#9 - Towards the Boundaries of E-flight

More than ever, the world is seeking disruptive innovation to reduce carbon emissions. The aviation industry inevitably has to follow this trend. This is exactly where ECHO-1 stands out. This 48-seat passenger aircraft, being 100% electric battery powered, will be among the first regional transporters to achieve near zero carbon emissions during operations. Capable of flying from Amsterdam to Milan in the year 2035, it will serve as the front runner in the regional air transport market due to its 800 kilometer nominal range.

Mission Objective

Venturi Aviation, a young Delft-based start-up aims to develop such an electric regional aircraft. It is therefore that this company requested our DSE group to perform a feasibility study on their innovative idea. This challenge entailed investigating the potential of the concept by performing an initial sizing of the aircraft. This challenge consisted of determining the conceptual aircraft configuration, evaluating aero-propulsive solutions as well as outlining the operational characteristics of the aircraft.

System Design

After having performed preliminary performance calculations on each of the four selected trade-off concepts, the truss-braced wing configuration stood out due to its extremely high lift-over-drag capabilities. Therefore the required aircraft weight and battery weight could be minimised, decreasing operational cost. Additionally, the 36 meter wingspan of ECHO-1 allows for implementing distributed propulsion. This highly efficient propulsive solution is capable of increasing the lift-over-drag ratio even further.

Moreover, the introduction of the truss allows for bending relief, hence a lighter structural wing mass. At the same time, the truss houses cables that provide the engines with electricity originating from the battery compartment, which is located in the belly of the fuselage.

After a significant number of iterations, a final converged design was obtained. At 20937 kg of maximum take-off weight, ECHO-1 is able to transport 5588 kg of payload over a range of 800 km at a cruise velocity of 500 km/h. Throughout its life-cycle, ECHO-1 produces 87% less greenhouse gasses than comparable kerosene aircraft. It can thus be concluded that ECHO-1 complies with requirements set by Venturi Aviation.

In terms of operational characteristics, ECHO-1 is able to charge up to 94.1% state of charge using 4 Megawatt Charging System chargers, while still allowing for a 30 minute turn-around time. Furthermore, as ECHO-1 has electric distributed propulsion, the risk involved with engine failure is much lower compared to traditional propulsion options. Additionally, the operational costs for ECHO-1 are substantially lower due to 48% lower refuelling cost, allowing for more operational profit compared to existing similar aircraft. Lastly, due to the truss and simple engines, vibrations are considerably decreased, leading to lower maintenance cost.

For airlines, operating ECHO-1 is thus financially attractive and the required runway length of only 1500 meters allows ECHO-1 to operate from the vast majority of regional airports. In the near future, ECHO-1 will change regional air transport considerably. Although electric flight has room for improvement, it shows great potential. With continuous progress in battery energy density, ECHO-1 should be reconfigured in the future to make optimal use of these developments. However, for now, the boundaries of E-flight have been found.