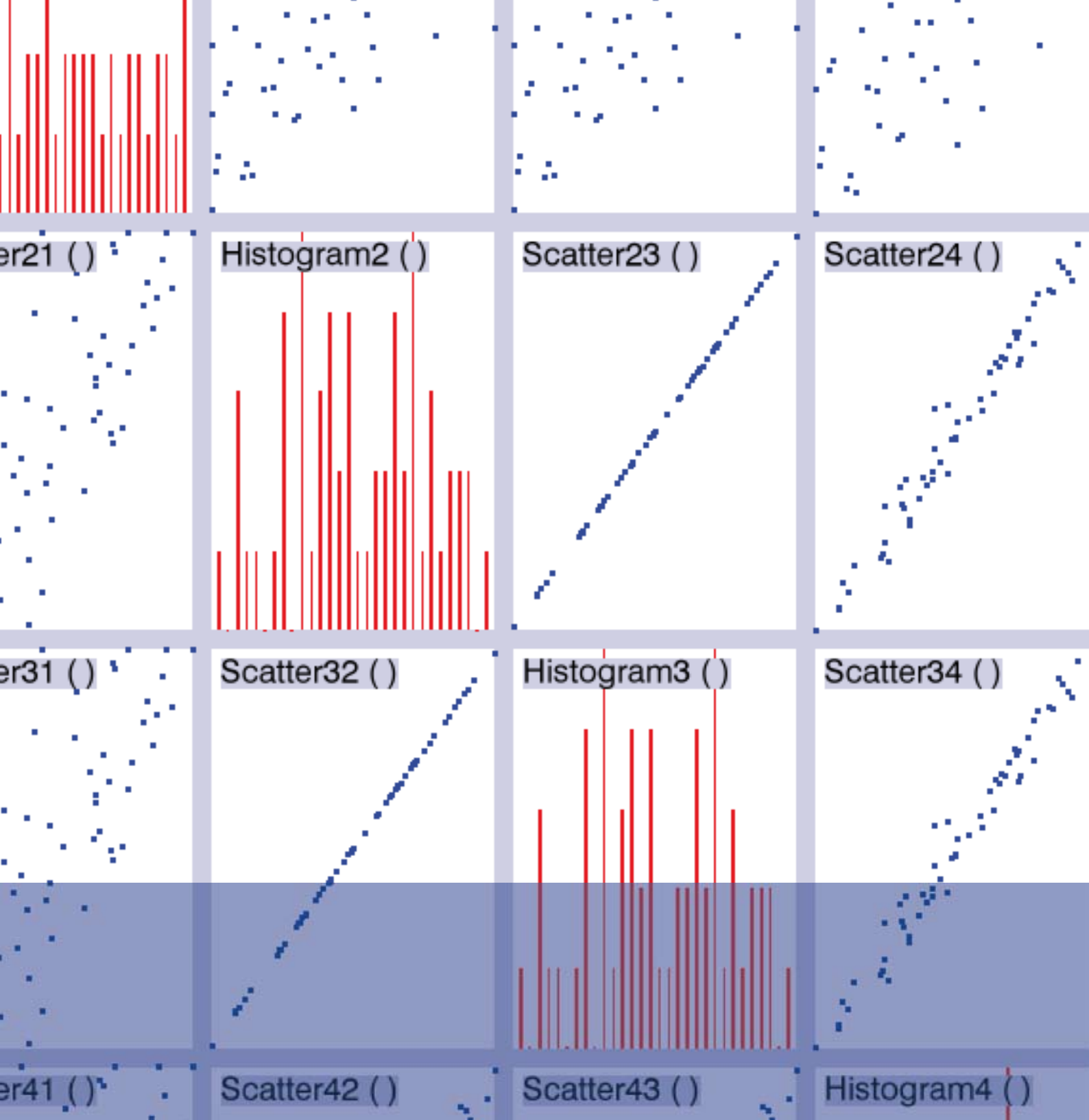


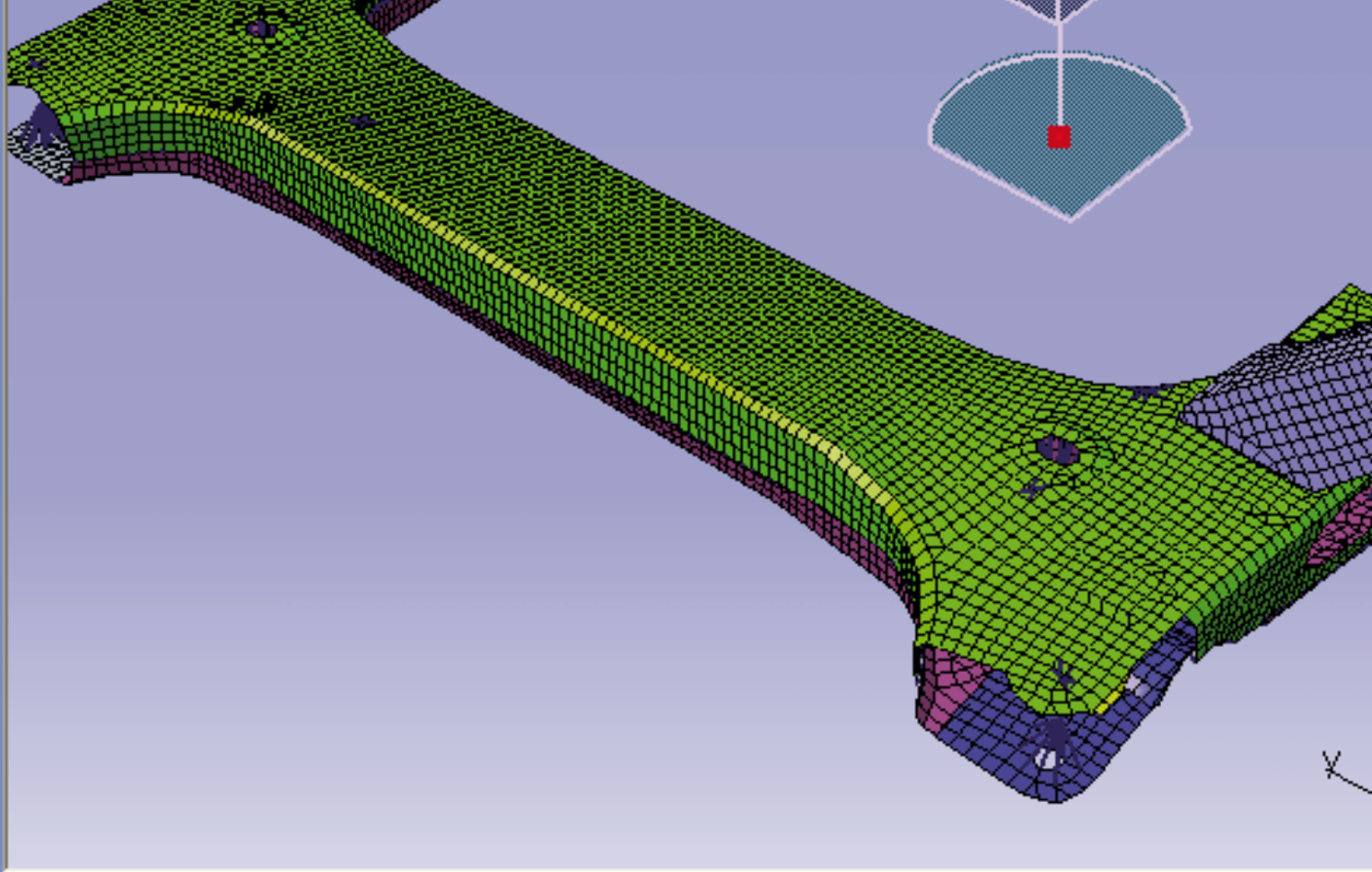
# LMS Virtual.Lab Optimization



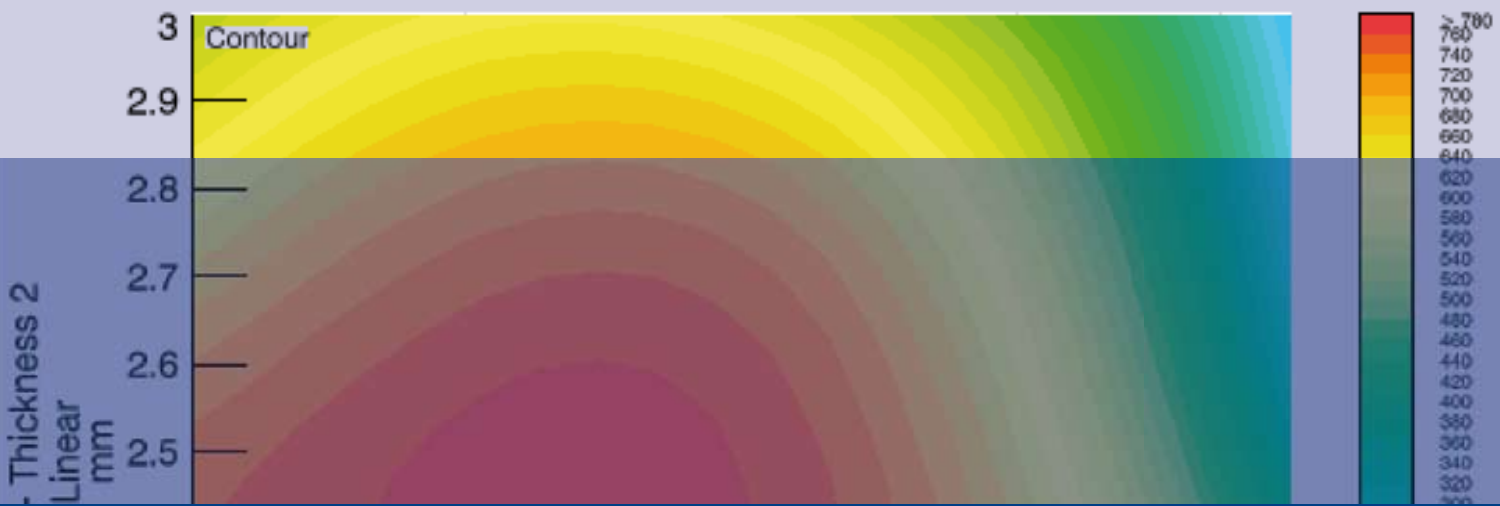


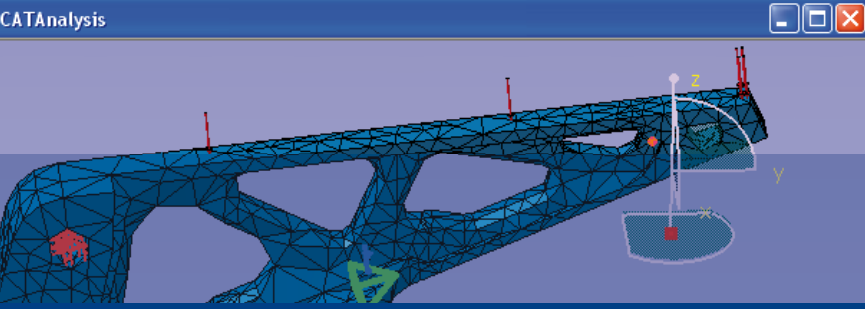
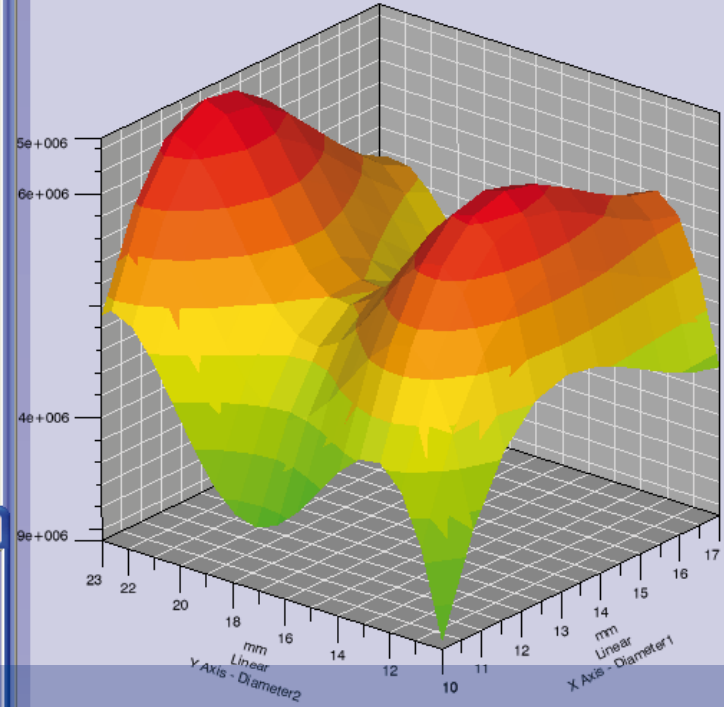
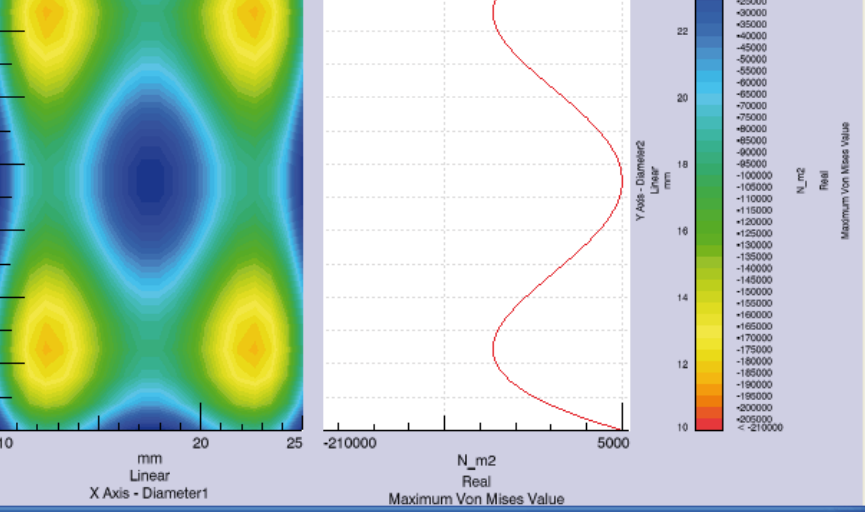
# LMS Virtual.Lab Optimization

Design exploration, reliability engineering and performance optimization



Model Contour - Contour Plot





# LMS Virtual.Lab Optimization

Design exploration, reliability engineering and performance optimization

LMS Virtual.Lab Optimization offers integrated optimization technology across all LMS Virtual.Lab applications. It provides more insight into each design, improving and optimizing it and assessing the overall quality.

LMS Virtual.Lab Optimization easily identifies the key parameters that have the most influence on the design specifications and optimizes the functional performance of products through parametric modification of geometry, material or other design variables. LMS Virtual.Lab Optimization also computes the product's robustness and reliability and provides the best optimization methods to meet the required objectives.

With LMS Virtual.Lab Optimization, design and analysis engineers can increase their knowledge about the design under study. With a few mouse clicks, users easily understand the relationship between some input parameters like dimensions and inertia properties or understand how the maximum stress of a component or system changes in function of its dimensions. Design objectives and constraints can easily be specified and LMS Virtual.Lab Optimization will automatically determine the optimal settings for the design to meet the targeted constraints and objectives.

LMS Virtual.Lab Optimization enables the definition and execution of Design Space Exploration, Optimization and Robust Design studies within LMS Virtual.Lab.

# LMS Virtual.Lab Optimization

LMS Virtual.Lab Optimization drastically improves the efficiency of any LMS Virtual.Lab-based engineering process by accelerating exploration of design alternatives, by finding the optimal solution to any design problem and by modeling uncertainty to manage risk. New scripting capabilities have increased the scalability of LMS Virtual.Lab Optimization.

## Design Space Exploration

Design Space Exploration allows users to automatically explore and visualize the design space through the use of a wide variety of Design of Experiments (DOE) techniques. DOE methods sample the design space with a minimum number of experiments, yielding the most relevant information about the design's performance. The results of these virtual experiments give critical insight into the variations of a design and the related 'trade-offs'.

## Response Surface Modeling

Design Space Exploration is mostly used in combination with Response Surface Modeling (RSM), which fits a continuous surface through the discrete data to get more insight into the influence of the design variables on the specified result quantities. This surrogate model allows the user to replace expensive simulation sequences.

# LMS Virtual.Lab Advanced Optimization

Advanced Optimization incorporates additional global and discrete optimization methods as well as multi-objective optimization and robust design techniques.

## Global Optimization

Global Optimization with three different state-of-the-art algorithms [Differential Evolution (DE), Self-adaptive Evolution (SE) and Simulated Annealing (SA)] solves general constrained optimization problems. These algorithms have a high probability of finding a global optimum. Discrete Optimization solves general constrained optimization problems including a mixture of continuous and discrete variables. A choice of discrete variables is available: either integer values only, or a catalog of real values, or a list of strings. Special optimization search routines effectively take into account the discrete character of the input variables.

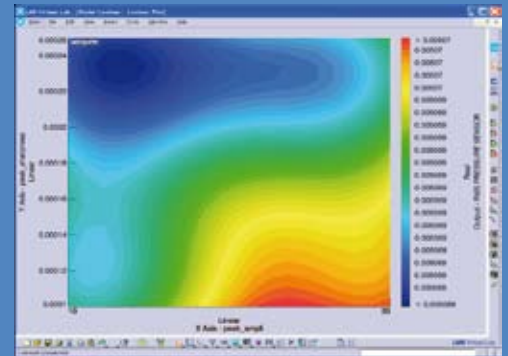
## Multi-Objectives Optimization

The Multi-Objective Optimization (MOO) module contains 9 MOO methods and allows users to efficiently optimize designs with two or more often competing objectives. MOO methods consist of local optimization methods, including the normal-boundary intersection method, the weighted objective method, the weighted Tchebycheff method and the min-max optimum method and the multi-objective optimization methods: non-dominated sorting evolutionary (NSEA and NSEA+) algorithms which calculate Pareto fronts. In addition, the trade-off method, the hierarchical method, the distance function method (Euclidian norm), the distance function method (goal programming) and the global criterion method compute individual Pareto points. New powerful post-processing functionalities provide more insight capabilities to explore the engineering design, including Pareto plots.

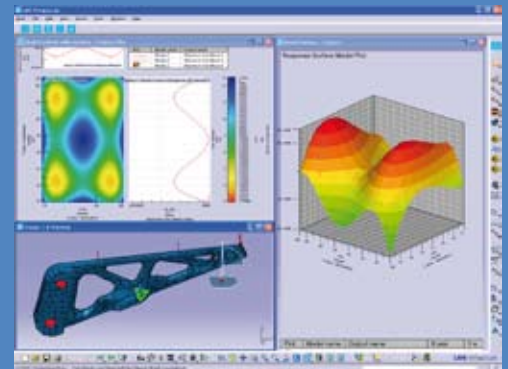
## Robust Design

Taking into account the influence of such parameter distributions, users can study the result variation around the optimal value and build higher-quality products by making the design more robust (less sensitive to parameter variability) and more reliable (lower probability of exceeding the design constraints).

VL-OPT.22.2

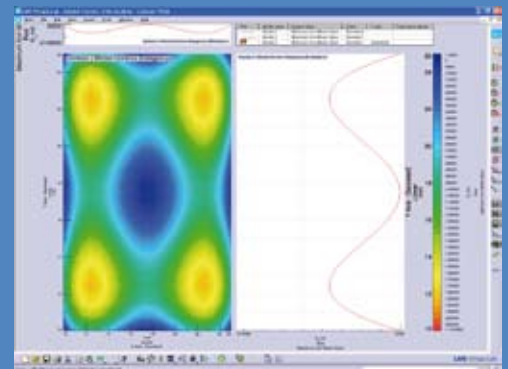


Response Surface Model: 2D contour plot.

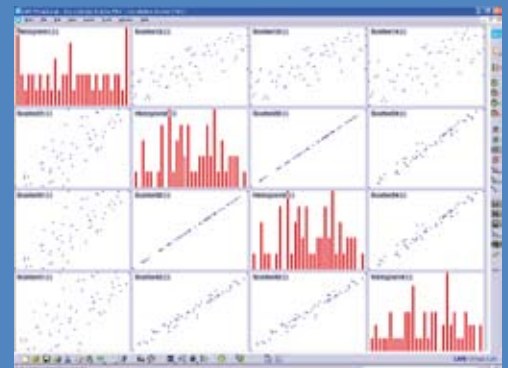


Response Surface Model: 3D Surface plot and 2D contour/section.

VL-OPT.35.3



Response Surface Model: Model Section 2D Color Map.



Correlation/Optimization Scatter Plot: Histogram on diagonal, Scatter off-diagonal.



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With a unique combination of 1D and 3D simulation software, testing systems and engineering services, LMS tunes into mission critical engineering attributes, ranging from system dynamics, structural integrity and sound quality to durability, safety and power consumption. With multi-domain solutions for thermal, fluid dynamics, electrical and mechanical system behavior, LMS can address the complex engineering challenges associated with intelligent system design.

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