Ansys

CASE STUDY /

Robert Bosch Gmbh – First Key User of Optislang

For more than 13 years of application, Bosch has been gaining an extensive experience of parametric optimization and stochastic analysis in virtual product development.

Methods of CAE-based optimization and stochastic analysis have become key technologies in parametric simulation. Thus, designs can be already tested and improved under the consideration of scattering properties in the development phase in order to reduce the number of hard ware tests and time to market. Beside parametric CAE models, state-of-the-art algorithms, a high degree of automation and the availability of powerful hardware is a crucial requirement for a successful implementation of parametric optimization in CAE - processes.

In an interview given in 2004 (first published in Simulation, 1/2004, page 78-79), Roland Schirrmacher (Corporate Sector Research and Advance Engineering at Bosch) defined the requirements for CAE software as follows:

The most important criteria are the functionality and the features of the software followed by operating stability and user-friendliness. The complex industrial tasks require sophisticated methods using various approaches and achieving a significantly improved design with a minimum number of iterations.

At that time, Mr. Schirrmacher said about the application of optiSLang at Bosch:

In the field of optimization, all methods implemented in optiSLang have been used successfully. As a first step, a Design of Experiment (DoE) scheme is often generated to obtain initial information about component behavior from the response surfaces and to possibly eliminate unnecessary parameters. Utilizing these response surfaces, several improved designs are simulated afterwards by using gradient or evolutionary strategies. These can be taken as starting designs for a gradient-based optimization or as an initial population. This procedure has proven especially successful in an optimization using improper initial designs and under highly nonlinear conditions.

The graphical user interface of optiSLang is designed intuitively and does not make high demands on the user providing a step by step procedure of necessary input. The most complex part of the task defi nition is to build the parameterized model and to connect all programs or commands associated to the workflow in one script. Bosch insisted to reference only this script during the development of optiSLang in order to guarantee the flexibility for a variety of tasks.

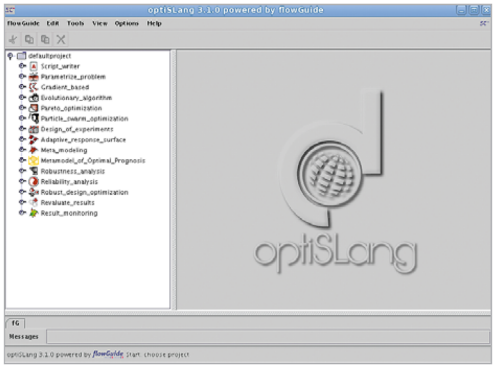
Robert Bosch GmbH was the first key customer in the industrial use of optiSLang. The application started in 2002 as a research project and since has been developed over the years to an integral part in the virtual development process at Bosch. Applications include et al.:

- Simulation of loads and durability regarding electric drives in vehicles.
- Simulation of the behavior of design elements exposed to thermal loads.
- Reliability analysis.
- Realistic simulations of dynamic designs including material models.
- Robustness evaluations toward scatter, such as manufacturing tolerances.
- Parameter identification for the calibration of material models.
- Optimization and robustness evaluation during the simulation of mechanical systems.
- Virtual product design.
- Sensitivity analysis of product life based on parametric models.
- Multiobjective optimizations.

In May 2015, we visited Mr. Schirrmacher and two of his colleagues in Stuttgart to take stock again regarding the use of optiSLang and the cooperation between Ansys and Bosch.

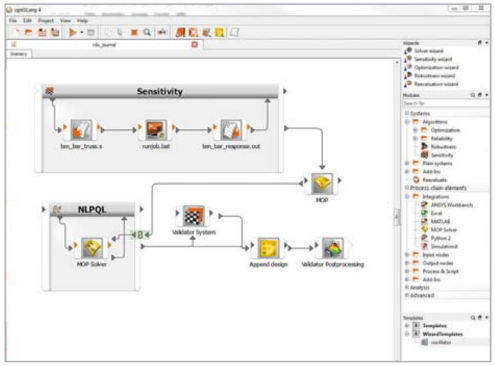
Since When Have You Been Using Optislang in the Product Development Process at Robert Bosch Gmbh?

The test phase of optiSLang started in 2002 with basic research and setting up software tools like ETK, optiPlug for Ansys or Optiqus-Plugin for coupling parametric CATIA-Models with Abaqus/CAE. After this phase was successfully finished, we began to implement the software into the product development process at Bosch. The first fields of application dealt with injector development and power tools. Meanwhile, optiSLang has been utilized in almost all business units of Bosch.



What Were the Reasons for Bosch to Decide in Favor of Optislang?

optiSLang was chosen out of three software products after a benchmark in the automotive industry in 2001. At that time, a major reason was that optiSLang had already implemented all essential methods, for example, Design of Experiment, meta-models or procedures of optimization, robustness and reliability. This also applied to the design variable types which could be processed ranging from binary to real and integers. Another reason for our decision was that Ansys allowed us to directly influence the software development combined with a fast and service-oriented support. The contact with the development department and the resulting short paths of communication are still reasons for the close and successful cooperation. We also appreciate the flexible and open licensing models provided by the company.



What Are the Most Important Applications of Optislang at Bosch?

The first fields of application were in structural mechanics combined with the CAE programs Abaqus and Ansys. Later projects were added in electrodynamics, fluid dynamics and thermodynamics. In recent years, optiSLang has been increasingly used regarding multibody simulation models as well as system models from Matlab or AMESim. Besides the application to product development, optiSLang is often used for parameter identifi cation of material properties. Also in the advanced development, optiSLang workflows are implemented for model development, pre-standardization by tolerance analysis, functional analysis as well as robustness evaluation. In the design of electric motors, optiSLang is part of the standard process for sensitivity analysis, optimization and robustness evaluation of, for example, eccentricity, brush running or other motor characteristics. In collaboration with the manufacturing, investigations of production tolerances along with evaluations and data analyses regarding correlations and parameter dependencies are conducted.

Which Methods and Workflows Are Used Most Intensively?

The most common applications are sensitivity analyses and robustness evaluations. optiSLang is also increasingly used for the generation of meta-models in order to efficiently describe the phenomena occurring in complex and extensive simulation tasks, to use them in system simulation as well as to draw conclusions for the optimization. During the advanced development process, sensitivity analyses regarding scattering parameters are conducted for a better product understanding and for setting the base to conduct multi objective optimizations.

What Are the Main BenefiTs from the Use of Optislang in the Virtual Product Development at Bosch?

By using optiSLang, we obtain a much better product understanding regarding the product robustness, sensitivities as well as the potentials for optimizations and their boundaries. Thus, we can specifically improve the product performance during the development stage to come up with an already optimized initial sample saving a lot of time and money in prototyping. In complex multi-domain application, optiSLang also finds optimal designs which have not been found by experts. By taking into account scattering effects, which is hardly or not at all possible in hardware tests, we can determine and evaluate product robustness and limiting samples a lot more accurately and faster. The saving of extensive tests regarding product life and durability especially accelerates our development process considerably.

How Important Are the Issues of Process Automation and Integration?

Due to the importance of these issues, there has been a cooperation to improve process automation and integration capabilities in optiSLang between Bosch and Ansys for quite some time. The main benefits are the control of system complexity and the standardization of the workflow management. Here, the intention at Bosch has always been to have a one-software-solution for all the different CAX processes. The multi-functionality of optiSLang has fulfilled this expectation. The aim is to generate interfaces for process integration with little programming effort. The implementation of simple standard templates must be possible without special knowledge. This is the only way to cope with the rising demand for simulations by the same human resources.

What Other Areas of Application in the Product Development at Bosch Can You Imagine in the Future?

In the future, we consider improvements in the visualization of correlations and results, for example, Pareto fronts in multi-objective optimizations, as an expandable application of optiSLang. In addition, the software will be increasingly used in sensitivity analyses of signals. Also the issue of meta-models is of crucial importance in order to obtain greater efficiency and opportunities in the approximation and evaluation of, for example, several operating points or characteristics. These meta-models can be stored as basis product knowledge for further modeling.

How Important Is the Issue of Robust Design Optimization at Bosch?

Robustness of designs is a very important issue for Bosch. Proving the design robustness during virtual prototyping is one of the most important applications of optiSLang, because the optimal nominal design does not represent an optimum in reality. However, the automatic combination with optimization procedures make high demands on the parametric modelling process. Today it is only applicable for some modules but not for the whole CAX portfolio. The qualification of parametric modeling and the automation of CAX processes as requirements for a more frequently use of Robust Design Optimization will be an important point on the agenda for the next years.

Which “Bottlenecks” Appear during the Implementation of Robust Design Optimization with Optislang Today?

We are constantly working on expanding and assessing our product knowledge regarding scatter conditions in manufacturing, material properties and environmental circumstances. In this process, a close cooperation between development and manufacturing departments plays a major role. Respectively, the interfaces between CAD and CAE process parameters and the transfer of geometric tolerances must be further improved and optimized. Another key point is the availability of efficient and powerful hardware in the CAE process in order to keep the overall response time as moderate as possible. In this context, it is still a major challenge to handle the complexity of 3D parametric CAE modeling. This includes constraints, loads and contact as well as the associated model size taking into account meta-models and a high number of parameters. Here, the license models of all commercial CAE codes used must ensure a simple availability of parallel computing and processes, storage management as well as bundling of calculations.

What Can Ansys Do to Overcome These Obstacles?

In this context, we expect from Ansys further development and improvement of automatic generation of best possible meta-models out of simulation or measurement data bases as a very important strategy of reducing the complexity of CAE-based simulations. In order to minimize the manual transfer of parameters or processes, the approach of generating transferable, reusable template structures inside optiSLang should be expanded. Here, of course, the compatibility between platforms and interfaces plays a crucial role. Also, the increased complexity of post-processing much more parameters, responses and objectives must be constantly monitored regarding the prevention of a decline in the software’s performance capacity.

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