RANGEAERO PRIVATE LIMITED

CUTTING DEVELOPMENT TIME AND COSTS FOR UNMANNED FREIGHT HELICOPTERS WITH SIMULIA'S ABAQUS UNIFIED FINITE ELEMENT ANALYSIS SIMULATION SOLUTIONS

Case Study

RangeAero engineers relied on SIMULIA's Abaqus advanced simulation technology to develop their Jestar autonomous freight helicopter, for regional commercial and military transport applications. They used the powerful analysis capabilities to ensure the design withstands the loads and stresses induced by aerodynamic forces without resorting to lengthy, costly prototyping iterations, which helped the company shorten time to market.

Challenge:

Develop autonomous freight helicopters—unmanned coaxial rotor-powered aircraft—for commercial and military transport quickly and cost-effectively to accelerate time to market. Leverage advanced simulation tools to analyze complex physical behaviors, thereby eliminating time-consuming and costly design and prototyping iterations.

Solution:

Replace existing simulation software with SIMULIA Abaqus® advanced simulation tools for analyzing geometric, material, and contact nonlinearities in lieu of lengthy, expensive prototyping iterations.

Results:

• Shortened development time by 40 percent
• Decreased development costs by 30 percent
• Cut prototyping costs by 40 percent
• Reduced weight of Jestar skid landing gear by 18 percent

> The skid landing gear on our new Jestar helicopter undergoes plastic deformation to dissipate the impact energy during hard landing scenarios, and we also need to keep the weight as light as possible. We analyzed different material combinations with different geometries for the landing gear using the Abaqus/Explicit Solver, which enabled us to find the right combination of materials—carbon fiber tubes and aluminum alloys—to maintain performance while reducing weight by 18 percent.
>
> — Arpit Sharma, CEO

RangeAero Private Limited is an India-based company pioneering the development of innovative, autonomous freight helicopters for regional commercial and military transport applications. These unmanned, coaxial rotor-driven aircraft, which are flown and controlled by ground crews, have notable advantages for transporting smaller volumes of freight on a regional basis, including less dependency on infrastructure and human pilots, greater operational flexibility and speed, optimal load capacity, and reduced operating costs. The company's helicopters have been designed to optimize cargo capacity while reducing their carbon footprint, making each delivery environmentally friendly, more efficient, and less costly. Combining optimized cargo capacity and sustainable flight methods provides the flexibility to satisfy many commercial and military freight transport applications.

However, designing rotor-based aircraft (rotorcraft) presents several unique engineering challenges due to their complex aerodynamic and mechanical characteristics, according to CEO Arpit Sharma. "Rotorcraft have highly complex aerodynamic behavior due to the interaction between the rotors, the fuselage, and the surrounding air," Sharma explains. "This interaction leads to unsteady aerodynamic loads, which can cause vibration and noise issues. Rotorcraft also have a complex mechanical structure that must be designed to withstand the loads and stresses induced by aerodynamic forces. The structural design must account for the rotor blades' flexibility and the dynamic response of the structure to unsteady aerodynamic loads.

"In addition, rotorcraft must be designed to be lightweight and compact to achieve the desired performance and efficiency," Sharma continues. "This is extremely challenging, however, because reducing the weight and size of the rotorcraft can also affect its structural integrity, stability, and the ability to control the aircraft."

To address these engineering challenges, RangeAero could either engage in a lengthy, costly series of design and prototyping iterations, which is not practical because of the need to shorten design cycles to accelerate time to market, or leverage advanced simulation tools to analyze the geometric, material, and contact nonlinearities associated with the aerodynamic and mechanical loads, and validate rotorcraft design behavior. Sharma says the company has used SOLIDWORKS Premium design and analysis software for design modeling and basic linear static stress analysis, and also had used Siemens Simcenter simulation tools, but RangeAero needed the power of advanced nonlinear simulation tools to quickly and cost-effectively develop its products.

RangeAero replaced its simulation solution with SIMULIA's Abaqus technology for advanced simulation software because Abaqus can solve all of the nonlinear problems associated with developing rotorcraft. "Abaqus offers advanced simulation capabilities for a wide range of structural simulations," Sharma says. "Using Abaqus has enabled the simulation of complex mechanical behavior, including nonlinear material behavior, geometric nonlinearities, and contact mechanics. Its integration with other software tools, specifically [SOLIDWORKS] CAD software, has also streamlined the design process, reducing the time and effort required to complete analysis tasks."

COMPLEX SIMULATIONS DEMAND ADVANCED TOOLS

With the power of Abaqus advanced simulation tools, RangeAero can simulate the effects of all of the different types of physical phenomena that affect rotorcraft performance, including nonlinear structural analysis, rotor dynamic analysis, dynamic drop simulations on landing gear, nonlinear contact analysis, and nonlinear materials (Such as composites, carbon fiber, metal alloys.) analysis, including plasticity, viscoelasticity,
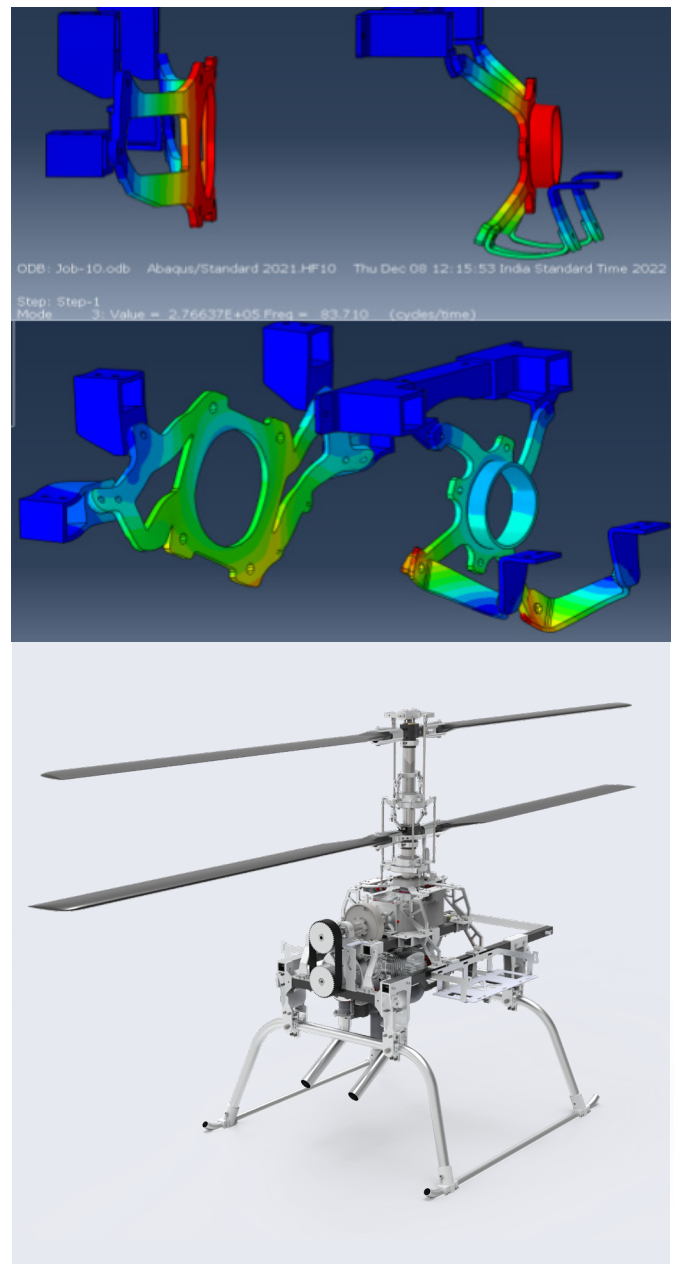
Using SIMULIA's Abaqus advanced simulation technology, RangeAero engineers can simulate the effects of all of the different types of physical phenomena that affect rotorcraft performance, including nonlinear structural analysis, rotor dynamic analysis, dynamic drop simulations on landing gear, nonlinear contact analysis, and nonlinear materials (Such as composites, carbon fiber, metal alloys.) analysis, including plasticity, viscoelasticity, and fatigue analysis.

and fatigue analysis. "Abaqus offers a range of simulation tools that can significantly reduce the time required to complete design and analysis tasks," Sharma stresses.

"Abaqus enables the automation of many of the tedious and time-consuming tasks involved in setting up and running simulations, such as meshing, boundary conditions, and post-processing," Sharma adds. "This has freed up time to focus on other aspects of the design process, such as optimization and validation. Abaqus also helps identify design issues early in the process, before expensive prototypes or production runs are made. By simulating the behavior of a product before it is manufactured, potential problems are identified and corrected early, avoiding costly delays and rework. Additionally, Abaqus can help optimize the design to reduce material usage, resulting in cost savings." With Abaqus, RangeAero has substantially reduced the number of design and prototyping iterations required, shortening design cycles by 30 percent, decreasing prototyping costs by 40 percent, slashing development costs overall by 30 percent, and bringing products to market five months sooner.

REDUCING WEIGHT, ELIMINATING VIBRATION, OPTIMIZING PERFORMANCE

Using Abaqus simulation tools, RangeAero can go beyond design validation and optimize designs, for example, by studying the rotor system's bending and torsional natural frequencies at the specific operating speed. Another example of how RangeAero leverages these capabilities is by optimizing the landing gear to reduce weight while ensuring optimal performance. "The skid landing gear on our new Jestar helicopter undergoes plastic deformation to dissipate the impact energy during hard landing scenarios, and we also need to keep the weight as light as possible," Sharma explains.

"We analyzed different material combinations with different geometries for the landing gear using the Abaqus/Explicit Solver, which enabled us to find the right combination of materials—carbon fiber tubes and aluminum alloys—to maintain performance while reducing weight by 18 percent," Sharma notes.

WINNING RACE TO MARKET

Abaqus simulation tools are not only helping RangeAero solve complex engineering problems without extensive prototyping, but also helping the company win the race to market. "As the unmanned aircraft [drone] industry is rapidly evolving, there's a race to be first to market with an innovative, quality product," Sharma points out.

"Thus, it's necessary to accelerate development and overcome engineering challenges more quickly," Sharma says. "Abaqus simulation tools are helping RangeAero overcome these challenges, and the better we can utilize it, the more likely we will win the race to market and become a market leader."

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