

SIEMENS

Ingenuity for life

Aerospace and defense

Airbus

Airbus uses Simcenter Testlab to improve and streamline its flutter analysis process

Product

Simcenter

Business challenges

Overcome high modal density and similar mode shapes

Provide better-defined and -equipped testing installation

Avoid spatial aliasing when working on deformed aircraft shapes

Keys to success

Use Simcenter Testlab Structures testing as a complete solution for modal analysis

Align online in-flight analysis at Airbus France with postprocessing at Airbus Germany

Achieve efficient analysis and reporting capabilities

Results

Effectively processed a significant amount of Airbus A380 in-flight data during offline analysis

Enhanced offline test analysis capabilities

Provided clear stabilization diagrams and high synthesis correlations

Siemens PLM Software solution enables processing of vast A380 in-flight data during offline analysis

Providing enhanced process validation

Modal identification methods used during flutter testing – like aircraft characteristics – have evolved to enable correct parameter identification. Frequencies and damping value estimations have to be as accurate as possible in order to define the aircraft fluttering margins used during those first critical in-flight test campaigns.

Flutter testing can be broken into three segments: real-time; near real-time and offline. In-flight real-time test campaigns are used to acquire live data during the test flight, mostly as a safety check to continue the flight envelope. The near real-time testing focuses on rapid modal estimation to determine the overall safety of the flight and the flutter test program. The offline testing deals with the finer analysis of the recorded flight data and final report production.

Simcenter Testlab™ Flutter Analysis software from Siemens PLM Software enables the user to validate data efficiently and effectively, automating the use of Simcenter Testlab Operational Modal Analysis software. It offers a full package with all the required functionality, such as data preprocessing, modal parameter estimation, mode shape animation and result validation.

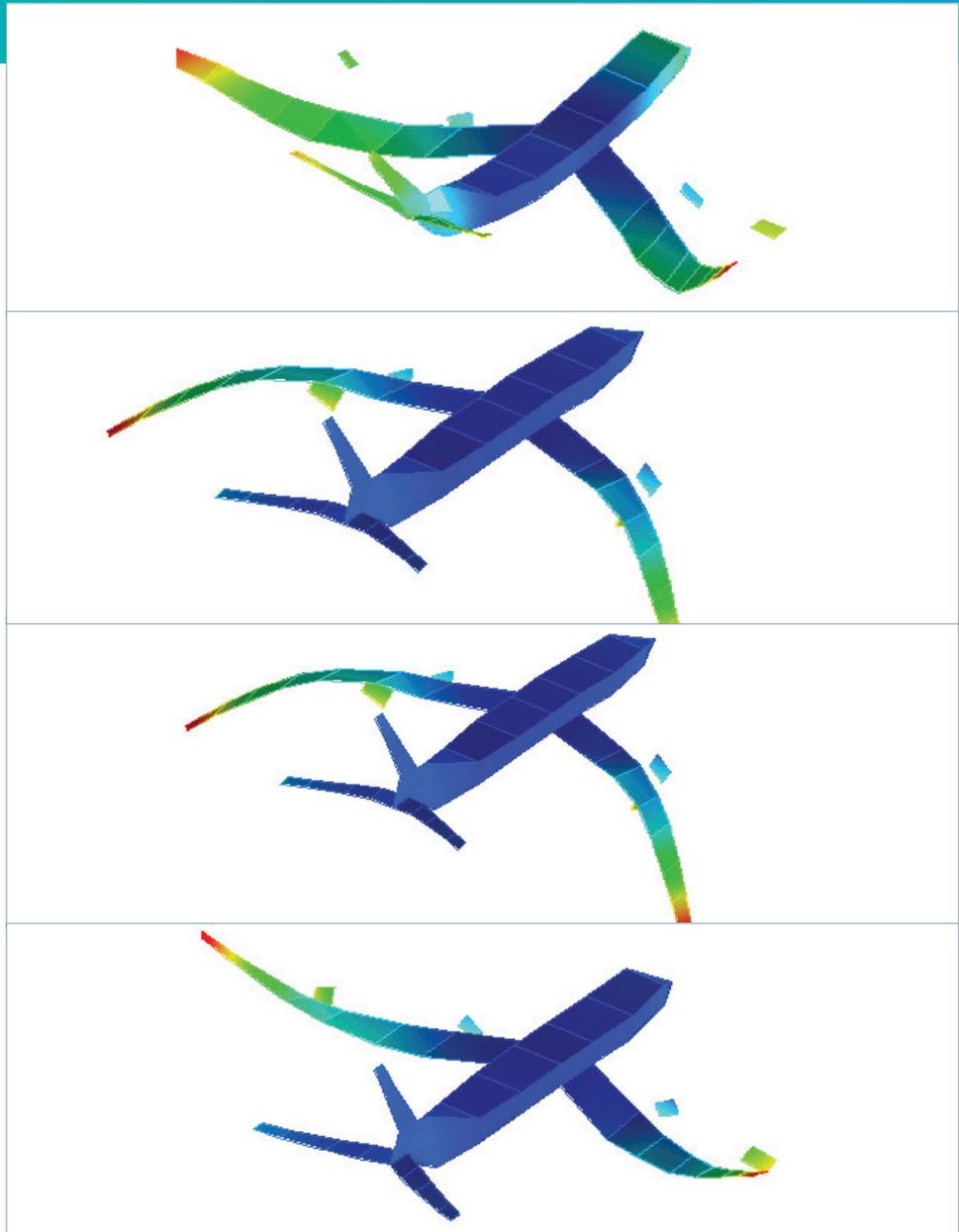


The Airbus flutter team in Toulouse, France faced several challenges working on the Airbus A380 campaign, but these were issues they had faced before with the Airbus A340 flutter campaign: high modal density and similar mode shapes, both placed in a low narrow frequency band.

In terms of modal identification, these new precise requirements called for a better-defined and equipped testing installation. This meant digging a bit to find the right kind of process. Measured data needed to be recorded at enough locations with high enough quality to improve power spectra and transfer function estimates and avoid

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Miquel Angel Oliver Escandell
Airbus Flutter team
Airbus



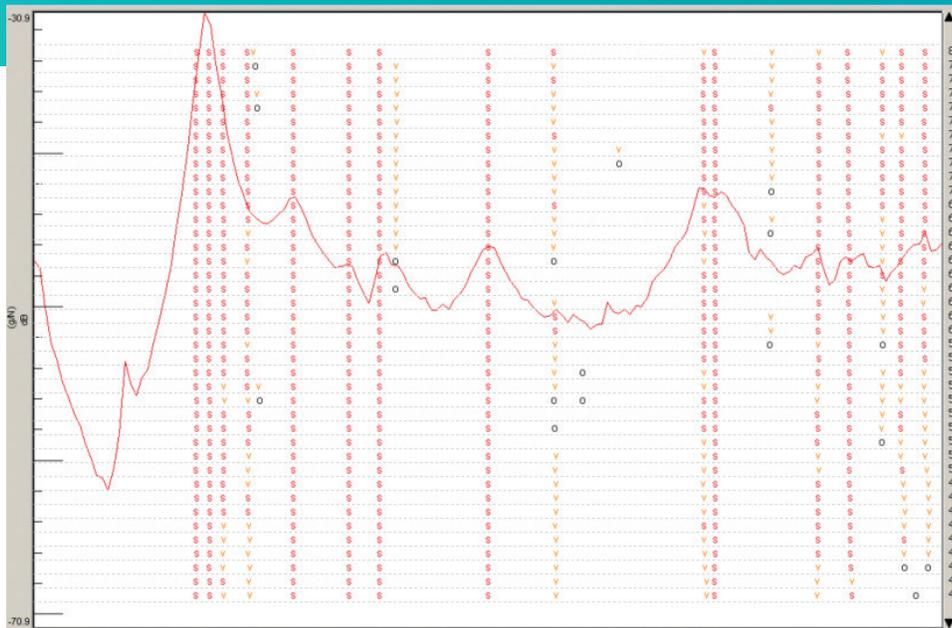
spatial aliasing when working on deformed aircraft shapes. This required some innovative thinking and serious process validation compared to current techniques.

Building on EUREKA FLITE projects

Since 2001, Airbus France and Siemens PLM Software have been cooperating on several EUREKA (European Research Cooperation Agency) projects called “FLITE” (Flight Test Easy). An intergovernmental initiative to support market-oriented European research and develop-

ment (R&D), the EUREKA FLITE projects focus on bringing new and powerful tools to structural engineers and aircraft designers, improving the quality and usefulness of data gathered during flight testing.

The FLITE consortium gathers world-ranking aircraft manufacturers and technology providers from France, Belgium and Poland. The FLITE projects offered a unique opportunity to confront new, advanced algorithms with challenging real-life aircraft data.



Finding the right data

In late 2007, Siemens PLM Software and Airbus agreed to start a project to evaluate Simcenter Testlab Polymax software, an analysis component of Simcenter Testlab Structures software, as a key solution to achieve high-quality offline, in-flight data processing for flutter analysis. Simcenter Testlab Structures is a complete solution for experimental and operational modal analysis, combining high-speed, multi-channel data acquisition with a suite of integrated testing, analysis and reporting tools. Siemens PLM Software is renowned for its modal testing experience and scalable solutions, from supporting impact testing on small structures to large test campaigns using multiple shakers and hundreds of measurement channels.

In the past, the flight test department of Airbus France performed data analysis using its in-house, near real-time analysis package, and transferred the results together with the raw data to Airbus Germany, where the numerical flutter predictions were correlated with actual flight tests. However, Airbus France felt the need to conduct further in-depth data processing so that it could transfer more complete results to Germany.

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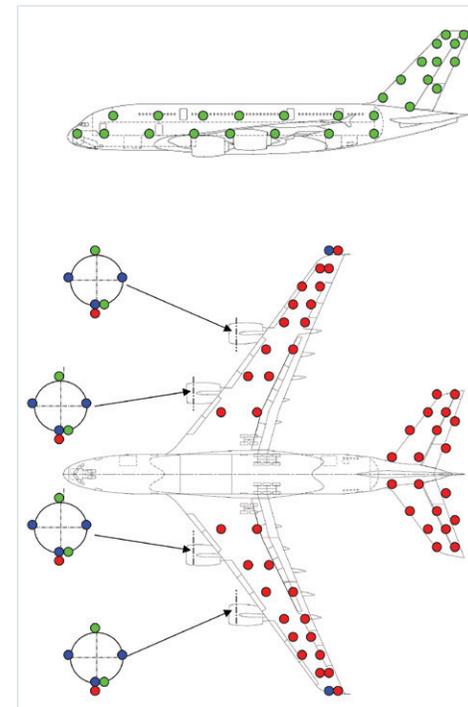
in-flight analysis occurring in Toulouse and the postprocessing completed in the design center in Airbus Germany," says Jean Roubertier, flight test department aero-elasticity expert at Airbus. "At this stage, we're very pleased with the results. Simcenter Testlab is able to provide us with the right type of results."

Realizing record-breaking data acquisition

The 525-seat Airbus A380 is the largest commercial passenger aircraft in the skies today, so it isn't surprising that simply due to its sheer size the acquired in-flight testing data is record-breaking as well.

"With more than 100 sensors, that was one of the largest setups for an in-flight flutter test campaign that I have ever seen," says Bart Peeters, Siemens PLM Software project manager. "Also, the amount of tests under different flight conditions was impressive. The resulting database is immense and efficient processing and report generation capabilities are required."

The Airbus Flutter team in Toulouse performed a variety of excitations, including control surfaces sine sweeps and pulses. Pulses are currently used to assure crew and aircraft safety, whereas sweeps are used to work out more accurate



results, enabling the update of theoretical finite element (FE) models. Thanks to integrating pulses into the process, the duration of flutter flights has been considerably reduced.

The basic concept behind the project was to compare classical experimental modal analysis (EMA) with Simcenter Testlab Operational Modal Analysis software. In classical EMA, the control surface excitation and aircraft response signals are converted to frequency response functions (FRFs). During the actual flight, other excitation sources, such as turbulence, are present. Sometimes this results in noisy FRFs. For example, an aircraft tail response sensor receives a rather limited contribution from the wing excitation. Therefore, the idea arose to neglect the excitation signal and apply operational modal analysis (OMA) to the aircraft acceleration signals.

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De-noising the data

Even with projects of this scale, there is always noise in the data that needs to be managed. Simcenter Testlab can be used to provide a clear picture with techniques that produce accurate analysis results, even from rather noisy data. This feature offers clients like Airbus a true competitive advantage when it comes to offline test processing.

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Solutions/Services

Simcenter Testlab
www.plm.automation.siemens.com/global/en/products/simcenter/testlab.html

Customer's primary business

Airbus is a leading global manufacturer of innovative commercial aircraft. Its product line comprises aircraft that range in size from the roughly 100-seat single-aisle A318 to the over 500-seat A380 wide body aircraft. Airbus consistently captures about half of all commercial airliner orders. www.airbus.com

Customer location

Toulouse
France

"We found that the exponential window, which allowed for cross-correlation calculations, was a good de-noising tool for our in-flight data," says Escandell, who worked on the project for a year. "And the validation tools, such as correlation levels, MAC matrix and mode shape complexity (MPD and MPC criteria) are complementary in regards to real-time identifications performed during flutter tests."

During the comparison testing, the flutter team at Airbus used Simcenter PolyMAX during sweep excitations of the aircraft.

The results, based on using an exponential window of 5 percent, appear to be good, supplying high synthesis correlations (98 percent using just two references) and clear stabilization diagrams.

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Airbus

Siemens PLM Software

Americas +1 314 264 8499
Europe +44 (0) 1276 413200
Asia-Pacific +852 2230 3333

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