dynardo
dynamic software & engineering

optiSLang® and Motor-CAD®

Combining fast machine evaluation with design variation.

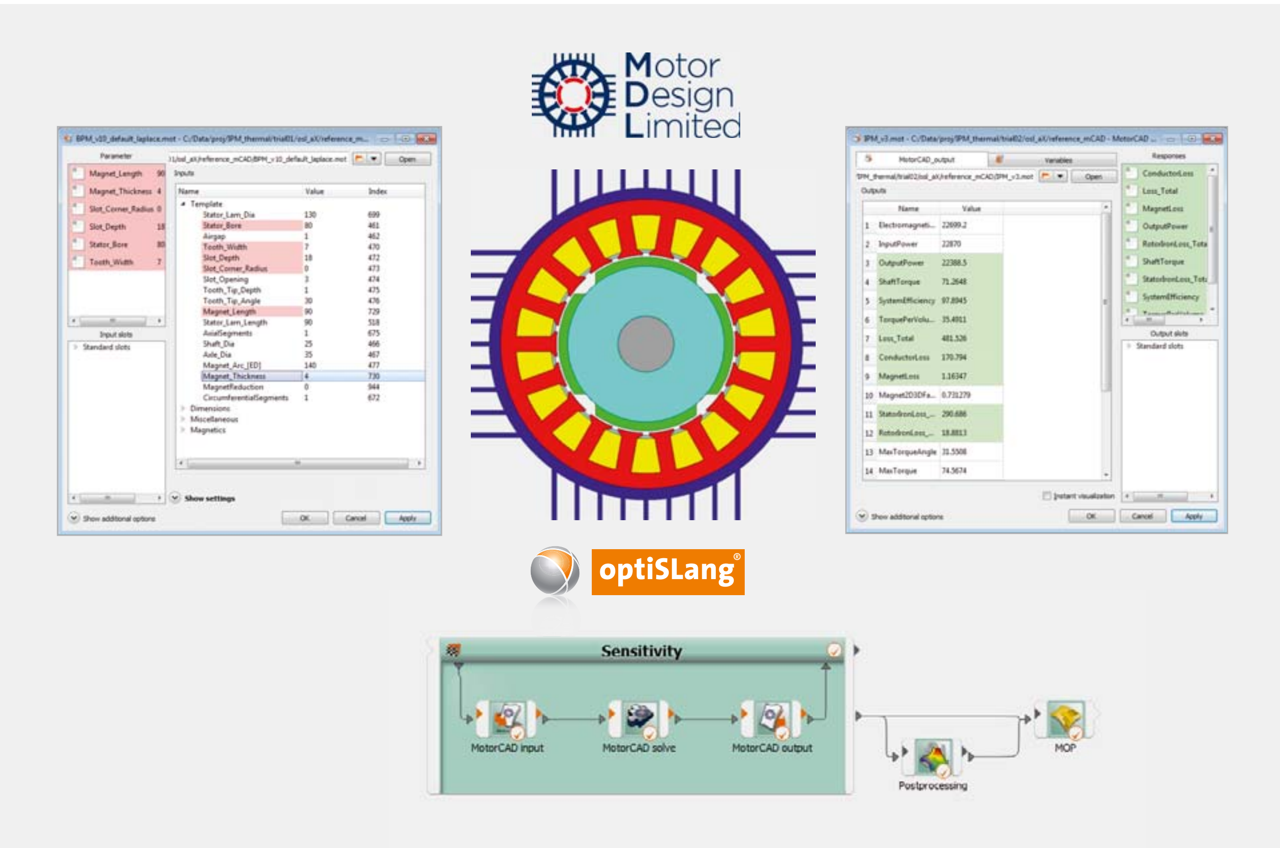
A linkage between Motor-CAD and optiSLang is established providing a world-leading design and optimization infrastructure for rotating electric machines. The connection allows engineers to automate electromagnetic and thermal machine model evaluations with Motor-CAD, to conduct efficient design variation studies, and to investigate response data in optiSLangs's postprocessing. Combining fast single-working-point and performance map computations by Motor-CAD with algorithms and meta-modeling capabilities by optiSLang enables a powerful machine design workflow targeting the real application case right from the start.

optiSLang®

optiSLang is an integration, automation and Robust Design Optimization (RDO) platform. Workflows involving one or several CAx tools (electromagnetic, optical, mechanical, CAD, etc.) can be automated, templatized and become subject to sensitivity analysis, optimization, and robustness evaluation. The interactive postprocessing provides powerful visualization, data inspection, and report capabilities.

Motor-CAD®

Motor-CAD is a unique software package dedicated to modeling the thermal and electromagnetic performance of motors and generators including the cooling system. Developed since 1998, Motor-CAD is used by major motor manufacturers and universities worldwide. Motor-CAD provides the ability to quickly and easily perform electromagnetic and thermal performance tests (steady-state and transient simulations) on fully parametrized electric machine models. A perfect combination of analytics, reduced models and 2D-FEM enables evaluations within



minutes or seconds. The comprehensive result data sets and standardized graphs provide the basis for quick and efficient design decisions. Export functions allow seamless integration into larger workflows.

Features of the Motor-CAD integration

optiSLang has a wide range of "integration nodes" for automated parameter exchange with external CAE tools and for their execution. The combination of the new custom integration and the custom wizard dedicated to Motor-CAD allows for an easy and user-friendly setup with any Motor-CAD project. Both parameters and responses are registered with a few mouse clicks. Response definitions can include scalars, signals (e.g. torque over angle or temperature transients) and data fields (e.g. performance maps). The integration is prepared for responses coming from all Motor-CAD working modes: thermal, EM, and performance map computations.

Leveraging Metamodels of Optimal Prognosis (MOP) for E-Machine Design

Generating high-quality meta-models from simulation results means capturing a representation of the system behavior. The representation can be exploited for exploring the design space under the view of various objectives and constraints. In electric machines the physical disciplines of electromagnetics, structural mechanics, and heat transfer intersect. Varying the geometry means shaping the electromagnetic field which creates the torque and impacting the various energy dissipation mechanisms. This is why each design change induces several overlaying effects, and it is the reason why an approach based on knowing the response quantities across a multi-dimensional design space enables much better machine designs as sequential low-dimensional tuning.

Dynardo's methodology of competing meta-models, variable filtering, and cross-validation-based quantification of model qualities allows the automated generation of a Metamodel of Optimal Prognosis (MOP). The MOP represents captured nonlinear system behavior, it is aware of parameter interactions, and it is associated with its Coefficient of Prognosis (CoP) as a conservative and reliable quality measure. Besides exploiting it for sensitivity analysis, system understanding, and illuminating causality chains from inputs to outputs, the MOP can also be used for algorithmic optimization. One purpose is shrinking the size of the problem remaining for direct optimization or eliminating it completely. Further value comes from comparing sets of objectives and constraints, e.g. exploiting the captured system behavior for identifying the most challenging and at the same time feasible optimization setup or exploring goal conflicts and trade-offs (see fig. 2).

Motor-CAD generates evaluations within minutes and MOP calls are just a few processor clock beats. Combining engineering competence with state-of-the-art algorithms on this basis allows for leveraging optimization potential in high-dimensional design spaces and develop best-performing E-machines.

Summary

Motor-CAD provides fast and accurate simulation power for electric machines. The convenient connection with optiSLang allows driving design variation studies and building high-quality meta-models. The best and most application-oriented electric machines can be designed when working with all available design degrees of freedom and aiming at good performance across multiple relevant working points. The combination of Motor-CAD with optiSLang is the ideal way to get the design space under control.

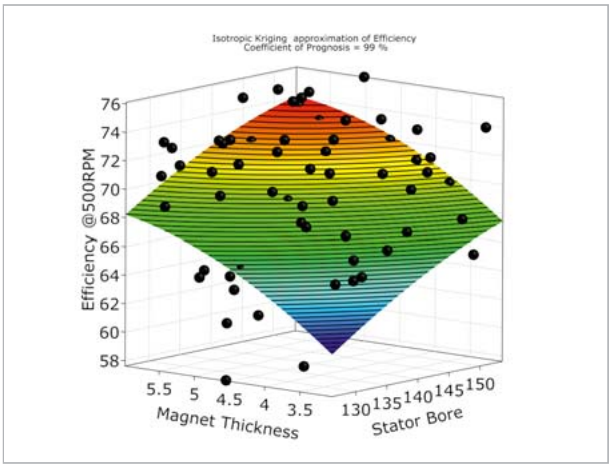


Fig. 1: 2D visualization of a multi-dimensional surrogate model for the efficiency (single working point) of an electric machine

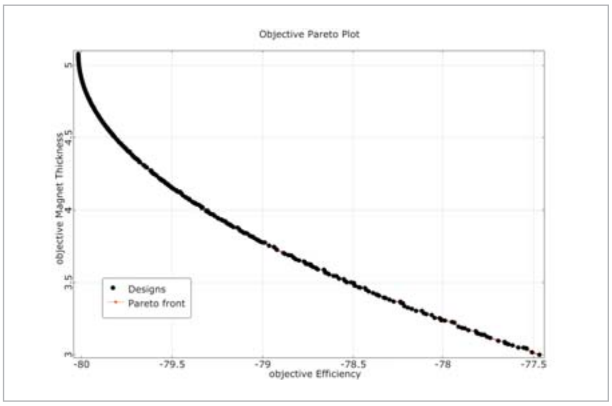


Fig. 2: Pareto front illustrating an exemplary goal conflict between the magnet thickness (i.e. cost) and efficiency

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