Messier-Bugatti optimized the A380 nosewheel steering and braking system with LMS Imagine.Lab AMESim

System simulation solution for ground loads

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When Every Gram Counts

To save weight on the A380 superjumbo aircraft, Messier-Bugatti used LMS Imagine.Lab AMESim and the Ground Loads solution to design an innovative decentralized hydraulic generation system with lightweight micro-pumps delivering power locally to emergency braking and landing gear steering systems.

KEY POINTS

Challenges

- Integrate and optimize the compromise between local electro-hydraulic generation system sizing & system performance in the early product development stages
- Assess the risk of the Airbus A380's new steering system overheating
- Replace time-consuming reverse-calibration methods

Solution

- LMS Imagine.Lab AMESim multi-domain platform
- LMS Imagine.Lab Ground Loads solution
- Multi-domain libraries
- Flexible DFS licensing system
- Efficient project assistance

Benefits

- Focus on innovation and R&D
- Delete legacy code development and maintenance costs
- Integrates in the current production pipeline and introduces new efficient simulation processes
- Reduce number of physical testing

Size definitely matters, especially when you're developing the world's largest passenger jet. With an overall length of 73 m and a wingspan of nearly 80 m, the Airbus A380 provides seating for 525 passengers and a range of 15,200 km (more than 9,400 miles) – sufficient to fly non-stop from New York to Hong Kong. To gain maximum fuel efficiency and payload capacity, weight savings was a must when developing this massive plane. Composites and other lightweight materials account for more than 25% of its structure, and engineers scrutinized every aspect of the aircraft to further trim it down.

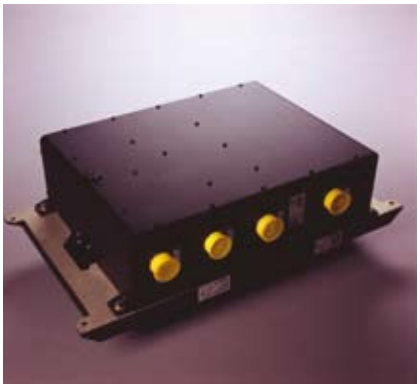
Of particular interest were heavy hydraulic lines running the length of the aircraft from large centralized pumps to equipment, such as brakes, landing gears and the nose wheel steering system. Ordinarily, large commercial jets have three sets of redundant hydraulics: two primary circuits and a third back-up for safety, all adding up to a big load of hefty piping.

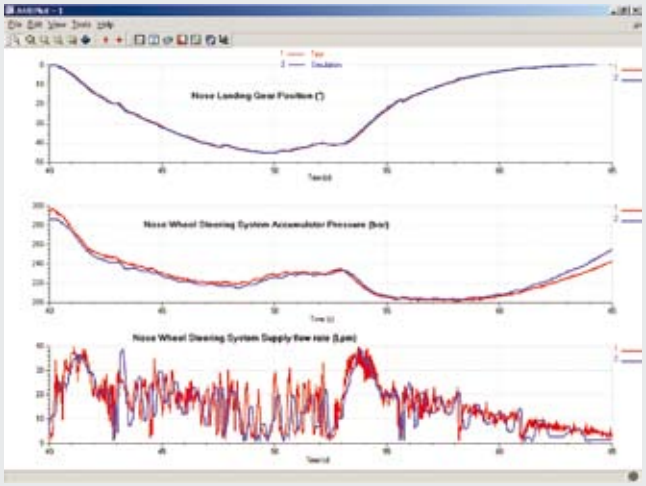
To reduce this bulk, the all-hydraulic backup circuit was replaced with a decentralized fluid-power generation system on the A380. Signals from electronic control units (ECU) activate multiple small electrically-driven micro-pumps, each located close to the systems to be controlled. The micro-pumps provide 5,000 psi (350 bar) of local hydraulic pressure over short runs of small-diameter lightweight piping for braking and steering, so it's always available in an emergency.

A tall order for the engineers

A world's first in a commercial airliner, this Local Electrical Hydraulic Generation System (LEHGS) was developed by Messier-Bugatti, a subsidiary of the SAFRAN Group and a world leader in aircraft landing and steering systems. An Airbus partner for over 30 years, the company's customers include 250 airlines, 20 military air forces and major global aircraft manufacturers.

In optimizing system performance, the engineering team on this project faced major challenges in integrating and sizing the large number of different physical parts, assemblies and subsystems for the mechanical, electrical and hydraulic





A380 nosewheel steering AMESim simulation/test bench results comparison - AMESim model matches real system behavior

Local Electro Hydraulic Generation System (LEHGS) with its Electronic Control Unit (ECU)

Pictures courtesy of Messier Bugatti

systems. Moreover, they needed to assess any risk factors such as electrical overheating.

Compounding the difficulty, demanding deadlines and budgetary constraints prohibited numerous time-consuming and costly physical tests of system mock-ups. Instead, work in designing and optimizing the performance of this first-ever system would have to be done early in the plane's development – before any hardware was built and at the same time the design of other aircraft systems was underway. A tall order that not many tier-one suppliers in the aircraft industry would take on.

The solution: advanced predictive software

Messier-Bugatti met these challenges with the LMS Imagine.Lab Ground Loads solution based on the AMESim simulation platform, which the company had implemented on previous projects for predicting the behavior of complex multi-domain intelligent systems. Engineers began by selecting and piecing together individual components and subsystems from among a library of pre-defined items: Hydraulic Resistance, Hydraulic Component Design, Electromechanical, Electric Motors and Drives, Thermal Resistance, Thermal Hydraulics, Thermal, Hydraulics and Electrical Basics.

Unlike conventional system modeling languages that require computer programmers to write software, the overall system model is created graphically in LMS Imagine.Lab AMESim, where engineers are prompted to enter parameters where necessary. In this way, the software creates a multi-domain system model from the overall conceptual information of interconnected parts and subsystems without requiring a full 3D geometry representation, so engineers can simulate and predict the behavior of intelligent systems long before detailed CAD geometry becomes available.

Throughout this process, Messier-Bugatti system engineers took advantage of convenient and cost-effective access to the LMS Imagine.Lab Ground Loads solution thanks to the system's flexible licensing arrangement, enabling them to optimize the use of specific modules and libraries while lowering overall system simulation expenses.

Simulating complex behavior

The LMS Imagine.Lab Ground Loads solution modeling and analysis capabilities allowed Messier-Bugatti to analyze system's hydraulic behavior in terms of performance, stability and robustness. Engineers also used the model to study the thermal characteristics of the hydraulic circuit and evaluate the need for heat exchangers. These results were then used to establish the sizing, output and other product specifications for the entire hydraulic power generation

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Michael BENMOUSSA
Senior Design Engineer
Messier-Bugatti

“The A380 enters into service with its nose wheel steering system control loop only tuned with LMS Imagine. Lab AMESim. Tests were just performed to confirm the good system performances”.

Michael BENMOUSSA, Messier-Bugatti

system including the tank, pump and accumulator.

By using the LMS Imagine.Lab Ground Loads solution, engineers were also able to explore a large set of parameters and scenarios. When developing a steering system, for example, various combinations of components and systems (actuators, motors, valves, ECU, etc.) could be compared from specification to validation, thus significantly improving the steering system quality.

With these predictive capabilities, Messier-Bugatti simulated the behavior of the electro-hydraulic system for the A380, validated system power-generating performance and enabled engineers to accurately size components early in development. This significantly reduced dependency on numerous physical prototypes. “With LMS Imagine.Lab AMESim, Messier-Bugatti is able to tune complex multi-physics systems without performing a large set of tests on bench,” commented Michael Benmoussa, Senior Design Engineer on the project.

Reduce the guesswork

“Simulation enabled us to anticipate and reduce the inherent development risks of a new technology by incorporating an upstream validation regarding the technical choices,” he noted. “Simulation results obtained in the early project stages using LMS Imagine.Lab AMESim were later confirmed on test benches with a very good accuracy”.

In this manner, the Ground Loads solution enabled the engineering team to significantly reduce guesswork and freed them to focus on innovation and R&D. “Messier-Bugatti was able to predict systems and equipment performances – including critical new technologies – on the entire flight domain,” commented Benmoussa. “The A380 enters into service with its nose wheel steering system control loop only tuned with LMS Imagine.Lab AMESim. Tests were just performed to confirm the good system performance.” ■

About Safran - Messier-Bugatti

The SAFRAN Group is an international high-technology group with four core businesses: Aerospace Propulsion, Aircraft Equipment, Defense & Security, and Communications. SAFRAN comprises a number of companies with prestigious brands in their own right, including Messier-Bugatti. Messier-Bugatti is a world leader in advanced braking,offering innovative solutions in several key areas for both civil and military aircraft: wheels and carbon brakes, braking control systems, steering systems, monitoring systems (tires, brakes, landing gear, etc.) and landing systems. Messier-Bugatti is a streamlined enterprise, giving clear competitive advantages such as the ability to swiftly respond to changing market and customer requirements.

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