Economist.com SCIENCE & TECHNOLOGY

Solar-powered manned flight

Flying for ever

Jun 11th 2009
From The Economist print edition

A new solar-powered aircraft attempts to fly around the world with zero emissions

Solar Impulse

WHEN an airliner takes off for a transatlantic flight it needs to carry some 80 tonnes of fuel, which accounts for around one-fifth of its weight. On really long flights, fuel can account for 40% of a plane's take-off weight, so that around 20% of the fuel is used to carry the rest of the fuel. Each tonne of fuel burned also produces 3.2 tonnes of carbon dioxide. Yet inside a hanger at a Swiss airfield is the prototype of an aircraft (illustrated above) that does not use any fuel at all. The wings of this aircraft are almost as big as those of an airliner, but they are covered in a film of solar cells that convert sunlight into electricity to drive its engines.

Solar-powered aircraft have flown before. The pioneer was Paul MacCready, whose Gossamer Penguin made the first manned flight in 1980 in California, with his then 13-year-old son at the controls. A derivative, Solar Challenger, crossed the English Channel in 1981. But nothing like HB-SIA, as the Swiss aircraft is known, has ever taken to the air. If it works as expected, another version will be built and this will take off, climb to 10,000 metres and, by storing some of the electricity generated during the day, continue flying through the night. Its pilots, Bertrand Piccard and André Borschberg, plan to cross the Atlantic in it and later to fly it around the world.

The prototype will be unveiled on June 26th by Solar Impulse, a project the aviators run. Mr Piccard helped pilot Orbiter 3, the first balloon to fly non-stop around the world, and comes from a family of adventurers: his grandfather, Auguste, was the first to fly a balloon into the stratosphere and his father, Jacques, plunged to record depths in a bathyscaphe. Mr Borschberg is an engineer and fighter pilot.

Testing to the limit

Although he has flown HB-SIA in a simulator, Mr Borschberg says he will not really know how it performs until the first test flight later this year. The prototype pushes some technologies to their limits, especially in the trade-off between weight and performance. So, although it has a wingspan of 61 metres, HB-SIA has room only for a pilot. It weighs just 1,500 kilograms, making it five times lighter than a high-performance glider would be if made that big.

The complex skeleton of HB-SIA is constructed from carbon-fibre composites formed into honeycomb and sandwich structures. This is covered in plastic film. The film on the upper surfaces of the wings and the horizontal rear stabilisers is embedded with 12,000 photovoltaic cells. These are capable of converting sunlight into electricity with an efficiency of 22%. Cells with slightly better conversion rates are available, but they are heavier.

A quarter of the weight of HB-SIA is accounted for by its lithium-polymer batteries, which will power the four electrically driven propellers during the first test flights. As those flights become longer and higher, the aircraft will start to draw power from its solar cells. It will fly slowly, only at about 70kph in windless conditions. Its electric motors can produce a maximum of 9 kilowatts, or 12 horsepower—which is about the same as the Wright brothers had. With all four engines at full power, HB-SIA is only as powerful as a motor scooter. Yet with careful rationing of its stored energy, it should be possible to achieve the closest thing yet to perpetual manned flight—with man being the limiting factor because of the need to carry food and drink, and to remain awake for long periods.

If the prototype succeeds in flying through the night then the design of its successor will be finalised. This aircraft, HB-SIB, is intended to operate in stints of around five days and nights. If it succeeds in crossing the Atlantic, it will then try to circle the globe, following the Tropic of Cancer and landing on each continent.

This will involve some daring, with the aircraft spending all day climbing as its batteries are recharged and then descending slowly under power throughout the night to conserve energy. It means keeping a close eye on the weather and navigating around windy areas. The team has experimented with simulated flights using real-time meteorological data. Encountering a headwind at night is a worry. "It could make the night much longer and cause you to run out of energy before sunrise, which would be a disaster," says Mr Borschberg. Success means a flight plan which ensures that "every morning you are in sunshine".

A number of companies and groups are sponsoring Solar Impulse, including the International Air Transport Association (IATA). At its annual meeting in Kuala Lumpur this week, the trade group pledged to cap emissions from aviation in 2020. A solar-powered airliner is still a distant dream, but IATA knows that pushing the boundaries of technology will be necessary to help clean up air travel.