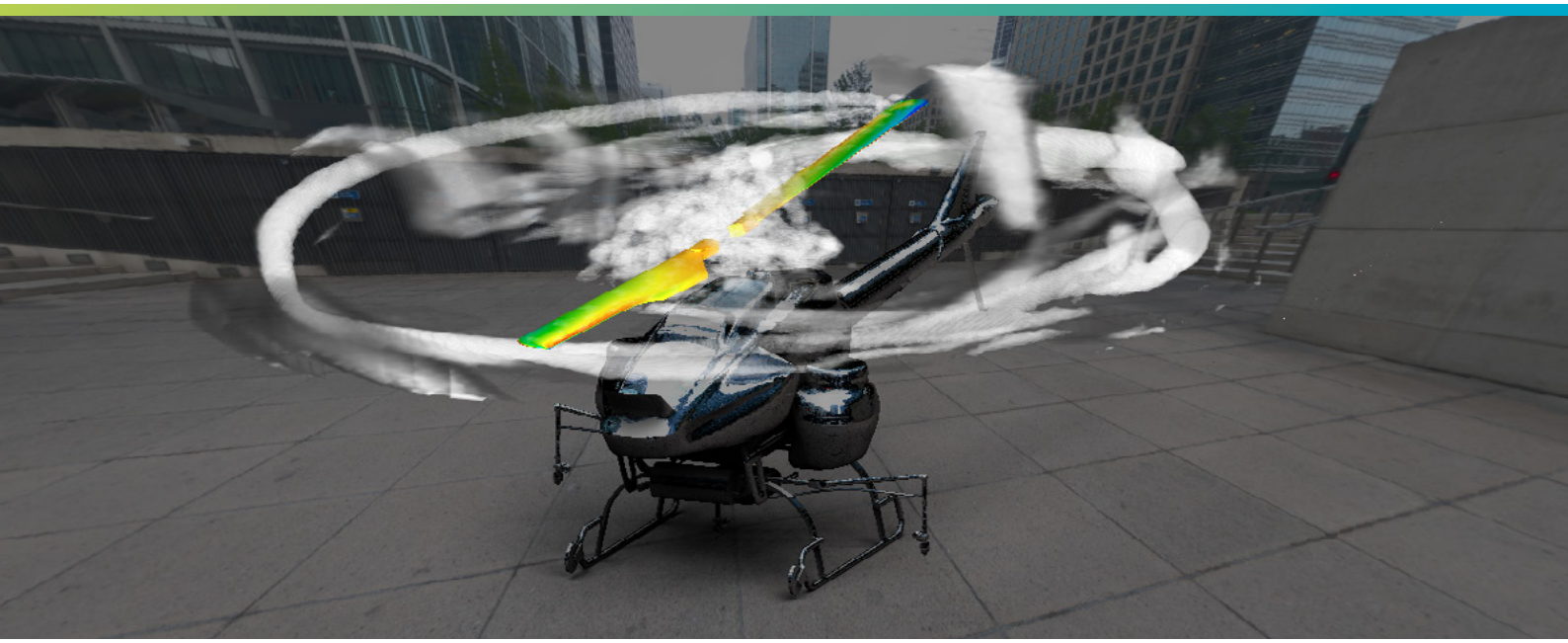
HEXAGON | MSC Software

Case study

A vision of sound

Yamaha shares how Fluid-Structure-Acoustics co-simulation helps in the design and development of unmanned helicopters for industrial use



“The visualization of sound, which is invisible, has a great impact on the design development of an unmanned helicopter. We expect that effective co-simulation of a fluid analysis and a structural analysis will contribute to the development of high-performance tailor-made main rotors optimized for industry and usage.”

Mr. Mizuno of Robotics Division,
Yamaha Motor Co., Ltd.

A key factor to consider when designing unmanned helicopters is where they will operate. Any aircraft that flies in a residential area needs to limit its production of noise pollution. Assessing the acoustic performance of industrial products is very complex and often happens in the later stages of design, once product specification details are in place.

Yamaha Motor took an innovative and integrated approach to design both for acoustics and performance early on.

Challenge

One of the main sources of sound from a helicopter is the fluid noise caused by the main rotor blades. Since it is not feasible to use an insulating material to physically block noise propagation by the rotor, Yamaha Motor had to look at the design of the rotor speed and the shape of blades. However, both these factors have a large impact on a helicopter's overall performance, with any changes generating multiple design trade-offs that need to be optimized.

Solution

As a result, Yamaha Motor turned to MSC CoSim Engine to holistically assess the performance of its unmanned helicopter FAZER R (Figure 1). The MSC CoSim Engine provides an interface for the direct coupling of different solvers/disciplines with a multi-physics framework. By combining scFLOW and MSC Nastran Co-Simulation, and Actran simulation, Yamaha was able to avoid repeating design cycles in fluid, structure, and acoustic areas respectively.

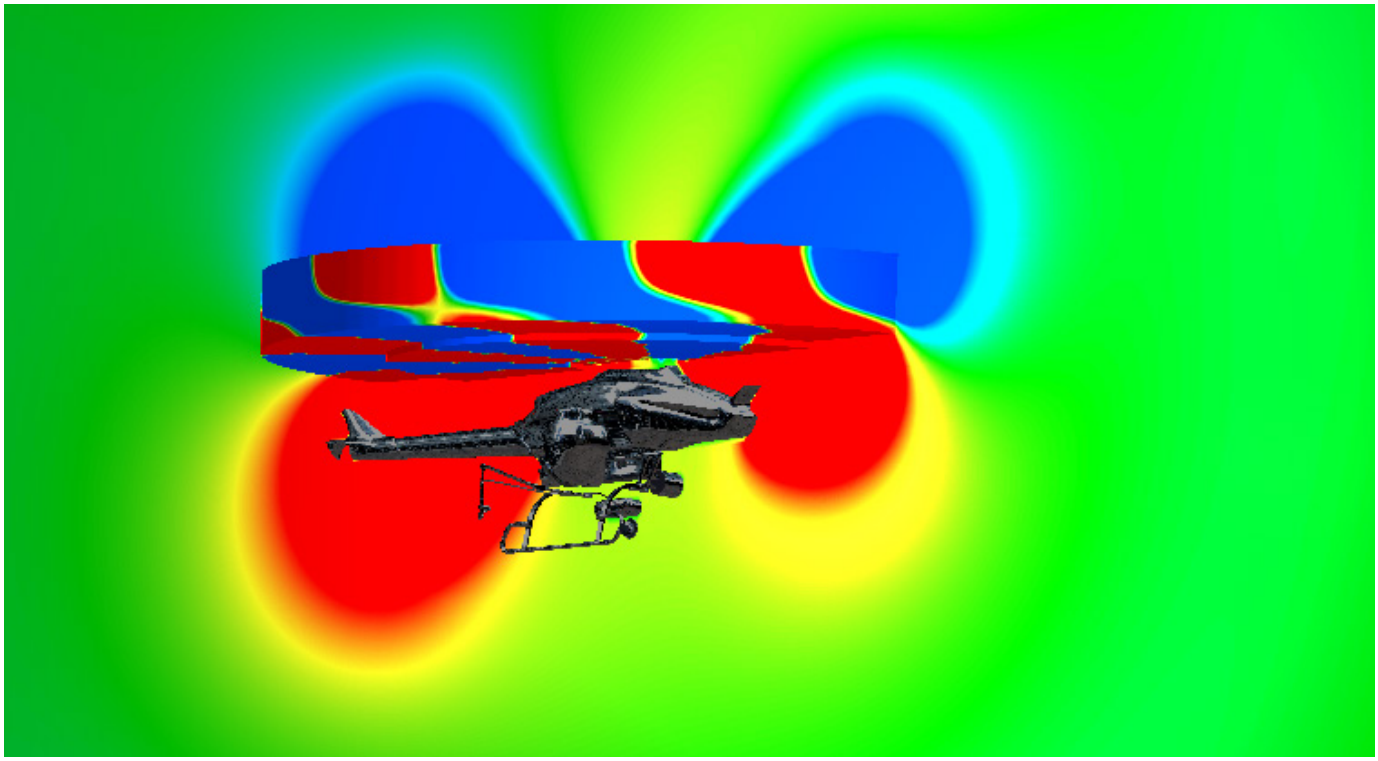
Using MSC CoSim, Yamaha simulated the air flow produced by the rotor, rotor deformation and the propagation of the fluid noise caused by the rotor. The MSC CoSim Engine ensured real world accuracy and stability in several ways.

> **"The multi-physics solution enabled by combining scFlow, MSC Nastran and Actran opens up new opportunities to innovate, allowing Yamaha Motor to develop different business scenarios for unmanned helicopters and address them using upstream to downstream design processes."**
>
> **Mr. Mizuno of Robotics Division,**
> Yamaha Motor Co., Ltd.

Conclusion

Co-simulation showed that the blades rose and fell slightly along with the airflow caused by the rotation of the main rotor in addition to pressure distribution and vortex generation. In addition, the result could be heard with the user's own ears.

By using fluid-structure-acoustic simulation, Yamaha was able to comprehensively analyze the performance of the main rotor and noise in a single analysis process, thereby dramatically shortening design and development lead times.



Co-simulation workflows

Yamaha used the following process, in their Fluid-Structure-Acoustics co- simulation:

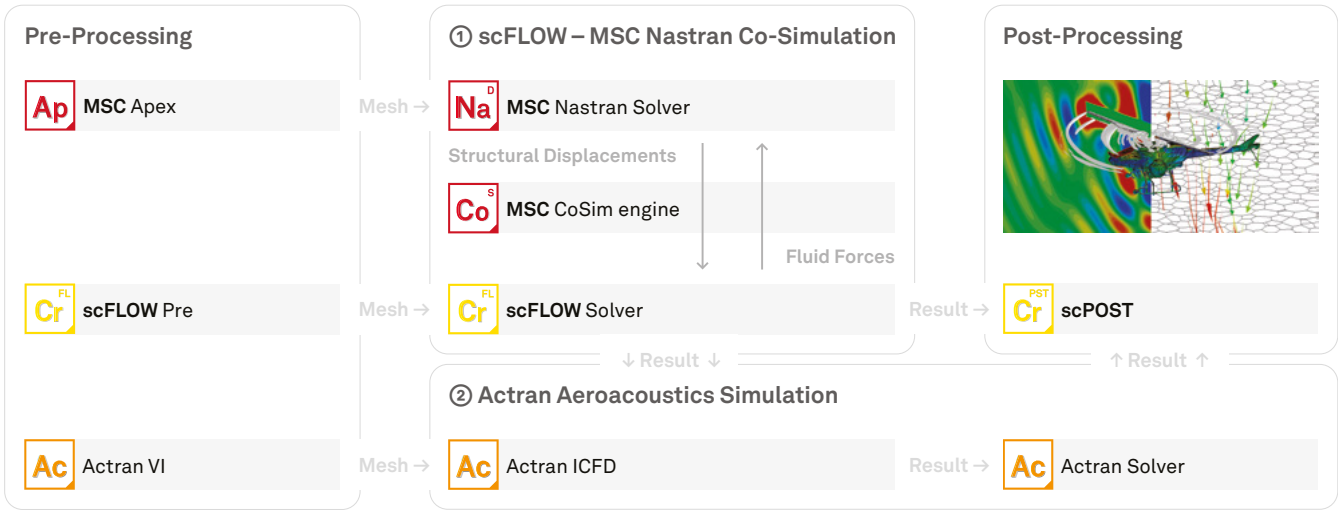
1. The airflow was analyzed with high accuracy to create an aero-acoustic source caused by the rotation of a main rotor.
    - Structural analysis software MSC Nastran then enabled an analysis of the elastic deformation of blades caused by rotation
    - Via the MSC CoSim engine, scFLOW and MSC Nastran exchanged information about the deformation of blades and the airflow change.
2. The aero-acoustic source data was transferred to Actran on a real-time basis and an acoustic simulation of the main rotor was performed.
    - Using acoustic simulation software Actran, the aero-acoustic source was extracted from the data obtained in co-simulation before performing a Fourier transform.
    - The propagation of sound waves was analyzed using the finite element method in Actran.

Actran received the data calculated in co-simulation on a real time basis and simultaneously performed an acoustic simulation.

About Yamaha Motor Co Ltd

Japan has led in the development and use of unmanned helicopters, notably in agriculture, with Yamaha Motor Co., Ltd. first launching its flagship RMAX unmanned helicopter in the early 1990s. Since then Yamaha Motor has continued to build on and improve its original designs to optimize the use of unmanned helicopters in different environments.

Key highlights:
Product: MSC Nastran, Actran, scFlow, MSC CoSim
Industry: eVTOL, Aerospace
Benefits:
Accurate and performant multi-physics simulation to optimize structural performance while reducing noise for unmanned aircrafts.



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

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