Man-Powered Flight: Achievements to Date with a New Suggestion

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Man's desire to fly is as old as humanity, but his many attempts to do so succeeded only sixty five years ago with the advent of mechanical power. However, mechanical power did not eliminate man's desire to fly on his own power; interested professionals as well as dedicated individuals have continued working on this problem for the past sixty years. Their efforts have recently begun to bear fruit. A summary review of these efforts is presented, together with some conceptual and technical developments which have led to the first noteworthy successes of man-powered flight. Since these successes rely, among other things, on wings with extraordinary aspect ratios, a point may soon be reached where the corresponding wing spans will become intolerable. The application of a particular wing configuration is suggested to alleviate this dilemma.

On June 28, 1968, the British magazine *PUNCH* published an illustration of a man-powered aircraft in flight ostensibly being demonstrated to a group of officials, a high-ranking military man among them. The latter's comment: "Absolutely useless . . . its payload is less than the smallest bomb we've got." This illustration well explains one of the reasons why man-powered flight has never received significant support from the Aeronautical industry. Similar reasons are given by many members of General Aviation, except for a minority of enthusiasts willing to pedal to become airborne but whose financial possibilities are generally too limited for the relatively substantial expenditures required to produce a man-powered aircraft possessing satisfactory flying qualities—as defined later in this article.

Today it is relatively easy to design and to build a well-flying airplane, adequately powered by a still too expensive, but reliable engine. Techniques are known, data are available and, in general, the state-of-the-art is such that design emphasis is placed on refinements, efficiency, and cost. Matters are very different with a man-powered aircraft (MPA), whose design requires a special variety of aerodynamic optimization and, above all, utmost ingenuity in structural concepts so as to satisfy the most difficult condition: an incredibly low T.O. weight[1] compatible with structural integrity. With the present state-of-the-art, the MPA constitutes a technically challenging goal, whose elusiveness is moving a number of professionals, and an even greater number of not-so-professional hopefuls, to try to reach it.

One can go back to Greek mythology and start with the legend of Daedalus and Icarus; the latter, as the legend goes, flew too close to the sun and met his death by drowning in the Aegean Sea when the wax, holding together his wings' feathers, melted and the wings disintegrated. Leonardo da Vinci (1452–1519) took a more scientific approach to flying before starting to design his flying machine; he studied the flight of birds (Sul Voli Degli Uccelli, 1505) and concluded that the only way for man to fly would be to imitate the birds as closely as possible. Considering that the aerodynamic, structural, and materials knowledge for the problem at hand was almost nil at da Vinci's time, it is no surprise that his machine was doomed to failure.

With the appearance of Joukowski's wing theory at the turn of the century and Prandtl's general aerodynamic theory, more basic knowledge became available to interested researchers who, in the twenties and thirties, again started investigating the possibilities of man-powered flight. In France attempts were made in the early twenties to fit bicycles with wings, making it possible to achieve jumps of noteworthy distances.[2] Jumps followed by an extended glide are not, however, what one might call "real flying," and further attempts with this approach were soon abandoned since the goal of a sustained horizontal flight at constant speed appeared hopelessly unattainable.

In Italy in the mid-thirties, Bonomi and Bossi produced an interesting two-propeller machine (Fig. 1) with which the pilot was able to take off using stored energy and to extend significantly his glide by pedaling[3]; but the machine suffered from overweight and could hardly sustain a true horizontal flight. In Germany at about the same time (1936) Haessler and Villinger designed and built a single seater with pusher propeller (Fig. 2) and flew, after assisted takeoff, some seven hundred meters at about three meters above the ground.[4]

These and similar attempts led a group of German experts to the conclusion that a systematic approach should be taken first to analyse and to define the basic MPA problems before attempting to find their solutions. Since the crucial problem of an MPA is the very limited power of man, it was immediately obvious that the first problem to be investigated

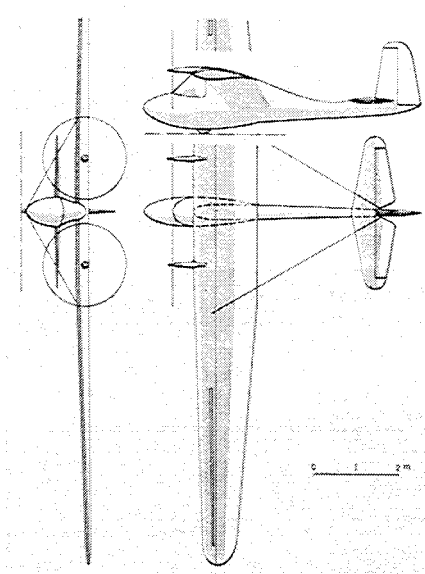

Fig. 1 Three-view of the Bossi-Bonomi MPA.

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