SOLAR IMPULSE

TWO PIONEERS FLYING AROUND THE WORLD IN A SOLAR AIRPLANE TO PROMOTE CLEAN TECHNOLOGIES

The founders and pilots

By pushing back the boundaries of the possible, going into the unknown and taking on a project deemed unfeasible by industry experts, Bertrand Piccard and André Borschberg want to support concrete actions for sustainability and show that the world can be run on clean technologies. The synergy between the different personalities and approaches of the two Swiss pioneers is a key success factor of the project.

Bertrand Piccard – Initiator and Chairman: a medical doctor, explorer and lecturer, achieved the first ever non-stop round-the-world balloon flight. Initiator of Solar Impulse, he brought together the partners to fund this project. Linking science with adventure to promote clean technologies, he develops the project's philosophy and outlines its symbolic and political reach.

André Borschberg – CEO and Co-Founder: an engineer by education and an entrepreneur, André Borschberg has solid experience in creating and managing companies, as well as in flying. His passion for aviation and his interest in innovative solutions have led him to develop the strategy to design and build the Solar Impulse airplanes and to organize the flight missions.

Key milestones:

- **1999:** Bertrand Piccard's vision
- **2003:** EPFL Feasibility study led by André Borschberg
- **2004-2009:** start-up financing, design and construction of Solar Impulse 1
- **2010:** first ever solar-powered day and night flight (André Borshberg)
- **2011:** special guest at Paris-le-Bourget International Air Show
- **2012:** first intercontinental solar flight across the Mediterranean to Morocco (Bertrand Piccard)
- **2013:** Across America Mission from San Francisco to New York City
- **2014:** Solar Impulse 2 maiden flight
- **2015:** departure for the Round-The-World Solar Flight from Abu Dhabi
- **3 July 2015:** first flight of 5 days and 5 nights without fuel over the Pacific from Nagoya, Japan, to Honolulu, Hawaii and longest solo flight ever achieved (André Borschberg)
- **April 2016:** Round-The-World Solar Flight resumes

The vision

Solar Impulse started off with Betrand Piccard's vision of building an airplane capable of flying night and day without using any fuel, propelled solely by solar energy. The aim of the project was to develop a symbol which would attractively promote a pioneering and innovative spirit, particularly in the field of renewable energy and clean technologies.

Solar Impulse's goal is to demonstrate that clean technologies, such as the ones used on the Solar Impulse airplane, have the potential to change lives, societies and future markets in an unprecedented way. Solutions exist to run the world on clean technologies.

"If an airplane can fly day and night without fuel, everybody could use these same technologies on the ground to halve our world's energy consumption, save natural resources and improve our quality of life. Our hope is to motivate everyone to reduce their dependence on fossil fuels in their daily lives and encourage concrete actions for sustainability," Bertrand Piccard.

The Piccard family heritage

Solar Impulse continues in the long tradition of the Piccard family – three generations of Swiss pioneers: Auguste, Jacques and Bertrand – having featured scientific exploration and protection of the environment from the skies to the ocean abyss.

"All my education was about pioneering, with the stories of my grandfather being the first person to explore the stratosphere and to see the curvature of the Earth, and my father diving with his Bathyscaphe to the deepest place under the sea, in the Marianna Trench. I was deeply inspired by my family, from whom I learned about the spirit of exploration, curiosity and perseverance," Bertrand Piccard.

The development and design

To translate Bertrand Piccard's vision into reality, it took more than ten years of calculations, simulations, construction and testing by a technical team brought together and led by André Borschberg. As a result, the Solar Impulse 2 – a genuine flying laboratory and concentration of clean technologies – is flying around the world with no fuel. To take up the challenge of achieving the first Round-The-World Solar Flight, each link in the propulsion chain, from the solar cells to the propellers, has been optimized.

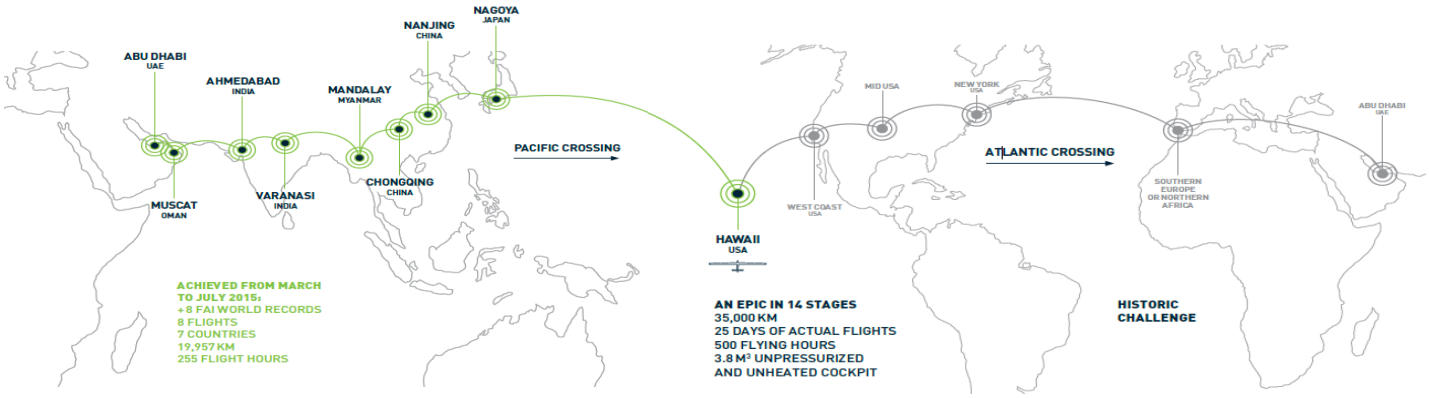
- Single-seater aircraft made of carbon fiber
- Unpressurised and unheated cockpit of 3.8m3 / 134ft3
- Wing span: 72m / 236ft (larger than a Boeing 747: 68m / 223ft)
- Length: 25 m / 82ft
- Weight (empty): 2300kg / 5100lb (equals an empty family car)
- Cruising Speed: 45-55km/h / 28-34mph (25-30 KIAS (Knots-Indicated Air Speed) at sea level)
- Max. Altitude: 8'500m / 28'000ft (Flight Level: 280)
- 17,248 solar cells built into the wings that power the four batteries (38.5kWh per battery) that in turn power the four electric engines (13.5kW / 17.5hp each) and the propellers
- The propulsion system is 93% efficient i.e. only 7% energy loss compared to a car that loses 70%

"*From the beginning, we knew that the plane would require a large wingspan to reduce drag and a large surface to insert enough solar cells and produce sufficient energy whilst at the same time have an ultra-light structure to save a maximum amount of energy and fly throughout the night on batteries. The aircraft structure uses the most advanced technologies and has stimulated scientific research in the fields of composite structures, lightweight materials, electric propulsion and methods for managing and storing energy,*" André Borschberg.

The Round-The-World Solar Flight

When the weather is right as of mid-April 2016, Bertrand Piccard and André Borschberg will resume flying around the world with no fuel, rising up to more technical, human and operational challenges. Solar Impulse 2 has already crossed half the globe – and with 20'000km left to lay down a marker for the future – crossing the remainder of the Pacific, the United States and the Atlantic, is surely going to be as exciting and adventurous as crossing Asia and the first leg of the Pacific.

In March 2015, Solar Impulse 2 took off from Abu Dhabi for a 35,000km journey to Oman, India, Myanmar, China, Japan, U.S.A, back to Europe and Abu Dhabi. However, in July 2015, after a record breaking flight of five days and five nights (117 hours and 52 minutes) and around 8'900km, Solar Impulse suffered battery damage due to overheating. This led to an unforeseen pause in the adventure as it was going to take the team more time to repair the battery system than the remaining time left before the end season with favorable weather conditions to continue the Round-The-World Solar Flight.



Clean technology solutions

When Solar Impulse was initiated in 2003, the aviation industry thought that a flight around the world powered by solar energy was infeasible. Therefore Bertrand Piccard and André Borschberg searched for the necessary knowledge elsewhere. It's thanks to a diversified team with a positive outlook and a wide network of partnerships that Solar Impulse has been able to develop technologies that give solutions capable of meeting many of the many challenges facing our society today. Indeed, the energy efficient solutions developed by Solar Impulse can already be used in electrical networks, houses, cars as well as IT equipment and household appliances.

"All the technologies developed with our partners, such as electrical motors with 97% efficiency, LED lamps for public/private lightening system, extremely efficient insulation foam that can reduce energy consumption for houses, light materials, high energy density batteries and ultra-thin solar cells, can be used on the ground to contribute to a cleaner and more sustainable world," Bertrand Piccard.

"*Just imagine your energy reserves increasing during flight! To make this dream a reality, we had to make maximum use of every single watt supplied by the sun, storing any surplus in our batteries. We tracked down every possible source of energy efficiency,"* André Borschberg.

The human challenge

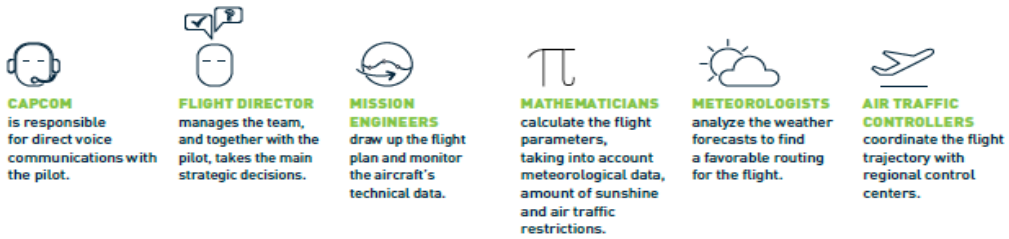
Solar impulse is approaching perpetual flight and therefore, theoretically, could fly forever solely powered by the energy of the sun. One of the main challenges is the human factor i.e. pilot's sustainability. No sleep is permitted whilst the plane is flying over populated areas, but over the oceans, sleep is planned and integrated in the form of short naps of up to 20 minutes at a rate of one to 12 times a day. The pilots have also developed techniques to relax the body while remaining awake – Bertrand Piccard uses techniques of self-hypnosis and André Borschberg yoga techniques.

"I got trained at hypnosis and self-hypnosis in 1992 in anticipation of the first transatlantic balloon race that would consist of five days and five nights over the Atlantic in a tiny capsule. I use all these techniques when flying with Solar Impulse. In the case of resting periods, the method is to dissociate the head from the body. The body can regenerate into a very deep relaxation while keeping the brain alert enough to check the instruments and follow what happens during the flight," Bertrand Piccard.

"Being able to stay awake, concentrate and to keep alert is a challenge. I did a lot of meditation to learn how to relax and breathe properly during the flight. With my trainer, we developed special exercises in order to keep blood circulation active and relax muscles. These were more postures than exercises, in some way derived from yoga. Above all however, passion has been the driving force behind this endeavor!" André Borschberg.

The Mission Control Centre

The Mission Control Center, which is based in Monaco, is in permanent contact via satellite with the airplane. More than twenty specialists anticipate every possible scenario and transmit information enabling the pilot to follow the optimum flight plan and complete his mission successfully. When flights are in progress, the flight parameters are re-calculated twice a day, taking into consideration the prevailing weather situation and amount of sunshine. Flight altitudes and track are optimized to ensure enough on-board stored energy to fly through the night. In search of the most suitable patterns for the Round-The-World Solar Flight, several thousand flights have been simulated taking account of varying meteorological conditions.



Advocacy

Through Solar impulse, Bertrand Piccard also actively promotes the use of new modern clean technologies as an opportunity for change and seeks to influence decisions and bring progress within political, economic, and social systems and institutions. His message conveys a visionary approach: solving climate change is not an expensive problem, but rather a unique opportunity for profit and job creation. Climate change, and in particular CO2 emissions, are mainly caused by inefficient energy sources. If those outdated technologies were to be replaced with modern technologies, such as the ones used on the Solar Impulse 2 aircraft, the energy consumption of the world, and therefore the C02 emissions, could divide by two.

"If an airplane can fly day and night without fuel, everybody can use these same technologies on the ground to halve our world's energy consumption, save natural resources and improve our quality of life. Solar Impulse is a perfect example to illustrate that solving climate change is a profitable opportunity, not an expensive problem, and that it is possible today to bridge ecology and economy," Bertrand Piccard.

Conclusion

Flying around the globe aboard their silent airplane, propelled solely by the energy of the sun, Bertrand Piccard and André Borschberg are making history with clean technologies. Through innovation and pioneering spirit, their adventure proves that change is possible and that there is reason to hope for a sustainable world. Solar Impulse's energy efficient solutions can already be used, not only in the air, but also on the ground, and have the potential to change lives, societies and future markets in an unprecedented way.

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