29 - Environmental Impact Reduction Through Aircraft Design

The demand for air travel is increasing rapidly by 4.3% each year. This poses challenges to the current flight network and places the environmental impact of aviation under greater scrutiny. The average distance of the top 60 busiest routes in the world is just over 1000 km. At present, either high-capacity aircraft (e.g. Boeing B777, Airbus A350) which are designed for large distances, or short-medium range aircraft at high operational frequencies (e.g. Airbus A320, Boeing B737) are being used on these routes. This not only increases emissions to the environment but also contributes towards aggravating airport congestion and noise pollution close to airports.

Mission Objective

The main goal of this project is to design an aircraft, which substantially reduces the environmental impact while being optimized to fly on busy short-distance routes, as well as to reduce the frequency of flights required to be operated per day on a given route. This design shall result in a reduction of 25% of CO_2 and 50% of NO_x emissions per passenger per km, in addition to a reduction of 20% of perceived noise emissions, when compared to the current state-of-the-art technology aircraft (Airbus A320neo). Moreover, the aircraft shall carry approximately 300 passengers to account for the high passenger load factors projected for the routes it flies. Lastly, the range of the aircraft shall be at least 3000 km, so that it can fly on most of the busiest routes around the world.

System Design

The aircraft is expected to enter into service by 2035, which leads to the core characteristics of the aircraft configuration being conventional. However, certain modifications have been implemented to improve the aircraft's performance. The aircraft has a high-density cabin which can hold between 290 to 330 passengers, depending on the chosen configuration, and has a harmonic range of 3000 km.

The aircraft is powered by 2 Water Enhanced Turbofans, which reduce the engines' NO_x emissions. The fuel used will be a blend of Sustainable Aviation Fuel (SAF) and kerosene up to 100% SAF blend. The use of SAF can potentially reduce the overall lifecycle CO_2 emissions. The positioning of the engines on top of the horizontal stabiliser allows in part for some noise originating from the engines to be shielded, reducing therefore the noise emissions of the aircraft, especially during takeoff. This unique positioning also leads to the implementation of an H-tail.

In order to drive ground operations to be more sustainable, the aircraft is capable of using electric power to taxi for 26 minutes. This reduces fuel consumption and reduces noise pollution whilst at the airfield. Additionally, the aircraft has been designed in such a way that the wingspan remains within the bounds of the ICAO Aerodrome Reference Code D standards.

From a materials and manufacturing perspective, the focus was mostly set on sustainability. State-of-the-art Aluminium-Lithium alloys will be used on the aircraft structure which ensures that the materials used in the aircraft are at least 75% recyclable and that the environmental impact caused throughout the overall lifecycle of the aircraft is lower when compared to the Airbus A320neo.