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CASE STUDY



Pipistrel: flying straight from simulation to production

The ESTECO optimization technology as a way to save product development time and skip any prototype phase for a hybrid-electric aircraft propeller.

Pipistrel, an aviation & aerospace company based in Slovenia, relied on ESTECO Technologies to design the propeller for a highly efficient, hybrid-electric aircraft. The work was part of the EU-funded project MAHEPA (Modular Approach to Hybrid Electric Propulsion Architecture), that had the aim of advancing two variants of a low emission, serial hybrid-electric propulsion architecture to TRL (Technology Readiness Level) 6.

The modeFRONTIER process automation and optimization software allowed automation in the simulation process and identification of innovative and optimized designs in a limited time.

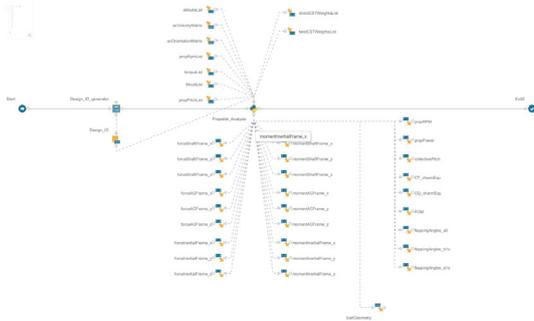
CHALLENGE

Engineers at Pipistrel had the challenge to design a propeller, driven by **hybrid-electric propulsion system** taking into account the different conditions the aircraft meets during the four flight phases: takeoff, climb, cruise and descent. Considering speed, power and thrust requirements changing during the flight, the objective was to **maximize takeoff thrust and recuperation power** during descent and **minimize power** during climb and cruise phase.

The optimization involved three stages: the preliminary propeller optimization, the airfoil optimization, and the final propeller optimization.



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We go straight into production.**



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The modeFRONTIER workflow

SOLUTION

For this multi-phase optimization project, Rok Lapuh and David Eržen, aerodynamics engineers at Pipistrel, used modeFRONTIER coupled with CHARM (Comprehensive Hierarchical Aeromechanics Rotorcraft Model) and XFOIL, an interactive program for the design and analysis of subsonic isolated airfoils. Benefiting from the ESTECO process automation technology, Pipistrel could **automate the simulation workflows**, simultaneously evaluate thousands of designs and **identify innovative optimized results**. This process was conducted in a fully autonomous way leaving Pipistrel’s engineers the task to select the most appropriate design.

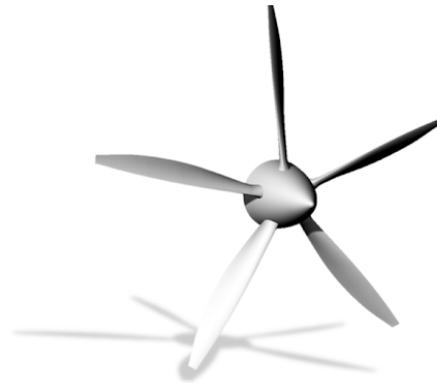
With the first propeller optimization, Pipistrel optimized the chord and twist distribution to get the maximum thrust and minimum power for a given set of airfoils. The results were then used as requirements for the airfoil optimization. The design team used modeFRONTIER to design the airfoil under specific geometry constraints (thickness, curvature or leading-edge radius), while increasing the lift and reducing the drag. They started a **Design of Experiments** phase and then used the **HYBRID genetic algorithm** to successfully run the airfoil optimization and get the Pareto front with the

optimal designs. At last, they used the optimum airfoil for the final propeller optimization. With the ESTECO optimization algorithms, engineers at Pipistrel could evaluate **almost five thousand designs in a limited time** and increase the thrust by 30% during takeoff.

BENEFITS

Before using modeFRONTIER, Pipistrel went through a manual process to simulate multiple designs and choose the preferred one. With the introduction of ESTECO Technology, Pipistrel engineers not only were able to automate this process, but could evaluate options not considered otherwise. “modeFRONTIER optimization technology gave me **the opportunity to think outside of the box** - said Rok Lapuh, Aerodynamics Engineer at Pipistrel - **We could find a design that is completely different from what we’re used to, but that may work even better**”.

They also dramatically **reduced the go-to-market time** as they moved from simulation directly to the production. “We trust the results we get with modeFRONTIER so much that we don’t expect we’ll require a prototype - said David Eržen, Aerodynamics Engineer at Pipistrel - **We go straight into production**”.



Optimization results: the final propeller design.

ABOUT ESTECO

ESTECO is an independent software company, specialized in numerical optimization and simulation process and data management. With a 20-year experience, ESTECO supports over 300 international organizations (such as Ford Motor Company, Honda, Lockheed Martin, Toyota and Whirlpool), accelerating the decision-making process and reducing development time. esteco.com

ABOUT Pipistrel

Pipistrel is an aviation & aerospace company based in Slovenia. It has more than 30 years of tradition in the ultralight and general aviation industry. Starting from a small business it has become the leading producer of efficient aircraft with electric and hybrid propulsion. pipistrel-aircraft.com



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