Skymaster Flying Propulsion Testbed Group 25

Historically, commercial aviation has proved to be resilient against external shocks, with traffic increasing by a factor of 2.4 since 2000. Pre- Covid--19, Airbus forecasted a demand for 39,000 new aircraft during the next 20 years, with traffic levels set to double every 15 years. Although these figures suggest a lucrative future for the industry, ensuring that this growth is fulfilled sustainability poses a serious challenge to aircraft design. Therefore, a significant amount of research is being performed into the feasibility of alternative propulsion systems. Examples of this are projects such as Ampaire Electric EEL and VoltAero Cassio, which equip existing aircraft with electric engines.

For the DSE, in collaboration with the Dutch Electric Aviation Centre (DEAC), we aimed to design the necessary modifications to the Cessna Skymaster so that it may be retrofitted with an experimental rear engine, for research into sustainable propulsion systems. The reason for the Skymaster being a suitable aircraft for the testbed, is due to its unusual center-line configuration, thereby eliminating any yawing tendency of the aircraft in case of engine failure. The modification starts with the removal of the engine and its corresponding mount and fuel as well as three seats from the cabin. From the known dimensions of these components a mass, balance and volume budgets were established for which the modifications are designed within.For the propulsion system, a survey was conducted to identify the most promising types of sustainable propulsion. It was found that using either a complete electric system or a hydrogen fuel cell-based system has the highest potential in the next 5 years. Both systems use an electric engine, where the electric configuration is powered by batteries and the hydrogen system using a fuel cell in combination with cryogenic hydrogen.

For the aircraft to function as a testbed, structural components were redesigned for the engine and fuel mounting. The engine mount selected consists of two parts; a permanent structure, mounted to the original hard points in the firewall frame and various sub-structures that are specific to the engine being tested. The fuel mount is located inside the fuselage and can hold both batteries and hydrogen tanks while maintaining accessibility from the front of the aircraft. For safety, an additional firewall is fitted between the passengers and the fuel in the fuselage.

Finally, the data acquisition system was designed. Since currently no off the shelf solution exists for monitoring hybrid testbed aircraft, the configuration and components of the aircraft had to be taken into consideration. The instrumentation design ultimately was designed to provide a balance between performance sensors and safety sensors giving the pilot crucial information such as engine and battery temperature as well as being able to record the revolutions per minute and torque of the engine.