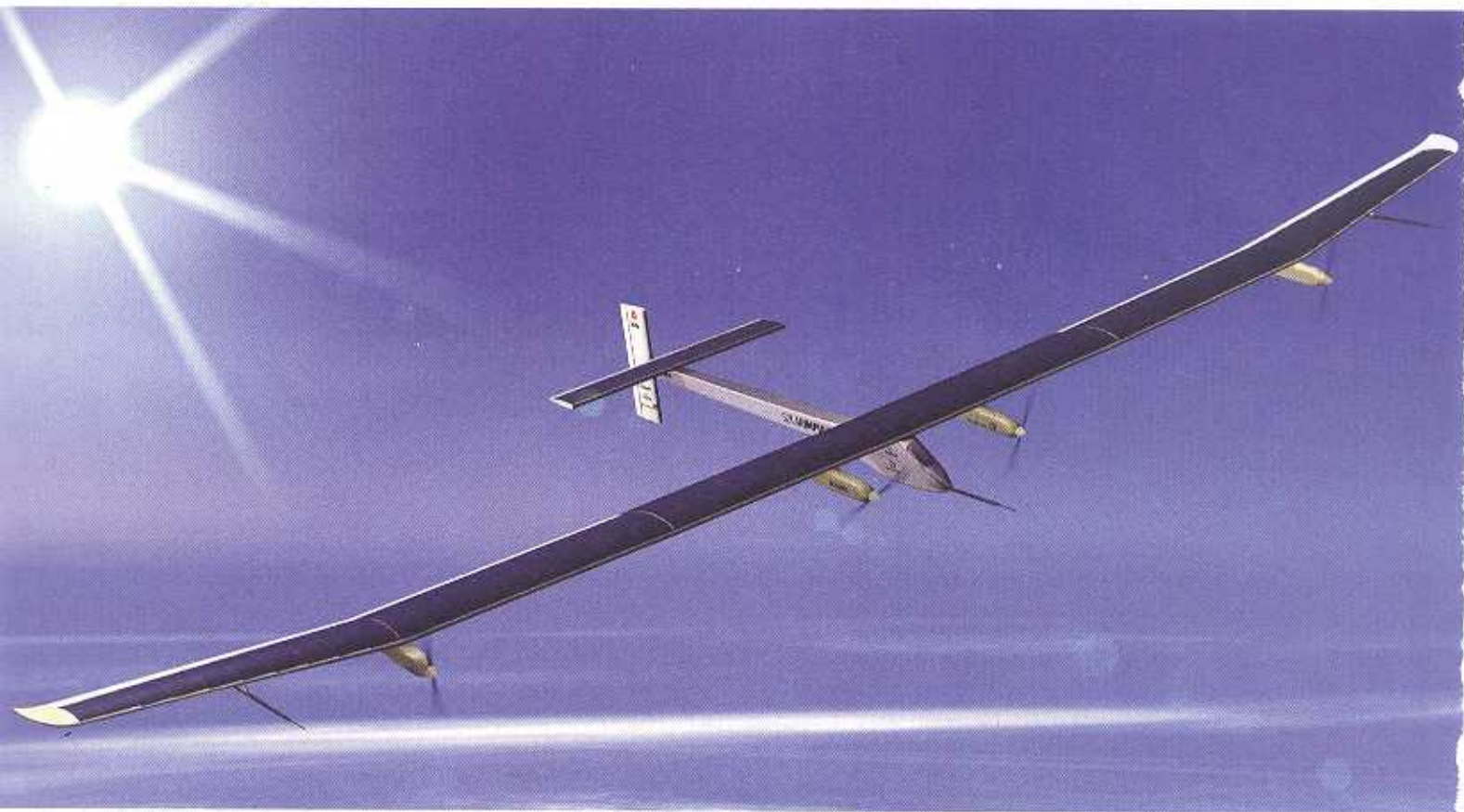


# Flies by night

Following six years of development, the Solar Impulse HB-SIA is said to have the potential to become the first manned solar aircraft to fly continuously through the day and night. **Jon Excell** reports



ANDRE BORSCHBERG has particularly good reason for ensuring that the strange-looking aircraft currently housed in a hangar on the outskirts of Zurich is sturdy and safe enough to fly in.

That's because when it takes to the sky next year in an effort to become the first manned solar aircraft to fly continuously through the day and night Borschberg — or his partner in the project, Swiss balloonist Dr Bertrand Piccard — will be sitting in the cockpit.

Unveiled earlier this summer, and due to make its maiden test-flight next month, the Solar Impulse HB-SIA is the result of six years of intense design and development and, its developers hope, the forerunner to a follow-on solar aircraft that will circumnavigate the world.

Covered in 200m<sup>2</sup> of solar cells, boasting a wingspan of 61m (the same as an Airbus A340) and weighing just 1,600kg, the aircraft is, claimed Borschberg, at least five times lighter than a high-per-

**The Solar Impulse HB-SIA is able to take off under its own power at a speed of 35km/h and has an average flying speed of 70km/h**

**'We are fighting everywhere to save some grams, working with project partner Solvay to find lighter materials'** *Andre Borschberg*

formance glider of equivalent size.

Able to take off under its own power at a speed of 35km/h, it has an average flying speed of 70km/h and a maximum altitude, owing to an unpressurised cockpit, of 27,900ft (8,500m).

Its 12,000 silicon solar cells, supplied by US firm Sunpower, are each 150 microns thick and have a conversion efficiency of 22 per cent. These are not the most efficient cells on the market, but they are among the lightest, and weight, explained Borschberg, is everything. He said: 'We are fighting everywhere to save some grams. We have used extremely thin layers of carbon

composite for the major parts... and worked with [project partner] Solvay to find lighter materials, such as special foam for insulating the gondolas and cockpit.' He added that the design team has even optimised the amount of glue used in the quest for weight savings.

The solar cells supply energy via electric motors to the aircraft's four twin-bladed 3.5m-diameter propellers and also charge lithium-ion batteries that power it during the night. This electric propulsion system has been designed with help from another of the industrial partners, Omega, part of the Swatch group, which has experience in





electric propulsion from its early experiments on the Smart car.

Although it has not yet flown, Borschberg is confident that the aircraft will perform as planned thanks to a specially designed simulation tool developed for the project by French engineering group, Altran.

He said: 'We can fly the aircraft virtually in real meteorological conditions around the world to allow us to evaluate the real potential performance of the airplane. [This] mission simulator... simulates all the energy balance of the airplane when it flies around the world: how much energy it collects, solar cell by solar cell. It takes into account the time of the day, the day of the year, how much power it uses depending on altitude, and many other conditions.'

A variation on this system will also be used to prepare for the real flights. Borschberg explained that this will take into account weather forecasts and then plan in advance the optimum route for the aircraft.

As well as ensuring that the aircraft makes the best possible use of sunny conditions, this capability will also help it avoid potentially dangerous weather conditions. 'The aircraft is designed within

**Borschberg and his team have even carefully optimised the amount of glue used on the aircraft in their quest for weight savings**

an envelope that allows it to take +3.5gs and -1.5gs, which is the standard envelope of a transport airplane, so in terms of structure and the loads it can take there are no problems,' said Borschberg. 'The problem is how you control such an aircraft because it is extremely light and very sensitive to turbulence... so we will avoid cumulonimbus clouds and the jet stream.'

Because these calculations require some fairly hefty processing and rely on up-to-the-minute weather forecasts, the planned round-the-world effort will be broken down into five three- to four-day long intercontinental chunks, each one interspersed with a break to plan a flight path for the next section.

In the meantime, Borschberg and his team are making the final preparations for the first prototype's maiden flight next month.

Though this will be carried out by a test-pilot, all later flights, including the day-night attempts, will be piloted by either Borschberg or Piccard. While he is clearly excited by the challenge, he warned that the aircraft's mechanical control system — chosen so that craft can still be flown if the electric systems fail — will make piloting it a physically

draining experience. He said: 'We have very big aileron surfaces — these are very big surfaces that are moved manually by the pilot so it is quite a lot of effort... we have tried to make them aerodynamically balanced so the forces in the cockpit do not exceed what the pilot can do.'

Clearly, for the longer flights that will be carried out by the follow-on aircraft, an easier-to-use electrical control system would be desirable, but no decision has been made on this yet.

In general, the round-the-world aircraft is expected to be roughly the same dimensions as the current model — albeit with a larger, more comfortable cockpit — but Borschberg anticipates further reductions in weight and improvements in efficiency.

One of the areas of improvement is likely to be in the battery technology. He said: 'The new push in renewable energy in the US and other countries leads to faster development of new battery technology. When we started we had about 150wh/kg — now we are at 220wh/kg and next year we hope to be at 240wh/kg. If something else came out that could double the capacity of the battery it would change the potential of such an airplane and that's what we are looking at very carefully.'

Whatever improvements might come further down the line, it's unlikely that Solar Impulse will kick-start a new era of solar-powered civil aviation. For Borschberg, the initiative has a more symbolic purpose, and will, he believes, make people think about what can be achieved with renewable energy. 'We hope that if people see that we can do it in the air they will accelerate the integration of these technologies on the ground... that would be how we would measure the success of this project.'

