modeFRONTIER

Thermal architecture design optimization brings enhanced comfort to aircraft passengers

ECS System Simulation - Architecture and Performance Optimization from the Early Phases of the System Design

courtesy of Alenia Aermacchi

The trend today in aircraft thermal design leans towards electronic system integration requiring higher heat densities and a more frequent use of composite primary structures. All these factors require **thermal** management and **architecture design** to achieve a suitable **robustness,** even in the early design stages. The thermal architecture should be able to prevent the risks of damage to temperature-sensitive equipment and limit the expensive overdesign of aircraft systems.

"The optimization platform helped us reduce pressure loss and noise level to the minimum."

The optimization of the thermal architecture is considered one of the key factors of future aircraft development. It requires a composite pyramid of simulation tasks to be set and managed: from equipment to aircraft section simulation to the global aircraft thermal analysis. Adopting this approach gives rise to a number of difficulties due to the **variety of physical models** to be **integrated** and the partners, techniques and tools interacting at each level of the pyramid. This case study from Alenia Aermacchi's **Environmental Control System (ECS)** department shows how the different design disciplines involved are handled effectively through process integration and automation, enabling the **optimization of the overall performance** from the early stages of system design.

CHALLENGE

One of the systems considered in the ECS design at Alenia Aermacchi is the air conditioning pack and distribution system. The air, supplied from the engine compressor, is processed in the conditioning pack before being distributed to the fuselage compartments. Enhancing the efficiency of the thermal architecture implies several constraints and requirements relating to **standards-compliance and**

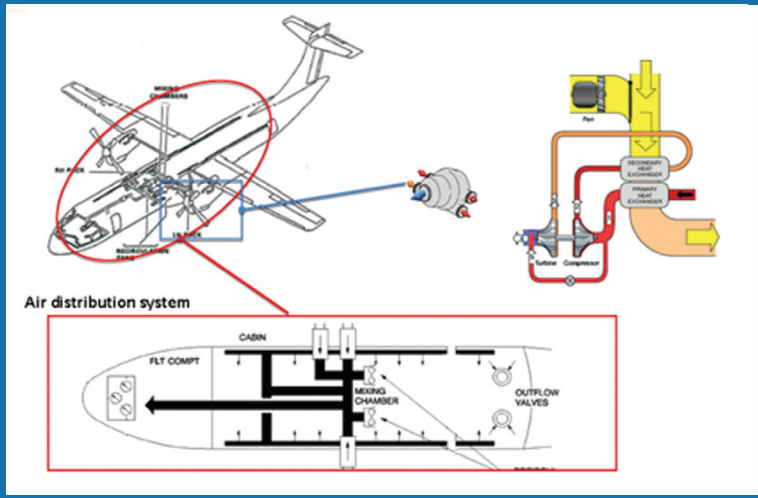

Figure 1. Air flows from the engine processor and through the air conditioning pack before distribution.

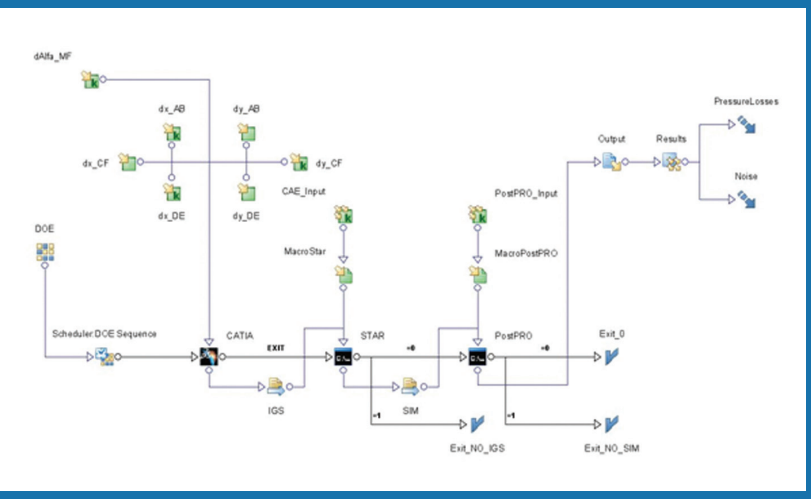

Figure 2. modeFRONTIER workflow for the nozzle shape optimizaiton.

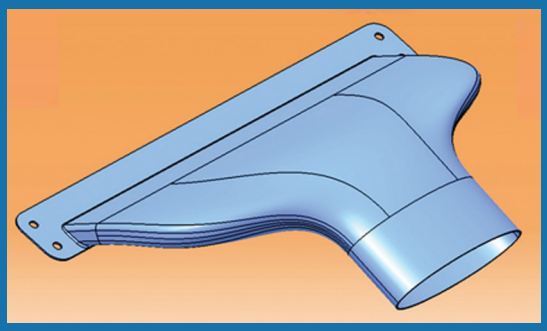

Figure 3. Final product developed after optimization.

safety regulations. Designers must adhere to given A/C configurations and maintain suitable thermo-acoustic insulation and temperature levels for both the cabin and cockpit.

SOLUTION

First, engineers at Alenia Aermacchi used the TPM approach to compare the performance of two alternative architectures, preferring a parallel layout composed of an underfloor and a low pressure air line fed from the mixing chamber and distributing the airflow in parallel through a set of risers. Next, after building the model for the selected architecture and its subsystems in LMS.Amesim, the workflow for the air nozzle shape optimization was built in modeFRONTIER. **"The optimization platform helped us reduce pressure loss and noise level to the minimum"** says Gaetano Mirra (CTO, General Systems - ECS and Ice protection specialist at Alenia Aermacchi).

modeFRONTIER BENEFITS

"modeFRONTIER automation and integration capabilities enabled us to simultaneously consider the fluid dynamic and acoustic analysis and easily handle the data flow including Catia, StarCCM+ ans PostPRO simulations in a unique environment" continued Mirra. "We found the **best configurations possible** for the nozzle shape and **refined** the **thermal architecture** design, further **enhancing passenger comfort** in terms of cabin thermal environment".

About ESTECO

ESTECO is a pioneer in **numerical optimization solutions**, specialized in the research and development of engineering software for all stages of the simulation-driven design process. Over **250 international** organizations have entrusted the modeFRONTIER **multidisciplinary and multiobjective optimization platform** with accelerating product innovation across a wide spectrum of industrial sectors. The company headquarters is located in AREA Science Park in Trieste, Italy.

About ALENIA AERMACCHI

Alenia Aermacchi is the global player which leads the **Finmeccanica aeronautics business** by continuously increasing its ability to design, build, integrate and support complex systems for both **commercial and defense** markets worldwide. In an equal-share joint venture with EADS, it owns ATR, which dominates the regional turboprop market. With the Russian company Sukhoi it is developing and marketing the Superjet 100. For more information visit: **www.aleniaaermacchi.com**