MILESTONES IN SOLAR AVIATION

The first night flight by a solar-powered aircraft – a feat unimaginable only a few years ago, and accomplished by the elegant *Solar Impulse* in July this year. A few weeks later, the *Zephyr*, a solar-powered unmanned drone,[1] returned to earth after 14 days in the air. These two historic, record-breaking feats demonstrate the enormous potential of renewable energy and new technologies. They promise to transform our perception of what is possible.

"All that is impossible remains to be achieved"

Jules Verne

Launched in 2003 by pioneering adventurer Bertrand Piccard and entrepreneur and aviation enthusiast André Borschberg, the ambition of the Solar Impulse project is "to contribute to the world of exploration and innovation, to the cause of renewable energies. To demonstrate the importance of the new technologies in sustainable development and… to place dream and emotion at the heart of scientific adventure."

The inspiration

On March 21, 1999, after 19 days, 21 hours and 47 minutes in the air, Bertrand Piccard and Brian Jones touched down in the Egyptian desert in their hot-air balloon, the *Breitling Orbiter 3*. This, the first, non-stop circumnavigation of the earth in a balloon, was widely hailed as the last great pioneering feat of the 20th century. On landing, Messrs. Piccard and Jones had only 40 kgs left of the 3.7 tons of liquid propane with which they began their adventure (in the Swiss town of Château d'Oex). Frustrated by the constraints of fossil fuel, Mr. Piccard resolved to repeat the experience, but without using fossil fuels or polluting emissions. Thus was born the Solar Impulse project.

The *Solar Impulse HB SIA*, the first manned aircraft able to fly day and night propelled solely by solar energy, has the wingspan of a large airliner (63.40 meters), and the weight of a midsize car (1,600 kgs). It is covered by some 12,000 solar cells which run four electrical engines and charge 400 kgs of lithium batteries.

The mission of the flight on July 7 and 8 was to "demonstrate the feasibility of a complete day-night-day cycle propelled solely by solar energy."

After six years of intense effort, countless calculations and simulations and 11 test flights, the 70-strong Solar Impulse team completed this "unprecedented" and "revolutionary" aircraft. And on July 8, 2010, at 9 a.m., *Solar Impulse*, with co-founder André Borschberg at the controls, touched down after a flight of 26 hours, 9 minutes and 10 seconds. It was the "longest and highest" flight in the history of solar aviation – a milestone in the field.

On leaving the cockpit, Mr. Borschberg said, "I've been a pilot for 40 years now, but this flight has been the most incredible one of my flying career. Just sitting there and watching the battery-charge level rise and rise thanks to the sun… and then that suspense, not knowing whether we were going to manage to stay up in the air the whole night. And, finally, the joy of seeing the sun rise and feeling the energy beginning to circulate in the solar panels again!" He added, "I have just flown more than 26 hours without using a drop of fuel and without causing any pollution."

Flight Report

Pilot: André Borschberg, CEO and co-founder
Take-off time: 07/07/2010 – 06:51
Landing time: 08/07/2010 – 09:02
Flight duration: 26 hours 9 minutes 10 seconds
Maximum speed: 68 knots / 125.9 km/h
Average speed: 20.6 knots / 38.2 km/h
Maximum altitude: 8,720 m (above sea level)

For Mr. Piccard, the flight "was a crucial step forward" in lending credibility to the potential of renewable energy and clean technologies.

Following Solar Impulse's maiden flight on April 7, 2010, Mr. Piccard noted, "our future depends on our ability to convert rapidly to the use of renewable energies. *Solar Impulse* is intended to demonstrate what can be done already today by using these energies and applying new technologies that can save natural resources."

1 A high-altitude long-endurance (HALE) unmanned air system (UAS)


Photo: Stéphane Gros


Photo: Solar Impulse


Photo: Stéphane Gros

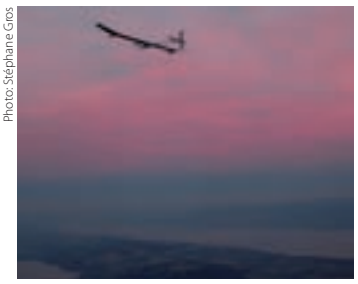
Photo: Stéphane Gros


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Photo: AFP/Pool/Fabrice Coffrini


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Photo: Keystone Pool/Dominic Favre

[This feat] "allows us to get closer to perpetual flight without using a drop of fuel!"

Bertrand Piccard

When *WIPO Magazine* spoke to Mr. Borschberg after the July flight, he noted that it was "a major step forward. We have an aircraft able to fly day and night, and this opens the opportunity to fly longer distances." He explained that, over the next three years, the Solar Impulse team planned a range of flights of increasing difficulty. The next step would be to complete an international flight (in 2011), then a transatlantic crossing (in 2012) before embarking on a round-the-world trip (in 2013).

The *Solar Impulse* is bursting with the latest in cutting-edge, innovative technologies and new materials – from solar cells, batteries and state-of-the-art communications[2], to innovative adhesives, high-tech polymer materials and light-weight energy-saving products.

In relation to intellectual property (IP), Mr. Borschberg explained that the project had a dual approach. While the 70-strong team was committed to developing the know-how associated with building a solar-powered aircraft, this type of information did not lend itself to formal IP protection, not least because of the complexity and expense associated with enforcing such rights. The technological challenges associated with building the aircraft, however, had led to the development of technologies that have since been patented. Many of these patents, he explained, were held by the project's 80 official partners, such as Solvay, Omega, and Swisscom. The project's extensive network of partners has enabled it to tap into a wide range of expertise and innovative resources. For example, its partnership with Bayer MaterialScience offers access to "innovative material solutions" that reduce energy consumption, just as the expertise of Swiss energy company SIG, helps to "optimize the energy chain and push the storage capacity of the batteries to their maximum." Mr. Borschberg noted that the team itself had developed an invention which it was in the process of patenting.

He underlined the importance of IP for the project, "because it involves the development of a lot of new technologies, many of which have broader applications. For example, the lighter-weight, more efficient batteries we need for the aircraft can be used in cars. Our partners need IP protection to make their research viable," he said. While licensing terms are included in the partnership agreements, Mr. Borschberg noted that the spirit and skills of the project itself lay in "developing innovative solutions" and that it was not commercially oriented.

The project effectively brings partners and suppliers together to come up with solutions to technical challenges. Mr. Borschberg likened the project to "a catalyst, if you like, for stimulating innovation."

The Solar Impulse team is now developing a second prototype, the *HB-SIB*, more suited to long-distance flight. Mr. Borschberg said, "we learned a lot and the aircraft performed better than expected; it was a gift, but we can still do better." This *HB-SIB* will integrate the latest technological developments, as well as an upgraded cockpit suitable for the round-the-world trip

2 This equipment cannot exceed 5 kgs or 50 watts and must be able to withstand temperature fluctuations between +80°C and -40°C.

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planned to take 25 days (5 legs of 5 days each). The cockpit of the first prototype "is really only good for 48 hours. At first we built the cockpit for the plane; now we need to build it for the pilot," Mr. Borschberg noted.

Funding

The Solar Impulse project, with a 10-year budget of US$100 million, is wholly funded by private companies, the Solar Impulse Foundation and the Project's Supporters Program. Enthusiasts can sign up at *www.solarimpulse.com* to receive real-time news, adopt a solar cell on the wing, reserve a visit to the Solar Impulse base or place their names on the aircraft's fuselage.

Solar Impulse is on track to achieve what many consider to be an impossibility, namely, "to produce a plane propelled exclusively by solar energy, which will take off under its own power and fly day and night, and achieve a round-the-world flight without fuel or pollution." The July 7/8 flight has redefined the limits of the attainable and opened the doors to a new era of solar energy usage.

A second solar aviation milestone was passed when the *Zephyr*, built by British company QinetiQ and billed as the "first eternal aircraft," broke the endurance flight record for unmanned aerial vehicles (UAV), or drones, setting a new world record for the longest non-stop UAV flight. On July 23, the *Zephyr*, an ultra-light carbon-fiber solar-powered unmanned aircraft, landed successfully after being airborne for 14 days (336 hours and 21 minutes).

The Managing Director of QinetiQ's U.K. Technology Solutions Group, Neville Salkeld, said, "We've now proved that this amazing aircraft is capable of providing a cost-effective, persistent surveillance and communications capability measured in terms of weeks, if not months. Not only is *Zephyr* a game-changing technology, it is also significantly more cost-effective to manufacture and deploy than traditional aircraft and satellites."

The aircraft weighs a modest 54 kgs, and is powered by paper-thin solar cells that cover the upper surface of its 22.5-meter wingspan.

The *Zephyr* can fly non-stop over a general area for weeks or months at a time, without the need to refuel.

Photo: QinetiQ

For QinetiQ, "IP is an important aspect of our business, and we continually file new patents." The company holds three patents in relation to the *Zephyr*, and has used WIPO's Patent Cooperation Treaty (PCT) to file for broad-based protection – e.g. PCT/GB2008/003890. The company also draws on "best available" technology from various suppliers, much of which is patent-protected. For example, that for the solar cells (or thin-film amorphous silicon technology) used to power the device is licensed from United Solar Ovonic LLC (Uni-Solar), which has also filed a number of international patent applications under the PCT.

While defense and security uses are its primary application, the *Zephyr* also has a range of other applications, such as environmental research, monitoring crops and pollution, providing tactical intelligence over disaster zones or forest fires and delivering mobile communications capabilities in remote areas.

These ground-breaking inventions have pushed the limits of what is technologically feasible. In generating new expertise and know-how about aircraft construction and alternative energies, they have opened the way to a new era of aviation, bringing us one step closer to achieving the "impossible" – perpetual flight.