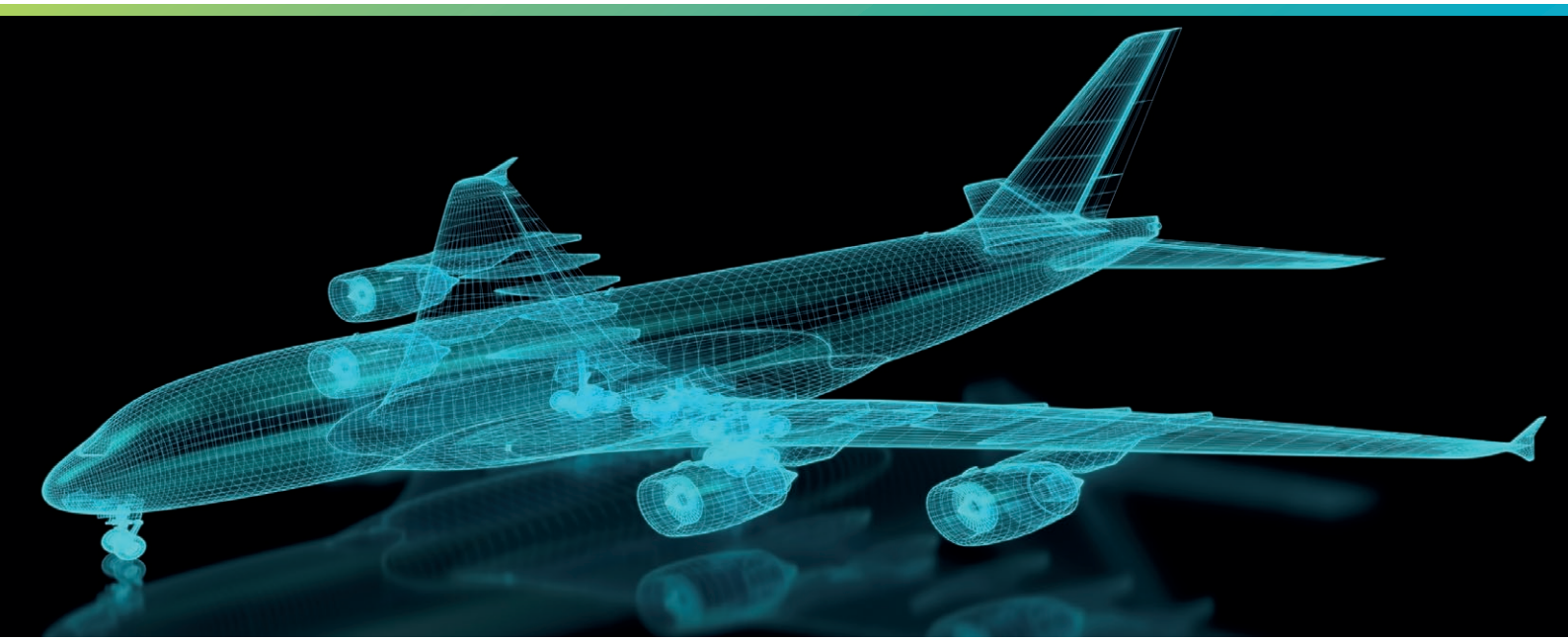
EMMAS

Romax uses its electro-mechanical knowhow for aircraft actuator collaborative design



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Youn Park,
Head of Aerospace, Romax Technology

Titled Electro-Mechanical Magnetic Actuator Systems, the EMMAS project was part-funded through the Aerospace Industrial Strategy (Advancing Technology Capability) competition. This competition was setup by the ATI (Aerospace Technology Institute), Innovate UK (the UK’s Innovation Agency), and BIS (Department for Business, Innovation and Skills). The project developed a novel actuator system that is mechanically robust, fault tolerant, thermally controllable and suitable for extreme environments. The production of a safe, robust and reliable electro-mechanical aircraft actuator system has been demonstrated.

The project

In the aerospace industry safety is of paramount importance and therefore, flight actuation systems (e.g. rudders and ailerons) demand high component reliability to achieve safe operation. Weight and efficiency are the key parameters that dictate the emissions and fuel burn of the aircraft; these are environmental factors that the industry is dedicated to improving and some of the main

Challenge

Advancing Technology Capability competition for collaborative R&D. To develop an innovative, safe, lightweight and reliable magneto-mechanical aircraft actuator system.

Solution

Through a successful collaboration of experts in their field the project brought together novel magnetic direct drive technology, actuator control and complete electro-mechanical system design and analysis. Developing an actuator system that is efficient, durable and reliable and contains a control system suitable for extreme environments.

Benefits

From methodical conceptual architecture selection to detailed design and analysis, this project has demonstrated the ability to realise high reliability of a controlled electromagnetic mechanical actuator to industry standards. Assisting the aerospace industry maintain its high levels of reliability and safety in the move towards more electric aircraft.

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drivers in the move to more electric aircraft. The benefits of electro-mechanical actuators as a replacement for other types, such as hydraulic actuators, are particularly attractive, however adoption has been limited due to concerns over reliability.

This project demonstrated that taking a complete system level view to actuator design can de-risk electromagnetic technology and enable a safe and reliable system to be developed that also exhibits the benefits of improved torque density and efficiency.

The partners were each selected for their expertise; Triumph Actuation Systems, the project lead, supplied their actuator design and control hardware. Magnomatics brought their novel pseudo direct drive concept; a magnetic system that combines a brushless AC motor with an integrated magnetic gear. The University of Sheffield applied their world leading control expertise to the control system design. Romax used their electro-mechanical engineering expertise, system design and analysis tools to assess the full system.

This project carried out a complete system level design and analysis of a rudder actuator, comprising novel fault tolerant pseudo direct drive concept (PDD), dedicated controller and ball screw mechanism. Starting from a review of all aircraft actuator systems, the consortium methodically and systematically assessed and compared each application with the magnetic drive operational characteristics and identified the best match to take into the project.

Early in the project Romax focussed on mass reliability trade off assessments for a large number of concepts, rapidly assessing each against the relevant aerospace standards and guidelines to ensure the concept ideas would meet with industry regulations. This was crucial early in the design stage as it enabled quantitative assessment and confident understanding of the concepts in order to select the appropriate actuator architecture.

Taking the resulting mechanical design of the actuator from Triumph, which included the novel PDD design from Magnomatics, Romax applied its industry leading

Electro-Mechanical Magnetic Actuator and Control Electronics

expertise to analyse the whole system for mechanical reliability. Using flagship software RomaxDESIGNER, Romax could assess the whole system (including stiffness, deflection and stress) due to important effects such as g-force, unbalanced magnetic pull, axial preload and bearing clearance.

The bearings are one of the key safety critical components in such a system and a technology that Romax has exhibited world leading capability for assessing going back over more than 25 years. By bringing this expertise to the project Romax was able to quantify the effect of many complex operating conditions and system effects on bearing reliability. For instance, the effect of electromagnetic forces (seen due to the presence of the PDD) on bearing damage was assessed. System design recommendations were made and implemented based on this analysis. Innovative dynamic models were also created enabling mode shapes and resonances to be identified as they vary with the motion of the ballscrew mechanism.

The controller was designed by The University of Sheffield and included dynamic models developed by Romax. This enabled the development of a robust control algorithm which was also built and tested. Together with state of the art hardware supplied by Triumph, the resulting control system was robust, resilient and suitable for the extreme environments seen by aerospace applications.

Overall the project has successfully increased the technology readiness level of magnetic units in aerospace applications by taking a system level approach to design and analysis, improving reliability, reducing risk and supporting the move towards more electric aircraft.

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Our technologies are shaping urban and production ecosystems to become increasingly connected and autonomous – ensuring a scalable, sustainable future.

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