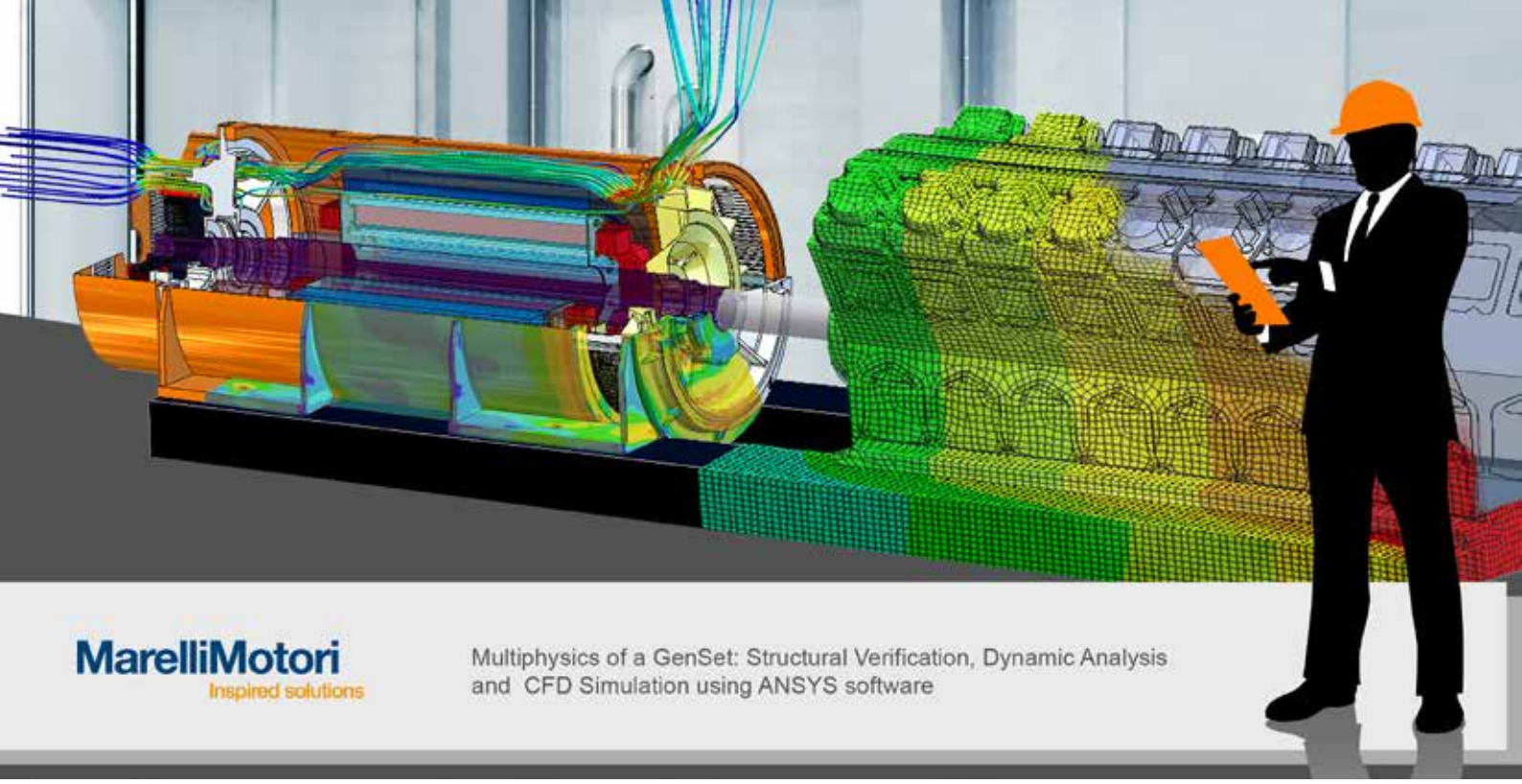

Cost Effective High Performance Design: Innovation is the Answer

Improving efficiency while reducing cost is a very complex engineering challenge: Marelli Motori hits the target through extensive use of CFD & fem multi-physics simulation in electrical motor and generator design

Marelli Motori is one of the world's leading generator and electric motor manufacturers. The company was founded in 1891 and enjoys worldwide brand recognition thanks to its extended sales, distribution and service networks across four continents. With two manufacturing facilities in Italy and Malaysia Marelli Motori sells these technologically advanced products in more than 120 countries. The business model is based on a successful combination of strategic key elements that enable Marelli Motori to offer innovative and inspired solutions to create value for customers: a wide range of innovative products, skilled people to provide sales & global support and continuous investment in R&D.

OBJECTIVES

Day-by-day power generation is becoming more competitive, reliable and eco-friendly. Marelli Motori is focused on innovation, aiming to match the market needs (Hydro, Cogeneration, O&G, Industrial applications, Marine) by increasing efficiency, reliability and lowering environmental footprint as much as possible.
These targets can't be achieved independently: improving the overall performance can lead to overly expensive products, making them "unsellable", so any activity aimed to increase the efficiency of the machine must be accompanied by cost reduction: this is the only way to be competitive in a global market.

It is therefore important to develop multiphysics simulations for all the components: Structural analysis to evaluate strength and deformation, Dynamic analysis to thoroughly study the operating behavior of the machine and Thermal CFD to improve cooling efficiency. This is all done while reducing the cost of product development and shorting the time-to-market.

SOLUTION

Numerous ANSYS simulations have been conducted to achieve optimal results: Structural simulation is done on the frame, shields, fan and shaft to reduce mass and while getting a better design by reducing waste material. In addition, the construction operations are considered by keeping mechanical safety and reliability in the foreground for each potential operating condition.

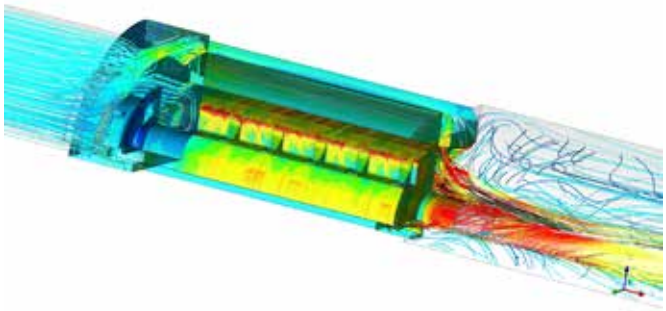

Fig. 1 - CFX_Velocity Streamline and Wall heat exchange contour of a Stator-Rotor submodel

The rotor assembly (including the fan), the stator and heat exchangers (where needed) have been simulated multiple times to find the optimal trade-off point between cost reduction and thermal efficiency, these components are the core of thermal exchange of the entire machine. Indeed, the subsequent design modifications arise from Structural and CFD calculations to increase cooling efficiency and thermal exchange, lowering hot-spots inside the Generator with the purpose to maximize power output. Doing the job in this way is complex because the aim is to design the entire family of components in the best way to extract heat from inside the machine, but at the same time there are many constraints about the feasibility of the individual shapes, the cost of production and the ease of the final assembly. Each component needs to overcome a Structural Assessment: parallel with the process described thus far, there has been the development of Dynamic simulations on sub-group of components inside of the machine and on the entire assembly. Modal Analysis to find Natural frequencies and subsequent Harmonic Response according to operating conditions were the key points to analyze the dynamic behavior of the machine. These simulations ensure mechanical reliability of the GenSet during the working phase. Talking about the design of new components or else the modifications done on the existing ones, drastic reduction of development times has been reached taking the advantage of using SpaceClaim: defeaturing, 3D Modeling as well as the ease of handling geometric parameterization inside Workbench interface, allowed to manage modifications very quickly.

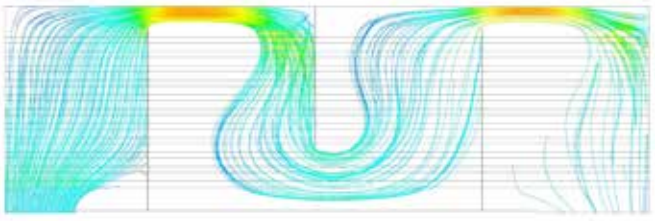

Fig. 2 - Velocity Streamline

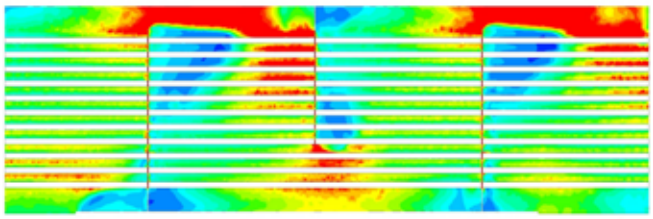

Fig. 3 - Wall Heat Exchange

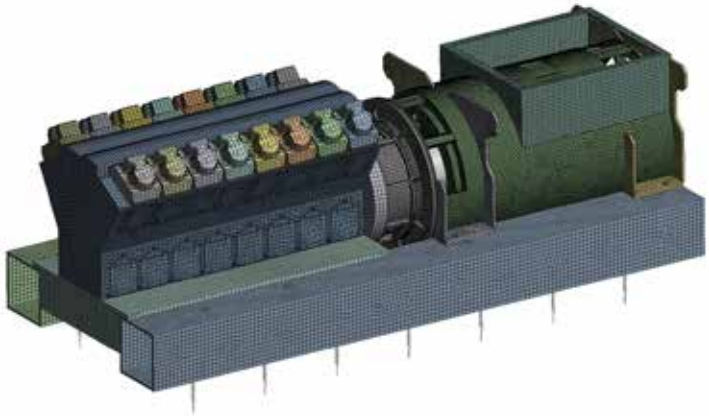

Fig. 4 - Entire GenSet model Meshed to realize Modal Analysis

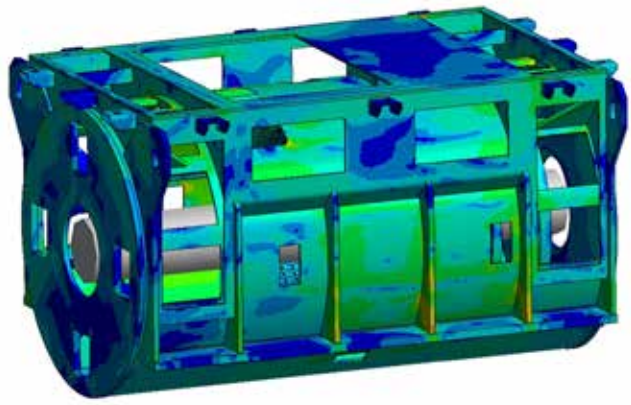

Fig. 5 - Structural analysis of a Frame loaded with Torque arising from the Stator

Given all these actions taken in terms of product improvement, what could be the other poits for future development? What about considering the possibility to snap-off dead times during product development?

Often the CAE analyst who is working on simulations, needs to leave their Workstation, for example going to the Test Room, on a meeting or to another Company headquarter; this involves the lack of possibility to follow the progress of computing operations, check the trend of convergence nor to modify any parameter. Moving away always with a laptop is not feasible, the easier way is to exploit the most common connection device. The idea is very simple and It is based on an ordinary smartphone (or a Tablet) connected on VPN, a dedicated APP with notifications about the simulation status and the possibility to manage only many Key parameters via Remote Control. Even better, if the application has push notifications that are activated only for some specific events, such as divergence of the calculation, or the completion of a point solution. The development of this

concept could means Zero additional costs about devices and considerable time saved. A rough calculation can demonstrate that the hours saved in a given year exceed a few hundred.

RESULTS

By applying multiphysics simulation to different aspects of electrical motor and generator design the best result for each single component has been achieved. The combination of Marelli Motori expertise and ANSYS software capabilities were key to achieve better competitiveness in today's market place.
Increased efficiency, cost reduction of components, reduced development time have been achieved for different product – series. Final results can be synthetized by the ratio "Power output over Final cost" which in many cases raised a double digit percentage improvement.

This Engineering simulation Project was honored with the award "ANSYS Hall of Fame 2017 - Top 10 Commercial entry "

Nicola Pornaro
R&D - Mechanical Technologies
Marelli Motori S.p.A.

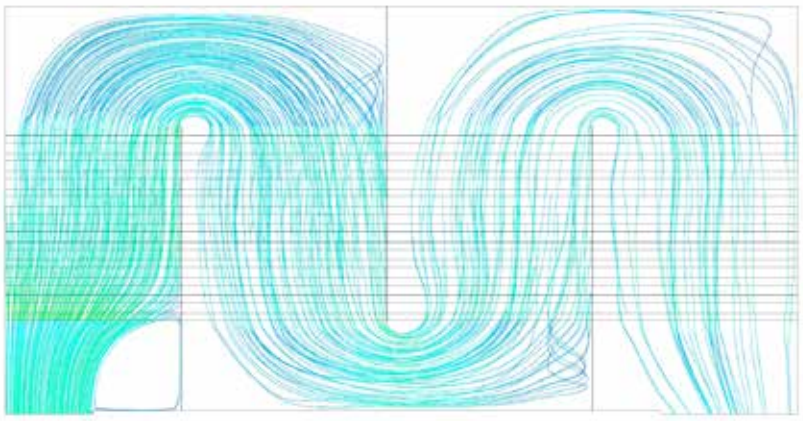

Fig. 6 - Velocity Streamline

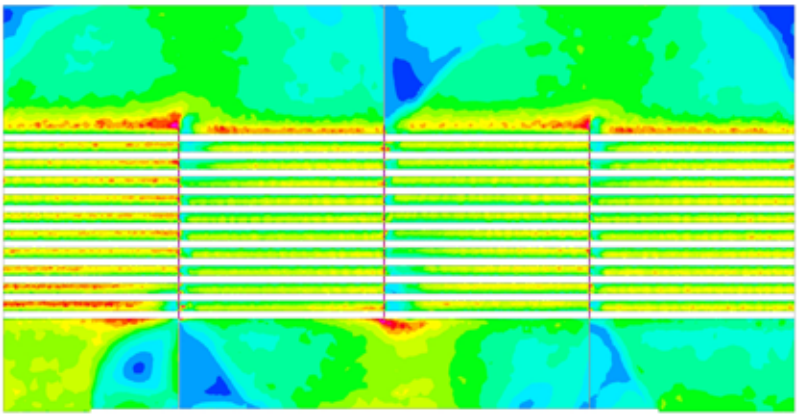

Fig. 7 - Wall Heat Exchange

NATIONAL PLAN INDUSTRY 4.0

Opportunities to foster investments for innovation and competitiveness

The plan foresees a set of tools available for Italian companies without any size, sector and territory constraints, that are willing to grow and invest in innovation.
Several are the opportunities included in the National Plan Industry 4.0:

- Super-amortization at 140%
- Iper-amortization at 250%
- New Sabatini
- R&D tax credit
- Fiscal benefits for SMEs and innovative Start-ups

EnginSoft is qualified to support you and assess the different options and to provide a specific consultancy also as far as other benefits and co-funding opportunities are concerned, taking into account also the possible participation in research projects on a regional, national and international level, in line with such topics.
Our monitoring action and the direct experience consolidated through the participation in several research projects, combined with our in-depth knowledge of the software and hardware available resources, can be placed at your disposal so to get further information regarding advantages and benefits for your company and for your investments in research and development.
For more information: a.messina@enginsoft.com