

## 9. Mittweidaer Laser Congress (MLT) in the context of the 24th International Conference Mittweida (IWKM)

### Meta-Modellierung und Darstellung Höherdimensionaler Daten Meta-Modelling and Visualization of multi-dimensional Data

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#### Abstract

In production industries, parameter identification, sensitivity analysis and multi-dimensional visualization are currently highly prioritized steps in the planning process for achieving optimal designs and getting the operator as well as the developer more skilled. Fast and Frugal reduced models, namely avoiding unnecessary complexity, generate millions of simulation results very fast and thereby enables Meta-Modelling, namely continuous multi-dimensional relations between parameters and the criteria. Sensitivity analysis and visualization can help in identifying the most-influential parameters and quantify their contribution to the model output, further reduces the complexity of the Meta-Model, and enhance the understanding of the solution structure. Typically, this requires a large number of simulations, which can be both very expensive and time consuming when the simulation models are numerically complex and the number of parameter inputs increases. There are three main constituent parts in this work. The first part is to substitute the numerical, physical model by an accurate reduced model, to provide data for and finally generate the so-called Meta-Model interpolating the original data. The second part includes a multi-dimensional visualization approach for the visual exploration of Meta-Models. In the third part, the Meta-Model is used to provide the two global sensitivity measures: i) the Elementary Effect for screening the parameters, and ii) the variance decomposition method for calculating the Morse-Smale Complex as well as the Sobol indices that quantify extremal pathes in parameter space and main as well as interaction effects. The application of the proposed approach is illustrated with an industrial application with the goal of optimizing a drilling process with respect to criteria characterizing the hole shape.