STAR-CAT5 helps to design "coolest business jet ever"

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Recently cited by Forbes magazine as "the coolest business jet ever", the Falcon 7X is the latest in a long line of high-class executive jets from Dassault Aviation. As well as being cool, the Falcon 7X is also revolutionary – being the first civil aircraft ever to be designed using virtual rather than physical prototypes. Designed entirely using Dassault Systèmes CATIA Product Lifecycle Management (PLM) tools, every component on the Falcon 7X was subjected to rigorous CAE analyses.

Dassault Aviation is committed to providing the very highest standards of comfort for Falcon 7X passengers. The aircraft features Dassault Aviation's breakthrough Environmental Control System, that maintains a constant cabin temperature and an adequate level of pressurization as the aircraft passes through extremes of external conditions. The Environmental Control System also manages safety critical aspects such as wing de-icing and avionics cooling. Central to the operation of the Environmental Control System is the mixing jet pump that mixes the air sent to the cabin from bleeds on different stages of the engine compressors. The pump's job is to maintain the pressure and temperature within the cabin air-conditioning system independent of the regime in which the engines are operating.

Dassault Aviation's current CAE process utilizes one-dimensional network analysis for sizing the mixing jet pumps. Although the process works well across a wide range of operating conditions, under certain extreme conditions – such as supersonic flow in the mixer – the accuracy of the network model was often found wanting due to the complex flow within the pump. In order to remedy this, Dassault Aviation adopted CD-adapco's STAR-CAT5 CFD software to better characterize the performance of the pump under extreme conditions. STAR-CAT5 is the only industrial-strength CFD software to be fully embedded within the CATIA V5 PLM system.

The aim of the CFD analyses was to numerically simulate the flow within the jet pump for different flight conditions and to compare the results with experimental data. The goal was to understand the phenomena that occur in the jet pump for each regime (subsonic, transonic or supersonic flow) in order to be able to refine the dimensions of the jet pump that would give an optimized mixing ratio for the downstream circuit.

The advanced capabilities of STAR-CAT5 enabled meshing of the real geometry of the jet pump without exiting CATIA V5. The mesh was exported to be optimized within STAR-CCM+, CD-adapco's next-generation CFD solver. In order to obtain the adapted refinement level, STAR-CCM+'s advanced capabilities were used to cut, combine, or fuse different parts of the mesh. Several parts of the mesh were created with STAR-CAT5 and were cut at the desired place with STAR-CCM+, then all the parts were combined and the interfaces were joined. Finally the resulting mesh was adapted in terms of size and shape for all areas of the flow.

The results of the STAR-CCM+ calculations were compared with laboratory tests and have very good agreement for all studied cases of flow, even for the more complex ones. These very high quality results now allow Dassault Aviation to optimize the in-house 1D code for extreme conditions of flow and encourage Dassault Aviation to continue in this direction in order to study more complex geometries.

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