



This was a unique presentation, delivered by an extraordinarily passionate devotee of finding challenges that take in exploration and adventure. His principal desire is to contribute to the knowledge and experience necessary to manage eco-friendly methods of travelling, and to 'explore.' On the way he has been amongst the first to be at places where the technology he has uses is derived entirely from the eco-system. He has been involved in solar-energy related developments for over two decades, and has reached the point of attempting to reach hitherto unprecedented targets in the air.

The speaker has already explored and achieved world-class records with solar-powered vessels at sea. In 2012 he led the circumnavigation of the globe in 'Planetsolar,' a project for which he created and secured sponsor funding. He and his crew covered 60,000 km in a vessel with an 85 tonnes (187,340lb) displacement. In statistical terms it was akin to a modern fully-laden variant of the Boeing 737 and it had an upper surface 32m (105ft) long and 15m (49.2ft) wide – an area roughly twice as large as the 220-seat theatre in which he conducted this presentation. Admittedly, more sedately than any airliner, it cruised at 7.5kts and was capable of 14kts at maximum power: the circumnavigation was conducted at an aeronautical dawdle, but one cannot possibly scoff at this remarkable achievement.



The solar-powered 'Planetsolar' vessel that circumnavigate the globe in 2012

He started the presentation with a video that looked back to the earliest of motor-powered vehicles and that charted in detail the evolution of solar-power (the various technologies used over almost a half-century provided a reminder of what effort has been devoted to this topic in the scientific community). Within the video his own attainments were evident but referred to with an un-boastful nonchalance, of his own part. With enthusiasm he mixed the words 'challenge' and 'exploration' as adroitly as a chef will work with butter and milk.

He is now working on the SolarStratos project: as the name implies it is an aircraft that will fly in the stratosphere, and rely totally on solar power. The project is currently being funded, and like all leading-edge technological challenges it relies on many sponsors who contribute to the overall cost, and inject resources and expertise. It is a radical application of a standard configuration: a very high-aspect ratio low-wing monoplane with conventional horizontal and vertical stabiliser surfaces at the rear. Beyond that conventional aeronautical engineers can return all but the most fundamental books to their shelves: it is a significant move towards combining the extremes of what structural, aerodynamic and energy management systems can manage.

In describing it's legacy he paid tribute to many predecessor successes that have pioneered aero-solar activity over four decades. His review covered four decades of work, ranging from Solar One in 1978, to the two-man Solar Impulse, that in 2015-16 circumnavigated the globe over 16 months. The latter was a well-publicised success, and originated from Switzerland: and perhaps no coincidence that our speaker is of Swiss nationality. Solar Impulse spaced its stages over a 16 month period, conducting 17 separate flights, each of considerable duration, and as such it relied heavily on a supporting ground team that monitored climatic conditions and passed on information of when unsuitable conditions were unavoidable. Overall the aircraft was in-flight for 23.25 days, covered 22,915 n.m. (42,438 km), averaged 41.0 kt (76.0 km/hr) and reached a record altitude for a solar-power aircraft at 29,114 ft (8,874 m).

Solarstratos is not promoted as a circumnavigation aircraft, but as a design that will carry a human crew and climb high enough to overcome all severe weather systems. To rise above major atmospheric activity it has to cruise in the stratosphere, and not at the transition height – 11,000m (36,080ft) - but very high in the stratosphere. The aircraft is planned to attain and cruise at altitudes in excess of 90,000ft, a domain hitherto accessible to only a few military reconnaissance aircraft. (The speaker did not allude to the lessons of others, but worthy of note is that NASA has demonstrated solar-powered flight in this altitude regime. These have been unmanned and the resources absorbed were very significant. Even so, after successful flights, the Helios, an all-wing design that had reached 98,563ft in 2001 was lost in tests two years later. In clear skies, it broken up due to instability caused by unexpected turbulence, 10 minutes after take-off.¹)

Solarstratos, being a manned aircraft, is almost certainly a conventional design for good reasons. The high-altitude capability does require a large-area wing, but also this provides a larger area on which to collect solar energy. Span is 24.8 m and the total area covered by solar cells is 22 sq.m. This requires a lightweight and relatively rigid wing: not prone to more than modest deflection for structural, aerodynamic, stability and solar cell efficiency needs. It will weigh only 250kg empty (a proportion of that attributable to batteries), and 450kgs with two pilots and necessary support on board. The propulsion system will use a 32 kW electric motor linked to a 2.2 m (7 ft 3 in) diameter 4-bladed variable-pitch propeller.

If it succeeds the solar-powered aircraft will fly higher than any before it and show that renewable energy can not only match fossil fuels but surpass them. The speaker is a close friend of Bertrand Piccard, who crewed Solar Impulse: they share a common belief that adventure can inspire people to take action to tackle climate change, and he commented that he would welcome his friend as second pilot, if he wants to join him in SolarStratos.

¹ A full report is available at https://www.nasa.gov/sites/default/files/64317main_helios.pdf



The initial SolarStratos demonstrator during trials

A prototype aircraft has flown (first flight data was 5 May 2016) but the design is still being refined, and additional funding sought. Published target funding is £7.6 million, with over half already used, and the programme is running currently with development concentrating on technical properties of the aircraft where performance is being challenged. A quoted target was wing mass reduction from 60 kg to 40 kg, and even with the best of modern materials that is undoubtedly a target (less than 2 kg/sq.m) that will need a radical application of knowledge, and designer mind-set. The attainments being targeted on the propulsion technology were equally startling in terms of the expected outcomes. Solar cell mass was quoted as 800 g/sq.m: compared to 10 kg/sq.m. for a domestic roof-top solar panel, and the battery technology being use was capable of storing 150 kW/kg, compared to one-tenth of this value in existing electric cars. There was a hint that a newer battery – Lithium-Sulphur – will deliver up to 500 kW/kg capability.

In a commercial organisation, it would be difficult to consider making a full-blooded charge to harness these teasingly high expansions of capability, but with a man who says challenges and exploration are the core of his interest, the situation is much more open, and these are the risk-takers that have often propounded what has seemed to be the 'impossible.' The wisdom of these potentially vast leaps in technological capability are what his investors will need to decide they can support with investment, and it would be fair to say that with appropriate investment that will see the project through the critical stages it is in at the moment could be a very significant demonstration of how to use new technology to overcome the hurdles of that the older technologies face. The project's objectives are:

- Attainment of the first manned stratospheric flight
- Absolute altitude record on board a manned solar aircraft
- Absolute altitude record on board a propeller aircraft

It will be a very significant attainment if all three objectives are fulfilled.

The lecture was attended by about 100 people. The presenter received warm appreciation from all, and carries the enthusiasm of many in answer to the question posed on the front of his project brochure, vis "Are you ready to flirt with the frontiers of space?"

Lecture notes by Mike Hirst