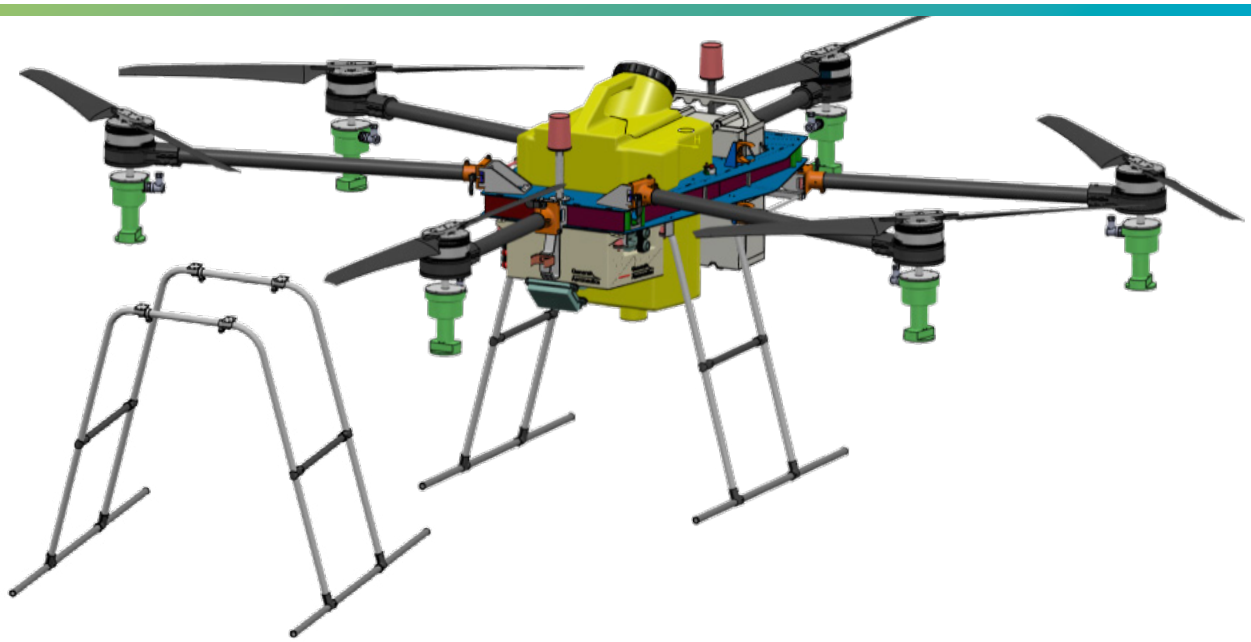
HEXAGON

Case study

Efficient analysis of landing gear in UAV with MSC Nastran nonlinear FEA

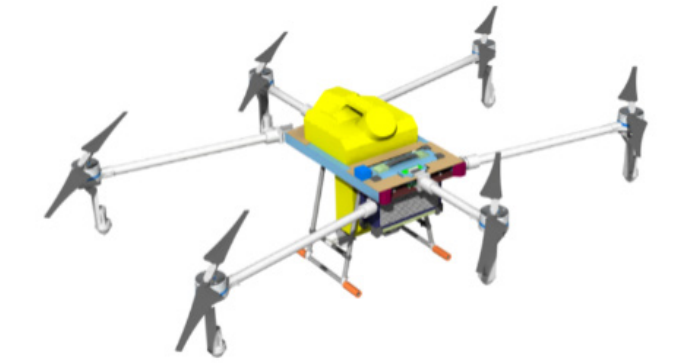
General Aeronautics used MSC Nastran to produce faster and accurate analysis for landing gear design using a hybrid non-linear static approach.



Bangalore-based General Aeronautics was established with the objective to address all aspects of aircraft design from a comprehensive system-level perspective.

With highly experienced members with many decades of expertise in industry and R&D organizations internationally, General Aeronautics provides integrated design and development solutions built on advanced engineering methods for aircraft analysis and design. It provides solutions for agriculture and emergency response using unmanned aerial vehicles (UAV).

During the design of any aerial vehicles, whether manned or unmanned, the landing gear forms one of the most critical components since it directly impacts the overall strength, durability, and structural integrity of the vehicle. As per the safety and operation norms specified under the Directorate General of Civil Aviation (DGCA) certification criteria, aerial vehicles must have the strength to retain structural integrity when dropped from a height of 13 inches. While it is acceptable for the structure to yield, it cannot fail. The plastic material in the landing gear can be used to ensure this.



Unmanned aerial vehicle (UAV)

Challenge

Physical testing of the landing gear is not only expensive, but it is also an extremely time-consuming process. Therefore, the team decided to opt for non-linear static analysis to capture the plastic zone and ensure the optimum configuration.

Before embarking on the design and analysis process, the team conducted a preliminary study to evaluate whether a cantilever model or support beam model would be a better fit. Based on the results, the engineers decided to go ahead with the support beam model. When challenged by deadlines, engineers are often challenged to do both linear static and non-linear static simulations using a common Finite Element model for time savings.

Solution

Hybrid non-linear static analysis

The team decided to perform non-linear static analysis on the support beam model. Using MSC Nastran Modal Analysis (SOL 101) & Implicit Nonlinear (SOL 400), the team could perform both linear static and non-linear static simulations. A common Finite Element model could be used for both linear and non-linear static simulation. With advanced contact modelling techniques offered by MSC Nastran, engineers could model the landing gear using the various in-built options.

The first step was to determine the overall approximate weight of the aerial vehicle. The structural weight was calculated using material density while the other system weights were calculated using lumped masses appropriately at the locations.

Next, the Finite Element modelling was done using shell and solid elements. Mechanically fastened joints were modelled using rigid and spring elements with appropriate stiffness. In instances where the joints were not mechanically fastened, contact modelling was used.

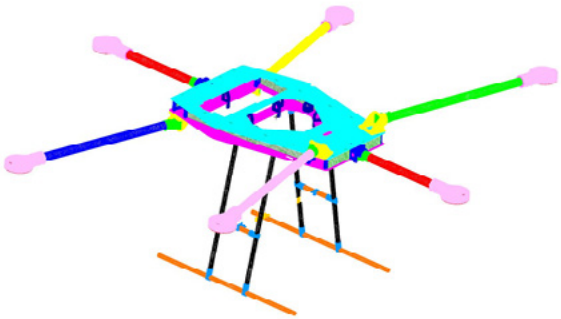
For further analysis, loads and boundary conditions were set using rigid elements. These conditions were used to analyze and calculate the energy absorbed by the structure and ensure that they were in line with DGCA specifications. An iterative study was done with the load applications by increasing load determine the maximum load that the structure can withstand.

To reduce the overall analysis time, the team bifurcated the process into two segments for a hybrid non-linear static analysis. The team first performed non-linear analysis on the landing gear assembly. After the conclusion of this, the results were applied to the vehicle assembly to test the strength and stability of the vehicle.

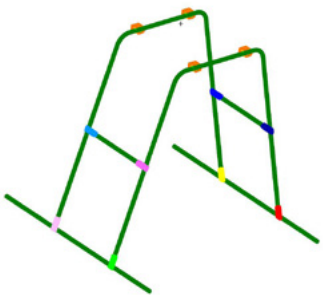
There are three kinds of non-linearities - geometric, material, and contact non-linearities - which were applied for the analysis. Material non linearity was handled by the material model specification.

The results show a deflection in the simply supported beam model, which represents the actual physical physics of the model. The maximum deflection was approximately 300mm and maximum stress of 604MPa, which was within the limits prescribed by DGCA.

The analysis helped confirm that the energy absorbed by the model is in line with the requirements for the 13 inch drop height. With this, the team could complete the landing gear design and go ahead with manufacturing.



Linear model



Non-linear model

Benefit

Effective analysis and time savings

Meeting the certification criteria is important not just from a vehicle safety point for view, but also for smoother operations. With adequate simulation-based testing, General Aeronautics' customers can use the vehicles more confidently.

Using the hybrid approach with MSC Nastran helped avoid the need for repeated physical testing of the vehicle, and ensured an effective and efficient way to cut the design lead time.

The UAV market is growing across segments including infrastructure, agriculture, and emergency medical services. Therefore, adopting a numerical simulation approach helps meet the industry demand by shortening the design lead time significantly.

About General Aeronautics

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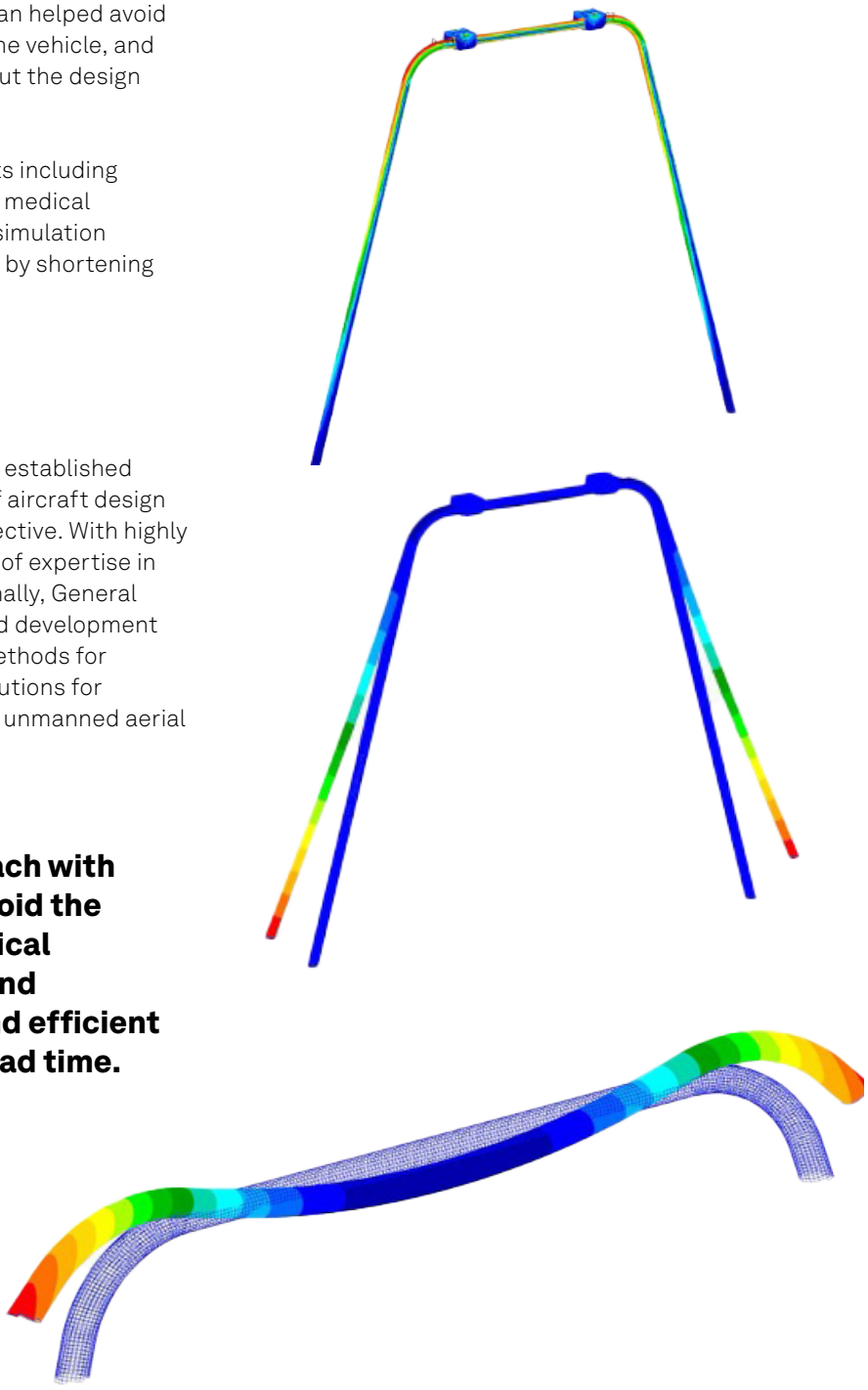
Key highlights:
Product: MSC Nastran
Industry: eVTOL, Aerospace
Benefits:
Fast and accurate drop test certification for UAV Landing Gear Certification.



Nonlinear landing gear deformation

Hexagon is a global leader in digital reality solutions, combining sensor, software and autonomous technologies. We are putting data to work to boost efficiency, productivity, quality and safety across industrial, manufacturing, infrastructure, public sector, and mobility applications.

Our technologies are shaping production and people-related ecosystems to become increasingly connected and autonomous – ensuring a scalable, sustainable future.

Hexagon's Manufacturing Intelligence division provides solutions that use data from design and engineering, production and metrology to make manufacturing smarter. For more information, visit hexagonmi.com.

Learn more about Hexagon (Nasdaq Stockholm: HEXA B) at hexagon.com and follow us @HexagonAB.