

# Human-powered aircraft

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A **human-powered aircraft** (HPA) is an aircraft belonging to the class of vehicles known as human-powered vehicles. Early attempts at human-powered flight were unsuccessful because of the difficulty of achieving the high power-to-weight ratio. Prototypes often used ornithopter principles which were not only too heavy to meet this requirement but aerodynamically unsatisfactory.

As of 2008, human-powered aircraft have been successfully flown over considerable distances. However, they are primarily constructed as engineering challenges rather than for any kind of recreational or utilitarian purpose.

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MIT Light Eagle human-powered aircraft, predecessor to the MIT Daedalus aircraft

## Royal Aeronautical Society Human Powered Flight Group

The Royal Aeronautical Society's "Man Powered Aircraft Group" was formed in 1959 by the members of the Man Powered Group of the College of Aeronautics at Cranfield when they were invited to join the Society. Its title was changed from "Man" to "Human" in 1988 because of the many successful flights made by female pilots.

Under the auspices of the Society, in 1959 the industrialist Henry Kremer offered the first Kremer Prizes of £5,000 for the first human-powered aircraft to fly a figure-of-eight course round two markers half-a-mile apart.

It was conditional that the designer, entrant pilot, place of construction and flight must all be British.<sup>[1]</sup> In 1973 Kremer increased the prize to £50,000 and opened it to all nationalities, to stimulate interest.

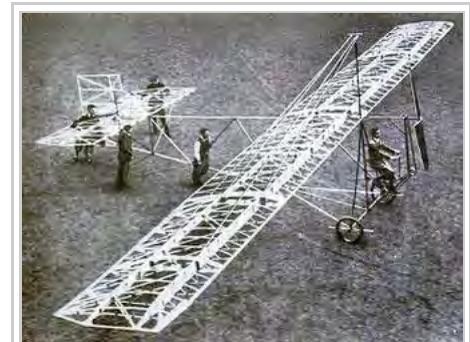
## First attempts

An early human-powered aircraft was the Gerhardt Cycleplane, developed by W. Frederick Gerhardt at McCook Field in Dayton, Ohio in 1923. The aircraft had seven wings stacked nearly 15 feet (4.6 m) high. The pilot pedaled a bicycle gear that turned the propeller. In early tests the aircraft was towed into the air by an automobile, and released. With Gerhardt as the pilot, the Cycleplane was able to maintain stable, level flight for short durations.<sup>[2]</sup> Its only human-powered takeoff was a short hop of 20 feet (6.1 m) with the craft rising 2 feet (0.61 m).<sup>[3]</sup>

In 1934, Engelbert Zaschka from Germany completed a large human-powered aircraft, the *Zaschka Human-Power Aircraft*. On 11 July 1934, the Zaschka-HPA flew about 20 meters on the Berlin Tempelhof Airport; the HPA took off without assisted takeoff.<sup>[4][5]</sup>

A craft called *HV-1 Mufli* (de) (*Muskelkraft-Flugzeug*) built by Helmut Hässler and Franz Villinger (de) first flew on 30 August 1935: a distance of 235 metres at Halle an der Saale. 120 flights were made, the longest being 712 metres in 1937. However, it was launched using a tensioned cable and so was not strictly human-powered.<sup>[6]</sup>

In March 1937, a team of Enea Bossi (designer), Vittorio Bonomi (builder), and Emilio Casco (pilot) met a challenge by the Italian government for a flight of one kilometre using their *Pedaliante*. The aircraft apparently flew short distances fully under human power, but the distances were not significant enough to win the competition's prize. Furthermore, there has been much dispute whether it ever took off under the pedal-power of the pilot alone, in particular because there is no record of official observation of it having done so.<sup>[7]</sup> Some arguments for and against the validity of Bossi's claim to have done so are presented by Sherwin (1976).<sup>[8]</sup> At the time the fully human-powered flights were deemed to be a result of the pilot's significant strength and endurance; and ultimately not attainable by a typical human. As with the *HV-1 Mufli*, additional attempts were therefore made using a catapult system. By being catapulted to a height of 9 metres (30 ft), the aircraft met the distance requirement of 1 kilometre (0.62 mi) but was declined the prize due to the launch method.<sup>[9][10][11]</sup>



Zaschka's Human-Power Aircraft, Berlin 1934

## First flights

The first officially authenticated take-off and landing of a man-powered aircraft (one capable of powered take-offs, unlike a glider) was made on 9 November 1961 by Derek Piggott in Southampton University's Man Powered Aircraft (SUMPAC) at Lasham Airfield.<sup>[12][13]</sup> The best flight out of 40 attempts was 650 metres.<sup>[14]</sup> The SUMPAC was substantially rebuilt by Imperial College with a new transmission system but was damaged beyond repair in November 1965.

The Hatfield Puffin first flew on 16 November 1961, one week after SUMPAC. The Hatfield Man Powered Aircraft Club was formed of



SUMPAC: The first successful human powered aircraft

employees of de Havilland Aircraft Company and had access to company support. Eventually its best distance was 908 metres (993 yd).<sup>[15]</sup> John Wimpenny said he was very pleased with the performance of the Puffin, which handled beautifully during the flight.<sup>[16]</sup> His record stood for 10 years.

Puffin 2 was a new fuselage and wing around the transmission recovered from the original Puffin. It flew on 27 August 1965 and made several flights over a half-mile, including a climb to 5.2 metres. After Puffin 2 was damaged, it was handed over to Liverpool University who used it to build the Liverpuffin.

After this date several less successful aircraft flew, until 1972 when the Woodford Essex Aircraft Group's Jupiter, designed and built by Chris Roper, piloted by John Potter flew 1,070 metres and 1,239 metres in June 1972. Due to Roper's ill health, the project was later continued at RAF Halton - Potter was a serving Royal Air Force (RAF) officer at the time.<sup>[17]</sup> In early 1977, a Japanese aircraft *Stork* completed three-quarters of the figure eight course before grounding a wingtip.

## Kremer Prize successes by Gossamer Condor and Albatross

In 1973, Kremer increased his prize money tenfold to £50,000. At that time, the human-powered aircraft had flown only in straight (or nearly straight) line courses, and no-one had yet even attempted his more challenging figure-eight course, which required a fully controllable aircraft. He also opened the competition to all nationalities; previously it was restricted to British entries only.

On 23 August 1977, the Gossamer Condor 2 flew the first figure-eight, a distance of 2,172 metres winning the first Kremer prize. It was built by Dr Paul B. MacCready and piloted by amateur cyclist and hang-glider pilot Bryan Allen. Although slow, cruising at only 11 mph (18 km/h), it achieved that speed with only 0.35 hp (0.26 kW).<sup>[18]</sup>

The second Kremer prize of £100,000 was won on June 12, 1979, again by Paul MacCready, when Bryan Allen flew MacCready's Gossamer Albatross from England to France: a straight distance of 35.82 km (22 miles 453 yards) in 2 hours, 49 minutes.

## Kremer speed prize and later flights by MIT team

A week after the cross-Channel flight of Gossamer Albatross, which used a propeller designed by the MIT team,<sup>[19]</sup> a student-led team at the Massachusetts Institute of Technology achieved first flight on their *Chrysalis* aircraft,<sup>[20]</sup> which demonstrated full controllability and was flown by 44 different pilots,<sup>[19]</sup> including female pilots who were the first to power a HPA.

On 11 May 1984, the third Kremer prize of £20,000 for speed went to the MIT design team for flying their Monarch-B<sup>[21]</sup> craft on a triangular 1.5 km course in under three minutes (for an average speed of 32 km/h): pilot Frank Scarabino. Further prizes of £5,000 are awarded to each subsequent entrant improving the speed by at least five percent.

Over the next four years, the MIT group continued to evolve their designs, with the Monarch and Monarch-B aircraft succeeded by three follow-on designs, the Light Eagle and two MIT Daedalus aircraft, the Daedalus-87



Human-powered aircraft display at the US National Air and Space Museum

and Daedalus-88. The current distance record recognised by the FAI was achieved on 23 April 1988 from Iraklion on Crete to Santorini in the MIT Daedalus 88 piloted by Kanellos Kanellopoulos: a straight distance of 115.11 km (71.53 mi).<sup>[22]</sup>

## Passenger aircraft

The first human-powered passenger flight occurred on 1 October 1984 when Holger Rochelt carried his sister Katrin in Musculair 1.

## Recent activities

Machines have been built and flown in Japan, Germany, Greece, Australia, New Zealand, South Africa, Austria, Canada, Singapore, the United States, and the United Kingdom, with their total number approaching a hundred.

With further funds from the late Henry Kremer, the Royal Aeronautical Society announced four new prizes:<sup>[23]</sup>

- £50,000 for the Kremer International Marathon Competition for a flight round a specified twenty six mile (marathon) distance course, in a time of under one hour;
- £100,000 for the Kremer International Sporting Aircraft Competition for a sporting aeroplane able to operate in normal weather conditions, as encountered in the United Kingdom;
- £1,000 for the Schools Competition;
- £500 for The Robert Graham Competition for students for experimental research or engineering design.

Attempts have been made to claim the £100,000 Kremer Sport prize. Students from Virginia Polytechnic Institute designed an aircraft as part of their AE4065/6 class. A team from the Pennsylvania State University designed the PSU Zephyrus as part of their AERSP 404H class. A team of aerospace engineering students from the University of Southampton designed and constructed the SUHPA.<sup>[24]</sup> Samuel DuBois based out of Prescott, WI finalized designs for a flying wing HPA <sup>[25]</sup> in September 2016 that he hopes to begin and finish building and testing by the spring of 2017. DuBois has not yet ruled out a possible Kremer Prize attempt.

In 2012, the Royal Aeronautical Society brought the Icarus Cup<sup>[26]</sup> for human powered flying into being. The first cup was won by Airglow, designed by John and Mark McIntyre. The Icarus Cup is different from the Kremer Prize in that it doesn't aim to simply break speed and distance records, but making human powered flying into a popular sport. Therefore, the competition includes challenges such as a slalom course, an unaided starting task and a landing accuracy test. The Icarus Cup is held annually at Lasham Airfield, Great Britain, the site of the first human-powered flight.

## Airships

Inventors have built human-powered airships. By gaining lift through buoyancy instead of air flowing past an airfoil, much less effort is required to power the aircraft.<sup>[27][28][29]</sup>

## Helicopters/rotorcraft

## Ornithopters

On August 2, 2010, Todd Reichert of the University of Toronto Institute for Aerospace Studies piloted a human-powered ornithopter named Snowbird. The aircraft with 32-metre (105 ft) wingspan and mass of 42 kilograms (93 lb) was constructed from carbon fibre, balsa, and foam. The pilot sat in a small cockpit suspended below the wings and pumped a bar with his feet to operate a system of wires that flapped the wings up and down. Towed by a car until airborne, it then sustained flight for almost 20 seconds. It flew 145 meters with an average speed of 25.6 km/h (7.1 m/s).<sup>[30]</sup> Similar tow-launched flights were made in the past, but improved data collection verified that the ornithopter was capable of self-powered flight once aloft.<sup>[31][32][33]</sup>

## See also

- Human-powered transport
- Solar-powered aircraft
- Zero-emissions vehicle
- Human-powered helicopter
- Controllable slope soaring
- Ornithopter
- List of human-powered aircraft

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## External links

- Video of first human-powered aircraft (SUMPAC) (<https://www.theguardian.com/science/2011/nov/09/50-years-human-powered-flight>)
- "Cycleplanes and Their Possibilities" (<http://www.flightglobal.com/pdfarchive/view/1913/1913%20-%201259.html>) *Flight* 1913
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