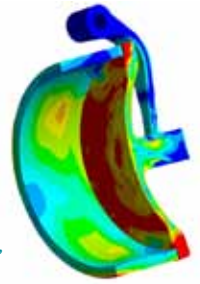


**Realize Your Product Promise™**

**ANSYS®**

# Design Exploration

Cameron used goal-driven optimization to determine the clapper angle on a check valve. The engineering team applied ANSYS DesignXplorer to discover and explore a multitude of solutions; they generated trade-off plots for 50 different sizes and pressure classes of the valve.



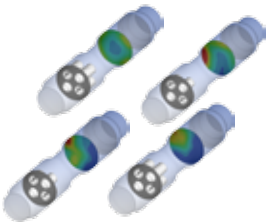
*“This line of points – essentially a flow performance curve for a wide range of feed conditions – was generated for each of the 50 valves, thus providing solutions in hours rather than weeks.”*

**Christophe Avdjian**

Design Development Manager, Engineered Valves  
Cameron Inc.

## ANSYS design exploration tools lead the way to Simulation-Driven Product Development.

Harness the power of parametric analysis to increase innovation and improve the return on your simulation investment.



Design exploration can provide useful insight into designs, such as understanding what parameters affect ammonia mass fraction at the catalyst inlet for a selective catalytic reductions system.

R&D engineers often use simulation to assess the performance of a single design — a part or a system with set CAD dimensions, inputs and material properties. Some have progressed to using ANSYS Workbench™ to run simple, probing, what-if studies to improve design.

ANSYS DesignXplorer® takes this to the next level, applying design-of-experiment (DOE) algorithms to efficiently and scientifically factor the design space. It also uses state-of-the-art response surface technology to interpolate the results.

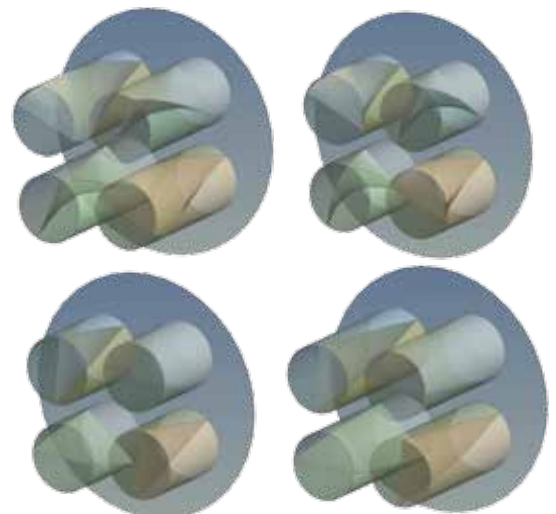
Our parametric technology calculates correlation and sensitivity along with a host of other insightful metrics so you can more completely understand your design space. Optimization algorithms help to determine the best combination of parameters, and Six Sigma analysis ensures that your design is robust.

### Simulation Driven Product Development

We developed the ANSYS Workbench environment as a central platform in support of Simulation-Driven Product Development™. As part of that vision, we created DesignXplorer to leverage the power of Workbench for parametric analyses. Workbench makes it easy to create and manage parameters. Setup is persistent, and updates are automatic.

You can add DesignXplorer’s systems (goal-driven optimization, parameters correlation, response surface and six sigma analysis) to the Workbench schematic with drag-and-drop simplicity. The remote solve manager (RSM) allows for distributed solve of design points.

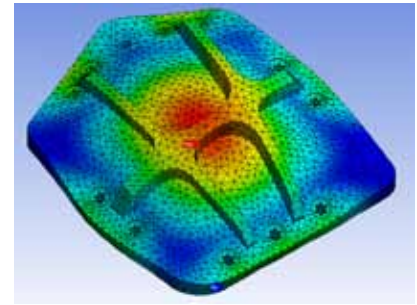
DesignXplorer leverages these and other ANSYS strengths to help you truly understand your design — and so that you can apply simulation to drive product development.



Automatically explore various design geometries to obtain an optimal design with DesignXplorer.

*“The team found that this approach shaved months off the development process and led to innovative designs through improved understanding of fuel cell behavior, especially the impact of a wide range of design variables.”*

**Andreas Vlahinos**  
President  
Advanced Engineering Solutions



Researchers at Advanced Engineering Solutions leveraged DesignXplorer with ANSYS Mechanical software to assess design sensitivity on thermal performance of a fuel cell stack.

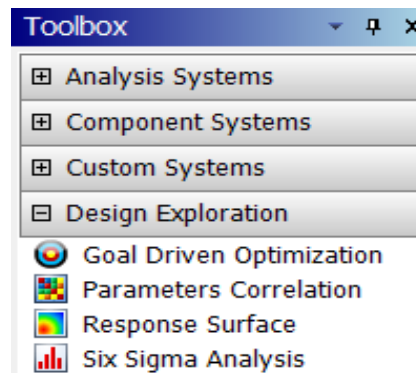


Organizations in a wide range of industries use ANSYS design exploration tools to increase design understanding and product performance.

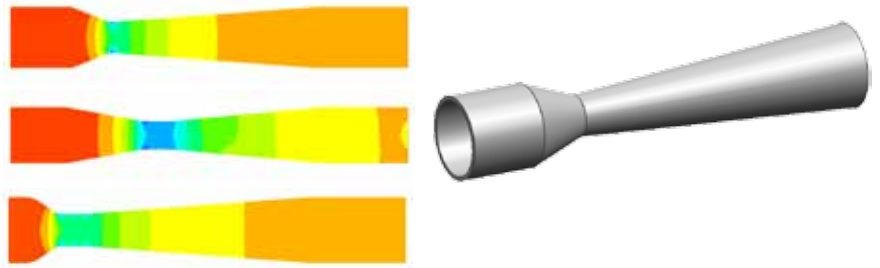
### Design Exploration for All Physics

ANSYS offers an unparalleled breadth of engineering simulation solutions across a broad range of disciplines that can accurately model the fluid, structural, thermal and electromagnetic physics of any design. ANSYS workflow technology — including bidirectional CAD interfaces, meshing and post-processing tools — simplifies the process to help increase productivity and enable exploration. All of these tools are integrated in the Workbench environment, so you can combine them to meet your simulation needs.

DesignXplorer technology is available for all physics within the ANSYS Workbench schematic. It supports analyses in which multiple physics are analyzed independently or in a coupled manner.

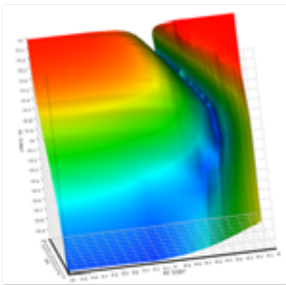


You can add design exploration systems to the ANSYS Workbench schematic — which can then be applied to all physics — with drag-and-drop simplicity.



When optimizing the air intake for an FSAE car, the University of Waterloo Formula Motorsports team used DesignXplorer to quickly and efficiently investigate design impact on overall performance, eliminating the need for multiple prototype cycles.

## ANSYS DesignXplorer provides the advanced tools you need to explore and improve your design.



The response surface method visualizes the relationship between input and output parameters; the example is an Ansoft Designer™ model.

### Design of Experiments and Response Surfaces

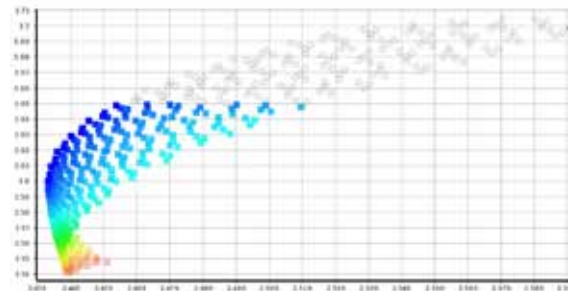
ANSYS DesignXplorer features a variety of DOE types, from basic Latin hypercube sampling (LHS) to central composite design (CCD) factoring to optimal space filling (OSF) — even to adaptive sparse grid or kriging methods. These scientific methods subdivide your design space to efficiently develop a series of simulation experiments for exploring designs. The DOE table of design points can be solved in batch mode on your local machine or remotely distributed for a simultaneous solve.

Our powerful response surface technologies include full second-order polynomial, kriging, non-parametric regression and neural network approaches. These serve to interpolate between the data points in multidimensional space. They can be visualized as a 2-D or 3-D description of the relationships between design variables and design performance.

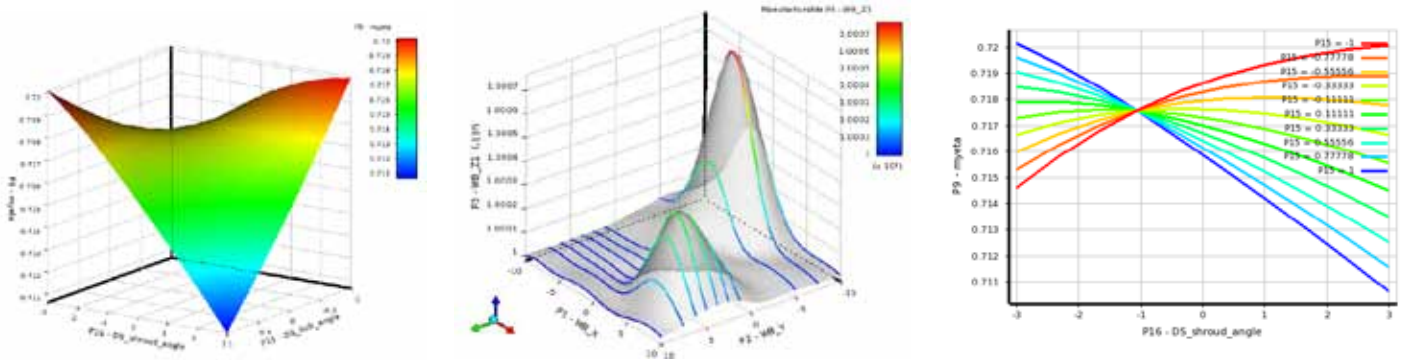
DesignXplorer can use the response surfaces as a reduced-order model. For example, while looking at optimization trade-offs, the algorithm can search the response surface to rapidly solve many thousands of samples. You can also probe the response surface or add design points at will.

### Optimization

Once you have explored the design and understand correlations and sensitivities, you may want to optimize the design. DesignXplorer includes several algorithms that help identify the most suitable candidates — taking into account multiple objectives and performance trade-offs.



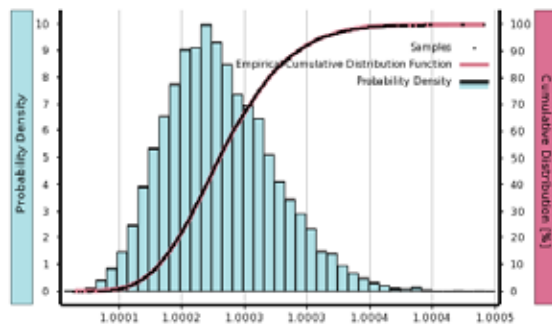
Trade-off charts help you to visualize possible and equivalent solutions to the optimization, providing insight for determining the best trade-offs to meet design goals.



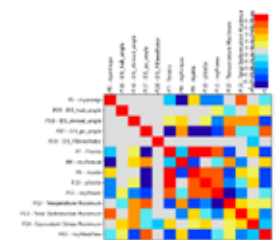
DesignXplorer's many chart options help you to understand the relationship between parameters.

### Six Sigma (Probabilistic) Analysis

Simulation often begins with specified deterministic values for dimensions, loads, boundary conditions and material properties. In the real world, however, these values often vary due to manufacturing tolerances or the range of operating conditions. A six sigma analysis runs a series of small variations on these inputs and calculates the expected output variation. This can help you to determine whether or not your design meets robustness requirements. Correlation, determination and sensitivity analysis helps in understanding how to improve robustness.



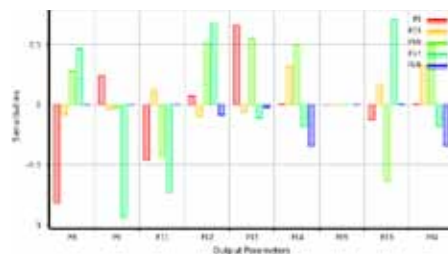
Six sigma analysis helps to ensure that the design is robust within expected input parameter ranges.



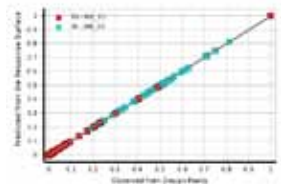
Parameters correlation identifies key parameters of a design before creating a surrogate model.

### Graphics Tools for Greater Understanding

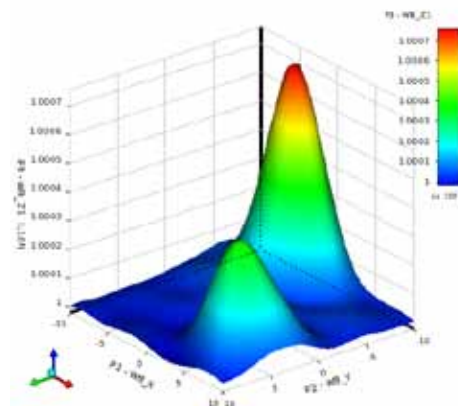
Extensive tools enable you to graphically investigate product behavior, including sensitivity plots, correlation matrices, curves, surfaces, trade-off plots and parallel charts with Pareto front display. The tools impart value in the form of understanding as you explore your design.



Global sensitivity plots identify the most critical design parameters.

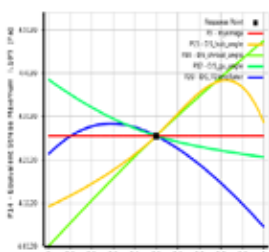


Goodness of fit tools for evaluating accuracy of response surface



Response surfaces: relationships between design parameters and design performance

## Our integrated toolkit means you can fully explore your design as well as manage the wealth of data it generates.



Local sensitivity curves assess local sensitivities of the output parameter across the range of each input parameter.

ANSYS DesignXplorer is part of our suite that delivers functionality — depth, breadth, a plethora of state-of-the-art capabilities and integrated multiphysics — providing confidence that your simulation results reflect real-world parameters. The comprehensive range of solutions provides access to virtually any field of engineering simulation that a design process requires. Organizations around the world trust ANSYS to help them realize their product promises.

### Geometric Parameters

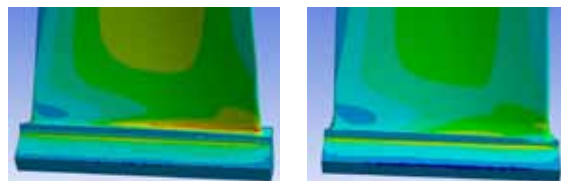
ANSYS Workbench supports CAD design parameter variations through our bidirectional CAD interfaces and ANSYS DesignModeler™. In addition, you can use ANSYS SpaceClaim Direct Modeler to parameterize neutral geometry formats.

### Managing Simulation Data

Design exploration can generate large volumes of data. ANSYS Engineering Knowledge Manager™ (EKM) enables capture and management of your simulation data, along with workflows and best practices, in a searchable and sharable environment. The EKM tool can improve the efficiency and productivity of simulation teams.

### High-Performance Computing

Large parametric problems require superior high-performance computing (HPC) to obtain high-fidelity results quickly. Advanced parallel processing efficiently utilizes multiple multi-core processors from a single machine or in a grouping of machines on a network. Thus, HPC enables you to increase the number of design variations you can compute in a given period, leading to better, more optimized products. Another significant advantage is getting your product to market in a shorter time frame. The end result is confidence that your design will thrive in the real world.



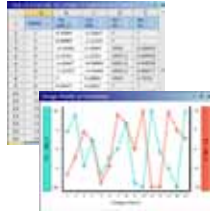
Using design exploration to study a range of variations, engineers at Power Systems Manufacturing defined blade parameters to be varied, assigned acceptable parameter ranges, and identified variables to optimize (blade natural frequencies and peak steady stresses at several locations on the compressor blade). Based on peak stress locations, design space definitions were created. ANSYS DesignXplorer redefined the CAD model and generated the series of design variations needed to carry out experiments for the entire range of parameters.

## ANSYS Design Exploration

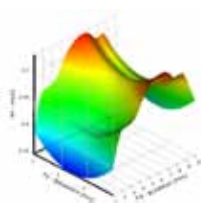
### Parameterized CAD



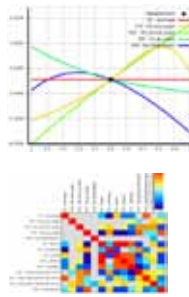
### Design of Experiments



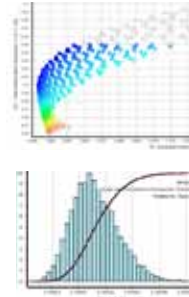
### Response Surface Methods



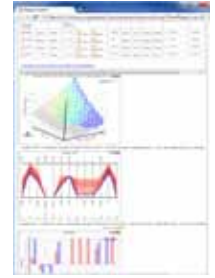
### Sensitivity/Correlation Analysis



### Optimization/Robust Design/Six Sigma



### Report Generation



Pre-Processing

Simulation

Post-Processing

Archive

## Other ANSYS Engineering Simulation Capabilities

### CAD



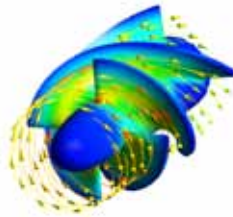
ANSYS DesignModeler and ANSYS SpaceClaim DirectModeler provide modeling and geometry creation functions as well as tools for importing CAD data from various sources. In addition, we collaborate with leading CAD developers to ensure an efficient workflow.

### Integration



ANSYS Workbench is the framework for the industry's broadest and deepest suite of advanced engineering simulation technology. It delivers unprecedented productivity, enabling Simulation-Driven Product Development.

### Multiphysics



To help ensure a successful product, R&D teams must accurately predict how complex products will behave in a real-world environment. The ANSYS suite captures the interaction of multiple physics: structural, fluid dynamics, electro-mechanics, and systems interactions. A single, unified platform harnesses the core physics and enables their interoperability.

### HPC



High-performance computing enables creation of large, high-fidelity models that yield accurate and detailed insight. ANSYS offers scalable solutions and partners with hardware vendors to ensure that you get the power and speed you need.

### Data Management



ANSYS EKM addresses critical issues associated with simulation data, including backup and archival, traceability and audit trail, process automation, collaboration and capture of engineering expertise, and IP protection.

Überreicht durch:

**CADFEM<sup>®</sup>**

**Simulation ist mehr als Software<sup>®</sup>**

Geschäftsstellen in Grafing bei München, Berlin,  
Chemnitz, Dortmund, Frankfurt, Hannover,  
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Competence Center FEM

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ANSYS is dedicated exclusively to developing engineering simulation software that fosters rapid and innovative product design. Our technology enables you to predict with confidence that your product will thrive in the real world. For more than 40 years, customers in the most demanding markets have trusted our solutions to help ensure the integrity of their products and drive business success through innovation.

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