Lightning-Strike Simulation Aids Composite Craft Protection

Aurora, IL - Lightning strike tests of a helicopter at Eurocopter's Donauwörth facility have verified the accuracy of finite element analysis techniques for characterizing the electromagnetic behavior of complete and custom-cabled modern aircraft structures constructed using advanced composite materials.

The exercise was performed using the Opera electromagnetic design software from Cobham Technical Services, as a final element of the company's work for the ILDAS (In-flight Lightning Strike Damage Assessment System) project. Simulation of the ILDAS tests highlighted how finite element techniques can easily generate accurate models of complex assembled airframes, and simulate the effects of lightning strikes rapidly - in around a day on a standard office PC - to help developers evaluate and optimize lightning protection measures during the design cycle.

Commercial passenger aircraft are struck by lightning once a year on average. Powerful strikes can result in costly delays for inspection and repair. The industry's current certification against lightning is based on threat levels derived from measurements of cloud-to-ground strikes. While this approach has served well for traditional airframes with good metallic conduction, modern aircraft are incorporating increasing amounts of lightweight composite materials. This makes them more susceptible to direct damage at lightning entry and exit points, and potentially to indirect energy

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coupling effects into the electrical systems as current flows through the aircraft. As a result, it becomes increasingly important to understand the exact nature of the threat by accruing data on actual in-flight strikes. Modeling the current flow patterns within complete assembled airframes with validated software can also reduce costly testing procedures.

The ILDAS project was conceived to develop an in-flight embedded system for measuring actual lightning strikes. This will help to better understand the threat, aid the design of lightning protection measures, and streamline post-strike inspections and maintenance by capturing and communicating actual data on occurrences, intensity, and strike points. Coordinated by The Netherlands' National Aerospace Laboratory, the partners are Airbus, Air France Industries, EADS Innovation Works, Cobham Technical Services (Lightning Testing & Consultancy), Cobham Technical Services (Vector Fields Software), Eurocopter Deutschland, Groupe Socius, LA Composite, Lufthansa Technik, ONERA, and Technische Universiteit Eindhoven.

Opera software was employed to predict lightning strike current flow patterns on structures with carbon fibre composite materials. This knowledge helped ILDAS partners to select the best locations for sensors, and then to compare current flow predictions against actual measurements. To achieve this goal, Cobham Technical Services generated an electromagnetic design model of a specific airframe configuration for an EC135 helicopter using CAD files from Eurocopter. This part of the exercise mainly involved simplifying non-critical parts of the original design data in order to minimize simulation times, while maintaining good representations of critical elements such as metal space

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frames and surface panels, carbon composite panels, electrical bonding and cable harnesses - including those for client-specific equipment.

The modeling work took around two man-weeks, but this depended on experience gained from detailed modeling and analysis of typical composite structures, together with comparison with measurements and simulations performed by other partners in the project. With this supporting work in place, subsequent models of variations on the basic helicopter airframe would be much quicker to create - providing a simple means of evaluating aircraft construction programs.

Once the model was ready, the simulation itself took a little over a day to run on a good-specification office PC. Real-life tests at Eurocopter's Munich facility then showed that the theoretical predictions of energy diffusion effects agreed very well with simulation predictions.

"Airframe structures making extensive use of composite materials have less natural protection against lightning," adds John Hardwick of Cobham Technical Services (Lightning Testing & Consultancy). "As lightning protection measures such as conductive coatings or strips add weight it's important to optimize the design, and simulation provides an effective means of achieving this."

"These real-life tests of ILDAS's embedded monitoring system concept illustrate how airframe-specific lightning protection can now be accurately evaluated and optimized during the design cycle," says John Simkin of Cobham Technical Services (Vector Fields Software). "Finite element techniques make it easy to model complex airframe surfaces and important electrical details.

The functionality of the Opera geometric modeler made it simple to accept CAD files and reduce the complexity of non-critical elements to ensure rapid simulation."

About Cobham: Cobham’s products and services have been at the heart of sophisticated military and civil systems for more than 70 years, keeping people safe, improving communications, and enhancing the capability of land, sea, air and space platforms. The Company has four divisions employing more than 12,000 people on five continents, with customers and partners in over 100 countries and annual revenue of more than £1.4bn / $2.1 billion.

Cobham Technical Services produces the world's most advanced software for modeling and analysing electromagnetic equipment and effects. Its virtual prototyping tools speed the design process - helping to achieve a user's goal, whether that is lowest cost, optimum performance, easier manufacturability, or the best combination.

About ILDAS: please see http://ildas.nlr.nl/ [1]

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