

ASCO and VUB Engineer Slat Tracks for Optimal Safety



Advanced research, conducted by ASCO, LMS and the Vrije Universiteit Brussel (VUB), is directed at how to re-design safety-critical components of airplanes. The team is applying life-prediction methods on virtual prototypes, using optimized test scenarios on the physical prototype and applying on-line damage-detection techniques during the physical test. This project represents a critical shift in the application of advanced LMS TecWare durability technologies from the automotive industry to aerospace. This two-million euro research project started in January 2001 and will continue until October 2003.

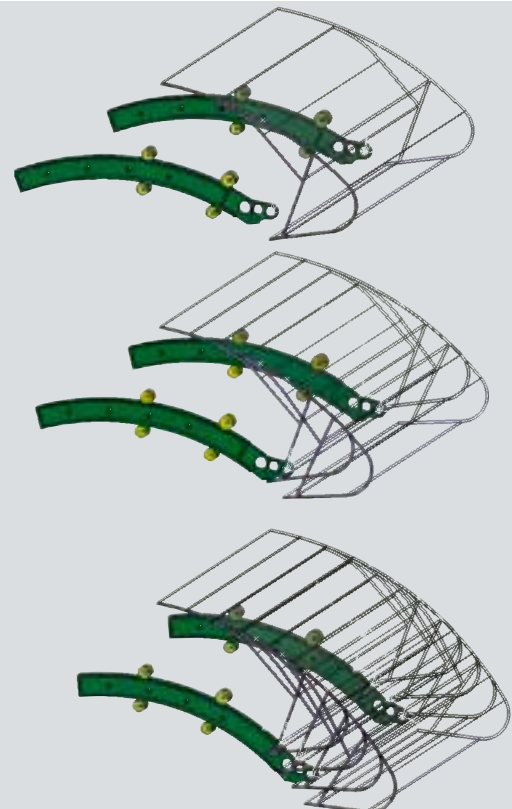
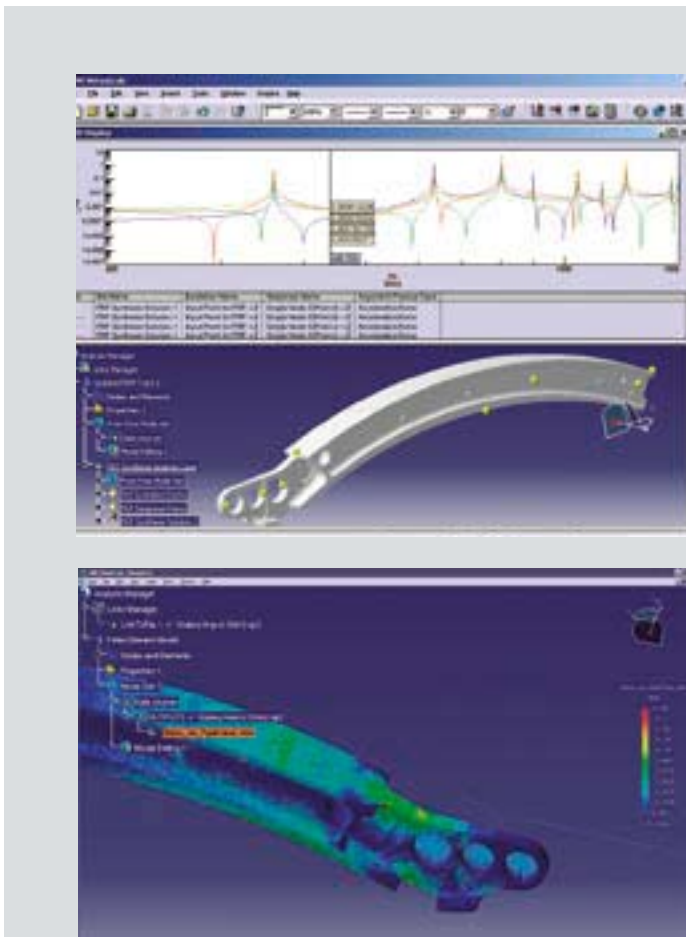
The project is supported by IWT-Vlaanderen, the institution of the Flemish Government promoting innovation through science and technology.

The objectives of the research

ASCO, a world leader in high-precision mechanisms for aerospace, the Mechanical Engineering department of the Vrije Universiteit Brussel (VUB), and LMS, participate in this research project and the Aeronautics Research Program of IWT-Vlaanderen provided financial support. The goal set is the investigation of ways to minimize the weight of an Airbus A320

slat track, while keeping within expected lifetime and safety margins. The slat track is the movable support structure that connects the wing with the leading-edge slats. Current designs of slat tracks are often over-designed, adding to the weight and operating cost of the aircraft. It is believed that the design can be optimized for lower weight while keeping the same functional performance.

Apart from improving the design of the slat tracks, the project mandate also includes the investigation of the structural and fatigue properties of the hard, strong maraging steel used for the slat tracks. An important objective is the continuing refinement of virtual prototyping and testing technologies to decrease development time. The experimentation and modeling also results in design targets that are more realistic



Slat tracks support the slats and enable together with the flaps the enlargement of the wing surface and angle. The track allows the movement of the slats giving the aircraft the necessary lift force during takeoff and landing.



and closer to real operational conditions (using LMS TecWare.) The realism includes the extension of crack-initiation analysis to crack growth, both based on Finite Element (FE) simulation techniques.

Throughout the physical test of the component, the correlation between modal parameters and damage evolution is monitored. The data will be used to qualify designs and to develop vibration-based, in-service, in-situ testing methods to replace the largely visual inspections and ultrasound techniques used today.

The project

LMS began the project by interpreting real-flight data taken from the Airbus test flights of the A320 and converting the data to load-time series on the slat track. An in-depth load-data analysis was performed to identify the characteristics of the slat track loading during real flight, using rainflow counting in LMS TecWare. This treatment of real data allows users to compare different flight conditions and different test flights so that they can derive a target from actual loads, rather than arbitrary targets taken from standards.

These load data are used to load the virtual slat track prototype as well as the physical prototype on the test rig for durability testing. The virtual prototype is

analyzed with LMS Virtual.Lab Durability for crack initiation. LMS TecWare defined time-optimized test scenarios that will run on the IST test rigs in the Mechanical Engineering department of the VUB. Combining virtual prototypes with real, measured load-data results in hybrid models that make optimal use of existing data.

A detailed FE model was made, starting from the CATIA V5 CAD model. To fine-tune the Finite Element Method (FEM) parameters, static and dynamic tests were performed and test data were correlated to the numerical model, resulting in a refined slat track model. The updating in LMS Gateway software assisted in finding the right material properties for the FE model, performing correlation and updating, and displaying the “before” and “after” values on a Modal Assurance Criterion (MAC) matrix for instant, convenient reference.

Extensive material tests were performed on maraging steel samples in order to identify both the crack initiation and crack growth material parameters of the maraging steel. Crack-initiation simulations are performed in LMS Virtual.Lab Durability with the geometry, the loading and the material characteristics. The lifetime between the first loading and crack initiation is calculated. The hot spots that will be prone to crack initiation are

also displayed on the model. This gives a good idea of which areas on the slat track are most heavily loaded, which areas are over-designed, and which areas are unlikely for crack initiation.

The crack initiation analysis is of key importance and is used as a design parameter for safety-critical components. As these components are never supposed to crack, the crack initiation is seen as the end of a component’s life. This is not the case for other non-safety critical metal components (such as parts of the fuselage skin), where even the crack propagation phase is seen as “useful lifetime.” However, ASCO has to prove that if there should ever be a crack in the slat track, the crack will never, under any circumstances, grow towards a dangerous failure situation – and this has to be proven not only with test data but also with the simulations from the FE models.

In the meantime, an IST slat track test rig has been designed and made operational at the premises of the VUB. The existing design and the ultimate re-design of the slat tracks will be extensively tested on this rig to assess how well they perform, and how well the virtual prototypes represent reality.

The next steps

In the next steps of the project, LMS engineers will join the ASCO specialists to re-design the track for weight reduction. For this work, LMS OPTIMUS will be used to explore the design space and make a better design, keeping to the durability targets and functional performance expectations, while reducing the weight. LMS also envisages assessing the robustness of the design with LMS OPTIMUS. ■



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