Nautilus tech by Faber Spa

The new frontier for hoods ventilation

The Company

For fifty years Faber Spa has designed and manufactured hoods, holding a key global position in production and technology. Research and development has played a central role in achieving this objective and has recently been strengthened through the implementation of FEM tools; in particular the ANSYS software platform.

Objectives

The desire for evermore complex and attractive designs, plus low energy consumption have brought about high-efficiency fan units with a reduced size, compared to hoods currently on the market.
Therefore, the objective of this activity was to develop a platform of fan units, with a size suitable to meet the new requirements for aesthetics, better energy efficiency, volumetric flow rate and noise to out-perform current state of the art hoods.

To achieve this, the product development plan has adopted new activities to develop the fluid dynamics, structural and thermal analysis.
The fluid dynamic analysis aims at developing or updating the ventilation systems; the structural analysis is used to predict the appliance behaviour during a drop test; the thermal analysis is applied to the behaviour prediction of the plastic moulded parts under operating conditions.
In addition to increased performance, a reduction in the time to market, a reduction of the product cost and an increase of quality and structural reliability were all project objectives.

Solution

The integrated development approach, using simulation, has produced more solutions within less time and less cost when compared to an experimental approach. Through a DOE (Design Of Experiment) with a high number of input parameters, it has been possible to investigate the parameter interactions and evaluate several technical solutions. This activity has therefore optimized the outputs with a high degree of confidence. This has enabled a mathematical RSM (Response Surface Methodology) model of the different analyses to be trained, validated and inspected; this has allowed output variation demand to be analysed, as a function of the input parameters, thus showing how they interact between themselves. The RSM has been generated using results obtained from the hydrodynamic and structural simulations.

CFD Analysis

The objectives of the fluid dynamic analysis were:

- To determine the fan's torque resistance curve, starting from the 3D set of the fan unit using FEM;
- To superimpose the torque curves, determined at increasing backpressure levels, to torque curve of any electric engine, in order to determine the operating point.

The simulations of the diffuser outside the hood have been carried out using the ANSYS CFX tool, in order to determine the torque curve under exit pressure conditions of 0 and 100 Pa. Moreover, further simulations have been carried out to replicate the real working conditions of the fan

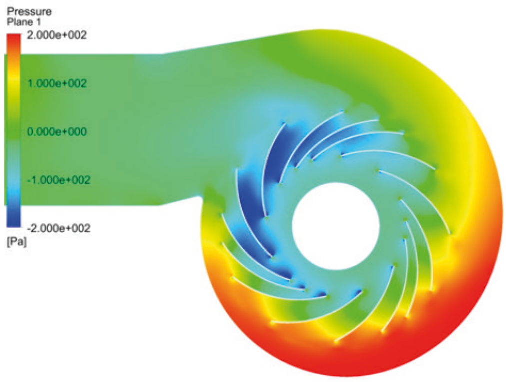

Figure 1 - Pressure contour

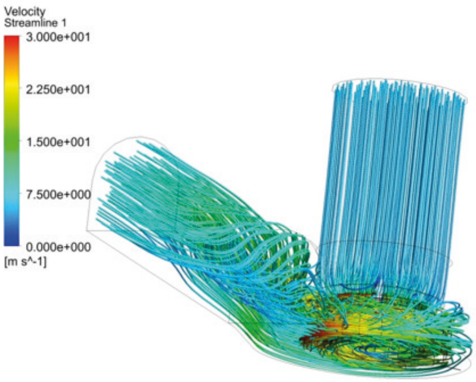

Figure 2 - Velocity Streamlines

and all the fluid dynamic quantities, in order to obtain the efficiency curves (FDE). The results of the simulations have been used both in qualitative and numerical terms: the qualitative analyses verify the flows trend inside the fan unit and consequently modify the shapes and geometries to minimize turbulence. The numerical results determine the efficiency values and to detect an error of the 3%, when analyzing the simulation results and the experimental data.

Structural analysis of the blower

A series of static analyses under operating conditions (temperature reached on the cooktop) were performed in order to determine the stress state of the plastic product.

The mechanical characteristics of the material have been defined by experimental tests normalized at increasing temperatures with respect to the environment, in order to verify the maximum stress state, which is tolerable under different conditions of use. In this case, the material behavior has been assumed as linear elastic and isotropic. Analyzing the results, it has been possible to verify the presence of a certain safety margin, in relation to the tolerable stress values and the deformations that could compromise the product integrity.

In addition to the normal operating conditions, the packaging drop test has proved to be a very critical condition from a structural point of view, considering the components resistance. A good design of the component therefore determines a limited number of modifications on the mould (or none in the best case).

In order to define the stress state generated by the drop test, a static analysis of the product has been carried out, introducing the same deceleration applied during the drop test. The static analysis doesn't take into account the product kinetic reaction, although it's advisable to proceed like so to check the reached stress state. In case this value is lower than then the maximum tolerable stress (considering all safety coefficients), then it's likely that no breakage will occurs on the product.

A preliminary drop test has been performed on the product, in order to evaluate its real deceleration. The hood used for the test weights 10 kg (including packaging) and was dropped from a 40cm height. The uniaxial accelerometer has been positioned on the engine in order to measure the crash force perpendicularly to the fall plane. The measured deceleration is 40g and this value has been used for the structural analysis and set in the 3 falling directions.

The simulation has allowed to reduce the maximum stress values introducing the following modifications:

- Rings and reinforcing ribs have been added to both sides on the engine shell;
- Radii have been added in the most stressed areas;
- Joints have been introduced in new areas;
- Ribs have been added in the area containing the engine power cables.

Conclusions

- Numerical simulations have enabled the project target to be reached in terms of fluid dynamic performance and to define the critical points of the product through thermo-structural analyses;
- The product development time has more than halved
- A greater awareness of the solution's robustness has been achieved compared to previous projects;
- From a fluid dynamic point of view a unimaginable performance level has been achieved by reducing the number of lab-test prototypes;
- Considering structural analyses, the product quality has been improved by reducing the time and cost usually caused by the mould modifications (to be applied in case no simulations were run).

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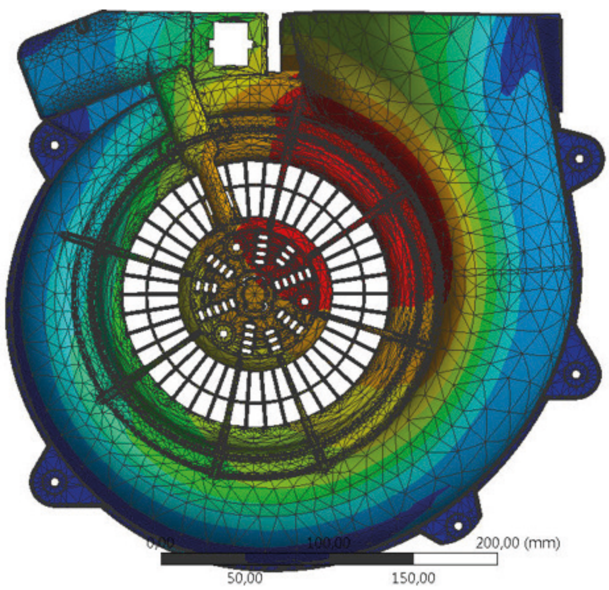

Figure 3 - Total deformation under impact loads