chords, the problem of laminar separation occurs.

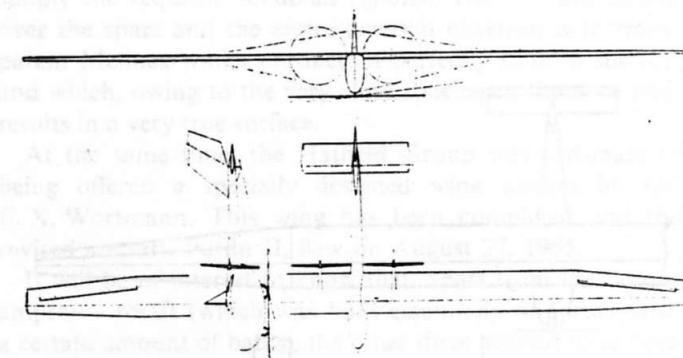


13. Wing weight vs. span — Left to right: Haessler-Villinger, Bossi-Bonomi, Southampton, Hatfield I, Southend, Hatfield II



15 Lippisch 3-view

16. Ottawa 3-view



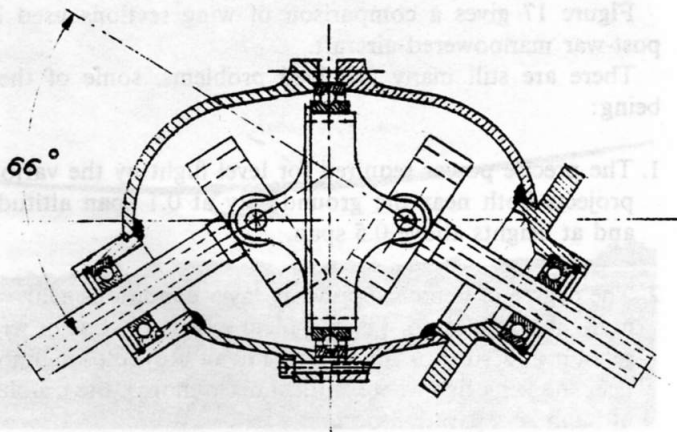
3. The actual propeller efficiencies.
4. The losses in the drive apart from propeller losses.
5. The best training for the human engine.
6. The optimum crew complement.

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 (2) *A. M. Lippisch*: "Manpowered Flight in 1929", Journal of Royal Aeronautical Society, Vol. 64, No. 595, July 1960.
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 (6) *Brian Worley*: "Can man fly?", "Aeronautics". February 1948.
 (7) *B. S. Shenstone*: "The problem of the very lightweight, highly-efficient aeroplane", Canadian Aeronautical Journal, Vol. 2, No. 3, March 1956.
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 (9) *Dr. D. R. Wilkie*: "Man as an Aero Engine", Journal of Royal Aeronautical Society, Vol. 64, No. 596, August 1960.
 (10) *Professor Kimura and Students of Nihon University, Tokyo, Japan*: Photograph—"Japanese Interest in Manpowered Flight", "Flight International", Page 167, 3 February 1966, and Page 366, 10 March 1966.
 (11) *H. Haessler*: "Manpowered Aircraft 1935-1937 and Today", Canadian Aeronautical Journal, Vol. 7, No. 3, March 1961.

14. Czerwinski's Double Universals



Appendix A

Regulations and Conditions for The Kremer Competition 1st February 1960. (Issued by the Royal Aeronautical Society.)

1. *General*

The prize will be awarded to the entrant who first fulfils the conditions.

Table III
Aircraft which have flown (early 1966)

Type	Haessler-Villinger "Mufli"	Bossi-Bonomi "Pedaliante"	Southampton	Hatfield "Puffin" Mk. I	Mk. II
Date 1st flight	1935	1936	1961	1961	1965
Span, m	13.5	17	24.4	25.6	28.4
Wing area, m ²	9.65	21.4	27.9	30.6	36.2
Aspect ratio	18.8	13.4	21.3	21.4	22
Wing weight, kg	24.1	45	36	29.5	38.6
Empty weight, kg	36.4	97.3	58.1	50	61.3
Flying weight, kg	111	162	121.6	113.5	124.8
Wing loading, kg/m ²	11.5	7.56	4.35	3.7	3.44

Table IV
Aircraft which have not yet flown (early 1966)

Type	Southend	Woodford	Lippisch	Ottawa	Haessler's "Mufli" Mk. II (H-4)
Span, m	27.4	24	15.2	27.4	25
Wing area, m ²	37	33	19.5	41.5	16.75
Aspect ratio	20.3	17.6	12	18	37.3
Wing weight, kg	38.6	32.7	—	39	—
Empty weight, kg	74.9	54	27.3	79	55
Flying weight, kg	210	117.5	91	220	115
Wing loading, kg/m ²	5.675	3.6	4.65	5.3	6.9
Status	Completed 1965, but not flown by Feb. 1966	Under construction Feb. 1966	Project given up	Project under way	Project

Table V
Estimated and Actual Dimensions and Weights
Hatfield and Southampton Aircraft

Type	Hatfield Puffin I		Southampton	
	Estimated	Actual as flown	Estimated	Actual as flown
Date of first hop	—	Nov. 16, 1961	—	Nov. 9, 1961
Span, m	24.4	25.6	24.4	24.4
Wing area, m ²	29.7	30.6	27.9	27.9
Aspect ratio	20	214	21.3	21.3
Wing section root	Laminar 14%	FX-05-191 Mod.	65.818	65.818
Wing loading, kg/m ²	3.28	3.7	4.3	4.35
Weights in kg				
Wing	17.9	29.5	29.0	36.0
Fuselage	5.9	10.5	7.6	9.1
Tail	3.3	1.8	2.9	1.2
Undercarriage				
Drive	5.9	6.8	13.0	10.3
Propeller		0.9		1.4
Equipment	1.1	0.5	3.0	0.1
Empty weight	34.1	50.0	55.5	58.1
Pilot	63.5	63.5	63.5	63.5
All-up-weight, kg	97.6	113.5	119.0	121.6

2. Prize

The prize is £5,000 sterling.

3. Eligibility

The entrant, designer and pilot must be citizens of the United Kingdom or the British Commonwealth. The aircraft must be designed, built and flown within the British Commonwealth.

4. Conditions of Entry

4.1 Aircraft

- 4.1.1 The machine shall be a heavier-than-air-machine.
- 4.1.2 The use of lighter-than-air gases shall be prohibited.

4.1.3 The machine shall be powered and controlled by the crew of the machine, over the entire flight.

4.1.4 No devices for storing energy either for take-off or for use in flight shall be permitted.

4.1.5 No part of the machine shall be jettisoned during any part of the flight including take-off.

4.2 Crew

4.2.1 The crew shall be those persons in the machine during take-off and flight, and there shall be no limit set to their number.

4.2.2 No member of the crew shall be permitted to leave the aircraft at any time during take-off or flight.

4.2.3 One handler or ground crew shall be permitted to assist in stabilising the machine at the wing tip during take-off.

4.3 Ground Conditions

4.3.1 All attempts, which shall include the take-off run, shall be made over approximately level ground and on a course to be approved by The Royal Aero Club.

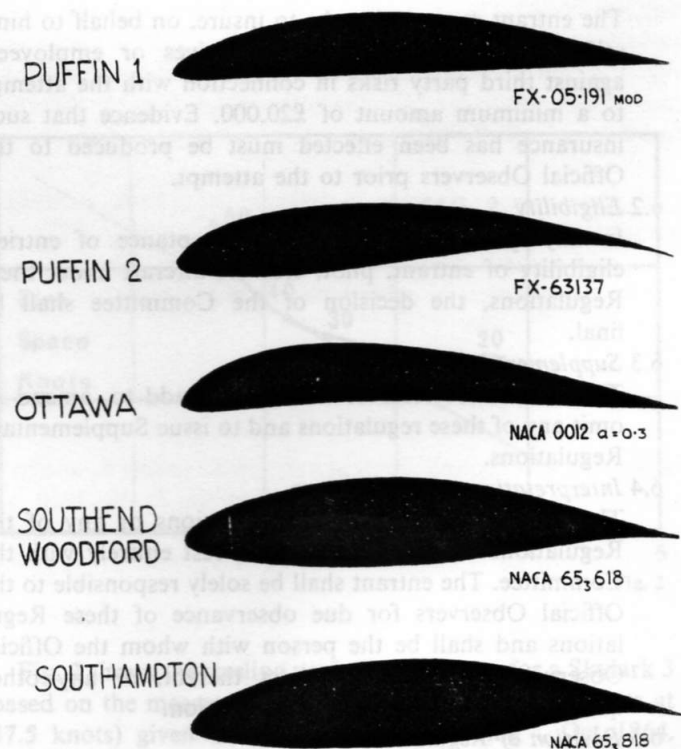
4.3.2 All attempts shall be made in still air, which shall be defined as a wind not exceeding a mean speed of approximately 10 knots, over the period of the flight.

4.4 Course

4.4.1 The course shall be a figure of eight, embracing two turning points, which shall be not less than half a mile apart.

7. Wing sections used by various manpowered aircraft

MAN-POWERED AIRCRAFT
1961-1965



- 4.4.2 The machine shall be flown clear of and outside each turning point.
- 4.4.3 The starting line, which shall also be the finishing line, shall be between the turning points and shall be approximately at right angles to the line joining the turning points.
- 4.4.4 The height, both at the start and the finish, shall be not less than ten feet above the ground, otherwise there shall be no restriction in height.
- 4.4.5 The machine shall be in continuous flight over the entire course.

4.5 Observation

Every attempt shall be observed by the Royal Aero Club or by any body or persons authorised by the Royal Aero Club to act as observers.

5. Application for Entry

- 5.1 Entry forms shall be obtained from the Royal Aero Club, Aviation Centre, Artillery Mansions, 75 Victoria Street, London, S.W.1.
- 5.2 The entry fee shall be £1 which shall be refunded upon the attempt taking place.
- 5.3 Each application form for entry shall contain an application for Official Observation of the competitor's attempt.
- 5.4 The fee for Official Observations shall be £15 15s. 0d. which shall be forwarded with the application form.
- 5.5 The entrant shall undertake to abide by the conditions for Official Observation as set out on the application form and shall undertake to defray all expenses incurred in connection with the Official Observation of the attempt.
- 5.6 Entry forms and application for Official Observation of an attempt must be received by the Royal Aero Club at least thirty days prior to the proposed date of the attempt. Applications will be considered in order of receipt at the Royal Aero Club Aviation Centre.

6. General Conditions

6.1 Insurance

The entrant must undertake to insure, on behalf to himself, his pilot(s), crew, representatives or employees, against third party risks in connection with the attempt to a minimum amount of £20,000. Evidence that such insurance has been effected must be produced to the Official Observers prior to the attempt.

6.2 Eligibility

In any question regarding the acceptance of entries, eligibility of entrant, pilot, crew or aircraft under these Regulations, the decision of the Committee shall be final.

6.3 Supplementary Regulations

The Committee reserves the right to add to, amend or omit any of these regulations and to issue Supplementary Regulations.

6.4 Interpretation of Regulations

The Interpretation of these Regulations or any of the Regulations hereafter issued shall rest entirely with the Committee. The entrant shall be solely responsible to the Official Observers for due observance of these Regulations and shall be the person with whom the Official Observers will deal in respect thereof, or any other question arising out of this Competition.

6.5 Revision of Regulations

These Regulations shall remain in force for a period of

two years from the date of publication. After this time, the Royal Aeronautical Society reserves the right to review and amend these Regulations if the prize has not been won.

Appendix B

Man Powered Aircraft Group—Conditions Governing Grants (Journal of the Royal Aeronautical Society)

(Vol. 64, No. 594, June 1960)

Conditions Governing Grants

1. The Royal Aeronautical Society (Man Powered Aircraft Group) will consider making financial contributions to one or more persons or organisations who submit promising projects designed to further the achievement of Man Power Flight.

2. Submissions must contain as much detailed information as possible and, for example, in the case of a project for a complete aircraft, should include the following and any other information which the submitting person or organisation considers relevant.

- (a) General description of the project in simple terms: describing particularly the more interesting or unusual features.
- (b) Three-view drawing of the project at 1/24 scale or larger.
- (c) Weight breakdown of structure, drive mechanism, controls, equipment and crew weight.
- (d) An analysis of project to be given, including drag and power requirements, preferably in graphical form, covering the range from zero speed to cruising speed.
- (e) Descriptive analysis of method of propulsion (e. g. propeller or flapping wings).
- (f) Stressing assumptions (including *V-n* diagram).
- (g) Calculations to show the duration of flight and manoeuvrability to be expected.
- (h) Estimated total financial outlay required for the project in as much detail as possible and also the monthly financial requirements throughout the duration of the job. These must be based on total costs and not upon any contribution which the Royal Aeronautical Society would be expected to make.
- (i) A progress plan against time from the initiation of the project to the completion of initial flight tests. This plan should be in the form of stages; e.g. completion of wing, fuselage, etc.

3. Submissions must reach the Royal Aeronautical Society not later than 31st October 1960.

4. Submissions will not be paid for by the Royal Aeronautical Society and will remain the property of the person or organisation making the submission. Submissions will be kept by the Royal Aeronautical Society until decisions on contributions are made.

5. On any question regarding the suitability of submissions for contributions, the decision of the Royal Aeronautical Society shall be final.

6. If requested, representatives of those submitting projects will attend a round-table meeting held by the Royal Aeronautical Society at which the features of the various designs submitted will be discussed. Such meeting would take place before any contributions from the Society are announced.

7. Any such contribution would not debar the recipient from entry for the Kremer Competition.

(*Swiss Aero-Revue* 8/1966)