E-Motor Simulation Solution

With its eSUITE™ solution, AVL supports the frontloading of engineering tasks over the entire process from the specification to virtual testing and calibration.

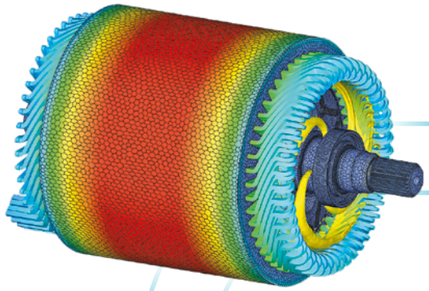
Engineers can now progress seamlessly through an embedded workflow, covering all major development challenges:

- Performance and efficiency
- Thermal behavior
- Durability
- NVH and
- System integration

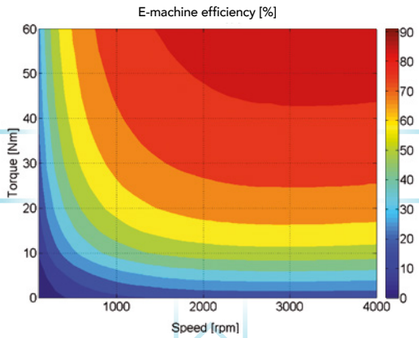
Focusing on electrical, mechanical, acoustic and thermal aspetcs, AVL's unmatched approach allows a comprehensive and streamlined analysis of the e-motor.

Accelerate your electrification process with us.

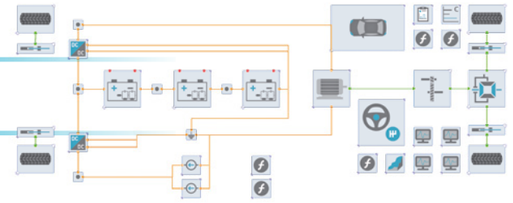
THERMAL LOAD



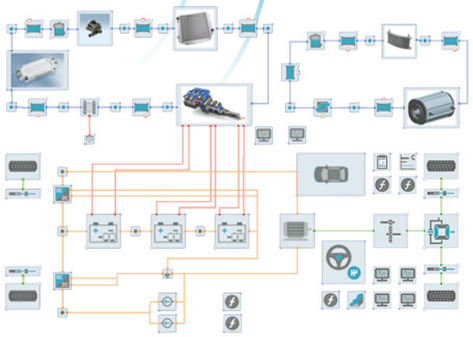
PERFORMANCE AND EFFICIENCY



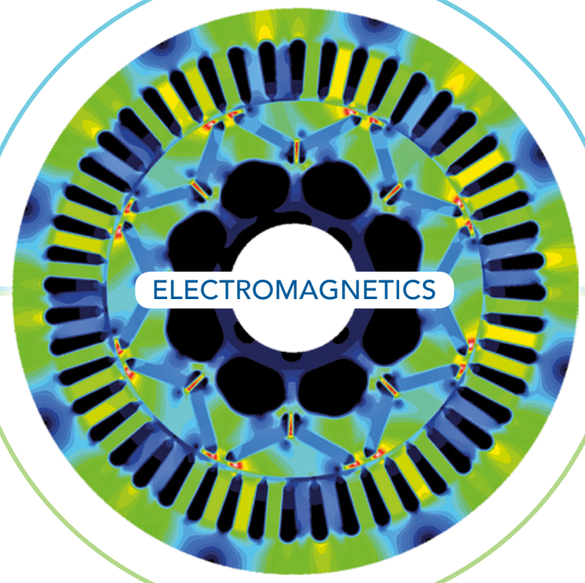
DRIVELINE DYNAMICS



THERMAL INTEGRATION

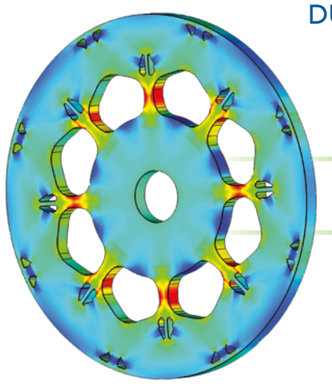


ELECTROMAGNETICS

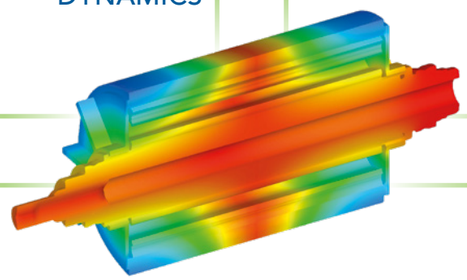


CONCEPT DESIGNER

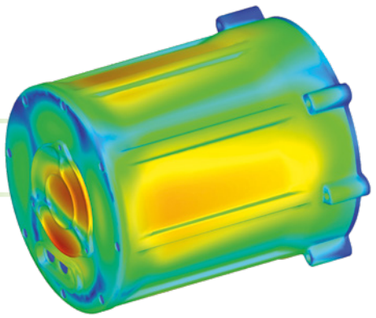
DURABILITY



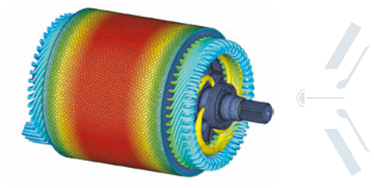
ROTOR DYNAMICS



NVH

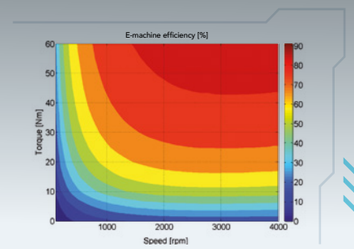


THERMAL LOAD



Based on the individual losses coming from the electromagnetic analysis, a multi-domain model is created, which includes the regions of the cooling media as well as the structural components. It allows the simultaneous calculation of the transient flow of gases and liquids, the heat transfer between fluids and structural components and the heat flow in solids. Different cooling concepts can thus be investigated in a time-saving manner. The thermal calculation provides the detailed three-dimensional temperature field of the model and helps to discover weak points of the cooling concept. The results will help you to optimize concept, design and performance of the e-motor.

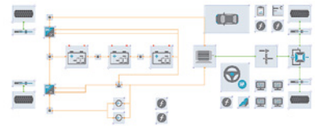
PERFORMANCE AND EFFICIENCY



Key factors in the design are performance and efficiency. Based on the results from the electromagnetic analysis, the acting torque and the electrical losses are extracted, for each current setting and speed under consideration of saturation effects. The ideal current control strategy is evaluated and used for the extraction of the efficiency map. In AVL's simulation workflow all these assessments are fully integrated, allowing a seamless continuation in the development process.

DRIVELINE DYNAMICS

Any driveline can be checked for typical dynamic phenomena like shuffle and clonk appearing during specific driving maneuvres. AVL's solution allows to take over the dynamic e-motor characteristics directly from the electromagnetic analysis without the need for any data manipulation.



E-MOTOR SIMULATION SOLUTION

AVL eSUITE™

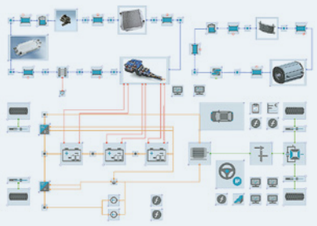
AVL's multi-disciplinary system simulation approach supports the seamless development process of any vehicle configuration from pure BEV to FCEV and HRV concepts.

AVL's flexible multi-body dynamic simulation solution for electrified powertrain systems offers durability and NVH analyses.

For battery, fuel cell and e-motor, AVL´s 3D multi-domain simulation tool calculates electric and magnetic fields, single and multi-phase fluid flows, chemical reactions, heat transfer and temperatures within fluids and structures.

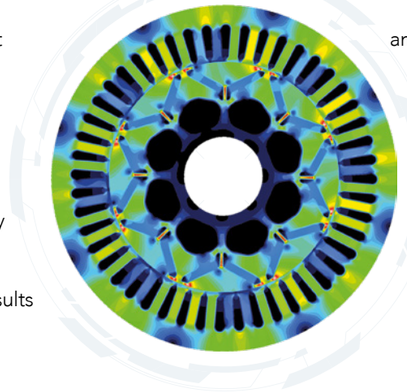
THERMAL INTEGRATION

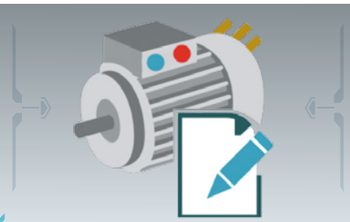
This step of the simulation workflow integrates the e-motor virtually into the vehicle cooling circuit. This allows engineers to investigate the thermal behavior of the e-motor under transient operating conditions. The equivalent thermal network is extracted from the 3D thermal analysis model. To save time, AVL's approach features an integrated topology generator and a parameter wizard. This ensures a fast model setup. The temperature at specific rotor and stator positions can be extracted for control function development tasks like thermal de-rating. This can be done for specific maneuvers or for whole driving cycles.



ELECTROMAGNETICS

The starting point of any detailed e-motor analysis is the 2D or 3D electromagnetic calculation. AVL's simulation solution efficiently supports you in the extraction of magnetic field results and other quantities required for further evaluations. An automated workflow allows you to quickly run a larger number of operating points and variants for electrical periods.





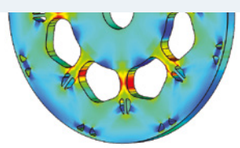
CONCEPT DESIGNER

AVL's unique e-motor concept design allows the evaluation of basic design parameters based on target performance attributes. Besides the torque and efficiency characteristics, an equivalent thermal model is created. The determined geometry parameters are used for contour and mesh creation for the subsequent electromagnetic analysis.

Increase Capabilities.
Push Limits.
Simulate.

Members of the AVL eSUITE™

FIND OUT MORE:
www.avl.com/e-motor-simulation

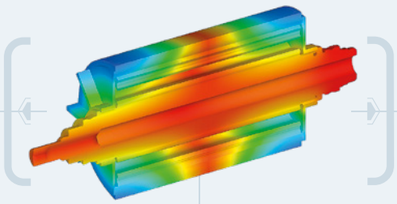


DURABILITY

The two major challenges regarding durability are overheating and mechanical stresses. An increase of the e-motor's operating temperature above critical levels may result in a performance degradation, premature wear of the insulation material or even total failure of the e-motor. The stresses due to centrifugal forces are used as mechanical durability criteria.

ROTOR DYNAMICS

This task covers the evaluation of torsional and bending vibrations of the e-motor rotor by including the electromechanical coupling torsionally and radially with different model fidelities. It considers torque ripple, rotor unbalance, gravity and stiffness fluctuation of roller bearings as excitations. In case of e-axles or transmission integrated e-motors, interactions between e-motor and gearbox are analyzed together.



NVH

AVL offers an unrivaled simulation solution to investigate noise and vibrations in the e-motor. Based on the detailed electromagnetic analysis, it considers fluctuations of the acting forces at the stator teeth. Effects like radial rotor offsets or current ripple can be investigated. Additional excitations caused by the rotor dynamics and roller bearings are examined together with those from the magnetic field. Besides the e-motor, also noise directly emitted by the inverter can be calculated. In addition, the engineer benefits from the detailed result assessment which supports the design optimization.