Joby Aviation

MSC Apex's advanced design trade-off FEA capabilities enable Joby Aviation to accelerate internal loads modeling to one-third of original time required

Joby Aviation is in a race against time to certify their all-electric, clean-sheet aircraft design, pushing the envelope of aviation by pursuing innovation in every area of the aircraft, while also attempting to be the first eVTOL aircraft certified worldwide.

With a composite airframe, tilt rotors, and capacity for 4 passengers and a pilot, the Joby aircraft is designed with a range of 150 miles to take customers from one side of a major metropolitan area to another in a fraction of the time it would by car or rail, and 100x quieter than a helicopter -- in Central California, where Joby is headquartered, this means going from San Jose to San Francisco in 15 minutes, compared to the 1.5-2 hours the same trip takes by car or rail today.

To achieve this seemingly impossible task, the engineers at Joby Aviation needed an engineering platform as next-generation as it's airframe in order to achieve it's ambitious certification goals, which is what led them to MSC Apex, with its integrated CAD-to-Mesh workflows, allowing for rapid design iterations to be completed in fractions of the time it took in traditional FEA software packages.

Above : Joby Aviation's eVTOL aircraft.

Challenge

To generate internal loads for a certified new aircraft, the full airframe FEA modeling environment must be organized, while also being flexible enough to handle rapid changes in every corner of the aircraft. Certification of a new aircraft is traditionally a very long multi-year process, which is complicated by analysis occurring sequentially with design changes.

Joby Aviation has set a target of ridesharing with passengers in 2024, requiring innovative concepts where design and analysis happen in parallel. To meet this goal, a company-wide focus on streamlining legacy workflows and processes was needed, in addition to support by advanced software. Simply put, the traditional ways of doing internal loads modeling would not work. Non-traditional engineering workflows require non-traditional engineering software. Joby Aviation needed a platform as next generation as its airframe in order to achieve its ambitious certification goals.

"I'm sure I'm not alone in getting frustrated with overcoming the inertia of 'the way things are done' in this world of new aircraft certification. But here at Joby, every opportunity we can get to pull that schedule to the left, we are open to exploring," said Brian Smith, Structural Analyst & Internal Loads Specialist at Joby Aviation, "Every problem has a solution, and it's worth taking a minute to figure out just how we're gonna craft ours. It's going to require the right plan, and the right tools."

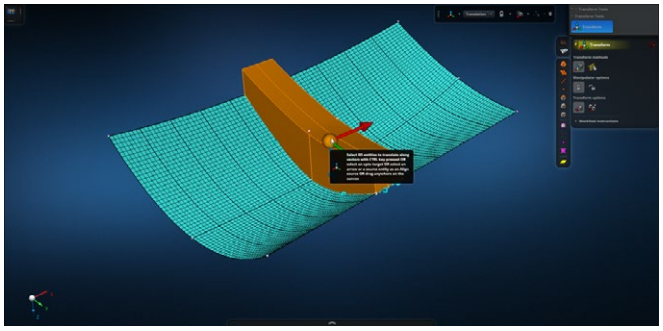
To find an optimized solution, engineers at Joby had to ask themselves where they spent the most of their time -- is there anywhere that someone is waiting for inputs to continue their work? Is there anything that can be done in parallel? Is there opportunity to either combine toolsets, or come up with ways for them to sync together?

Solution

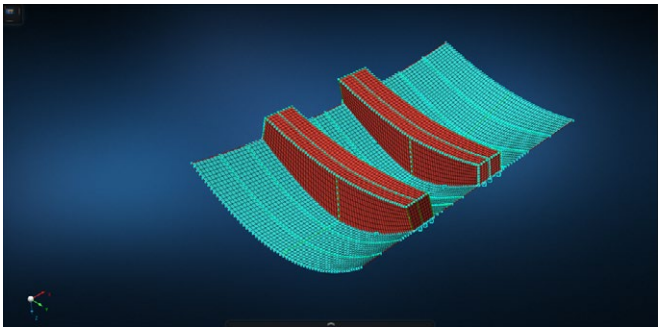
When MSC Apex was evaluated, every step of design and analysis was compared to the current toolset to measure the time saved, and to look for efficiencies. During this evaluation phase, a benchmark was completed, focusing on time spent in the areas of geometry cleanup, meshing, mesh connection, design change incorporation, and achieving a run-ready NASTRAN model.

A game-changer arose during this benchmark when a design change was incorporated, and this change needed to be reflected by updating the existing structural finite element model (FEM) for Internal Loads modeling. Whereas the traditional toolset required a complete model rebuild, MSC Apex was able to incorporate the design change and modify the existing FEM, thus enabling a new Internal Loads model to be built in a fraction of the time.

Key highlights:
Product: MSC Apex
Industry: Aerospace
Benefits:
- Internal Loads modeling speed provided to Joby was valuable and led to faster modeling time compared to other software products.
- Design changes allowed for on-the-fly updates to existing FEM instead of building a new FEM from scratch every time.
- Since MSC Nastran & NX Nastran are so similar, Joby was able to start in MSC Apex and export an MSC Nastran BDF file that was seamlessly integrated into Femap/NX Nastran for solving and post processing.



Above : MSC Apex's Transform tool can be seen in action on a doubly-curved fully composite fuselage section, allowing for "on-the-fly" design changes with all elements and connections staying intact, requiring almost zero re-work.



Above : Completed design change benchmark results, showing vast reduction in time spent and number of tools used.

Results

This benchmark resulted in a five-day workflow being reduced to a single day of effort, with much of the time saved due to seamlessly switching an outdated part to a new design with no re-meshing required.

In addition to the engineering time saved, overall frustration was decreased immensely also, which was traditionally caused by repetitive and mundane tasks throughout the internal loads finite element modeling process. This frustration was prevented through the focus on user experience as well as the technical modeling process in MSC Apex. By incorporating updates based on real-world feedback and suggestions from Joby Aviation in both product and people-focused dimensions, MSC Apex is helping drive a greater shift towards ecosystem-level support in engineering.

"The Apex platform is so fundamentally more usable than other pre-processors, it gives you the freedom to build the model how you want to, rather than making the user conform to whatever the pre-processor's 'method' is. The pre-processor should be the tool, and the engineer the driver, not the other way around, and MSC Apex gives the user freedom when others do not." - Brian Smith, Structural Analysis & Internal Loads Team, Joby Aviation.

Above: Rear image of Joby's eVTOL aircraft, showing the vast amounts of doubly-curved surfaces on the fuselage and wing

Design change scenario: Extra pax capacity	Traditional FEM tools	MSC Apex
Time to completion	45+ minutes	15 minutes
#Tools used	36 menus	7 tools

About Joby Aviation

Joby Aviation, Inc. (NYSE:JOBY) is a California-headquartered transportation company developing an all-electric vertical take-off and landing aircraft which it intends to operate as part of a fast, quiet, and convenient air taxi service beginning in 2024. The aircraft, which has a maximum range of 150 miles (241 kilometers) on a single charge, can transport a pilot and four passengers at speeds of up to 200 mph (321 km/h). It is designed to help reduce urban congestion and accelerate the shift to sustainable modes of transit. Founded in 2009, Joby employs around 1,000 people, with offices in Santa Cruz, San Carlos, and Marina, California, as well as Washington, D.C. and Munich, Germany. To learn more, visit www.jobyaviation.com.

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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.

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