Application of ANSA optimization tools to automotive HVAC system

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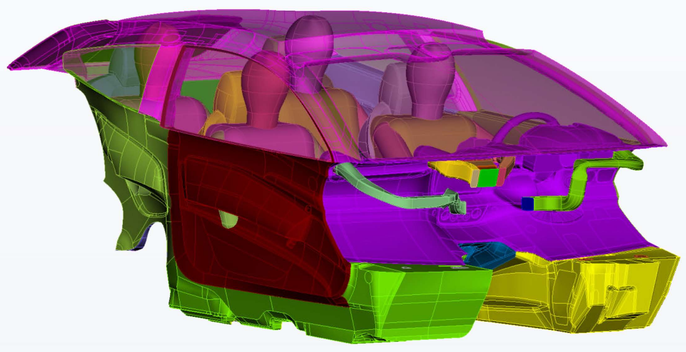
Introduction

Optimization process plays a central role in industrial design, even more in automotive. In this work an optimization procedure will be applied to improve Ferrari GTC4Lusso HVAC system performances, reducing total-pressure loss.

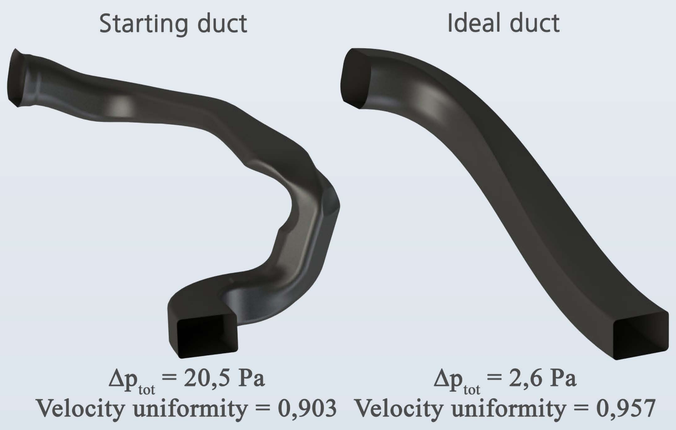


Passenger area and HVAC ducts

The analysis will be focused on the left duct, which shows the greatest loss in the preliminary CFD simulation.

Objectives

Approaching the total-pressure drop of the ideal duct, which is the result an optimization procedure with the only constraints of inlet and outlet interfaces and manufacturing. Unfortunately, the theoretical conduit can not cope with the surrounding parts of the car.

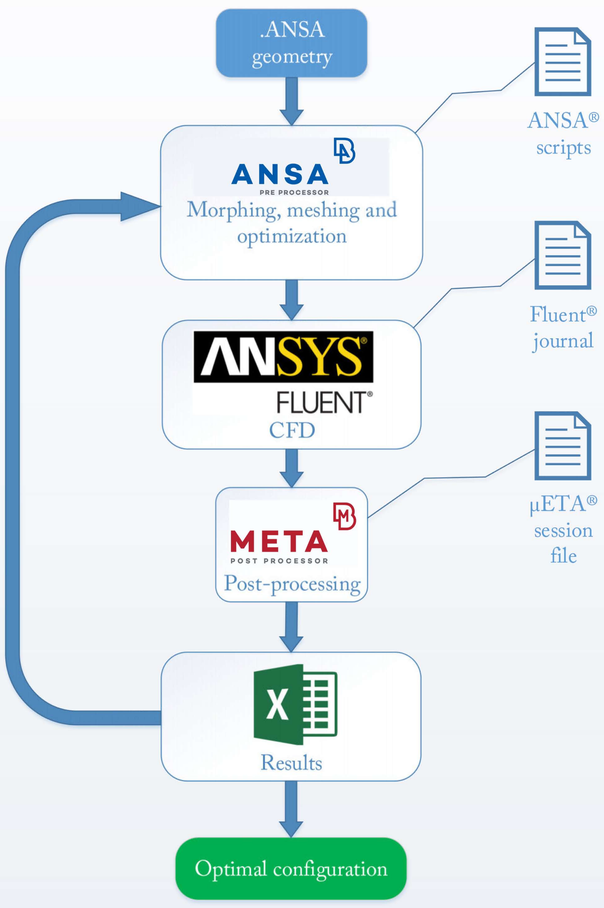


Duct geometry

The aim is to set up a methodology which could modify such a complex geometry, meeting space requirements and saving time, avoiding the new generation of the CAD and mesh for each new configuration. Morphing techniques respond to these needs, allowing to reshape directly the mesh.

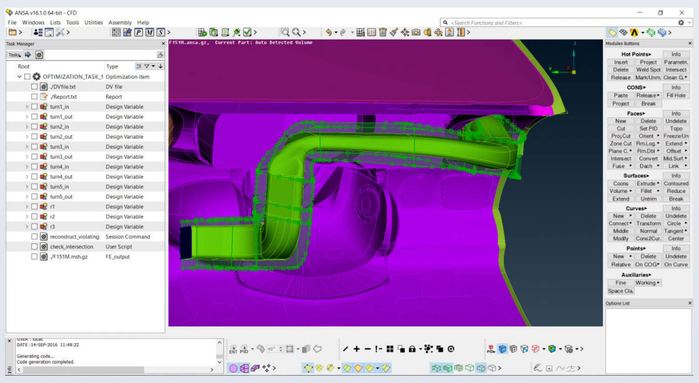
Methodology

A random optimization task is set up in ANSA®, in which more than 1000 new configurations are generated, as shown in the next diagram.



Optimization process

13 morphing parameters drive the duct wall displacements, which have to necessarily agree with the dimensions of the surrounding parts.

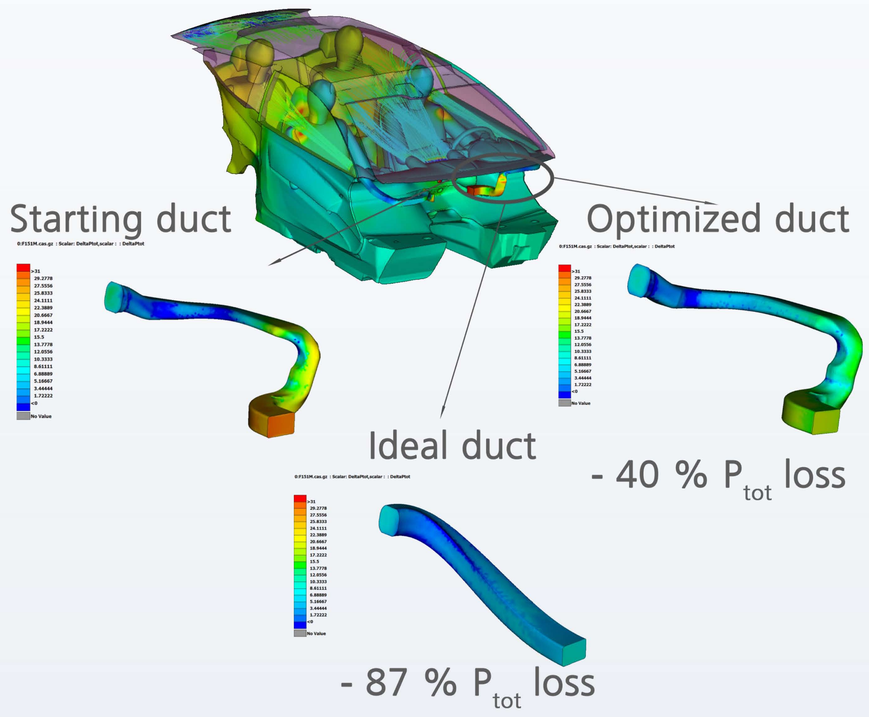


Morphing and optimization in ANSA®

Fluent® is used to run steady RANS simulations of HVAC and passenger area, with k-ε realizable turbolent model and non-equilibrium wall functions. A cluster with 1216 cores and 3 GB Ram/core is used to perform the analysis. Groups of 4 configurations are submitted to the cluster and analyzed in parallel, using 128 cores for each of them. CFD results are read by µETA®.

Results

In a week of computational time, the procedure generates many improved designs. Among them, the configuration with the highest total-pressure drop reduction, complaining with space requirements, shows a Δp_{tot} = 12,4 Pa and an increased flow uniformity index to 0,914.



Δp_{tot} drop for different duct configurations

Conclusions

Complicated geometry, such as the object of this procedure, showing three different cross section shapes, asymmetric area decrease, elbows etc, requires many parameters to be accurately described, using a CAD parametric optimization procedure. ANSA® morphing tools overcome this problem by easing shape variations. A significant number of morphing parameters is needed to perform an efficient mesh modification, while avoiding issues related to excessive mesh deformation. The procedure developeded is suitable for aerodynamics optimization, not only for automotive, but also for other range of applications.

Acknowledgements

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