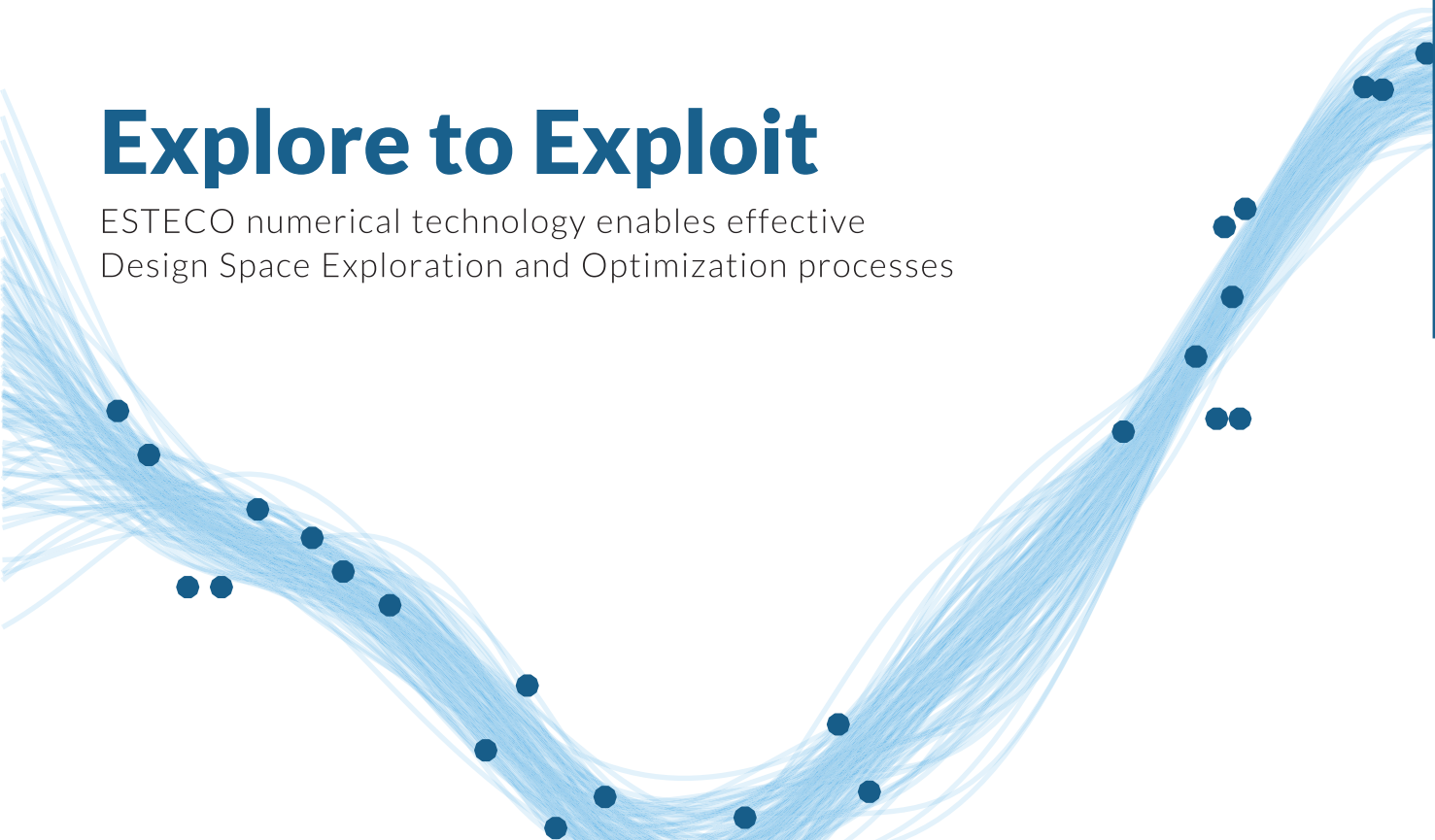




# Explore to Exploit

ESTECO numerical technology enables effective Design Space Exploration and Optimization processes



**Product innovation is all about finding the balance between designer creativity and product performance: exploration is the starting point.**

There are many different ways to start investigating the possible options when approaching the design of new products or systems. However, an in-depth understanding of the design space and the automation of the engineering process - all supported by advanced analytics and prediction tools - are essential to ensuring successful and sustainable engineering innovations, both when starting from scratch and when drawing from previously acquired experience.

Used across all industries and simulation disciplines, the ESTECO numerical technology has evolved to respond to the most varied needs of designers based on the problem at hand. Simulation models used for virtual prototyping can express an extremely varying range of characteristics in terms of: assumptions on model linearity, problem dimension (variable number), complexity - represented by both the number of objectives / constraints and number of disciplines involved - minimum reliability level accepted, variable type (discrete, continuous, categorical) and many more aspects.



**With more than 15 years' experience, ESTECO supports leading organizations in designing the products of the future, today.**

modeFRONTIER and VOLTA are products of ESTECO SpA



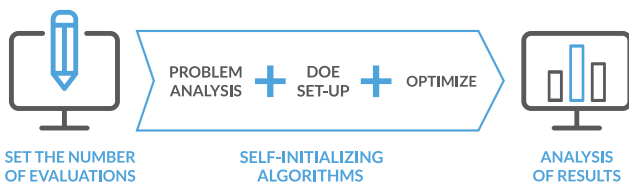
## FACING UNKNOWN CHALLENGES

When approaching new design challenges or time to deliver keeps shrinking, design exploration automation becomes the essential tool to succeed in improving product performances. The new self-initializing algorithm family helps teams set up an initial investigation of the design space when little knowledge is available or rapidly identify promising design solutions.

## NEW SELF-INITIALIZING ALGORITHMS

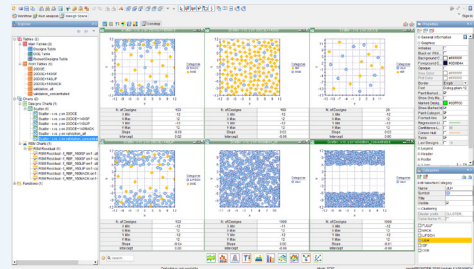
Teams can now get their optimization projects on the fast track exploiting the single-parameter setup of the classic ESTECO algorithms.

MOGA-II, NSGA-II, MOPSO, HYBRID, SIMPLEX, ARMOGA, MOSA and Evolution Strategy can now be exploited in the self-initializing mode, where the algorithms analyze the problem characteristics, automatically generate the most suitable DOE and start searching for optimal solutions. All by setting a single parameter: the number of evaluations.



## SEARCH DEEP DESIGN SPACE

A comprehensive understanding of the design space is an iterative process. The ESTECO numerical expertise delivers a wide range of DOE algorithms and fillers, along with surrogate methods to increase the amount of knowledge of complex engineering problems and thoroughly explore all design options before assessing the performance.



## ADAPTIVE SPACE FILLER

Limited computational resources and small experimental datasets are often an issue: space filling algorithms are the best suited option to increase design space knowledge. The Adaptive Space Filler (ASF) combines state-of-the-art space filling strategies with the predictive ability of response surfaces. The space filler iteratively adds points to the design space and uses them to train and constantly improve the accuracy of an RSM based on one or more user-defined criteria. ASF masters the design space exploration by building a finely distributed DOE dataset and at the same time by training a reliable RSM for RSM-based optimization or further design space investigation.

## EXPLORE + EXPLOIT IN ONE CLICK!

### STEER YOUR OPTIMIZATION THE SMART WAY

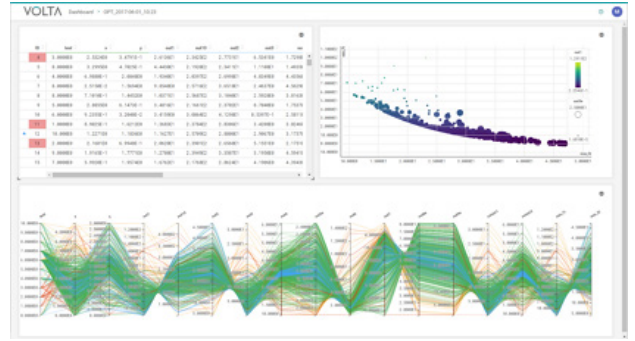
The proprietary ESTECO algorithm encloses multiple numerical investigation strategies to offer a smart exploration of the design space.

Designers benefit from its search capabilities in multiple scenarios. being this a first, explorative concept phase, or when little knowledge about variable behavior / problem characteristics is available or when resources, both in terms of computational capability and time slots, are scarce.

- Make the best out of time and computational resources available exploiting the internal adaptive algorithm strategy
- generate new design ideas
- rapidly identify variable correlations
- set up an initial investigation of the design space when little knowledge is available
- identify promising areas of the design space to be further exploited

## AFTER EXPLORING, EXPLOIT

After exploring and understanding relations underlining the Design Space, engineers have at their disposal a wide selection of innovative algorithms to further refine their designs and identify optimal candidate solutions. The suite of ESTECO optimization algorithms are shaped to respond to different design needs and tackle both discrete and continuous variables to solve single and multi-objective problems. On top of the reliable implementation of traditional methods consolidated by the engineering practice, ESTECO offers sophisticated multi-strategy algorithms that boost engineers' knowledge with advanced artificial intelligence.



Parallel coordinate charts helps reveal interesting patterns in complex data, filters let you explore multidimensional spaces

## UNLEASH THE POWER OF RSM

The ESTECO optimization platform generates reliable meta-models effective in approximating the multivariate input/output behavior of complex systems with no computational effort. The training, validation, and screening tools help create the most accurate model choosing from a wide range of methods. By evaluating the accuracy indicators, comparing surfaces and contextually understanding variable correlations, experts can focus on RSM tuning while the entire team benefits from model re-use.

ESTECO RSM algorithms unlock

- hundreds of experiments performed in seconds
- superior accuracy of metamodels with the Validation tool
- single-click switch from RSM-based to direct optimization
- export to the Functional Mock-up Units (FMUs) format, to be embedded into any third-party systems simulation software
- import of in-house methods and re-use of RSMs
- easy and quick wizard-based set-up and supervised model training

## FINE-TUNED MULTI-STRATEGY OPTIMIZATION ALGORITHMS

Besides the traditional methods, ESTECO provides fine-tuned multi-strategy optimization algorithms able to multiply the capabilities of single approaches. Engineers are able to combine powerful optimization methods to further reduce the time and effort required to complete the design cycle.

**FAST** | accelerates the process by exploiting RSM performance over the region of most interest in the Design Space, reaching a high-speed detection of the optimal solutions.

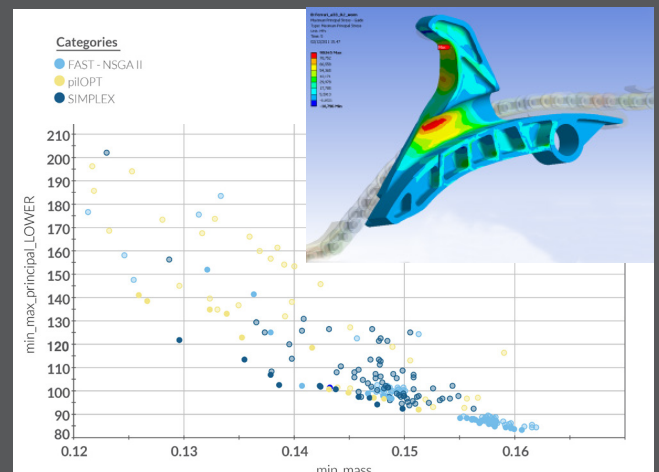
**HYBRID** | automatically combines the robustness of Genetic Algorithms with the accuracy of Gradient methods, providing an unprecedented balance between exploration and refinement capabilities.

**SAnGeA** | provides an automatic screening phase, coupled with a Genetic Algorithms global search phase, reliably identifying the most meaningful variables to face high-dimension and unconstrained problems.

## BORGWARNER GOES FULL SPEED WITH PILOPT

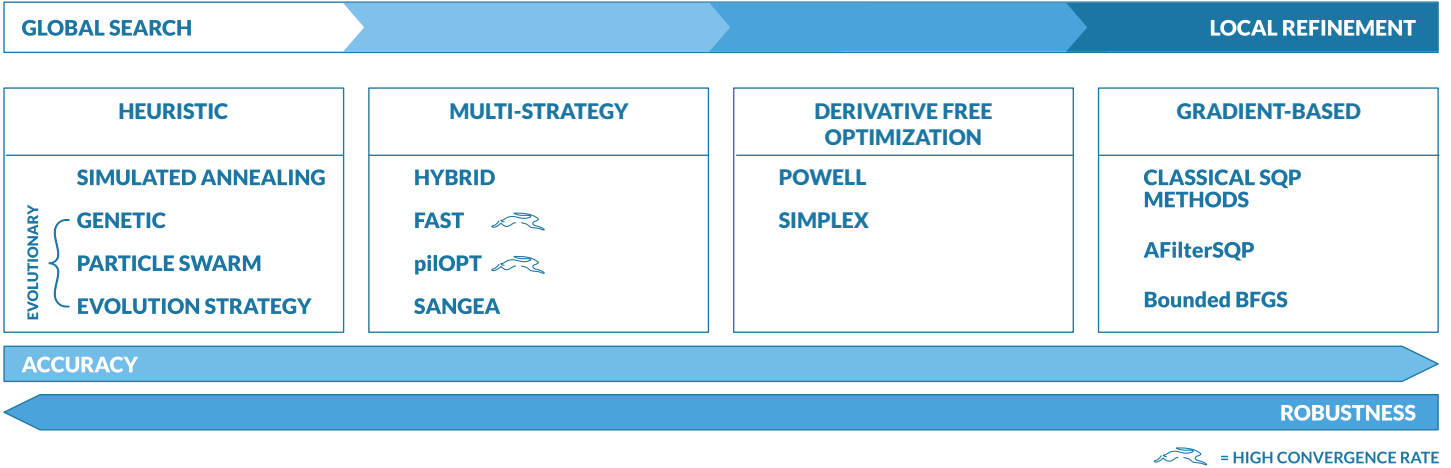
Borg Warner, the automotive component and parts giant, used modeFRONTIER optimization and integration capabilities with ANSYS Workbench and ANSYS Mechanical to improve the tensioner arm for a Ferrari V8 engine (California and 458 Italia) and a FIAT Punto engine.

ALGORITHM CHOSEN	OBJ 1: MINIMIZE MASS	OBJ 2: MINIMIZE STRESS	NUMBER OF EVALUATIONS
BASELINE	151g	90.9 Mpa	-
SIMPLEX	153g (+1,3%)	69 Mpa (-24.1%)	110
FAST-NSGA II	153g (+1,3%)	62.5 Mpa (-31.2%)	576
PILOPT	149g (-1,3%)	68 Mpa (-25.2%)	50



# A FULL COLLECTION OF BEST-IN-CLASS ALGORITHMS

The unique expertise of ESTECO in the field of numerical methods for design optimization is made available through its software solutions, empowering companies to improve their product development process. With the all-encompassing set of Design of Experiment (DOE) and Optimization algorithms, engineering teams find crucial support to their Design Space Exploration and Optimization processes. Discover the full list of powerful ESTECO algorithms created to enable optimization-driven design.



“ The use of MOGA-II algorithm allowed to compute and test 50,000 different geometries in about 5 days to achieve a satisfactory Pareto convergence starting from a set of 48 blade parameters to alter the reference propeller geometry ”

**MICHELE VIVIANI**  
 Associated Professor,  
 GENOA UNIVERSITY

## EXPLORE DESIGN PERFECTION

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ESTECO is an independent technology provider delivering first-class software solutions aimed at perfecting the simulation-driven design process. With more than 15 years' experience, the company supports leading organizations in designing the products of the future today.

Our smart engineering suite brings enterprise-wide solutions for design optimization, simulation data management and process integration and automation.

