Electric Aircraft – the future of aviation or just wishful thinking?

Since the dawn of aviation, the primary source of aviation propulsion has been based on aviation fuel or gasoline, with its high energy density of around 43.02 MJ/kg, with Jet-A or Jet-A1 having strict specifications for performance defined in DEF STAN 91-91 or ASTM specification D1655. This high energy density allows the vast power required to lift the large commercial airliners such as the Airbus A380 on journeys across the globe.

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The concept of the "More Electric Aircraft" has been in development for more than a decade, with the EU funded MOET and then Clean Sky (1 and 2) initiatives pushing research and development into great utilisation and efficiency of electrical power systems in Aircraft. These research programmes have a long term objective of significantly reducing the fuel consumption of commercial aircraft across all aspects of the flight by improving the overall energy efficiency of the aircraft in every respect. In practice this means improving the weight of the aircraft by using lightweight composite materials, reducing drag with improved aerodynamics, optimising the flight profile (particularly take off) to reduce fuel consumption during the ascent to cruising altitudes, and maximizing the efficiency of the on board electrical power systems.

Even with this long term goal of increased aircraft fuel efficiency, the resulting savings while useful commercially as small improvements will result in large savings over long journeys on a repeated basic, in fact these fuel savings are still

relatively marginal in terms of the overall propulsion which is largely dominated by conventional aviation fuels. Interestingly, the most recent EU research projects (Clean Sky and Clean Sky 2) also hint at the need to reduce emissions, particularly in the upper atmosphere.

Innovation to achieve significant shifts in performance have often been driven by military requirements, with the Jet turbine engine being an obvious example during world war 2 and the cold war following immediately, with an example being the race to achieve speeds in excess of Mach-1 (supersonic – Chuck Yaeger in the Bell X-1 in 1949) and numerous altitude and speed records following. The drive to ever-increasing speeds led to massive improvements in performance and reliability, which have been used in the commercial aviation sector for subsequent decades. This has made intercontinental air travel a reality for the mass market driving down prices and increasing availability to almost anyone.


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The ultimate expression of this transformation of capability from military to commercial aircraft was the Concorde aircraft operated by British Airways and Air France. Despite the phenomenal performance of Concorde it was plagued by complaints of excessive noise and pollution during its operational life and this impact on the environment has become a more consistent complaint against modern jet air travel in recent years.

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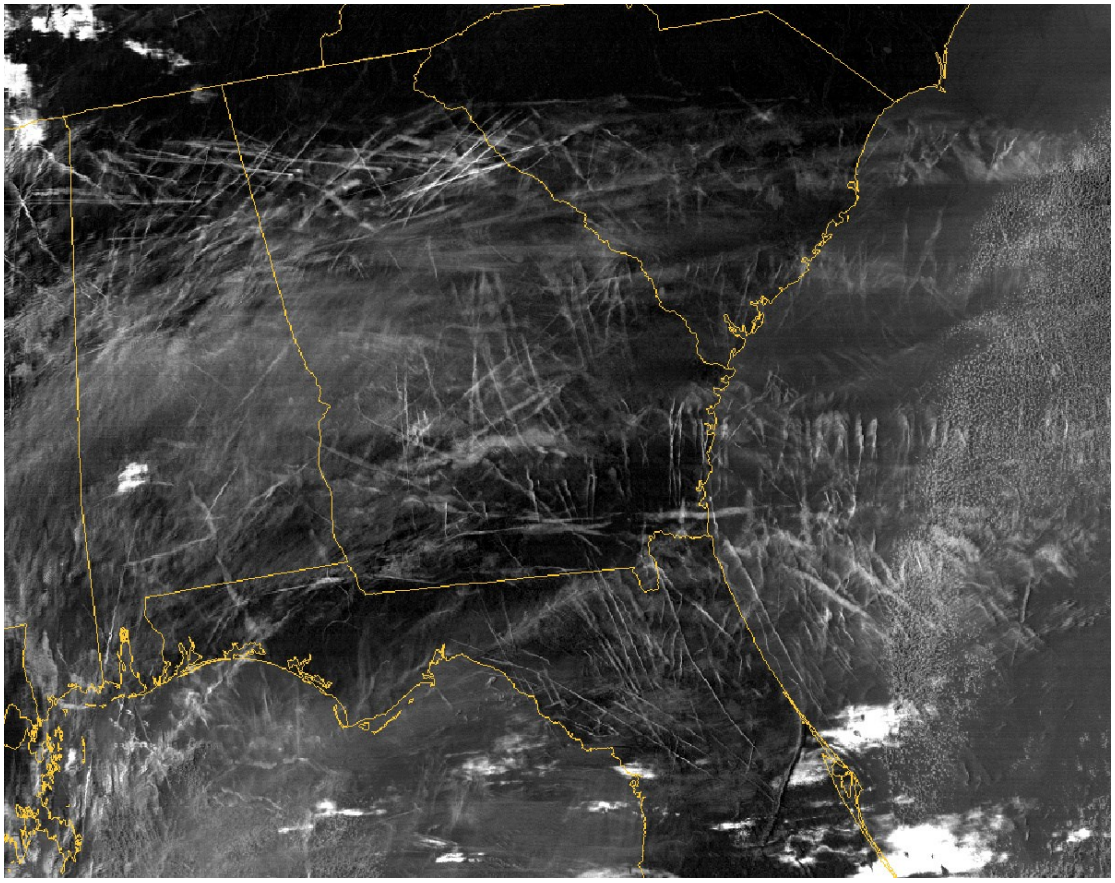
An illustration of the impact that jet travel has on the environment was apparent with the grounding of all commercial aircraft over continental USA following the events of September 11th 2001 where the reduction in contrails (condensation caused by aircraft) actually caused a 1.8 degree increase in temperature. While these contrails are condensation, they illustrate the density of aircraft in the skies. The obvious connotation for the observer is the emissions from those same aircraft that are invisible to the naked eye, but are contributing to the overall greenhouse gasses in the atmosphere.



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One additional question that follows is whether these fuel hungry engines can be replaced by purely electric propulsion. At the one end of the scale we can see electric only propulsion such as the current round the world endurance aircraft, powered by Solar power alone – which is an interesting technical exercise, but not a particularly realistic option for mass transit of passengers.

Therefore, where does electric power fit in the long-term adoption for air travel by the consumer? In practice this is still some way off, although the Airbus prototype E-Fan Aircraft is due to be put into production by 2017. The E-fan is a very light 2-seater aircraft, powered by 2 electric motors, however clearly the relative speed and carrying capacity are orders of magnitude lower than those required by commercial carriers.

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It is not unreasonable to expect that within the next decade, this technology will perhaps have been extended to short-range commuter style aircraft or business aircraft – especially targeting those applications still using conventional turbo-prop propulsion. Airbus, in fact, has medium term plans for just such an aircraft, with targets of perhaps 60 passengers, making it a suitable platform for short range commuter aircraft.

In technology terms, the key limiting factor, in common with the electric car, is the need for battery storage (The E-fan aircraft uses Lithium Ion batteries for example) - and this is the main source of both weight and fuel restriction. Aircraft typically have a longer fuelling time than a car, therefore rapid recharging is possible and effective, however the energy density in batteries is still a critical problem. With Lithium Ion batteries having perhaps a maximum energy density of 900 kJ/kg (compared to 43MJ/kg for aviation fuel), clearly there is a significant storage problem to be solved to achieve the required capacity for large aircraft or long distances (or both!).

The final issues to be overcome are those of safety and reliability. Until the energy storage issue is addressed, the public will be sceptical of purely electric aircraft (much as the electric car still has to achieve a critical level of public confidence). In aircraft this is obviously more critical as a perceived reliability issue will have a significant impact on consumer confidence. If prototype aircraft such as the E-Fan can build that confidence, there is the prospect of purely electric commercial aircraft on the horizon, perhaps within the next two decades.

It will be fascinating to see the drive towards more electrification of aircraft for commercial travel in the future and it will be a dramatic and exciting change for the aviation industry if a commercial aircraft can be propelled by electric power. alone