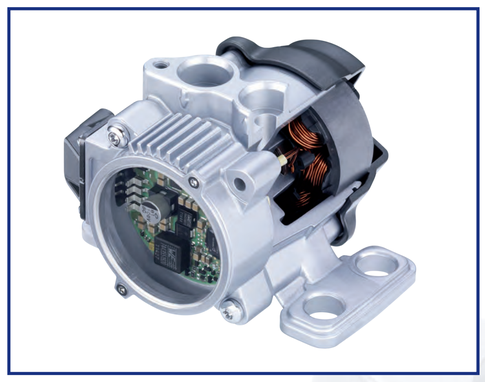
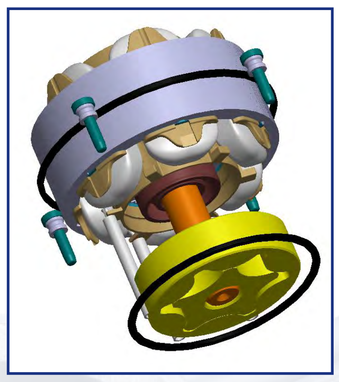
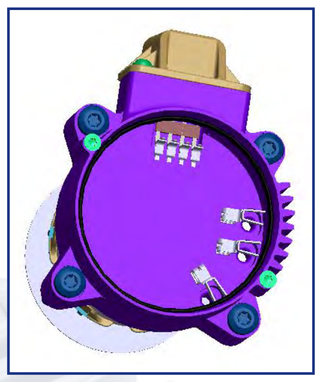
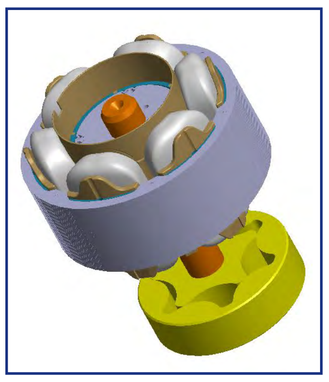
PIERBURG PUMP TECHNOLOGY

Sara Gronchi, *Calculation - Simulation Dept. Engineer, Livorno*;
e-mail: sara.gronchi@it.kspg.com
Raffaele Squarcini, *Calculation - Simulation & Testing Dept. Manager, Livorno*;
e-mail: raffaele.squarcini@it.kspg.com

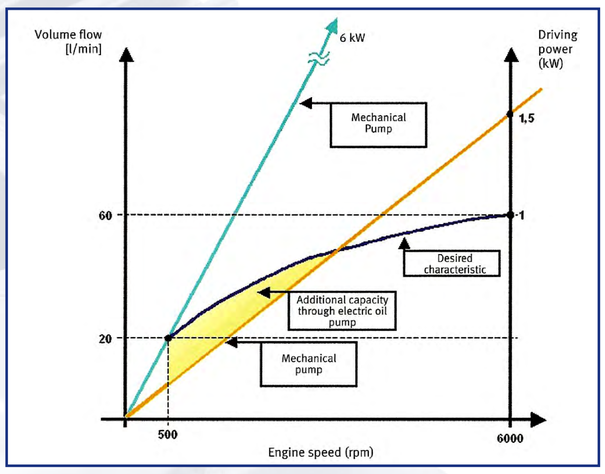
eOP design

System analysis and process description to design an **e**lectric **O**il **P**ump, through the connection of a lumped parameters **Mechatronic System** and an hydraulic part optimization

ADVANCED DEVELOPMENT IN AUTOMOTIVE FIELD

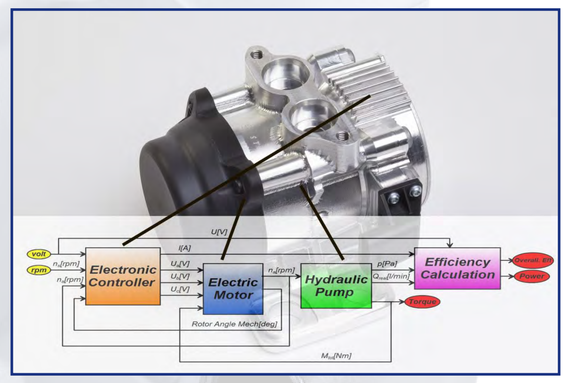
The eOP is used in order to reduce the emissions while optimizing the absorbed energy and then the car efficiency.
The actual trend to obtain this improvement is the electrification of the auxiliary components that can be driven independently from the engine shaft.
In this field, the eOP is one of the most requested components used for automatic and hybrid transmissions and as well as for main lubrication system.

eOP as auxiliary pump for engine lubrication.

WORK STRATEGY IN OUR COMPANY

PPT has the entire management of the three modules that compose an eOP: hydraulic pump, electric motor and electronic controller.
The main target of the company is the satisfaction of the customer requirements. This can be achieved through the realization of an efficient design by integrating all three components modeled in mono-dimensional Simulink environment.



WORKFLOW

1) The pumping gear design depends on hydraulic requirements of the oil circuit, expressed by the specific customer usually as flow rate and delivery pressure set to a specific temperature. From this input a design optimization tool starts in order to obtain the most suitable gears under fixed conditions. A 3D cad of the gerotors is the final result.

Why a "gerotor" solution?
This type of pump is the best compromise in terms of noise, dimensions, robustness and packaging.

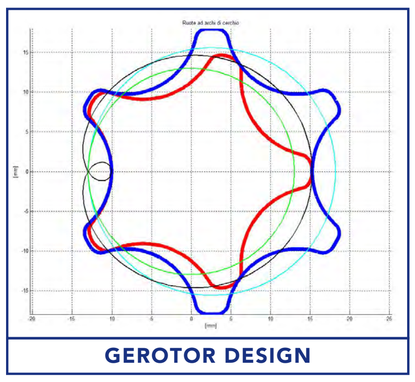
2) The calculation of the torque absorbed by the pump is necessary in order to dimension the electric motor.
A lumped parameter code in Simulink environment is implemented to calculate the total required torque as the sum of three contributions: hydraulic, coulombian and viscous.

Why a 1D Model adoption?
Simplify the 3D behaviour of a physical system and reproduce the reality with 1D code that inevitably doesn't describe some details of the phenomenon but provides an overall vision of the entire Mechatronic System.

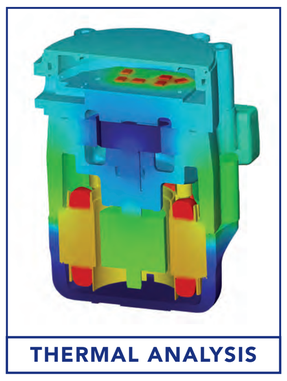
3) The eOP is driven by an electric motor, with its electronic control system. For this reason, the electric motor must generate an available torque higher than the total torque requested by the hydraulic mechanism, to allow the pump to generate the expected performances.
Also the model of the electric parts is built in Simulink ambient.

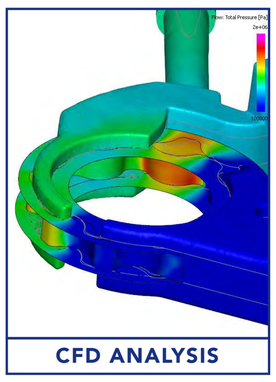
4) The entire model consists in the integration of all components: three macroblocks (hydraulic, motor and control electronic) connected by two closed loops in only one system in Simulink environment that provides the overall electronic power and efficiency.
The electric parameters modification is performed in order to find the equilibrium working point between the pump and the motor.

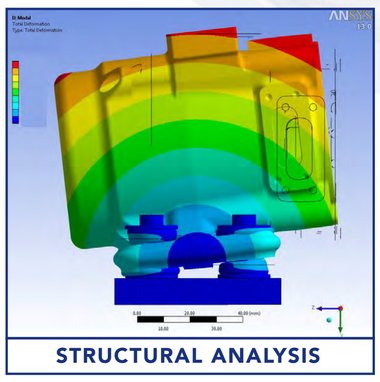
5) In addition to the **Simulink** model, we perform the **CFD**, **thermal and structural** analyses of the pump.



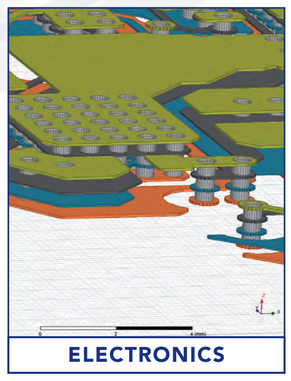
GEROTOR DESIGN

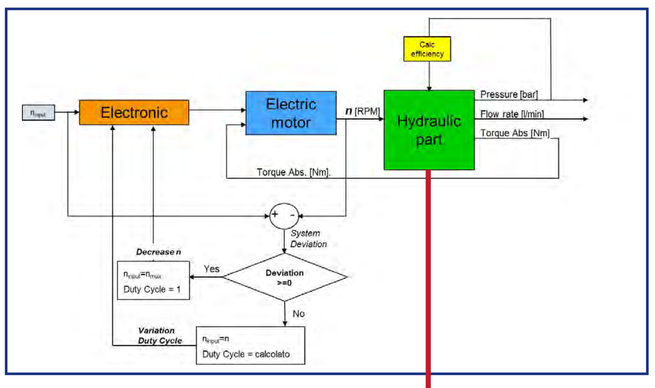

THERMAL ANALYSIS


CFD ANALYSIS



STRUCTURAL ANALYSIS


ELECTRONICS



CONCLUSIONS

A Mechatronic System is completely developed in our company, through the collaboration of various departments and several specialists, which led the team to design a great product aimed to the advanced developments in automotive field, reducing fuel consumption and emissions.
The mono-dimensional code links the electric part to the hydraulic system, optimize the interaction between the two parts. Simulation results comply with the experimental data and give to the team the possibility of further improvements of the model and better modifies of the entire model. A good result from numerical point of view means time to market reduction.